



Astronomy and the ‘National Calendar’ of India

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Abstract

The sun, the moon and the wonder of the night sky led to the ‘growth of ‘astronomy’, and later to the development of the calendrical system. The different festivals as well as various other social events are celebrated in different countries based on their respective calendrical systems. These different customs, in turn, have provided distinct identities to these different societies.

While India has given much to the rest of the world in the realm of the calendrical system, she has herself been influenced by them. The paper below provides an overview of the same and has been divided - besides 'Introduction' and 'Conclusion' - into sections such as: a. Primacy of ‘lunar’ calendar in the Indian calendrical system, b. Greek influence on the Indian calendrical system, c. Pre-Islamic, Islamic, and Parsi calendars, d. Calendar Reforms Committee and the National Calendar of India.

1. Introduction

The sun, the moon and the wonder of the night sky led to the interest of mankind in the study of ‘astronomy’. The apparent movement of the sun around the earth, the phenomenon of sunrise and the setting sun as well as the different phases of the moon all contributed to the growth of ‘astronomy’. Since these celestial bodies are always in movement and exhibit quite a regular pattern, ‘time’ becomes a useful construct to measure ‘motions’ and ‘activities’ as well as to sequence events.

The occurrence of an event with respect to ‘time’, however, is also related to ‘space’. The same event will be recorded to have happened at different times from different places. ‘Time’ is thus relative to the ‘space’ from where it is being measured. According to the

theory of 'special relativity' therefore, it is 'space-time', which is the true measure of events in the cosmos.

Notwithstanding such a nuance, 'time' as we experience in our daily lives helps in understanding the past, the present and the future. *Life is, furthermore, lived in a cycle of time from day to day and from year to year.* When seen in this light, the invention of the 'calendar' enabled mankind to organize life better. It has helped to plan better, for instance, in agriculture and industry, in civil administration as well as in fixing days of social festivals etc. The Babylonians are credited to be the first people to have originated the (annual) calendar. India also contributed to the development of calendar in her own way.

It is worth recognizing that *formulating an annual calendar* – for the next year – in ancient India involved careful observations of the movement of the moon, the sun, the earth, and the constellation of stars in the night sky. It appears that five yearly observations of the previous five years were compiled of the relevant parameters and their averages computed to arrive at the expected results for the next cycle of seasons and months. All this required complex calculations regarding the position of the earth, the sun, and the moon.

2. Primacy of 'lunar' Calendar in the Indian Calendrical system

Calendar was very much in use in ancient India and gets mentioned in the Rig Veda. *It was the lunar calendar that was followed.* Moon occupied an important place in this calendrical system on account of its proximity to earth. A month comprised 29-30 lunar days.

As the lunar month comprises the two phases of 'Shukla Paksha' (waxing moon) and 'Krishna Paksha' (waning moon) of fifteen days each, the lunar month was counted either from new moon to new moon (Amavasya-ant – '*amanta*' month) or from full moon to full moon (Poornima-ant – '*poornimanta*' month). The lunar day was measured from moonset to moonset during 'the Shukla Paksha' and from moonrise to moonrise during 'the Krishna Paksha'.

The fifteen days ('Tithi') identified with each phase of the waxing ('Shukla Paksha') and waning moon ('Krishna Paksha') are known as 'prathama', 'dwitiya', 'tritiya', 'chaturthi', 'panchami', 'sashthi', 'asthami', 'navami', 'dashmi', 'ekadasi', 'dwadashi', 'tryodashi', 'chaturdashi' and 'Poornima' or 'Amavasya'. Generally, every second day of 'dwitiya', 'panchami', 'asthami', 'ekadasi', 'tryodashi' and 'Poornima' or 'Amavasya' were considered auspicious for 'fasting' or for any 'vrat'.

The duration of 'Tithi' is, however, not the same as a solar day. It is generally smaller than a solar day, but sometimes longer as it varies from 20 hours to 26 hours due to the irregularity of the motion of the moon. 'Tithi' begins from the first day of the waning moon under the 'amanta' month and from the first day of the waxing moon under the

'purnimanta' month. Every next 'Tithi' begins when the moon is ahead of the movement of sun by 12 degrees in the geocentric orbit. The 'Tithi' was, furthermore, divided into 30 'Muhurtas' of 48 minutes each.

The constellation of stars (asterism) called 'Nakashtras', with respect to the moon's movement in the sky, distinguish one lunar month from another. The whole night sky was accordingly divided into 27 divisions *equal to the number of days taken by the moon to orbit the earth*. The sighting of the different 'Nakashtras' was done at dawn, that is, immediately before the sun rise. The 'Nakashtras' were, furthermore, named after the most prominent star ('Yogtara') in the constellation.

The names of the different 'Nakshatras' being: 1. Ashwini, 2. Pushya, 3. Uttara Phalguni, 4. Dhanishta, 5. Purva Bhadrapad, 6. Vishakha, 7. Uttar Bhadrapada, 8. Shatabish, 9. Hasta, 10. Krithika, 11. Mrigshirsh, 12. Purva Phalguni, 13. Purva Ashadh, 14. Adra, 15. Revati, 16. Rohini, 17. Chitra, 18. Ashlesha, 19. Anuradha, 20. Shrivana, 21. Bharani, 22. Jyestha, 23. Punarvasu, 24. Magh, 25. Swati, 26. Moola and 27. Uttar Asadh.

The twelve months of the year were given their names after the 'Nakashtras'; however, since there were 27 'Nakashtras', some of them were dropped to make up the final list of 12 months. The twelve months being: 1. Chitra (Chaitra), 2. Vaisakh, 3. Jyestha, 4. Asadh, 5. Sravana, 6. Bhadra, 7. Asvina, 8. Kartika, 9. Mrigshirsa, 10. Pausa, 11. Magh and 12. Phalgun.

Since the lunar year of twelve months constituted only 354 days – falling short of 365 days of a solar year by around 10 days, it was made compatible with the solar year by adding a 'adhikmas' ('malmas') of 30 days after every three years. To this extent, the calendrical system in use was a lunar-solar calendar. The four days of vernal equinox, autumn equinox, summer solstice and winter solstice heralding the different seasons occupied a very important place in this lunar-solar calendar.

2.1 The first month of the year in the lunar-solar calendar

During the period of the '*Brahmanas*' and the '*Vedanga Jyotisa*' (1500 to 100 BCE), the first month of the year began during the spring season around the 'vernal equinox' (March 21-22 in the Gregorian calendar). It has left behind the legacy of new year's celebrations around this period in the Indian sub-continent, such as 'Holi' (in most parts of north India), 'Rongali Bihu' (Assam), 'Pohala Baisakh' (Bengal), 'Vaisakhi' (Punjab), 'Gudhi Parwa' (Maharashtra), 'Ugadi' (Karnataka, Telangana, Andhra Pradesh), Puthandu (Tamil Nadu) and Navreh (Kashmir).

Perhaps, the most ancient of these new year's celebrations 'Holi' – the festival of colours – takes place closest to the 'vernal equinox' and is preceded by 'Holika Dhan', which marks the end of the preceding year. 'Holika Dhan' occurs on 'Phalgun Purnima' in the lunar-solar calendar; the succeeding first day of Krishna Paksha ('Krishna Prathama') in

the lunar month of Chaitra is 'Holi', which symbolizes the New Year. 'Holika Dhan' – *when bonfire is made* – symbolizes the destruction of all bitterness towards others that may have crept up during the year gone-by.

Over a period of several millennia this gave rise to different folk lore such as the day when the god of love 'Kamadeva' shot his arrow at 'Shiva' lost in his meditation; angered Him and was reduced to ashes! 'Shiva' is also known as 'Somnath', that is, lord of the moon and is depicted in images as wearing the crescent moon in His hair.

The other important festival of 'Deepawali' – the festival of lights – is celebrated during the night on 'Amavasya' or on the 'new moon day' in the lunar-solar month of Kartik. Deepawali, similarly, got associated with the day Sri Ramchandra (incarnation of 'Vishnu') – *God incarnate in human form* – returned to Ayodhya after killing the demon king Ravana.

By the time of the rise of '*Siddhanta Jyotisa*' (100 to 400 C.E.), however, there appears a change regarding the reckoning of the first month of the year, which got shifted to the 'winter solstice' when the day is the shortest in the northern hemisphere. The first day of the year, that is, December 22 of the Gregorian calendar marked thus the ascendant sun or the sun in 'the Uttarayan' with the days becoming longer every next day until June 21 (summer solstice).

3. Greek influence on the Indian Calendrical system

The political vacuum created by the decline of the Mauryan empire led to the Bactrian-Greeks making inroads into India. Between 100 to 300 C.E., north-west India saw the rule of the Bactrian-Greeks who were subsequently defeated by the Parthians who, in turn, were later ousted from the modern-day Afghanistan (known earlier as 'Sakasthan') by the Sakas who belonged originally to Central Asia. All these successive dynasties used Greek as their language and were influenced by the Greek astronomy.

One of the 'satraps' (provinces) of the Sakas extended to Central India with Ujjain as their capital. It is here that the Greek calendrical system and the Indian system got intermingled. The 'Julien' (Roman) calendar, which was based on the Greek calendrical system of 365 days comprised twelve months of either 30, 31 or 28 days. One more day was added every four years known as 'the leap year'.

3.1 Introduction of the 'sidereal solar year' in the Indian calendrical system

This intermingling also saw the introduction of the 'sidereal solar year' in the Indian calendrical system. While the 'geocentric solar year' refers to the position of the earth in its annual revolution on the ecliptic with the same orientation with respect to the sun (vernal equinox to vernal equinox), the 'sidereal solar year' refers to the earth coming back to the same point in its annual revolution with respect to the constellation of stars ('the tropical Zodiac').

Both these years were thought to have the same number of days; however, there exists a difference between the two. While the number of days in a 'sidereal solar year' is equal to 365.25636 days, it is equal to 365.24219 days in a 'geocentric solar year'. The 'geocentric solar year' is thus marginally shorter than the 'sidereal solar year'. Such a difference between these two years arises on account of the tilt of the earth on its axis by 23.4 degrees.

Over a period of 72 years this difference leads to a difference of one day between a 'sidereal solar year' and a 'geocentric solar year'. After 720 years, therefore, this turns into a difference of 10 days. It was noticed by the Christian Church, for instance, that after a passage of around 'a millennium' the date of 'Easter' – the most celebrated festival of the Christians – was no more falling in the spring season according to the 'Julian' calendar'.

It is worth mentioning that the 'Julien Calendar' was introduced by Julius Caesar throughout the Roman Empire in 46 BCE after his victory of Egypt in 47 BCE and on the advice of Greek astronomers of Alexandria. After a lapse of more than a millennium, the Christian church felt the need to set up a Calendar Reform Committee to investigate into the discrepancy between the observed seasons and the day of 'Easter' based on the rules of the 'Julien Calendar'.

On the advice of the Committee, subsequently, the Julian calendar was advanced by 10 days in 1582 to make it compatible with the 'geocentric solar year' and the reformed calendrical system came to be known as 'the Gregorian calendar' after the name of the then Pope of the Christian Church.

3.2 The western (tropical) 'Zodiac' and the Hindu 'Panchang'

The 'sidereal solar year' mattered in the Greek calendrical system due to the importance of 'the Zodiac' in their astrology. The night sky was divided into a 360 degrees circle and divided into 12 divisions of 30 degrees. A month was equal to the number of days the Sun took in passing the 30 degrees distance on this celestial circle ($12 \times 30 \text{ degrees} = 360 \text{ degrees}$), beginning from the initial point.

The constellation of stars (the Tropical Zodiac), which the Sun passed in its apparent movement around the earth were known as 1. Aries, 2. Taurus, 3. Gemini, 4. Cancer, 5. Leo, 6. Virgo, 7. Libra, 8. Scorpius, 9. Sagittarius, 10. Capricornus, 11. Aquarius, and 12. Pisces.

The Indianized names of these clusters of stars are: 1. Mesh, 2. Vrushabh, 3. Mithun, 4. Kark, 5. Sinh, 6. Kanya, 7. Tula, 8. Vrushchik, 9. Dhanu, 10. Makar, 11. Kumbh, 12. Meen respectively. A man's destiny was said to be based on the position of the planets in the different Zodiac signs at the time of his birth.

While the position of the earth with respect to the sun and the planets was taken to be changing from one solar day to another, its position with respect to the constellation of

stars was taken to have the same pattern year after year during the earth's annual revolution around the sun. All astrological calculations were based on this premise, until the knowledge of the earth's 'precession' on its axis.

It is common knowledge that the earth rotates on its axis in 24 hours – causing day and night – and revolves around the sun in around 365 days. Moreover, since earth is tilted on its axis by 23.4 degrees with respect to earth's orbital plane, the sun's rays do not fall on the earth equally and give rise to different seasons in a year. This tilt also determines the direction of earth's axis vis-a-vis the clusters of stars. However, very little was generally known about earth's axial precession in ancient times.

Moreover, since the earth is observed to also wobble slightly on its axis like an off-spinning toy top, it does not follow a fixed pattern year after year in its relation to the constellation of stars. 'The trend in the direction of this wobble relative to the fixed positions of stars is known as axial precession' and the possibility of the earth returning to the same position with respect to a particular constellation of stars is around 26,000 years in the cycle of axial precession! (NASA, 2020: "Milankovitch Orbital Cycles and Their Role in Earth's Climate").

It was, therefore, pointed out that while a child's birth chart ('horoscope') showed him in the Zodiac of 'Aries' on the premise that the earth's position with respect to the cluster of stars is fixed, in reality 'Aries' had moved eastward, and the child's Zodiac was truly 'Pisces'. When the Greek astrologers came to realize this, they came up with the theory of 'trepidation' arguing that precession is 'oscillatory', and the old position will soon be once again restored. They were, however, proved wrong as the change is 'unidirectional' and 'accumulative', and overtime shows a big difference between the 'solar year' and the 'sidereal year'.

In the meantime, the Greek calendrical system got the support of the 'Siddhantic Jyotisa' school in India, which led to the introduction of the 'sidereal solar calendar' into India. This was followed by the introduction of western astrology into India. To the twelve cluster of stars and the moon, the sun, the five planets (Mercury, Venus, Mars, Jupiter, Saturn) were added 'Rahu' and 'Ketu' – the 'Navagrahas' – which together determined the 'Rashi' in the Indian 'astrology'.

The Hindu 'Panchang' ('almanac'), today, has thus the five limbs of 'Tithi', 'Nakashtras', 'Var' (weekdays), 'Yog' and 'Karan'. The last two ('Yog' and 'Karan') in 'the Panchang' have significance with reference to the planetary positions, the constellation of stars and their conjunctions to each other, and these together are claimed to influence people's lives on earth. Besides making 'the horoscope' of a child, marriages also came to be fixed in India based on proper matching of the horoscopes of the boy and the girl.

Gautam Budha was very critical of 'astrology' as he was against all kinds of miracles. Even Kautilya's Arthashastra does not approve of it. Astrology was, therefore, shunned during

their times. However, by the time we come to the 10th century C.E., we find that 'astrology' had become an integral part of the Indian society. This is corroborated from the first-hand accounts of Alberuni, as provided in his scholarly work 'Tahqiq Ma-lil-Hind'. He mentions that astrologers having knowledge of astronomy were highly respected in society. India, since then, has not changed much in these last one thousand years.

3.2.1. Hindu 'Panchangs' and the loss of the 'cosmic connection'

Since most of the schools of 'the Hindu Panchangs' abide by the rules of the 'nirayana system', which does not recognize the effect of earth's precession on its axis, the dates of different festivals recommended by them have not been falling in the same seasons as in the past. On independence, Prime Minister Jawaharlal Nehru, therefore, set up the Calendar Reforms Committee in 1952, under the chairmanship of Professor Meghnad Saha to examine the various calendrical systems in use in India.

The Committee went into the details and found that the value of 365.258576 days in a year as calculated by 'Surya Siddhanta' that was followed by the 'nirayana system' is even larger than the correct sidereal value of days in a year by 0.016560 days. The Committee, furthermore, observed, 'As the value is still used in almanac framing, the effect has been that the year-beginning is advancing by 0.165 days per year, so that in course of nearly 1400 years, the year beginning has advanced by 23.2 days, so that the Indian solar year, instead of starting on the day after the vernal equinox (March 22) is now starting on April 13'.

Similar criticisms have been made by others as it was pointed out that 'Makar Sankranti is celebrated 23 days after the shortest Earth Day of the northern hemisphere' (Patrizia Norelli-Bachelet, 2002). It was also remarked that 'India has lost its cosmic connections' (ibid). The Calendar Reforms Committee also observed that 'in continuing to follow the nirayana system, the Hindu calendar makers are under delusion that they are following the path of Dharma. They are committing the whole Hindu society to Adharma'!

3.3 Introduction of 'Era' (Samvat) in the Indian Calendrical system

The zero year or the first year in the chronology of years in India began generally with the coronation of a king. Accounting of the zero year was, therefore, 'regal' in character and did not provide data for an extended period of the annual movements of the celestial bodies for a careful study. In this respect, the Indian calendrical system lagged others.

The Greeks followed their Olympiad Calendar, and the successive years were counted from the pan-Hellenistic event of the athletic contest beginning from 776 B.C.E. This enabled the study of a much longer period of the movements of celestial bodies. This concept of 'era' also got introduced in India consequent to the Indian contact with the Bactrian- Greeks. It saw the beginning of the 'Saka era' into India. Later, other eras like 'the Vikram Samvat' took roots in India.

4. Pre-Islamic, Islamic, and Parsi calendars

The pre-Islamic calendars such as those of the Jews were also **lunar-solar calendars**; the difference between a lunar year comprising 354 days and a solar year comprising 365 days was made compatible by adding an intercalary week, fortnight, or month after a given number of years. However, since this addition was not generally known to the public – *and the intercalary week, fortnight or month was considered inauspicious for holding any event or for having any festivals* – it created difficulties for the Arabs who gathered in Mecca for their annual Hajj pilgrimage and discovered that they had arrived during an intercalary week, fortnight, or month.

The Hajj pilgrimage is a pre-Islamic custom of Arabia and is also one of the five injunctions (pillars) of Islam. To remove the difficulty of the pilgrims arising from the intercalary period, it is claimed, Prophet Mohammed prohibited ('nasi') the practice of intercalation. The Islamic calendar, therefore, **is purely a lunar calendar**. Consequently, the cycle of (Islamic) lunar year advances every next year vis-a-vis the (geocentric) solar year by 10-11 days.

Each month, in the Islamic calendar, begins with the observation of one (waning) crescent moon and ends with another (waning) crescent moon, and comprises 29-30 days. *The day begins and ends at sunset under the Islamic calendar*. Weekdays are specified by number, with day one corresponding to Saturday night and Sunday daytime. Day 6 is called 'Al-Jumma', which is the day of congregational prayer. It begins at sunset on Thursday and ends at sunset on Friday. Al-Sabt is the seventh day beginning from Friday night to Saturday daytime.

4.1 The solar calendar followed in Iran and Afghanistan

The Republic of Iran and Afghanistan, although being predominantly Muslims, follow the Solar Hijri calendar. As such, although the 'epoch' or the first year of this calendar begins with the year of migration of Prophet Mohammed and his followers from Mecca to Medina, *the Iranian calendar (including those in Afghanistan) is purely a (geocentric) solar calendar based on observations of the celestial movement of earth around the sun*. It comprises 365 days and twelve months. The first month of the year (*Farvardin*) begins with the spring season (March-April). The festival of 'Nowruz' marks the beginning of the 'new year, which is also celebrated by the Parsis of India as well as by the Shia Muslims all over the world.

5. Calendar Reforms Committee and the National Calendar of India

The Calendar Reforms Committee submitted its report to the Government of India in 1957, which was approved by both the Houses of the Parliament in the same year. India, therefore, has an Indian National Calendar ('Bhartiya Rastriya Dindarsika') today and is used for all civil purposes. It is a (geocentric) solar calendar; the length of a day is from sunrise to sunrise of 24 hours.

This is different from the Gregorian calendar where the day starts from midnight at 12.00 A. M. The timings for all-India – **the Indian Standard Time (IST)** – is based on the local meantime of the Central Station of India situated at Ujjain (82 degrees 30 minutes longitude east of Greenwich and 23 degrees 11-minute north longitude).

The year comprises twelve months; while five months have 31 days each, seven months have 30 days making it a total of 365 days. The 'new year' begins with the month of Chaitra (March 21- April 21) in the spring season. (This is different from the Gregorian Calendar which has January as the first month).

The other months being Vaisakh (April 21-May 21), Jyestha (May 22-June21), Asadh (June22-July 22), Shravana (July23-August22), Bhadra (August22-September22), Ashwin (September 23- October 22), Kartika (October23-November 21), Pausha (December 22-January 20), Magha (January 21- February 19) and Phalgun (February 20 -March 20).

One more day is added to the month of Chaitra during the leap year. The Indian National Calendar has, furthermore, adopted the 'Saka' era for chronological history. **The Committee did not favour the 'lunar' or the 'luni-solar' calendar on account of the difficulty in calculating days and months.** Neither did it favour the 'sidereal solar calendars' followed by the different calendrical (Panchang) schools of India.

In respect to declaring the dates of different Hindu festivals, however, it continues to follow the 'lunar-solar' calendar in accordance with the Hindu Panchangs. The *Positional Astronomy Centre (Government of India), Kolkata* has, therefore, been bringing out an all-India Nirayana Solar Calendar since April 2004 – also known as '**Rastriya Panchang**' – to meet the requirements of the different schools of the Panchang creators.

In regard to Muslim festivals, the dates of religious festivals are fixed based on the 'lunar calendar'. The *Gazette of India*, moreover, uses the National Calendar along with the Gregorian calendar.

6. Conclusion

It is well acknowledged that India had achieved great heights in the past in the realm of astronomy. The Indian pundits (scientists) were, therefore, able to very correctly predict the solar and lunar eclipses. Science has, moreover, grown rapidly in the last five hundred years, post- 'Renaissance' in Europe. This has happened in three steps of: (a) observation, (b) mathematics and (c) verification of results deduced from mathematics. The concepts of 'space' and 'time' likewise have come to occupy new meanings as knowledge has grown. It has also weakened the hold of 'astrology' on the human mind, particularly so in the West. The usefulness of the calendar, nevertheless, continues to be there since life is lived in predictable cycles of different seasons and years.

That the sun, the moon and the different planets affect the earth and lives thereon cannot be denied. There is, therefore, a perpetual need for understanding 'astronomy' better. It

does not help, however, to be dogmatic as it may only lead us astray. At the same time, search for knowledge ought to be pursued in all humility with ‘science’ and ‘spirituality’ working together. Broadly, the approach ought to be to work together with nature, submit to nature rather than ‘to subdue nature’.

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