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A Review of the Mathematical contributions of some important Ancient Indian Mathematicians

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Introduction:

The history and heritage of ancient Indian mathematics is vibrant and glorious. "The European mathematicians believed that they gathered knowledge of numbers from the Arabs but the Arabs admit that they got this knowledge from India."[1] Ancient Indian mathematics experts did original research in various disciplines such as numerology, geometry, algebra, and trigonometry. "The knowledge and usage of cubes, cube roots, square roots and under roots also existed in India."[2] They used mathematics in various interdisciplinary and multidisciplinary branches of knowledge such as astrology, architecture, and astronomy. The impact of this research was not limited to the Indian subcontinent, but it reached Arab and European mathematicians. Famous mathematicians of ancient India include Aryabhatta, Brahmagupta, Bhaskaracharya, Varahamihir Sridharacharya and Mahaviracharya. Aryabhatta was one of the most famous mathematicians and astronomers of ancient India. He stated the value of the i.e. (3.1416). He made an important contribution to geometry by developing the decimal system. In the book Aryabhattiya, he discussed trigonometry, algebra and round mathematics in depth.

Brahmagupta was a famous mathematician and astronomer who was the first to make independent use of zero, he proposed the laws of negative numbers. The formula for area and circumference was explored. "In his book 'Bramhasphutsiddhanta' he formulated astronomical calculations and mathematical theories."[3] Varahamihir (505–587 AD) made major contributions to mathematics and astrology. In the book 'Panchasiddhantika', many concepts of astronomy and mathematics were presented and trigonometric tables were created. Sridharacharya (870-930 AD) explained many concepts in algebra and formulated the formula of quadratic equations. Bhaskaracharya (1114-1185) made important contributions to mathematics and first mentioned calculus. He presented various theories of arithmetic and geometry in the book 'Lilavati'. He explained the theory of Earth's gravity by studying trigonometry and spheres in depth. "As for the Greeks, they learnt a lot about the sciences, arts, philosophy, mathematics and medicine from India."[4] The present paper reviews the mathematical contributions of some important ancient Indian mathematicians.

Aryabhatta: Father of Indian Mathematics and Astronomy:

In the fifth century, there was a famous and learned mathematician and physical scientist named Aryabhatta. Aryabhatta studied at Nalanda University. Aryabhatta invented zero and gave it the symbol '0'. Further, he stated that zero is not just a number but an independent concept. The search for zero went further and discovered negative numbers. Using this zero, he estimated the distance between the Earth and the Moon very accurately. He said that 39,736 kilometres is the circumference of the Earth, according to today's calculations which is 39,843 kilometres. Aryabhata said that the moon does not have its light, but it shines because of the sun's light. The name

Aryabhatta is known as one of the brightest stars in Indian mathematics and astronomy. His contributions have left a lasting impression on the intellectual field around the world. The first teacher of Indian mathematics was Aryabhatta. On April 19, 1975, India's first artificial satellite "Aryabhatta" was launched into space in memory of this mathematician and astronomer's name. "He wrote the book Aryabhatiya in 499 A.D. It deals with mathematics and astronomy; it explains scientifically the occurrence of solar and lunar eclipses."[5]

Since ancient times, Aryabhatta's place has been at the forefront of the great mathematical astronomy and astrology branches. Aryabhatta is considered to be the father of the dasaman system, the decimal system is famous all over the world. His most famous works are Aryabhattiya and Aryasiddhanta. He researched ancient astrology texts. It has four divisions: Gippikapada, Mathapada, Kala kriyapada and Golapada. He discovered gravity out of curiosity about the rocks falling from the mountain, the water of the waterfall and the water in the clouds, Aryabhatta had to face boycott for some time for seeing the annular solar eclipse. Aryabhatta suffered neglect due to the ignorance of the people. Aryabhata is also known as Ashmakacharya. At the age of 21, he composed the book Aryabhatiya.

Birth and Early History:

Aryabhatta was born in 499 AD (476 according to some references). His early life and work took place during the Gupta period, which is known as the golden age of India. According to a passage from Aryabhattium, Aryabhatta was born on Sunday, March 21, 499. At that time, Aries was Sankranti. This state of Sankranti falls between Sri Lanka and Ujjain. Ganitacharya Arya may have been born somewhere in this vast region, but later he came to Kusumpur, now called Patna, where his wedding ceremony took place. The Aryabhattiyam, written by him, is considered to be very important and was taught as a textbook in Gurukuls till the 16th century AD. This work led to the opening of a new school of astronomy. The followers of this sect consider Paramacharya Aryabhatta as their guru. His disciple Aryabhatta is respectfully addressed by the names of the Lord. An astronomer named Bhaskara I (7th century AD) says that no one knew anything about the movements of planets except Aryabhata. The Persian scholar Alberuni has written many times in his writings about "Aryabhatta of Kusumpur". Kusumpur was a city of flowers. Later, its name was Pataliputra. There's an interesting story behind the name.

Bhaskara I, one of the ancient commentators of Aryabhatiyam, was born in A.D. 629. Aryabhatta is referred to as Ashmanacharya and his religious text 'Ashmak Tantra'. Astronomy is also known as rock mathematics. The people of Asmak district had a lot of knowledge of this science. Asmak district is mentioned in many Puranas. Some scholars believe that the district was the region between the Narmada River and the Godavari River, which flows south of the Vindhya Mountains. The possibility that Aryabhata's parents were from the same Asmaka district cannot be ruled out.

Kusumpur was later called Pataliputra-Patna, and it became the capital of Magadh (Bihar). Aryabhatta had composed a book called "Aryabhattiyam" in Patna itself. Patna was the main centre of education at that time. The world-famous Nalanda University was located in this state. The university had a separate department for the study of astronomy. Buddhism was widely propagated during Aryabhata's time. Jainism also existed at that time. Aryabhatta was not a follower of any of

these. In ancient times, before the composition of the book, it was customary to praise the deity president as an invitation. The same has been done at the beginning of Aryabhattiyam. This shows that they were worshippers of the nirguna form of the Supreme Being. The people of Kusumpur, the abode of Aryabhata, had surrendered to Brahma and they too considered this principle to be superior. Little information is available about Aryabhata's family life, but information about his disciple tradition can be found in the writings of Bhaskar I. Aryabhatta used to hold the title of Vidyaguru. Pandurang Swami Latdev and Nishant were prominent among his disciples. Among them, Latadev Mahapandit had gained fame as an astronomer. He has been referred to as Acharya Sarva-Siddhanta Guru. According to Varahamihira's statement, this lata deva composed two compositions.

Mathematical contributions:

Aryabhatta's major book 'Aryabhatiya' is a testament to his deep knowledge and new thoughts. This astronomical book sheds light on a variety of topics, including mathematics, arithmetic, algebra and trigonometry.

Aryabhattiyam:

Aryabhatta's timeless work Aryabhattayam is a work summarizing the sources of astronomy. His language is very serious and purely scientific. Aryabhata has explained the direct issues briefly. Nothing inconsistent or unrelated was said in this work. Technical terms are strong in the language. It is difficult to understand the meaning of verses without description. There are a total of 121 shlokas in Aryabhatiyam which are divided according to the theme – "these are divided into four parts namely Geetika Pada, Matha Pada, Kal Kriya Pada and Golpada."**6** According to the work, it is divided into two parts in terms of the verses used. 'Dasagitika' in Lyric verses and 'Arya Ashtasat' in Arya shlokas are notable. There are 13 verses in the Dasagitika, the first verse is Mangalacharan. The second verse gives the definitions used in the sutras. Finally, the 13th Dasagitika Sutra is the result. Since these three verses do not count, they are called 'Dasa-Geetika'. These include evidence of ages, rotation period of planets, etc. (i.e. period of planetary movement), zodiac differences, astronomical (orbital) evidence, equator coincidences of planets, etc. The remaining parts of the 108 verses are called Aryabhatiyam. He has three pi. Thirty-three verses of the mathematical verse give information on the determination of time based on the motion of the planets. The last 25 verses are the kal Kriyapad and the last 50 verses are the 'golpada'.

Place and value methods:

One of Aryabhatta's most important contributions was the development of the space value system, which is the cornerstone of today's mathematics. He introduced the concept of zero, which was a revolutionary idea and which transformed the calculation. The place and value method made it possible for mathematicians to effectively and accurately represent large numbers.

Price of pi-

Aryabhatta accurately calculated the value of the pi. "His estimate of 3.1416 was far ahead of his time and is still significantly accurate today."[7] This value was significant for various mathematical and astronomical calculations.

Algebraic equations-

Aryabhatta entered the field of algebra and solved linear and quadratic equations beautifully and effectively. His methods laid the foundation for the algebraic concepts still used today.

Trigonometry-

Aryabhatta's research on trigonometry was revolutionary. He defined trigonometric functions such as signs, cosines, and versine, which formed the basis for the study of triangles and their properties. His sine table was an important contribution, especially to astronomical calculations.

Astronomical foresight-

In addition to his mathematical skills, Aryabhatta was an avid astronomer. His observations and calculations were important for the enhancement of the understanding of celestial bodies.

Heliocentric theory-

Although Copernicus later popularized the concept of a heliocentric universe, Aryabhatta had already proposed a similar theory centuries ago. He suggested that the Earth rotates on its axis and orbits the Sun.

Eclipse:

"Aryabhatta accurately explained the causes of solar and lunar eclipses. His understanding of the Earth-Moon-Sun system was remarkably advanced for his time."[8]

Calculation of astronomical dimensions-

Aryabhatta accurately calculated the length of the sun's year and the lunar month. Their methods for predicting planetary positions were also of high quality.

Legacy and influence-

Aryabhatta's work had a profound impact on the development of mathematics and astronomy in India and beyond. Mathematicians and astronomers of later centuries, such as Brahmagupta and Bhaskaracharya II, built on the basic principles of Aryabhatta, which further enriched the tradition of Indian mathematical and astronomical studies. Aryabhatta's legacy continues to this day. His contributions to mathematics and astronomy continue to inspire and surprise scientists and scholars today. The International Astronomical Union named a crater on the moon after him, which is an appropriate tribute to his lasting impact.

Evaluate:

Aryabhatta's talent as a mathematician and astronomer is a testament to the intellectual skills of ancient India. His work, characterized by its origin and depth, laid the foundation for the development of modern mathematics and astronomy. Aryabhatta was the first to show that the earth is round and revolves around itself. He also proved that even though we think that the stars in the sky revolve around the earth, they are stable and the earth itself revolves around the sun. He also found that there are 365 days in a year, 6 hours, 12 minutes and 30 seconds. Aryabhata used the 'sign function' used in geometry in his calculations. Understanding Aryabhatta's contributions gives us pride in the rich intellectual heritage of our country and the individuals who shaped the path of human knowledge.

Brahmagupta:

Brahmagupta is known as one of the greatest mathematicians of the seventh century. He discovered the rules for how to use the 'zero' invented by Aryabhata. He invented various methods of solving linear equations and Quadratic equations, i.e. linear and class equations. Brahmagupta

discovered many theories about cyclic coordinates, i.e. cyclic squares. He also prepared a table of the value of the sines used in trigonometry. "Bramhagupta proposed the theory of Gravitation before Newton."[9]

Brahmagupta wrote the book 'Brahmasphuta Siddhanta' in 628 AD. The book has a total of 24 chapters and 1080 verses and discusses arithmetic, algebra, geometry, and trigonometry in depth. Brahmagupta wrote a second book, 'Khandakhadika', in 665 AD. In this book, he described the laws of intuition and trigonometry. Brahmagupta introduced the concept of zero in this book. He explained the rules for the use of zero in mathematical operations. Until his time, zero was not used in mathematics. Brahmagupta invented the formula for the area of quadrilaterals in geometry. The present book describes the methods of predicting eclipses, planetary motion and time measurement methods in astronomy and suggests that the Earth is spherical. In short, the theory of cosmology was translated into Arabic and Latin, and so the knowledge in this book reached Europe. It also inspired Indian and European mathematicians.

"The earliest recorded Indo-Arab intellectual contact happened in 771 CE when a Hindu astronomer and mathematician reached Baghdad with a Sanskrit work called Brahma Siddhanta by Brahmagupta. This text was translated into Arabic with the help of an Arab mathematician, and was named Sindhind."[10]

Bhaskaracharya:

Bhaskaracharya is known as a famous scientist, mathematics expert and astronomer of the 12th century. "He wrote 'Siddhanta Shiromani' book in 1150 A.D. in four parts."[11] Its first part consists of Lilavati (based on arithmetic), the second part algebra (on algebraic problems), the third part is planetary mathematics (mathematics related to astronomy) and the fourth part is Goladhyaya (mathematical theory on spheres). He also wrote the book 'Karan Kutuhul' based on the theories of astronomy and mathematics. Although we credit Newton and Legnis for discovering the mathematical branch of differential equation and integration, i.e., calculus, there is much evidence in their texts that calculus was first used by Bhaskaracharya.

Concluding remarks:

The work of the ancient Indian mathematician Aryabhatta also influenced the West. Arab and European mathematicians absorbed Aryabhatta's knowledge of mathematics and spread it around the world. The decimal method and the use of zero laid the foundation for modern mathematics. It was on Aryabhatta's mathematical concepts that scientists were able to conduct their research in various fields of modern physics and other multidisciplinary disciplines.

It is an irony that the people of India know very little about these great mathematicians of India. Evidence shows that ancient Indian society lived an advanced and elevated life compared to other countries. At that time, universities like Taxila, Nalanda, Vikramshila, and Vallabhi in India were famous as centres of study of many branches of knowledge. Many subjects like philosophy, mathematics, geometry, chemistry, physics, astrology, astronomy Ayurveda history, and geography, art, architecture and Defence science were taught.

It was a miracle that Indian astronomers were well aware of the planets and the movements of the earth, the sun and the moon, and that their predictions were largely correct. It is also an amazing fact that in ancient times Indian astronomers could accurately analyze the movements of planets

without micro telescopes. Varahamihir was a talented astrologer and mathematician of that time. It is said that the present city of Mehrauli is still famous by its name and the nearby Qutub Minar was once the centre of the movement of stars, which was later reshaped by the Muslim rulers and named Qutub Minar. It's hard to say how true this statement is, but it doesn't seem unnatural for Varahamihir to be Mehrauli. Mahaviracharya's book 'Ganitsar Sangraha' has given a new direction in the field of mathematics. This book has encouraged research and study in various branches of mathematics.

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