History of Mathematics and Importance of '0' and '∞'.

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Abstract
Maths is older than oldest of civilization on this planet and at the same time it is as new as any. Mind and matter is proportional to spirituality and Science. To balance these two, mathematics play a very important role. Since deals with "why" and technology is related with "how" where as 'why' and how can't move without "what".
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I.   Introduction :

Growth of any country is measured by science of technology, and certain degree of social maturity and material prosperity are essential ingredients for the development of mathematics and mathematical Sciences. It is beyond dispute that the ever since the starting of (dawn), Vedic civilization mathematics has been held in the highest esteem.

It is mentioned in Närăd Samhita (cf.[1], Chapter 1):

यथा शिखा मयूराणां नागानां मणयो यथा।

तद्वद् वेदांगशास्त्राणां गणितं मूर्धनि स्थितम्॥

That is, as crest in peacocks and gem in serpents, so is mathematics among all branches of learning Bhaskaracharya, Aryabhatta, Acharya Varahmir and many more are renowed mathematician of Vedic period. During Rigvedic period it was estimated that one year consisted of twelve months composed of three hundred sixty days and three hundred sixty nights as given below ([12]; I, 164, 11):

द्वादशारं नहि तज्जराय वर्वर्ति चक्रं परि द्यामृतस्य ।

आ पुत्रा अग्ने मिथुनासो अत्र सप्त शतानि विंशतिश्च तस्थुः ॥

That is, the sun's wheel with twelve spoke (months) revolves around (the Earth) and is never destroyed. oh fire! on this wheel are mounted, seven hundred and twenty people (360 days and 360 nights)

In those early days the main purpose of mathematics was to provide a suitable calendar processes of counting and calculations for day to day working of the people. Of course, a calendar System was the first head of the society and therefore the development of astronomy received the first preference of the ancient scholars. This is the reason that Acharya värähmihir empathically Writes (cf. [3],chapter II,8)

अप्रदीपा यथा रात्रिरनादित्यम यथा नभ

तथा असंवत्सर्ये राजा भ्रमानी अंध आह्वानः

That is, a being without a calendar is like a night without lamp, the sky without the Sun and a blind (person) moving on the sound.

Along with astronomy, arithmetic and geometry too were introduced during the early vedic age. The natural number system which is known as root of mathematical analysis. Zero and infinite too play a vital role in the study of limiting process of various algebraic structures, which reads to the development of mathematical analysis. Emphasizing. The great importance of zero, decimal system and concept of infinity, a renowned orientalist A-L. Basham, write (cf [14], p- 496).

"The unknown man who devised zero and the decimal system was from the world's point of view, after Buddha, the most important son of India. His achievement was the work of an analytical mind of the first order and he deserves much more honour than he has so far received. The mathematical implications of zero and infinity were fully understood in medieval India". Bestrand Rusell ([15]; p-3); on the other hand writes:

"As for 0 it is very recent addition, even the Greeks and the Romans has no such digits."

It is well known that algebra is an outgrowth of arithmetic and geometry. Since arithmetic and geometry were fairly advanced during vedic and later vedic period, algebra too was used in various mathematical calculations. These mathematical concepts undoubtly lie at the root of modern mathematical analysis.

Aim of the present paper is to focus on two vital number '0' and '∞' of number system.

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The Mathematical form of Zero.

In an elementary calculation zero appears in 'chhandah shastram' of Pingal, which was composed to around the year 200 B.C (for details see [6]), Pingal, however, does not claim that he discovered the number zero. It may be mentioned here that 'Shunya' (Zero) appears at many places in Vedic literature, but as explained in 'Vedic Padanukram kosa' [7] the meaning of shunya in vedas is 'sky' "empty space and 'atmosphere' etc Monier Williams too referes for arithmetical zero the Brihatsamhitā of vārāhmihir, which was composed in the beginning of sixth century A.D of course, calculations involving zero have appeared at a number of places in Panchasiddhantika too of vārāhmihir. As pointed out by Vārāhmihir, the number zero was well known and in common use during the time of vasistha Siddhanta.

In order to calculate the shadow at the time of given Lagna (ascendant), vårahuihir has used Vasistha siddhanta an given below (cf.[8]; II; 12 ,13):

व्यर्के लग्ने लिप्ता: प्राक् पश्चाच्छोधितास्तु चक्रार्धात ।

कार्यश्छेद: शून्याम्बराजूलवणो दषटकानाम्' ॥ 2 ॥

लब्धं द्रादश हीनं मध्यान्छच्छायया समायुम्तम् ।

सा विज्ञेया छाया वशिष्ठ समास सिद्धान्ते ॥ 3 ॥

Its meaning is, deduct the sum from the lagna and change the remainder into minutes of are for the forenoon. In case it is after noon, Subtract the minutes from a half circle (i,c 180° = 180x60 = 10800 minutes) to form the minutes - Divide 64800 by the minutes so obtained. Now add the result to the noon shadow of the dale and subtract 12 from it to obtain the shadow at the time of given lagna. This (calculation is provided by succinct vasistha Siddhanta.

In above formulation, according to vasistha Siddhanta, provides the method of calculation for The (i) forenoon shadow (ii) afternoon shadow at time of a given lagna. In other words, - We may write :

(I) Forenoon shadow = {648007 ÷ (lagna- Sun, in minuts) + noon shadow **-12**}

(II) Afternoon shadow 64800 ÷ {10800 - (lagna-Sun, in minutes) + noon shadow -12}

The above calculations in vasistha Siddhanta clearly demonstrate that the use of mathematical zero was fairly known in those days. Sharma (cf. [8], pp. 32-33) has evaluated that according to vasistha Siddhanta the man lagge behind by 8° from the correct one for the sun rise at Ujjain in the year 478 elapsed, i;e in 505 A.D., beginning Monday chaitra Shukla (the year of composition of Panchasiddhantikā). He has calculated that for the difference all 8° to happen in 505 A.D the Vasistha Siddhanta would have been composed 1600 years before. This implies that Vasistha siddhanta was composed around the gear - 1095 B.C.

Zero and infinity at kapilthaka, Gurukul

The great Gurukul of Mathematical sciences established by Adityadas, father a vārāhmibir, at kapitthaka (near ujjain) flourished for more than 800 years and played a vital role for the development of mathematics and allied sciences. C. Boyer Writes [9]

"Budh Gupta (Vikramaditya) made Ujjain the capital of his Kingdom in 476 A-D instead of Pataliputra. The fame of Pataliputra started to decline this time. Then Ujjain turned to be a flourishing city. Varahinihir was one among the Narratanas of Vikramaditya, A school of Mathematics was originated and flourished at Ujjain. It is also Varahmihir school. Patalipata School of mathematics started its decline by this time. The Ujjain school flourished from the time of värah mikir (480-587 AD) to the time of Bhaskara II (1114-1185 A.D).

Varāhmitir, Kalyanvarman, Brahmagupta, Mahariracharya and Bhaskara II are the prominent schoolars of this school!

In Brahmagupta (628AD) has used zero in the operation of addition, subtraction and multiplication. He was the first to point out that any number divided by zero is 'Tatchhed' (Zero-denominator). Bhaskaracharyą (1150 AD) has extensively used zero and infinity in his

tamn books "Lilawati and Bijaganita" He writes in Lilawati

"योगे खं क्षेप समं वर्गा दौ खं भाजितो राशि: ।

खहर: स्यात् खगुण: खं खगुणश्चिन्तयश्च शेष विधौ ॥

That is sum of a number with zero is equal to that number and square of zero is zero. A number divided by zero is "Khahar" and multiplication of a number by zero makes it zero. -

Bhaskaracharya , considering this universe as finite (hows over large it may be), provides a clear concept of infinity, He write [10]

अस्मिन् विकारः खहरे न राशावपि प्रविष्टेष्वपि निःसृतेषु।

बहुष्वपि स्याल्लय सृष्टिकालेऽनन्तेऽच्युते भूतगणेषु यद्वत्।।

That is as all the beings findings abode in God and coming out of him at the time al destruction and creation respectively of this Universe make no change in Him. Like wise any number added to or subtracted from Khahar quantity does not make any change.

Bhaskaracharya has also studied the limiting value of $0 \div 0$. He writes (cf .[11],p.72)

शून्ये गुण के जाते खं हारश्चेत् पुनस्तदा राशिः ।

अविकृत एव ज्ञेयस्तथैव नितश्चयुतः

That is, if a number is multiplied by zero and also divided by zero et remains unchanged.
In other word, the above complet states |

$$\frac{x \times 0}{0} = x$$

In language of modern mathematics the above assertion is correct provided in place of zero we take an infinitesimal quantity & such that

$$\lim_{\varepsilon \to 0}\left(\frac{x \times \varepsilon}{\varepsilon}\right) = x$$

Although Bhaskar does not explicitly mention the team limit in the modern mathematical Sense, intuitively its significances is involved in the above calculation. He was therefore, the precursor al calculations in Europe by more than 500 years.

Zero and Infinity in Vedant Philosophy

The concept of zero and infinity have been extensively used. Vedant Philosophy involves the mortality of soul, rebirth and theory of arma , which depend on the concept cel infinity and zero. According to shvelashvatar Upanishad' soul been imagined in the form ([12];v,9]

'बालाग्र शतभागस्य शतधा कम्पितस्य च । .

भागो जीव : सविज्ञेय : सचान्त्याय कल्पेता।'

That, a hundredth part of hair point is divided again In to hundredth parts (that is, a hair-point in divided into 10,000 parts). The soul is known to reside there and assumed to be infinite.

Thus, in the language al modern mathematics, the soul can be expressed in the form al 'Vedic functional' V(X) such that

$$V(X) = \int_{\infty,\ x=\infty}^{0,\ x\neq 0}$$

And $\int_{-\infty}^{\infty} V(x)dx = 1$

The above mentioned 'Vedic functional' has been redefined by a renowned physicist, Paul Dirac, in 1928, who termed it as delt function $\delta(x)$. but a singular distribution (see also (107) According to the formulation of Schwartz, s is expressed in the form:

$(\delta, \phi) = \int_{-\infty}^{\infty} \delta(x)\emptyset(x)dx$

Where (x) is a test functions that is the body
of living being in terms of Vedent Philosophy) : with compact support. The properties of
$<\delta, \emptyset>$ testify almost all virtues al . Vedant Philosophy (for delails see 17)

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