The zodiacal pillars of Sringeri

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The objective of this note is to see whether the twelve Rashistambhas (zodiacal pillars) of Vidyashankar temple, Sringeri have any astronomical significance. It is found that only two pillars are aligned with the direction of the rising sun on winter and summer solstice times, with partial obstructions by other pillars. The fortuitous alignment of the two pillars can be used to demonstrate the effect of precession on the Indian Siddhantic calendar, although these alignments have no bearing on the prevalent calendar.

The Vidyashankar temple at Sringeri, is a place of pilgrimage for Hindus and attracts a large number of tourists throughout the year. The place itself is famous as one of the Mathas established by the sage Shankara of the 8th century AD. Historians[1,2] cite records to date the construction of the temple to 14th century, by Vidyaranya who was instrumental in the rise of the Vijayanagar empire in South India.

The twelve pillars in the Vidyashankar temple (see Figure 1 for the ground plan) are popularly known as Rashistambhas (zodiacal pillars). Symbols of the twelve divisions of the zodiac are engraved on these pillars. The temple is an architectural marvel. Among the many delicate carvings, lions that are engraved in biped positions on the pillars may be mentioned. There are stone balls inside the growling faces of the lions and they can be moved inside their mouths. It is said[3,4] that the design of the pillars involved certain astronomical concepts – for example, the first rays of the rising sun fall on specific pillars with the zodiacal symbol on the pillar corresponding to the position of the sun.

Here we have to recognize that the symbols of the zodiac have two connotations. They represent the zodiacal constellations, i.e. nirayan rashis (Mesha, Vrishabha, etc.) which are used in India. They also represent zodiacal signs, i.e. sayan rashis (Aries, Taurus, etc.) used in the West. The rashis are fixed with respect to the zodiacal constellations in the sky, because they start from a fixed point on the ecliptic. The signs, on the other hand, shift with respect to constellations as they start from the vernal equinox which shifts backward by 1° in about 71 years due to precession. It is the signs that have an intimate relationship with the seasons, which in turn depend upon the solstices and equinoxes. As the Gregorian calendar is a seasonal (tropical) one, the date of entry into each sign is fixed as shown in Table 1. The association of the rashis is not fixed with respect to the seasons, they lag behind the seasons by 1 day in 71 years. The rashis and signs were identical in about AD 300 and now they differ by 24° or 24 days. The Rashistambhas of Sringeri most probably represent rashis and not signs.

The point of sunrise on the eastern horizon is determined by the time of the year and the geographical latitude of the observer, $\phi = 13.5$ N for Sringeri. We assign to the rising point an azimuth A, which is the angle between the point of sunrise X and the geographical north point N on the horizon, as shown in Figure 2. The angular distance XX' between X and equator BX is the declination δ of the sun. It remains almost constant during the day as the sun moves along the small circle CX. From spherical trigonometry we get

$$\cos A = \sin \delta / \cos \phi,$$

$$\sin \delta = \sin \lambda \sin e,$$

where λ is the tropical longitude of the sun measured from vernal equinox and e is the obliquity of the ecliptic equal to 23.5°. Table 1 gives the azimuth of the rising sun at Sringeri on various dates of the year. It also gives the azimuth of the moon when

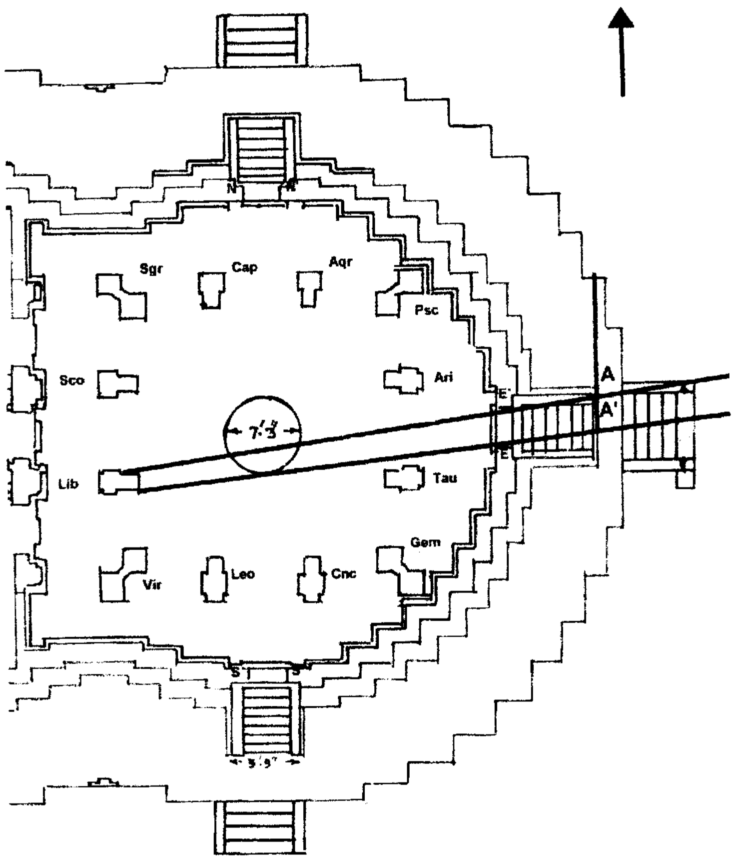

Figure 1. Ground plan of Sringeri temple (courtesy Archeological Survey of India).

it reaches extreme declinations of ±28.5°, because the moon's orbit is inclined to the ecliptic by 5°.

We see that the rising sun has the same azimuth twice during the year, once in Uttarayana from 22 December to 22 June, and again during Dakshinayana from 22 June to 22 December. This is illustrated in Figure 3 for a dark chamber where sunlight can enter through a slit in the eastern wall. The directions of the sunbeam on various dates are indicated in Figure 3. As can be seen on days of equinox, i.e. March 21 and September 22, the sunbeam is perpendicular to the wall. The azimuth of the sun at the time of rise is given in Table 1 for different constellations.

The eastern door of the temple has a certain width *EE′* (Figure 2). In this case a pillar can be fully illuminated when the sun beam enters the temple. The azimuth of the rising beam can be calculated from the width of the door and the width of the pillar. Table 2 shows the dates for full illumination of various pillars during the year. In the case of Mesha, Vrishabha, Simha and Makara, the two periods merge into a single period. The pillars of Mithuna, Karka, Kumbha and Meena are never illuminated. Further, illumination of the Simha and Capricorn pillars is obstructed by those for Vrishabha and Mesha respectively.

A solar month in the Indian calendar starts from the sun's sankramana (entry) into each rashi, e.g. Mesha month starts from the entry of the sun into Mesha rashi. At present, Mesha sankramana occurs on 14 April. However, this date changes by one day in 71 years due to precession. During the 14th century Mesha sankramana used to occur on 5 April. The corresponding dates for the beginning of various solar months are given in Table 3.

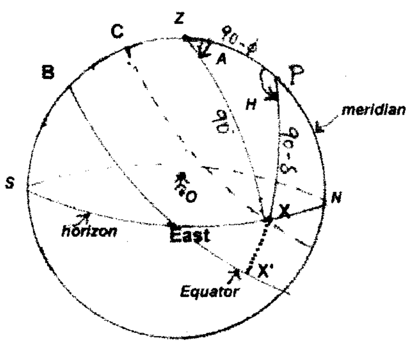

Figure 2. Definition of azimuth *O* is the location of observer in this celestial sphere. If *X* represents the point of sunrise on any day, *NX*, i.e. the angle XON is the azimuth.

Table 1. Azimuth of the rising sun

Sign	Entry date	Tropical longitude of the sun, λ	Declination (degree)	Azimuth, *A*	Ray no. in Figure 3
Aries	22 March	0	0 (Vernal equinox)	90	4
Taurus	21 April	30	14.5	75	5
Gemini	22 May	60	20.2	69	6
Cancer	22 June	90	23.5 (Summer solstice)	66	7
Leo	23 July	120	20.2	69	8
Virgo	23 August	150	14.5	75	9
Libra	23 September	180	0 (Autumnal equinox)	90	10
Scorpio	23 October	210	–14.5	105	11
Sagittarius	22 November	240	–20.2	111	12
Capricorn	22 December	270	–23.5 (Winter equinox)	114	1
Aquarius	21 January	300	–20.2	111	2
Pisces	20 February	330	–14.5	105	3
Moon	Maximum		28.5	61	
Moon	Minimum		–28.5	119	

Table 2. Full illumination of various pillars

Pillar	*A*	*A′*	Duration
Mesha (Aries)	108	114	8 November–1 February
Vrishabha (Taurus)	65	72	7 May–13 August
Mithuna (Gemini)	46	48	Never
Karka (Cancer)	52	52	Never
Simha (Leo)	66	67	22 June ± 10 days
Kanya (Virgo)	70	72	6–17 May, 28 July–8 August
Tula (Libra)	80	82	6–11 April, 1–8 September
Vrischika (Scorpio)	94	96	10–14 March, 5–10 October
Dhanur (Sagittarius)	105	107	1–20 February, 23 October–12 November
Makara (Capricornus)	113	114	22 December ± 10 days
Kumbha (Aquarius)	123	124	Never
Meena (Pisces)	130	132	Never

Table 3. Solar and tropical months

Solar month		Tropical month		
Month	Sankramana date during 14th century	Sign	Month*	Entry date
Mesha	5 April	Aries	Madhava	22 March
Vrishabha	5 May	Taurus	Sukra	21 April
Mithuna	5 June	Gemini	Suci	22 May
Karka	6 July	Cancer	Nabha	22 June
Simha	6 August	Leo	Nabhasya	23 July
Kanya	7 September	Virgo	Isha	23 August
Tula	8 October	Libra	Urja	23 September
Vrischika	8 November	Scorpio	Sahas	23 October
Dhanur	5 December	Sagittarius	Sahasya	22 November
Makara	5 January	Capricorn	Tapas	22 December
Kumbha	5 February	Aquarius	Tapasya	21 January
Meena	5 March	Pisces	Madhu	20 February

*Names of tropical months are from the Indian Astronomical Ephemeris.

Tropical months which have recently come into use, start from the entry of the sun into signs, e.g. the Madhava month starts from the entry of the sun into the sign of Aries on 22 March. The dates of commencement of various tropical months are also given in Table 3.

A comparison of Tables 2 and 3 shows that on the days of equinox the rising sun beam reaches the deity as expected. Further, there is no correspondence between the date of illumination of a pillar and the date of entry of the sun into the corresponding rashi or sign. The mismatch with rashis will continue to increase with time. There is only one exception, viz. the date of entry into the sign of Capricorn on winter solstice. This is a fact that needs to be verified throughout the year.

The northern and southern doors offer another clue. A narrow beam of rising sun illuminates the pillars from these doors only in the days of solstice. On 22 December, when the sunbeam from the eastern door illuminates the Sagittarius pillar, another narrow beam illuminates the Virgo pillar from the southern door. Similarly on 22 June, the sunbeam illuminates the Leo pillar from the eastern door and the Sagittarius pillar from the northern door. From the widths of the doors, it can be verified that the arrangement corresponds to $\phi = 13.5°$.

Since the rashis match only for 22 December, i.e. winter solstice, it may be concluded that marking the passage of Uttarayana was the most important task of this arrangement.

Since it was and is the lunar calendar that is being followed, one can verify if this arrangement helped in matching the lunar and solar calendars.

The summer solstice is marked by illumination of the pillar for Leo and not that for Cancer, as it should be. In both cases, there is obstruction by other pillars in the path of the sunbeam. It may be argued that gaps in the lion's body will allow illumination of these pillars.

Full moon by itself does not determine solstices and equinoxes because we seldom have a full moon on any sankramana day. So the lunar months are attached to solar months by fixed rules. For example, the new moon ending (amanta) month which contains Mesha sankranti is called as Chaitra as Chitra nakshatra and is opposite to Meshadi (starting point of Mesha). As Mesha sankaramana occurs on 14 April, at present the lunar Chaitra may start or end on that date. That is why Mesha

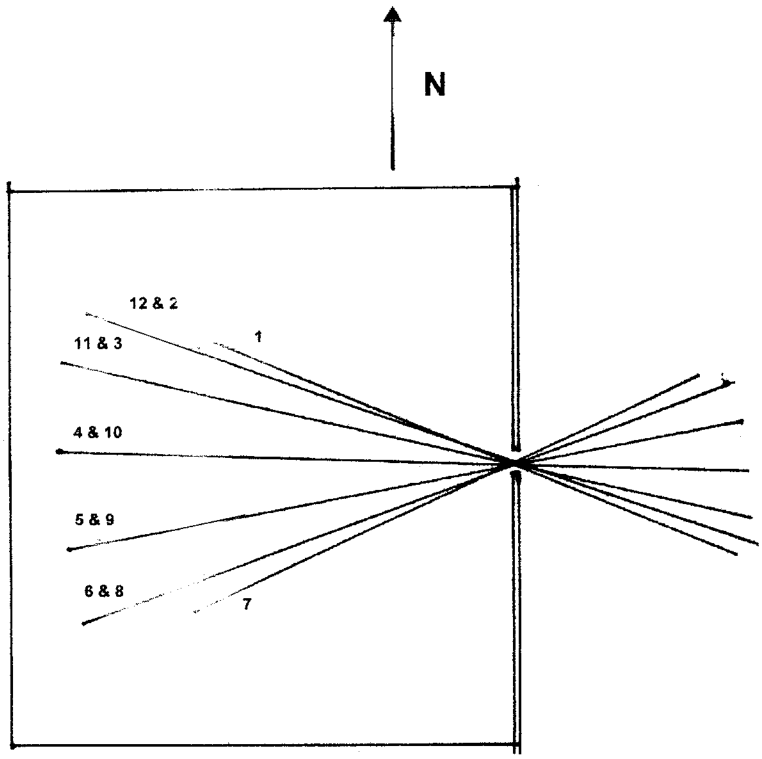

Figure 3. Direction of rising sunbeams on various dates (see Table 1 for numbering of the beams).

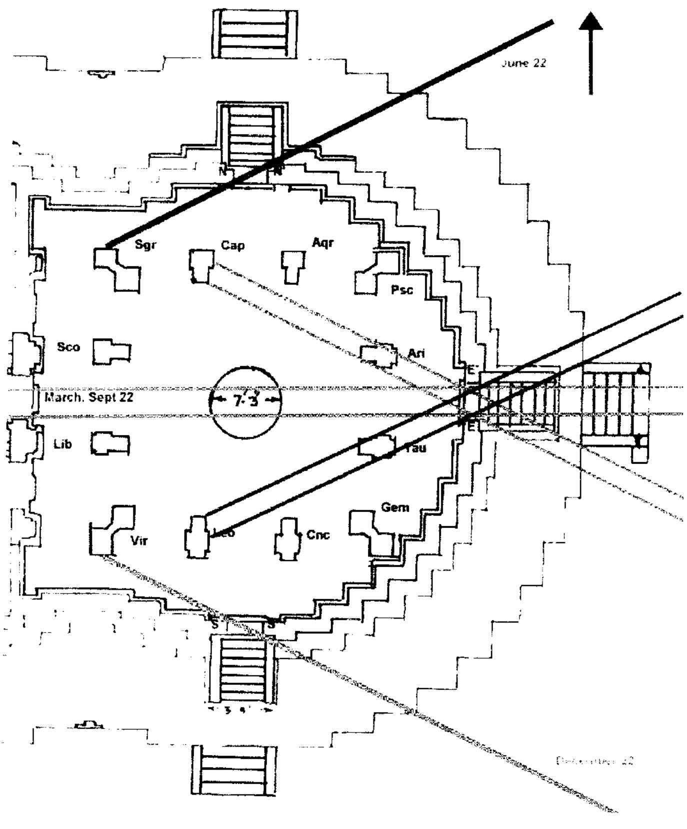

Figure 4. Direction of sunbeams on days of equinoxes and solstices as they enter the temple.

Table 4. Illumination of the pillars by the full moon

	Pausha paurnima	Ashadha paurnima
Date of full moon	21 December–20 January	22 June–21 July
δ (Sun)	–23.5 to –20.2	23.5 to 20.2
δ (Moon) Maximum	28.5 (23.5 + 5)	–15.2 (–20.2 + 5)
δ (Moon) Minimum	15.2 (20.2 – 5)	–28.5 (–23.5 – 5)
Azimuth (moon) (in degrees)	50 to 76	106 to 120
Pillar illumination	Expected: Mithuna–Karka	Dhanur–Makara
	Actual: Simha–Kanya	Dhanur–Makara

Table 5. Observations carried out to verify pillar illumination at sunrise

Date	Illuminated pillar
22.12.2000	Sagittarius
22.06.2001	Leo
21.02.2002	Sagittarius
11.03.2002	Scorpio

Table 6. Observations indicating that the north and south gates were designed for marking solstices

Date	Object	Declination	Azimuth	Comment
17.10.2000	Alpha Aries	23°27′N	70°	Seen through north gate
21.02.2001	Beta Corvus	23°23′S	123°	Seen through south gate
20.12.2001	Jupiter	22°51′N	69°6′	Seen through north gate at 7:20 pm
10.11.2003	Moon	22°14′N	69°8′	Seen through north gate
8.12.2003	Moon	24°27′N	67°	Not seen through north gate
10.12.2003	Saturn	22°14′N	69°	Seen through north gate at 7:30 pm
	Moon	26°56′N	63°	Not seen through north gate
2.6.2004	Moon	23°56′S	118°	Seen through south gate
2.7.2004	Moon	27°37′S	134°	Not seen through south gate
3.7.2004	Moon	25°36′S	124°	Not seen through south gate
4.7.2004	Moon	22°24′S	113°	Not seen through south gate

masa is called Chaitra in South India, while it is called Vaishakha in the north. Similarly, the full moon of Chaitra can occur any time between 31 March and 29 April. During the 14th century it would have occurred between 22 March and 20 April.

Let us consider the months of Pausha which contains Makara sankramana, and Ashadha which contains Karka sankramana. Then the full moon of Pausha should be found between half Mithuna and half Karka, and the full moon of Ashadha should be found between half Dhanu and half Makara. Let us see whether this tallies with the illumination of pillars in the Sringeri temple.

Table 4 gives the dates of full moon during the 14th century, and the range of declination of the sun during this period. The maximum and minimum declination of the moon and the names of the pillars illuminated by the moon (expected and actual) are also given. We see that the full moon of Ashadha paurnima illuminates the right pillars only on some occasions. The full moon of Pausha paurnima illuminates pillars that are completely off the mark.

Observations were carried out during 2000–04 to verify pillar illumination at sunrise (Tables 5 and 6).

Practical difficulties during solstices are the winter fog and onset of monsoon. Thus it was difficult to carry out systematic observations throughout the year. An alternative method was attempted as follows.

Since it is the declination of the celestial body that matters, it was decided to watch for bright stars, the moon and planets with declinations close to $\pm$ 23.5°. Table 6 provides important clues on the fact that the north and south gates were designed for marking solstices.

The first three entries in Table 6 are observations made by the author after noting the time of rise of the stars (Alpha Aries, Beta Corvus) and planets, watching them from the pillar. Azimuth was calculated subsequently. (Subsequent observations were obtained from two tourist guides, who could only identify the moon. However, the 'bright object' as reported by them, was easily associated with Saturn.)

Thus it is clear that the north and south gates are designed for observing the solstices. The eastern door is aligned exactly to the east, which can be verified on equinoxes. However, the first rays of the sun will not reach the idol as they are obstructed by the Dhwaja Sthambha, another pillar outside the temple. This was easily verified by noting the rise of the three stars on the belt of Orion.

Some questions remain unanswered. For example, was the symmetrical structure of the pillar aimed at architectural aesthetics? Why was the Uttarayana day (winter solstice) given priority? What was the purpose of the pillars on which the sunbeam never falls?

There is another aspect of interest to historians. Some of them[5] opine that the temple was constructed in different stages. Did the pillars exist prior to the construction of the walls with beautiful carvings? The answer to this may throw more light on the purpose and utility of the pillar design.

The above investigation indicates that the arrangement of two Rashistambhas in Vidyashankar temple, Sringeri is aligned in the direction of the rising sun during winter and summer solstices (Table 2). It should be noted that one pillar has the right sign and the other is completely off the mark. That the winter solstice pillar is called Makara, is in conformity with the wrong popular belief that Makara sankramana always represents the beginning of Uttarayana.

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