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### A Study on Sūnya

**A. Robina Tony\***

Assistant Professor, Department of Mathematics, Ethiraj College for Women, Chennai, TN, IND.

**Harine E**

Department of Mathematics, Ethiraj College for Women, Chennai, TN, IND.

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#### ABSTRACT

In this paper, light has been shed on the initial development of Zero in India. A brief description of its applications and symbolization is also explored. It emphasises the contribution of Zero - a multifaceted mathematical object by India to the world. It also discusses the carbon dating details of the Bakshali Manuscript.

#### Keywords:

Bakshali Manuscript;  
Contribution of Zero;  
Sūnya.

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#### 1.0 INTRODUCTION

Mathematics in general, was referred to as *Ganita* in Sanskrit. Mathematics in its early stages was divided into major classifications such as Geometry (*ksetrganita*), Algebra (*bijaganita*) and Arithmetic (*patiganita*). In ancient India, Mathematics developed at first during the Vedic period in the form of hymns and oral memorization of Vedas. All the mathematical works that were created during this age were transmitted orally and in manuscript form. The oldest existing mathematical script is called the *Bakshali manuscript*, which was found in 1881 in the village of Bakshali.

The major Hindu contributions to Mathematics were in the form of Sanskrit. The *Surya Siddhanta* from 400C contains the modern roots of Trigonometry. The *Aryabhatiya* written by Aryabhata, and *Panchasiddhanta* of Varahamira contains five Astronomical canons (*Surya Siddhanta*, *Romaka Siddhanta*, *Paulisa Siddhanta*, *Vasishta Siddhanta* and *Paitamaha Siddhanta*). The *Brahmasputa Siddhanta* (628 CE) was an astronomical work by Brahmagupta which introduces cube

\* Corresponding author's e-mail: [a.robinatony@gmail.com](mailto:a.robinatony@gmail.com) (A. Robina Tony)

roots, fractions, the barter system and further practical mathematics. He is well known for his famous theorem of diagonals of a cyclic quadrilateral. Later, in the end of 8<sup>th</sup> century, Bhaskara I expanded the works of Ayabhatta like *Maha Bhaskariya*, which exposes the solutions of indeterminate equations. Further *Ganita Saar Sangraha* of Mahavira, *Trishatika* of Shridhara cover separate sections of mathematical topics. *Maha Siddhanta* of Aryabhatta II, *Ganita Tilaka* of Shripathi Mithra are early works which emphasize permutations and combinations. The works of BhaskaraII *Lilavati* focusses on *Patiganita* (arithmetic), *Bijaganita* (algebra) and *Surds* (irrational). He discloses the proof of Pythagoras theorem, and later Mathematics was developed in Kerala. In all these different ages, the development of Mathematics, from the oral memorization of Vedas to handwritten manuscripts about major sections of Mathematics, wouldn't have been possible without the usage of the numerical digit zero.

Zero, which is a numeral and numerical digit, plays a primitive role in geometry, trigonometry, statistics, algebra and arithmetic. It also creates more accurate ways to describe fractions and helps to simplify calculations.

## 2.0 INCEPTION OF ZERO

Zero is a powerful and essential tool in mathematical computation. Many interesting questions in science were about zero. Behind every revolution lies the concept of zero. Despite the development of Mathematics in different countries, growth in the number of Mathematicians and evolution of new topics, the invention of zero is still a debate.

Depending on the records collected presently, zero has been independently invented three times. Zero is referred to as *shunya* in Sanskrit, meaning void/empty or nothing. The symbol for this number is a dot which was referred as bindu or dot. The ancient Indians represented zero as a circle with a dot inside, which stays blotted in Atharvedha.

Zero, which was invented three times, was first recorded by the *Babylonians* from Mesopotamia but there was no usage. Secondly, it was found by the *Mayans* in central America in 4 A.D, which was later invented by Indians in the 5<sup>th</sup> century A.D. The credit for the inventions of zero was given to Indians. It was later then the knowledge travelled from India to Cambodia in the 7<sup>th</sup> century A.D from where it branched to China and many Islamic countries.

Indians till date, take the credit for the invention and clear designation of zero as 'something beyond nothing'. They clearly depicted the difference between 58, 580, 508 and 5008. In 628 A.D, *Brahmagupta* an Indian astronomer and great mathematician, took the credit for the invention of zero.

## 3.0 ROOTS OF ZERO IN INDIA

Aryabhatta, in his treatise *Aryabhatiya*, mentioned not only zero but also elegantly mentioned it as 'sthanam sthanam dasa gunam' or place to place in ten times in value. He also described the need for other numerals for zero. In his text included a zero-letter code for numerals in his positional number system. But in his number system, he represented zero as an unknown element X.

In 628 A.D., Brahmagupta in his treatise *Bramasphuta Siddhanta* "The opening of the universe" specified the rules regarding the arithmetic operation of the number zero. In the fundamental rules of Brahmagupta the formula for the division was incorrect which was corrected by Bhaskara in the 12<sup>th</sup> century in his book *Leelavathi*.

#### 4.0 EVERYTHING FROM NOTHING

Infinity '∞' which is called *Adi-Anantha-Sesha* in Sanskrit was numerically visualized as one-infinity-zero in India. This name *anantha* has a spiritual background. The symbol of infinity was compared to the beloved lord Adhishesha. During this age, the spiritual sense reached the peak which gave the meaning of infinity as everything.

The Jain mathematical text "*Surya Prajnapti* (3<sup>rd</sup> - 4<sup>th</sup> century BCE) classifies all numbers into three sets: enumerable, innumerable, and infinite. The invention of zero immensely simplified computations and has helped mathematicians to develop vital mathematical disciplines such as algebra, calculus, and other areas of science."

#### 5.0 THE UNDEFINED CASE

During his childhood of Ramanujam, it had been his simple question "what is nothing by nothing?" His question of  $0/0$  led to a great argument among Mathematicians.

We know that  $2/2=1$

$$5/5=1$$

$$10/10=1$$

Then  $0/0=?$

The answer of Ramanujam was  $0/0$  could be anything. The zero of the numerator can be many times the zero of the denominator. Another method for finding is the expression  $0/0$ , which may be obtained by determining the limits of the expression  $\lim [f(x)/g(x)]$ . This limit is applied independently on both operands of the fraction. This rule is called L HOPITAL'S RULE (or) Bernoulli's Rule, which provides a technique to evaluate the limit of indeterminate forms.

#### 6.0 THE UNEARTHING OF THE EXTANT SCRIPT

The *Bakshali manuscript* is an ancient Indian Mathematical manuscript written in additional 70 leaves of birch bark that was found in 1881. This manuscript was found within the village of Bakshali near Peshawar (present Pakistan). This was eventually handed to Oxford in 1902. Recently, in 2017 this document was carbon-dated by the Bodleian library by Marcus du Sautoy (Professor of Mathematics) and David Chivall (radio dating scientist). They have uncovered the date of the Bakshali manuscript and the birth of the concept of zero. "They found that some pages in the manuscript dated to the third or fourth century. This pushes back the origin of what would eventually become the zero symbol."

"This zero in India is that the seed from which the concept of zero as a number in its own right represented by the identical dot or circle will emerge some centuries later, something many considers as one of the of the greatest moments in the history of Mathematics said lead researcher Marcus du Sautoy. For mathematicians and historians like du Sautoy, the manuscript represents the foremost important clues to understand a mathematical concept that would help in the development of various fields of science."

#### 7.0 CONCLUSION

The most marvelous accomplishment for which the world is beholden to our nation is the invention of zero and infinity. Throughout all its history, despite rejection and exile, zero has defeated those who opposed it and established its importance, especially as an essential tool in the field of

mathematics. Zero has shaped the foundations of Philosophy, Religion, Science and Mathematics. India has taken Mathematics from rudimentary to its current sophisticated position by including zero in the positional number system and has unleashed the true power of numbers.

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