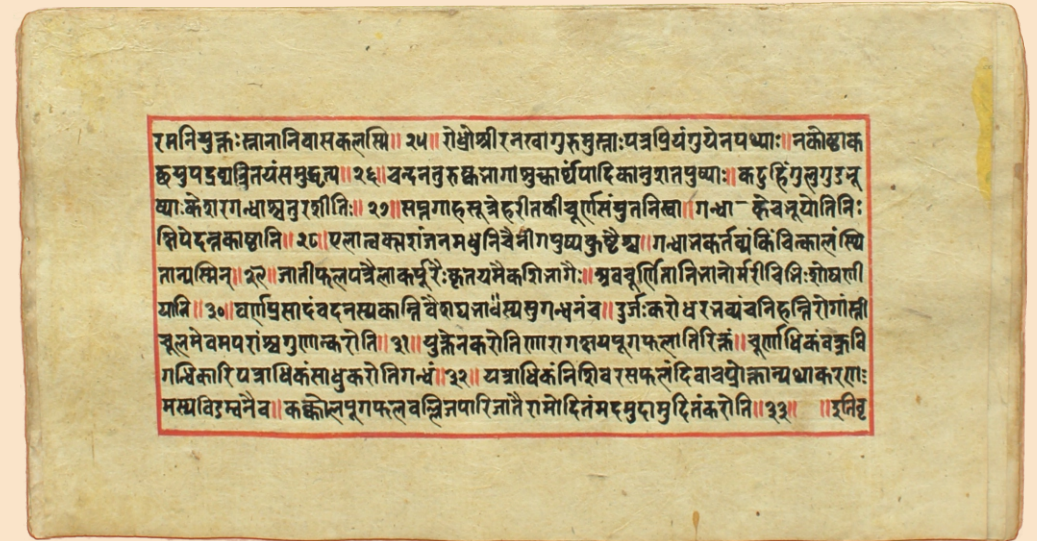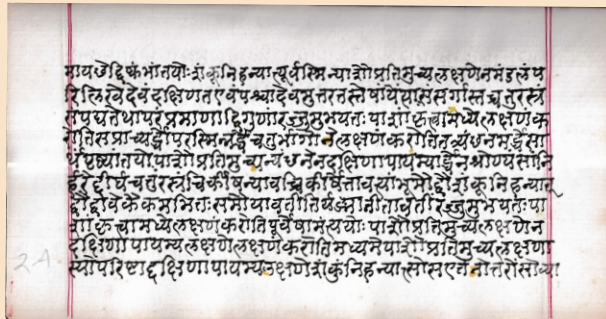**SAMHITA: South Asian Manuscript Histories and Textual Archive**
is an initiative of the India International Centre (IIC), supported by the Ministry of External Affairs, Government of India, to build a database and open-access digital library (https://www.samhita.iicdelhi.in) on manuscripts of South Asian provenance housed in collections outside India on an online platform accessible to scholars worldwide. 'Samhita' means 'collection' or 'compilation' in Sanskrit. An estimated two lakh manuscripts have travelled outside the country over the centuries, carried by scholars, pilgrims and collectors. SAMHiTA seeks to bring these together on one platform to renew collective engagement with South Asia's textual heritage.

Our goal is for libraries and universities to come together to:
• Inventory South Asian manuscripts, so copies are not lost through neglect
• Digitise select manuscripts
• Make available searchable texts in different languages
• Build a relational database to facilitate connections between texts, authors, and places
• Establish an integrated framework for critical editing, translation, research and education

INDIA INTERNATIONAL CENTRE **IIC** where ideas grow

40, Max Muller Marg, New Delhi 110003
www.iicdelhi.in

The Mathematical Sciences
South Asia's Contributions

SAMHiTA: South Asian Manuscript Histories and Textual Archive
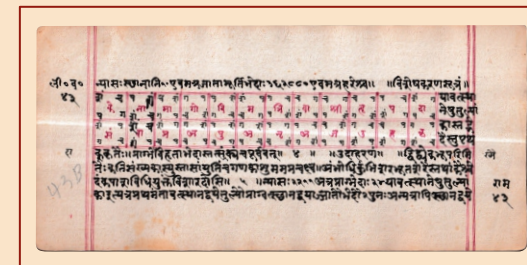
5 -14 SEPTEMBER, 2025

11 am to 7 pm

IIC Art Gallery, 2nd Floor,
Kamaladevi Complex

South Asian Manuscript, Histories and Textual Archive

INDIA INTERNATIONAL CENTRE **IIC** where ideas grow

विदेश मंत्रालय
MINISTRY OF **EXTERNAL AFFAIRS**
सत्यमेव जयते

Līlāvatī

By Bhāskara II
12th century

Sanskrit
Devanāgari script
Paper
21 x 10 cm

Bharat Itihas Sanshodhak Mandal

SAMHiTA

South Asian Manuscript Histories and Textual Archive

A project of -
India International Centre, New Delhi

Supported by -
The Ministry of External Affairs, Government of India

In collaboration with -
The Centre for Traditional Indian Knowledge Systems
and Skills (CTIKS), IIT-Bombay

Inauguration by Dr S. Jaishanker,
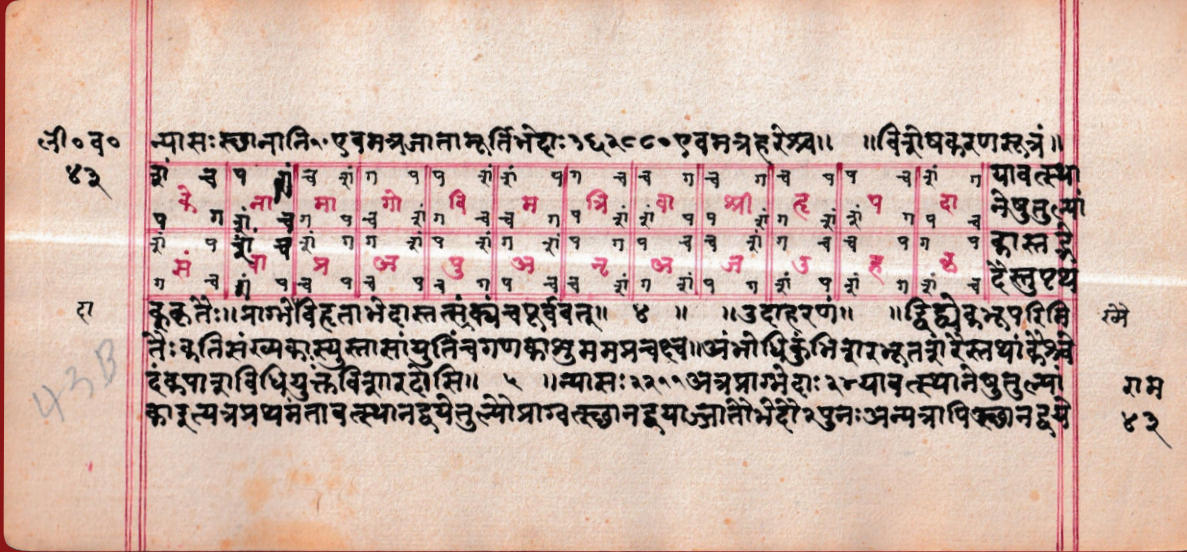Hon. Minister of External Affairs, Government of India

on Thursday,
4 September 2025 | 6.30 pm

**IIC Art Gallery, 2nd Floor,
Kamaladevi Complex**

On display from 5 to 14 September | 11am to 7 pm

Zīj-i Muḥammad Shāhi

Compiled for Maharaja Jai Singh	Farsi
	Nasta'liq
18th century	Paper

National Library and Archives Organization of the Islamic Republic of Iran

Sudha Gopalakrishnan
Project Director, SAMHiTA

"In all the worldly and spiritual domains, and for all activities everywhere else bounded by time and space, the function of numbers is indispensable. They may well be any discipline- Love, Economics, Music, Drama, Medicine, Cookery, Architecture, Metrics, Aesthetics, Poetry, Logic or Grammar. Mathematics is ever present in all of them."

Gaṇitasārasaṃgraha
(Compendium of the Essence of Mathematics)

One can imagine a Jaina scholar named Mahāvīra from the Deccan, getting inspired by his own insight on the omnipresence of numbers and mathematical precepts across disciplines, inserting these verses quoted above as an introduction to his path-breaking work. The author probably lived during the ninth century, a time of lively exchange between philosophical schools, and of artistic, literary and scientific innovation. It was a tradition in South Asia from early days that core texts were amplified and extended by successive scholars through new perspectives, knowledge and commentarial interpretations.

This exhibition of texts and manuscripts of select works shows how breakthroughs in Indic mathematics advanced transcontinental trade and the exchange of ideas. It gives a glimpse of the distinct regional traditions that emerged across the country. And it shows how there was always interaction between domains: chhanda-s (metrics) followed a mathematical grid, patterns in the visual arts were derived numerically, and combinatorics was applied to perfumery and musical theory.

We hope that this exhibition will arouse interest in the range of ideas and areas of experience explored in our texts, and enhance understanding of the mathematical imagination in India.

Message from the President, IIC

The IIC is privileged to host this exhibition on India's remarkable contribution to mathematics and allied disciplines, with the support of the Ministry of External Affairs, Government of India, and in partnership with the Centre for Traditional Indian Knowledge Systems and Skills, IIT-Bombay.

The history of Indian mathematics is a fascinating story of concepts and techniques travelling from the subcontinent to China, Cambodia, Central Asia and the Abbasid Empire from the middle of the first millennium CE. Indian knowledge systems, in turn, drew inspiration from influences from both East and West. This reflects India's cross-roads culture, inherent in its being at the intersection of both caravan routes connecting it to Central Asia, and maritime routes linking it, thanks to the monsoons, to the Indian Ocean littoral, both East and West. In the early first millennium, the mathematical turn in astronomy was stimulated by engagement with Hellenistic models prevailing in Gandhara, while Sanskrit works of the early modern period apply methods of observational astronomy developed in Central Asia.

Our aim has been to trace historical developments, the influence of concepts like the decimal system and zero on global science, and the give-and-take between mathematics, astronomy, navigation, and the performing arts. Manuscripts bear witness to these contacts: on display are astronomical tables where both Devanagari and Farsi scripts are used.

We hope this exhibition encourages further exploration of how these traditional methods can be applied to enlarge both our sense of global intellectual history, and mathematics research and teaching today.

Shyam Saran
President, IIC

Message from the Director, IIC

The survey and interpretation of manuscripts in Sanskrit and other languages are starting to reveal the full scale and significance of India's contributions to mathematics, astronomy and the applied sciences. This is a significant step towards getting our past into perspective. It also has implications for our future, for there is much to learn from the algorithmic techniques devised by Indians, the economy of computation methods, and the mnemonic devices used in teaching.

This exhibition features landmark works by Āryabhaṭa and Bhāskara II. It also brings into view the calculation methods adopted by record-keepers and accountants, and others who ran the administration at different levels. We see how traders and artisans internalised mathematical theories in their practice. Our endeavour is to bring out the many dimensions of mathematical practice in India, and the cognitive dexterity they called for.

K.N. Shrivastava
Director, IIC

Introduction

We can trace the development of Indic mathematics from works composed from the second millennium BCE.
The displays unfold this story over seven sections:

१. Inceptions

traces the emergence of a conception of numbers and geometric thinking, and of the idea of zero

२. Breakthroughs

explains the investigations in trigonometry and calculus inspired by *jyotiṣa* from the 5th century CE

३. Form and Pattern

looks at how mathematical ideas and techniques are refracted in sculpture, architecture and music

४. Diffusions

describes the journeys of Indic concepts and texts to East and West Asia, and how their influence resonated through the centuries

५. Crystallisation of Regional Traditions

looks at some regional works on mathematics, particularly texts on astronomy from Kerala

६. Renewals

shows how Sanskrit works were rendered in Arabic and Persian, as well as the engagement with other traditions by Sanskrit scholars

७. Applications

discusses practices of accounting, measurement and record-keeping as imparted through manuals and teaching systems

Manuscripts illuminate the complex, variegated history of how numbers were conceived and manipulated, geometry was theorised and applied, the decimal system devised, and theories developed over the centuries. Commentaries, diagrams, tables, and the rendering of numbers in figures and words show us how ideas evolved and were elaborated by successive generations, how abstract notions were visualised, and how computation was carried out. The journeys of manuscripts map transformative cultural encounters; marginal notes by scribes exhibit computational thinking in practice.
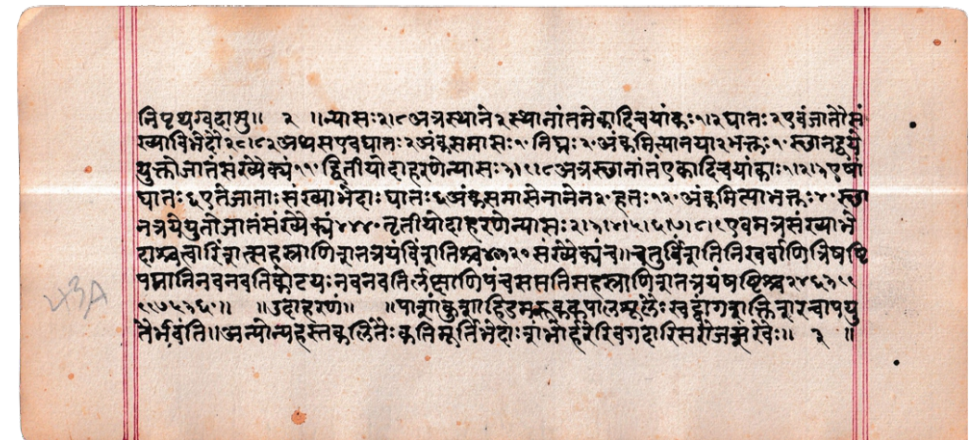
Līlāvatī

By Bhāskara II
12th century
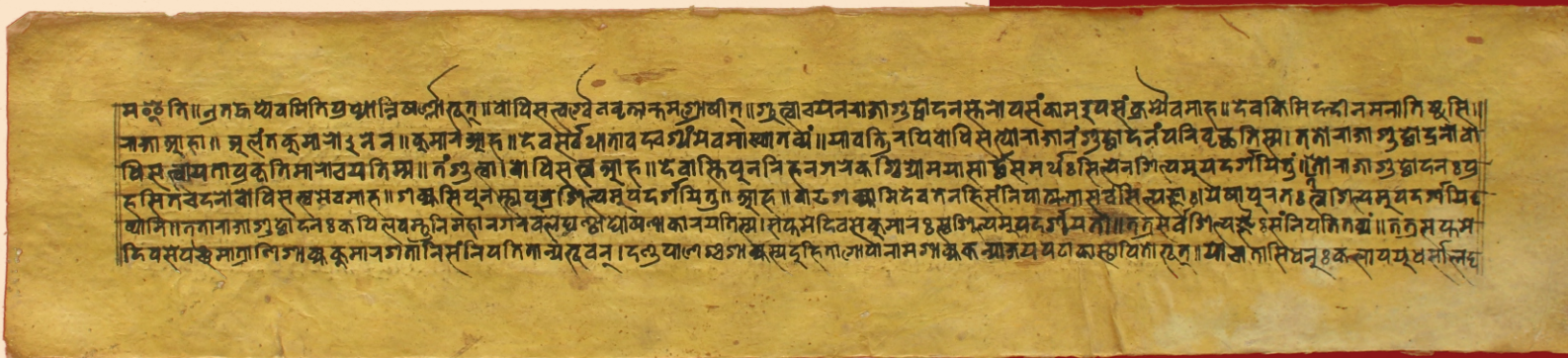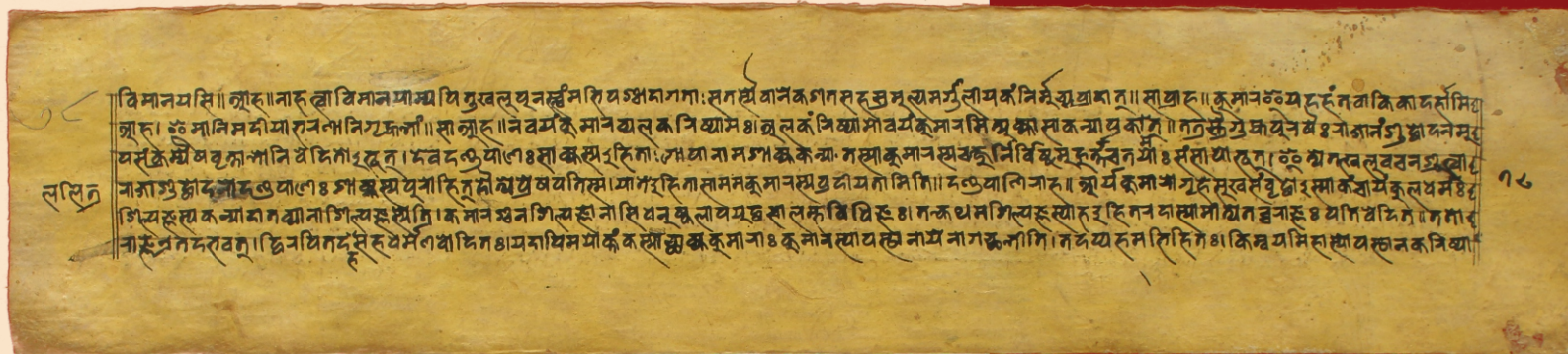
Sanskrit
Devanāgari script
Paper
21 x 10 cm

Bharat Itihas Sanshodhak Mandal

१ INCEPTIONS

Vedic and post-Vedic texts record some of the earliest engagements with mathematics in South Asia. The decimal system, with the base of 10, was in use by the time of the *Ṛgveda*.

We see a fascination with large numbers in the invocations. We also find reference to very small numbers. It is worth speculating on how these came to be imagined, since it is difficult to visualise their being used in everyday life.

Lalitavistara Sūtra

The Bodhisattva refers to quadrillions and infinitesmals in this text of the early centuries CE.

Nepal

17th century

Sanskrit
Pracalit Nepal script
Paper
38 x 8 cm

British Library
(Endangered Archives Programme)

Digitised by Tribhuvan University
Courtesy Shanker Thapa

Mṛtasañjīvinī

By Halāyudha
13th century

Sanskrit
Devanāgari script
Paper

Oriental Institute Baroda

Major Vedic ceremonies and sacrifices were performed before fire altars, the construction of which led to investigations in geometry. The results are reflected in the genre of texts known as *Śulbasūtras*, which show how to construct different shapes using a cord *(śulba)* to mark off lengths, and how to transform one shape into another. In one of these texts, dated to the eighth century BCE, we see a formulation of the theorem that was later ascribed to Pythagoras.

Vedic texts were composed and passed on orally. The strong emphasis on memorisation continued even with the emergence and spread of writing. Versified knowledge was recited according to a rigorous system of cadences that minimised chances of error. This may explain the early investment in prosody, or works on verse metre and composition.

Piṅgala's *Chandaḥ Sūtra*, composed around the 3rd century BCE, uses matrices to tabulate different metres, and devises a binary style notation to represent combinations of long and short syllables. It contains perhaps the earliest reference to *śūnya* or zero, which radically simplified the representation of figures and is in global use today.

ॽ BREAKTHROUGHS

From the middle of the first millennium CE, Indic mathematics made advances which proved pivotal for the development of the discipline, not just on the subcontinent but all over the world. Successive generations of scholars built on, argued with, and refined one another's work, to accelerate insights in trigonometry and the solution of algebraic equations. Treatises were composed in Pataliputra, Malwa, Ujjain, the Deccan and Maharashtra.

These treatises on astronomy were known as *siddhānta-s*. Scholars have ascribed their production to the need for accurate calendars in an economy dependent on agriculture, and to the criticality of astronomy for long-distance navigation. The mathematical turn in astronomy received a stimulus from engagement with Hellenistic views of the universe, through contact with the Indo-Greek kingdoms in Gandhara.

Gaṇitasārasaṃgraha

The first independent treatise on gaṇita

By Mahāvīra
9th century

Sanskrit
Devanāgari script

*Shri Mahavir Jain
Aradhana Kendra, Koba*
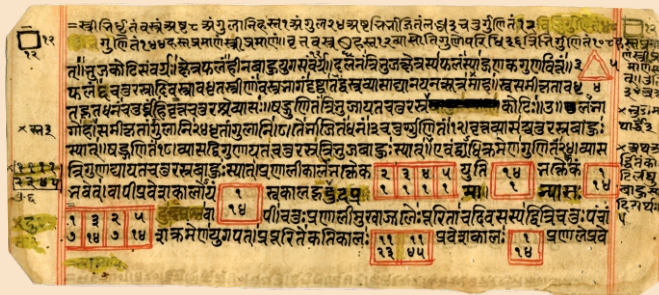
Āryabhaṭa (476–550), used mathematics to analyse the trajectories of the visible planets, moon and sun, conjunctions and eclipses. His work on planar trigonometry and the *kuṭṭaka* method to solve first-order indeterminate equations, was defining for future developments. The *bhāṣya (commentary)* by **Bhāskara I** (late sixth to early seventh century) elucidated Āryabhaṭa's ideas.

Bakshālī Manuscript

Peshawar, Pakistan
8th–12th century

Sanskrit
Śāradā
Birch bark
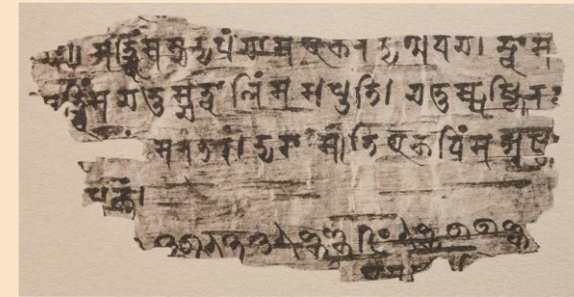
*Photograph Courtesy
Bill Casselman and University of Washington*

Līlāvatī

By Bhāskara II
12th century

Sanskrit
Devanāgari script
21 x 10 cm
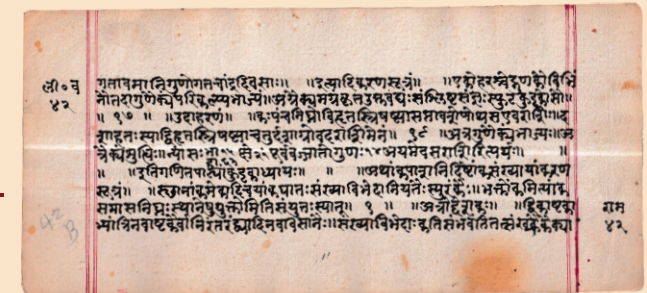
Bharat Itihas Sanshodhak Mandal

In the seventh century, **Brahmagupta** formulated rules for the arithmetic of zero and negative numbers, and also examined quadratic equations. **Mahāvīra** (ninth century) presented practical problems on commercial transactions, weights and measures.

The Bakshālī manuscript, discovered in Peshawar, is the earliest surviving manuscript to use a dot to symbolise zero. It employs a full-fledged decimal notation system for calculations related to buying, selling, and estimating losses, and includes a useful technique to approximate square and cube roots.

Bhāskara II (born 1114) designed his works to be useful to students, and the wide circulation of *Līlāvatī* attests to his success. There are 500 manuscripts, apart from translations into many regional languages and over 30 medieval commentaries. His comprehensive works discuss permutations, give accurate formulae for the surface area and volume of a sphere, and general solutions to quadratic equations involving integers.

FORM AND PATTERN

In the first millennium, trade expanded in scale, and the arts in ambition and innovation. Mathematicians posed a number of their questions in terms of the problems or challenges confronting artisans and merchants, and their solutions gave direction in both theory and practice. We see this in discussions of permutations and combinations from the sixth century CE.

Varāhamihira (fl. c. 550) worked out how to generate different combinations of ingredients to produce perfumes. Combinations of flavours are addressed by **Śrīpati** (fl. eighth century) and **Mahāvīra**. In the 13th century, Śārṅgadeva's *Saṃgītaratnākara* discusses the generation of musical phrases through the combination of notes and rhythmic patterns of different durations.

In the Ellora sculptures (eighth century) and Chola Nataraja (tenth century), the interplay of verticals and horizontals, and of circles and lines, corresponds to the body's movement in time, as scholar practitioners have demonstrated. The evolution of temple architecture has been analysed in terms of the derivation of composite structures from a few basic types, resulting in complex geometries. From the measurements prescribed in the *Samarāṅgaṇasūtradhāra* (11th century), we may see how design and geometry are conceived as a whole, and the ways in which practice followed text.

Samarāṅgaṇasūtradhāra

By Paramāra King Bhoja | 11th century
Oriental Institute Baroda

Sanskrit | Devanāgari script | Paper
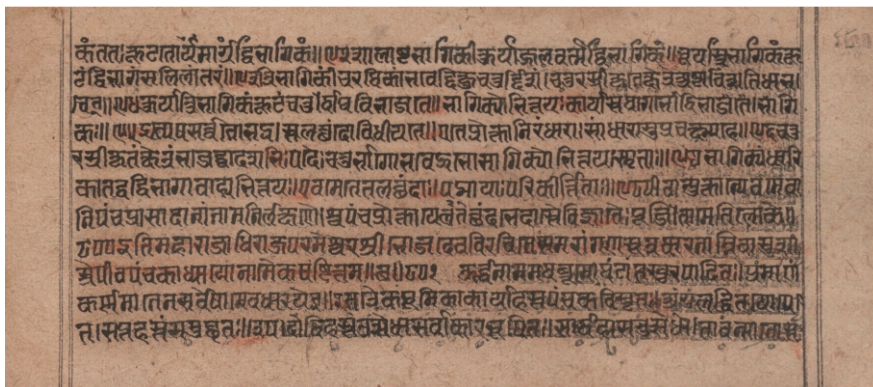
DIFFUSIONS

In this section, we look at texts that travelled, references to Indic mathematics in other literatures, and works that reflect its long-term influence.

India's achievements in mathematics attracted people from elsewhere to its centres of learning, and led to its scholars being invited to courts abroad, and treatises being requested as ambassadorial gifts. The influence of Indic mathematics was institutionalised in calendars, is traceable in royal inscriptions, and radiated through the advances in observational astronomy in subsequent centuries.

In the sixth century, a family with origins in Varanasi was engaged in the astronomical bureau of the Tang court in China, to reconcile Indian and Chinese astronomical models. The symbol for zero was introduced to China at this time; it is also seen in a seventh-century inscription in Cambodia. Following the establishment of Baghdad in the eighth century, the Abbāsid Caliph, al-Manṣūr, commissioned an astrologer to produce a work in Arabic based on the Indian *Siddhānta* texts. **Abū Ma'shar Ja'far Balkhī** (787–866), **Al-Khwārizmī** (c. 780–850) and other scholars translated Sanskrit works on astronomy and gaṇita.

Kitāb al-Tafhīm li-Awā'īl Ṣinā'at al-Tanjīm

('Book of Instruction in the Elements of the Science of Stars')

By Abū al-Rayḥān Al-Bīrūnī (973 – 1048)

Farsi

Nasta'līq

Paper

Abu Raihan Al Biruni Library, Tashkent

੫ CRYSTALLISATION OF REGIONAL TRADITIONS

Sanskrit works on *gaṇita* were translated into regional languages, and accounting manuals and calendars were produced in Bangla, Ahomiya and Meiteii, among others. Of mathematical interest, though not exclusively devoted to mathematics, is the ninth-century *Siribhūvalaya*, written in a system of numbers encrypted from a base text in Kannada.

Kerala produced a brilliant line of scholars starting with **Mādhava** (1340–1425) and continuing till the 17th century. Mādhava gave the first-ever infinite power series expansion of trigonometric functions, preceding by several centuries the work of Newton and Leibniz. **Nīlakaṇṭha Somayāji** (1444–1544) introduced a major revision of the Indian planetary model, offered a systematic exposition of aspects of mathematical astronomy, and addressed the importance of empirical validation of tradition. **Jyeṣṭhadeva** (1500–1575) wrote the *Yuktibhāṣā* in Malayalam, termed the first textbook of calculus. It continues the tradition of rigorous proof set by Nīlakaṇṭha, and contains an algorithm to obtain accurate approximations of pi.

In the 16th century, Nandigrama on the Gujarat coast was home to a distinguished lineage of *jyotiṣa* scholars, who relocated to Varanasi in 17th century.

Tantrasaṃgraha
By Nīlakaṇṭha Somayāji (1444–1544) | 1500

Manuscript dated to the 19ᵗʰ century
Sanskrit | Malayalam script | Palm leaf
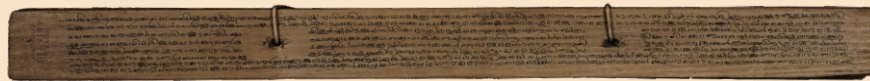
Royal Asiatic Society of Great Britain and Ireland

Yuktibhāṣā
By Jyeṣṭhadeva (1500–1575) | c. 1525

Malayalam | Palm leaf

Royal Asiatic Society of Great Britain and Ireland

੬ RENEWALS

Translations of mathematical works produced within and outside South Asia from the ancient to the early modern period speak of the scientific interests of the patrons who commissioned them as well as the capacity of mathematicians to engage with new models and methods.

We also observe processes of selection and adaptation that occurred when making sense of an unfamiliar cosmology. Abd al-Azīz Śams-i Tahānisarī, who rendered *Bṛhatsaṃhita* into Farsi in the 14th century, replaced terms referring to the flat-earth cosmology of the Sanskrit tradition with those reflecting the Islamicate spherical model of the universe.

Mahendra Sūri, a Jaina astronomer at Fīrūz Shāh Tughlaq's court, wrote a Sanskrit manual on the astrolabe titled *Yantrarāja*, reflecting his fascination with the instrument, which had reached the subcontinent in the 11th century. Invented probably in Greece in the second century BCE, the astrolabe was improved and popularised in West Asia in the eighth century CE, and was used to tell the time and to aid trigonometric calculations. Indian astronomers trained in Perso-Arabic sciences came to produce astrolabes, and several with Sanskrit notation were designed.

Tarjuma-yi Barāhī
By al-Azīz Śams-i Tahānisarī
14ᵗʰ century

Farsi
Nasta'līq
Paper

*Abu Rayhan Beruni Library
Tashkent*

Siddhāntasindhu

Sanskrit
Devanāgari
Paper

Courtesy
City Palace Jaipur

Tuhfat-ul-Abrār

By Ghulam Hussain Jaunpuri
19th century

Farsi
Nasta'līq script
Paper

Tarjuma-yi Līlāwatī

By Abu'l Faiz Faizi
16th century

Farsi
Nasta'liq
Paper
18.5 x 12 cm

Manuscript dated
to 1675

Columbia University through Upenn

A popular work authored by a member of Akbar's court was the *Tājikanīlakaṇṭhī*, which rendered Perso-Arabic astrological traditions in Sanskrit. At the court of Shāh Jahān Nityānanda worked with Farīd al-Dīn Dihlavī to translate his book of astronomical tables into Sanskrit.

In the 18th century, Maharaja Sawai Jai Singh and the scholars he brought together engaged with the advances in observational astronomy made in Central Asia. Engagements with the Euclidean tradition are found in the writings of Kamalakara Bhatta in the 17th century and Ghulam Hussain Jaunpuri in the 19th.

APPLICATIONS

Mathematics was extensively employed in domains such as accounting, conversion of weights and measures and navigation.

Arabic
Nasta'liq script
Paper

Manuscript dated to 1552 CE
Scribe is Darwish Muhammad

Al-Risālah al-Śamsīya fi al-Ḥisāb

By Nizām al-Dīn al-Nīsābūrī al-A'raj | 13 - 14 centuries

The *Gaṇitasārakaumudī*, an Apabhraṃśa work by Ṭhakkura Pherū, a Jaina trader associated with the Delhi Sultanate, deals largely with conversions of weights, measures and proportions.

Different groups, from accountants to artisans, made use of different areas of mathematics. Accounting manuals were produced across India, from the Farsi Dasturul Amal to Tamil accounting texts. As the scribe-accountant became central to administration, a genre dealing with practical mathematics became popular in south India. Works like the *Kaṇakkatikāram* discuss the computations involved in measuring land, gold and grain. Students who would train as accountants would first develop a general literacy and numeracy through local tiṇṇai schools set up in the veranda of the teacher's home.
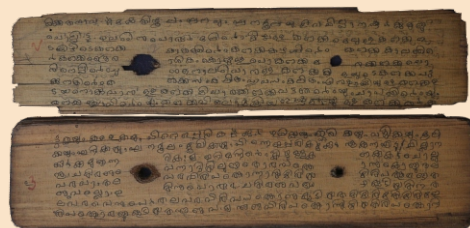
Kaṇakkatikāram

19-20th century

Malayalam
Palm leaf

Courtesy Head
Oriental Research Institute and
Manuscripts Library, Thiruvananthapuram