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Ancient Vedic Mathematics and its Application

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Abstract

The 'Vedas' are considered 'divine' in origin and are assumed to be direct revelations from God. Much of the hype about this topic is based on one single book authored by the Sankaracharya, Jagadguru Swami Sri Bharati Krisna Tirthaji Maharaja titled Vedic Mathematics and published in the year 1965 and reprinted several times since the 1990s. In this the authors probe into Vedic Mathematics and explore whether it is really 'Vedic' in origin or 'Mathematics' in content. The entire field of Vedic Mathematics is supposedly based on 16 one - to three - word sutras (aphorisms) in Sanskrit, which can solve all modern mathematical problems. In this paper we have gone through different literature on ancient Vedic mathematics and its application. In this paper we discussed the Sutra: Nikhilam Navataścaramam Daśatah and its application.

Keywords: Vedas, Vedic mathematics, sutras and Nikhilam Navataścaramam Daśatah

Introduction

India today has active and excellent schools of research and teaching in mathematics that are at the forefront of modern research in their discipline with some of them recognised as being among the best in the world in their fields of research. It is noteworthy that they have cherished the legacy of distinguished Indian mathematicians like Srinivasa Ramanujam, V. K. Patodi, S. Minakshisundaram, Harish Chandra, K. G. Ramanathan, Hansraj Gupta, Syamdas Mukhopadhyay, Ganesh Prasad, and many others including several living Indian mathematicians. But not one of these schools has lent an iota of legitimacy to 'Vedic Mathematics'. Nowhere in the world does any school system teach "Vedic Mathematics" or any form of ancient mathematics for that matter as an adjunct to modern mathematical teaching. The bulk of such teaching belongs properly to the teaching of history and in particular the teaching of the history of the sciences. Mantras from the early Vedic period (before 1000 BCE) invoke powers of ten from a hundred all the way up to a trillion, and provide evidence of the use of arithmetic operations such as addition, subtraction, multiplication, fractions, squares, cubes and roots. A 4th Century CE Sanskrit text reports Buddha enumerating numbers up to 10, as well as describing six more numbering systems over and above these, leading to a number equivalent to 10. Given that there are an estimated 10 atoms in the whole universe, this is as close to infinity as any in the ancient world came. It also describes a series of iterations in decreasing size, in order to demonstrate the size of an atom, which comes remarkably close to the actual size of a carbon atom (about 70 trillionths of a metre). Vedic mathematics is the name given to the ancient system of mathematics, or, to be precise, a unique technique of calculations based on simple rules and principles with which any mathematical problem can be solved – be it arithmetic, algebra, geometry or trigonometry. Vedic mathematics was rediscovered from the ancient Indian scriptures between 1911 and 1918 by Sri Bharati Krishna Tirthaji, a scholar of Sanskrit, mathematics, history and philosophy. He studied these ancient texts for years and after careful investigation, was able to reconstruct a series of mathematical formulae called *sutras*. Bharati Krishna Tirthaji, who was also the former Shankaracharya of Puri, delved into the ancient Vedic texts and established the techniques of this system in his pioneering work, Vedic Mathematics (1965), which is considered the starting point for all work on Vedic mathematics.

Vedic mathematics was immediately hailed as a new alternative system of mathematics when a copy of the book reached London in the late 1960s. Some British mathematicians, including Kenneth Williams, Andrew Nicholas and Jeremy Pickles, took interest in this new system. They extended the introductory material of Bharati Krishna's book, and delivered lectures on it in London. In 1981, this was collated into a book entitled Introductory Lectures on Vedic Mathematics. A few successive trips to India by Andrew Nicholas between 1981 and 1987 renewed interest in Vedic mathematics and scholars and teachers in India started taking it seriously. A great deal of research is also being carried out on how to develop more powerful and easy applications of the Vedic *sutras* in geometry, calculus and computing. . The system is based on 16 Vedic *sutras* or aphorisms, which are actually word formulae describing natural ways of solving a whole range of mathematical problems. 16 *Vedic sutras and their corollaries* are shown in table 1.

Sl. No.	***Sutras***	***Sub Sutras or Corollaries***
1	Ekādhikena Pūrvena, also a corollary	Ānurūpyena
2	Nikhilam Navataścaramam Daśatah	Śisyate Śesamjnah
3	Ūrdhva - tiryagbhyām	Ādyamādyenantyamantyena
4	Parāvartya Yojayet	Kevalaih Saptakam Gunỹat
5	Sūnyam Samyasamuccaye	Vestanam
6	(Ānurūpye) Śūnyamanyat	Yāvadūnam Tāvadūnam
7	Sankalana - vyavakalanābhyām	Yāvadūnam Tāvadūnīkrtya Vargaňca Yojayet

8	Puranāpuranābhyām	Antyayordasake' pi
9	Calanā kalanābhyām	Antyayoreva
10	Yāvadūnam	Samuccayagunitah
11	Vyastisamastih	Lopanasthāpanabhyām
12	Śesānyankena Caramena	Vilokanam
13	Sopantyadvayamantyam	Gunitasamuccayah Samuccayagunitah
14	Ekanyūnena Pūrvena	
15	Gunitasamuccaya	
16	Gunakasamuccayah	

16 slokas has been compiled from stray references. Each slokas gives one or more mathematical theories formulated by Bharati Krishna Tirthaji. A major part of the body of mathematical knowledge from the Vedic period that has come down to us is from the Sulvasutras. The Sulvasutras are compositions aimed at providing instruction on the principles involved and procedures of construction of the vedis (altars) and agnis (fireplaces) for performing the yajnas, which were a key feature of the Vedic culture. The fireplaces were constructed in a variety of shapes such as falcons, tortoise, chariot wheels, circular trough with a handle, pyre, etc (depending on the context and purpose of the particular yajna) with sizes of the order of 20 to 25 feet in length and width, and there is a component of the Sulvasutras describing the setting up of such platforms with tiles of moderate sizes, of simple shapes like squares, triangles, and occasionally special ones like pentagons. Many of the vedis involved, especially for the yajnas for special occasions had dimensions of the order of 50 to 100 feet, and making the overall plan involved being able to draw perpendiculars in that setting. This was accomplished both through the method that is now taught in schools, involving perpendicularity of the line joining the centres of two intersecting circles with the line joining the two points of intersection, as also via the use of the converse of \Pythagoras theorem"; they were familiar with the Pythagoras theorem", and explicit statement of the theorem is found in all the four major Sulvasutras. The Sulvasutras also contain descriptions of various geometric principles and constructions, including procedures for converting a square into a circle with equal area and vice versa and a good approximation to the square root of 2.

The Sulvasutras, like other Vedic knowledge, were transmitted only orally over a long period. There have also been commentaries on some of the Sulvasutras in Sanskrit, but their period remains uncertain. When the first written versions of the Sulvasutras came up is unclear. The text versions with modern commentaries were brought out by European scholars (Thibaut, Burk, van Gelder and others) starting from the second half of the nineteenth century. With regard to genesis of his study of the Sulvasutras Thibaut mentions that the first to direct attention to the importance of the Sulvasutras was Mr. A.C. Burnell, who in his Catalogue of a Collection of Sanskrit Manuscripts, remarks that we must look to the Sulva portions of the Kalpasutras for the earliest beginnings among the Brahman. While the current translations are reasonably complete, some parts have eluded the translators, especially in the case of Manava Sulvasutra which turns out to be terser than the others. New results have been brought to light by R.G. Gupta, Takao Hayashi and perhaps also by others, not recognised by the original translators. Lack of adequate mathematical background on the part of the translators could be one of the factors in this respect. There is a case for a relook on a substantial scale to put the mathematical knowledge in the Sulvasutras on a comprehensive footing. There is also scope for work in the nature of interrelating in a cohesive manner the results described in the various Sulvasutras. The ritual context of the Sulvasutras lends itself also to the issue of interrelating the ritual and mathematical aspects, and correlating with other similar situations from other cultures; for a perspective on this the reader may refer Seidenberg.

Another natural question that suggests itself in the context of the Sulvasutras is whether there are any of the fireplaces from the old times to be found. From the description of the brick construction it would seem that they would have been too fragile to withstand the elements for long; it should be borne in mind that the purpose involved did not warrant a long-lasting construction. Nevertheless, excavations at an archaeological site at Singhol in Panjab have revealed one large brick platform in the traditional shape of a bird with outstretched wings, dated to be from the second century BCE; it however differs markedly from the numerical specifications described in the Sulvasutras. This leaves open the possibility of finding other sites, though presumably not a very promising one.

Apart from the Sulvasutras, mathematical studies have also been carried out in respect of the Vedas, mainly concerning understanding of the numbers. For a composition with a broad scope, including spiritual and secular, the Rig-Veda shows considerable preoccupation with numbers, with numbers up to 10,000 occurring, and the decimal representation of numbers is seen to be rooted there. The Yajurveda introduces names for powers of 10 upto 1012 and various simple properties of numbers are seen to be involved in various contexts for instance. There is scope for further work in understanding the development as a whole; this would involve familiarity with mathematics on the one hand and knowledge of Vedic Sanskrit on the other hand.

The Sutra: Nikhilam Navataścaramam Daśatah

The sutra reads "*Nikhilam Navataścaramam Daśatah"*, which literally translated means: all from 9 and the last from 10". We shall presently give the detailed explanation presently of the meaning and applications of this cryptical - sounding formula and then give details about the three corollaries.

He has given a very simple multiplication.

Suppose we have to multiply 9 by 7

1. We should take, as base for our calculations that power of 10 which is nearest to the numbers to be multiplied. In this case 10 itself is that power.
   (10)
   9 – 1

7 – 3
6 / 3

2. Put the numbers 9 and 7 above and below on the left hand side (as shown in the working alongside here on the right hand side margin)
3. Subtract each of them from the base (10) and write down the remainders (1 and 3) on the right hand side with a connecting minus sign (–) between them, to show that the numbers to be multiplied are both of them less than 10.
4. The product will have two parts, one on the left side and one on the right. A vertical dividing line may be drawn for the purpose of demarcation of the two parts.
5. Now, the left hand side digit can be arrived at in one of the 4 ways,
   a. Subtract the base 10 from the sum of the given numbers (9 and 7 i.e. 16). And put (16 – 10) i.e 6 as the left hand part of the answer or
      9 + 7 – 10 = 6
   b. Subtract the sum of two deficiencies (1 + 3 = 4) from the base (10) we get the same answer (6) again or
      10 – 1 – 3 = 6
   c. Cross subtract deficiency 3 on the second row from the original number 9 in the first row. And you find that you have got (9 – 3) i.e. 6 again
      9 – 3 = 6
   d. Cross subtract in the converse way (i.e. 1 from 7), and you get 6 again as the left hand side portion of the required answer
      7 – 1 = 6

This availability of the same result in several easy ways is a very common feature of the Vedic system and is great advantage and help to the student as it enables him to test and verify the correctness of his answer step by step.

6. Now vertically multiply the two deficit figures (1 and 3). The product is 3. And this is the right hand side portion of the answer
   (10)
   9 – 1
   7 – 3
   6 / 3
7. Thus 9 × 7 = 63

This method holds well in all cases and is therefore capable of infinite application.

Conclusion

Vedic mathematical methods are derived from ancient systems of computations, now made available to everyone through the great work of Jagadguru Swami Sri Bharati Krisna Tirthaji Maharaja, who published a book on Vedic mathematics in 1965. Compared to conventional mathematical methods, these are computationally faster and easy to perform. In this paper we have shown the second sutras of Bharati Krishna Tirthaji which is applicable for multiplication only. Vedic Mathematics mainly deals with various Vedic mathematical formulas and their applications of carrying out tedious and cumbersome arithmetical operations, and to a very large extent executing them mentally.

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