# THE UNTAPPED WEALTH OF MANUSCRIPTS IN INDIAN ASTRONOMY AND MATHEMATICS

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# Estimate of Klaus Janert (1965)

- We have reason to suppose that more than one million of Indian manuscripts are deposited in libraries, public or private and that more than 600,000 different manuscripts have been listed in some manner in printed catalogues since the origin of Indian studies a century and a half ago. ...

  The present ... Annotated Bibliography of Catalogues of Indian Manuscripts contains 339 titles of publications comprising approximately 700 separate volumes, parts or fascicles with a total of nearly 185,000 pages and about 550,000 catalogue entries of Indian manuscripts 500,000 of which were catalogues or listed in India.

  K. L. Janert, *An Annotated Bibliography of the Catalogues of Indian Manuscripts Part I*, Franz Steiner Verlag, Wiesbaden 1961, p. 9.

# Estimate of Biswas and Prajapati (1998)

- There are some 3.5 million manuscripts in various collections in India. In addition about 60,000 Indian manuscripts are preserved in 20 different countries of Europe and North America. Several other countries in Asia also have nearly 150,000 manuscripts in Indian scripts and languages. ...

  Only about one million manuscripts have been recorded in published catalogues or hand lists brought out by libraries and institutions. It was also found that several private and institutional collections remained unattended for years, without even being recorded or listed in any form. These one million manuscripts have been listed in about 2,000 volumes of catalogues published till about 1990; out of these nearly 300 were published by overseas institutions.

  S. C. Biswas and M. K. Prajapati, *Bibliographic Survey of Indian Manuscript Catalogues*, Eastern Book Linkers, Delhi 1998, p. xiv.

# Language-wise Distribution of Catalogued Manuscripts

| Language | No. of Manuscripts | Percentage |
|---|---|---|
| Sanskrit, Prakrit, Apabhramsa | 8,29,653 | 78.39 |
| Hindi (Bhasha, Maithili, Bhojpuri, Rajasthani, etc.) | 87,412 | 8.26 |
| Tamil | 39,666 | 3.75 |
| Gujarati | 16,121 | 1.52 |
| Persian | 14,722 | 1.39 |
| Kannada | 13,818 | 1.31 |
| Malayalam | 11,815 | 1.12 |
| Urdu | 10,029 | 0.95 |
| Telugu | 9,216 | 0.87 |
| Marathi | 6,552 | 0.62 |
| Bengali | 4,915 | 0.46 |
| Panjabi | 4,107 | 0.39 |
| Arabic | 2,949 | 0.28 |
| Pali | 2,050 | 0.19 |
| Oriya | 1,826 | 0.17 |
| Tibetan | 1,364 | 0.13 |
| Sinhalese | 1,317 | 0.12 |
| Others | 892 | 0.08 |
| **Total** | **10,58,424** | |

Source: Subhash C. Biswas and M. K. Prajapati, *Bibliographic Survey of Indian Manuscript Catalogues*, Eastern Book Linkers, Delhi 1998, p. xx.

# Estimate of Dominik Wujastyk (2011)

"How many Indian manuscripts are there? The National Mission for Manuscripts in New Delhi works with a conservative figure of seven million manuscripts, and its database is approaching two million records (http://www.namami.org/manuscriptdatabase.htm, consulted 18 August 2011). The late Prof. David Pingree, basing his count on a lifetime of academic engagement with Indian manuscripts, estimated that there were thirty million manuscripts, if one counted both those in public and government libraries, and those in private collections (David Pingree, personal communication in the 1990s). For anyone coming to Indian studies from another field, these gargantuan figures are scarcely credible. But after some acquaintance with the subject, and visits to manuscript libraries in India, it becomes clear that these very large figures are wholly justified. The Jaina manuscript library at Koba in Gujarat, which only started publishing its catalogues in 2003, has an estimated 250,000 manuscripts. The Sarasvati Bhavan Library in Benares has in excess of 100,000 manuscripts. There are 85,000 in various repositories in Delhi. There are aboutr 50,000 manuscripts in the Saraswati Mahal Library in Thanjavur in far south."

https://www.academia.edu/1020918/Indian_Manuscripts, p.2 (accessed on March 15, 2019)

# Current Estimate of NMM

"The National Mission for Manuscripts was established in February 2003, by the Ministry of Tourism and Culture, Government of India. A unique project in its programme and mandate, the Mission seeks to unearth and preserve the vast manuscript wealth of India. India possesses an estimate of ten million manuscripts, probably the largest collection in the world. "

https://www.namami.gov.in/national-mission-manuscripts (accessed on 15 March 2019).

The Mission also gives the following summary of its performance so far, which mentions that over 4.2 million manuscripts have been documented:

- 42.03 lakhs Manuscripts have been documented.
- Set up a web-based National Database of Manuscripts with information on 2.7 million manuscripts.
- 1st, 2nd and 3rd Phase of the Digitization of manuscripts project is completed and 4th phase is in process. Total 2.96 lakhs manuscripts (2.61 Crore Pages) have been digitized.
- Initiated a Publication Programme. 30 unpublished Manuscripts have been published.

https://www.namami.gov.in/performance-summary (accessed on 15 March 2019).

# Estimates of the Manuscript Wealth of India

- Given the results of the surveys done by the NMM so far, it does seem that 10 million is indeed a reasonable estimate for the number of Indian manuscripts that are extant.
- Of these, perhaps only about 2 to 3 lakhs are in repositories outside India.
- Again, the number of manuscripts in Sanskrit can be expected to be of the order of 8 million.

# Distribution of Manuscripts over Different Disciplines

- To make any assessment of the extent of manuscripts in different disciplines, what is required is to systematically compile the information provided in various catalogues into some sort of a 'union catalogue' which lists all the works along with various details such as the author, discipline, etc., provided in the individual catalogues.
- The first such compilation was made by Theodor Aufrecht in his *Catalogus Catalogorum*, which was published in three volumes during 1891-1903. Aufrecht's work was based on 94 catalogues and his first volume listed about 60,000 works and authors alphabetically, with appropriate catalogue references.
- During 1966-2015, Madras University has published 39 volumes of the *New Catalogus Catalogorum* variously edited by V. Raghavan, K. Kunjunni Raja, N. Veezhinathan and Siniruddha Dash.
- The Volumes I-XXXXIX cover all the texts and authors with their names beginning from 'a' to 'su''. The series is expected to be completed soon with the publication of a couple of volumes.

# *Catalogus Catalogorum*

**आर्य** father of Cauṇḍappācārya, Ādityadeva and Mañcayāyya. Oxf. 371b.

**आर्यतुल्य** jy. by Duḥkhabhañjana. Oudh VIII, 14.

**आर्यदेव** poet. Sbhv.

**आर्यपक्षग्रहदीप** jy. B. 4, 116.

**आर्यभट** composed in 499:

Āryāshṭaçata or Siddhānta (jy). W. p. 232. Oxf. 325b. Cambr. 38. L. 143. B. 4, 116. Pheh 9. NW. 522. Oppert 1208. 4518. 7851. II, 3107. 4486. 6643. 9890. Rice 28 (and ↄ:). W. 1730. Quoted by Brahmagupta. W. 1733.

ↄ: Mack. 721. Oppert 4519.

ↄ: by Parameçvara. Oppert II, 3484. 9891.

Daçagītisūtra. W. p. 232. Oxf. 325b. W. 1730.

Siddhāntamuktāvalī. Oppert II, 6502.

To an Āryabhaṭa one stanza is attributed in Kavikaṇṭhābharaṇa 2, 1, another in Sbhv.

**आर्यभट** modern:

Mahāsiddhānta jy. Cambr. 39. L. 1568. W. 1731.

**आर्यभटतुल्यकरणग्रन्थ** jy. by Dāmodara. Bhr. 346.

# *New Catalogus Catalogorum*

**आर्यभटीय** or Āryabhaṭatantra or Āryasiddhānta or Vṛddhāryasiddhānta or Laghvāryasiddhānta. by Āryabhaṭa I. Comprises the Daśagītikāsūtra and Āryāṣṭaśata in 3 pādas. According to some mss. and C.s, the two parts are considered as two separate works and the name Āryabhaṭīya is applied to the first or the second or to the whole. Edns. Kern, Leiden, 1874 (with C.); *TSS.* 101, 110 and 185, the three pādas of Āryāṣṭaśata with C.; Eng. Transl., P. C. Sen Gupta, *Dept. of Letters, Cal. Uni.*, XVI, 1927; W. E. Clark, Chicago Uni. Press. 1930; French Transl., Gaṇitapāda, L. Rodet, *JA.* Ser. 7, Vol. XIII. 1879, pp. 393-434.

Adyar II. p. 48a (2 mss.). Ādhyan Nambūdripād 30. AK. 848. Alph. List. Beng. Govt. p. 108 (no. 770) (same ms. as RASB. 6827). America 4668. 4669 (Āryāṣṭaśata). 4670 (Daśagītisūtra). Ānandāśrama 6668. B. IV. 16. BC. 77 (and C.). 107. 233. 265. 516. Bd. 859 (Gola). Bikaner 4445. 4446-7 (Daśagītisutra). Bomb. Uni. 329 (with C.). 330-4. 335 (with C.). BORI. 5 of 1869–70. 859 of 1887-91 (Sid. and Gola). 848 of 1891-95 (Gola). Cambr. 37. 39. GD. 870-1. Gov. Or. Libr. Madras 10 (2 mss.). Granthappura p. 37. IO. 2767. 6263-73. L. 1566. Luck. Uni. p. 33. Mad. Uni. R. K. S. 52(a). MD. 13385-88 (order of pādas different in the last). MT. 3870(c). 4875. 5261 (last two chs.). Mysore I. p. 329 (2 mss. 1 with C.). Oppert I. 1208. 4518. 7851. II. 3107. 4486. 6643. 9890. Oxf. 325b. Pheh. 9. RASB. X.A. 6827. Rice 28 (and C.). Sucindram 156. 157. Tāmarakkāṭṭu Mana 59c (Āryāṣṭaśata). TCD. 633A. 634A. 635A. 636A. 637A. E. 638. 643A. 645C. 650. 729D. Tra. Ad. Rep. 1109, 11. Trav. Uni. 475A. 501A. 1092A. 5131B. 5848. 5957B. 10617. 13259A.B. 13300A. 13305 A.B. T. 24. L. 1334A. C. 2333. C. 2160D.

# Subject-heads used in the *New Catalogus Catalogorum*

***Subjects***

adv.—advaita.
alaṁk.—alaṁkāra.
anu. adv.—anubhavādvaita.
Āpāst.—Āpastamba.
Āśval.—Āśvalāyana.
Av., Ath. v.—Atharvaveda.
Bhārad.—Bhāradvāja.
Bodh., Baudh.—Bodhāyana, Baudhāyana.
Br.-Brāhmaṇas
Bud.—Buddhistic.
dh.—dharmaśāstra.
Dig.—Digambara.
Drāhyā.—Drāhyāyaṇīya.
dvai.—dvaita.
gr.—grammar.
gṛh.—gṛhya.
Hiraṇ., Hiraṇyak.—Hiraṇyakeśiya.
jy.—jyotiṣa.
Kaś. Sai.—Kaśmir Śaivism.
Kāty.—Kātyāyana.
Kṛ. Yv., Kṛṣṇ. Yv.-Kṛṣṇa Yajurveda.
lex.—lexicon.
mā.—māhātmya.
Mādh.—Mādhyandina.
med.—medicine.
mīm.—Mīmāṁsā (pūrva).
ny.—nyāya.
paur.—paurāṇika.
pr.—prayoga.
rel.—religion.
Ṛv.—Ṛgveda.
śai.-śaivism.
Śāṅkh.—Śāṅkhāyana.
śr.—Śrauta.
śrivaiṣ—śrīvaiṣṇava.
sū—sūtra.
Sv.—Sāmaveda.
Śvet.—Śvetāmbara.
Taitt.—Taittirīya.
Up(s).—Upaniṣad(s).
vaid.—vaidic.
Vaikh.—Vaikhānasa.
vaiś.—vaiśeṣika.
vaiṣ.—vaiṣṇava.
Vāj. Vs.—Vājasaneya, Vājasaneya saṁhitā.
ved.—vedic.
viś. (v). adv.—viśiṣṭādvaita.
Yv.—Yajurveda.

# *New Catalogus Catalogorum*

- The Volumes I-XIV present manuscript references and other details based on around 400 Catalogues and a large number of secondary sources.
- Volumes XV-XXXIX have compiled details from over 900 Catalogues along with the secondary sources.
- It may be estimated that, when completed, the entire series of volumes of NCC will have information on over 300,000 texts and authors.
- An estimate of the extent of manuscript wealth in any discipline can be had by compiling the entries in various volumes of NCC that come under each subject category/categories.
- Such an analysis is yet to be undertaken.

# *Union Catalogue of Tamil Manuscripts*

- As regards the wealth of manuscripts in different disciplines, there is detailed information available only for the case of Tamil Manuscripts.
- In 1991, the Tamil University Thanjavur, published a five volume Union Catalogue of 21,973 Tamil Manuscripts listed in various published catalogues from 17 Indian repositories (holding 20,804 manuscripts) and 22 Repositories abroad (holding 1,169 manuscripts).
- The last of these volumes gives a bibliometric analysis of about 21,875 manuscripts whose subjects could be identified among a list of about 330 subject-headings.
- The subject-wise distribution of Tamil manuscripts can worked out on the basis of this bibliometric analysis.
- We see that religion, philosophy and other humanities and social sciences, account for about 41.5% of the Tamil manuscripts; literature accounts for another 30% of the manuscripts. The rest, which constitute about 28.5% of the manuscripts are in various sciences – including the science of language which accounts for nearly 6% of the manuscripts.

# Subject-wise distribution of Tamil manuscripts

| **Subject/Discipline** | **Number of Manuscripts** | **% of Total** |
|---|---|---|
| Medicine | 3,350 | 15.31 |
| Astrology | 1,250 | 5.71 |
| Astronomy and Mathematics | 120 | 0.55 |
| Chemistry | 120 | 0.55 |
| Architecture | 60 | 0.27 |
| Veterinary Science | 40 | 0.18 |
| Grammar, Prosody, Lexicon | 1,300 | 5.94 |
| Music & Dance | 220 | 1.00 |
| Drama | 210 | 0.96 |
| Literature | 6,100 | 27.89 |
| Religion (Samayam) | 6700 | 30.63 |
| Philosophy | 1725 | 7.89 |
| Dharmaśāstra (Nītinūl) | 400 | 1.83 |
| Other Humanities and Social Sciences | 280 | 1.28 |
| **Total** | **21, 875** | **100** |

Source: K. C. Sellamutthu et al (Eds.), *A Union Catalogue of Tamil Manuscripts,* Vol. V, Tamil University, Thanjavur 1991, pp. 2148-2156.

# Sanskrit Manuscripts on Science in Kerala and Tamil Nadu

- During 1995-97, Krishna Venkateswara Sarma did a pioneering survey of Sanskrit manuscripts in Science in 247 manuscript repositories in Kerala and 147 manuscript repositories in Tamil Nadu.
- During the course of this survey, about 150,000 manuscripts 'were examined partly in situ in person and partly through their catalogues or hand-lists when available'. The Survey revealed that of the total of 150,000 manuscripts surveyed, 12,244 manuscripts (more than 8%) pertained to various sciences including Astrology, Astronomy & Mathematics, Medicine, Architecture, Musicology, Chemistry, Veterinary Science and Agriculture.
- The manuscripts on Astrology, Astronomy and Mathematics and Medicine together accounted for 11,000 (or 90%) of the manuscripts pertaining to Science.
- However, unlike in the case of the Tamil manuscripts, the Sanskrit manuscripts on Astronomy and Mathematics constituted a much larger proportion (nearly 25% of the manuscripts on Science, and 30% of the manuscripts in Jyotiṣa) while the Sanskrit manuscripts on Medicine were only 10% of the Sanskrit manuscripts on Science.
- The survey also found that these 12,244 manuscripts actually correspond to about 3,473 separate texts, of which only 229 or about 6.6% of these texts had been edited and published so far.

# Sanskrit Manuscripts on Science in Kerala and Tamil Nadu

| **Discipline** | **No. of Manuscripts** | **% of Total** | **No. of Texts** | **No. of Texts Edited so far** |
|---|---|---|---|---|
| Astrology | 6,794 | 4.53 | 1,572 | 65 |
| Astronomy& Mathematics | 2,919 | 1.95 | 934 | 100 |
| Medicine | 1,286 | 0.86 | 586 | 28 |
| Architecture | 599 | 0.40 | 200 | 10 |
| Musicology | 326 | 0.22 | 82 | 9 |
| Chemistry | 166 | 0.11 | 61 | 13 |
| Veterinary Science | 146 | 0.10 | 31 | 4 |
| Agriculture | 8 | | 7 | 0 |
| **Total** | **12,244** | **8.16** | **3,473** | **229** |
| **Total Manuscripts Surveyed** | **150,000** | | | |

K. V. Sarma, *Science Texts in Sanskrit in the Manuscript Repositories of Kerala and Tamil Nadu*, Rashtriya Sanskrit Sansthan, New Delhi 2002, p.15

# K. V. Sarma's Survey on Sanskrit Manuscripts on Science in Kerala and Tamil Nadu

37. Āryabhaṭīya: By Āryabhaṭa (Ed.)
Āḍhyan Nampūtirippād 30
Adyar D. VII. 34-40 (7 mss.)
Cali. Mal. 892-b, 2852, 3556-a
Cali. Skt. D. 69
Deśamaṅgalam Vāriyam 200-a, 201, 676-a, 1022, 1545-a
Kani (3 mss.)
Kerala I. 1823-40 (18 mss.), 1851-63 (13 mss.); V. 22580-91 (12 mss.)
Koṭṭayam Payyalikka 19-a
Koṭṭayam Vayaskara 13-a
KVS 276, 320, 436, 491, 493
Madras D. 13385-95 (11 mss.); R. 3870, 5261, 18268
Mad. Uni. RKS 52-a
Nagapatnam 436

42. - C.: By Yallayārya, son of Śrīdhara
KVS 322
Madras R. 5261

43. - C. : By Raghunātha
Adyar D. VII. 39

44. - C. Prakāśa *or* Prakāśikā *or* Bhaṭaprakāśikā: By Sūrya-devayajvan (Ed.)
Adyar D. VII. 40-41
Kerala I. 1852-59 (8 mss.); V. 22579, 22589-90 (2 mss.)
KVS 277, 321
Madras D. 13389-93 (5 mss.), 13407; R. 3862-a, 6122, 18268; shelf No. 23.2.26
Oppert I. 8127

# Manuscripts and Source-works in Astronomy and Mathematics

- One of the earliest surveys of the manuscripts in Astronomy and Mathematics was conducted in early 1960s by Samarendra Nath Sen with the assistance of Amulya Kumar Bag and Sreeramula Rajeswara Sarma.
- Their *Bibliography* published by INSA in 1966 was based on information compiled from 79 catalogues and listed 660 works under 480 authors, together with another 320 works whose authors were not known.
- A comprehensive survey of the manuscripts and source-works on Indian Astronomy and Mathematics was undertaken by David Pingree.
- Pingree, it seems, embarked on this mammoth enterprise in 1955, and he was still working on it at the time of his demise in 2005.
- Five volumes of Pingree's *Census of Exact Sciences in Sanskrit* (covering all authors from 'a' to 'va', in about 1,700 pages) appeared during 1970-1994.
- The last volume in the Series A was said to be nearly complete when Pingree passed away in 2005; unfortunately, it still remains unpublished.

# *Census of the Exact Sciences in Sanskrit*

The scope of the *Census* is outlined in the introduction to the first Volume:

> " ... *Census of the Exact Sciences in Sanskrit* (hereafter to be referred to as CESS)... will provide all available bibliographical information concerning works in *jyotiḥśāstra* and related fields and biographical information concerning their authors. *Jyotiḥśāstra* is divided into three *skandhas* or branches: *hora* or genethlialogy and other forms of horoscopic astrology, *gaṇita* or mathematics and mathematical astronomy, and *saṁhitā* or divination. The related fields to which attention is paid in CESS are cosmology and geography (largely of the Jainas) and those aspects of *dharmaśāstra* that involve the determination of the proper times for the performance of ritual acts. It is intended to include all the works and all the authors in these subjects that can be identified.
>
> CESS will consist of two series: Series A will contain articles on authors arranged in the order of Sanskrit alphabet, and the Series B articles on the Books (mainly in Sanskrit, though some non-Sanskritic material is included arranged in the same manner ...The article on each author will first give as much information as is available on his date, ancestry, locale, religious affiliation, and social position; it will then list his works relevant to *jyotiḥśāstra*, and, under each work, list its commentators, its manuscripts and editions, and any discussions of it; finally there will be given a table of its contents and those passages in it which inform us about the author. ... "

D. Pingree, Census of the Exact Sciences in Sanskrit Series A, Volume I, American Philosophical Society, Philadelphia 1970, p. viii

# Census of Exact Sciences in Sanskrit

*ĀRYABHAṬA* (b. 476; *fl.* 499)

Āryabhaṭa himself states (Gaṇitapāda 1) that he wrote the *Āryabhaṭīya* in Kusumapura (=Pāṭalipura, modern Patna) and that he was twenty-three years old in Kali 3600 (=A.D. 499) (Kālakriyā 10). The statement of Nīlakaṇṭha (b. 1443) that he was born in the Aśmakajanapada (on Gaṇitapāda 1) probably refers to his predecessor as commentator, Bhāskara (*fl.* 629). He wrote two works: the *Āryabhaṭīya* influenced particularly South India, his ārdharātrika system Northwest India, Īrān, and the early ʿAbbāsid caliphate.

1. The *Āryabhaṭīya*, expounding the audayaka system and based in part on the *Paitāmahasiddhānta* of the *Viṣṇudharmottarapurāṇa*, contains four parts:

1. Daśagītikā (10 vss.)
2. Gaṇitapāda (33 vss.)
3. Kālakriyā (25 vss.)
4. Golapāda (50 vss.)

(the last three pādas are known collectively as the *Āryāṣṭaśata*). Aside from anonymous commentaries which will be listed in *CESS*, ser. B, the following are known:

Prabhākara (*ca.* 525); Bhāskara (*fl.* 629); Someśvara (*fl.* 1040); Sūryadeva (b. 1191); Parameśvara (*ca.* 1380-1460); Nīlakaṇṭha (b. 1443); Yallaya (*fl.* 1482); Raghunātha (*fl.* 1590); Kodaṇḍarāma (*fl.* 1854) (in Telugu); Ghaṭīgopa; Bhūtiviṣṇu; and Virūpākṣa Sūri (in Telugu).

# Census of Exact Sciences in Sanskrit

Manuscripts:

Berlin 834 (Chambers 480). 9ff. Copied by Kalyāna, the son of Meghajī Rāola at Kāśī in Śaka 1547 = A.D. 1625. With the commentary of Bhūtiviṣṇu.

Bombay U 332. 10ff. Copied in Śaka 1574 = A.D. 1652.

Berlin 1730 (or. fol. 808). 7ff. Copied by Viṣṇu in Śaka 1611 = A.D. 1689.

Bombay U 333. 4ff. Copied in Śaka 1782 = A.D. 1860 from a manuscript copied in Śaka 1611 = A.D. 1689 (Berlin 1730?).

Baroda 9331. 6ff. Copied in Saṃ. 1918 = A.D. 1861.

Bombay U 330. 6ff. Copied in Śaka 1785 = A.D. 1863 from a manuscript copied in Śaka 1760 = A.D. 1838. (See Bhāu Dājī [1865] 397.)

Editions:

Ed. H. Kern, Leiden 1875. With the *Bhaṭadīpikā* of Parameśvara. Based on IO 6271 and a now lost manuscript of Whish. Reprinted and translated into Hindī by Udaya Nārāyaṇa Singh, Madhurapur, Etawah 1906.

Ed. K. Sāmbaśiva Śāstrī (I and II) and Suranad Kunjan Pillai (III), *TSS* 101, 110, and 185, Trivandrum 1930, 1931, and 1957. With the *Bhāṣya* of Nīlakaṇṭha; omits the Daśagītikā. Based on two manuscripts at the University of Kerala and one belonging to the Rājā of Kilimanur.

Translations:

Anonymous, *Zīj al-Arjabhar* (*ca.* 800). Arabic.
Anonymous. 1860. Marāṭhī (see Bombay U. 334).
L. Rodet [1879b]. (Gaṇitapāda only). French.
G. R. Kaye [1908a]. (Gaṇitapāda only). English.
Baidyanath Rath Sastri, Chicago 1925 (unpublished thesis). English.
P. C. Sengupta [1927b]. English.
Walter Eugene Clark, Chicago 1930. English.

Discussions:

C.M. Whish [1827a]; F.-E. Hall [1860]; W. D. Whitney [1860]; H. Kern [1863]; Bhāu Dājī [1865] 392-406 and 413-414; Y. Sarkār [1878]; L. Rodet [1880]; S. Dvivedin [1892] 2-7; S. B. Dikshit [1896] 190-210; G. Thibaut [1899] 54-55; T. R. Pillai [1905]; G. R. Kaye [1908a]; [1909/10]; J. F. Fleet [1911a]; [1911f]; L. D. S. Pillai [1911] 2, 6, 8, 16-20(b), and 48-75; N. K. Mazumdar [1911/12]; J. F. Fleet [1915b]; P. C. Sengupta [1920/21]; R. Sewell [1921/22]; [1923/24a]; G. R. Kaye [1924]; A. A. K. Ayyangar [1926]; B. Datta [1926b]; S. K. Ganguly [1926b]; [1926c]; B. Datta [1927c]; S. K. Ganguly [1927a]; P. C. Sengupta [1929]; S. K. Ganguly [1930]; B. Datta [1932b]; P. K. Gode [1938]; S. N. Sen [1963]; and S. Prakash [1965] 419-449.

# *Census of the Exact Sciences in Sanskrit*

- Around 400 catalogues are listed in the first Volume of the *Census*. Supplementary lists are given in each successive Volume so that the total number of catalogues from which the information has been compiled adds up to around 600.
- The Volumes of the *Census* also present a comprehensive bibliography of secondary sources – listing over 2,000 articles and books related to *jyotiḥśāstra*.
- The first four Volumes of the *Census* (covering letters 'a' to 'ma') included information on 2,450 authors in all. The corresponding information in the case of Volume V (covering letters 'ya' to 'va') was not provided. It is estimated that, when the contents of the unpublished sixth Volume is also taken into account, the total number of authors could be more than 4,000.
- The Volumes of the *Census* constitute a rich source for studying all aspects of the large corpus of manuscripts in *jyotiḥśāstra* such as: The total number of manuscripts, the total number of source-works and their distribution over different sub-disciplines and the historical periods and locations of the authors, details of source-works which have been edited, translated and studied, and so on.
- Such studies have not been carried out so far – perhaps because, like in the case of *NCC*, the Volumes of the *Census* are not yet complete.

# The Wealth of Manuscripts in Jyotiḥśāstra

In his survey of the literature on *jyotiḥśāstra*, published in 1981, Pingree estimated the total number of manuscripts pertaining to *jyotiḥśāstra* to be around 100,000:

> "At present there exist in India and outside of it some 100,000 manuscripts on the various aspects of *jyotiḥśāstra.* The great majority of these were copied within the seventeenth, eighteenth, and nineteenth centuries; for manuscripts cannot long survive in India except under exceptional circumstances."
>
> D. Pingree, *Jyotiḥśāstra Astral and Mathematical Literature*, Otto Harrassowitz, Wiesbaden 1981, p.118

We may now recall the findings of the Survey of Sanskrit manuscripts in Kerala and Tamil Nadu, due to K. V. Sarma (mentioned earlier), that there are 6,714 manuscripts (corresponding to 1572 works) on Astrology and 2,919 manuscripts ( corresponding to 934 works) in Astronomy and Mathematics.

Hence, we can conclude that out of about 100,000 manuscripts on *jyotiḥśāstra*, the number of manuscripts pertaining to Astronomy and Mathematics could be around 30,000.

Again, using the result of the same survey, we can also conclude that these 30,000 manuscripts are associated with roughly around 9,000 source-works on Astronomy and Mathematics in Sanskrit. This is indeed a huge wealth of literature, much of which (as we shall see below) remains untapped so far.

# Modern Scholarship in Indian Astronomy and Mathematics

The Indian tradition of Astronomy and Mathematics was fairly flourishing during the eighteenth century and, in several parts of the country the tradition continued well into the middle of the nineteenth century.

However, the British policy of stopping all allocations for the support of indigenous learning (both by the local village societies as well as by the former Indian rulers), coupled with the policy of exclusively reserving all Governmental jobs to those who were trained in the new English education system, led to a steep decline in indigenous learning during the course of the nineteenth century.

We shall here focus on the growth of modern scholarship – the modern phase of the European scholarship – in Indian Astronomy and Mathematics which may be said to have been initiated in the second half of the eighteenth century by the British and European scholars (and the British administrators in India).

Here, we shall essentially make use of the comprehensive Bibliographies of Pingree and Sarma to assess the progress achieved by modern scholarship of the last two and a half centuries in comprehending the Indian tradition of Astronomy and Mathematics by studying, editing, translating and analysing the technical contents of the large corpus of nearly 9,000 source-works as estimated above.

# Source-works Edited/Translated During 1800-1875

The first full-fledged translations of Indian Mathematics texts appeared during the decade, 1810-1820, starting with the translation of *Bījagaṇita* and *Līlāvatī* of Bhāskarācārya (c.1150), by E. Strachey and J. Taylor in 1813 and 1816.

This was soon followed in 1817 by an authoritative translation, along with detailed explanation of the mathematical content of these works (based on an examination of their traditional commentaries), by Henry Thomas Colebrooke. Colebrooke's work also included a translation of the Gaṇita and Kuṭṭaka chapters of the *Brāhmasphuṭasiddhānta* of Brahmagupta (c.628).

Editions of Indian source-works started appearing in the 1830s. Here again, the Sanskrit texts of *Līlāvatī* and *Bījagaṇita* of Bhāskarācārya were the first to be published from Calcutta in 1832 and 1834.

The British administrator Lancelot Wilkinson had gathered a group of traditional Indian scholars at Sehore and he published an edition of the celebrated treatise, *Siddhāntaśiromaṇi* of Bhāskarācārya, along with the auto-commentary *Vāsanābhāṣya*, from Calcutta in 1842.

In the next year, Wilkinson published an edition of the famous Astronomical manual (karaṇa) *Grahalāghava* of Gaṇeśa Daivajña (c.1520) along with the commentary of Mallāri (c.1588).

In 1859, Fritz Edward Hall and Bāpū Deva Śāstri (the doyen among traditional scholars, who had also been trained in modern learning in the Sanskrit College of Varanasi) published an edition of the *Sūryasiddhānta* along with the commentary *Gūḍhārthaprakāśaka* of Raṅganātha (c.1603) as a part of the Bibliotheca Indica series from Calcutta.

# Source-works Edited/Translated During 1800-1875

As regards translations of source-works of Indian Astronomy, a Marathi translation of the *Siddhāntaśiromaṇi* was published in 1837.

In 1848, H. R. Hoisington of the Batticotta Seminary in Sri Lanka published an edition and translation (along with explanatory notes) of the popular work of the Vākya system, *Cūḍāmaṇi Uḷḷamuḍaiyān* (in Tamil) of Tirukkoṭṭiyūr Nambi (c.1234).

However, unlike the work of Colebrooke on Indian Mathematics which was published in 1817, the first detailed exposition in English of a classical Siddhāntic text of Indian Astronomy appeared only in 1860. This was the famous translation of *Sūryasiddhānta* (together with detailed explanatory notes) by Rev. Ebenezer Burgess, which was revised by William Dwight Whitney.

Soon, this was followed by an English translation of the *Golādhyāya* of *Siddhāntaśiromaṇi* by Lancelot Wilkinson revised by Bāpū Deva Śāstri in 1861.

Another landmark publication was the edition (and translation into German) of the Ṛk and the Yajus recensions of the ancient *Vedāṅgajyotiṣa* (c.1300-1100 BCE), with the commentary of Somākara (c.1350 CE) on the Yajus version, by Albrecht Weber from Berlin in 1862.

We have referred to all the editions and translations that were published during 1800-1875, mainly because they were pioneering efforts, and also because there were indeed so few of them – only about 15 source-works were edited and about 10 translated (two of them only partially) in the entire seventy-five period under consideration.

# Source-works Edited/Translated During 1800-1875

| Translated During 1800-1875 | Edited During 1800-1875 |
|---|---|
| 1. Vedāṅgajyotiṣa of Lagadha (c.1300-1100 BCE)<br>2. Bṛhatsaṁhitā of Varāhamihira (c.550 CE)<br>3. Brāhmasphuṭasiddhānta of Brahmagupta (c.628) (PART)<br>4. Sūryasiddhānta<br>5. Pāvalūriganitamu ( in Telugu) of Mallaṇa (c.1100) (PART)<br>6. Līlāvatī of Bhāskarācārya (c.1150)<br>7. Bījaganita of Bhāskarācārya (c.1150)<br>8. Siddhāntaśiromaṇi of Bhāskarācārya (c.1150)<br>9. Cūḍāmaṇi Uḷḷamuḍaiyān (in Tamil) of Tirukkoṭṭiyūr Nambi (c.1234)<br>10. Grahalāghava of Gaṇeśa Daivajña (c.1520) | 1. Vedāṅgajyotiṣa of Lagadha (c.1300-1100 BCE)<br>2. Āryabhaṭīya of Āryabhaṭa (c.499 CE)<br>3. Bṛhatsaṁhitā of Varāhamihira (c.550)<br>4. Sūryasiddhānta<br>5. Līlāvatī of Bhāskarācārya (c.1150)<br>6. Bījaganita of Bhāskarācārya (c.1150)<br>7. Siddhāntaśiromaṇi of Bhāskarācārya (c.1150)<br>8. Mitākṣarā or Vāsanābhāṣya Autocommentary of Bhāskarācārya (c.1150) on Siddhāntaśiromaṇi<br>9. Cūḍāmaṇi Uḷḷamuḍaiyān (in Tamil) of Tirukkoṭṭiyūr Nambi (c.1234)<br>10. Commentary on Vedāṅgajyotiṣa by Somākara (c.1350)<br>11. Bhaṭadīpikā on Āryabhaṭīya by Parameśvara (c.1430)<br>12. Grahalāghava of Gaṇeśa Daivajña (c.1520).<br>13. Commentary on Grahalāghava of Gaṇeśa Daivajña by Mallāri (c.1588)<br>14. Udāharaṇa on Grahalāghava of Gaṇeśa Daivajña by Viśvanātha (c.1600)<br>15. Gūḍhārthaprakāśaka on Sūryasiddhānta by Raṅganātha (c.1603) |

# Source-works Edited /Translated During 1800-2019

- The compared to the period 1800-1875, the next seventy-odd year periods 1876-1947 , 1948-2019 indeed saw significant increases both in the number of source-works edited as well as translated.
- This was a period when a number of Indian scholars, most of them from a background of traditional scholarship, but trained also in modern institutions of higher learning (including the new institutions of Sanskritic learning), started playing a leading role in the editing and translating source-works of Indian Astronomy and Mathematics.
- The prime mover in the editing of source-works was Sudhākara Dvivedin, a student of Bāpūdeva Śāstri in Varanasi.
- His example was soon followed by number scholars in Calcutta, Poona, Trivandrum and other places.
- During 1878-1910, Sudhākara Dvivedin edited and published more than twenty important texts, often with his own Sanskrit commentary.

# Source-works Edited /Translated During 1800-2019

- We have looked in detail through the comprehensive bibliographies of Sen, Pingree and Sarma, cited in the last section, to make a preliminary master list of the published translations of the source-works of Indian Astronomy and Mathematics (many of them have been translated several times and also into different languages) during the last two centuries.
- What this list reveals is that while there were only 10 works which were translated during 1800-1875, this number rose to 20 during 1876-1947, and further increased substantially to 65 during 1948-2019.
- We have not made any detailed survey of the source-works which have been edited during 1876-1947 and 1948-2019.
- However, from our perusal of these bibliographies and other sources, it seems that the number texts edited during these periods may be estimated to be around 135 and 300 respectively.

# Source-works in Indian Astronomy and Mathematics Edited /Translated During 1800-2019

| Period | No of Source-works Edited | No. of Source-works Translated |
|---|---|---|
| 1800-1875 | 15 | 10 |
| 1876-1947 | About 135 | 20 |
| 1948-2019 | About 300 | 65 |
| **Total** | **About 450** | **95** |

# Source-works Translated During 1876-1947

1. Baudhāyanaśulvasūtra (Prior to c.800 BCE)
2. Āpastambaśulvasūtra (Prior to c.800 BCE)
3. Kātyāyanaśulvasūtra (PART)
4. Mānavaśulvasūtra
5. Atharvaṇajyotiṣa
6. Sūryaprajñapti (in Prākṛta)
7. Candraprajñapti (in Prākṛta)
8. Āryabhaṭīya of Āryabhaṭa (c.499 CE)
9. Pañcasiddhāntikā of Varāhamihira (c.550)
10. Triśatikā of Śrīdhara (c.750)
11. Khaṇḍakhādyaka of Brahmagupta (c.665)
12. Dhavalā (in Prākṛta ) of Vīrasena (c.800) on Ṣaṭkhaṇḍāgama of Puṣpadanta and Bhūtabali
13. Gaṇitasārasaṅgraha of Mahāvīra (850)
14. Laghumānasa of Muñjāla (c.932)
15. Bhāsvatī of Śatānanda (c.1099)
16. Makarandasāriṇī of Makaranda (c. 478)
17. Yantracintāmaṇi of Cakradhara (c.15th Century)
18. Tithicintāmaṇi of Gaṇeśa Daivajña (c.1530)
19. Sūryasiddhāntarahasya of Rāghavānanda Śarman (c.1591)
20. Yantrarājaracanā of Savai Jayasimha (c.1725)

# Source-works Translated During 1948-2019

1. Parāśaratantra of Parāśara (c.1300-1100 BCE)
2. Kātyāyanaśulvasūtra
3. Bakṣāli Manuscript
4. Yavanajātaka of Sphūjidhvaja
5. Candravākya of Vararuci (c. 4th Century CE)
6. Tiloyapaṇṇatti (in Prākṛta) of Yativṛṣabha (c. 5th Century)
7. Āryabhaṭasiddhānta of Āryabhaṭa (c.499) (PART)
8. Paitāmahasiddhānta of Viṣṇudharmottarapurāṇa
9. Mahābhāskarīya of Bhāskara I (c.620)
10. Brāhmasphuṭasiddhānta of Brahmagupta (c.628)
11. Āryabhaṭīyabhāṣya of Bhāskara I (c.629)
12. Laghubhāskarīya of Bhāskara I (c.635)
13. Karaṇaratna of Devācārya (c.687)
14. Gaṇitapañcaviṁśī of Śrīdhara (c.750)
15. Pāṭīgaṇita of Śrīdhara (c.750)
16. Śiṣyadhīvṛddhida of Lalla (c.750)
17. Vāsanābhāṣya on Brāhmasphuṭasiddhānta of Brahmagupta by Pṛthūdakasvāmi (c.860) (PART)
18. Vaṭeśvara Siddhānta of Vaṭeśvara (c.904)
19. Mahāsiddhānta of Āryabhaṭa II (c.950) (PART)
20. Karaṇatilaka of Vijayanandi (c.966)
21. Trilokasāra (in Prākṛta) of Nemicandra (c.975)
22. Dhīkoṭidakaraṇa of Śrīpati (c.1039)
23. Siddhāntaśekhara of Śrīpati (c.1039) (PART)
24. Gaṇitatilaka of Śrīpati (c.1039)
25. Vāsanābhāṣya Autocommentary of Bhāskarācārya on Bijaganita (c.1150)
26. Mitākṣarā or Vāsanābhāṣya Autocommentary of Bhāskarācārya on Siddhāntaśiromaṇi (c.1150) (PART)
27. Karaṇakutūhala (c.1183) of Bhāskarācārya
28. Pañcaviṁśatikā (c. 13th Century)

# Source-works Translated During 1948-2019

29. Gaṇitasārakaumudī (in Prākṛta) of Ṭhakkura Pherū (c.1320)
30. Gaṇitakaumudī of Nārāyaṇa Paṇḍita (c.1356)
31. Bījagaṇitāvataṁsa of Nārāyaṇa Paṇḍita (c.1356) (PART)
32. Yantrarāja of Mahendrasūri (c.1370) (PART)
33. Yantrādhikara of Padmanābha (c.1400)
34. Dhruvabhramaṇādhikara of Padmanābha (c.1400) (PART)
35. Sphuṭacandrāpti of Mādhava (c.1400)
36. Mahājyānayanaprakāra of Mādhava (c.1400)
37. Lagnaprakaraṇa of Mādhava (c.1400) (PART)
38. Grahaṇāṣṭaka of Parameśvara (c.1410)
39. Grahaṇamaṇḍana of Parameśvara (c. 1410)
40. Grahaṇanyāyadīpikā of Parameśvara (c.1432-33)
41. Goladīpikā II of Parameśvara (c.1432-33)
42. Goladīpikā I of Parameśvara (c. 1443-44)
43. Golasāra of Nīlakaṇṭha Somayājī (c.1500)
44. Tantrasaṅgraha of Nīlakaṇṭha Somayājī (c.1500)
45. Candracchāyāgaṇita of Nīlakaṇṭha Somayājī (c.1500)
46. Siddhāntadarpaṇa of Nīlakaṇṭha Somayājī (c.1500)
47. Autocommentary on Siddhāntadarpaṇa by Nīlakaṇṭha Somayājī (c.1500)
48. Grahasphuṭānayane Vikṣepavāsanā of Nīlakaṇṭha Somayājī (c.1500)
49. Kuṭṭākāraśiromaṇi of Devarāja (c. 15$^{th}$ century)
50. Siddhāntasundara of Jñānarāja (c.1503)
51. Pratodayantra of Gaṇeśa Daivajña (c.1530 )

# Source-works Translated During 1948-2019

52. Ekaviṁśatipraśnottara of Citrabhānu (c.1530 )
53. Gaṇitayuktibhāṣā (in Malayalam) of Jyeṣṭhadeva (c.1530)
54. Sūryaprakāśa of Sūryadāsa on Bījagaṇita of Bhāskarācārya (c. 1538)
55. Buddhivilāsinī on Līlāvatī of Bhāskarācārya by Gaṇeśa Daivajña (c.1545) (PART)
56. Turīyayantraprakāśa of Bhūdara (1572)
57. Karaṇapaddhati of Putumana Somayājī (c.1580)
58. Rāśigolasphuṭanīti of Acyuta Piṣāraṭi (c.1585)
59. Candrārkī of Dinakara (c.1589)
60. Bījapallava on Bījagaṇita of Bhāskarācārya by Kṛṣṇa Daivajña (c. 1600) (PART)
61. Sarvasiddhāntarāja of Nityānanda (c.1639) (PART)
62. Pāṭīsāra of Munīśvara (c.1650) (PART)
63. Karaṇakesarī of Bhāskara (c.1681)
64. Brahmatulyasāriṇī of Malūkacandra (c.17$^{th}$ Century)
65. Yantraprakāra of Savai Jayasiṁha (c.1725)
66. Sadratnamālā of Śaṅkaravarman (c.1819)
67. Siddhāntadarpaṇa of Candraśekhara Sāmanta (c.1869)

# Progress Achieved during 1948-2019 in our Understanding of Indian Astronomy and Mathematics

- Compared to the period 1800-1875, significant progress was achieved in the study of Indian Astronomy and Mathematics, during 1876-1947. This was mainly by way of editing about 135 source-works.
- Till 1947, the number of source-works that were translated and analysed were very few – in all adding to about 30 in number.
- Substantial progress has indeed been achieved in the last seventy years 1948-2019, mainly by the dedicated efforts of large number scholars in studying, editing, translating and analysing the technical contents (mathematical and astronomical) of a number of important texts.
- During the period 1948-2019, it is estimated that nearly 300 source-works have been edited and 65 works have been translated – often with detailed explanatory notes.

# Progress Achieved during 1948-2019 in our Understanding of Indian Astronomy and Mathematics

- From the list of source-works translated during the period 1948-2019 displayed earlier, we can see that they include several important works such as the *Śulvasūtras*, the *Bakṣāli Manuscript* and many seminal works of famous Astronomers/Mathematicians such as:

  Lagadha, Parāśara Sphūjidhvaja, Āryabhaṭa, Varāhamihira, Bhāskara I, Brahmagupta, Devācarya, Śrīdhara, Lalla, Vaṭeśvara, Āryabhaṭa II, Muñjāla, Śrīpati, Bhāskarācārya II, Ṭhakkura Pherū, Nārāyaṇa Paṇḍita, Padmanābha, Mādhava, Parameśvara, Makaranda, Nīlakaṇṭha Somayājī, Devarāja, Jñānarāja, Gaṇeśa Daivajña, Jyeṣṭhadeva, Bhūdara, Putumana Somayājī, Acyuta Piṣāraṭi, Savai Jayasiṁha, Śaṅkaravarman and Candraśekhara Sāmanta.

- A detailed study of these translations and the explanations given therein do provide us with substantial insights into the historical development of the concepts, theories, techniques as well as the methodology of the Indian tradition of Astronomy and Mathematics.

- Many of these insights have also been brought out in various publications that have appeared in the last twenty years.

# The Untapped Wealth of Manuscripts on Indian Astronomy and Mathematics: The Way Forward

- While the above discussion shows that significant progress has been achieved by the modern scholarship in Indian Astronomy and Mathematics during the last seventy years, the fact of the matter is that there are still many large gaps in our current knowledge of this great tradition.
- We shall not here go into the details of the various historical periods and the broad areas which need to be investigated in depth.
- Since this discussion is on the untapped wealth of manuscripts in Indian Astronomy and Mathematics, we may note that we have prepared a representative list of 190 important source-works which are yet to be edited and published.
- As per the details given in the bibliographies of Sen, Pingree and Sarma cited above, manuscripts of these works are listed in various catalogues. Our list is only indicative of the huge corpus of important source-works which are perhaps easily locatable, but are yet to be edited and studied.
- Indeed the untapped wealth of manuscripts is indeed huge – after all, the number of source-works which have been edited so far add up to a mere 450, in the ocean of the total estimated 9,000 source-works in the are of Indian Astronomy and Mathematics.

# The Untapped Wealth of Manuscripts on Indian Astronomy and Mathematics: The Way Forward

In conclusion, we would like to emphasise that we are as yet far from achieving a comprehensive understanding of the fundamental concepts and techniques, theories and methodologies and even the historical development of Indian Astronomy and Mathematics. This is mainly because:

- Only 450 (or 5%) of the estimated 9,000 source-texts (which are available in the form of manuscripts) have been edited and published so far.
- Further, even among the 450 or so published works, only about 90 or so texts have been seriously studied and explicated via translations and explanatory commentaries with a view to bring out their technical (mathematical-astronomical) content.
- Most of these editions and studies have been brought out during the last seventy years or so; and this is largely due to the voluntary and dedicated efforts of a number of Indian scholars, as there has been little scope or support for such work in our institutions of higher learning.

There is thus an urgent need to reorient our national priorities and give due importance to the Preservation, Digitization, Listing and Cataloguing, Editing & Publishing, and Promoting Systematic Studies of the large corpus of source-works of the great tradition of Science and Technology in India. Training young scholars for undertaking all these tasks should indeed form an integral part of the courses and research conducted in our institutions of higher learning.