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ASTRONOMY IN TEMPLE CONSTRUCTION

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In Temple construction two important things are to be fixed before starting construction. 1. The auspicious time for the beginning in Boomi Pooja, Kumbha Abhishekam etc. 2. The fixing the Directions (mainly 8, North, East, South, West and the 4 in between directions). Here Astronomy plays the important role and based on it only the construction proceeds.

Astronomy is the branch of Science that deals with **the study of celestial bodies** (such as stars, planets, satellites, comets, nebulae, star clusters, and galaxies) and phenomena that originate outside the atmosphere of Earth (such as the cosmic background radiation). It is concerned with the evolution, physics, chemistry, meteorology **and the motion of celestial objects,** as well as the formation and the development of Universe.

The auspicious time is based on the aspects and positions of celestial bodies, especially the nine Graha (not synonym to planets) and the stars at ecliptic plane of Earth (27 Nakshatra). The positions of the Navagraha, with reference to the Earth are changing constantly. Hence to assess their positions in the celestial shere, their motion is to be assessed, with reference to the fixed ecliptic stars. The positions of these ecliptic stars which are constant (fixed, not moving, as for as Earth is concerned) can be ascertained, by creating imaginary celestial co-ordinates passing through the celestial sphere. These are with reference to the celestial equator which is nothing but the extension of the equator of the Earth. The celestial co-ordinates that pass through the north and south celestial poles cutting the celestial equator at right angles are the longitudes and their angle is mentioned as right ascension. They are 360 in total, one for each degree of angle. The celestial coordinate that passes exactly at the celestial equator is 0° declination and the co-ordinates that are parallel to this celestial equator are latitudes and their angle is mentioned as declination. That pass through the northern hemisphere are 90 in number (one for each degree) and are denoted with N or +ve sign and the other 90 that pass south to equator are denoted with S or -ve sign. These are celestial co-ordinates of equatorial system. In this system, the declination of the Graha, especially of the Sun, is used in calculating the positions of Graha.

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The other system is ecliptic co-ordinatres, where the ecliptic of the Earth is the central line and is marked as 0° celestial latitude. The ecliptic is the annual path of the Earth around the Sun. The lines passing parallel to this are the celestial latitudes, 90 northwards and 90 southwards and are marked as N or + and S or –ve sign. The north and south poles of the ecliptic are known as Kadamba in our Nation's astronomy and the longitudinal lines passing through these ecliptic poles cutting the ecliptic at right angles are the celestial longitudes and are 360 in number, one for each degree. These celestial co-ordinates of ecliptic system are used to fix the positions of the Graha. Thus, the positions of Graha are mentioned relative to the Earth's position in the ecliptic and not with reference to the celestial sphere and this itself proves that these are all developed in our Nation and spread to the whole world. This is because, in our astronomy the positions of Graha are assessed with reference to Earth's position in the ecliptic, there by understanding the effect of Graha on Earth, where as in the western astronomy they are described with reference to the celestial sphere. These co-ordinates are the celestial longitudes and latitudes. The co-ordinates of ecliptic and equatorial systems differ by 23° 27` to its ecliptic path around the Sun.



The longitudes and latitudes of the Earth are same as that of right ascension and declination of celestial sphere. The longitudes pass through the North and South poles of Earth cutting the Equator of the Earth at right angles. They are 360 one for each degree. The prime meridian is the longitude of 0 degree longitude and the other longitudes are mentioned as East, if they are east to this prime meridian and west if they are west. The latitudes of the Earth pass parallel to equator of the Earth and the latitudes in northern hemisphere are denoted as N or +ve sign and the southern latitudes are denoted as S or –ve sign. These are of equatorial system and they are also important in arriving the auspicious time, as the effect of Graha varies at different longitudes and Latitudes. Besides, these co-ordinates of the Earth and the declination of the Sun are important in fixing the direction at the place of temple construction.

Magnetism is not useful in fixing the directions exactly. This is because, the north magnetic pole is on Ellef Ringnes Island in northern Canada, about 870 miles from the geographic North Pole. The south magnetic pole is off Wilkes Land, Antarctica, about 1,710 miles from the geographic South Pole.



In this figure, GN Geographical North Pole and MN is Magnetic North Pole. Moreover, their positions vary at different periods of time. For example, the North Magnetic Pole moves slowly over time due to magnetic changes in the Earth's Core. In 2001, it was determined by the Geological Survey of Canada to lie near Ellesmere Island in northern Canada at 81.3°N, 110.8°W. It was estimated to be at 82.7°N, 114.4°W in 2005. In 2009, it was moving toward Russia at between 34 and 37 mi (55-60 km) per year. The positions of North Magnetic Pole at various periods are 81.3°N, 110.8°W (2001), 82.3° N, 113.4°W (2004 est), and 82.7°N, 114.4°W

(2005 est) and of the South Magnetic Pole are $64.6 \circ S$, $138.5 \circ E$ (1998), $63.5 \circ S$, $138.0 \circ E$ (2004 est) and $64.487 \circ S$, $137.684 \circ E$ (2007). Hence, an alternate method of fixing the directions exactly is required. The fixing of directions is a very essential basic thing, in temple constructions, because the places and front view of various Deities should be exact as mentioned in temple architecture, Agama and Veda. For this, our ancestors developed a system and method using Astronomy and the Śanku. The Śanku is a Gnomon, usuaslly a 12 Angula (1/2 cubit) height, wooden, cylindrical, massive, straight rod (pillar, pole).

Using this Śanku, the directions are fixed exactly, by the following method. It is carried out on an equinoctial day, when the Sun raises exactly in straight line of Earth's equator (0° declination). In the following figure, ESWN is a circle on a level ground. O is the centre of circle (Śanku). The 'w' is the point at which the tip of the shadow of Sanku enters into the circle in the forenoon. The 'e' is the point at which the tip of the shadow of the Śanku goes out of the circle in the afternoon. Then, 'ew' is the East West line. With fish arcs (Timi or Matsya), north south line is Fixed.





But, declination of The Sun varies from forenoon to afternoon. This is because, Sun's Declination (δ) undergoes constant change. It is due to the inclination of the Earth and is 23° 27 `. So in a year the total Uttarayana (23° 27 ` × 2, from the line of Capricorn to the line of Cancer) and Dakshinayana (23° 27 ` × 2, from the line of Cancer to the line of Capricorn) of Sun is 23° 27 ` × 4 = 93° 48 ` in 365 .256364 days. Hence, the directions vary, very slightly from 'ew' to 'e`w' as shown in the figure. To fix the directions exactly, the declination difference 'd' ($\delta - \delta$ `) in half a day (on the day of measurement) can be calculated, by the following method.

The distance of the shadow-tip from the east-west line is defined as the $ch\bar{a}y\bar{a}$ -bhuja ("bhuja or base of shadow"). Let the difference between the $ch\bar{a}y\bar{a}$ -bhuja when the tip of the shadow enters into the circle and the $ch\bar{a}y\bar{a}$ -bhuja when the tip of the shadow passes out of the circle be d. Let δ be the Sun's declination when the tip of the shadow enters into the circle in the forenoon and δ' the Sun's declination when the tip of the shadow enters of the shadow passes out of the shadow passes out of the circle in the forenoon and δ' the Sun's declination when the tip of the shadow enters into the shadow passes out of the circle in the shadow passes out of the circle in the afternoon.

 $d = \frac{(\text{Rsin } \delta' \sim \text{Rsin } \delta) \times \text{hypotenuse of shadow}}{\text{Rcos } \phi},$

where ϕ is the local latitude. This *d* denotes the correction which is applied as follows:

Construct a circle with ew as diameter, and with centre e and radius d draw an arc cutting this circle at e' towards the north if the Sun's *ayana* is north, or towards the south if the Sun's *ayana* is south. Then e'w is the true orientation of the east-west line.

Now, through O, draw a line EW parallel to e'w. Then, relative to the point O, E is the east and W the west. The line NS, drawn through O, at right-angles to EW is the north-south line, N being the north and S the south relative to O.

Here, θ (Rsine θ) is local latitude. The value of Rcos θ (local co-latitude) and the local latitude Rsine θ can be calculated by using the Śanku on the equinoctial day or in any other day by taking into consideration of the Sun's declination on that particular day, as follows.



NESW is Horizon, NESW are directions, Z is Zenith of the local place, ZRSTNP is Local Meridian, R is the point of intersection of local meridian and Celestial Equator, RETW is Equator, O Local Place, RD is perpendicular (\perp) to Horizon, Sun is at R at mid noon, OY is Śanku and is perpendicular (\perp) to Horizon, OX is its equinoctial mid shadow, XY is its Hypotenuse, RO is celestial radius, Arc RZ (\angle ROY) is Local Latitude. 1. \triangle RDO similar to \triangle YOX, 2. \angle ROY= \angle OYX = \angle DRO, 3. All these three are angle θ , 4. Rsine θ is local latitude, 5. \angle RDO = \angle OYX = 90° 6. RO and YX are Parallels, and because the line (OY) cut these parallels RO and YX, the opposite angles (\angle ROY= \angle OYX) are equal in degrees.

Latitude of any place on the surface of the Earth is R sine θ of this Sanku Triangle,

where θ is the angle between the Sanku and the hypotenuse. R sine θ is known as Jya (String) or exactly Ardha Jya (1/2 String) of a Bow and Arrow, in our Hindu Astronomy. This Jya became Sine in Western world, on spread from Bharat. R cos θ = R × Adjacent side ÷ Hypotenuse and R sine $\theta = R \times Opposite$ side \div Hypotenuse. Adjacent side is Sanku and opposite side is the shadow of Śanku and from the height and shadow of the Śanku, Hypotenuse is derived. Hypotenuse is equal to $\sqrt{\left[(\text{Sanku})^2 + (\text{Shadow of Sanku})^2\right]}$. Hence, Lattitude Rsine $\theta =$ 3438` × Shadow of Śanku ÷ $\sqrt{\left[(\text{Śanku})^2 + (\text{Shadow of Sanku})^2\right]}$. Here Śanku is of 12 Angula keep any length) and Shadow of Śanku is at exactly mid noon of the place in length (we can concerned, on the equinoctial day. So its termed as equinoctial mid shadow. R is 3438 minutes of angle. This is because, $2\pi R$ is 360 ° (Circumference of a circle which is 360° always). So, R is 360 $^{\circ}$ ÷ 2 π = 3438 $^{\circ}$. Thus, by using the Sanku and the above calculations, both developed and adopted in our Nation in the remote past, we can fix the directions exactly at the place of construction of the Temple and it is the very reliable, exact and correct method in fixing the directions. The R sine θ (Ardha Jya) values including the computation and derivation for the angles of a circle from $3^{\circ} 45$ to 90 ° are given at intervals of $3^{\circ} 45$ (totally 24 values) by Aryabhatta in 2741 B.C.E in his Astronomial and Mathematical text Āryabhattīyam in slokas 11 and 12 of 2nd Addhyāyah (Ganita Pādah). Sūrya Siddhāntah gave these values in 16 to 23 slokas (including values of versed sine, Utkrama Jya) of 2nd Adhyāyah (Sputa Gatih). Value of Ardha Jya for 90 $^{\circ}$ is 3438` where the length of the chord (string of the bow) will be equal to radius of the circle.

This method and science of fixing the directions exactly, at any locality on Earth, by using the Śanku and these calculations, are detailed well in the ancient astronomical texts of our Nation, in the remote past itself. Even the ancient non-astronomical texts are also describes it, at times. For example, "Nedunal Vādai" an ancient Sangham Tamil Literature and one the Ettuthokai texts, describes it as follows.

The meaning is "The Sun rising at east, proceeds towards west. On the day at which there were no shadows, exactly at mid noon, neither on north or south side of the two Śanku (wooden sticks), the experts of civil engineering who knew well the texts of civil engineering and architecture (Silpa Sāstra), fixed the directions at that place with ropes, after worshiping God and thus started constructing a great palace for the great King."

The two Sanku will not cast their shadows at their northern and southern sides, at exact mid noon only on a day when the local latitude of that place and the declination of the Sun is exactly equal. That means, on that particular day, the Sun rises in the East exactly in the line of the latitude of that place. Thus, the Sun will be exactly at the zenith of that place, at exact mid noon, on that day. Thus, our ancestors knew the Sun's declination (and other celestial co-ordinates) and the latitude co-ordinates (and other co-ordinates) of the Earth. This can be proved by citing the following proofs.

1. Sūrya Siddhāntaḥ 2 and 57th sloka of 1st Adhikāraha (Madhyamādhikāraha) clearly reveals that this text was taught at the end of Krta Yuga of the present 28th Mahāyuga i.e. 1296000 +864000+5112 (21,60,112) years before present. Sloka 8 and 9 of 1st Adhikāraha mentions it was taught every yuga to Rshies by Bhāskara (Sun God) i.e. even prior to this period. The 8th Adhikāraha (Nakṣatragrahayutyadhikāraha 21 Sloka) gave the Polar Longitude (DHRUVAḤ, DHRUVAKAM) and Latitude (VIKṢEPAḤ) of all 28 Ecliptic stars, as follows.

Asterisms.	YOGA-TÁBÁS or prin- cipal stars.	App	arent tude	longi- s,	Apparent latitudes		
		8	0		0		
As'wini,	a Arietis,	0	8	0	10	N.	
Bharaní.	Musca,	0	20	0	12	N	
Krittiká,	Tauri, Pleiades,	1	7	30	5	N.	
Rohiní,	a Tauri, Aldeharan,	1	19	80	• 5	N	
Mríga,	λ Orionis,	2	3		10	8.	
Ardrá	a Orionis,	2	7	20	9	S.	
Punarvasu,	ß Geminorum,	3	3		6	N.	
Pushya,	5 Canori,	8	16		0	N.	
As'leshá,	a 1 and 2 Cancri,	3	19		7	8.	
Maghá, ·	a Leonis, Regulus,	4	9		0	N.	
Purvá-phálguní	δ Leonis,	.4	24		12	N.	
Uttará-phálguní,	8 Leonis,	5	5		13	N.	
Hasta	y or & Corvi,	5	20		11	S.	
Chitra.	a Virginis, Spica,	6	0		2	S.	
Swátí,	a Bootis; Arcturus,	6	19		87	N.	
Vi'sákhá,	a or x Libra,	7	9		1	80' S.	
Anurádhá.	& Scorpionis,	7	14		8	8.	
Jyeshthá,	a Scorpionis, Antares,	7	19		4	8.	
Múla,	v Scorpionis,	8	1		9	8.	
Púrváshádhá,	ð Sagittarii,	8	14		5	30' S.	
Uttaráshádhá,	τ Sagittarii,	8	20		5	S.	
Abhijit,	a Lyri,	8	26 4	6	60	N.	
S'ravana,	a Aquilæ,	9	10		30	N.	
Dhanishtha,	a Delphini,	9	20		36	N.	
S'atatáraká,	λ Aquarii.	10	20		0	30' 8.	
Púrvábhádrapadá,	a Pegasi,	10	26		24	N.	
Uttarábhádrapadá.	a Andromedo,	11	8		26	N.	
Revatí,	ζ Piscium, 11	29	5		0 0	N.	

The other ancient astronomical texts of our Nation also detail these data. Bhāskara's Mahābhāskariyam and Laghu Bhāskariyam, Lallācārya's Śishyadhīvrddhita Tantram, Brahmagupta's Brahmasphuṭa Siddhāntaḥ and Khanḍa khādyaka, Śrīpati's Siddhānta Śekara, Bhāskarācārya's Siddhānta Śiromanī gave the celestial longitudes and celestial latitudes of these 27 ecliptic stars.

2. The astronomical terms and the names of these co-ordinates are given in these ancient astronomical and mathematical texts, at the remote past itself. This clearly proves that our ancestors had expertise knowledge in astronomy, including co-ordinates and they applied them in their day to day life. The following is the glossary of astronomical terms, though it is not a complete collection.

Agrā – Amplitude, Ahorātrav<u>r</u>tta – Diurnal circle, Akşa Amsa – Latitude of a place, Akşajya – R sine Latitude, Akşakarna - Equinoctial Mid Shadow, Akşakoti - Co-latitude, Akşonnati -Inclination of Earth's Axis, Apakrama – Greatest Declination, Apakramavrtta – Ecliptic, Apamandala, Krāntimandala Krāntivrtta – Ecliptic, Ardhajya – R sine, Avanama – Zenith Distance, Ayanānta – Solstice, Ayanacalana – Oscillation of Eqinox, Bhūgola – Earth, Gola – globe, sphere, Candrakarna – Distance of Moon from Earth, CandraPāda – Nodes of Moon (Rāhu and Ketu), Chayākarna – Hypotenuse of a Sanku Triangle, Drkjya- Rsine of Zenith, Dīrgāmsa – Longitude of a place, Desāntra – Longitude of the place, Drkgola – Visible Celestial Sphere, Drksepa – Ecliptic Zenith Distance, Drksepamandala – Vertical circle through central ecliptic point, Drgmandala – Visible vertical circle, Drgamascāpa – Zenith Distance, Dhruva – Pole, Dhruvaka – Polar Longitude, Jya – R sine, Hora – 1/24 th of a day, Kadamba – Pole of ecliptic, Kakşa – Orbit, Kapāla – Hemisphere, Kotijya – R cosine, Koti – Perpendicular Side Of Right Angled Triangle, Krānti, Apama – Declination, Krāntijya – Rsine declination Lanka and **Ujjaini** (Line of Prime Meridian), Krāntipāda – Eqinox, Ksipti, Sara – Celestial Latitude, Kshitija (Harija) – Horizon (Vateśvara Gola 3-2), Lambajya – Rsine of co-latitude, Lambāmsa - Co-latitude in degrees, Lambana - Parallax of Longitude, Mandanīca - Perigee and Perihelion, Mandocca – Apogee and Aphelion, Nādivalaya, Visuvadvalaya, Nādivrtta, Visuvadvrtta – Celestial Equator, Natakāla – Hour Angle, Nati, Avanati – Latitudinal Parallax, Nīcocca V<u>r</u>tta – Epicycle, Parama Lambana – Horizontal, maximum parallax, Paridhi, Nemi – Circumference, Pūrvāparā - East West Line, Ravikarna - Distance of Sun from Earth, Rekha, Madhya Rekha -**Prime Meridian**, Samamandala – Prime Vertical, Sphutaviksepa – Celestial Latitude corrected by Parallax, Sanku – Gnomon Rsine Latitude, Trijya – Rsine of an arc of 90°, Unnati, Unnata – Altitude, Udvrtta, Unmandala – Equinoctial, 6'o clock, east west circle, Vidigvrtta – Intermediate Cardinal Points, Viksepa – Celestial Latitude of a Graha (Polar Latitude), Vimandala – Orbit of a Graha, Viśuvat – Equator, <u>Vrtta – Circle (Vertical)</u>, Yamayotrav<u>r</u>tta – The Local Meridian passing through North South Cardinal Points. These are all the some of the astronomical terms frequently used in the ancient astronomical texts of our Nation, showing the richness of our ancestor's knowledge in astronomy.

3. Reference of Lanka Ujjiani Prime Meridian in our Nation's ancient astronomical texts

A. Sūrya Siddhāntaḥ 37 to 42,52,70 and 71st Śloka of 12th Adhyaya mentioned about Lanka as a great city situated in the southern part of Nation Bharata on Earth's Circumference (Equator) [39 Śloka]. It mentioned 4 cities 1. Lanka 2. Yamakoti of Bhadraasva Nation in East 3. Romaka in Ketumaalaa Nation in West 4. Opposite to Lanka is Siddhapuri of Kuru Nation. These 4 cities situated on Earth's circumference at equal distances (90° apart). In these places there is no equinoctial mid shadow (when Sun raises at Equator (Equinox) with 0° declination). Śloka 1-62 mentions Avanti (Ujjaini) in Prime Meridian (Rekha).

B. Āryabhaṭṭīyam of Āryabhaṭṭa (2764 B.C.E.) mentions in the 14th Sloka of 4th Addhyāya (Golapāda) as, from the centre of land and water, at a distance of one quarter of the Earth's circumference lies Lanka and exactly northwards of Lanka at a distance of 1/16 of the Earth's Circumference lies Ujjaini ($360^\circ \div 16 = 22.5^\circ$),

C. Brahmagupta (30 B.C.E.) in Brahmasphuta Siddhāntah of (21-9) at 1/15th part (24°),

D. Varāhamihira (123 B.C.E.) in Pancasiddhāntikā in 10,11,17,19, 26 and 32nd sloka of 13th Addhyāya (Trilokyasamsthānam) 17th sloka and

E. Mahābhaskariyam of Bhāskara (522 /629 C.E.) both texts mentioned in 1,2,sloka of 2nd Addhyāaya mentions that Lanka and Ujjaini are in the same meridian,

F. Karanaratnam of Devācarya 30th sloka of 1st Addhyāya mentioned in the same way,

G. Lallacārya's Śishyadhīv<u>r</u>ddhita Tantram 17th Addhyāya (Bhoogolāddhyāya) in sloka 3,4 and 12 and 19th Addhyāya (Bhuvanakośa) 24 and 25 sloka describes Kanya (Kumārikā) part of Bhārat Nation. Lanka is in this part. 40th sloka describes Ujjaini at Prime Meridian,

H. Vateśvara Siddhāntaḥ and Gola 10th sloka of 5th Addhyāya of Gola part mentioned the four cities including Lanka in Equator, 1,2 sloka of 8th section of 1st Addhyāya that Lanka and Ujjaini in Prime Meridian

I. Sripati's Siddhānta Sekara in 2nd Addhyāya 95 to 97 sloka mentioned that Lanka and Ujjaini in Prime Meridian

J. Siddhānta Dharpana of Nilakanda Somayaji 15th sloka mentioned that Ujjaini is north to Lanka by 1/15th part of Earth's Circumference,

K. Bhāskaracārya's (486 C.E.) Karankutukalm 1-14 sloka mentioned that Ujjaini in Prime Meridian (Madhya Rekha),

L.Goladeepikā of Paramesvara in 3rd Addhyāya describes the Earth and its divisions, In 8,9 and 26 to 29 sloka mentioned the four cities including Lanka. In 77 to91 describes the Nation Bhārat and 92nd sloka after describing the river Ganga, mentioned that Lanka is situated at the top of the mountain in the Malya Island, one of the six islands of Kumaari Island situated at the southern most end of Bhārat (Anga, Yava, Malaya, Sankhaka, Kumuda and Varāha), Rivers flown from Malaya mountain were Krtamālā and Tāmpraparanī,

M. Laghumānasam of Manjulācārya 3rd sloka of 4th Addhyāaya mentioned Avanti (Ujjaini) in Prime Meridian. This proves that initially Lanka Ujjaini was the prime meridian and when the westerners copied these co-ordinates from these texts, they changed it to Greenwich.

4. The Jantar Mandir, present even to-day at Ujjaini, Delhi, Varanasi and Jaipur and the various instruments like Transit Instument, Sun-Dial, Ram Yantra etc. constructed there proves our ancestor's knowledge in astronomy.

5. ANKGOR WAT OF CAMBODIA

The measurements and meaning became apparent when the unit of measurements were changed from meters to cubits. It was then that the temple began to demonstrate the ways in which the history of the king, cosmology, astronomy, the calendar and the realm of Gods were all interrelated. All the information gleaned from inscriptions about culture and architecture of Angkor Wat was suddenly manifest in the temple itself. Both northern and southern corridors of the third gallery are 202.14 meter long and the eastern and western corridors are 114.22 and 114.24 meters respectively. Why and how the circumference was constructed in a remarkably accurate manner? The answer lies in understanding the basic.

If we alter the unit of measurement from meters to cubits it has shown the answer. Cubit is a length from elbow to outstretched fingertips. Cubits and related units were inherited in Cambodia from Bharat. Might be the King Suryanarayanan's (in whose period it was constructed) cubit used. One cubit will be about 0.43545 meters. North south axis in the sanctuary is of 13.41 cubits and 13.41 cubits is a basic module in the second gallery, devoted to Brahma, who is situated in the north celestial pole. Ankgor Wat is situated 13.43 degrees of Northern Latitude. Thus, the construction of the temple was done, with measurements of structures, at a value equal to the local latitude of that place. It proves that the temple sthapati knew astronomy very well. If we estimate the longitude of Ankgor Wat in relation to Ujjaini Lanka Longitude, it may yield better results. Ujjaini Lanka is the prime Meridian in ancient days (0°) It is $75^{\circ}46'38''$ and Ankgor Wat is $103^{\circ}52'$ of Greenwhich. Hence Ankgor Wat is $28^{\circ}5'22''$ East of Ujjaini Lanka Meridian.

On measuring we should follow how in what manner our ancestors adopted, 1. The outer axial measurements should extend the farthest physical point of the structure, 2. The inner axes should extend from doorway to doorway only and not to cross the thresholds, 3.Raised surface ledges to be included, 4. In bridge and cause way the measurements should extend to wall of staircase and and centre of staircase, 5. Balustrades are the boundary of measurements along the causeway, 6. Paths of circumambulations should be included in measurements, 7. The central space also should be included, 8. The circumference of each of the four enclosures is determined by a line along the centre of the circumference corridors. Assess it with their own scale and ways and not with the so called modern methods which will not yield results exactly.

We should view the ancient structures with the eyes and mind of the constructors and not with our own. This is the very needed lesson Ankgor Wat teaches us.







Thus, when we understand and follow the methods and means of the constructors, then only we can understand the basic aspects and the secrecy of the construction correctly otherwise we will be misled to wrong conclusions.

6.360 DEGREES OF A CIRCLE AND VEDA

Rg Veda Samhitā 1st Mandalam 164th Sūktam (Hymn) 48th Mantram (verse) reveals,

द्वादश	प्रधयश	चक्र मेकं	त्रीी	णे	नभ्यानि	क	उ	तच्चिवे	त्त ।	
तस्मिन्त्र	नकं	त्रिशता	न	शड्	् क वोर्ऽा	र्पताः	ষ	ष्टिर्न	चलाचलासः	11

Dvādaśa pradhayaś cakram ekam trnī nabhyāni ka u tacciketa |

Tasmintsākam triśatā na śańkavo'rpithā satsirna calācalāsah ||

Meaning: Dvādaśa– 12; pradhaya: – the arcs of a wheel; cakram ekam – one wheel; tr<u>n</u>ī - three; nabhyāni – axles or hubs or centre part of the wheel; triśatā ṣaṭṣi – 360; śańkava – spokes of the wheel; calācalāsaḥ – movable and immovable.

The arcs are twelve, the wheel is one and three are the axles. Who indeed knows it? Within it are collected three hundred and sixty spokes, which are as it were movable and immovable.



This shows clearly that the time divisions in our Nation, is based on the angular distance covered by the Earth, in the Ecliptic round the Sun, in that particular time. One year is the time required for the Earth to travel 360° (one full circle) of angular distance, in its ecliptic around the Sun. In the same way, one month for 30° (one arc-rāsi-sign), one day for 1° (amsa- spoke), one ghatika (nādi-nādika) for one minute (lipta-kala), one vighatika (vinādi, vinādika) for one second (vilipta, vikala) and one Gurvakshara is the time required for the Earth to travel one third (tatpara) in its ecliptic around the Sun. Thus, there is an exact confluence of the spatial distance traveled by the Earth in the Ecliptic in its unidirectional motion and the Time Measurements developed in our Nation. This is completely Scientific and is totally based on the angular distance covered by the Earth in the Ecliptic and the time required for that. Thus, the concept of 360° of angles for a circle, is based on Earth's revolution round the Sun in the Ecliptic, as revealed in $\diamond g$ Veda verses 1-164-48 and 11. Hence, it is clear that 1. The concept of 360° of angles for a circle and 2. The Time Space and the Direction Concept (Dik Deśa Kāla Vardhamāna) of the most modern science, had been developed scientifically and applied in the day-to-day life, by our Ancestors, in the remotest antiquity itself.

7. Dates at which the rays of Sun fall on Sivalinga at various temples shows that our ancestors knew astronomy well and with that sound knowledge only they have constructed temples in a very scientific way. In the following, the dates and the name of the temple are given, where the Sun rays and or Moon rays are falling on the Idols at a particular time and date in every year.

1. Tamil New Year Day, Chitrai 1 (Souramana) Kattur Chennai and Sankaran Koil, Thirunelveli (SankaraNarayanar, Gomathiamman) on Gomathiamman, 2. Chitria 2,3,4 Kalnattampuliyur Thiruchirapalli, 3.Chitrai 7 to 18 Chembanar Swarnpuresvarar, 4. Chitrai 11,12,13 Kumbakonam Nagesvarar, 5.Chitrai 13,14 Thiruvasi, 6.Chitrai 13,14,15 Thiruchotruthurai,7.Chitrai 18,19,20,21 Patteesvaram Sree Dhenupureesvarar, 8.Aadi 1,2,3,4,5 Thirunedunkulathur Chennai, 9. Aavani **19,20,21 and Maasi 19,20,21** Thirunaraiyur, 10. Purattasi 7,8,9 and Punguni 7,8,9 Thirupainjili, **11. Purattasi 8, Panguni 8** Thiruppatrurai, 12. Thai Rathasaptami 1. Kanchipuram Ekambaranathar_2. Thiruchenkodu Erode, 13. Thai Amavasyai for 1 week_Thirunelveli Sree Nelliayappar, 14. Masi Sivaratri Thirumurukanpoondi Avinasi, 15. Masi 13, 14, 15 Thirucherai, 16. Masi 18 Sree ARUNACHALESVARAR, 17. Masi 24, 25, 26 Thirukarukavur, 18. Masi 30 for 1 week Nannilam, 19. Masi 8,9,10 Evening Time from 5-30 PM onwards first on Nandhiyam Peruman, then at the footstep of Kuruvarai (Sanctum Sanctorium), then at the base, middle part and then upper part of Sivalinga, (2 minutes at each part) Tharamangalam Salem, 20. Panguni 1,2,3 Manthurai, 21. Panguni 13,14,15 Thiruvedikudi, 22. Panguni 26,27,28 SreeMakudesvarar ThirupandiKodumudi Erode and on Equinoctial days, Modhera (DharmaAranya), Gujarath 102 Kms from Karnavati, on the bank of Pushpavathi River. The temple was constructed during the rule of King Beemdev of Solanki Kingdom, in 1026 C.E.. The Light Rays of the Sun fall on Surya Bhagavan (the Main Diety) in the mornings. Sthalapurana says Sree Rama with Seetha Matha on return to Ayodhya, after victory at Lanka worshiped here, on the advice of Rishi Vasista. In Thirunaraiyur, Thirupainjili and Thiruppatrurai these temples are constructed in a very special manner so that the rays of the Sun worship Sivalinga both during Uttarayana and Dakshinayana transits of the Sun, as shown by the dates mentioned above, which are exactly six months apart.

The most interesting will be the temple at Thirunagesvaram, near Kumbakonam. Here we worship Sree Naganathasamy (Senbaka Aranyesvarar) and Piraiyanivannuthal Umaiambikai (Arthachandrabimba Gujambikai). On Karthikai Month Pournami (mostly the star of the day is Krittika), Night 8 to 9 PM, the Light Rays of Moon will fall at the feet of Piraiyanivannuthal Umaiambikai. Chandra is said to perform Pooja and worship Piraiyanivannuthal Umaiambikai on Karthikai Pournami day. The following diagram shows that the Earth and the Moon are in conjunction with the ecliptic star Kritika. However with Earth as the reference point the Moon is in conjunction with the star Kritika and the Sun is exactly 180 degrees apart at Vriscika Rasi and thus it I s a full moon day (Pournami). Since the Sun is at Vriscika Rasi, it is Kartika month. This month is named as Kartika, because in almost in all Kartika months of all years, the Sun is at Vriscika Rasi and the Moon is at 180 degree apart from the Sun (full moon) in conjuction with the star Krittika. In our Nation, all the months of the year are named in this way only, i.e. with astronomical basis only. This shows our ancestors thorough astronomical knowledge. Here on the



Full moon day of Karthikai month, the Moon rays worship the feet of Piraiyanivannuthal Umaiambikai.

The same thing happens at Thingalur near Kumbakonam. Here we worship Kailasanathar and Periyanayakiambal. On Phalguna (Panguni) month Pournami (mostly the star of the day is Uttara

Phalguni, Uttiram), at Sun Rise, the Light Rays of the Sun fall on Sivalinga and at Moon Rise, the Light Rays of The Moon fall on the Sivalinga. Here the Moon is in conjunction with the star Uttara Phalguni (Uttiram) and is 180 degree apart from the Sun on seen from the Earth. Hence it is a full moon day and the month is named as Phalguni (Panguni). The Sun is at Meena Rasi with reference to Earth.



In these two temples the rays of Moon worship God on a particular month's full moon day only and not in all 12 full moon days of a year. This is because the Earth's axis is inclined at 23° 27[°] to its ecliptic path around the Sun. Thus the temples are constructed in a special manner that the rays can enter into the Sanctum Sanctorum at a particular angle calculated according to the declination of the Sun and the Moon, on this month's full moon day of this particular month. This is because the part of the Earth in direct line with the Sun varies constantly, when it revolves round the Sun in its Ecliptic. This is shown in the following figures.



Here it is shown that the Sun Rays fall straight at the Equator of the Earth on March 21st and September 23rd, at the tropic of Cancer on June 21st and at tropic of Capricorn on December 22nd. COCLUSION

In our Nation, the temple construction and architecture are completely based on astronomy and is done entirely on scientific basis only. Astronomy and Śankusthapānam are the basic, for arriving at the auspicious time for construction and for fixing the directions exactly. These scientific procedures are followed in our Nation, even in the remote past and are proved with strong evidences. Besides, the calculation of 360 degrees for a circle and the co-ordinate system of astronomy and geography are developed in our Nation, in the very ancient period itself. Thus, our Nation is the pioneer in astronomy, architecture, mathematics and the related sciences.