Éléments de mathématiques en sanskrit I
Formation Doctorale

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Sanskrit is associated in the popular imagination with

- prayer and ritual (*mantrā*)
- literature (*Kālidāsa, Abhijñānaśākuntalaṃ*)
- philosophy (*Veda*)

rather than science (Medicine, Astronomy, Mathematics....)

Difficulties

- Eurocentric ‘modern’ science Only since late 18th century in the West
- Texts/manuscripts are inaccesible, not translated
- Historical context not always understood

The mathematics are mainly from

- the whole of the Indian subcontinent, including Pakistan(Takshila), Nepal
- Hindu, Buddhist, Jain ..cultures (*Pāli, Prakṛt*)
- Also regional languages (Malayalam, *Yukti-bhāṣhā*)

Map


ISTAN
TAJIKISTAN
AFGHANISTAN
C H I
PAKISTAN
NEPAL
BHUTAN
BANGLA-
DESH
INDIA
BURMA
SRI
LANKA
MALDIVES

Characteristics of mathematical literature

- Composition in verse form
- Use of synonymous words
- Metaphorical expression (unexpected processes for the exposition of technical matter)
- Memorization (orality) and Written form

> *Whatever may be his special field, every pandit possesses a common stock of knowledge in grammar (vyākaraṇa), exegesis (mīmaāṃsā) and logic (nyāya). Thanks to that, he is endowed with a sharp linguistic awareness, equipped with a rich store of potential resources of expression, and has at his disposal a number of heuristic tools.*

Pierre-Sylvain Filliozat, "Ancient Sanskrit Mathematics: An Oral Tradition and a Written Literature"

Transliteration

I. Simple Vowels

$$a\ \bar{a}\ i\ \bar{\imath}\ u\ \bar{u}\ \underset{\cdot}{r}\ \underset{\cdot}{\bar{r}}\ \underset{\cdot}{l}\ \underset{\cdot}{\bar{l}}$$

II Dipthongs

$$e\ ai\ o\ au$$

Transliteration

I. Simple Vowels

a ā i ī u ū ṛ ṝ ḷ ḹ

II Dipthongs

e ai o au

III Modifications

ṃ ḥ

IV Consonants

1. Velar
   k kh g gh ṅ
2. Palatal
   c ch j jh ñ
3. Retroflex
   ṭ ṭh ḍ ḍh ṇ
4. Dental
   t th d dh n
5. Labial
   p ph b bh m

Semivowels

y r l v

Sibilants

ś s ṣ

Aspirate

h

Development in Ancient and Early Classical Period (till 500 CE)

1. geometric methods of construction
2. combinatorial methods
3. Development of decimal place-value system

Development in Later Classical Period (500 -1250)

1. *Varāhamihira*
2. Mathematics of *Brahmagupta* (c 628)
3. From *Brahmagupta* to *Bhāskara* (c 1150)

Development in Medieval Period (1250 - 1850)

1. *Nārāyaṇa Paṇḍita* (c.1356) and construction of magic squares
2. Kerala School and development of calculus (1350-1825)
3. *Mādhava* Series for Pi and end-correction terms

Sūtra

A *sūtra* is a rule . Its form is concise, unambiguous, terse, understandable with nothing irrelevant and faultless.

अल्पाक्षरमसन्दिग्धं सारवद् विश्वतोमुखम् ।
अस्तोभमनवद्यञ्च सूत्रविदो विदुः ।।

Viṣṇudharmottarapurāṇa (3.5.1)

alpākṣaramasandigdham sāravad viśvatomukham |
astovamanavadyañca sūtravido viduḥ ||

śulba-sūtras

"The rules of the cord",
Category *smṛti* ("remembered text") as opposed to *śruti* ("heard", i.e., from divine sources). earliest by *Baudhāyana* roughly 800 BCE (3 chapters and 520 *sūtras*).
Rules for laying out with cords the sacrificial fire altars of the Vedas. plane geometry, comparable to the first two books of Euclid (around 300 BCE) earliest explicit statement of 'Pythagorean' theorem (around 600 BCE) *bhujā-koṭi-karṇa-nyāya* in the later literature A formula for the square root of two (understood to be approximate *saviśeṣaḥ*)
$\sqrt{2} = 1 + \frac{1}{3} + \frac{1}{3.4} - \frac{1}{3.4.34}$ (*BSS*2.12)

Right-angled Triangle

दीर्घचतुरश्रस्य अक्ष्णयार ज्जु पार्श्वमानी तिर्यङ्मानी च
यत् पृथग्भूते कुरुत : तदुभयं करोति ।।

BSS(1.12)

dīrghacaturśraṃ akṣṇayārjju pārśvamānī tiryanmānī ca
yat pṛthagbhūte kurutah : tadubhayaṃ karoti||

The rope corresponding to the the diagonal of a rectangle makes whatever is made by the lateral and the vertical sides individually.

Example

Bodhāyana

$3^2 + 4^2 = 5^2$
$5^2 + 12^2 = 13^2$
$15^2 + 8^2 = 17^2$
$7^2 + 24^2 = 25^2$
$12^2 + 35^2 = 37^2$
$15^2 + 36^2 = 39^2$

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$15^2 + 36^2 = 39^2$ and so on.

Remark

The result was known to the Babylonians circa 1800 BCE, stated only as examples.