

A GENERAL REVIEW ON THE CONTRIBUTION OF ANCIENT INDIAN MATHEMATICIANS

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Abstract

In the field of mathematics, especially in algebra, calculus, mensuration, and trigonometry, huge development occurs because of our ancient Indian mathematicians, who contributed their whole lives in different fields of mathematics. Since it has its history of more than 4000 years, blooming for a long time in the past, the equivalence of modernity was seen in Europe. Afterwards, it dispersed in China, Asia, and the eastern portion, especially in its middle part. In addition to the discovery of zero, our ancient mathematicians made innovative contributions in the field of geometry, arithmetic, the binary system, negative numbers, and many other areas. The most important groundbreaking invention of an Indian mathematician was the decimal place value system, which is used now overall in the world was initially developed in India. the period of 400BCE to 1600 BCE, which is considered the classical period, is generally called the golden era of Indian mathematics. Meanwhile, many Indian mathematicians such as Aryabhata, Varahamihira, Brahmagupta, Bhaskara I, Bhaskara II, and Mahavira, Madhava of Sangamagrama, and Nilakantha Somayaji spread their work and explored many other branches of mathematics. The current paper aims to study ancient Indian mathematician and their contribution to the field of mathematics.

Keywords- *Trigonometry, Mensuration, Calculus, Arithmetic, Golden age.*

Introduction

Generally, Mathematics is called the Queen of Science, having fundamental practices that show different patterns, various structures, and relationships by using the concept of abstract and logical reasoning. It gives the global language of measurement

and computation, which is required for basic natural world and the critical problem solutions in different fields. As it's one part, it is about exploring patterns in numerical, numbers, shapes, and various qualities, to find out the solution of different practical problems like construction, commerce, and astronomy, ancient civilizations, especially those that were in Mesopotamia, Egypt, Greece, China, and India developed separate mathematical system. this hard work laid the basis for the evolution of different mathematical thoughts, which have gone through centuries of exploration and discovery. The main field of mathematics contains arithmetic, algebra, geometry, calculus, probability, and statistics, each has its own practices that provide various purposes in Advanced real-world phenomena and developing theoretical frameworks. On the other side, the basic operations and the theory of numbers are discussed in Arithmetic, while Algebra shows symbolic forms to find equations and to evaluate structures. Geometry studies shapes and spatial relationships, while calculus explores variation and rates of change in terms. Probability and statistics give uncertainty and synthesize data to make sure results in different areas, from starting from economics to biology. This is not only one subject but also one field that can transcend cultural and temporal boundaries, with its integrity and techniques shaping

advancements in science, technology, engineering, and economics. From ancient civilizations to modern societies, mathematics continues to evolve, driving innovation and serving as a powerful tool for understanding the complexities of our universe. The study of ancient mathematics is not merely a historical inquiry but a reflection of human ingenuity and the quest for understanding fundamental principles of the universe. By examining the origins, methodologies, and achievements of ancient mathematicians, this research aims to illuminate the cultural, scientific, and philosophical contexts that shaped early mathematical thought.

The Contribution of Ancient Indian mathematics stands as a cornerstone in the development of global mathematics, offering profound contributions that continue to influence mathematical thought and practice today. Central to these contributions is the invention of the decimal numeral system around the 5th century BCE. This system, based on ten symbols and positional notation, revolutionized arithmetic and laid the foundation for complex mathematical operations. Coupled with the concept of zero, pioneered in India and formalized by mathematician Brahmagupta in the 7th century CE, the numeral system enabled precise calculations and became fundamental to global mathematical practices. In algebra, Indian mathematicians made significant advancements. Brahmagupta furthered these developments with rules for arithmetic involving zero and negative numbers, influencing algebraic methods across cultures. Indian mathematicians also excelled in geometry, as seen in the Sulba Sutras, ancient texts from around 800-500

BCE. These texts provided geometric rules and constructions used in architecture and ritualistic practices. Aryabhata, in the 5th century CE, expanded geometric and trigonometric principles in his work "Aryabhatiya," which included methods for calculating areas and exploring planetary motion. In astronomy, Aryabhata proposed a heliocentric model of the solar system and made precise astronomical calculations, such as the Earth's circumference. Varahamihira's "Pancha-Siddhantika" compiled earlier astronomical knowledge and contributed to advancements in celestial mechanics. The transmission of Indian mathematical knowledge through trade and scholarly exchanges, particularly to the Islamic world and later to Europe, furthered the impact of these contributions. Indian concepts of zero, decimal system, algebraic methods, and trigonometry became integral to the development of mathematics in the Islamic Golden Age and the European Renaissance. Ancient Indian mathematics has left an indelible mark on global mathematics, enriching the discipline with foundational concepts and practical applications that continue to shape mathematical thinking and innovation worldwide

Contribution of an Indian mathematician

Kamala Kara' contribution

Kamalakara worked mostly in the field of trigonometry and astronomy, which considerably contributed to the improvement of trigonometry and astronomical tables. The mathematical ingenuity of jyotiṣa authors, as discussed by Montelle and Plofker, evolved into a

profuse variety of table-text types, focused on the significance of numerical tables in the calculation of astronomy. In addition to this, the success of Indian mathematicians, especially those from Kerala, breaks the boundaries and lays down a pathway to the infinite, as highlighted by Mallayya, who contributed to modernization in mathematical techniques like series approximation and error analysis, which are fundamental in the development of accurate astronomical tables. Afterwards, Plofker's research indicates that while classical Indian mathematical astronomy highly depends on trigonometry, which is plane, methods for perfect solutions of spherical triangles were not separately invented, showcasing the impact of different mathematical traditions on astronomical computations.

Shripati's contribution

Shripati was considered one of the notable figures in Indian mathematics and the field of astronomy, and made a huge contribution that helped to increase these fields. His work falls within the broader context of Ancient Indian Mathematics and Astronomy, where scholars like Aryabhata, Brahmagupta, and others have made substantial contributions that are often overlooked in Eurocentric education. Shripati's works likely correspond with the different regions of focus in Indian mathematics, containing zero and place value systems, Vedic mathematics, algebra, trigonometry, and analysis. Additionally, Shripati's work may have been influenced by the rich tradition of Sanskrit mathematical astronomy, which integrated various knowledge systems and cosmological concepts, adapting them into

familiar mathematical models. Overall, Shripati's contributions likely played a crucial role in advancing mathematical and astronomical knowledge in India, contributing to the broader tapestry of intellectual achievements in these fields.

Mahavir Acharya contribution

A notable mathematician, Mahavir Acharya, provided his work to group theory, especially in the relation of group solution fields and Sylow subgroups. Furthermore, Mahavir Acharya's work gives a pathway to practical geometry and mathematics in the Near East, demonstrating a range of practical geometry along with a vast background of methods and problems spanning millennia. Furthermore, the Vedic Sutras, in which Mahavir Acharya's work is in, are applications of computer arithmetic unique in the design of Vedic multipliers that increase computational speed and accuracy through ancient mathematical principles.

Brahmagupta's contribution

Brahmagupta's work in algebra holds significant importance due to his pioneering contributions that laid the foundation for mathematical concepts still relevant today. He was the first to define zero algebraically, influenced by Indian philosophical ideas and terminology. Additionally, Brahmagupta's formula for calculating the area of a quadrilateral by its sides, even when not inscribed in a circle, showcases his mathematical ingenuity and practical applications in land management expertise. Despite the underrepresentation of Indian mathematical achievements in Western discourse, Brahmagupta's innovative ideas in solving Diophantine equations and his

concept of zero attachment to mundane affairs continue to inspire modern mathematical research and generalizations. Furthermore, the characterization of Brahmagupta quadrilaterals through elliptic curves demonstrates the lasting impact of his work on diverse mathematical fields, leading to the construction of families of elliptic curves with specific properties and applications

Bodhayana contribution

Bodhayana, an ancient Indian mathematician, made significant contributions to mathematics, particularly in the field of geometry. His work on right-angled triangles and the decimal system has had a lasting impact on mathematical development. Additionally, the emphasis on reason and science by Arabs in the Middle Ages, as discussed by Kong and Ma, helped promote the development of mathematics, with implications for the European Renaissance. Furthermore, the historical review by Nathanson highlights the importance of mathematical contributions in trigonometry, such as new relationships and tables, which were also significant aspects of Bodhayana's work. Bodhayana's mathematical achievements, alongside those of other ancient Indian mathematicians, have played a crucial role in shaping the foundations of mathematical knowledge and practice.

Jain philosophy contribution.

Jaina philosophy has seen significant contributions throughout history. Scholars like Bhaṭṭa Akalaṅka, Vidyānanda, Hemacandra, and others have played crucial roles in developing Jaina pramāṇa-śāstra, focusing on epistemology and logic.

Additionally, Jainism's historical roots trace back to the pre-Vedic period, with contributions in art, architecture, and religious practices, reflecting cultural aspirations and providing centres for worship, education, and more. Furthermore, Jaina morality offers guidance in navigating modern challenges, emphasizing the importance of moral wisdom in today's society. Scholars in Jaina studies have also delved into various aspects, including philosophy, ethics, rituals, and the historical development of Jainism, shedding light on its relation to Buddhism and Ajivikism. Jainism's ethical principles, particularly non-violence, have been highlighted as guiding forces for sustainable economic

Aryabhata's contribution

Aryabhata's groundbreaking work included the development of the concept of zero, the use of algebraic equations to solve astronomical problems, and the accurate calculation of the value of pi. Aryabhata's work also involved the creation of a mathematical system that laid the foundation for trigonometry and the calculation of planetary positions, which greatly influenced future advancements in these fields. Aryabhata also made significant contributions to astronomy and mathematics. In astronomy, he worked on time reckoning, spherical geometry, and trigonometry, with his legacy appreciated for introducing the concept of the sine and creating the first sine table. Aryabhata's mathematical work included pioneering the use of trigonometric identities and finite difference calculus, which are fundamental in modern calculus. Additionally, his text Aryabhatiya contained the principle of

relativity of motion, crucial for his theory that the Earth rotates on its axis, marking a pivotal moment in the history of astronomy. Furthermore, Aryabhata's system of planetary constants was influenced by earlier Indic astronomical traditions, showcasing his integration of diverse ideas into his work. Aryabhata's contributions extended beyond mathematics and astronomy, as he also delved into the fields of algebra and arithmetic, laying the groundwork for future advancements in these areas. Moreover, Aryabhata's

Bhaskar Acharya contribution

Bhaskaracharya, an influential mathematician in medieval India, introduced key algebraic concepts and techniques that have left a lasting impact on mathematics. His work encompassed operations involving positive and negative numbers, surds, and zero, as well as algebraic, simultaneous, and indeterminate equations, as highlighted in the treatise on algebra from his Sanskrit magnum opus Siddhanta Shiromani. Bhaskar Acharya's algorithm for dealing with expressions involving multiples of zero, treated as infinitesimals, and zero-divisors has been considered significant, bearing similarity to the ideas of Newton and Leibniz in the development of Calculus. Furthermore, his law of impending operations involving zero, particularly division by zero, has been defended for its philosophical consistency and simplicity, challenging the methods of infinitesimals and limits. These contributions have solidified Bhaskaracharya's legacy in the realm of algebra and mathematics, shaping fundamental principles still studied and applied today.

Narayan Pandit contribution

Narayana Pandit, an Indian Mathematician from the 14th Century CE, made significant contributions to mathematics by introducing Narayana's numbers and "Ganitakaumudi", a sequence that produces a limiting constant akin to the Golden Ratio observed in the Fibonacci sequence. Furthermore, research has focused on Narayana-Mandelbrot polynomials, a novel concept that extends the Mandelbrot companion matrix, showcasing the ongoing relevance and impact of Narayana's work in modern mathematical explorations. Additionally, studies have delved into the finite nature of Narayana's numbers that can be expressed as a product of three repdigits in various numerical bases, shedding light on the intricate properties and limitations of these unique sequences. These findings collectively highlight Narayana Pandit's enduring legacy in mathematics and his pioneering contributions to the field.

Conclusion

The study of ancient mathematicians has discovered rich and intellectual achievements that laid the foundation for modern mathematical theories and practices. From the practical mathematics of ancient Mesopotamia, ancient mathematicians developed methodologies and concepts that continue to shape our understanding of mathematics today. The research underscores the interdisciplinary nature of studying ancient mathematics, highlighting its cultural, scientific, and philosophical dimensions. By studying the historical contexts and methodologies of ancient mathematicians, we can say that their work gives us a pathway for studying

modern mathematics. this study contributes to ongoing discussions on the evolution of mathematical thought and its enduring impact on human civilization.

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