Indian Calendars

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ABSTRACT

The Indian calendars are interesting, but very complicated. Indians use both solar and lunisolar calendars. The solar calendars follow the sidereal year. The lunisolar calendars are of two types; some have months that run from new Moon to new Moon, while some have months that run from full Moon to full Moon. Leap months are a common feature of these lunisolar calendars. In addition to leap months, the lunisolar calendars sometimes skip months. One lunar month can sometimes overlap three solar months, so the lunar month corresponding to the overlapped solar month is skipped. They also follow the Moon for the days, so sometimes they skip or add days. They are probably the most complicated calendars currently used in the world. There are also several regional variations. Specifically the two types of lunar calendars are used in northern and southern India respectively. Another important highlight is that none of the Indian calendars takes into account the precessional motion of the earth; therefore they have to be adjusted to arrive at the correct results.

SOLAR CALENDARS

The solar year is the time period of the earth's revolution around the sun. If instead of taking the sun as a fixed body, we assume the earth to be fixed, then the sun will seem to be moving around the earth. Therefore, the time taken for the sun to make a complete revolution of the earth and come back to the same reference point in the sky will be the measure of a year. The reference point to which the sun returns every year is fixed in two different ways, which yields different results for the length of the year.

Sidereal or nirayana system

A fixed point on the ecliptic with reference to a background star.

Tropical or sayana system

Any of the two equinoxes or equinoctial points, which for calendarical and astronomical purposes is normally taken to be the vernal or March equinotical point.

Affect of precession

Due to the precessional motion of the earth, under the tropical system the distance that the sun has to travel is reduced to 360°-50".3 every year. And therefore the length of the tropical year is less by about 20min 24.5sec to that of the sidereal year.

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Leap Year in Sidereal system

In a nirayana or sidereal year calendar when the months have a fixed number of days and a normal year has 365 days, to compensate for the left over period of 0.256363 day, there will be continuous leap years, including century years, at intervals of four years, also there will be additional leap years added mathematically added at intervals of 157 years, this can be rounded off to 160 years. This rounding up is probably so that these leap years will not coincide with the usual leap years that are added every four years. If we take a scenario where 4AD was taken to be a leap year, also 2AD was a specially added leap year. If we were to follow a 157 year interval, in the third cycle we get a sum of 316 which is divisible by 4. So now the question is does this leap year contain two leap days? However, if we follow a 160 year cycle, we do not run into the problem.

In India the sidereal or nirayana system is followed by the traditional calendar. It follows the calendarical principles laid down in the ancient astronomical treatise named as Surya Siddhanta. The fixed initial point is the point on the ecliptic which is placed opposite the bright star Chaitra (Spica – α Virgins) located close to the ecliptic. This fixed point is also the vernal equinoctial point of the vernal equinox day of 285AD. Due to the precessional motion the fixed point in the sky which was opposite to the star Chaitra has shifted considerably since 285AD (23°49' on 1ST January 1997).

INDIAN SOLAR CALENDARS

There are twelve **rasis** or zodiacs in the sky. The ecliptic lies in the middle of this zodiac belt. These twelve zodiacs divide the ecliptic into twelve equal arcs of 30° each. In the tropical system the start of these divisions is from the vernal equinoctial point, but in the sidereal system, the start of the divisions is made from the earlier mentioned fixed point from which Mesha rasi (Aries) starts.

The length of the months are based on the time taken by the sun to traverse the respective rasis, which is the period covered from the time at which the sun enters the concerned rasi, to the time it enters the next rasi. The moment at which the sun enters a rasi is known as a Samakranti.

The samkranti however, may take place at any time of day or night. The day of the month of the traditional calendar known as the savanna or panchang day starts with **sunrise**. Therefore, depending on the time of the samkranti and the convention followed to determine the starting day for the month, there are four different conventions for four different regions. The month may commence on the same day as the samkranti, or on the following day, or sometimes in some regions, the day after. Due to the regional variances, sometimes the same month has different number of days in different regions. Also the same month in the same region may have different number days in different years.

REGIONAL VARIATION IN INDIAN SOLAR CALENDARS

There are four different conventions for choosing the starting day1of the months followed in different regions of India.

Orissa School

The solar month begins on the same day when the sun enters the concerned rasi. This convention is followed in Orissa, Punjab and Haryana where solar calendars are used.

Tamil School

When the samkranti takes place before sunset, the month begins on the same day. If it takes place after sunset, the month begins on the next day. Generally followed in Tamil Nadu.

Malyali School

The month begins on the same day if the samkranti happens before aparahna, i.e., before $3/5^{th}$ Of the time from sunrise to sunset. Otherwise, it begins on the next day. Generally followed in Kerala.

Bengal School

When a samkranti takes place between sunrise and the following midnight, the solar month begins on the next day, and when it begins after midnight, the month begins on the day following the next day, that is, on the third day. This is the general rule, and in some special circumstances, there are some deviations from this rule. Generally followed in Bengal, Assam and Tripura

LUNISOLAR CALENDAR

The lunar month counted from new moon to new moon is known as amanta and lunar calendar based on this month is called amanta calendar. When the month is counted from full moon to full moon it is known as purnimanta and the respective calendar as purnimanta calendar.

As the lunar year is shorter than the solar year, and is kept adjusted to the latter by the addition of intercalary months at intervals. The starting day of the lunar year will differ from year to year and will oscillate between the days of March and April. This is because Chaitra generally covers the period from 15^{th} March to 13^{th} April.

Amanta Lunisolar Calendar

The amanta calendar is also known as mukhyamana (mukhya meaning primary), especially in the north, because even where purnimanta calendar is followed, the amanta calendar is used to fix the dates of festivals.

The amanta lunar calendar starts from the Chaitra. The months of the amanta lunar calendar are named after the solar months in which the new moon of the lunar month occurs.

The months are divided into two parts – Sukla paksha (bright half of the month), covering the time period from new moon to the next full moon, and Krishna paksha (dark half of the month), covering the period from full moon to the next new moon.

Tithi

Tithi is the time during which the moon gains successively 12° or its integral multiples. There are 30 tithis, of which 15 are Sukla paksha and 15 are Krishna paksha. Tithis are serially numbered 1 to 15, and are suffixed 'S' – Sukla (bright half of the month) or 'K' – Krishna (dark half of the month).

The days of the months of the lunar calendar are numbered in accordance with the serial number of the Tithi prevailing at sunrise.
As the motion of the moon is not steady, the duration of a Tithi may vary from 19.98 hours to 26.78 hours. This sometimes results in a Tithi period covering two successive sunrises, or falling between these, i.e. not covering any sunrise. When this happens there is a break in the counting of tithis because one Tithi will be repeated and one will be omitted.

Adhika month

In the Indian lunisolar calendar the intercalary months are not added in a mechanical manner. The Indian astronomers devised a method which uses the true positions of the sun and moon to add the intercalary months. When two new moons occur within one solar month then two lunar months occur with the same name based on the solar month. The first lunar month of the two is prefixed with the title 'Adhika' or 'mala' and is considered as an intercalary month. The second one starting from the next new moon is prefixed 'suddha' and this latter month is considered to be the true or normal month.

Under the above system intercalary months occur at an interval of 2 years 11 months, 2 years 10 months, or 2 years 4 months. The average time interval works out to be 2.7 years which is the theoretical average time interval for occurrence of such months.

Kshaya month

It may happen that a lunar month will completely overlap any of the short three nirayana solar months of Agrahayana, Pausha and Magha. In this case, no new moon will occur in that overlapped solar month, and thus there will be no lunar month named after this solar month. There would be a missing or 'Kshaya' month in the lunar year. This might occur at intervals as close as 19, 46, 65, 76, 122 and 141 years.

When such a Kshaya month occurs in a lunar year, there will always be two Adhika lunar months in that period, one before and after the Kshaya lunar month. One of these two Adhika months is treated as an intercalary month and other one as a true month.

JAVA PROGRAM

A JAVA program was written to calculate the Solar/Lunar Longitude, the Ephemerical Solar/Lunar Longitude and the Surya Siddhantic Solar/Lunar Longitudes, given one of the following:

Gregorian date
Fixed date
Julian Date
Hindu Amanta Lunar Date
Hindu Solar Date (Orissa School).

The program provides inter-conversions between the above mentioned formats.

The code is an add-on to an applet made by Dershowitz N. and Reingold E.M, and calculates the ephemerical versions of the data where as theirs calculates the Surya Siddhantic version.

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