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Mathematical Concepts and its Theories in the Vedas

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ABSTRACT

Vedas are four in numbers; viz. *Rigveda*, *Yajurveda*, *Sāmaveda* and *Atharvaveda*. The word '*Veda*' itself means knowledge. The Vedic seers invented mathematical, geometrical, astronomical, botanical formulas without which health the present development in various aspects cannot be imagined.

The Vedic civilization originated in India bears literary evidence of Indian culture, literature, astronomy and mathematics. The Vedas and Vedāṅgas are primarily religious in content but embody a large amount of astronomical and mathematical knowledge. Although the requirement of mathematics in Vedic period was clearly not for its own sake, but for the purpose of religion and astronomy, since the Vedas are not texts on mathematics, but they mention a lot of mathematical concept.

In this paper, an attempt has been made to highlight different mathematical concepts and theories as found in the Vedas.

KEYWORDS: *Area of triangle, big number of Yajurveda, concept of infinity Concept of Algebra*

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INTRODUCTION

The woks of the Vedic religion have given the first literary evidence of Indian culture and hence mathematics. Though the Vedas and Vedangas are primarily religious in content, but they embody a large number of astronomical knowledge. In the Vedic age the requirement for mathematics was to determine the correct times for Vedic ceremonies and the accurate construction of alter. Thus it led to the development of astronomy and geometry.

Mathematics has been found mostly in *Vedāṅga Kalpa* and *Jyotis* and in the Vedas, such as *Rig-Veda*, *Yajurveda* and *Atharvaveda* and also in *Śatapatha Brāhmaṇa*. Of course, *Rigveda* is considered as the oldest. They contain several mathematical concepts.

Mathematics is classified as *aparā vidya* in the Vedic lore. There is a dialogue between Nārada and the sage, Sanat Kumar found in *Chāndogya Upaniṣad*.[1] Here, it is said that when Nārada approaches the sage for supreme knowledge, at that time Sanat Kumar asks what sciences and arts he already knows. Thereupon, Narada tells him that he was learned astronomy and arithmetic (*rāśividyā*). Thus mathematics is introduced in the scriptures as an aid and adjunct to *parāvidyā*, the spiritual knowledge of *Brāhmaṇa*.

Mathematics is considered to be the most pre-eminent and essential science. It is said in *vedāṅga jyotiṣ* as:

cf. *yathā sikhā mayūrāṇām nāgānām maṇayo yathā/*
tatvadvedāṅga śāstrānām gaṇitam mūrdhanisthitam//

"As the crests on the heads of peacocks, as the gems on the hoods of serpents, so is mathematics (to be reckoned) at the crown of the sciences known as vedanga".[2]

The *Veda Saṁhitā* is composed of hymns to various duties and also hymns praising all forms of knowledge. Thus the Vedas are not texts on mathematics but they mention a lot of mathematics but they mention a lot of mathematical concepts. Since Veda came down as an oral tradition for very long, so Vedic evidence is primarily indirect and is more of an indicator of the kind of concepts that exited than a definition or explanation of those concepts.

Modern age is the age of globalization and of science and technology. So it is obvious to see surrounding us the wide use of mathematics in the field of science and technologies. Though mathematics is developed in later Vedic age by several mathematician like Āryabhaṭṭa, Barāhmihira, Pythāgoras etc. but its concepts found in Vedas also. And these concepts found in the Vedas are in later period developed and explained by the mathematicians and by scholars. Here we will have a discussion about mathematical concepts in the Vedas.

Rigveda is the oldest of the Vedas. It contains a wealth of knowledge on a variety of subjects. Some of them relate to the broader field of mathematics.

The science of geometry was first invented in India by the Hindus from the Vedic rules for the construction of sacrificial alters. Geometry is used throughout the *Rigveda*. However, the emphasis was not based on proofs but on usage. On the other hand modern geometry is based on only proofs. The word geometry comes from *jyā* and *miti*. *Jyā* on Sanskrit means earth and *miti* means measurement. So *jyāmiti* means measuring the earth. Some of the hymns, which deal with cosmology, imply that these poets were very familiar with geometry.

In *Rigveda* there is a verse deal with the formation of the universe. Here one has a conception of the circumference of a circle. It says-

kāsītpramā pratimā kim nidānam
ājyam kimāsīt paridhiḥ ka āsīt/
chandaḥ kimāsīt praugam kimuktham
yaddevā devamayajanta visve//[3]

Here, the Sanskrit words *pramā, pratimā, nidānam ājyam, paridhiḥ, chhandaḥ, praugam* are all geometrical terms which also occur later in the *Śulbasūtra*.

Chariots are described in great detail in many different verses of the *Rigveda*. For example, RV. i. 102. 3; RV. i. 53. 9; RV. i. 55. 7; RV. i. 141. 8; RV.ii. 12. 8 etc. The proficiency in chariot building presupposes a good detail of knowledge of geometry. The fixing of spokes of odd or even numbers require knowledge of dividing the area of the circle into the desired numbers of small parts of equal area, by drawing diameters. This also presupposes the knowledge the knowledge of dividing a given angle into equal parts.[4]

Area of a triangle is mentioned in the *Ayurveda*. Here it is stated that-

yo akrandayat salilam mahitvā
yoyam kṛtvā tribhujam śayānaḥ/
vatsaḥ kāmadugho virājaḥ
sa guhā cakre tanvaḥ parācaiḥ//[5]

It means that he who prepared a threefold home and lying there made the water below through his greatness- calf of *virāja* giving each wish, fulfilment, made bodies for him far off, in secret. Here 'threefold home' refers to the triangle of heaven, firmament and earth, wherein Agni dwells as sun, lightning and fire.

Moreover in *Rigveda* there is a principle of *trita*. It says that to him as wild joy he fought with him who stayed the rain; his helpers sped like swift streams down a slope. When Indra, thunder-armed, made bold by some draughts, as Trita cleaveth Vala's fences, cleft him through.[6]

In *Vaidik Sampatti*, Pandit Raghu Nandam observes that this reference to *trita* is the geometrical conception of a ratio of circumference (*paridhiḥ*) to diameter (*vyās*) of a circle. As we know in geometry, this ratio must be more than 3.

Circumference ÷ Diameter = 22÷7= 3×7+1

Since the diameter is almost one third of the circumference, hence the ratio is called *Trita*. If the circumference is 22, the diameter must be 7. In this mantra, a conception has been drawn in which, the ratio is exactly 1÷3. Therefore, the diameter will cross the circumference and will not actually fit in.[7]

One has also an example of using 'Pi' in the *Rigveda*. In the *Rigveda*, a formula to find the area of a circle is mentioned showing that the Ṛsis knew of Pi, approximating it to be equal to 22÷ 7. It was used in the formula for the area of a circle. It is said in the *Rigveda* thus-

tritaḥ kūpe'vahito devānhavata ūtaye
tacchuśrāva bṛhaspatiḥ kṛnvanaṁhūraṇādurū/[8]

"*Trita*, when buried in the well, calls on the well, on the gods to succour him. That call of his, Bṛhaspati heard and released him from distress. Mark this woe, ye earth and heaven."[9]

In this verse, the well, which is cylindrical, has been sunk defectively, for if the ratio is only 1÷ 3 then any one will be squeezed in that. *Trita* was obviously trapped into a three dimensional equivalent of the diagram. The implication is that, if the ratio is more or less than 22÷7, then the diameter will be inexact.[10]

Moreover, there are references to fractions in the Vedas. In the *Rigveda*, the hymn of *puruṣa* has a reference of fractions. It mentions the fractions ¼, ½, ¾ and also mentions the fact ¼ + ¾ =1.[11] *Śatapatha Brāhmaṇa* mentions these similar results by saying 1/3+2/3=1.[12] *Atharvaveda* also mentions same functions.[13] The *Maitrāyaṇī Saṁhitā* also there are some terms such as *Kala* (1÷16), *Kustha* (1÷12), *Pāda* (1÷4) and *Śapha* (1÷8).[14] It is noteworthy that the word kala has been frequently used in the Śulba Sūtras to denote fraction. Moreover, *Yajurveda* also mentions the series of fractions like ½ 1 ½ 2 2 ½ 3 3 ½ and 4.[15]

Big numbers: In *Yajurveda*, Numbers starting from four and with a difference of four forming an arithmetic series is discussed.[16] The *Yajurveda* also mentions the counting of numbers up to 10^18 and the highest is being and named *parārdha* i. e. the half of heaven or the half of that which is above.[17] It mentions *ayuta*, *niyuta* the series of 10 up to 10^{18}in steps of powers of 10 viz. *sahasra* or a thousand (10^3), *ayuta* or ten thousands (10^4), *niyuta* or myriad (10^5), *prayuta* or a hundred a thousand (10^6), *arbuda* or a million (10^7), *nyarbuda* or a hundred millions (10^8), *samudra* or an ocean (10^9), *madya* or middle (10^{10}), *anta* or end (10^{11}) and *parārdha* or a hundred thousand million or a billion. Similar type reference also has been mentioned in the *Atharvaveda*. Here it is stated that-

bṛhat te jālam bṛhat indra sūra
sahasrārghasya śatavīryasya/
tena śatam sahasramayutam nyarbudam
jaghāna sakrodasyūnamabhidhāya senayā//[18]

The concept of one and its mathematic properties, arithmetic progression and arithmetic series are also seen in the Vedas as well. *Atharvaveda* states the fact that 1×1and 1/1=1.[19] There are some examples of multiplication and division in *Śatapatha Brāhmaṇa*. e. g. 360×2= 720, 720×80=57, 600.[20] Again it mentions some examples of division in the section 10. 24. 2. 1—20 where it mentions the result of dividing 720 by all the integers from 2-23. There is also a reference to multiplication in the *Yajurveda* where it is that 1×3=3, 3× 5=15, 5×7=35 etc.[21]

Concept of infinity was also known during Vedic times. They were aware of the basic mathematical properties of infinity and had several words denoting infinity, such as *ananta*, *pūrṇam*, *aditi*, *asaṁkhyāta* etc. *Asaṁkhyāta* is mentioned in the *Yajurveda*[22] and the *Bṛhadāraṇyakopaniṣad* as describing the number of mysteries of Indra as *ananta*.[23] The concept of infinity also says in the *Atharvaveda*. It states that infinity can came out of infinity only and infinity is left over from infinity after operations on it.[24] Moreover, there is a concept of infinity in the Vedic prayer from *Śukla Yajurveda*.It states-

om pūrṇamadaḥ pūrṇamidam
pūrnāt pūrnamudacyate

pūrnasya pūrnamādāya
pūrnamevavasisyate

-It means, from infinity is born infinity. When infinity is taken out of infinity, then only infinity is left over. Thus this verse is as much metaphysical as it is mathematical. Here in this verse gives the concept of infinity.

Moreover, one has get concept of zero in the Vedas especially in the *Atharvaveda*. The concept of *śunya* or void also as nothingness, was originally conceived as the symbol of Brāhman, expressing the sum of all distinct forms. The symbol of zero and the decimal system of notation are described in the Atharvaveda.[25] It describes how the number increases by 10 by writing zero in front of it. In fact, the concept of *śunya* was not just mathematical or scientific, but is deeply rooted in all branches of thought, especially metaphysics and cosmology.

Concepts of Algebra:

The development of the Hindu Algebra can be traced to the Brāhman period. There is a passage in the *Śatapatha Brāhmaṇa* in which the *Mahāvedi* (the great alter) is described to be of the form of an isosceles trapezium, in which the unit of measure is 14.[26] It states- indeed, those who do it in that way, deprive their Father Prajapati of his due proportions and they will become the worse for sacrificing, for they deprive Father Prajāpati of his due proportions. As large as the *Mahāvedi* of seven fold fire alter is fourteen times as large as he measures out the *Vedi* of the one hundred and one fold alter. He now measures off a cold, thirty six steps (yards) long and folds it up into seven equal parts; of this he covers the space of the three front (eastern) parts with bricks, and leaves four parts free.[27]

There are also several references to arithmetical principle in the Vedas. In the *Atharvaveda* there is a reference consecutively of numbers from 1 to 10. It states-

ya etam devamekavṛtam veda
na dvitīyo na tṛtīyascaturtho napyucyate/
na pañcamo na ṣaṣṭaḥ saptamo nāpyucyate
nāṣṭamo na navamo daśamo nāpyucyate//[28]

-It means, to him who know with this God as simple and one, neither second nor third nor yet fourth is He called, He is called neither fifth nor sixth nor yet seventh, He is called neither eighth nor ninth, nor yet tenth. Again hymns of *Atharvaveda* give references to additions of numbers with multiple of 10.[29] Thus, *Yajurveda* also give references to additions of 2 and additions of 4. It states, may my one and my three, and my five, and my five and my seven and similarly up to thirty three prosper by sacrifice.[30] Also it states that may my four and my eight and my twelve and similarly up to forty eight prosper by sacrifice.[31] Thus it shows the additions of two and four. On the other hand *Rigveda* mentions the digit 99. It states-

indro dadhīco astabhirvṛtraṇyapratiṣkṛtaḥ
jaghāna navatīrnava//[32]

-It means with bones of Dadyac for the arms Indra resistless in attack struck nine and ninety Vṛtas dead.

In the *Atharvaveda* there is a reference to multiplication by 11 from 22 to 99. It states-

ye tee rātri nṛcaksaso draṣṭāro navatirnava/
aśītiḥ santyaṣṭa uto tee sapta saptatiḥ//
ṣaṣṭiśca ṣat ca revati pañcāśat pañca sumnayi/
catvāraścatvarinśacca trayastriṁśacca vājini
dvau ca tee viṁśatiśca tee rātryekādasāvamāḥ//[33]

This is a hymn to Night for protection from friends, robbers, snakes, and wolves. Here it is said that the ninety nine examiners (sentinel stars), O night, who look upon mankind, eighty eight in number or seven and seventy are they, sixty and six, O opulent, fifty and five, O happy one, forty and four and thirty three are they, O thou enriched with spoil, twenty and two has thou, O night, eleven, yes and fewer still.[34]

We have also an arithmetical mode of expression in the Vedas. Here for the sake of metrical facility, the numbers which are large are expressed in additive method. For instance, there is an expression for 3339 in *Rigveda*. It states-

trīṇi śatātrī sahasrāṇyagnim
triṁśacca devā nava cāsaparyan//[35]

Conclusion:

Thus the Vedas are only of secular character but they have also several mathematical concepts. These mathematical concepts gradually developed in later Vedic period by mathematician. And in modern time also, which is an age of science and technology; these concepts of mathematics are not irrelevant.

Notes and references:

[1] *Chandogya Upaniṣad*, vii. 1
[2] Mehta. D. D., (1974) Positive Sciences in the Vedas, Arnold Heinemann Publishers (India) Private Limited, p. 107
[3] *Rigveda*, x. 130. 3
[4] See. Kulkarni, R. R., (1983) Geometry According to the *Śulva Sūtra*, Vaidic Samssodhana Mandala, Pune
[5] *Atharvaveda*. viii. 9. 2
[6] *Rigveda*, i. 52. 5
[7] Mehta, op. cit. p. 118
[8] *Rigveda*. i. 105. 17
[9] Translated by Griffith
[10] Mehta, op. cit, p. 119
[11] *Rigveda*, x. 90. 4
[12] *Śatapatha Brāhmaṇa*, 4. 6. 7. 3
[13] *Atharvaveda*, xix. 6. 2
[14] *Maitrāyaṇī Saṁhitā*, iii. 7. 7
[15] *Yjurveda*, xviii. 26
[16] ibid, xviii, 25
[17] ibid, xvii. 2
[18] *Atharvaveda*, viii. 8. 7
[19] ibid, xiv. 3. 12
[20] *Śatapatha Brāhmaṇa*, 2. 3. 4. 19. 20
[21] *Yajurveda*, xviii. 24
[22] ibid, xvi. 54
[23] *Bṛhadāraṇyaka Upaniṣad*, 2. 5. 10
[24] *Atharvaveda*, x. 8. 24
[25] ibid, v. 15. 1- 11
[26] *Śatapatha Brāhmaṇa*, x. 3. 7. 8
[27] Max Muller (1972), Sacred Books of the East Series, vol. xliii, p. 310
[28] *Atharvaveda*. xiii. 4. 16-18
[29] ibid, v. 15. 1-11
[30] *Yajurveda*, xviii. 24
[31] ibid, xviii. 25
[32] *Rigveda*, i. 84. 13
[33] *Atharvaveda*, xix. 47
[34] Translated by Griffith
[35] *Rigveda*. x. 52. 6