Calendars

by Suman

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Introduction to Calendar

A calendar is a system of organizing days for social, religious, commercial, or administrative purposes. This is done by giving names to periods of time, typically days, weeks, months, and years. The name given to each day is known as a date. Periods in a calendar (such as years and months) are usually, though not necessarily, synchronized with the cycles of some astronomical phenomenon, such as the cycle of the sun or the moon. Many civilizations and societies have devised a calendar, usually derived from other calendars on which they model their systems, suited to their particular needs.

Our Years

A year, which is approximately 365.24 days – one complete orbit of Earth around the Sun.

A month, which is approximately 29.53 days – one complete orbit of the Moon around the Earth.

Since these time spans are not easily divided, calendars have always been imperfect. Some were rooted in tradition, while others evolved as humankind gained a greater understanding of science and astronomy. Some calendars, like the Christian calendar (which is the primary calendar in use today) focused on the Earth's orbit. Others, like the Islamic calendar, focused on the Moon's orbit. Still others, like the Jewish calendar and Chinese calendar, combine both.

Most calendars are based on astronomical events. From our perspective on Earth, the two most important astronomical objects are the Sun and the Moon, which is

why their cycles are very important in the construction and understanding of calendars.

Our concept of a year is based on the earth's motion around the sun. The time from one fixed point, such as a solstice or equinox, to the next is called a tropical year. Its length is currently 365.242190 days, but it varies. Around 1900 its length was 365.242196 days, and around 2100 it will be 365.242184 days.

Now it may be worthwhile to explain in brief the basic structure of calendars:

The Gregorian Calendar

The Gregorian calendar is the calendar that is used throughout most of the Western world. It began to be used from 1582. It replaced the previous Julian calendar because the Julian Calendar had an error: it added a leap year (with an extra day every four years) with no exceptions. The length of the Julian year was exactly 365.25 days, but the actual time it takes for the Earth to go around the Sun once is closer to 365.2425 days. This difference is just over ten minutes each year.

This made the seasons get out of track, since the real first day of spring in western Europe (the equinox - day and night the same length) was happening earlier and earlier before the traditional March 21 as the centuries went by. By the 1500s, it was starting around March 11, ten days 'too early' according to the calendar. So what they did was to move the calendar forward ten days in 1582, and at the same time to make sure it didn't happen again. To do this, they

made an exception to the previous 'leap year rule' (add February 29 every four years). There would be no February 29 for every year that ends in 00 - unless it could be divided by 400. So the year 2000 was a leap year anyway, because it can be divided by 400, but 2100, 2200, and 2300 will be common years, with no February 29.

It was first suggested by the Neapolitan doctor Aloysius Lilius, and was made official by Pope Gregory XIII, after whom it was named, on February 24, 1582.

The months of the Gregorian calendar year are, in order:

January (31 days)
February (28 or 29 days)
March (31 days)
April (30 days)
May (31 days)
June (30 days)
July (31 days)
August (31 days)
September (30 days)
October (31 days)
November (30 days)
December (31 days)

If February has 28 days, then the year is 365 days long. If February has 29 days, then the year is called a leap year and it is 366 days long. A leap year usually happens once every four years.

But here is a technical problem that a person born as

per Gregorian calendar on 29th february in a leap year, can celebrated his birthday only at 4-years' interevals when a leap years occurs. This view does not appear to be right, if one views the matter in a logical and proper manner, understanding the true scientific meaning of anniversary day.

It should be appreciated that birthdays, wedding days etc. are the anniversary days of the original event. It means that it is the particular day in the cycle of years, when the astronomical circumstances that existed, when the original event happened, are nearly repeated in the best manner, making it the anniversary day of the event. It should be remembered that exact repetition or recurrence of the same circumstances is not possible, and so a day has to be chosen that resembles the original day in the best way.

But how to choose this day? The main markers for measuring time which is ordinarily done by the counting of succeeding days in the eternal flow of time, have been the motion of the two most prominent luminaries in the sky, the Sun and the Moon. The number of days taken by the sun to return to the same reference point in its apparent path in the sky, known as the ecliptic, has been the measure of the year, and a particular day in this cycle is marked by the number of days that have elapsed since the day the Sun has been on the 1st point or reference point. For the sake of easy reference, any particular day is reckoned by pointing to the successive days of the months, twelve of which of nearly equal length make the Year. In this sloar system, a person born on 29th February should celebrate his birthday on 1st march in non-leap years, because it is the 60th day from the start of the year which is the 1st day.

Lunar Calendar

A lunar calendar is a calendar that is based on cycles of the moon phase.[1] The only widely used purely lunar calendar is the Islamic calendar, whose year always consists of 12 lunar months. A feature of a purely lunar year, on the Islamic calendar model, is that the calendar ceases to be linked to the seasons, and drifts each year by 11 or 12 days, and comes back to the position it had in relation to the solar year[2] every 33 or 34 Islamic years. It is used predominantly for religious purposes. In Saudi Arabia it is also used for commercial purposes.

(the lunar calendar used by Muslims; dates from 622 AD (the year of the Hegira); the beginning of the Muslim year retrogresses through the solar year completing the cycle every 32 years)

Lunar Month and Fortnights

The lunar month is divided into two fortnights or Pakshs, and 30 lunar days or "tithis" which is roughly equal to 27 and a half solar days. The Tithi is really expressive of the phase of the Moon and is the longitudinal angular difference between the positions of the Moon and the sun. It is reckoned in units of 12^0 and thus there are 30 Tithis, 15 being the bright half (Sukla Paksha) and 15 being of the dark half (Krishna Paksha). The time period when the Moon

[1] *A lunar phase or phase of the moon refers to the appearance of the illuminated portion of the Moon as seen by an observer, usually on Earth.*

[2] *A solar year (also known as a tropical year), for general purposes, is the length of time that the Sun takes to return to the same position in the cycle of seasons.*

gains 12^0 over New Moon, that is, from 0^0 is Sukla Pratipada (S-1); again the period through which it gains 12^0 to 24^0 is known as Sukla Dwiteey (S-2); and similarly the period through which it gains 180^0 to 192^0 is known as Krishna Pratipada (K-1) and so on. Krishna Paksh starts in the fortnight when the moon wanes (decreases) and ends on Amavasya, when there is no moon. The next day with the beginning of the small new moon the Shukla Paksh starts again , which ends on a the full moon day called Purnima, at the end of the fortnight.

Lunar days of a Fortnight

The 15 days of both the bright and the dark fortnights each month are called as follows:

The first day - Pratipada
Second day - Dvitya
Third day - Tritiya
Fourth day - Chaturthi
Fifth day - Panchami
Sixth day - Shashti
Seventh day - Saptami
Eighth day - Ashtami
Ninth day - Navami

Tenth day - Dashami
Eleventh day - Ekadashi
Twelfth day - Dvadashi
Thirteenth day - Trayodashi
Fourteenth day - Chaturdashi
Fifteenth day of bright fortnight - Purnima
Fifteenth day of dark fortnight - Amavasya

Lunisolar Calendar (Popularly Known as Vikram Samvat)

A lunisolar calendar is a calendar in many cultures whose date indicates both the moon phase and the time of the solar year. If the solar year is defined as a tropical year then a lunisolar calendar will give an indication of the season; if it is taken as a sidereal year* then the calendar will predict the constellation (a constellation is a group of celestial bodies, usually stars, which appear to form a pattern in the sky) near which the full moon may occur. Usually there is an additional requirement that the year have a whole number of months, in which case most years have 12 months but every second or third year has 13 months.

Months of Lunisolar Calendar

In the Indian luni-solar calendric system days are counted on the basis of the Tithi at sunrise. The days are not labeled separately from 1 as in the solar calendar, but

**A sidereal year is the time taken by the Earth to orbit the Sun once with respect to the fixed stars.*

the tithi is their only label. When two successive days have the same tithi, the latter is called an adhika tithi where adhika means "extra". Sometimes, one tithi may never touch a sunrise, and hence no day will be labeled by that tithi. It is then said to be a tithi kshaya where kshaya means "loss".

In India, the birthday anniversary of saints and other great men is generally celebrated on the basis of the luni-solar calendar. For example; Lord Buddhas birthday is celebrated on Vaisakha Purnima day, Bhagavatpads sankaracharya's birthday on Vaisakha Sukla Panchami. Sri Ramakrishna Paramahamsa's birthday on Phalguna Sukla Dviteeya and Lord Chaitanya's birhday on Phalguna purnima Tithi. Again most of the religious festivals are fixed on the basis of the luni-soloar calendar. Hence another method of celebrating one's birthday will be to follow the luni-solar calendar. The dates as per this calendar will oscillate in relation to the solar calendar. It has the slight disadvantage that the actual future dates cannot be forecast without consulting the almanac which is not so in the case of the solar calendar.

The names of the lunar months are derived from nakshatra region in which the Moon is located on **purnima** or the full moon day. The 12 lunar months are and make up the six seasons (Ritu) ::

1.Chaitra (March-April) ..... Vasanta Ritu (Spring)
2.Vaishakh (April-May)
3.Jyeshta (May-June) ..... Greeshma (Summer)
4.Aashaadh (June-July)
5.Sharaavan (July-August) ..... Varsha (Monsoon)

6.Bhadrapad (August-September)

7.Ashwin (September-October) ..... Sharad (Autumn)

8.Kaartik (October-November)

9.Margasheersh (November-December) ..... Hemanta (Winter)

10.Paush (December-January)

11.Maagh (January-February) ..... Shishira (Dewey)

12.Phalgun (February-March)

Adhika (Purushottam) Maas

The Names of the Rashis

The Solar Calendar

This begins with Vernal Equinox, on or about March 21. The 12 months, known as the Saur Maas, correspond to the entry of the Sun into the signs of the Zodiac Rashi.

The 12 Rashi (Moon Signs)

1.Mesha (Aries) The Ram

2.Vrishabha (Taurus) The Bull

3.Mithuna (Gemini) The Twins

4.Karkata (Cancer) The Crab

5.Simha (Leo) Lion

6.Kanya (Virgo) The Maiden

7.Thula (Libra) The Scales

8.Vrishchika (Scorpio)The Scorpion

9.Dhanus (Sagittarius) The Bow

10.Makara (Capricorn) The Goat

11.Kumbha (Aquarius) The Pot

12.Meena (Pisces) The Fish

Extra Months

The extra month is known by various name: Adhik Maas, Mal Maas, Purushottam Maas, Malimmacha.

The Sankaranti is the transit of the sun from one Rashi to another, and it takes about 30 days and some more time to travel one rashi. It is possible that in a lunar month there may not be a Sankranti. The successive New moon may occur while the Sun is in a particular Rashi. The lunar month between those two new moons will not have a Sankranti. This phenomenon occurs once in three or four years. Such a lunar month is called Adhika maasa (extra month). It is given the name as the succeeding lunar month. The two consecutive lunar months having the same name are distinguished by adding the prefixes adhika (extra) and nija (proper) respectively to the name of the month. For example, if a lunar month elapsed without a solar transit and the next transit into Mesha Rashi (Aries) then this month without transit is labeled adhik Chaitra. the next month will be labeled according to its transit as usual and will get the epithet nija ("original") or shuddha ("clean").

Lost Months

It is also possible that in a particular lunar month two Sankrantis may occur, i.e. no new moon will occur as the Sun passes through a Rashi. In that event there will be a gap in the sequence of the names of the lunar months.

For example, if the sun tranists into Mesh and Vrishabh in a lunar month, then it will be called Chaitra-Vaishaakh Kshay. There will be no separate months labeled Chaitra and Vaishakh.

A Kshaya masa occurs very rarely. Known gaps between occurrence of Kshaya masas are 19 and 141 years. In the year 1963, no new moon occurred when the Sun passed through Vrischika Rashi, so the name "Maargasira" had to be skipped. The lunar month following Kaartika was called Pausha. Maargasira was called "Kshaya Maasa" or skipped month. The last was in 1983. January 15 through Feburary 12 were Pausha-Magha kshaya. February 13 onward was (adhika) phalguna.

Note: Whenever a kshaya maasa occurs there will be two adhika maasaas – one before and the other after the lunar month. Of these only one is taken as nija maasa and the other one is adhika. The period of such recurrence of such gaps varies from 19 years to 141 years.

Note:

Vikram Samavat (Luni-solar) – Vikram Samvat begins from the tithi of Chaitra Sukla 1 (Sukla Pratipad) according to the Chaitradi system, and from Kartika Sukla 1 on Kartikadi system (in Gujarat) and from Vaisakhi (solar) in Punjab. The Vikram Samavat started from 57 B.C.

Saka Era (Solar & Luni-solar) – Saka Era begins from (1) March 22 or March 21 of the National Calendar (Solar), (2) From Chaitra Sukla Pratipad (Luni-solar) and Vaisakhadi (Solar) Saka era started form 78 A.D.

Religious Observances in case of Extra and Lost Months

Among normal months, adhika months, and kshaya months, the earlier are considered "better" for religious purposes. That means, if a festival should fall on the 10th

tithi of the Ashvayuja month (this is called Vijayadashami) and there are two Ashvayuja months caused by the existence of an adhika Ashvayuja, the first adhika month will not see the festival, and the festival will be observed only in the second nija month. However, if the second month is ashvayuja kshaya then the festival will be observed in the first adhika month itself.

When two months are rolled into one in the case of a kshaya masa, the festivals of both months will also be rolled into this kshaya masa. For example, the festival of Mahashivaratri which is to be observed on the fourteenth tithi of the Magha krishna paksha was, in 1983, observed on the corresponding tithi of Pausha-Magha kshaya krishna paksha, since in that year, Pausha and Magha were rolled into one, as mentioned above. When two months are rolled into one in the case of a kshaya masa, the festivals of both months will also be rolled into this kshaya masa.

It is a fact that the solar year is made up of 365 days and about 06 minutes and the lunar year is made up of 354 days.

Thus both the solar and the lunar years have gaps of 11 days, 1 hour, 31 minutes and 12 seconds. As this gap increases each year, it approximates in three years to one month. [Note: The moon takes about 27.3 days to make one complete orbit around the earth. The earth orbits around the sun once every 365.2422 days (= earth's orbital speed of 29.79 km per second). The earth and the moon in 27.3 days have moved as a system about 1/12 of the ways around the sun. This means that from one full moon to the next full moon, the moon must travel 2.2 extra days before it

appears full. This is due to the curve of the earth's orbit around the sun. The moon is still making one complete orbit (circle) in 27.3 days. But to line up with the earth and sun to become a full moon again it takes 29.531 days. 29.531 day Lunar months = 354.372 days per lunar year. Thus we arrive at a difference of 10.87 days a year between a lunar year and a solar year of 365.2422 days per year.]

Year of the Lunisolar Calendar

The new year day is the first day of the shukla paksha of Chaitra. In the case of adhika or kshaya months relating to Chaitra, the aforementioned religious rules apply giving rise to the following results:

If an adhika Chaitra is followed by a nija Chaitra, the new year starts with the nija Chaitra.

If an adhika Chaitra is followed by a Chaitra-Vaishakha kshaya, the new year starts with the adhika Chaitra.

If a Chaitra-Vaishakha kshaya occurs with no adhika Chaitra before it, then it starts the new year.

If a Phalguna-Chaitra kshaya occurs, it starts the new year.

Another Kind of Lunisolar Calendar

In the lunisolar calender, there is another kind, which differs from the former in the way that the months are named. When a full moon, instead of new moon, occurs before sunrise on a day, then that day is said to be the first day of the lunar month.

In this case, the end of the lunar month will coincide

with a full moon, which is called the Purnimanta mana or full moon ending reckoning, as against the Amanta mana or new moon ending reckoning that was used before. Due to this, the definition leads to a number of complications, which includes the first paksha of the month will be krishna and the second will be shukla. Also, the new year is still on the first day of the Chaitra shukla paksha.

Though the regular months are defined by the full moon, the adhika and kshaya lunar months are still defined by the new moon. That is, even if the Purnimanta system is followed, adhika or kshaya months will start with the first sunrise after the new moon, and end with the new moon. The adhika month will therefore get sandwiched between the two pakshas of the nija months. For example, a Shravana adhika masa will be inserted as nija Shravana krishna paksha, adhika Shravana shukla paksha, adhika Shravana krishna paksha, and nija Shravana shukla paksha after which Bhadrapada krishna paksha will come as usual.

If there is an adhika Chaitra, then it will follow the nija, Chaitra krishna paksha, at the end of the year. Only with the nija, Chaitra shukla paksha, will the new year start. The only exception is when it is followed by a kshaya, and that will be mentioned later. The kshaya month is more complicated. If in the Amanta system there is a Pausha-Magha kshaya, then in the Purnimanta system there will be the following pakshas, Pausha krishna paksha, Pausha-Maagha kshaya shukla paksha, Maagha-Phaalguna kshaya krishna paksha and a Phalguna shukla paksha.

In a special kshaya case where an adhika masa precedes a kshaya masa gets even more convoluted. Suppose Kaartik

is adhik and Margasheersh is kshaya. In such a case, we should remember that the Ashvayuja shukla paksha is the same in both the systems. After this come the following pakshas, nija Kartika krishna paksha, adhika Kartika shukla paksha, adhika Kartika krishna paksha, Kartika-Magashirsha kshaya shukla paksha, Magashirsha-Pausha kshaya krishna paksha, Pausha shukla paksha, followed by the Magha krishna paksha etc as usual.

The considerations for the new year depends upon if there is a Chaitra-Vaishakha kshaya shukla paksha, if an adhika Chaitra precedes it, then the adhika Chaitra shukla paksha starts the new year, and if not, then the kshaya shukla paksha starts the new year. If there is a Phalguna-Chaitra kshaya shukla paksha then it starts the new year. It must be noted, however, that none of these above complications can cause a change in the day of religious observances.

Since only the name of the krishna pakshas of the months will change in the two systems, the festivals which fall on the krishna paksha will be defined by the appropriate changed name. That is, the Mahashivaratri, defined in the amanta mana (a month begins with a new moon) to be observed on the fourteenth of the Magha krishna paksha will now, in the purnimanta mana, (a month begins with a full moon) be defined by the Phalguna krishna paksha.

Eras

Hinduism has of four eras or ages, of which we are currently in the last. The four are:

Krita Yuga or Satya Yuga

Treta Yuga

Dvapara Yuga

Kali Yuga

They are often translated into English as the golden, silver, bronze and Iron Ages. (Yuga means era or age.) The ages see a gradual decline of dharma, wisdom, knowledge, intellectual capability, life span and emotional and physical strength. The epoch provided above is the start of the Kali Yuga. The Kali Yuga is 432,000 years long. The Dvapara, Treta and Krita (Satya) Yuga-s are two, three and four times the length of the Kali Yuga respectively. Thus they together constitute 4,320,000 years. This is called a Chaturyuga.

A thousand and a thousand (i.e. two thousand) chaturyuga-s are said to be one day and night of the creator Brahma. He (the creator) lives for 100 years of 360 such days and at the end, he is said to dissolve, along with his entire Creation, into the Eternal Soul or Paramatman.

A non-vedic view of the timespan of a yuga is given by Swami Sri Yukteswar Giri, the guru of Paramahansa Yogananda. This is detailed in his book, The Holy Science. According to this view, one complete yuga cycle is equal to one complete "precession of the equinox", a period of approximately 24,000 years. The ascending phase consists of a 1200 year Kali, 2400 year Dwapara, 3600 year Treta and 4800 year Krita (Satya) yuga. The descending phase reverses this order, thus both ascending and descending phases equal 24,000 years. According to calculations given in the book, the most recent yuga change was in 1699, when the Earth passed from Kali Yuga (the lowest material age) to Dvapara Yuga (the second age associated with electrical, atomic and finer forces). We are in an ascending spiral right

now, and will pass into the Treta Yuga in 4100 CE. According to the book, the motion of the stars moving across the sky (a.k.a. the "precession of the equinox") is the observable of the Sun's motion around another star. The quality of human intellect depends on the distance of the Sun and Earth from a certain point in space known as the Grand Center, Magnetic Center or Vishnunabhi Vishnu. The closer the Sun is to it, the more subtle energy the Solar System receives, and the greater is the level of human spiritual and over all development. As the Sun moves around its companion star, it brings us closer to or drives us farther away from Vishnunabhi, resulting in the rising and falling ages here on Earth.

Yukteswarji tells us that the calendars of the higher ages were based on the Yugas, with each era named after its Yuga. Hence, the year 3000 BCE was known as descending Dwapara 102 (because the last descending Dwapara yuga began 102 years earlier in 3102 BCE). He stated that this method was used up until the recent Dark Ages, when knowledge of the connection with the yugas and the precession cycle was lost; "The mistake crept into the almanacs for the first time during the reign of Raja Parikshit, just after the completion of the last descending Dwapara Yuga. At that time Maharaja Yudhisthira, noticing the appearance of the dark Kali Yuga, made over his throne to his grandson, the said Raja Parikshit. Maharaja Yudhisthira, together with all the wise men of his court, retired to the Himalaya Mountains... thus there was no one who could understand the principle of correctly calculating the ages of the several Yugas". Thus, Yukteswar assumed that Raja Parikshit was not trained in any vedic principles even though

he alone ruled the world many year. Thus, he interpreted that Yugas are not calculated correctly. Consequently, he gave the theory that when the Dwapara was over and the Kali era began no one knew enough to restart the calendar count. They knew they were in a Kali Yuga (which is why the old Hindu calendar now begins with K.Y.) but the beginning of this calendar (which in 2006 stands at 5108) can still be traced to 3102 BCE, (3102+2006=5108) the start of the last descending Dwapara Yuga. So, the length of yugas according to Yukteswarji :

Descending Dwapar BC. 3102 to BC. 703
Descending Kaliyuga BC 702 to 498 AD.
Ascending Kaliyuga AD 499 to 1698 AD.
Ascending Dwapar AD 1699 to 4099 AD.

To this day there is still much confusion why the Kali starts at this date or what the correct length of the Yugas should be. Yukteswar suggests that a return to basing the Yuga calendar on the motion of the equinox would be a positive step.

History

The Hindu Calendar descends from the Vedic times. There are many references to calendrics in the Vedas. The Vedanga (adjunct to Veda) called Jyautisha (literally, "celestial body study") prescribed all the aspects of the Hindu calendars. After the Vedic period, there were many scholars such as Aryabhata (5th century CE), Varahamihira (6th century) and Bhaskara (12th century) who were experts in Jyautisha and contributed to the development of the Hindu Calendar.

The most widely used authoritative text for the Hindu Calendars is the Surya Siddhanta, a text of uncertain age, though some place it at 10th century.

The traditional Vedic calendar used to start with the month of agrahayan (agra=first + ayan = travel of the sun, equinox) or Margashirsha. This is the month where the Sun crosses the equator, i.e. the vernal equinox. This month was called margashirsha after the fifth nakshatra (around lambda orionis)*. Due to the precession of the Earth's axis, the vernal equinox is now in Pisces, and corresponds to the month of chaitra. This shift over the years is what has led to various calendar reforms in different regions to assert different months as the start month for the year. Thus, some calendars (e.g. Vikram) start with Chaitra, which is the present-day month of the vernal equinox, as the first month. Others may start with Vaisakha (e.g. Bangabda). The shift in the vernal equinox by nearly four months from agrahaayana to chaitra in sidereal terms seems to indicate that the original naming conventions may date to the fourth or fifth millennium BCE, since the period of precession in the Earth's axis is about 25,800 years.

The Tilt of the Earth's Axis and Its Elliptical Orbit

We have all known that the seasons are caused by the tilt of the Earth's axis of rotation - the 23.4° offset of the axis from a direction perpendicular to the Earth's orbital plane. The direction of the rotational axis stays nearly fixed

**Lambda Orionis is a star in the constellation Orion. (constellation orion is a group of celestial bodies, usually stars, which appear to form a pattern in the sky).*

in space, even as the Earth revolves around the Sun once each year. As a result, when the Earth is at a certain place in its orbit, the northern hemisphere is tilted toward the Sun and experiences summer. Six months later, when the Earth is on the opposite side of the Sun, the northern hemisphere is tilted away from the Sun and experiences winter. The seasons are, of course, reversed for the southern hemisphere.

The solstices mark the two dates during the year on which the Earth's position in its orbit is such that its axis is most directly tilted either toward or away from the Sun. These are the dates when the days are longest for the hemisphere tilted toward the Sun (where it is summer) and shortest for the opposite hemisphere (where it is winter).

However, there is a complication. The Earth's orbit is very close to being a perfect circle, but not quite. It is somewhat elliptical, which means that the distance between the Earth and the Sun varies over the course of the year. This effect is too weak to cause the seasons, but it might have some influence over their severity. The remainder of this page explains this possibility.

The Earth reaches perihelion - the point in its orbit closest to the Sun - in early January, only about two weeks after the December solstice. Thus winter begins in the northern hemisphere at about the time that the Earth is nearest the Sun. Is this important? Is there a reason why the times of solstice and perihelion are so close? It turns out that the proximity of the two dates is a coincidence of the particular century we live in. The date of perihelion does not remain fixed, but, over very long periods of time, slowly regresses (moves later) within the year. There is some

evidence that this long-term change in the date of perihelion influences the Earth's climate.

The Length of the Year

We can measure the length of the year in several different ways. The length of the year from equinox to equinox (equivalently, solstice to solstice) is called the tropical year, and its length is the basis for our Gregorian (civil) calendar. Basically, the tropical year is the year of a complete cycle of seasons, so it is natural that we use it for ordinary purposes. But we can also measure the length of the year from perihelion to perihelion, which is called the anomalistic year. On average, the anomalistic year is about 25 minutes longer than the tropical year, so the date of perihelion slowly shifts over time, regressing by about 1 full day every 58 years. The date of perihelion thus moves completely through the tropical year in about 21,000 years.

It is important to note that we are talking about long-term trends here. There are small year-to-year variations in the dates and times of solstice and perihelion due to our leap-year cycle and the effect of the Moon on the motion of the Earth.

Precession

Most of the difference in the average lengths of the two kinds of year is due to the very slight change in the direction of the Earth's rotation axis in space from one year to another. We usually think of the Earth's axis as being fixed in direction – after all, it always seems to point toward Polaris, the North Star. But the direction is not quite

constant: the axis does move, at a rate of a little more than a half-degree per century. So Polaris has not always been, and will not always be, the pole star. For example, when the pyramids were built, around 2500 BCE, the pole was near the star Thuban (Alpha Draconis). This gradual change in the direction of the Earth's axis, called precession, is caused by gravitational torques exerted by the Moon and Sun on the spinning, slightly oblate Earth.

Because the direction of the Earth's axis determines when the seasons will occur, precession will cause a particular season (for example, northern hemisphere winter) to occur at a slightly different place in the Earth's orbit from year to year. At the same time, the orbit itself is subject to small changes, called perturbations. The Earth's orbit is an ellipse, and there is a slow change in its orientation, which gradually shifts the point of perihelion in space. The two effects - the precession of the axis and the change in the orbit's orientation – work together to shift the seasons with respect to perihelion. Thus, since we use a calendar year that is aligned to the occurrence of the seasons, the date of perihelion gradually regresses through the year. It takes 21,000 years to make a complete cycle of dates.

We would not expect the 21,000-year cycle to be very important climatologically because the Earth's orbit is almost circular - the distance to the Sun at perihelion is only about 3% less than its distance at aphelion. That is, whether perihelion occurs in January or July, it seems unlikely that our seasons would be much affected. At least, that is the case now; but the eccentricity of the Earth's orbit (how elliptical it is) also changes over very long periods of time,

from almost zero (circular orbit) to about three times its current value. The eccentricity of the orbit varies periodically with a time scale of about 100,000 years. So, it would be reasonable to suppose that if the 21,000-year perihelion shift cycle were to have any effect on climate at all, it would only be during the more widely-spaced epochs when the orbital eccentricity was relatively large. That is, climatologically, the 100,000-year cycle of eccentricity should modulate the 21,000-year cycle of perihelion.

In fact, Mars has an orbit much more eccentric than the Earth's, and its perihelion cycle (which has a period of 51,000 years) does apparently have a significant effect on climate and prevailing wind direction there.

Change in Obliquity

There is another important cycle that has the potential to affect the Earth's climate; it is a 41,000-year variation in obliquity, the tilt of the Earth's axis with respect to a direction perpendicular to its orbital plane. This variation is different from precession – the two motions are at right angles to each other – and astronomically is a much smaller effect. The obliquity varies by only a few degrees back and forth, and the current value of 23.4° is near the middle of the range. However, climatologically, the obliquity variation has the potential to have a fairly direct effect on seasonal extremes. After all, it is the obliquity that causes our seasons in the first place – if the Earth's axis were perpendicular to its orbital plane, there would be no seasons at all.

The astronomical cycles described above are called Milankovitch cycles after Milutin Milankovitch, a Serbian

scientist who provided a detailed theory of their potential influence over climate in the 1920s. Milankovitch's work was an attempt at explaining the ice ages, and it built upon previous astronomical theories of climate variation postulated by Joseph Adhemar and James Croll in the 19th century. Although the Milankovitch theory is well-grounded astronomically, it remains controversial. The theory predicts different effects at different latitudes, and thus its use as a predictor of global (or at least hemispheric) climate change is not unambiguous. The exact mechanisms by which the relatively modest variations in the Earth's orbit and axis direction might result in such large effects as the ice ages are not well established. The theory's popularity has tended to vary depending on the type of long-term climatological data that has been available and the method used to establish a time scale for the data.

The 21,000-year perihelion cycle and the 41,000-year obliquity cycle do in fact appear to be present in the climatological record. But the dominant climate cycle that is seen has a period of about 100,000 years. Although this coincides with the period of change in the eccentricity of the Earth's orbit, the theory outlined above does not predict that we should see this period directly - the effect of eccentricity should appear only as a modulation of the 21,000-year perihelion cycle. The mechanism by which the Earth's orbital eccentricity could affect the climate in such a direct and important way is not known, although recent evidence (published in 2000) indicates that atmospheric carbon dioxide may play a leading role in amplifying the orbital effect. However, some researchers still have doubts about the association between the 100,000-year climate cycle

and orbital variations. Thus, many questions remain about long-term climate variations and their relationship, if any, to astronomical causes.

Makara Sankranti

Transition of the Sun from sidereal Sagittarius to Capricorn during the winter solstice in the northern hemisphere (Uttarayana) is known as Makara Sakranti. Unfortunately, there are several ways of calculating the Hindu solar calendar, so its date may vary by up to one day in various parts of India depending whether local custom dictates the use of the old or new Hindu calendar or astronomical tables. This is further confused by the fact that the date reported as a holiday is sometimes the 1st of Makara and sometimes the eve. It always occurs around the 14th or 15th of January.

Makhara sankranthi as the name suggests is date on which Sun enters the zodiac sign capricorn or makara rasi as per tamil calendar. This is currently 14th Jan.(all sankranthis that is dates on which the sun enters different zodiac signs or rashis will be same dates as previous year) whereas our festivals are performed as per tithi/star/month as per the moon cycle and hence differs from year to year. Pongal/makhara sankranthi falling on the same date however needs an explanation and correction. Yes the date will be the same for many many years. It was perhaps 13th many years earlier. Some 60 years from now it could be 15/16th and will continue changing in approx 70 years. This is because of what is known as precession of the equinoxes due to which we will advance every year by approx 50.3 secs. This

will naturally not show up in successive years but this 50.3 secs accumulates and eventually total a day in say 70 years.

1. Basically the Axis of the Earth also rotates in a gigantic circle and takes 84600 years to complete the rotation. (It is called as "Paranchan Gati" of the Axis).

2. Due to this movement of the axis, every 72 years, the Equinox moves 1 degree farther -- Called as "Precession of Equinox"

3. So every 72 years the Sun Sign Calnder needs a movement of 1 day ahead.

4. That is why Makar-Sankranti was celebrated in India on 14th of Jan in last century and now slowly becoming 15th of Jan. It will continue to shift and whan Makar Sankranti occurs (Paush-Magh) remain the same. Ultimately we shall have it in summer and the name of the month remaining the same as now because of the way they are definied in luni- solar calendar.

5. Makar (i.e. Capricorn) Sankranti is the day when SUN enters Capricorn sign. This is the RULE OF THUMB if you do not remember complete calendar of Sun Signs.

विज्ञान सम्मत भारतीय काल गणना

भारतीय काल गणना सर्वाधिक शुद्ध और वैज्ञानिक है। इस गणना के आधार पर पृथ्वी की आयु एक अरब ९७ करोड़ वर्ष से अधिक है। आज के वैज्ञानिक भी अब इस बात को मानने लगे हैं कि पृथ्वी को अस्तित्व में आये लगभग दो अरब वर्ष बीत चुके हैं।

श्रीमद्भागवत पुराण तथा मार्कण्डेय पुराण के अनुसार वर्तमान में श्वेतवराह कल्प चल रहा है। समय को अनन्त मानते हुए इसकी गणना के लिए 'कल्प' को एक इकाई माना गया। एक 'कल्प' में एक हजार चतुर्युग तथा १४ मन्वन्तर होते हैं। अर्थात् एक मन्वन्तर में करीब ७२ चतुर्युग होते हैं। इस समय ६ मन्वन्तर समाप्त हो चुके हैं तथा सातवां 'वैवस्वत' नाम का मन्वन्तर चल रहा है। इस सातवें मन्वतन्तर की २७ चतुर्युगी बीत चुकी हैं तथा २८वां चतुर्युग चल रहा है। इसका अर्थ हुआ कि वैवस्वत मन्वन्तर में सत्युग, त्रेता, द्वापर तथा कलियुग २७ बार आ चुके हैं। २८ वें चतुर्युग के भी तीन युग सत्ययुग, त्रेता तथा द्वापर बीत चुके हैं। इस समय 'कलियुग' चल रहा है। अर्थात् 'श्वेतवराह' कल्प के सातवें 'वैवस्वत' मन्वन्तर की २८ वीं चतुर्युगी के 'कलियुग' में इस समय हम हैं।

युगाब्द क्या है

महाभारत का युद्ध समाप्त होने के बाद हस्तिनापुर में महाराज युधिष्ठिर सिंहासन पर बैठे। उनके राज्यारोहण के ३६ वर्ष बाद योगेश्वर श्रीकृष्ण ने महाप्रयाण किया। ईसा से ३१०२ वर्ष पहले की यह घटना है। श्रीकृष्ण के दिवंगत होने के साथ ही कलियुग प्रारम्भ हुआ। कलियुग को शुरू हुए २०१० में चैत्र शु. १ को ५१११ वर्ष पूरे हो जायेंगे। कलियुग की यह गणना ही कलियुग संवत् या युगाब्द कही जाती है।

इन सारी चतुर्युगियों, मन्वन्तरों के कुल वर्ष जोड़ने पर वर्तमान

पृथ्वी की आयु १ अरब ९७ करोड़ तीस लाख वर्षों से कुछ अधिक आती है।

लेकिन भारतीय कालगणना मात्र दो अरब वर्ष की ही नहीं है। समय की सबसे बड़ी इकाई 'तल्लाक्षण' का उल्लेख हमारे ग्रन्थों में मिलता है। बौद्ध ग्रन्थ ललित विस्तर में गणितज्ञ अर्जुन तथा बोधिसत्व की बातचीत का वर्णन है। आचार्य अर्जुन सौ कोटि (करोड़) अर्थात् $१०^{९}$ से आगे गणना करते हुए तल्लाक्षण तक पहुँचते हैं जिसका मान $१०^{५३}$ है। इसका अर्थ है कि १ के बाद, ५३ शून्य लगाने पर जो संख्या, आये वह तल्लाक्षण है। 'ललित विस्तर' उस काल का ग्रन्थ है, जब रोम में 'दस हजार' ($१०^{४}$) से अधिक की संख्या का ज्ञान किसी को नहीं था। इसी प्रकार समय की सबसे छोटी इकाई '**त्रुटि**' भी प्राचीन भारत के गणितज्ञों की खोज है। एक **विपल** का मान ०.४ सैकण्ड होता है तथा एक विपल में १३,५०० त्रुटि होती हैं, अर्थात् **त्रुटि एक सैकण्ड** का ३३,७५० वाँ भाग है। आज के हजारों वर्ष पूर्व भारत के गणितज्ञों ने समय की इतनी छोटी इकाई की गणना कर ली थी।

प्राचीन भारत के वैज्ञानिकों ने ग्रहों, नक्षत्रों आदि की गति व स्थिति के आधार पर वर्ष, मास, दिन, घंटे, आदि की सूक्ष्म एवं अत्यन्त सही गणना की। सूर्य सिद्धान्त के अनुसार एक वर्ष ३६५ दिन २५ घटी, ३१ पल, ३१ विपल तथा २४ प्रतिविपल का माना गया है। ढाई घटी एक घंटे के बराबर होती है। एक घटी में साठ पल ($२^{१}/२$ पल ≈ १ मिनट), एक पल में साठ विपल ($२^{१}/$ विपल ≈ १ सैकण्ड) तथा एक विपल में साठ प्रतिविपल होते हैं।

इस सूक्ष्म गणना के आधार पर सूर्य, चन्द्र, पृथ्वी, बुध, मंगल आदि ग्रहों की गति तथा सापेक्ष गति का हिसाब लगा कर 'भारतीय पंचांग' का निर्माण हुआ। यह पंचांग इतना वैज्ञानिक है कि अमरीका के अंतरिक्ष संस्थान 'नासा' के वैज्ञानिक अपनी सारी गणना करने के बाद

भारत के 'पंचाग' को देखते हैं और यदि उनका हिसाब पंचांग से मेल खाता है तभी वे आश्वस्त होते हैं। रूस के अंतरिक्ष वैज्ञानिकों की गणना का तो आधार ही 'पंचांग' हैं।

सबसे बड़ी इकाई तल्लाक्षण

१०० कोटि = आयुत
१०० अयुत = नियुत
१०० नियुत = कंकर
१०० कंकर = विवर
१०० विवर = क्षोम्य
१०० क्षोम्य = निवाह
१०० निवाह = उत्संग
१०० उत्संग = बहुल
१०० बहुल = नागबाल
१०० नागबाल = तितिलम्ब
१०० तितिलम्ब = व्यवस्थानप्रज्ञप्ति
१०० व्यवस्थानप्रज्ञप्ति = हेतुहील
१०० हेतुहील = करहु
१०० करह = हेतुविन्द्रीय
१०० हेतुविन्द्रीय = समाप्तलम्भ
१०० समाप्तलम्भ = गणनागति
१०० गणनागति = निरवद्य
१०० निरवद्य = मुद्रावाल
१०० मुद्रावाल = सर्वबाल
१०० सर्वबाल = विषपज्ञगति
१०० विषयज्ञगति = सर्वज्ञ
१०० सर्वज्ञ = विभुतंगमा
१०० विभुतंगमा = तल्लाक्षण
तल्लाक्षण = $१०^{४३}$

महीना – दो पूर्ण चन्द्रमा के बीच का समय एक महीना है। दो नये चन्द्रमा अर्थात् एक अमावस्या से दूसरी अमावस्या के बीच का समय भी एक माह है। उत्तर भारत में दो पूर्णिमा के बीच के समय को एक महीना माना जाता है, परन्तु दक्षिण भारत में दो अमावस्या के बीच के समय को एक महीना माना जाता है। उत्तर भारत की गणना में पूर्णिमा को महीना समाप्त होता है। अतः यह महीना पूर्णिमान्त कहलाता है। दक्षिण भारत का मास अमावस्या को समाप्त होता है, इसलिये दक्षिण भारत की गणना का माह अमान्त कहलाता है। एक महीने का समय लगभग २९.५ दिन होता है।

वर्ष – पृथ्वी सूर्य की परिक्रमा लगभग ३६५.२४२२ दिन में करती है। इस समय को **सायन वर्ष** कहते हैं। भारत में हम **निर्अयन वर्ष** से गणना करते हैं। इसका समय ३६५ दिन ६ घण्टे ९ मिनट ९.७ सेकण्ड के लगभग है। **इस तरह निर्अयन वर्ष सायन वर्ष से करीब २० मिनट**

बड़ा है। इस तरह करीब ७२ वर्ष में एक दिन का अन्तर आ जाता है।

उपरोक्त विवरण से हमने देखा कि एक दिन लगभग २४ घण्टे का है, एक माह करीब २९.५ दिन का है और एक वर्ष लगभग ३६५.१/४ दिन का है अतः माह में दिन का और वर्ष में माह का भाग नहीं जाता है। इसीलिये काल की गणना कठिन है। प्रकृति अपने रहस्य आसानी से प्रकट नहीं करती, इसलिये वर्ष और माह की गणना में कठिनाई उत्पन्न हुई है।

माह अर्थात् दो पूर्ण चन्द्रमा या दो नये चन्द्रमा के बीच का समय, चन्द्रमा की पृथ्वी की परिक्रमा के समय से निर्धारित होता है और वर्ष पृथ्वी की सूर्य की परिक्रमा के समय के निर्धारित होता है।

काल गणना की विभिन्न विधियाँ

उपरोक्त कठिनाइयों के कारण काल गणना की अलग-अलग विधियों की कल्पना की गई। कुछ विद्वानों ने बारह माह का एक वर्ष मान लिया। अब एक माह लगभग २९.५ दिन का होता है, इसलिये एक वर्ष ३५४ दिन का होगा। क्योंकि इस विधि में चन्द्रमा को महत्व दिया गया है, इसलिये इसे **चान्द्र वर्ष** कहते हैं। हिजरी सन् (जो मुसलमान मानते हैं) इसी तरह से निर्धारित किया गया है। इस विधि में जब नया चान्द दिखाई देता है, उसी समय सायंकाल से नया माह प्रारम्भ हो जाता है। नया चान्द कभी २९ दिन से दिखाई देता है और कभी ३० दिन से। इसलिये कोई माह २९ दिन का और कोई माह ३० दिन का होता है।

सौर वर्ष – पृथ्वी सूर्य की परिक्रमा लगभग ३६५.२५ दिन में पूरी करती है। कुछ विद्वानों ने इस अवधि को एक वर्ष मान लिया। इस अवधि में सूर्य (वास्तव में पृथ्वी) १२ राशियों में भ्रमण करता है। इन बाहर राशियों के नाम हैं - १. मेष, २. वृषभ, ३. मिथुन ४. कर्क, ५. सिंह,

६ कन्या, ७. तुला, ८. वृश्चिक, ९. धनु, १०. मकर, ११. कुम्भ, १२. मीन। जब मेष राशि में सूर्य आता है तो पहला माह मेष संक्राति से वृषभ में सूर्य आता है तब वृषभ संक्राति से दूसरा माह, इस तरह से १२ माह मान लिये गये।

सौर-चान्द्र वर्ष – चान्द्र वर्ष केवल चन्द्रमा के आधार पर है, अतः इस वर्ष के महीनों का मौसम से कोई सम्बन्ध नहीं रहता। कभी मोहर्रम सर्दी में आता है, कभी वर्षा में तो कभी गर्मी में। सौर वर्ष का सम्बन्ध चन्द्रमा से नहीं रहता अतः अमावस्या कब आयेगी और पूर्ण चन्द्र कब होगा इसका ज्ञान नहीं रहता और इसलिये समुद्र में ज्वारभाटा का पूर्व ज्ञान नहीं हो पाता। भारत में सूर्य, चन्द्र और पृथ्वी तीनों के भ्रमण का ध्यान रख कर पंचांग बनाया गया है। चन्द्रमा पृथ्वी की परिक्रमा करता है। पृथ्वी सूर्य की परिक्रमा करती है और सूर्य भी अपने सौरमण्डल को साथ लेकर ब्रह्माण्ड में भ्रमण करता है। इसलिये भारतीय गणना अधिक वैज्ञानिक है, परन्तु कुछ कठिन भी है।

विक्रम सम्वत् और शक सम्वत् सौरचान्द्र सम्वत् हैं। यह चैत्र शुक्ल प्रतिपदा से प्रारम्भ होते हैं। इसके बारह मासों के नाम हैं- चैत्र, वैशाख, ज्येष्ठ, आषाढ़, श्रावण, भाद्रपद, आश्विन, कार्तिक, मार्गशीर्ष, पौष, माघ और फाल्गुन। दक्षिण भारत में माह अमान्त होते हैं और उत्तर भारत में पूर्णिमान्त। यद्यपि दोनों में नया वर्ष चैत्र शुक्ल प्रतिपदा से ही प्रारम्भ होता है।

अधिक मास – भारतीय सम्वत् सौर चान्द्र वर्ष है। सौर वर्ष लगभग ३६५.२५ दिन का होता है और चान्द्र वर्ष ३५४ दिन का। इस तरह हर वर्ष दोनों में लगभग ११ १२ दिन का अन्तर आ जाता है। अतः लगभग २१ वर्षों में सात चान्द्र माह बढ़ जाते हैं। इनका समायोजन करने के लिये अधिक माह की व्यवस्था की गई। २१ वर्ष में लगभग सात अधिक माह आते हैं। कभी-कभी क्षय मास भी आता है।

सौर वर्ष के मास संक्रान्ति से प्रारम्भ होते हैं। चान्द्र वर्ष के मास अमावस्या को समाप्त होते हैं (दक्षिण भारत की पद्धति के अनुसार)। इसलिये प्रायः दो संक्रान्ति के बीच एक अमावस्या आती है। **कभी-कभी दो संक्रान्ति के बीच दो अमावस्या आ जाती हैं। ऐसी स्थिति में उन दो अमावस्या के बीच एक माह अधिक माह कहलाता है और वह चान्द्र वर्ष १३ माह का हो जाता है।**

वर्ष, माह, पक्ष और तिथि- भारतीय पद्धति में एक वर्ष में १२ माह होते हैं। कभी-कभी अधिक माह भी होता हे, तब एक वर्ष में १३ माह हो जाते हैं। एक माह में दो पक्ष होते हैं- कृष्ण और शुक्ल। पूर्णिमा के बाद चन्द्रमा की कलाएँ क्षीण होती हैं। अतः पूर्णिमा के बाद प्रतिपदा से अमावस्या के पक्ष को कृष्ण पक्ष कहते हैं। उसके बाद दूसरे पक्ष को शुक्ल पक्ष कहते हैं।

बाहर माह के नाम-करण – जिस माह की पूर्णिमा के दिन चन्द्रमा चित्रा नक्षत्र में होता है, उस माह को चैत्र माह कहते हैं। वैशाख की पूर्णिमा को चन्द्रमा विशाखा, ज्येष्ठ की पूर्णिमा को ज्येष्ठा नक्षत्र, आषाढ़ की पूर्णिमा को पूर्वाषाढ़ा या उत्तराषाढ़ा, श्रावण की पूर्णिमा को पूर्वाभाद्र या उत्तरा भाद्र, आश्विन की पूर्णिमा को अश्विनी, कार्तिक की पूर्णिमा को कृतिका, मार्गशीर्ष की पूर्णिमा को मृगशिरा, पौष की पूर्णिमा को पुष्य, माघ की पूर्णिमा को मघा और फाल्गुनी की पूर्णिमा को पूर्वा फाल्गुनी या उत्तरा फाल्गुनी नक्षत्र में चन्द्रमा होता है। इस तरह बारह महीनों का नामकरण किया गया है।

उत्तर भारत में पहले कृष्ण पक्ष माना जाता है और दक्षिण भारत में पहले शुक्ल पक्ष। उत्तर भारत में जिसे हम चैत्र कृष्ण पक्ष कहते हैं, दक्षिण भारत में उसे फाल्गुण कृष्ण पक्ष कहते हैं। इस तरह उत्तर भारत के हर माह के कृष्ण पक्ष को दक्षिण भारत में उसके पहले वाले माह का कृष्ण पक्ष पुकारा जाता है।

तिथि

अंग्रेजी में डेट (Date), अरबी में तारीख और हिन्दी में तिथि से माह के दिनों की गणना की जाती है। भारतीय गणना में हर पक्ष में १५ तिथियाँ होती हैं। तिथि सूर्य और चन्द्रमा की कोणीय स्थिति से निर्धारित की जाती है। जब सूर्य और चन्द्रमा दोनों पृथ्वी के एक ओर सीधी रेखा में स्थित होते हैं तब चन्द्रमा अस्त रहता है। इस समय अमावस्या होती है और जब सूर्य पृथ्वी के एक ओर और चन्द्रमा दूसरी ओर एक ही सीधी रेखा में स्थित होते हैं तब पूर्णिमा होती है। इस समय पूरा चन्द्रमा दिखाई देता है। अमावस्या और पूर्णिमा को पृथ्वी सूर्य और चन्द्रमा की स्थिति रेखा चित्र से दिखाई देता है।

चन्द्रमा की गति शीघ्र है और सूर्य और पृथ्वी की गति मन्द है। पृथ्वी को केन्द्र मानने पर सूर्य और चन्द्रमा की कोणीय दूरी १८०° अंश होने पर पूर्णिमा होती है। अब यहाँ से चन्द्रमा चल कर सूर्य के पास पहुँचता है तो वह १८० अंश चलता है और इनकी कोणीय दूरी शून्य अंश हो जाती है और अमावस्या की स्थिति बन जाती है। चन्द्रमा के इस भ्रमण में १५ तिथि बनती हैं। इस तरह १८० / १५ = १२° जब चन्द्रमा चलता है तो एक तिथि पूरी हो जाती है।

इस तरह पूर्णिमा के अन्त से चन्द्रमा १२° ओर चलता है तब कृष्ण पक्ष की प्रतिपदा का अन्त हो जाता है और कृष्ण पक्ष की द्वितीया का प्रारम्भ हो जाता है। फिर चन्द्रमा जब १२° ओर चल लेता है तो कृष्ण पक्ष की द्वितीया का अन्त होकर तृतीया प्रारम्भ हो जाती है। इस तरह चन्द्रमा जब १८०° का भ्रमण कर लेता है तब १५ तिथि पूर्ण हो जाती हैं। इसके पश्चात् जब चन्द्रमा १२° और चलता है तो शुक्ल पक्ष की प्रतिपदा का अन्त होकर शुक्ल पक्ष की द्वितीया प्रारम्भ हो जाती है। इस तरह दोनों पक्षों कृष्ण और शुक्ल में १५-१५ तिथियाँ होती हैं और पूरे माह में ३० तिथियाँ होती है।

तिथियों की वृद्धि और क्षय – एक तिथि का मान लगभग एक दिन या २४ घण्टे होता है। परन्तु सूर्य और चन्द्रमा की गति हमेशा एक सी नहीं रहती। यह गति कम या ज्यादा होती रहती है। अतः कभी-कभी तिथि २४ घण्टे से बड़ी हो जाती है और कभी तिथि २४ घण्टे से छोटी हो जाती है। इससे स्पष्ट है कि तिथि परिवर्तन रात या दिन में कभी भी हो सकती है, **परन्तु सूर्योदय के समय जो तिथि होती है वही तिथि उस दिन की मानी जाती है।** उदाहरण के लिये १५ जनवरी सन् २००८ को प्रातः काल पौष शुक्ल सप्तमी है। अतः इस दिन सप्तमी कहलाती है। वह सप्तमी दोपहर को २.११ पर समाप्त हो जाती है और अष्टमी प्रारम्भ हो जाती है। फिर भी दिन भर सप्तमी ही कहलायेगी।

कभी कभी लगातार दो दिन सूर्योदय के समय एक ही तिथि रहती है, तब तिथि बढ़ जाती है। कभी-कभी तिथि २४ घण्टे से कम होती है, उस हालत में पहले दिन चतुर्थी और दूसरे दिन प्रातः काल षष्ठी तिथि आ जाती है। तब पंचमी तिथि क्षय हो जाती है। उदाहरण के लिये २८ नवम्बर २००७ को सवेरे ७ बजकर ३६ मिनट तक चतुर्थी है, फिर दिन भर पंचमी है, परन्तु २९ नवम्बर को सूर्योदय के षष्ठी है। अतः पंचमी का क्षय हो गया।

वारों के वैज्ञानिक नाम

भारतीय वार व उनके नाम आज पूरे विश्व में प्रचलित हैं। ये पूर्णतः वैज्ञानिक गणना के आधार पर तय हुआ है। ब्रह्म पुराण, सिद्धान्त शिरोमणि आदि ग्रन्थों के अनुसार वर्तमान कल्प अर्थात् सृष्टि का प्रारंभ चैत्र शुक्ल १ को हुआ। इस दिन सभी ग्रह मेष राशि में थे। इसी दिन प्रथम सूर्योदय हुआ। इसलिये यह दिन सूर्यवार या रविवार कहलाया। भारतीय ज्योतिष गणना में पूरे दिन सुर्यावार या रविवार कहलाया। भारतीय ज्योतिष गणना में पूरे दिन को २४ होरा (घंटे) तथा ६० घटी में विभाजित किया गया। प्रत्येक 'होरा' का स्वामी क्रमानुसार कोई न ग्रह

है। रविवार के २४ होरा समाप्त होने के बाद २५ वें होरा का स्वामी चंद्रमा है, इसलिये सूर्यवार के बाद चंद्रवार (सोमवार) आता है। इसी हिसाब से सप्ताह के सात दिन क्रम से आते हैं। हमारी मान्यता के अनुसार सूर्योदय के साथ ही नया वार या दिन प्रारंभ होता है।

चैत्र शुक्ल १ (वर्ष प्रतिपदा) से नये वर्ष नये संवत् का प्रारंभ ज्योतिषीय काल गणना के अनुसार है तथा सर्वाधिक वैज्ञानिक है। इसी दिन पहला सूर्योदय हुआ तथा सृष्टि का निर्माण हुआ। इसलिये भारत में प्रचलित सभी संवत् वर्ष प्रतिपदा से ही आरंभ होते हैं। इस समय पूरे देश में विक्रम संवत् सबसे अधिक व्यवहार में लाया जाता है। २०६४ वर्ष पूर्व उज्जैन के सम्राट विक्रमादित्य ने शक आक्रमणकारियों को भारत से निकाल बाहर किया था। राष्ट्रीय गौरव के इसी प्रसंग को याद रखने के लिये महाराज विक्रमादित्य के नाम से यह विक्रम संवत् प्रारंभ हुआ।

इसी प्रकार सम्राट १९२९ वर्ष पूर्व शालिवाहन द्वारा विदेशी आक्रमणकारियों के सम्पूर्ण विनाश के तेजस्वी प्रसंग की स्मृति में 'शालिवाहन शक संवत' प्रारंभ हुआ। दक्षिण भारत में 'शक संवत' अधिक प्रयोग में आता है। भारत में प्रचलित कुछ अन्य प्रमुख संवत् इस प्रकार हैं

श्रीकृष्ण संवत् (कृष्ण जन्म से प्रारम्भ)	– ५२३५
युगाब्द (कलियुग संवत्)	– ५१११
बौद्ध संवत्	– २५८४
महावीर संवत्	– २५३६
श्रीशंकराचार्य संवत्	– २२८९
कलचुरी संवत्	– १७६१
वलभी संवत्	– १६८९

फसली संवत् — १४२०

बंगला संवत् — १४१६

हर्ष संवत् — १४००

इस तरह हम समझ सकते हैं, कि हमारी गणना पूर्ण रूप से वैज्ञानिक है। इसमें सूर्य और चन्द्रमा दोनों के भ्रमण को आधार बनाया गया है तथा महीनों का नामकरण भी वैज्ञानिक विधि से किया गया है।