Beyond zero: India's contribution to math and science

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Introduction

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- This led to large numbers up to 10^{12} found in Yajurveda 17.2.
- Names of 53 places (10^{53} = *tallakṣaṇa*) in Buddhist *Lalitavistara sutta*, chp. 12.

Efficient arithmetic

Shukla Yajurveda 17.2

एका च दश च दश च शतं च शतं च सहस्त्रं च सहस्त्रं च अयुतं च अयुतं च नियुतं च नियुतं च प्रयुतं च अर्बुदं च न्यर्बुदं च समुद्रः च मध्यं च अन्त्यः च परार्धः च

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- (5th c.) *Āryabhaṭīya* $\pi = 3.1416 = \frac{62832}{20000}$

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  विबुधनेत्रगजाहिहुताशनत्रिगुणवेदभवारणबाहवः।
  नवनिखर्वमिते वृतिविस्तरे परिधिमानमिदं जगदुर्बुधाः॥

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- Corresponds to $\pi = 3.1415926535922\ldots = \frac{2{,}827{,}433{,}388{,}233}{9\times10^9}$, (accurate to 11 places)

Precise fractions and π

- (15th c.) *Karaṇapaddhati* (VI, 7) (reverse sexagesimal *kaṭapayādi* system) circumference =

  चरडांशुचन्द्राधमकुंभिपाल = 31,415,926,536

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- i.e., $\pi = 3.1415926536$

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- Greeks and Romans could not say the precise length of the (tropical) year.
- Hence, Julian calendar had badly defective length of the (tropical) year at $365\frac{1}{4}$.
- (Julian calendar reformed the earlier defective Roman calendar, and the Romans laughed at the Greek calends.)

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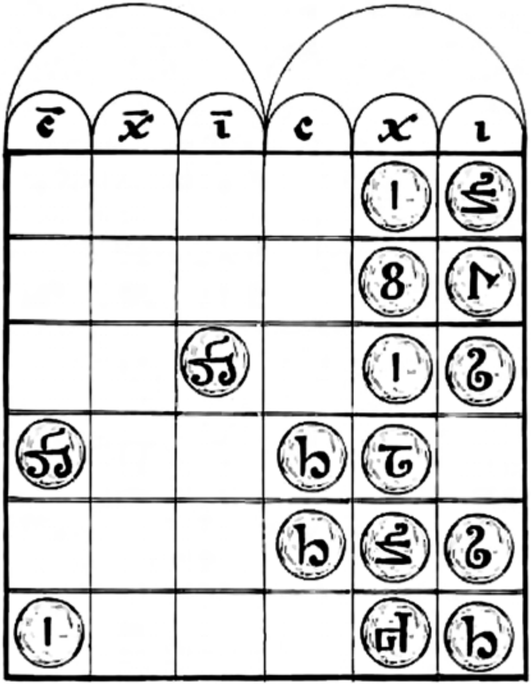
- (Understood zero as blank space, but continued using inefficient abacus.)



13

87

4 019

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539

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- but were puzzled by zero,
- as suggested by its very name from sifr = zephyr = cypher = mysterious code.

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- Florentine law said numbers in financial contracts must also be written in words. We still follow it.

Moral of the story

- (Raju's epistemic test) imported or copied knowledge is hard to understand.

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- Solves quadratic equations.

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- *Meru prastāra* ("Pascal's triangle") in Halauyudha's 10th c. commentary.

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- Used also in theory of Indian music.

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- Involves a conceptual error.
- As the term "jya" suggests, sine relates to the circle (as in Indian texts): word "trigonometry" is a conceptual misnomer.

Āryabhaṭa's table of sine differences

- मखि भखि फखि धखि णखि ञखि
  ङखि हस्झ स्ककि किष्ग श्घकि किघ्व ।
  घ्लकि किग्र हक्य धकि किच
  स्ग श्झ ङ्व क्ल प्त फ छ कलार्धज्या ॥१२॥

Translation

- 225, 224, 222, 219, 215, 210, 205, 199, 191, 183, 174, 164, 154, 143, 131, 119, 106, 93, 79, 65, 51, 37, 22, 7—[these are the] Rsine [differences] [for the quadrant divided into as many equal parts, each part hence being 225′] [in] minutes.

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- (Circumference of the circle in minutes is $360 \times 60 = 21,600$.)

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- which used an infinite series for precise sine values.
- (Indians knew how to sum infinite sereis. Nīlakaṇṭha states the sum of infinite geometric series.)

The infinite series for sine

- The "Taylor" series expansion for the sine stated in two verses, as follows.

  निहत्य चापवर्गेण चापं तत्तत्फलानि च ।
  हरेत् समूल्युग्वर्गैस्त्रिज्यावर्गहतैः क्रमात् ॥ ४४० ॥
  चापं फलानि चाधोऽधो न्यस्योपर्युपरित्यजेत् ।
  जीवाप्त्यै, संग्रहोऽस्यैव विद्वान् इत्यदिना क्रितः ॥ ४४१ ॥

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- These together give the *jīvā*, as collected together in the verse beginning with "*vidvān*" etc.

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- Numerator: multiply the arc s by its square s^2, this multiplication being repeated n times to obtain $s \cdot \prod_{1}^{n} s^2$.
- Denominator: multiply the square of the radius, r^2, by $[(2\,k)^2 + 2\,k]$ ("the squares of successive even numbers increased by that number") for successive values of k, repeating this product n times to obtain $\prod_{k=1}^{n} r^2\,[(2k)^2 + 2k]$.

Math translation: contd.

- Thus, the nth iterate is obtained by

$$t_n = \frac{s^{2n} \cdot s}{(2^2 + 2) \cdot (4^2 + 4) \cdot \cdots \cdot [(2n)^2 + 2n] \cdot r^{2n}}. \quad (1)$$

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- The rule further says:

$$\begin{aligned} \text{jīvā} &= s - t_1 + t_2 - t_3 + t_4 - t_5 + \ldots && (2) \\ &= s - \frac{s^3}{r^2 \cdot (2^2 + 2)} + \frac{s^5}{r^4 (2^2 + 2)(4^2 + 4)} - \cdot && (3) \end{aligned}$$

Math Translation

<+->Substituting (1) jīvā $\equiv r \sin\theta$,(2) $s = r\theta$, so that $s^{2n+1} / r^{2n} = r\theta^{2n+1}$, and noticing that(3) $[(2k)^2 + 2k] = 2k \cdot (2k+1)$, so that(4) $(2^2+2)(4^2+4)\cdots[(2n)^2 + 2n] = (2n+1)!$,and cancelling r from both sides, we see that this is equivalent to the well-known expression

$$\sin\theta = \theta - \frac{\theta^3}{3!} + \frac{\theta^5}{5!} - \frac{\theta^7}{7!} + \cdots . \qquad (4)$$

Details in my book *Cultural Foundations of Mathematics*, Pearson Longman, 2007.

Madhava's sine table (in verse)

श्रेष्ठं नाम वरिष्ठानां हिमाद्रिर्वेदभावनः।
तपनो भानुसूक्तज्ञो मध्यमं विद्धि दोहनम्॥
धिगाज्यो नाशनं कष्टं छन्नभोगाशयाम्बिका।
म्रिगाहारो नरेशोऽयं वीरो रणाजयोत्सुकः॥
...
छायालयो गजो नीलो निर्मलो नास्ति सत्कुले।
रात्रौ दर्पणमभ्राङ्गं नागस्तुङ्गनखो बली॥
धीरो युवा कथालोलः पूज्यो नारीजनैर्भगः।
कन्यागारे नागवल्ली देवो विश्रुवस्थली भृगुः॥
तत्परादिकलान्तास्तु महाज्या माधवोदिताः।
स्वस्वपूर्वविशुद्धे तु शिष्टास्तत्खण्डमौर्विकाः॥ २.१.५॥

Madhava's sine table (translated)

Table: Mādhava's sine values

No.	Kaṭapayādi	kalā (′)	vikalā(″)	tatparā(‴)
1	श्रेष्ठं नाम वरिष्ठानां	224	50	22
2	हिमाद्रिर्वेदभावनः	448	42	58
3	तपनो भानुसूक्तज्ञो	670	40	16
4	मध्यमं विद्धि दोहनम्	889	45	15
...	...	...	...	...
21	धीरो युवा कथालोलः	3371	41	29
22	पूज्यो नारीजनैर्भगः	3408	20	11
23	कन्यागारे नागवल्ली	3430	23	11
24	देवो विश्वस्थली भृगुः	3437	44	48

Accuracy of Madhava's sine values

Table: Accuracy of Mādhava's sine table.

No.	Mādhava's sine value	Difference
1	0.0654031452	0.0000000160
2	0.1305262297	0.0000000375
3	0.1950903240	0.0000000020
4	0.2588190035	−0.0000000416
...	...	...
...	...	...
21	0.9807852980	0.0000000176
22	0.9914448967	0.0000000353
23	0.9978589819	0.0000000587
24	1.0000000000	0.0000000000

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Why calculus developed in India

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- Because two key sources of wealth in India were
  1. agriculture and
  2. overseas trade.
- That required an accurate calendar and accurate techniques of navigation,
- which required the science of astronomy.

How and why Europeans stole the calculus

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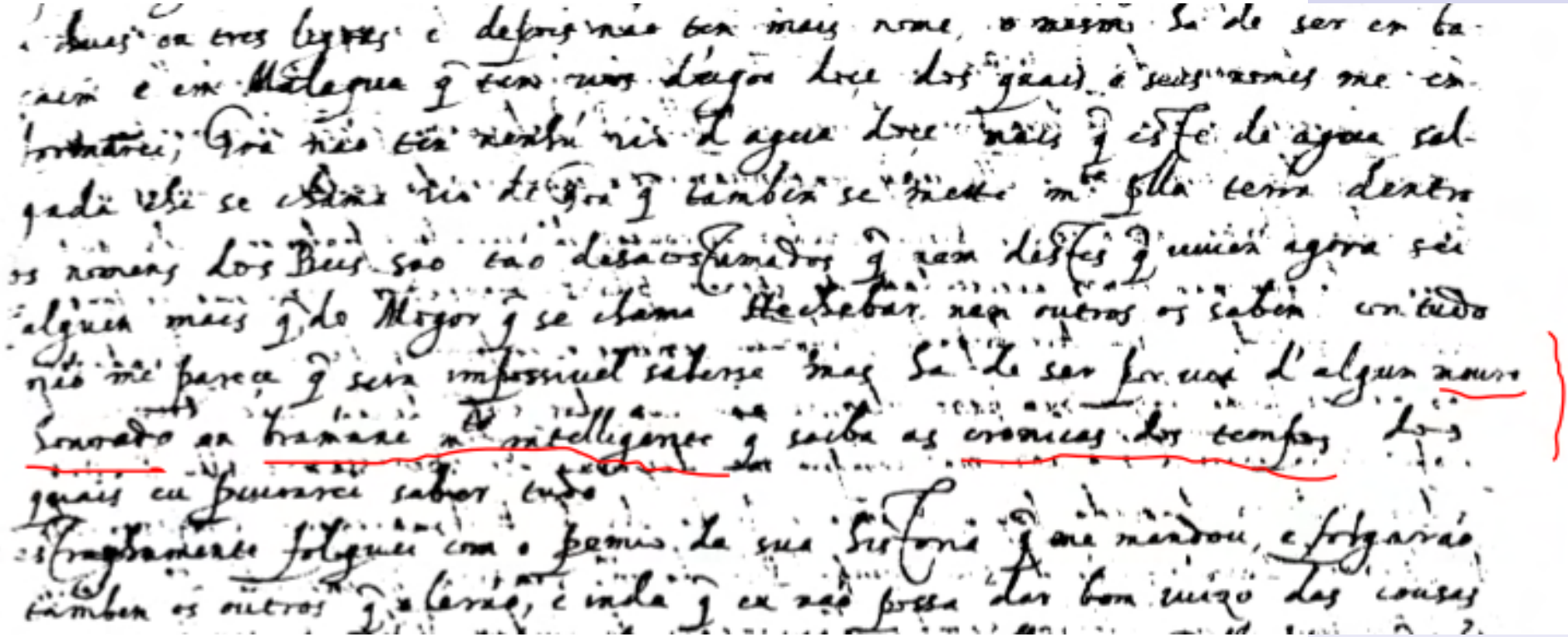
- Europeans understood the practical use of precise sine values
- but failed to understand how Indians summed infinite series.
- Unlike Arabs, Europeans then did not acknowledge their non-Christian sources (because of the Inquisition etc.).

Matteo Ricci's letter of 1581

- In 1581 a student of Clavius (author of Gregorian reform, 1582), Matteo Ricci, was in Cochin and wrote that he was looking for "an honorable Moor or an intelligent Brahmin to tell him about Indian methods of timekeeping".



Science

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  2. Astronomy, NOT astrology. *Vedānga Jyotiṣa* from −1500 CE does not contain a single sentence on astrology. (My challenge since 2001.)
     - Neither does ANY Indian astronomy text, across 3000 years, down to the 16th c. (including Varahamihira's *Pañcasiddhāntikā*).

Contrast: Kepler

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- In contrast, Kepler earned a livelihood from astrology.
- Wrote that God created astrology as the natural profession for astronomers!

Indians against superstition-1

Eclipses NOT due to demons

- Lalla, Vateshvara etc. speak out against superstition, E.g. Lalla *Śiṣyadhīvrdhida*, chp. 20

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- "If an artful demon is the cause of an eclipse. . .
  - then how is that that an eclipse can be determined by calculation?
  - Why does it always occur only on *poornima* or *amavasya*?"

Indians against superstition-2

Spherical Earth

- "If the earth is flat,

Indians against superstition-2

Spherical Earth

- "If the earth is flat,
- why can't tall trees, alas, be seen at great distance?"

Indians against superstition-3

Earth not supported

- "If the earth is supported by a serpent (śeṣa nāga), tortoise etc.

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Earth not supported

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  - by whom are *they* supported in space?
  - If they can stand unsupported why not the earth?"

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- Contemporary Bible (5th c. Vulgate) says earth is flat. (E.g. Daniel:4-10-11:)
- "behold a tree. . . and the height thereof was great. . . . and the sight thereof to the end of all the earth.
- On Greek superstition, Atlas held up the earth. No one contested it in all Greek literature.

Origin of experimental method

Payāsi's experiments

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- The first record of the experimental method is found in India 2500 years ago.
- In the *Dīgha Nikāya*.
- Payāsi performed some 30 experiments with condemned felons to test the existence of the soul and life after death.

- (weight of the soul?) “weigh the man, strangle him with a string and weigh him again”

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- and so on.
- This was 2000 years before Francis Bacon.

Cultural pride?

Matter of pride?

- So, isn't all this a matter of great pride?

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Matter of pride?

- So, isn't all this a matter of great pride?
- No. It is a matter of great shame!
- Shame that we forget about calculus in India for 500 years,
- until my 1998-2007 project. (Part of it done here in NMML.)

Theft of calculus story

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Theft of calculus story

- Those who forget history repeat past mistakes.
- Calculus was stolen in the 16th c.,
- But the story that "calculus was stolen" was itself stolen in the 21st c.!
- Repeatedly, in 2000, then 2004, then 2007 (as soon as my book on calculus theft was published).

Prof Raju's charge of plagiarism found correct

UK varsity warns lecturer

Shams Ur Rehman Alavi
Bhopal, November 7

THE SCIENTIFIC fraternity in the United Kingdom (UK) has been taken by a storm after the charges of plagiarism levelled against a faculty member of the prestigious University of Exeter by the renowned City-based mathematician Professor C K Raju were found to be correct.

The university has issued a warning to the defaulter faculty member Ugnario Almeida who allegedly plagiarised the path-breaking works of Prof Raju in the field of mathematics and published them in his name.

A mathematician and physicist, Dr C K Raju is well known for his research in which he has claimed that European mathematicians did not invent calculus, which was perhaps transferred from India to the West. He was staggered to find his unpublished work plagiarised by the UK lecturer early this year.

Soon after the 'discovery', Dr Raju, who is Head of Centre for Computer Science with the Makhanlal Chaturvedi National University of Journalism, and the university's the then DG Sharad Chandra Behar took up the issue with the Vice-Chancellor of the University of Exeter in March this year.

Recently, the VC of the University of Exeter Professor Steve Smith, wrote a letter to Behar that a investigation was undertaken after the complaint of Dr Raju and after the enquiry was conducted, a written warning has been issued to Almeida that he must adhere to conventionally accepted norms of authorship/acknowledgement in publications and any failure in future would be referred to a tribunal constituted under the university's statutes which could lead to his dismissal from the university.

Continued on page 5

Prof C K Raju

UK varsity warns lecturer

Continued from page 1

Dr Raju had charged Almeida, Lecturer in Mathematics Education at the School of Education in Exeter, Dr Zadorozhnyy, Department of Classics, University of Liverpool and another person for plagiarism of his innovative research.

According to Dr Raju, he had placed an advertisement for Research Associate on his project, Madhava and the origin of calculus on the internet in 1998, following which, Almeida had contacted him showing his interest in history of mathematics.

Almeida came to India to meet Raju and after his return to England raised some funding from the university for the project. In process, he reportedly gained access to Raju's unpublished works by saying that this was needed to raise more funds.

The association between the two continued until mid-2000.

However, Almeida then allegedly co-opted Dr George Joseph, Reader in Economics Department of the University of Manchester, on the grounds that his British citizenship will help in raising more funding. The terms subsequently became unacceptable for Dr Raju because it appeared to him that Almeida wanted to take over Dr Raju's ideas but giving him only a side role.

The association thus ended but to Raju's astonishment, he found that his thesis was presented by Dr Joseph in a conference in December 2000 and then Almeida, John and Zadorozhnyy wrote a paper, "Keralese mathematics: its possible transmission to Europe and consequential educational implications" in a journal in 2001.

Dr C K Raju, who played a leading role in the development of India's first supercomputer, Param, is an author of several books. He has questioned scientists like Einstein and Isaac Newton and challenged the long-existing beliefs that calculus was invented in Europe.

He has written several books including the famous, 'The Eleven Pictures of Time'.

The eminent Bhopal mathematician was astounded when he found that his unpublished work was freely used without credit to him and it appeared on a website recently. The complaint to the VC, University of Exeter was made and now the reply from the university and the findings of enquiry have at last proved the Indian mathematician correct.

PEARSON LONGMAN

History of Science, Philosophy and Culture in Indian Civilization

General Editor D. P. Chattopadhyaya

Volume X Part 4

Cultural Foundations of Mathematics

The Nature of Mathematical Proof and the Transmission of the Calculus from India to Europe in the 16th c. CE

C. K. RAJU

PHISPC

Centre for Studies in Civilizations

ANALYSE THIS

Kerala scholars cracked math code before Newton

JAYANTO

Vijay Dutt
London, August 13

A LITTLE-KNOWN school of scholars in Kerala discovered one of the founding principles of modern mathematics much before Sir Isaac Newton, to whom the finding is currently attributed, a new research here says.

Dr George Gheverghese Joseph, an Honorary Reader of the University of Manchester, says the 'Kerala School of Mathematics and Astronomy,' identified the 'Infinite Series' — one of the basic components of calculus — in about 1350.

"The 'Infinite Series' was identified by these little-known scholars in Kerala all of whom were from within 500 km of Cochin," Dr Joseph, hailing from Kottayam, told HT. The scholars of the school also discovered what amounted to the Pi series and used it to calculate Pi correct to 17 decimals.

The research, carried out by teams led by Dr Joseph and Dennis Almeida of the University of Exeter, found evidence that the Indians passed on their discoveries to Jesuit missionaries who visited India during the 15th century.

vdutt@aol.com

HT CORRECTION

The claim made by two British researchers that they were the ones who unearthed the fact that Kerala mathematicians invented the calculus long before Sir Isaac Newton (Hindustan Times, August 14, 2007) was incorrect. The Kerala infinite series has been known to British scholars since 1832. Recent work on transmission of the calculus was first done by C.K. Raju, Editorial Fellow of the Project of History of Indian Science, Philosophy and Culture and is published in his book, Cultural Foundations of Mathematics: the Nature of Mathematical Proof and the Transmission of the Calculus from India to Europe in the 16th century. One of the British researchers, Dennis Almeida, was even warned in 2004 by Exeter University against plagiarising Raju's work." The error is regretted.

Question 1

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  - Pañcatantra story: "Loyal monkey cuts off your nose",
  - repeatedly makes a joke of tradition:
  - in 10 minutes discredits 10 years work of the knowledgeable.

Don't miss: 5 howlers from the Indian Science Congress

Inaugurating the conference, Health Minister Dr Harsh Vardhan on Saturday said India had given the world algebra and the Pythagoras's Theorem, which is used to calculate the length of the hypotenuse of a right-angle triangle.

IndiaToday.in
New Delhi, January 5, 2015 | UPDATED 14:26 IST

A+ A-

Picture for representational purpose

Nothing Vedic in 'Vedic Maths'

Advocating 'Vedic mathematics' as a replacement for traditional Indian arithmetic is hardly an act of nationalism; it only shows ignorance of the history of mathematics

C.K. Raju

Gujarat has made it compulsory for school students to read the texts of Dinanath Batra, endorsed by Prime Minister Narendra Modi. According to news reports, Mr. Batra has now proposed a non-governmental education commission which will Indianise education through, for instance, Vedic mathematics. The Minister for Education has also mentioned Vedic mathematics as part of her agenda.

Ignorant of tradition

One appreciates the desire of these people to work for Indian traditions. But where in the Vedas is "Vedic mathematics" to be found? Nowhere. Vedic mathematics has no relation whatsoever to the Vedas. It actually originates from a book misleadingly titled *Vedic Mathematics* by Bharati Krishna Tirtha. The book admits on its first page that its title is misleading and that the (elementary arithmetic) algorithms expounded in the book have nothing to do with the Vedas. This is repeated on p. xxxv: "Obviously these formulas are not to be found in the present recensions of Atharvaveda." I have been pointing this out since 1998. Regrettably, the advocates of "Vedic mathematics," though they claim to champion Indian tradition, are ignorant of the actual tradition in the Vedas. Second, they do not even know what is stated in the book — the real source of "Vedic mathematics." Third, they are unaware of scholarly writing on the subject. When education policy is decided by such ignorant people, they only end up making a laughing stock of themselves and the Vedas, and thus do a great disservice to the very tradition which they claim to champion.

Everyone learns how to add, subtract, multiply and divide in school. Why should we replace those algorithms with "Vedic mathematics"? Will that Indianise education? No. The standard arithmetic algorithms actually originated in India, where they were known by various names such as *patiganita* (slate arithmetic). However, the word "algorithm" comes from "algorithmus": the Latinised name of al Khwarizmi of the 9th century House of Wisdom in Baghdad. He wrote an expository book on Indian arithmetic called *Hisab al Hind*. Gerbert d'Aurillac (later Pope Sylvester II), the leading European mathematician of the 10th century, learnt these techniques from the Umayyad Khilafat of Córdoba. He did so because the primitive Greek and Roman system of arithmetic (tied to the abacus), then prevailing in Europe, was no match for Indian arithmetic. However, accustomed to the abacus (on which he wrote a tome), Gerbert was perplexed by algorithms based on the place-value system, and foolishly got a special abacus (apices) constructed for these "Arabic numerals" in 976 CE. Hence the name "Arabic numerals" — became a learned pope amusingly thought there was some magic in the shape of the numerals which made arithmetic efficient.

Later, Florentine merchants realised that efficient Indian arithmetic algorithms conferred a competitive advantage in commerce. Fibonacci, who traded across Islamic Africa, translated al Khwarizmi's work, as did many others, which is why they came to be known as algorithms. Eventually, after 600 years, Indian algorithms displaced the European abacus and were introduced in the Jesuit syllabus as "practical mathematics" circa 1570 by Christoph Clavius. These algorithms are found in many early Indian texts, such as the *Patiganita* of Sridhar or the *Ganita Sara Sangraha* of Mahavira, or the *Lilavati* of Bhaskara II. So, advocating "Vedic mathematics" as a replacement for traditional Indian arithmetic is hardly an act of nationalism. On the contrary, it only shows ignorance of the history of mathematics. Spreading this ignorance among future generations will weaken the nation, not strengthen it.

The techniques of "Vedic mathematics" are designed for mental arithmetic, traditionally used by lower caste artisans such as carpenters or by people like Shakuntala Devi. There are many other such systems of mental arithmetic today. If that is what we intend to promote, we should first do a systematic comparison. We should also be honest and refrain from using the misleading label "Vedic" which is the main selling point of Bharti Krishna Tirtha's system, and which attracts gullible people who infer value just from the wrapper.

Wrong solutions persist because an insecure political dispensation values the politically loyal over the learned

Suppressing real Mathematics

Promoting the wrongly labelled "Vedic mathematics" suppresses the mathematics that really does exist in the Vedas. For example, Yajurveda 17.2 elaborates on the decimal place value system (the basis of Indian algorithms) and some of these names for numbers are still in use, though terms such as ayuh (ashtadam) have changed meaning. That passage shows that the place value system extends back to Vedic times, and it was a late acquisition only in mathematically backward Europe.

Likewise, the theory of permutations and combinations is built into the Vedic metre (and Indian music in general), as explained in various texts from Pingala's *Chandahsastra* to Bhaskar's *Lilavati*. The alea sastra of the Rigveda gives a beautiful account of the game of dice, which is the foundation of the theory of probability. The romantic story of Nala and Damayanti in the Mahabharata further relates dice to sampling theory (to count the number of fruits in a tree).

More details are in my article on "Probability in Ancient India" available online and published in the *Elsevier Handbook of the Philosophy of Statistics*. However, all these scholarly efforts are jeopardised, for they too are viewed with suspicion.

We need to change the Western and colonial education system, especially with regard to mathematics. Traditional Indian *ganita* has much to offer in this process, but "Vedic mathematics" is definitely not the right way.

Wrong solutions like "Vedic mathematics" persist because an insecure political dispensation values the politically loyal over the learned who are loyal to the truth. ("Merit" apparently is important only in the context of reservations.) Such political processes are historically known to damage real traditions.

As I wrote over a decade ago in my book *The Eleven Pictures of Time*, those who attain or retain state power through religion are the worst enemies of that religion, whatever be the religion they claim to represent: Christianity, Islam, or Hinduism.

(C.K. Raju is author of Cultural Foundations of Mathematics. *He was professor of mathematics, and Editorial Fellow of the Project of History of Indian Science, Philosophy and Culture.)*

वैदिक गणित में वैदिक कुछ नहीं

चंद्रकांत राजू

गुजरात के स्कूलों में दीनानाथ बत्रा की किताबें पढ़ाना अनिवार्य किया गया है। प्रधानमंत्री नरेंद्र मोदी ने इन किताबों का समर्थन किया है। खबरों के अनुसार बत्रा ने एक गैर-सरकारी शिक्षा आयोग बनाया है, जो शिक्षा के भारतीयकरण और वैदिक गणित आदि के बारे में सुझाव देगा। भारत के शिक्षामंत्री ने भी अपने एजेंडे में वैदिक गणित का उल्लेख किया है।

भारतीय परंपराओं के लिए काम करने की इच्छा सराहनीय है। लेकिन 'वैदिक गणित' वेदों में है कहां? कहीं नहीं! वैदिक गणित का किसी वेद से कोई संबंध नहीं है। 'वैदिक गणित' नाम निकल चला इसी शीर्षक की एक पुस्तक से, जो भारती कृष्णतीर्थ ने लिखी। वह पुस्तक भी अपने पहले पन्ने पर यह मानती है कि 'वैदिक गणित' का वेद से कोई संबंध नहीं! यही बात आगे चल कर भी दोहराई गई है : 'इन सूत्रों का जिक्र अथर्ववेद में नहीं पाया जाता है'। यह बात मैं 1998 से कह रहा हूं। खेद है कि जो लोग अपने को भारतीय परंपराओं का चैंपियन मानते हैं, वे खुद उन परंपराओं और वेदों से अनभिज्ञ हैं। न वे यह जानते हैं कि जो पुस्तक 'वैदिक गणित' का असली स्रोत है, उसमें क्या लिखा है। तीसरे, वे इस विषय पर लिखे शोध-पत्रों से भी अनभिज्ञ हैं। जब ऐसे अज्ञानी लोग शिक्षा नीति बनाते हैं तो वे खुद को और वेद को एक उपहास का पात्र बना देते हैं।

विवाद

साधारण गणित के गुणा-भाग के तरीके सभी ने स्कूल में सीखे। उन्हें छोड़ 'वैदिक गणित' क्यों करना चाहिए? क्या इससे शिक्षा का भारतीयकरण होगा? हर्गिज नहीं!

'एल्गोरिथ्म' (जोड़-घटाना, गुणा-भाग की पद्धति) वास्तव में भारत से विकसित हुई। इसके भारत में पाटीगणित जैसे कई नाम थे। 'एल्गोरिथ्म' शब्द अल ख्वारिज्मी के लातीनी नाम से आता है। नौवीं सदी में अल ख्वारिज्मी ने भारतीय गणित पर 'हिसाब अल हिंद' नामक एक मशहूर वर्णनात्मक पुस्तक लिखी। गर्बर्ट (जो बाद में पोप सिलवेस्टर द्वितीय बना) दसवीं सदी का प्रमुख यूरोपीय गणितज्ञ था। उसने कॉर्डोबा के उमय्यद खिलाफत से इस गणित का आयात किया। उस समय यूरोप में अबैकस (अंकगणक) से बंधी गणित की आदिम ग्रीक और रोमन प्रणाली प्रचलित थी, जो भारतीय गणित की तुलना में बहुत पिछड़ी थी। गर्बर्ट अबैकस का जानकार था। उसने उस पर एक किताब भी लिखी थी। इसलिए वह 'स्थान मूल्य प्रणाली' पर आधारित एल्गोरिथ्म को समझ न पाया, और अज्ञानतावश इन 'अरबी अंकों' के लिए 976 में एक विशेष अबैकस बनवाया। पोप को लगा कि अंकों के आकार में ही कुछ जादू था, इसलिए उसने इसे 'अरबी अंक' कहा। !

बाद में फ्लोरेंस के व्यापारियों ने समझा कि भारतीय गणित से लेन-देन में प्रतिस्पर्धात्मक लाभ है। फिबोनाची ने अल ख्वारिज्मी की किताब का अनुवाद किया। औरों ने भी किया। आखिरकार, छह सौ साल बाद यूरोपियों ने अबैकस छोड़ भारतीय एल्गोरिथ्म अपनाया। 'व्यावहारिक गणित' के नाम से जेसुइट पाठ्यक्रम में इसे क्रिस्टोफ क्लाविउस ने 1570 के आसपास शुरू किया। गणित के ये तरीके श्रीधर की 'पाटीगणित' या महावीर के 'गणित सार संग्रह' जैसे कई प्राचीन भारतीय ग्रंथों में पाए जाते हैं। इसलिए इस पारंपरिक भारतीय गणित को हटा कर 'वैदिक गणित' पढ़ाना कोई राष्ट्रवाद नहीं। यह केवल गणित के इतिहास के अज्ञान का प्रदर्शन है। आने वाली पीढ़ियों में ऐसा अज्ञान फैलाने से राष्ट्र मजबूत नहीं, बल्कि कमजोर होगा।

पश्चिमी और औपनिवेशिक शिक्षा-व्यवस्था को बदलना जरूरी है, विशेष रूप से गणित के संबंध में। भारतीय परंपराओं का इस प्रक्रिया में काफी योगदान है। लेकिन भ्रामक लेबल वाले 'वैदिक गणित' को फैलाना निश्चित रूप से सही तरीका नहीं है।

'वैदिक गणित' के यह एल्गोरिथ्म मन ही मन में गणित करने के लिए उपयुक्त हैं। पारंपरिक रूप से या तो निम्न जाति के कारीगर या फिर शकुंतला देवी जैसे लोगों ने इसे इस्तेमाल किया। मानसिक गणित की कई अन्य ऐसी प्रणालियां आज उपलब्ध हैं, और अगर हमारा इरादा इनको बढ़ावा देना है तो हमें पहले एक व्यवस्थित तुलना करनी चाहिए। और ईमानदारी से 'वैदिक' जैसे भ्रामक लेबल को हटा देना चाहिए, जो भारती कृष्ण तीर्थ की प्रणाली का मुख्य विक्रय बिंदु है और उनको आकर्षित करता है, जो बाहरी आवरण से किसी चीज के मूल्य का अंदाजा लगाते हैं।

'वैदिक गणित' को बढ़ावा देने से वेद में जो असली गणित है वह दब जाता है। उदाहरण के लिए, यजुर्वेद 17.2 से पता चलता है के दशमलव स्थान मूल्य प्रणाली बहुत प्राचीन है। अंकों के उन नामों में कुछ नाम आज भी प्रचलित हैं (हालांकि अरब या अर्बुदम जैसे कुछ का अर्थ बदल गया है)। केवल गणितीय रूप से पिछड़े यूरोपियों ने हजारों साल के विलंब के बाद उसे अपनाया।

इसी तरह क्रमपरिवर्तन और संयोजन के सिद्धांत वैदिक छंद (और भारतीय संगीत) में बुने हुए हैं, और इसका वर्णन पिंगल के 'छंदःसूत्र' से भास्कर की 'लीलावती' में मिलता है। ऋग्वेद के अक्ष सूक्त में पांसे के खेल का सुंदर वर्णन है। यह खेल संभावना के सिद्धांत का आधार है, और महाभारत में नल और दमयंती की रोमांटिक कहानी इसे नमूना सिद्धांत से जोड़ती है (एक पेड़ पर फलों की संख्या गिनने के लिए)। परंपरा के स्वयंभू चैंपियन जब वैदिक गणित को महज भ्रामक चिप्पी के आधार पर प्रोत्साहन देते हैं, तो ऐसे सभी गंभीर प्रयास खतरे में पड़ जाते हैं, क्योंकि उन्हें भी कोई गंभीरता से नहीं लेता।

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'वैदिक गणित' जैसे गलत समाधान इसलिए बने रहते हैं, क्योंकि असुरक्षित राजनेता राजनीतिक वफादारी चाहते हैं और सच्चाई के प्रति वफादार विलानों को दरकिनार करते हैं। ('योग्यता' केवल आरक्षण के संदर्भ में महत्त्वपूर्ण है!) इतिहास बताता है कि ऐसी राजनीतिक प्रक्रियाओं से परंपराओं को नुकसान होता है।

जैसे मैंने अपनी किताब 'इलेवेन पिक्चर्स ऑफ टाइम' में लिखा था कि जो लोग धर्म का इस्तेमाल कर राज्य सत्ता पाते हैं या बनाए रखते हैं, वे उस धर्म के सबसे बड़े दुश्मन होते हैं, चाहे वह जिस भी धर्म के प्रतिनिधित्व का दावा करें, ईसाई, इस्लाम या हिंदू। ❐

ckr@ckraju.net

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- Let us invest in knowledge, and create some space for truly knowledgeable truth-seekers.

Gaṇita vs math

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- Whether or not we had it earlier, we had it different.

Gaṇita vs math

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  - formal math claims to be exact knowledge (but in a fantasy world inaccessible to the senses; e.g. a geometric point is declared invisible).

E.g. 1. Geometry: "Pythagorean theorem"

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- Difference: Manava *śulba sūtra* uses square roots.

Manava *śulba sūtra*

- Manava *śulba sūtra* 10.10

manava-sulba-sutra-10-10.png

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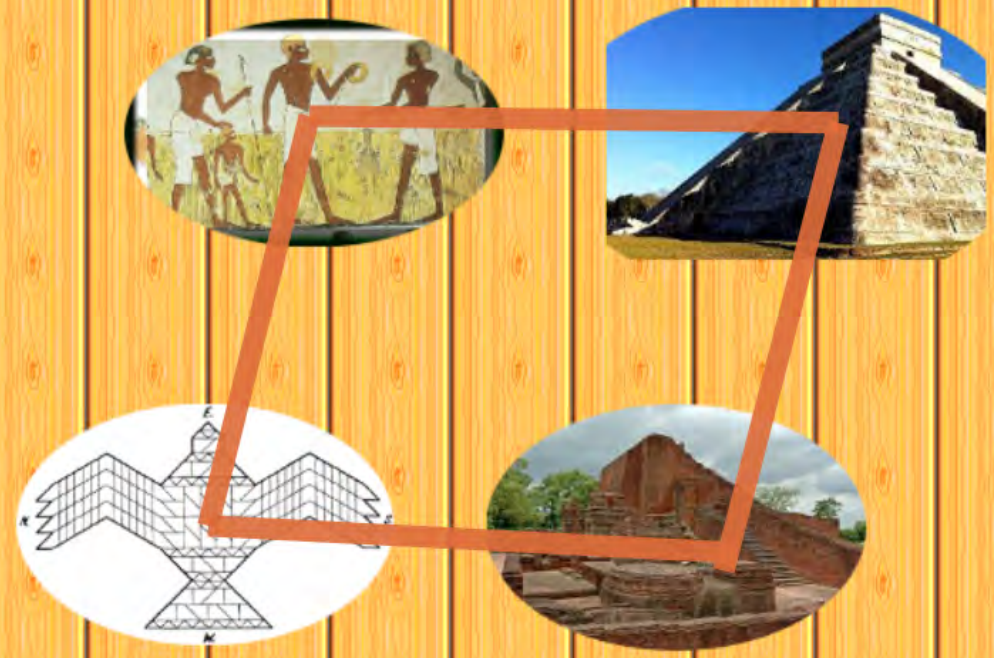
Rajju Ganit

Part 2



C. K. Raju


Aide et Action
WORKSHOP ON RAJJU GANIT
18TH TO 24TH, MAY, 2017
Venue : BRC, Chamarajanagara
SUPPORTED BY
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E.g. 2: Different concept of zero

Zeroism

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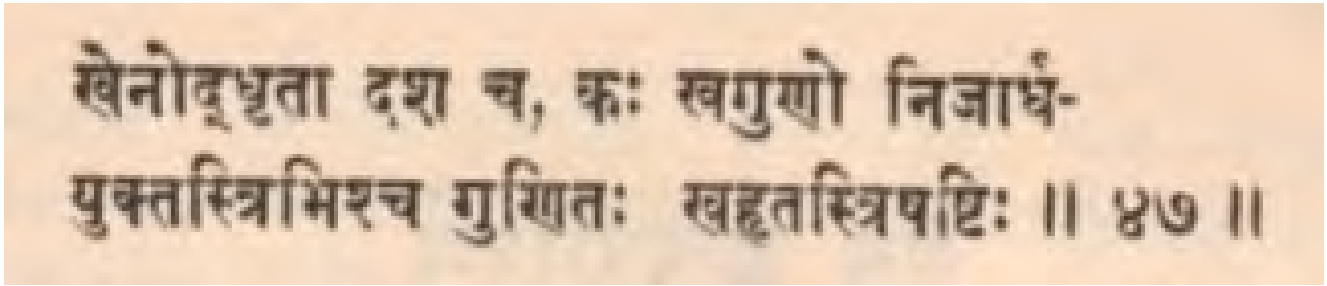
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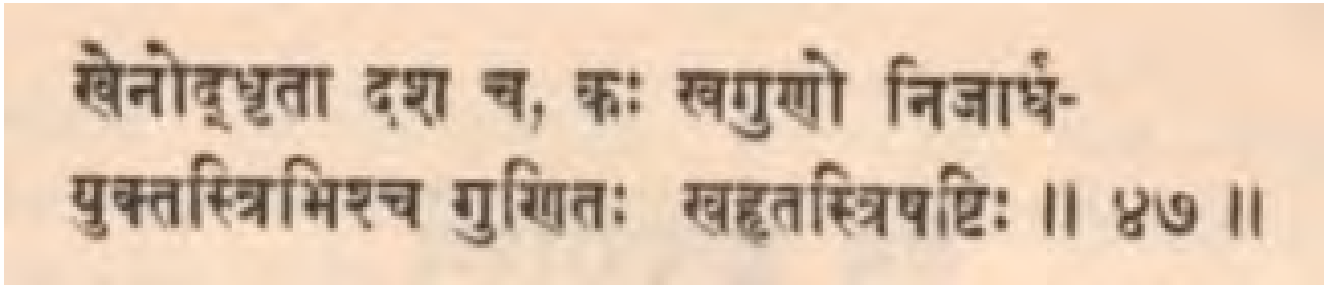
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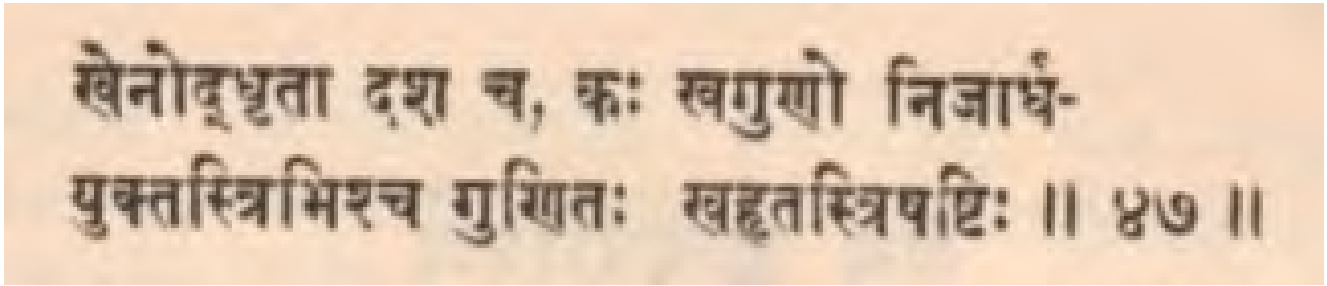
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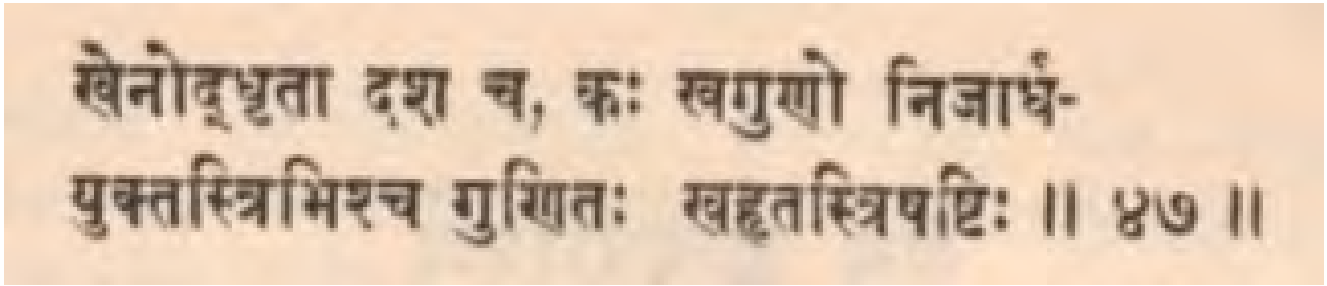
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- $$\frac{\left(x \times 0 + \frac{x}{2} \times 0\right) \times 3}{0} = 63$$
- $x = 14$.
- Division by zero (a) NOT a mistake, (b) NOT pāṭīgaṇita, (c) NOT to be understood using limits.

Calculus without limits

0 as infinitesimal completely changes how calculus is done (without limits, with zeroism).

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- This involves doing calculus and summing infinite series with so-called non-Archimedean arithmetic (*avyakt* fractions).

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- Correcting that error also corrects his theory of gravitation.
- Here are some recent papers on my new theory of gravitation.

Retarded gravitation theory

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Abstract. We propose a Lorentz-covariant theory of gravity, and explain its theoretical origins in the problem of time in Newtonian physics. In this retarded gravitation theory (RGT), the gravitational force depends upon both retarded position and velocity, and the equations of motion are retarded functional differential equations. We explicitly solve these equations, under simplifying assumptions, for various NASA spacecraft. This shows that the differences from Newtonian gravity, though tiny, are just appropriate to explain the flyby anomaly as a $\frac{v}{c}$ effect due to earth's rotation. We also show that, in the case of a spiral galaxy, the combined velocity drag from a large number of co-rotating stars enormously speeds up a test particle. RGT can also be tested in the laboratory. It necessitates a reappraisal of current laboratory methods of determining the Newtonian gravitational constant G.

Keywords: Retarded gravity, galactic rotation curves, flyby anomaly, functional differential equations, experimental tests of gravity
PACS: 04.80.Cc, 04.50.Kd, 98.62.Dm, 45.20.D-, 02.30.Ks

INTRODUCTION

The notion of time is fundamental to this reformulation of gravity. Though published long ago[1], my analysis of the notion of time is perhaps not so widely known, and this is briefly summarized below.

The problem of equal intervals of time in Newtonian physics

It is well known that Newtonian physics had a difficulty in defining equal intervals of time. One cannot bring back one hour from the past and put it side by side with one hour in the future and compare the two in the present to say by inspection that the two time intervals are equal. The equality of two time intervals is a matter of definition. Such a definition is needed to make sense of Newton's first law: "uniform" motion means a particle covers equal distances in equal times. This presupposes a theoretical clock: what is uniform motion according to a pendulum would not be uniform motion according to one's heart beats, or an atomic clock. Newtonian physics does not explicitly specify which clock to use. For applications to planetary motion or ballistics, there are many clocks which one could use in practice. However, the lack of a theoretical definition of equal intervals of time became prominent when Newtonian physics had to be reconciled with Maxwellian electrodynamics. If we define equal intervals of time so as to make Newtonian physics valid, that makes Maxwellian electrodynamics invalid.

Functional differential equations. 4: Retarded gravitation

C. K. Raju

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(Submitted 27-06-2015)

Abstract

Are functional differential equations (FDEs) only about electrodynamics? No. They apply also to gravitation. We explain a recent reformulation of gravitation, called retarded gravitation theory (RGT), which is Lorentz covariant, and uses functional differential equations. RGT modifies the Newtonian "inverse square law" gravitational force: the RGT force depends upon (a) retarded distance, and (b) includes a velocity-dependent term. RGT, since Lorentz covariant, theoretically improves on Newtonian gravitation. At the same time, RGT has the practical advantage over general relativity theory (GRT) that a solution of the many-body problem is feasible in RGT. Hence, RGT can and ought to be applied to the galaxy where Newtonian physics apparently fails but GRT cannot be applied. The tiny velocity dependence of the RGT force is amplified across a hundred billion co-rotating stars in the galaxy, so that non-Newtonian velocities of stars in spiral galaxies are to be expected on RGT, even without dark matter. Possible experimental tests of RGT include the flyby anomaly observed for NASA spacecraft which depends systematically on velocity-effects due to the rotation of the earth.
We further clarify that Laplace's objection to pre-relativistic naive theories of retarded gravitation (NRG) does not apply to RGT. We solve the 2-body FDEs of RGT for the sun-Jupiter case: the system is stable despite tiny differences from Newtonian gravitation. Thus, FDEs are a general feature of post-relativity physics.

1 Recap

In three earlier articles[1, 2, 3] in this series, we saw that functional differential equations (FDEs) are fundamentally different from ordinary differential equations (ODEs). Hence, doing physics with FDEs leads to a paradigm shift in physics. Further, FDEs arise naturally in classical electrodynamics: *without* any new physical hypotheses but just by doing the math right. The right way to solve for the classical hydrogen atom, even without radiation damping, is to use FDEs and that changes the qualitative features of the solution.

What happens if we have radiation damping? The problem of the motion of even a single charged particle, in classical electrodynamics, with radiation damping has remained mathematically unsolved for a century because of runaways. These runaways can be controlled by modifying Maxwell's equations at the microphysical level, so that the equations of motion

A proposed experiment to test theories of the flyby anomaly

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June 25, 2017

Abstract

We use Lorentz covariant retarded gravitation theory (RGT), without simplifications, to validate the earlier calculations for the flyby anomaly as a gravitational effect of Earth's rotation at the special relativistic ($\frac{v}{c}$) level. Small differences persist between the theoretical predictions of RGT and the data reported by Anderson et al. That reported data, however, is not direct observational data but consists of un-modeled residues. To settle doubts, we propose a 3-way experimental test to discriminate between RGT, Newtonian gravitation (no flyby anomaly), and Anderson et al.'s formula. This involves two satellites orbiting Earth in opposite directions in the equatorial plane in eccentric orbits. For these orbits, Earth's rotation should not affect velocity on (1) Newtonian gravitation and (2) the formula of Anderson et al. However, (3) on RGT, one satellite gains and the other loses velocity, by typically a few cm/s/day, which is easily measurable by satellite laser ranging.

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- and makes church superstitions credible.
- As in the creationism of Stephen Hawking.

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DNA Sunday

THE mag

Mumbai, January 16, 2011

The Christian propaganda in Hawking's work

What do the Pope and Stephen Hawking have in common? Both propagate a Christian view of how the universe came into being: While the Pope is direct, seeing the hand of God in the Big Bang, Hawking does it more subtly. His popular books provide a scientific veneer to Christian theology, while projecting non-Christian views of creation as unscientific, reveals Professor CK Raju, who is currently with the School of Mathematical Sciences, Universiti Sains Malaysia

The Grand Design: New Answers To The Ultimate Questions Of Life
Stephen Hawking and Leonard Mlodinow
Bantam Brooks
199 pages
Rs599

Stephen Hawking's new book, *The Grand Design: New Answers To The Ultimate Questions of Life*, has a misleading subtitle. It aims to answer the ultimate questions not of life, but of theology. Those concern creation and God.

Science, too, has a big bang theory of the origin of the cosmos. How does that compare with the religious account of creation given by (Christian) theology?

This question has preoccupied Hawking since his first book in 1973. (That was not the *Brief History Of Time*, but a book on general relativity called *The Large-Scale Structure Of Space-Time*.) The concluding sentence of that book spoke of a "moment of creation" (called a "singularity") when the laws of physics break down (see box). Hawking claimed to have proved that the "laws of physics" imply creation.

Does the big bang (a dense state of the cosmos) coincide with creation (a true beginning of time)? People commonly confound the two; that includes scientists—the website of the Large Hadronic Collider also speaks of creation. But a dense state of the cosmos need not be a moment of creation. In the Hindu view of a quasi-recurrent cosmos, the cosmos periodically goes through a dense egg state (*hiranyagarbha*). The same is true of general relativity. If the cosmos rotates, for example, the big bang might not be a beginning of time, but only the other side of a big crunch. So, while the observed cosmic microwave (millimeter) background might be evidence for a past dense state of the cosmos, it is no evidence for creation or a beginning of time. The whole point of Hawking's singularity theory was to try to settle this doubt whether the big bang did amount to creation. Strangely, this book never comes to grips with the common confusion between the big bang and instantaneous creation.

Creation and the Bible

Now instantaneous creation, a few billion years ago, is not exactly the Bible story of creation in 7 days, some 6,000 years ago. But Christian theologians explained long ago how the two are compatible! Hawking's earlier view coincided with those of Thomas Aquinas, a key 13th century church theologian, who stated in his *Summa Theologica* that after creating the world, God ruled it with eternal laws.

Theology is about power, not the Bible. This was renamed "soft power" by Huntington, a modern strategist, who recognised its role in the US agenda for global hegemony.

The politics of "science and creation" relates to the civilisational clash between Christianity and Islam. Creation at one instant in the past is opposed to the Islamic view of continuous creation, or the Buddhist view of non-creation, or even the Hindu view of a quasi-recurrent and long-lived cosmos. So, the subtle propaganda point in Hawking's work has all along been that science is opposed to all non-Christian views of creation, which are hence false. This influences large numbers of people who implicitly believe in science, especially if they don't understand it.

FJ Tipler even argued that singularity theory shows that "Judeo-Christian theology is a part of physics". The book under review obliquely refers to that argument through the Hollywood film, *The Matrix*, which combines Tipler's idea of humans as characters in a computer-generated virtual reality with the story of Christ as saviour.

Hawking: Theology in a scientific bottle

The weaknesses of singularity theory were pointed out by various people including CJS Clarke and this reviewer. The theory had no experimental consequence, and hence was not science. A singularity is merely a mathematical infinity which can be easily eliminated by changing a mathematical definition.

In a public debate with this reviewer, Roger Penrose, the originator of singularity theory, could not defend the physical interpretation of a singularity (it might be just a common shock wave, as this reviewer argued). The proofs of Hawking's singularity theorems used biased assumptions about time, called the "chronology condition" (that time is not 'cyclic') which are central to the revised Christian theological dogma from the 4th century. Hawking justified those assumptions using arguments very similar to Augustine's (a 4th century theologian). This was explained in this reviewer's book *The Eleven Pictures of Time*. In an indirect acknowledgment of this critique, Hawking's latest book has only a single passing line on singularity theory: "It seems the laws of evolution of the universe may break down at the big bang".

The Brief History Of Time pushed that creationist idea, and gave Hawking the image of a super-scientist, among laypersons. But the weakness of singularity theory, combined with its proximity to Christian theology, damaged Hawking's image among scientists. The inspired (if devious) marketing line for the present book is that, according to Hawking, God is not needed for creation. So, what is the new answer to the mystery of creation? This is never explained in the book, surely *by design*. That subtlety has also been missed by reviewers, so it needs to be made explicit.

Hawking's earlier answer (like Aquinas' theology) had a defect. If the "laws of physics" break down at the moment of creation, then how can they be eternal? So the new answer given (implicitly) by Hawking is that God created only the laws of physics, which are "eternal" in the sense of being outside time. The cosmos was created according to these laws, and hence does not (directly) require God for its creation. That is, Hawking, the scientist, can speak comfortably only of the "laws of physics", while the Christian theologian can say those "laws" were created by God just as they had been saying all along.

Patchwork models, not reality

How do we know that there are "laws of physics", or that they do not change capriciously with the epoch? Or that they exist when/where the cosmos does not? Hawking appeals to "model-dependent realism": only models matter, there is no reality. Even a comprehensive model is not needed, a patchwork will do. Hawking advocates this "philosophy" since he needs to patch general relativity (which models the cosmos at large scales) with quantum field theory (which models the cosmos at very small scales). Though Hawking suggests that the two can be patched together, the lay reader is never warned that no one has quite succeeded in doing that so far.

How did the "laws of physics" create the cosmos? The authors use Feynman's idea of alternative past histories without pointing out its key lacuna. (Feynman's idea was that all that could have happened did happen.) That formulation can make predictions, like astrology, but those predictions cannot be refuted by experiment. Science must be refutable, but Hawking has changed that to mean that it must be reputable.

Why did God create the world he did? The new answer (using alternative past histories) is that he just haphazardly created all possible worlds — billions of them — of which we are aware of only one. The final leap in the book is into M-theory, which supposedly explains everything, but is never explained in the book. Instead, the book just concludes by passing it off as the unified theory Einstein was looking for. The authors apparently think this is a book in the Complete Idiot's series.

Hawking's claim — that he has no need for God in his system — is not original: a similar claim was made long ago, in a similar context, by Laplace. Not only al-Ghazali, but also Isaac Newton thought that God intervenes in the cosmos from time to time. The universe may be like a giant piece of clockwork, but it was necessary to wind up the clock (or recharge the batteries) occasionally. Newton needed God's intervention since he was unable to prove the stability of the planetary system. Laplace did so, hence his boast that he had no need for God in his system.

So what does that mean for the layperson? This iron "rule of law" not only eliminates divine intervention, it also eliminates any creative human intervention, to bring about a particular future. This not only makes life utterly pointless, it cuts out the basis of the belief in science. In contrast, the Islamic belief in continuous creation allows human creativity, like the Buddhist belief in conditioned coorigination (*paticca samuppada*) or the Hindu belief in creative action (*karma*). Hawking's answer to this is very very old hat—something called Conway's "Game of Life" which shows how complexity may give rise to the illusion of creativity. The authors neglect the whole host of difficulties with that, perhaps because they believe "philosophy is dead". But what they give in its place is half-baked science to support full-blown theology which suits the pursuit of world power by one superpower. themag@dnaindia.net

COVERSTORY

In a nutshell

Politics of creation

Both science and religion have stories about cosmic creation. The Christian belief is that God created the world at a certain point of time. This appears to tie in with the Big Bang theory. But in fact, extrapolating backwards from an expanding universe only tells us there was a dense state of the cosmos, and not that there was a moment of instantaneous creation or a beginning of time.

To get around this, Hawking earlier applied the notion of 'singularity' to argue that the Big Bang did go back to a moment of creation. A singularity is commonly believed to be a mathematical point of infinite density into which all matter flowed. But Hawking believed that the laws of physics must break down at a singularity.

So here's the Catch-22: you can cook up a moment of creation with the singularity theory, but in that case, the laws of physics (such as the law of gravitation) are not eternal and won't apply there. Hawking's new book makes use of some dubious science to imply that God made only the laws of physics, which then created the cosmos. (Hence, the blurb: "God not needed for creation".) In Hawking's new scheme of things, the laws of physics are 'eternal' in the sense of being outside time, which begins only post-creation. So, Hawking, the scientist, can speak comfortably only of the "laws of physics", while the Christian theologian can say those "laws" were created by God just as they had been saying all along.

More importantly, these views of creation are contrary to the Hindu view of a quasi-recurrent cosmos, the Islamic view of continuous creation, and the Buddhist view of non-creation. So, Hawking's theories have been used to argue that science agrees with Christianity but is contrary to other religions. Given that people tend to believe authoritative scientists without understanding what they say, this is powerful propaganda in the ongoing clash of civilizations.

Half-baked science

Hawking's new theory is that the cosmos was spontaneously created by the laws of physics. But how do we know there are eternal laws of physics? How do we know the "laws" do not change with every epoch?

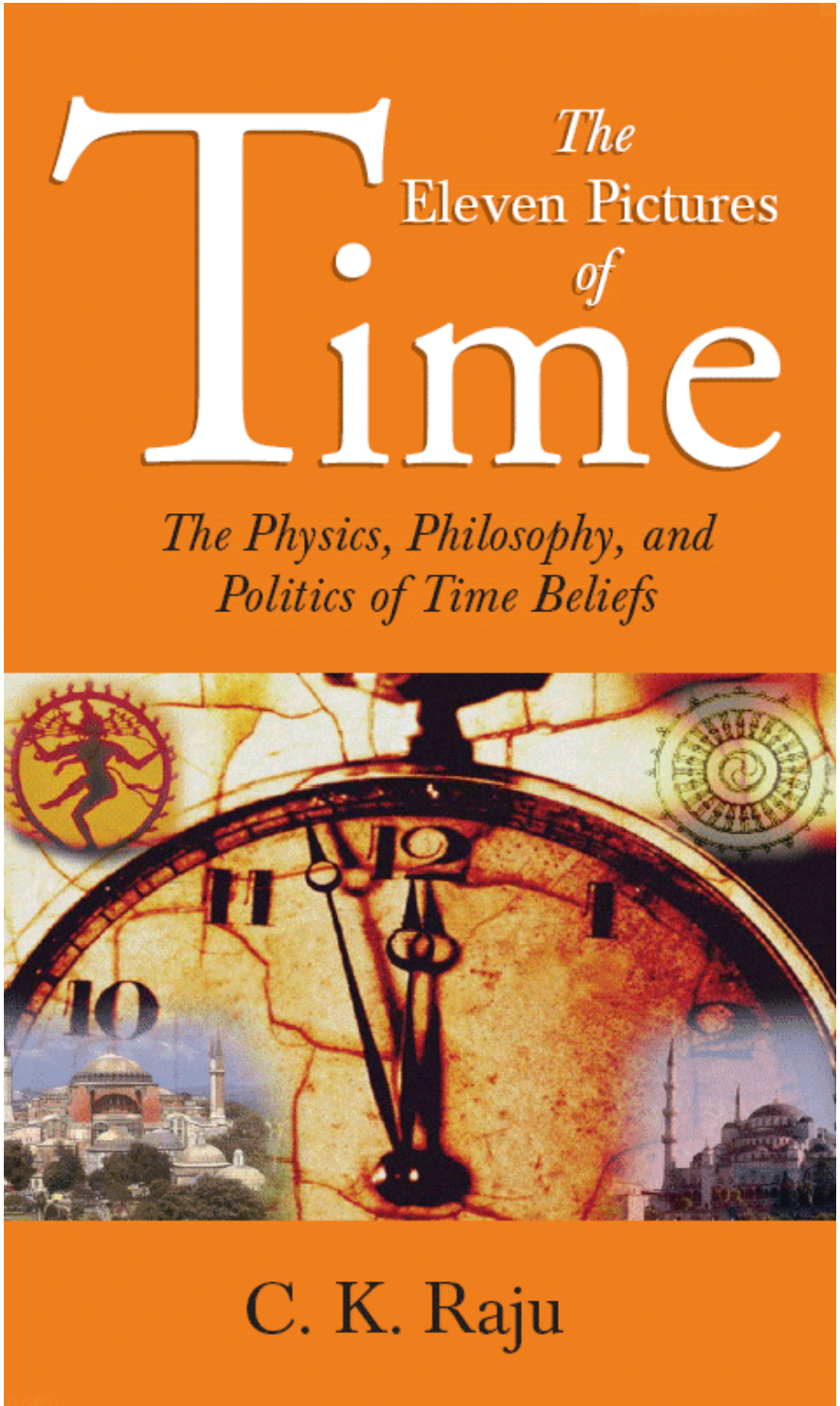
Hawking gets around such questions by resorting to "model-dependent realism". He also adopts physicist Richard Feynman's idea that all that could have happened did happen. He uses this idea to marry the physics of the large (gravitation) to the physics of the small (quantum theory). But this is a 'shotgun wedding' because there is no accepted way to match the two as yet. Also, a universe ruled entirely by law suggests that human creativity or "free will" is an illusion; this is fatal to the philosophy of science, and makes life meaningless.

God's hand in Big Bang

In a sermon last week, Pope Benedict said God's mind was behind the Big Bang, and Christians should reject the idea that the universe came into being by accident.

"Contemplating it, we are invited to read something profound into it: the wisdom of the creator."

Benedict and his predecessor John Paul have been trying to shed the Roman Catholic Church's image of being anti-science, a label that stuck when it condemned Galileo for saying that the earth revolves around the sun, challenging the Bible.



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- Why? Because Western math-in-science has made core of Hinduism disreputable.

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- (Newtonian physics mechanistic: allows only eternal recurrence, or repeated rebirth, with no escape [as in Nietzsche].)

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- Correcting Western misunderstanding of calculus essential for a non-mechanistic physics.

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  - May restore core ethical values.