Mahavira: A Mathematical Prodigy Of The Ancient India

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Abstract

Mahavira or Mahaviracharya was a 9th century (about 800-870 CE) Jain mathematician, who made significant contributions to the development of Algebra, born in the present-day city of Gulbarga, Karnataka, in southern India. He perhaps took his name to honour the great Jainism reformer Mahavira. He was the author of the earliest Indian text Ganitsarasangraha (dated 850 CE) devoted entirely to mathematics. He was patronised by the king Amoghavarsha of the Rashtrakuta Dynasty. Mahavira stresses the importance of mathematics in both secular and religious life and in all kinds of disciplines including love and cooking. He was the first one to separate Astrology from Mathematics. He is highly respected among Indian Mathematicians because of his establishment of terminology for concepts such as equilateral triangle, isosceles triangle.

Keywords :- Significant, Dynasty, Stress, Secular, Terminology .

Introduction:-

Mahavira or Mahaviracharya, was a 9th-century Indian Jain mathematician possibly born in Mysore, in India. He authored Ganita-sara-sangraha or the Compendium on the gist of Mathematics in 850 CE. He was patronised by the Rashtrakuta emperor Amoghavarsha. He separated astrology from mathematics. It is the earliest Indian text entirely devoted to mathematics. He expounded on the same subjects on which Aryabhata and Brahmagupta contended, but he expressed them more clearly. His work is a highly syncopated approach to algebra and the emphasis in much of his text is on developing the techniques necessary to solve algebraic problems. He is highly respected among Indian mathematicians, because of his establishment of terminology for concepts such as equilateral, and isosceles triangle; rhombus; circle and semicircle. Mahavira's eminence spread throughout southern India and his books proved inspirational to other mathematicians in Southern India. It was translated into the Telugu language by Pavuluri Mallana as Saara Sangraha Ganitamu.

He discovered algebraic identities like $a^3 = a\ (a+b)\ (a-b) + b^2\ (a-b) + b^3$ He also found out the formula for ${}^nC_r$ as $[n(n-1)(n-2)\ldots (n-r+1)]/[r(r-1)\ (r-2)\ldots 2.1]$. He devised a formula which approximated the area and perimeters of ellipses and found methods to calculate the square of a number and cube roots of a number. He asserted that the square root of a negative number does not exist. Arithmetic operations utilized in his works like Ganita-sara-sangraha uses decimal place-value system and include the use of zero. However, he erroneously states that a number divided by zero remains unchanged.

Rules for decomposing fractions

Mahāvīra's *Gaṇita-sāra-saṅgraha* gave systematic rules for expressing a fraction as the sum of unit fractions.[14] This follows the use of unit fractions in Indian mathematics in the Vedic period, and the Śulba Sūtras' giving an approximation of $\sqrt{2}$ equivalent to $1+\frac{1}{3}+\frac{1}{3\cdot4}-\frac{1}{3\cdot4\cdot34}$.[14]

In the *Gaṇita-sāra-saṅgraha* (GSS), the second section of the chapter on arithmetic is named *kalā-savarṇa-vyavahāra* (lit. "the operation of the reduction of fractions"). In this, the *bhāgajāti* section (verses 55–98) gives rules for the following:[14]

- To express 1 as the sum of *n* unit fractions (GSS *kalāsavarṇa* 75, examples in 76):[14]

  rūpāṃśakarāśīnāṃ rūpādyās triguṇitā harāḥ kramaśaḥ /
  dvidvitryaṃśābhyastāv ādimacaramau phale rūpe //

  When the result is one, the denominators of the quantities having one as numerators are [the numbers] beginning with one and multiplied by three, in order. The first and the last are multiplied by two and two-thirds [respectively].

$$1=\frac{1}{1\cdot 2}+\frac{1}{3}+\frac{1}{3^2}+\cdots+\frac{1}{3^{n-2}}+\frac{1}{\frac{2}{3}\cdot 3^{n-1}}$$

- To express 1 as the sum of an odd number of unit fractions (GSS *kalāsavarṇa* 77):[14]

$$1=\frac{1}{2\cdot 3\cdot 1/2}+\frac{1}{3\cdot 4\cdot 1/2}+\cdots+\frac{1}{(2n-1)\cdot 2n\cdot 1/2}+\frac{1}{2n\cdot 1/2}$$

- To express a unit fraction $1/q$ as the sum of *n* other fractions with given numerators $a_1, a_2, \ldots, a_n$ (GSS *kalāsavarṇa* 78, examples in 79):

$$\frac{1}{q}=\frac{a_1}{q(q+a_1)}+\frac{a_2}{(q+a_1)(q+a_1+a_2)}+\cdots+\frac{a_{n-1}}{(q+a_1+\cdots+a_{n-2})(q+a_1+\cdots+a_{n-1})}+\frac{a_n}{a_n(q+a_1+\cdots+a_{n-1})}$$

- To express any fraction p/q as a sum of unit fractions (GSS *kalāsavarṇa* 80, examples in 81):[14]

  Choose an integer *i* such that $\frac{q+i}{p}$ is an integer *r*, then write

$$\frac{p}{q}=\frac{1}{r}+\frac{i}{r\cdot q}$$

  and repeat the process for the second term, recursively. (Note that if *i* is always chosen to be the *smallest* such integer, this is identical to the greedy algorithm for Egyptian fractions.)

- To express a unit fraction as the sum of two other unit fractions (GSS *kalāsavarṇa* 85, example in 86):[14]

  $\frac{1}{n}=\frac{1}{p\cdot n}+\frac{1}{\frac{p\cdot n}{n-1}}$ where p is to be chosen such that $\frac{p\cdot n}{n-1}$ is an integer (for which p must be a multiple of $n-1$).

$$\frac{1}{a \cdot b} = \frac{1}{a(a+b)} + \frac{1}{b(a+b)}$$

- To express a fraction p/q as the sum of two other fractions with given numerators a and b (GSS *kalāsavarṇa* 87, example in 88)

$$\frac{p}{q} = \frac{a}{\frac{ai+b}{p} \cdot \frac{q}{i}} + \frac{b}{\frac{ai+b}{p} \cdot \frac{q}{i} \cdot i}$$ where i is to be chosen such that p divides $ai + b$

Some further rules were given in the *Gaṇita-kaumudi* of Nārāyaṇa in the 14th century.

Line and Influence :-

He Born in the city of Mysore, Mahavracharya halled from a lineage steeped in Jain traditions. While his exact birthdate remain shrouded in mystery, scholars estimate him to have lived around the mid-9th century CE. Growing up in a milieu rich with thematical knowledge, Mahavira was exposed to the works of earlier Indian mathematicians like Aryabhata and Brahmaputa, whose ideas would profoundly shape his own mathematical journey.

Mahaviracharya's Legacy :-

Mahaviracharya's Ganita Sara Samgraha not only served as a comprehensive textbook for mathematics in its time but also had a lasting impact on the development of mathematics in India and beyond. His ceas were later adopted and expanded upon by subsequent Indian mathematicians, and his influence can be seen in the works of later European mathematicians such as Fibonacci

Mahaviracharya's contributions to mathematics were not limited to his theoretical work. He also applied his mathematical knowledge to practical problems, such as those related to astronomy, engineering, and commerce. His work on arithmetic, for example, was used by merchants to calculate profits and losses, while his work on geometry was used by architects and builders to design structures.

Mahaviracharya's legacy as a mathematician is one of innovation, ingenuity, and unwavering dedication to the pursuit of knowledge. His work continues to inspire mathematicians and scholars today, reminding us of the power of human intellect to transcend cultural and temporal boundaries.

In conclusion, Mahaviracharya was a true pioneer in the field of mathematics, whose contributions nave left a lasting impact on the world. His work is a testament to the brilliance and ingenuity of indian mathematician and serves as a reminder of the importance of preserving and promoting our rich mathematical heritage.

The Ganita sara Samaraha: A mathematical Treasure Trove.

The Ganita Sara Samprata is a monumental work that provides a detailed exposition of various mathematical Concepts. It is divided into nine chapters, each dedicated to a specific arrea of mathematics as follows :-

1. Arithmetic: This chapter covers fundametal operations with Integers, fraction, and zero. Mahaviracharya introduced innovative methods for solving problems involving fractions, Square roots, and Cube roots.

2. Algebra: The algebraic section of the Ganita Sara samgraha zis particularly noteworthy. Mahaviracharya delved into linear, quadratic and Simultaneous equation, provide systematic solution for Wide range of problems. He also introduced the Concept of negative namber and their operations.

3. Geometry: Mahaviracharya's Contoribution to geometry arre Significant. He explored the properties of various geometric figures, including triangles, quadrilaterals and Circles. He derived formulas for Calculating areas, perimeters and Volumes of different shapes.

4. Trigonometry: the trigonometric section of the Ganita Sara Sangraha showcases Matanviracharya's deep understanding of the Subject. He disussed trigonometric ratios, their properties and their applications in solving astronomical and Geometrical problem-

5. series and progressions: Matanviracharya imvestigated various types of series and progressions, including arithmetic, geometric, and harmonic progressions. He developed methods for finding the sum of finite and infinite Series.

6. Combination and permutations: This chapter deals with the theory of deter permutation and Combinations. Maharbiracharya presented elegant Solutions to probleons involving the arrangement and Section of objects

7. Indeterminate equations:- Mahentiracharya explored the theory of indeterminate equations particulary those expration of the frist and second degree. He provided method for finding integers solution of these equations.

8. Shadow problems: The section deals with problems related to shadows and their lengths, which were crucial for astronomical Calculations.

9. Miscellaneous Topics: The Final Chapter Covers a variety of miscellaneous topics including problems involving the measurement of time, interest Calculations and the Construction of Geometric figures.

Mahaviracharya's Impact on Mathematics:

Mahaviracharya's Ganita Sara Sorngraha had a profound impact on the development of mathemates in India and beyond. His work was influential in shaping the mathematical tradition of Sabsequent Indian mathematicians and was transmitted to other Caltures through various channels.

Key Contributions of Mahaviracharya including as follows

1. Systematization of Mathematical knowledge: He organized and systematized the mathematical knowledge of his time , presenting it in a clear and Concise manner.

2. Introduction of New Concepts: He introduced several new concepts such as negative numbers, zero, and indeterminate equations, which expanded the scope of mathematical inquiry.

3. Development of Innovative Techniques: He developed innovative techniques for solving various mathematical problems, including algebraic equations, geometric Constructions, and trigonometric Calculations.

4. Application of Mathematics. to practical problems: He emphasized the practical applications of Methamatics, demonstrating its relevance to fields like astronomy, engineering and Commerce.

Legacy:

Mahaviracharya's Legacy as a brilliant mathematician endures Ganita Sara samgraha remains a valuable resource for historians of mathematics and Continues to inspire mathematicians and research Scholars world wide. By building upon the foundations laid by earlier Indian mathematicians, Mahaviracharya eter elevated Indian mathematics to new solidifying its position as one of the world's leading .

Conclusion:-

Mahaviracharya's contributions to mathematics are a testament to the intellectual brilliance of ancient Indian Carvilization. His Ganita Sara samgraha is a masterpiece that showcases his deep understanding of mathematical principles and his ability to apply them to real world problems. By Studing Studying luminaries as Mahaviracharys, we can gain a for the rich mathematical heritage of the works a deeper appreciation goodia and its enduring impact on the global mathematical landscape.

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