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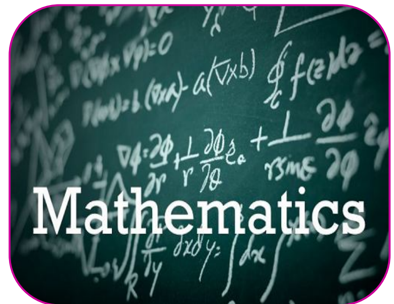
ANCIENT INDIAN CONTRIBUTIONS TOWARDS MATHEMATICS



Madhuri N. Gadsing
Department of Mathematics,
Jawahar Arts, Science and Commerce College,
Anadur (M.S.), India.

ABSTRACT

Mathematics having been a progressive science has played a significant role in the development of Indian culture for millennium. In ancient India, the most famous Indian mathematicians, Panini (400 CE), Aryabhata I (500 CE), Brahmagupta (700 CE), Bhaskara I (900 CE), Mahaviracharya (900 CE), Aryabhata II (1000 CE), Bhaskara II (1200 CE), chanced to discover and develop various concepts like, square and square roots, cube and cube roots, zero with place value, combination of fractions, astronomical problems and computations, differential and integral calculus etc., while meditating upon various aspects of arithmetic, geometry, astronomy, modern algebra, etc. In this paper, we review the contribution of Indian mathematicians from ancient times.

KEYWORDS: *Mathematics , development of Indian , astronomical problems and computations.*

INTRODUCTION:

Mathematics having been a progressive science has played a significant role in the development of Indian culture for millennium. Mathematical ideas that originated in the Indian subcontinent have had a profound impact on the world.

The aim of this article is to give a brief review of a few of the outstanding innovations introduced by Indian mathematicians from ancient times. In ancient India, the most famous Indian mathematicians belong to what is known as the classical era [1-8]. This includes Panini (400 CE), Aryabhata I (500 CE) [9], Brahmagupta (700 CE), Bhaskara I (900 CE) [5, 6], Mahavira (900 CE), Aryabhata II (1000 CE), Bhaskaracharya or Bhaskara II (1200 CE) [10-13].

But it seems that, there is much work to do in the field of history of Indian mathematics. The main challenge is to identify manuscripts and to translate them into a language that is more familiar to modern scholars.

ANCIENT INDIAN MATHEMATICIANS:

Panini (400 CE)

Panini was a Sanskrit grammarian who gave a comprehensive and scientific theory of phonetics, phonology, and morphology. Panini is considered the founder of the Sanskrit language and literature. A treatise called Astadhyayi (or Astaka) is Panini's major work. It consists of eight chapters, each subdivided into quarter chapters. In his work, Panini distinguishes between the language of sacred texts and the usual language of communication. Panini gives formal production rules and definitions to describe Sanskrit grammar.

Aryabhata I (500 CE)

Aryabhata is the author of several treatises on mathematics and astronomy, some of which are lost. Direct details of Aryabhata's work are known only from the Aryabhatiya, his text. The Aryabhatiya presented a number of innovations in mathematics and astronomy in verse form, which were influential for many centuries. In his text Aryabhatiya, he discussed about the rules of calculation used in astronomy and mathematical mensuration though with no feeling or logic or deductive methodology. Amongst other important contributions of Aryabhata is his approximation of π (pie) to four decimal places as 3.14146. He introduced the concept of zero and decimals. Aryabhata's work on trigonometry is also important, including the tables of values of the sine functions as well as algebraic formulae for computing the sine of multiples of an angle.

His useful contribution to the world of science includes explanations of the solar and lunar eclipses. Aryabhata calculated the sidereal rotation as 23 hours, 56 minutes and 4.1 seconds; the modern value is 23:56:4.091. Similarly, his value for the length of the sidereal year at 365 days, 6 hours, 12 minutes and 30 seconds. The actual value shows that his calculation was an error of 3 minutes and 20 seconds over a year. In 1975, the Indian government named its first satellite Aryabhata in his honor.

Brahmagupta (700 CE)

His important work was regarding Arithmetic and Astronomy. In his work on arithmetic, Brahmagupta explained how to find the square and square root, cube and cube root of an integer. He also gave the rules for dealing with five types of combination of fractions. He gave the sum of squares of the first 'n' natural numbers as $\frac{n(n+1)(2n+1)}{6}$ and sum of the cubes of the first 'n' natural numbers as $[\frac{n(n+1)}{2}]^2$. Brahmagupta was the one who gave the concept of place value of ZERO. His 'Bramhasuptasiddhanta' is probably the earliest known text to treat zero as a number in its own right, rather than as simply a placeholder digit as was done by Babylonians or as symbol for lack of quantity as was done by Greeks and Romans. The famous Pythagoras theorem is seen to be discussed in the Bramhasuptasiddhanta. Bramhagupta established the basic mathematical rules for dealing with zero i.e. $1 + 0 = 1,\ 1 - 0 = 1,\ 1 \times 0 = 0$ etc. Although his understanding of division by zero was incomplete, he thought that 1/0=0 which was proved wrong by Bhaskaracharya after almost 500 years later. He also discussed or dealt with the mathematical operations of positive numbers and negative numbers. Bramhagupta developed 'Astronomical model'. He also gave the solution of general linear equation and quadratic equations. He also has done tremendous work in geometry and trigonometry.

Bhaskara I (900 CE)

He was apparently the first to write numbers in the Hindu decimal system with a circle for the zero. He was the one who gave a unique and remarkable rational approximation of the sine function in his commentary on Aryabhata's work. His work can be seen in his Mahabhaskariya and Laghubhaskariya.

Mahaviracharya or Mahavira (900 CE)

He wrote the 'Ganitasarasangraha' which is revised version of Bramhagupta's Bramhasuptasiddhanta, which includes numerical mathematics, algebra and geometry. He separated astrology from mathematics. His work is highly similar to that of Bramhagupta and Aryabhata but expressed them more clearly. He was the one who discussed the term, Geometric Progression which is considered as important in the field of mathematics. He designed the formula which gives the approximate area and perimeters of ellipses and found the method to calculate the square of a number and cube roots of a number. He also state the fact that the square root of a negative numbers did not exist. He was the first Indian mathematician who discovered the L.C.M. method for the summation of the fractions. He discovered algebraic identities like $a^3 = a(a+b)(a-b) + b^2(a-b) + b^3$. Also he was found the formula

$$n_{c_r} = \frac{n(n-1)(n-2)(n-3)....(n-r+1)}{r(r-1)(r-2)...3.2.1}.$$

Bhaskaracharya or Bhaskara II (1200 CE).

Bhaskara represent a significant contribution to mathematical and astronomical knowledge in the 12th century. When it came to algebra, Bhaskaracharya followed Bramhagupta's work closely. He filled many gaps in Bramhagupta's work. His main work Siddhanta Shiromani, is divided into four parts called Lilavati, Bijaganita, Grahaganita and Goladhyaya. These four sections deal with arithmetic, algebra, mathematics of the planets, and spheres respectively. In section Lilavati, progressions, permutations, solutions of quadratic, cubic and quartic indeterminate equations and other topics are explained. His work Bijaganita contains the positive and negative numbers, zero, infinity and indeterminate equations. In Grahaganita and Goladhyaya, Bhaskara accurately defined many astronomical quantities, trigonometry, including the sine table and relationship between different trigonometric functions. He also developed spherical trigonometry. He is particularly known in the discovery of the principles of differential calculus and its application to astronomical problems and computations. While Newton and Leibnitz have been credited with differential and integral calculus, there is strong evidence to suggest that Bhaskara was a pioneer in some of the principles of differential calculus.

In his writings, he described the place-maker and arithmetic properties of zero and asserted that any number divided by zero gives infinity. He dealt with methods of manipulating surds and his work included a study of permutations and combinations. He integrated trigonometry with astronomical calculations by introducing trigonometric formulae such as

$$\sin(A+B) = \sin A \cos B + \cos A \sin B$$

He explained, 'The hundredth part of the circumference of a circle seems to be straight. Our earth is a big sphere and that's why it appears to be flat, also earth has no support and has a power of attraction.' He also explained that, on the moon, one day is equivalent to fifteen earth-days and one night is also equivalent to fifteen earth-days. He accurately calculated the time that earth took to revolve around the sun as 365.2588 days that is difference of 3.5 minutes of modern acceptance of 365.2563 days. This was much before Newton or Leibnitz would come up with differential or integral calculus and to explain the force of gravity.

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