The Indic Mathematical tradition

Who was the Jeddi Knight who (re)defined Zero

Narrated by

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The Indic Mathematical tradition

Objective

Chronology
The main contributors
Astronomy
Calendrics

WHO INVENTED THE ZERO

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Scope of Presentation

- The Problem of Indic Chronology
- What they said about Indic contributions to Mathematics and Astronomy
- The Sutra Era of Vedic Mathematica
- Indologists who studied India
- Misdating of Aryabhatta
- The Vedanga period
- Conventional Timeline
- The assumptions we make

The Indic Mathematical tradition

Scope of Presentation

continued

- Proposed chronology
- Some definitions
- Calendars and Tithi
- The celestial clock and the sidereal zodiac
- Precession of the Equinoxes
- Hindu cosmological time frame
- Hindu Panchanga
- Who invented the zero ?

The Indic Mathematical tradition

Famous indologists who studied Indic literature

Sir William Jones (1746-1794) the founder of Indology, largely responsible for postulating a Proto Indo European language for which no speakers have been found and for misdating the chronology of ancient India	Hermann George Jacobi (1850-1837)was the first to suggest that the Vedic Hymns were collected around 4500 BCE based on Astronomical observations made by the Vedics
Thomas Babington Macaulay (1800-1859) decreed English to be the medium of instruction, drafted the Indian Penal Code	Friedrich Maximilian Mueller (1823-1900) translated the books of the east. His private views of these books were vastly at variance with his public pronouncements
Roberto Di Nobili(1577-1656),Jesuit Priest, posed as a Brahmana ,posited a counterfeit Veda, called the Romaka Veda	Rudolf Roth(1821-1893) studied rare manuscripts in Sanskrit
Abbe Dubois, Jean Antoine (1765-18) went to India to convert the heathen returned discouraged that it was very difficult too accomplish	William Carey'(1761-1834),Missionary
Sir Charles Wilkins (1749-1836) Translated the Bhagavad Gita in 1785	Colonel Colin Mackenzie (1753-1821) Collector of Indian Manuscripts
Henry Thomas Colebrook (1765-1837) Studied Sanskrit from the Pundits and wrote on the Vedas	Horace Hayman Wilson (1786-1860) First Boden Professor of Sanskrit at Oxford U wrote on the Puranas
August Wilhelm Schlegel (1767-1845) Lecturer in Sanskrit ,Bonn University	Franz Bopp (1791-1867) Did detailed research leading to postulation of Proto Indo European (PIE)
James Mill (1773-1836).Completed The History of British India in 1817	Colonel Boden who endowed the Boden Chair of Sanskrit Studies in 1811 with the purpose of debunking the Vedas
Sir Monier Monier-Williams (1819-1899),Boden Professor of Sanskrit, Oxford	Robert Caldwell (1815-1891) Collected Sanskrit manuscripts, a British missionary
Sir Alexander Cunningham (1814-1893), member of Asiatic Society of Bengal	Vincent Smith(1848-1920), author of Oxford History of India
Frederick Eden Pargiter (1852-1897) published 'Purana texts of the Dynasties of the Kali age"	Arthur Anthony McDonell(1854-1930), brought 7000 Sanskrit manuscripts from Kashi to Oxford University
Sir Mark Aurel Stein (1862-1943),Archaeological Survey of India	Maurice Bloomfield (1855-1928), interpreted the Vedas
Arthur Barriedale Keith (1879-1944) published 'The religion of and philosophy of the Vedas' in 2 volumes in 1925, Canbnot be regarded as a authentic or reliable translation	Sir Robert Erie Mortimer Wheeler(1890-1976)
	Alexander Basham
Morris Winternitz (1863-1937), wrote History of Indian Literature	Alain Danielou (1907-1994)
Sir John Hubert Marshall,(1876-1958) director general Archaeological Survey of India	Joseph Campbell (1904-1987) follows in the tradition of Heinrich Zimmer, albeit he uses the word myth much too liberally
Edwin Bryant (Ph.DColumbia,1997)	
Heinrich Zimmer (1890-1943) author of Philosophies of India "Indian philosophy was at the heart of Zimmer's interest in oriental studies, and this volume therefore represents his major contribution to our understanding of Asia. It is both the most complete and most intelligent account of this extraordinarily rich and complex philosophical tradition yet written."	

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The Problem of Ancient Indic Chronology

- Created by Sir William Jones (1746-1794)
- He single handedly retrofitted Indic History to fit his own misconceptions
- Lopped off 1200 years from Puranic Itihaasa texts
- Mistakenly identified the identity of Sandrocottus, referred by Megasthenes with Chandragupta Maurya
- Thus was born the subject of Indology analogous to Entomology, the study of insects

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It must have been the Aryans !

- Eurocentricity (a euphemism for a clearly racist attitude) gave greater credit to Greece and later to Babylonian mathematics rather than recognize Indic and Vedic mathematics on its own merits
- Indics incapable of discovering and utilizing a gamut of mathematical techniques
- Ergo, since the Indics were incapable, the discoveries were made by a mythical race from elsewhere – the Aryans
- The Circular argument persists to this day – assumptions are treated as facts and any conclusion contradicting the assumption is therefore dismissed summarily as absurd

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Colonialism and its forms of knowledge

The command of Language and the Language of Command

Sir William Jones learning Sanskrit from Indian Pundits

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What the rest of the world said about Indic contributions

The historian Florian Cajori, one of the most celebrated historians of mathematics in the early 20th century, suggested that "Diophantus, the father of Greek algebra, got the first algebraic knowledge from India." This theory is supported by evidence of continuous contact between India and the Hellenistic world from the late 4th century BC, and earlier evidence that the eminent Greek mathematician Pythagoras visited India, which further 'throws open' the Eurocentric ideal.

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Saad al-Andalusi,

the first historian of Science who in 1068 wrote Kitab Tabaqut al-Umam in Arabic (Book of Categories of Nations) Translated into English by Alok Kumar in 1992

To their credit, the Indians have made great strides in the study of numbers (3) and of geometry. They have acquired immense information and reached the zenith in their knowledge of the movements of the stars (astronomy) and the secrets of the skies (astrology) as well as other mathematical studies. After all that, they have surpassed all the other peoples in their knowledge of medical science and the strengths of various drugs, the characteristics of compounds and the peculiarities of substances.

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TimeLine according to MaxMueller[4]

- **Chandas Rg Veda 1200 to 1000 BCE**
- **Mantras later Vedas 1000 to 800 BCE**
- **Brahmanas 800 to 600 BCE**
- **Sutras 600 to 200 BCE**

Timeline according to Keith[5]

- **Taittiriya Samhita 500 BCE**
- **Baudhayana 400 BCE**
- **Ashvalayana 350 BCE**
- **Sankhayana 350 BCE**
- **Yaska 300 BCE**
- **Apastambha 300 BCE**
- **Pratisakhya 300 BCE**
- **Panini 250 BCE**
- **Katyayana 800to 600 BCE**

The Indic Mathematical tradition

- Yajnavalkya who wrote the Shatapatha Brahmana (as well as the Brihadaranyaka Upanishad)in which he describes the motion of the sun and the moon and advances a 95 year cycle to synchronize the motions of the sun and the moon
- Lagadha who authored the Jyotisha Vedanga
- Baudhayana the author of the Sulvasutra named after him
- Apastambha "
- Katyayana "
- Panini the Grammarian for the Indo Europeans
- Pingala Binary System of number representation Aryabhatta the astronomer laureate of ancient India
- Varahamihira who synthesized the knowledge
- The author of the Jaina treatises the Suryaprajnapati, Chandraprajnapati and the seventh section of Jambudvipaprajnapati

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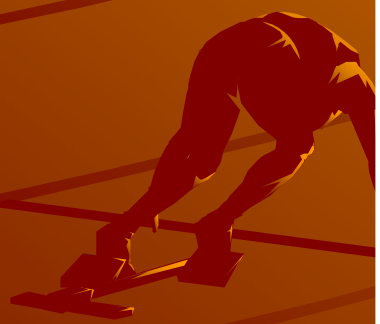
Savants in the Mathematical Sciences

Indian Subcontinent, through the Millennia



Apastambha	Narayana
Aryabhatta I	Nilakantha Somayaji
Aryabhatta II	Panini
Ashvalayana	Paramesvara
Baudhayana	Patodi
Bhadrabahu	Pingala
Bhartrihari	Pillai
Bhaskara I	Prthudakasvami
Bhaskara II	Rajagopal
Bose	Ramanujan
Brahmadeva	Sankara
Brahmagupta	Sridhara
Govindasvami	Sripati
Harish-Chandra	Varahamihira
Hemchandra	Vijayanandi
Jagannatha	Virasena Acharya
Jyesthadeva	Henry Whitehead
Kamalakara	Yajnavalkya
Katyayana	Yaska
Lagadha	Yativrsabha
Lalla	Yatavrisham Acharya
Madhava	Yavanesvara
Mahavira	
Mahendra Suri	
Manava	

The Indic Mathematical tradition

Proposed chronology of the Vedics

A work in progress

What is the proper sheet anchor to use

- The sheet anchor the Western Indologists use is the ascension to the throne of Chandragupta Maya
- The Indics especially the Mathematicians preferred to use the end oof Mahabharata or the death of Sri Krishna as the reference year

The Indic Mathematical tradition

Proposed chronology of the Vedics

A work in progress

Event	Individual	Date
Birth	Veda Vyaasa	
Birth	Apastambha	~3300 BCE
Birth	Baudhayana	3200 BCE
Birth	Aryabhatta	2765 BCE
Coronation of	Gautama Buddha	1888-1807 BCE
Coronation of	Chandragupta Maurya	1554 BCE
Reign of	Ashoka Maurya	1472 BCE
	Kanishka	1294 - 1234 BCE
Coronation of	Chandragupta of Gupta dynasty	327 BCE
		123 BCE
Pancha Siddhantas, authored by	Varahamihira	102 BCE to 78 CE
Reign of	Vikramaaditya	30 BCE
Birth of	Brahmagupta	78 CE
Era of	Salivahana	486 CE
Writings	Bhaskara II	486 CE
	Siddhanta Siromani	

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The Structure of Indic Literature

- We can only discuss what survived the millennia of wars and destruction. Literally thousands of manuscripts were destroyed when Ikhtiar Khalji rode into Bihar with a small band of looters around 1200 CE
- Indic Literature is derived from a Srautic parampara – an oral tradition, which is one reason that the original language has still survived
- Hence there is great importance paid to brevity
- The content needs to be maximized for a given number of syllables hence the need for Sutras

The Indic Mathematical tradition

The structure of Vedic Literature (continued)

EachVeda consists of Samhitas, Brahmanas, Aranyakas - speculation in the solitude of wilderness eventually taking shape as the Upanishads,

To these were appended what were later called the Vedangas comprising of

Shiksha (phonetics) Sandhi rules

Chandas (meter)

Nirukta (etymology)

Vyakarana (grammar)

Jyotisha (astronomy and calendric functions)

KalpaSutras(Ritual procedures and the associated mathematics)

Note the emphasis on brevity throughout, sandhi to make the content more compact, phonetics for mnemonic purposes. Panini's Ashtadhyayi is a tour de force as the worlds oldest Grammar text and Nirukta for associativity in remembering the meaning of words

The Indic Mathematical tradition

The Vedanga Period

- The Vedanga (IAST vedāṅga, "member of the Veda")
- are six auxiliary disciplines for the understanding and tradition of the Vedas.
- Shiksha (śikṣā): phonetics and phonology (sandhi)
- Chandas (chandas): meter — Pingala
- Vyakarana (vyākaraṇa): grammar — Panini
- Nirukta (nirukta): etymology — Yaska
- Jyotisha (jyotiṣa): astrology — Lagadha
- Kalpa (kalpa): ritual — Apastambha, Baudhayana, Katyayana , Manava
- The Vedangas are first mentioned in the Mundaka Upanishad
- as topics to be observed by students of the Vedas.
- Later, they developed into independent disciplines,
- each with its own corpus of Sutras.

The Indic Mathematical tradition

What were the SulvaSutras (literally Sutras of the cord)

As we emphasized absence of a likhita parampara 5000 years ago(scriptural resources)demanded brevity and the sutra represents a technological marvel of high order. A set of Kalpasutras attached to each Veda consisted of

Grihya Sutras (associated with household duties)

Srauta Sutras

Dharma Sutras

Sulvasutras

In what follows we wll be concerned with Jyotisha and the SulvaSutras

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What kind of Math problems did the Sutrakaras tackle

geometry for practical use in the construction of alters and places of sacrifice.

construction of squares and rectangles of equivalent squares and rectangles, construction of equivalent circles,

construction of squares equal to the sum of two given squares or the difference of the two given squares.

they knew the theorem which is today attributed to Pythagoras.

Familiar with surds like sqrt 2 and transcendental numbers like PI

complex numbers using the imaginary number 'i' or $\sqrt{-1}$

For obtaining the diagonal , the rule given in the Sulva Sutras is to multiply the side of the square by

$1 + 1/3 + 1/(3 \times 4) - 1/(3 \times 4 \times 34)$ Which is = 1.4142 approximately equal to $\sqrt{2}$

The 3 problems of antiquity were,

I Duplication of the cube

II Trisecting an angle

III Squaring the circle

The Indic Mathematical tradition

The Indian Mathematicians of the ancient era primarily number theorists.

Excelled in Diophantine Equations

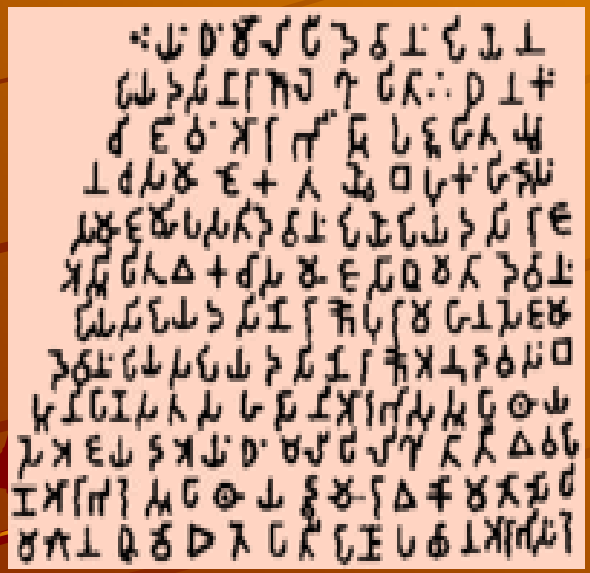
ax + by = 1: this is a linear Diophantine.

X**n + y**n = z**n*:** For *n* = 2 there are infinitely many solutions (x,y,z***), the Pythagorean triples. For larger values of ***n***, Fermat's last theorem states that no positive integer solutions *x*, *y*, *z* satisfying the above equation exist.

X**2 - n y**2 = 1: (Pell's equation) which is named, mistakenly, after the English mathematician John Pell. It was studied by **Brahmagupta** and much later by Fermat

The Indic Mathematical tradition

Example of Brahmi script



The Indic Mathematical tradition

Panini पाणिनि

- Based on new research 3100 BCE
conventional date (520 BCE - 460BCE)

- Probably the single most influential individual in the linguistic and mathematical development of India.

- The worlds first Grammarian
- the worlds first developer of Linguistics as a science
- codified rules of Sanskrit grammar
- first suggested alphameric symbols for numbers

- Postulated use of zero and place value system ???

The Indic Mathematical tradition

Apastambha
Author of SulvaSutras
References
Books:

G G Joseph, *The crest of the peacock* (London, 1991).

Articles:

R P Kulkarni, The value of p known to Sulbasutrakaras, *Indian J. Hist. Sci.* 13 (1) (1978), 32-41.

G Kumari, Some significant results of algebra of pre-Aryabhata era, *Math. Ed. (Siwan)* 14 (1) (1980), B5-B13.

A E Raik and V N Ilin, A reconstruction of the solution of certain problems from the Apastamba Sulba Sutra Apastamba (Russian), in A P Juskevic, S S Demidov, F A Medvedev and E I Slavutin, *Studies in the history of mathematics* 19 'Nauka' (Moscow, 1974), 220-222; 302.

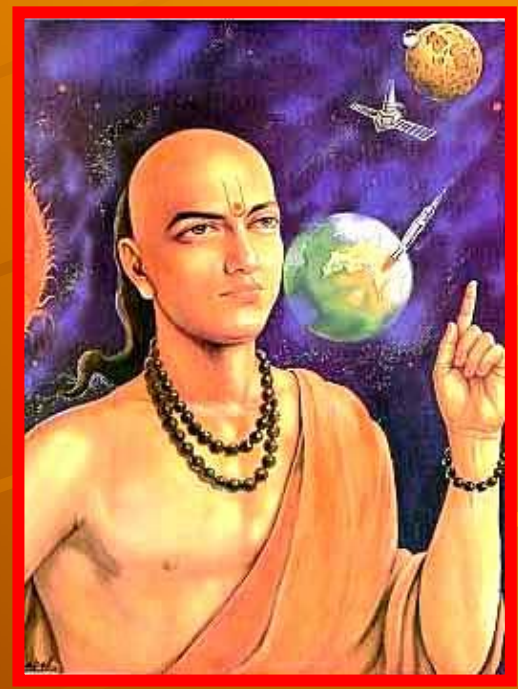
The Indic Mathematical tradition

Aryabhata I (the elder)

आर्यभट

Born 2765 BCE (based on modern research)
conventional dating (476 - 550 CE)

astronomer mathematician of the ancient world



The Indic Mathematical tradition

Misdating of Aryabhata

"Aryabhata is the first famous mathematician and astronomer of Ancient India. In his book *Aryabhatteeyam*, Aryabhata clearly provides his birth data. In the 10th stanza, of the Kalakriya, or the reckoning of time he says 60 x 6 = 360 years elapsed in this Kali Yuga, he was 23 years old. The stanza of the sloka starts with "Shastyabdanam Shadbhiryada vyateetastra yascha yuga padah.""Shastyabdanam Shadbhi" means 60 x 6 = 360. While printing the manuscript, the word "Shadbhi" was altered to "Shasti", which implies 60 x 60 = 3600 years after Kali Era.

षष्टयब्दानाम षद्भिह्यिर्दा व्तीतस्त्र यश्च युगपादाः ।
त्रयधिका विंशति रब्दास्त देह मम जन्मनो अतीताः ।।

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Misdating of Aryabhata

As a result of this intentional arbitrary change, Aryabhata's birth time was fixed as 476 A.D Since in every genuine manuscript, we find the word "Shadbhi" and not the altered "Shasti", it is clear that Aryabhata was 23 years old in 360 Kali Era or 2742 B.C. This implies that Aryabhata was born in 337 Kali Era or 2765 B.C. and therefore could not have lived around 500 A.D., as manufactured by the Indologists to fit their invented framework. Bhaskara I is the earliest known commentator of Aryabhata's works. His exact time is not known except that he was in between Aryabhata *(2765* B.C.) and Varahamihira (123 B.C.)."

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The Indic Mathematical tradition

Aryabhata आर्यबठा

- Explains the causes of eclipses of the Sun and the Moon.

- Estimated the length of the year at 365 days 6 hours 12 minutes 30 seconds is remarkably close to the true value which is about 365 days 6 hours.
-
- book has four chapters:

(i) the astronomical constants and the sine table
(ii) mathematics required for computations
(iii) division of time and rules for computing the longitudes of planets using eccentrics and epicycles
(iv) the armillary sphere, computation of eclipses.

The Indic Mathematical tradition

Summary of Aryabhata's work 2565 BCE (new and consistent chronology) π

- **Approximation for PI**
- **"Āryabhatīya", a tour de force consisting merely of 108 verses**
- **developed astronomical and mathematical theories in which the Earth was taken to be spinning on its axis and the periods of the planets were given with respect to the sun (in other words, it was heliocentric) A calculated the earth's sidereal period to be 23 hrs 56 m 4.1 s. (23.9344725428 h) remarkably close to the accurate value of 23 h 56 m 4.091 s**
- **Laid the foundation for a mathematical infrastructure to solve future problems in the field of Astronomy including Trigonometry**
- **believed that the Moon and planets shine by reflected sunlight and he believes that the orbits of the planets are ellipses.**

The Indic Mathematical tradition

Bhartrihari

Bhartrihari (c.100 BCE?)

- **the conventional date for B'hari is at least a half a centuries later , but if he is a brother of the famous Vikramaditya, it does not compute**
- **Bhartrihari is the odd man out in India's anthology of the ancients. First of, how does one categorize him.**
- **Is he more important for his philosophical writings, or for being the first ancient to study Linguistics after Panini or was he best known for being a well known member of one of the most illustrious ruling dynasties of India.**
- **Here are 2 curriculum vitae until we have time to digest all that he has produced**

Author of Vaakyapaadiya, Traya-Satakam

http://www.urday.com/bharatri.htm

http://www.iep.utm.edu/b/bhartrihari.htm

The Indic Mathematical tradition

Sage **Yajnavalkya** (याज्ञवल्क्य) (c. 1200BCE)
of Mithila

- advanced a 95-year cycle to synchronize the motions of the sun and the moon.
- credited with the authorship of the Shatapatha Brahmana, in which references to the motions of the sun and the moon are found.
- 1800 BC is sometimes suggested by the astronomical evidence within the Shatapatha Brahmana, while some Western scholars dispute his historicity.
- major figure in the Upanishads. His deep philosophical teachings in the Brhadaranyaka Upanishad, and the apophatic teaching of 'neti neti' etc. is found to be startlingly similar to the Buddhist doctrine and to modern science.

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So, who invented the Zero and the decimal place value system

Was it Yajnavalkya ?

Pingala perhaps ?

Was it Panini ?

Or Apastambha ?

Or was it Aryabhata ?

Or perhaps none of the above

The Indic Mathematical tradition

The Celestial Timekeepers

Or

How to design a calendar
By Observing the Sun and the Moon

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Definitions (see figure)

- **Ecliptic** - **the great circle on the celestial sphere that lies in the plane of the earth's orbit (called the plane of the ecliptic). Because of the earth's yearly revolution around the sun, the sun appears to move in an annual journey through the heavens with the ecliptic as its path.**
- **Celestial sphere** or armillary imaginary sphere enveloping the earth appears to turn as the earth rotates
- **Celestial equator**
- **equinox (ē´kwĭnŏks) , क्रांतीव्रुत्त (Kranthivruth)**
  either of two points on the celestial sphere where the ecliptic and the celestial equator intersect.
- **Periodicity of the saptarishi or Gr**eat Bear constellation or the Ursa Major
- **equatorial coordinate system**
- **Line of Declination**
- **Line of right ascension**

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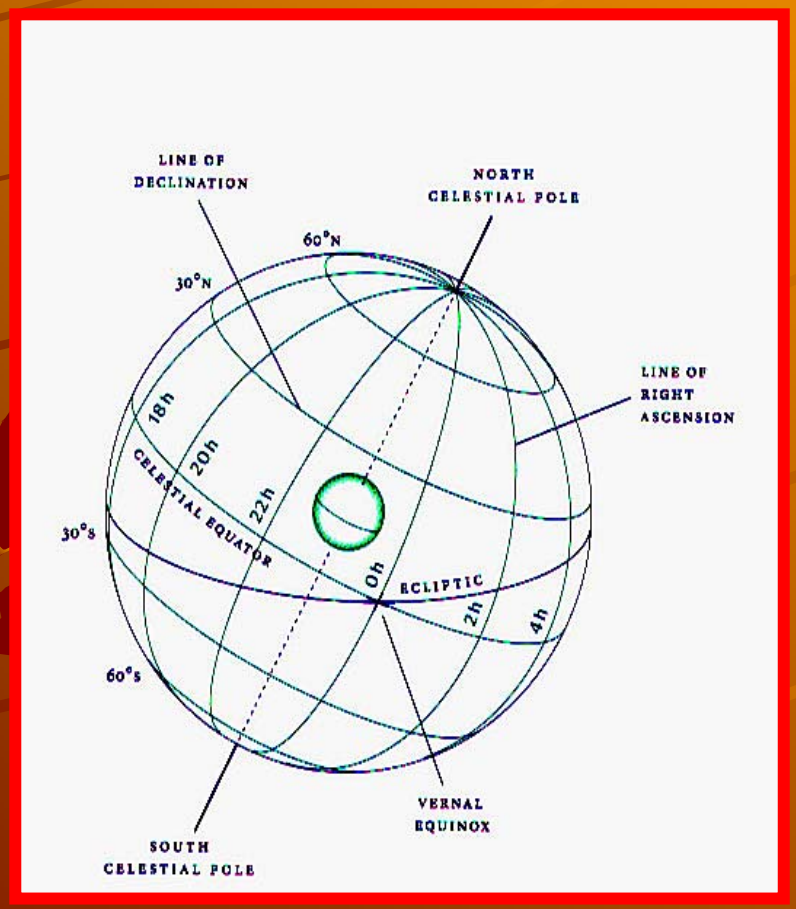

The Celestial sphere

Known also as the Armillary sphere

Showing the ecliptc and its inclination to the celestial equator and is the inclination of the earths axis to the axis perpendicular to the plane of the ecliptic

About 23.5 degrees

The Indic Mathematical tradition

The armillary sphere

depicts the way the ancients saw the universe,as they gazed at the sky. Armillary spheres have concentric rings to indicate planetary orbits, the zodiac band of constellations, and terrestrial and celestial measurement circles such as the Tropics of Cancer and Capricorn and the equator. Sometimes they are mounted with an orrery inside. Sometimes they are mounted as garden sundials.

A Ptolemaic armillary sphere has an earth globe at the center, surrounded by celestial circle and zodiac armillary rings, demonstrating the geocentric theory of the universe developed by Ptolemy and others in ancient Greece and Rome. The latest view is that Ptolemy was certainly not the first or the only oneto develop a calculation algorithm based on a geocentric model. The Indics were already there, no pun intended, as were probably the Chinese

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Some more definitions

Sidereal Year Ysd = 365.2596296 days

Solar or tropical Year Y = 365.25636031

Synodic Month M = 29.53058888 days

Sidereal Month Msd = 27.32166156 days

Sidereal Day = 23 hrs 56 mts 4.091 sec = 86,164.091 seconds

Solar Day = 24 hours = 86,400 seconds

Metonic cycle

Yajnavalkya cycle

The Indic Mathematical

Some more definitions

Sidereal Day

An **apparent sidereal day** - the time it takes for the Earth to turn 360 degrees in its rotation; more precisely, is the time it takes a typical star to make two successive upper meridian transits. This is slightly shorter than a solar day.

There are 366.2422 sidereal days in a tropical year, but 365.2422 solar days, resulting in a sidereal day of 86,164.091 seconds (or: 23 hours, 56 minutes, 4.091 seconds).

The reason there is one more sidereal day than "normal" days in a year is that the Earth's orbit around the Sun offsets one sidereal day, giving observers on Earth 365 1/4 days, even though the planet itself rotated 366 1/4 times (the Earth rotates in the same direction around its axis as it does around the Sun: seen from the northern sky, counter-clockwise).

Midnight, in sidereal time, is when the First Point of Aries crosses the upper meridian.

A **mean sidereal day** is reckoned, not from the actual transit, but from the transit of the mean vernal equinox (see: mean sun).

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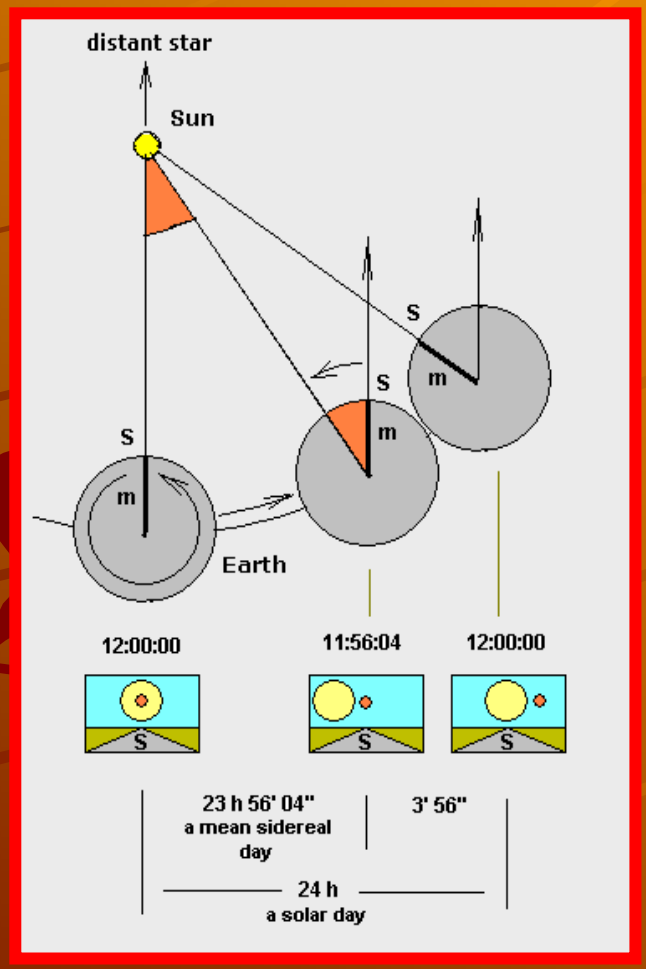

The difference between the sidereal day and the solar day from Wikipedia.

For the same reason the sidereal year is longer than the solar or tropical year by about 20 minutes.

We will come back to this when we discuss the precession of the equinoxes

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Calendar and Tithi

The Indian Almanac or Panchangam(5 limbs) has 5 concepts imbedded within it. Five items are named for each day of the week (vara), the tithi, the Nakshatra, the Karana , and the Yoga at sunrise and sunset.

The Indian calendar uses lunisolar parameters.

The month that is used is a Synodic month, and such a month has a period of 29.5306 days (the 24 hour day or solar day)and the year used is a sidereal year (365.2596296) days

The lunar day begins at sunrise and the length of the lunar day is

determined by the length of time between sunrises –defined as the angular distance between the sun and the moon (12 degrees)

The waxing and waning phases are known as Shukla and Krishna Pakshas and each comprise 15 days

The lunar date is referred to as the Tithi

The Indic Mathematical tradition

Values for the Lunar sidereal orbit and the Lunar Synodic orbit are given in Table below

COMPARISONS	Lunar sidereal orbit	Lunar synodic orbit
AD 2000.0	27.32166156	29.53058888
AD 498	27.3216638	29.530591
Àryabhata	27.321668	29.530582
Paulisa Siddhanta	27.321673	29.530587
1604 BC	27.321668	29.530595

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Comparison of *The Àryabhatiya of Àryabhata* and Astronomic values.			
Astronomy Constants	**AD 2000.0**	**Aryabhatiya**	**1604 BC**
Rotations per solar orbit	**366.25636031**	**366.2563589**	**366.25635656**
Days per solar orbit	**365.25636031**	**365.2563589**	**365.25635656**
Days per lunar orbit	**27.32166120**	**27.3216638**	**27.32166801**
Rotations per lunar orbit	**27.39646289**	**27.39646514**	**27.39646936**

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ASTRONOMIC AUTHORITY	Àryabhata (from Clarke and Kay)	Surya Siddanta
Years in Cycle	4,320,000	4,320,000
Rotations of the earth	1,582,237,500	1,582,237,828
Days	1,577,917,500	1,577,917,828
Lunar Orbits	57,753,336	57,753,336

Kay notes 57,753,339 lunar orbits rather than 57,753,336 per Clarke.

Synodic Months	53,433,336	53,433,336
Mercury	17,937,920	17,937,060
Venus	7,022,388	7,022,376
Mars	2,296,824	2,296,832
Jupiter	364,224	364,220
Saturn	146,564	146,568

The Indic Mathematical tradition

English calendar weekdays	Indian calendar weekdays
Sunday	*Raviwar*
Monday	*Somwar* *(Chandrawar)*
Tuesday	*Mangalwar*
Wednesday	*Budhwar*
Thursday	*Guruwar*
Friday	*Shukrawar*
Saturday	*Shaniwar*

Chaitra
Vaishakh
Jeshta
Ashadh
Shrawan(Sawan)
Bhadrapad(Bhado)
Ashwin
Kartik
Margshirsh
Paush
Magha
Falgoon (Fagan)

The Indic Mathematical tradition

Months according to Indian Panchang

Month	Suns Longitude	Duration	Gregorian
	deg min	d	
1. Vaisakha	23 15	30.9	Apr. 13
2. Jyestha	53 15	31.3	May 14
3. Asadha	83 15	31.5	June 14
4. Sravana	113 15	31.4	July 16
5. Bhadrapada	143 15	31.0	Aug. 16
6. Asvina	173 15	30.5	Sept. 16
7. Kartika	203 15	30.0	Oct. 17
8. Margasirsa	233 15	29.6	Nov. 16
9. Pausa	263 15	29.4	Dec. 15
10. Magha	293 15	29.5	Jan. 14
11. Phalgura	323 15	29.9	Feb. 12
12. Caitra	353 15	30.3	Mar. 14

The Indic Mathematical tradition

Zodiac sign	Sanskrit Name	Sector begin	Sector end
Aries	Mesha	00	30
Taurus	Vrishabha	30	60
Gemini	Mithuna	60	90
Cancer	Karka	90	120
Leo	Simha	120	150
Virgo	Kanya	150	180
Libra	Tula	180	210
Scorpio	Vrishchika	210	240
Sagittarius	Dhanus	240	270
Capricorn	Makara	270	300
Aquarius	Kumbha	300	330
Pisces	Meena	330	360

The Indic Mathematical tradition

Koenrad Elst opines

- India may well have been the source rather than the receiver of knowledge
- both the solar and the lunar Zodiac may well have originated in India.
- If the Rg-Veda does refer to a 12-part Zodiac, it precedes the Babylonian Zodiac by centuries
- As for China: in his famous Science and Civilization in China, Joseph Needham notes, again by using the equinoctal precession as a time marker, that the Chinese 27-part Zodiac dates back to the 24th century BC.

The Indic Mathematical tradition

Methodology for chronology

- Use as proof a method similar to that of Euclid
- Propose a minimum set of Axiomatic principles
- Look for incompatible results , reductio ad absurdum
- The set of hypotheses with the minimum score of incompatible conclusions is the most plausible candidate for a chronology

The Indic Mathematical tradition

Cosmological Units used by the Vedics

Y = solar or tropical year
DY = 360 Y = divine year
1 Dwapar Yuga = 2KY = 864,000 Y
1 Treta Yuga = 3 KY = 1,296,000 Y
1 Krita Yuga = 4 KY = 1,728,000 Y
KY = 432,000 Y = Kaliyuga
MY = 10 KY = 4,320,000 = Mahayuga
Y = 365.2563589 solar or tropical day

The Indic Mathematical tradition

Cosmological Units used by the Vedics

Thus, we have a day in Brahma's life of 1 Kalpa
1 Brahma Day (day and night) = 2 Kalpa
1 Kalpa = 4,320,000,000 earthly years (Y) =14 Manus + 1Kritayuga = 1000 MY =14*71.4+.4 Mahayugas
Kaliyuga = 432,000 Y = 1KY = 1200 divine years (DY) = 1 Yuga
1 DY = 360 Y
Dwapara = 864,000 Y = 2KY = 2400 DY
TretaYuga = 1,296,000 Y = 3KY = 3600 DY
Kritayuga = 1,728,000 Y =4 KY = 4800 DY = 0.4 MY =.4/71.4 = 5.6022408964e-3
Mahayuga (MY) = 4,320,000 earthly years = 10 KY = 12000 DY
1Manvantra (M) = 71 MY = 306.72 million years
1 Manu = 1M + 1 KritaYuga = 308.448 million years = 856,800 DY
1 Kalpa = 14 Manus + 1KritaYuga = 14*71.4 +.4 = 1000 MY = 12,000,000 DY = 4.32 billio

The Indic Mathematical tradition

So how old is the Universe

6 M	=1,850,688,000 Y (6*308,448,000) = 6 M
And 27 MY = 0.3781512605 M	= 116,640,000 Y (27 * 4,320,000) = 27/71.4
And 28th (Krita+Treta +Dwapara = 0.012605042 M	= 3,888,000 Y (9*432,000) =0.9 MY =.9/71.4
5107 Y of Kaliyuga	= 5107 Y
So the current year 2006 CE	= 1 ,971,221,108 Y

The Indic Mathematical tradition

Nakshatras

The Moon is easily observable

Define 27 fixed star constellations called Nakshatras, along the Ecliptic

Observe that the moon returned to the same Nakshatra in 27.32166 days – hence the division into 27 Nakshatras.

The moon is in each one of these Nakshatras approximately 1 day and 18 minutes

The Sun traverses the same path though the sky except it takes 365.258756481 days or a sidereal year

Using the same nakshatras they observed that it takes 13 1/3 days for the sun to traverse a Nakshatra

The sun moves about 1 degree a day which means each Nakshatra spans 13 1/3 degrees

The Indic Mathematical tradition

Precession of the equinoxes

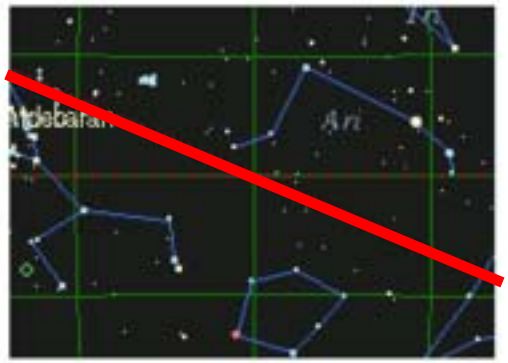
At the end of a tropical year from one vernal equinox to the next with respect to the fixed stars , the earth appears to fall short by 50.26 seconds of longitude.

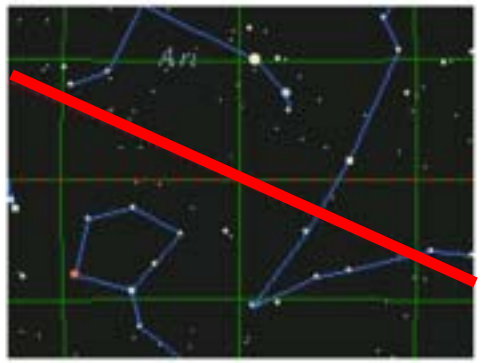
That means it takes approximately 26000 years for the precession to complete 360 degrees or 1 revolution of the vernal equinox as it traverses a different Nakshatra every 1000 years.

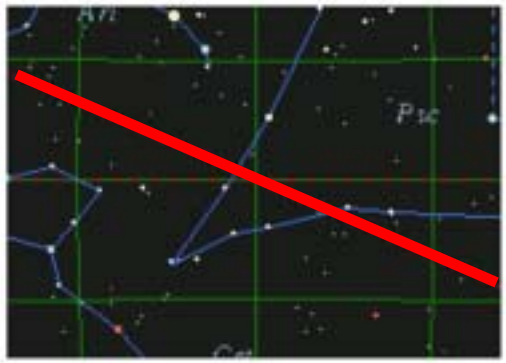
Voila , here we have a 26000 year clock and by noting the Nakshatra in which the vernal equinox occurred we can tell when the event occurred. By dividing each Nakshatra into 4 padas we can refine the unit of time to 250 years . This is a fairly reliable method of dating events such as the composition of the Rg or the date of the Mahabharata war

The Indic Mathematical tradition

Precession of the equinoxes







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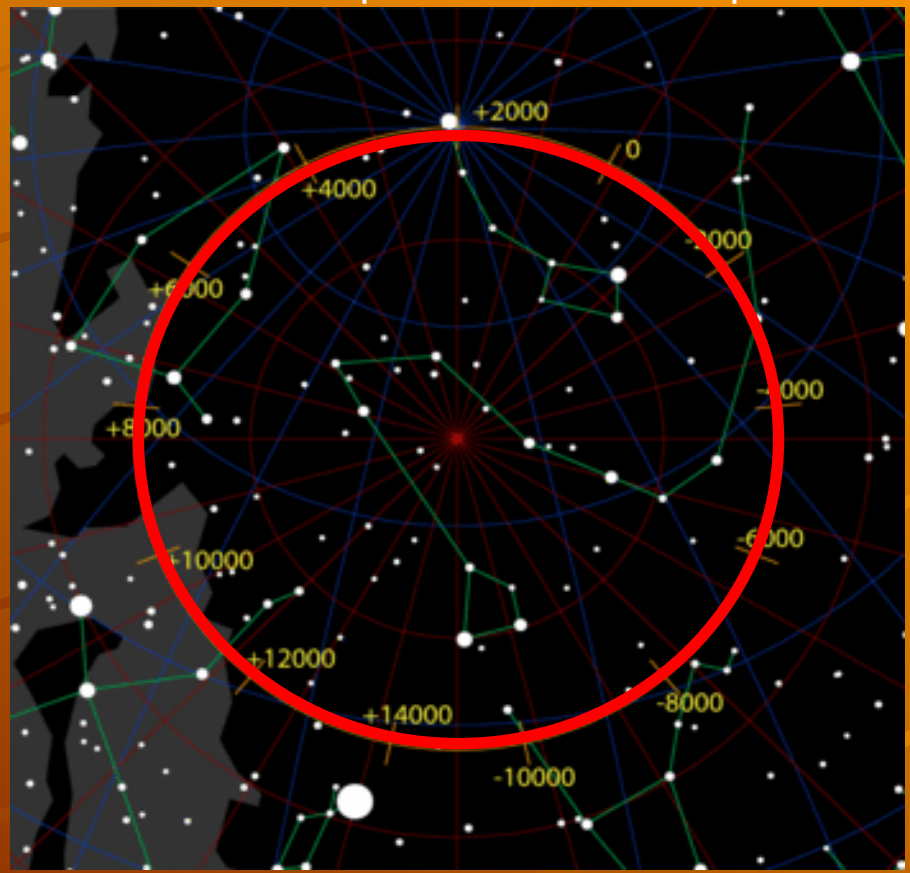
Precession of the equinoxes and the pole star



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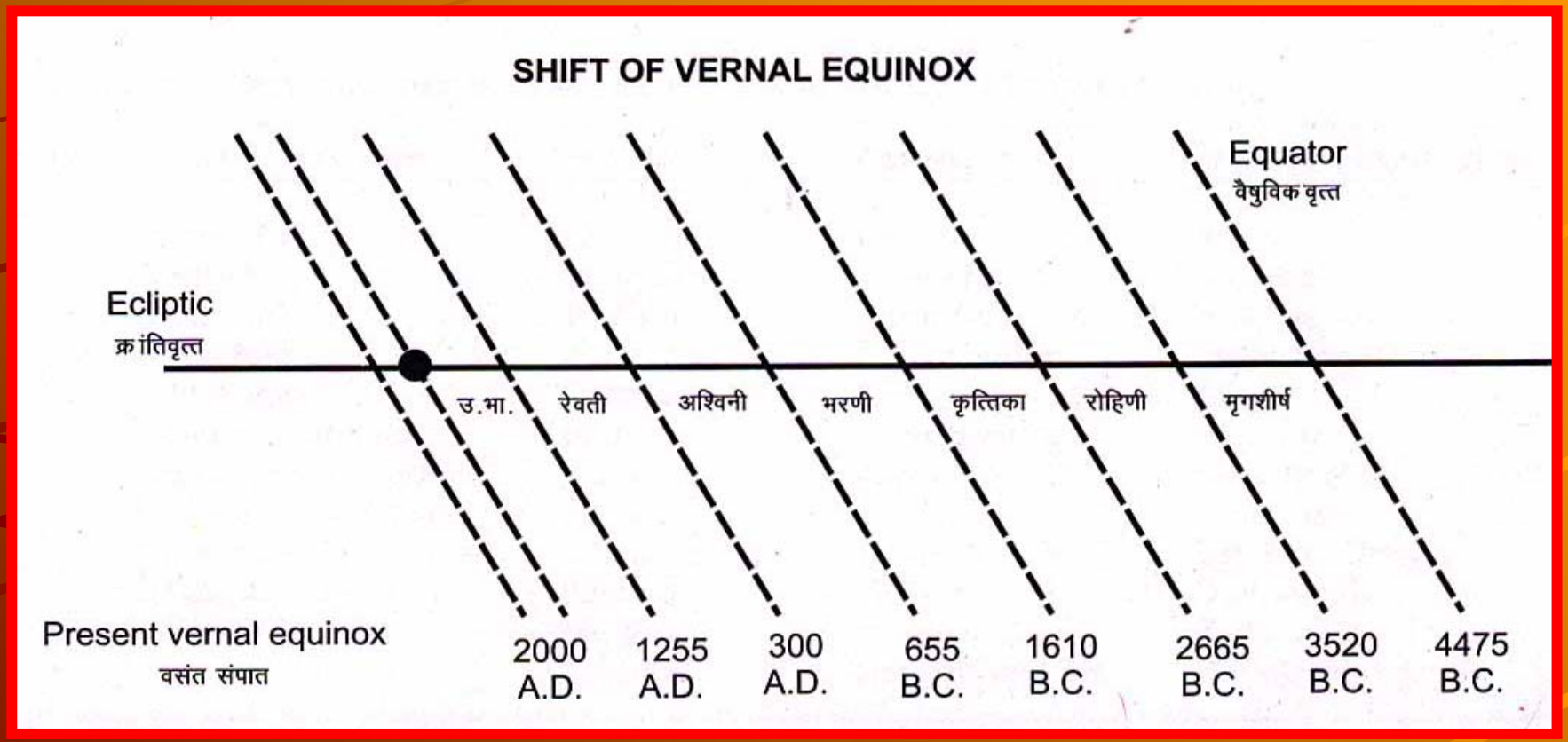
Precession of the Equinoxes



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Summary and Conclusions

Deciphering the age of an event

- Observations about the Nakshatra in which the Vernal Equinox occurs tell us the era in which the observations took place (Archaeo-Astronomy)
- Look to manuscripts written by Astronomers and Mathematicians, since they have a penchant for precision in their observations and remarks
- We are at the beginning of discovery of our forgotten past

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References

- The Vedic Mathematicians by Kosla Vepa, available at my site

Please visit my website indicstudies.us for many more references

The Indic Mathematical tradition

Some of my general interest publications

1.The Societal Stockholm Syndrome
2.India and the Great Game
3.What's in a name
4.Kaushal's Blog
5.Review of the Audiovox PPC 4100 PDA Phone
6.India and US Missile defense
7.Indo_US relations (circa 1999)
8.History of the Indic civilization - A prolegomena
9. The South Asia File
10. Vedic Mathematicians in Ancient India, Parts I,II, and III
11. The debate over the origin of the Vedics

More at my websites
Indicstudies.us,
vepa.us,
kaushal42.blogspot.com

The Indic Mathematical tradition

I dedicate this research to the Goddess Sarasvati

And the river that bears her name

And the Brahmi civilization that flourished on the banks of the river for over 3000 years giving rise to the first phonetic and syllabic script

Om Sarveshaam Swastir Bhavatu

Sarveshaam Saantir Bhavatu

Sarveshaam Poornam Bhavatu

Sarvesham Mangalam Bhavatu