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SUNDRI LESSONS TO ALGORITHMS: THE PIONEERING SPIRIT OF JAIN MATHEMATICS

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ABSTRACT

Jain Mathematics is a deep part of our cultural and scientific history. This study traces its growth from the teachings of the first Tirthankara, Rishabhdeva, to his daughter Sundri, and later to the 9th-century cryptographic text Siri Bhoovalaya, showing that it was far ahead of its time. Jain scholars worked on ideas like combinatorics, recursion, very large numbers, and algorithms long before similar work appeared in Europe or the Islamic world. The paper looks at the wide range of Jain mathematical texts, the importance of teaching women mathematics early on, and what this strong focus on numbers says about Jain society from ancient times to today. It argues that Jain mathematics was more than just solving problems—it was part of a whole way of thinking that joined logic, ethics, and cosmology, creating a tradition of learning and precision that still matters today.

Keywords: Sundri, Algorithms, Jain Mathematics

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1. INTRODUCTION

Jainism, one of the world's oldest surviving religious traditions, is globally renowned for its foundational principles of ahimsa (non-violence), anekantavada (multi-faceted reality), and aparigraha (non-possessiveness). However, alongside this profound philosophical and ethical framework flourished a rigorous and systematic tradition of scientific inquiry, particularly in the field of mathematics. For Jain thinkers, mathematics was far more than a practical tool for commerce and astronomy; it was a sacred language—a means to quantify the cosmos, map the intricacies of the soul's journey, and embody the principles of logical order and precision that underpin a moral life.

This integration is symbolized in the powerful legend of the first Tirthankara, Rishabhdeva, imparting knowledge of mathematics to his daughter, Sundri. This narrative is not a mere anecdote but a foundational statement of principle: the pursuit of knowledge, especially systematic and logical knowledge like mathematics, is universal and inclusive. It establishes an early cultural endorsement of female intellect and scholarship that was exceptional in the ancient world.

We tracs the evolution of this unique Jain mathematical tradition over thousands of years, from its earliest expressions in canonical literature to its apex in formalized theorems and cryptographic complexity.

Jain mathematical tradition represents a distinct and highly advanced intellectual current, one that wove together abstract reasoning, practical application, and ethical philosophy in a way that was centuries ahead of its time.

2. THE PRIMORDIAL MATHEMATICAL TREATISE

The source of Jain mathematical knowledge is not contained in a single physical text but is an Ādi Paramparā (Original Canonical Tradition) and Śruta-Jñāna (Oral Knowledge) passed down through tradition and referenced in later Jain Digambara and Śvetāmbara commentaries.

This tradition establishes the ontological status of mathematics (Saṃkhyāna / Gaṇita) within Jain thought. It is not presented as a human invention but as a fundamental, revealed knowledge system (Vidyā) essential for cosmic order and human civilization (Pravṛtti).

First Tirthankar Rishabhdeva is credited with establishing the 72 Arts for men (Strī-Puruṣārtha) and the 64 Arts for women (Pum-Puruṣārtha). Mathematics is embedded within these, notably:

- Saṃkhyāna (Counting & Enumeration)
- Māna (Measurement)
- Rāśi (Calculation of volumes)
- Rajju (Geometry/Geodesy)

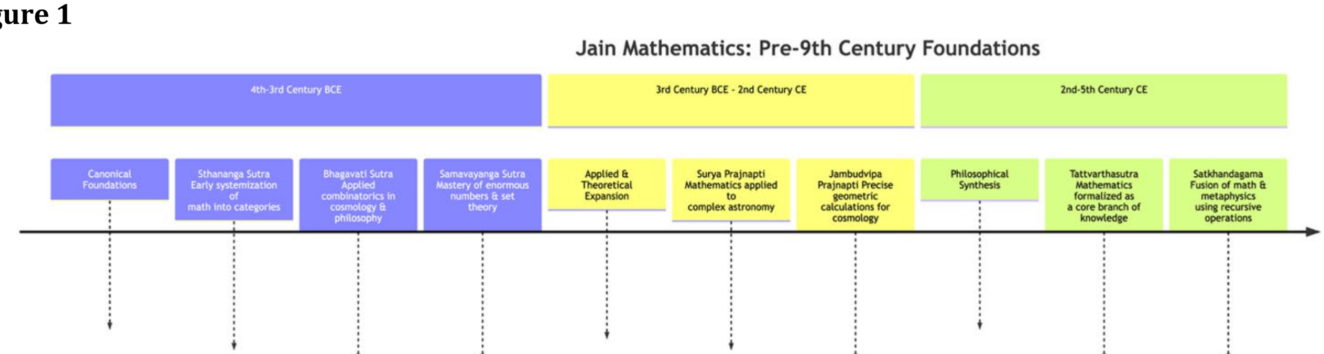
According to Jain tradition, Rishabhdeva, the first Tīrthaṅkara, taught his daughter Sundarī the principles of numeracy and mathematical reasoning. This early instruction symbolizes the inclusive foundation of Jain mathematics, where even women were initiated into advanced learning. Tradition holds that Rishabhdeva seated his daughter Sundarī on his left thigh and taught her to write numbers from right to left, marking the symbolic beginning of Jain mathematical instruction known as Indian numeral system. These numerals spread to the Islamic world through translations of Indian text. From the Islamic world, they traveled to Europe via Spain and Italy in the Middle Ages, where they became known as Arabic numerals, since Europeans learned them from Arabic scholars. The teaching positions mathematical precision as a means to purify thought, avoid error (vibhrama), and cultivate the logical clarity necessary for spiritual advancement. The instruction of Sundarī is the seminal act establishing that intellectual and spiritual capabilities are not gender-defined.

This foundational inclusivity allowed for the broader participation and application of knowledge across society, a key factor in the community's historical success in trade, finance, and arts. It established a core societal value that numeracy and logical education were essential for all, contributing to the Jain community's prominence in fields requiring these skills for millennia. It provides the philosophical justification for why Jain texts relentlessly pursue mathematical concepts: to understand the ordered (vyavastha) and quantified (parimāṇa) nature of the universe and the soul's journey within it.

3. IMPORTANT JAIN MATHEMATICAL FINDS: PRE-9TH CENTURY

The foundations of Jain mathematics are deeply embedded in its canonical and philosophical texts. This period is characterized by the development of abstract numerical concepts not for their own sake, but as a necessary language to describe a vast and complex cosmos.

Figure 1



4. THE CANONICAL CORE (C. 4TH – 3RD CENTURY BCE)

The earliest mathematical ideas are found in the Jain Āgamas (canonical texts), composed in Ardhamagadhi Prakrit. Their primary driver was cosmological and philosophical enumeration.

Sthānānga Sūtra - One of the oldest Jain texts to explicitly systematize knowledge, including mathematics. It organizes all doctrines into ten categories. It dedicates one of its ten divisions (upānga) specifically to mathematics (saṃkhyāna), signaling its formal importance from the very beginning. It lists fundamental mathematical operations under terms like:

- Vyavahāra (practical calculation)
- Rajju (geometry, literally "rope" for measurement)
- Rāśi (volume, heap)
- Kala-savanna (calculations of time)
- Vikalpa (permutations and combinations)

Bhagavatī Sūtra (Viyāhapaṇṇatti): This is the most important canonical text for early Jain mathematics, containing detailed discussions on cosmology, philosophy, and geometry, often using numerical concepts. It contains explicit problems calculating the number of ways philosophical propositions can be combined or arranged. For example, it explores the number of possible types of knowledge that can be generated from different perspectives. It provides calculations for the circumference and area of circular shapes, including an early approximation of π (pi) as √10 (approximately 3.1623), which was a common and practical value used in ancient India. It also engages in sophisticated classification, listing and counting various types of souls, realities, and cosmic categories, laying the groundwork for a set-theoretic approach to philosophy.

Sūrya Prajñapti: An astronomical text that represents the application of mathematics to understand time and the cosmos. It provides detailed calculations for the durations of day and night, planetary cycles, and celestial movements using fractions and ratios. It also presents a complex mathematical model of the solar system, calculating the relative distances and sizes of the sun, moon, and planets.

Jambūdvīpa Prajñapti: A cosmological text that applies geometry to map the Jain universe. It provides precise, detailed measurements of the continents and oceans that make up the Jain cosmological map. While mythological, the calculations themselves are geometrically consistent and complex. It also demonstrates advanced thinking about area, volume, and symmetric structures on an immense scale.

Samavāyānga Sūtra: Perhaps the most striking canonical text for its sheer numerical ambition.

The Mathematics of Enumeration: It is essentially a vast catalogue of the universe, systematically enumerating types of souls, bodies, heavens, hells, and philosophical concepts. It doesn't just use large numbers; it provides a systematic classification of infinity. It lists sets with numbers of elements progressing geometrically: 1, 2, 3, ... 10, 12, 16, ... 100, 1000, ... 10^10, ... up to 10^60 (a number called śīrṣaprahelikā). This relentless enumeration trained Jain scholars to think in terms of sets, subsets, and orders of magnitude, creating a cultural comfort with abstraction and immense scale that was unparalleled elsewhere.

5. THE EARLY SCHOLASTIC PERIOD (C. 2ND CENTURY BCE – 5TH CENTURY CE)

This period saw the development of commentaries (niryuktis and bhāṣyas) on the Āgamas and the beginnings of independent scholarly works that started to formalize these mathematical ideas.

Tattvārthasūtra: (c. 2nd – 5th Century CE) Umāswāti (also known as Umasvami)

authored this as the first Jain text written in Sanskrit and the first to present the entire Jain doctrine in a systematic, philosophical form. It is accepted by all Jain sects. It explicitly lists mathematics (saṃkhyāna) as one of the five essential types of knowledge (jñāna), alongside sensory knowledge, scriptural knowledge, mental perception, and omniscience. This philosophically cemented the role of mathematics as a fundamental tool for understanding reality.

Satkhaṇḍāgama: (c. 2nd Century CE) authored by Puṣpadanta and Bhūtabali. This is the most revered Digambara canonical text. Its mathematical content is not a separate chapter but is woven into its metaphysical structure. The text uses recursive processes to generate complex karmic categories. A rule is applied to a set, then applied again to the result, and so on. This is a fundamental concept in computer science known as recursion, used here for philosophical classification centuries before its formal definition. It provides a highly quantified, almost mathematical, analysis of the binding and shedding of karmic particles (pradeśas), treating karma as a measurable, quantifiable entity.

6. SUMMARY OF PRE-9TH CENTURY CONTRIBUTIONS

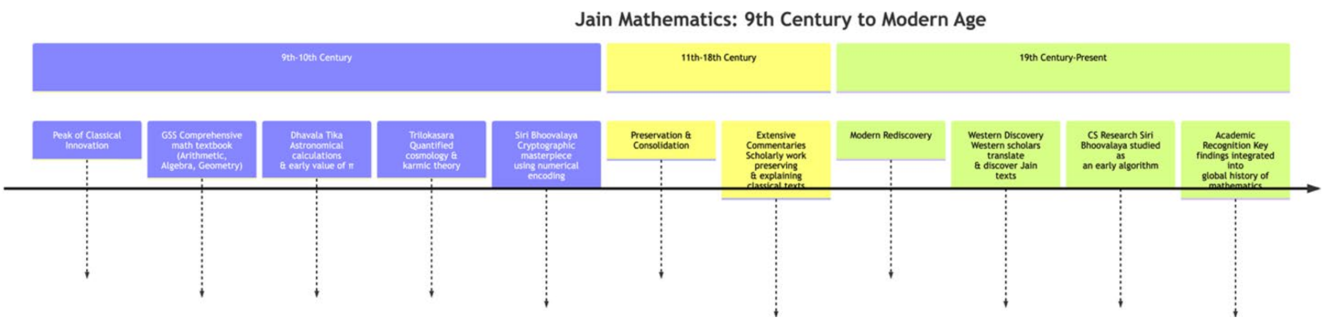
Before the 9th-century golden age of independent treatises, Jain mathematicians had already established a formidable intellectual tradition. Mathematics developed primarily to describe a vast, complex, and quantified cosmos and soul-theory, not just for trade or astronomy. They developed a sophisticated lexicon for enormous numbers and different types of infinity (ananta), far exceeding the numerical needs of other contemporary civilizations. They began formalizing the mathematics of arrangements and selections to solve philosophical and cosmological problems. A relentless focus on enumeration and categorization of all aspects of reality laid the groundwork for set-theoretic thinking. The use of recursive processes in texts like the Satkhaṇḍāgama shows an early understanding of algorithmic generation of complexity from simple rules.

This foundational period created a unique intellectual environment where thinking in abstract numbers, sets, and algorithms was second nature, setting the stage for the groundbreaking independent works of the 9th and 10th centuries.

7. IMPORTANT JAIN MATHEMATICAL FINDS: 9TH CENTURY TO MODERN AGE

This timeline highlights the transition from groundbreaking independent treatises to a period of consolidation and commentary, and finally to the modern re-evaluation of these ancient ideas in the context of computer science and history of mathematics.

Figure 2



8. THE CLASSICAL PEAK (9TH – 10TH CENTURIES CE)

This era represents the golden age of independent Jain mathematical scholarship, producing comprehensive treatises that synthesized and advanced knowledge.

Gaṇitasārasaṅgraha (GSS): (c. 850 CE) Authored by Mahāvīrācharya. This is the first truly independent and systematic mathematical treatise by a Jain author that is entirely secular in its presentation. It is a comprehensive textbook that covers almost all branches of mathematics known to the Jains at the time. It provided arithmetic, definitive rules for operations with fractions, including the now-standard method of dividing by a fraction by multiplying by its reciprocal. Algebra, it offered systematic, generalized rules for solving linear and quadratic equations. His rule for solving quadratic equations is particularly elegant. Geometry, it gave formulas for calculating the area of an ellipse and the volume of a frustum of a cone. His formulas for cyclic quadrilaterals were advanced for the time. Combinatorics, it contains the most detailed and systematic pre-12th century rules for permutations (vikalpa) and combinations (bheda). He provided a general formula for calculating ⁿC_r and worked on problems involving combinations with repetition. Operations, it detailed algorithms for finding squares, cubes, square roots, and cube roots of numbers.

Dhavala Tikā: (c. 816 CE – 816 CE) authored by Virasena (with assistance from his disciple, Jinasena). A monumental commentary on the Shatkhandagama, this work is famous for its mind-boggling cosmological calculations. It uses large Nnumbers, calculated the time taken for a soul to achieve liberation, involving numbers of an immense scale (on the order of 10^60 and beyond), demonstrating unparalleled comfort with exponentiation and iterative calculation. It calculated value of π and provided a remarkably accurate value for π. Virasena stated that the circumference of a circle with a diameter of 100,000 yojanas is approximately 314,159 yojanas; effectively using $\pi \approx 3.14159$, which is correct to five decimal places. This was one of the most accurate approximations in the world at the time.

Trilokasāra (or Trilokasara): (c. 10th Century CE) authored by Nemicandra Siddhānta Chakravartin. This text is a masterful synthesis of Jain cosmology, karma theory, and mathematics. It quantifies the structure of the universe and the soul's journey within it. It covered mathematical cosmology and provided precise calculations for the dimensions, volumes, and population of the various realms (lokas) within the Jain universe. This wasn't myth but a rigorous, numbers-driven model of cosmology. It spoke about karma as mathematics and presented a highly quantified model of karma, calculating the number of karma particles (pradeśas) that can bind to the soul and the mathematical processes for their attachment and shedding. This represents a unique fusion of abstract mathematics, metaphysics, and ethics.

Siri Bhoovalaya: (c. 9th Century CE) authored by Acharya Kumudendu. This work is considered as the pinnacle of Jain cryptographic and algorithmic thinking. It is a singular work in the entire history of mathematics. It speak about Polyglot Numerical Encoding; this is not a find of a specific theorem but of a method—a revolutionary information system. The entire text is a massive grid of numbers where each number represents a syllable. Using different interpretive rules (like a cipher key), the same grid can be read to produce coherent texts in multiple languages (Sanskrit, Kannada, Tamil, etc.) on diverse subjects like grammar, poetry, philosophy, and mathematics itself. It is now studied as a monumental, pre-modern example of data compression, cryptography, and algorithmic language processing. It functions like a modern computer program where a single data stream (the number grid) is interpreted by different "programs" (the rules) to output different results (the verses). It anticipates core concepts of computer science by a millennium.

9. THE SCHOLASTIC AND PRESERVATION PERIOD (11TH – 18TH CENTURIES)

Following this classical peak, the nature of Jain mathematical activity shifted. The focus moved from creating new, independent treatises to Writing Commentaries (Tikās) that scholars produced extensive commentaries on the works of Mahāvīrācharya, Virasena, and Nemichandra, explaining their complexities and preserving their knowledge for future generations. Systematizing Knowledge where the focus was on ensuring the survival and accurate transmission of the existing colossal body of knowledge. Integration with Philosophy, in which the mathematics continued to be deeply embedded in philosophical and cosmological texts, maintaining its role as the language of cosmic order. While this period saw fewer "new" finds, it was crucial for the preservation of the tradition's intellectual heritage through centuries of social and political change.

10. THE MODERN REDISCOVERY (19TH CENTURY – PRESENT)

The modern era's "finds" are not new Jain discoveries, but rather the rediscovery and recognition of Jain achievements by Western and Indian historians of mathematics.

Recognition of Pioneering Combinatorics (19th-20th C.): The work of historians like M. Rangacarya (who translated the GSS in 1912) and later, A. N. Singh and B. Datta, brought to light the fact that Jain mathematicians like Mahāvīrācharya had developed a full-fledged theory of permutations and combinations centuries before it appeared in Europe. This forced a revision of the global history of mathematics.

Analysis of the Siri Bhoovalaya (20th-21st C.): Modern scholars, including computer scientists and cryptographers, have begun to analyze this text not just as a religious oddity but as a serious technical achievement. Its study has revealed:

Its structure as a finite-state automaton.

Its use of modular arithmetic and positional notation for linguistic encoding.

Its conceptual parallels with modern coding theory and steganography (hiding information within another medium).

Appreciation of Mathematical Philosophy: Modern scholars now highlight the unique Jain philosophical framework that enabled this mathematical revolution. The concepts of:

Anekāntavāda (multi-faceted reality) encouraging multiple solutions and perspectives to a problem.

Syādvāda (the theory of conditional predication) introducing a formal seven-valued logic.

Cosmological vastness requiring a mathematics of enormous numbers.

These are now understood as the drivers that pushed Jain thought into such advanced mathematical realms.

The most important "find" from the 9th century onward was the Jain development of mathematics as a formal, independent discipline (exemplified by the Ganitasarasangraha), coupled with their unparalleled application of algorithmic and cryptographic principles to language and information (exemplified by the Siri Bhoovalaya). The modern age's contribution has been to recognize these achievements, analyzing them with contemporary tools and rightly placing them in the pantheon of world science.

11. THE VALUE OF EDUCATING WOMEN: SUNDRI'S LEGACY AND SOCIETAL REFLECTION

The legend of Rishabhdeva and Sundri is a powerful cultural archetype. Its significance extends far beyond a single story, reflecting deep-seated societal values and practical realities.

It establishes intellectual inclusivity, in most ancient civilizations, formal education in abstract fields like mathematics was almost exclusively a male prerogative. The Sundri legend explicitly challenges this norm. By having the foremost spiritual authority teach his daughter mathematics, Jain tradition made a foundational statement: the capacity for logical reasoning, abstraction, and intellectual rigor is not gendered. This created a powerful symbolic permission for women's education, setting Jain society on a different trajectory from many of its contemporaries.

Jain society has historically been mercantile. Women, often managing households and finances in their husbands' absence, required high numeracy for accounting, investment, loan management, and evaluating profit margins. Mathematical skill was directly tied to economic survival and prosperity. Jain rituals, fasting calendars, and religious festivals are highly complex and date specific. Women, as primary keepers of domestic religious practice, needed to calculate lunar cycles, festival dates, and periods of fasting (upvas), which required a firm grasp of the calendar and arithmetic.

The preservation of knowledge through copying manuscripts was a sacred duty. Numeracy was essential for accurately copying mathematical and astronomical texts, a task in which women of scholarly families undoubtedly participated. As the first teachers of children, mothers with a grounding in numbers and logic were crucial for passing these essential skills to the next generation, ensuring the community's continued commercial and intellectual success.

The value placed on educating women in mathematics was not merely ideological; it was a pragmatic adaptation. It ensured the economic resilience, religious integrity, and cultural continuity of the community. A numerate female population was a strategic asset, making the Jain community exceptionally adept at trade, finance, and knowledge preservation. This focus reflects a society that valued pragmatism, internal stability, and the maximization of its collective intellectual capital, regardless of gender.

12. A SOCIETY BUILT ON NUMBERS: FROM SUNDRI TO ALGORITHMS

The Jain community's deep and enduring focus on mathematics is not an academic curiosity; it is a key to understanding its very soul. This engagement reveals core aspects of Jain society across history:

The Jain universe is not chaotic; it is meticulously ordered and quantifiable. The dimensions of the loka (cosmos), the classification of life forms (jivas), the time cycles for the rise and fall of civilizations, and the journey of the soul through various stages of liberation (gunasthanas) are all described in precise numerical terms. Mathematics was the language to describe this divine, ordered reality. A society that thinks this way naturally values precision, detail, and systematic thinking in all aspects of life, from business to religious practice.

The central Jain doctrine of karma is, at its heart, a mathematical model. Karma is conceived as a subtle matter that bonds to the soul in exact quantities (pradeshas). The process of liberation involves a meticulous calculation of neutralizing this karma through asceticism. This framework makes ethics a science. Right and wrong are not vague concepts; they have quantifiable consequences. This likely fostered a culture of extreme personal accountability, meticulous record-keeping (both karmic and financial), and a goal-oriented approach to spiritual life.

The early development of advanced arithmetic, algebra, and algorithms provided Jains with an unparalleled advantage in trade, banking, and finance. Their ability to calculate interest, manage complex ledgers, assess risks, and model profit and loss with superior methods made them trusted and successful merchants. This mathematical prowess was directly responsible for the community's economic prosperity and influence throughout Indian history. It fostered values of honesty (as accurate calculation is a form of truthfulness) and trustworthiness in business dealings.

The principle of anekantavada (non-absolutism) encourages understanding an issue from multiple perspectives. Mathematics, particularly combinatorics and set theory, provides a framework for this. How many different philosophical viewpoints (nayas) can be generated from a set of principles? How can seemingly contradictory statements be reconciled within a larger logical system? Mathematics trained the mind to think in structured, multi-faceted ways, essential for the sophisticated philosophical debates for which Jain monks were famous.

This ingrained mathematical culture seamlessly transitioned into the modern era. Jain communities have produced a disproportionately high number of accountants, statisticians, engineers, computer scientists, and financiers. The comfort with abstraction, algorithms, and complex systems, honed over centuries, translates directly into proficiency in the digital age. The Siri Bhoovalaya, with its algorithmic structure, is now studied by computer scientists, creating a direct bridge between an ancient tradition and modern technology.

13. GLOBAL CONTEXT AND COMPARATIVE ANALYSIS

Table 1 Placing Jain Achievements on a Global Timeline Reveals their Truly Pioneering Nature.

Concept	Jain Development (c. 1st-9th C. CE)	Parallel Development Elsewhere
Combinatorics	Systematic rules in Bhagavati Sutra (c. 3rd BCE) & formalized by Mahāvīrācharya (850 CE).	Europe: Formalized by Pascal, Leibniz (17th C.)
Recursion/Algorithms	Recursive structures in Satkhandagama & implemented in Siri Bhoovalaya (9th C.).	Europe: Formalized in 20th-century computer science.
Large Numbers	Enumeration up to 10^60 (shirsha prahelika). Place-value system in use.	Europe: Romans struggled with large numbers; place-value adopted from India via Arabs c. 12th C.
Cryptography	Complex polyglot numerical encoding in Siri Bhoovalaya (9th C.).	Middle East: Al-Kindi's frequency analysis c. 9th C. was simpler. European complex ciphers developed later.
Women in Math	Symbolic & practical inclusion (Sundri legend, economic/ritual roles).	Europe: Formal exclusion; figures like Hypatia are extreme exceptions.

This comparison shows that Jain scholars were not just slightly ahead; they were conceptualizing and formalizing entire fields of thought that would remain dormant in other parts of the world for centuries. Their work in combinatorics and algorithm-like structures represents a parallel, independent invention of profound ideas.

14. CONCLUSION

The story of Jain mathematics, from its beginnings with Ṛṣabhadeva and Sundarī to the complex algorithms of the Siri Bhoovalaya, is more than a record of technical progress—it reveals a culture that united logic, ethics, and cosmology into a single vision of knowledge. Far from being marginal, Jain mathematics was central to intellectual life and globally ahead of its time.

Its roots in Sundarī's inclusive teaching made numeracy and reasoning a shared social foundation, shaping Jain success in trade, crafts, and education. Core texts like the Samavāyānga Sūtra, Bhagavatī Sūtra, and Satkhaṇḍāgama built a centuries-long project to quantify reality, leading to advanced works such as Mahāvīrācharya's Gaṇitasārasaṅgraha and the cryptographic Siri Bhoovalaya.

Comparisons show Jain scholars developed combinatorics, recursion, and large-number theory long before similar ideas appeared in Europe or the Islamic world, proving India's pioneering role in algorithmic thought.

The legacy of Jain mathematics is twofold: technically, it foreshadows modern information theory, and philosophically, it models a knowledge system grounded in ethics (ahiṃsā), humility (anekāntavāda), and universal vision. In today's algorithm-driven age, it reminds us that true wisdom lies not only in calculation but in using knowledge with purpose, inclusivity, and cosmic balance.

CONFLICT OF INTERESTS

None.

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None.

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