

THE UNTAPPED WEALTH OF MANUSCRIPTS ON INDIAN ASTRONOMY AND MATHEMATICS

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Abstract

Among the ancient Indian Sciences, Astronomy and Mathematics occupy a prime position along with the Sciences of Language and Health. All these Sciences are distinguished by an extensive textual tradition which goes back to the Vedic period and the tradition continued to flourish till at least the middle of the nineteenth century. A large part of the great manuscript wealth of India pertains to these and other sciences and technologies, which have played a crucial role in the history of our civilisation.

Unlike in the case of other ancient sciences, the vast corpus of manuscripts in Astronomy and Mathematics has been extensively surveyed and documented during the last fifty years, mainly due to the painstaking efforts of the eminent scholars Samarendra Nath Sen (1918-1992), Krishna Venkateswara Sarma (1919-2006) and David Pingree (1933-2005). We shall make use of their documentation to present (i) an estimate of the vast corpus of source-works in Indian Astronomy and Mathematics, and (ii) an assessment of what has been accomplished by modern scholarship over the last two centuries by way of editing and translating some of these source-works with a view to comprehend and elucidate their technical (mathematical-astronomical) content.

We find that of the estimated 9,000 source-works of Indian Astronomy and Mathematics (which are preserved in around 30,000 manuscripts), only about 150 texts were edited, and just about 30 texts translated during 1800-1947. During the last seventy years, another 300 texts have been edited and 66 texts have been translated, many of them with detailed explanatory notes.

While significant progress has been achieved by the modern scholarship in Indian Astronomy and Mathematics during the last seventy years, 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:

1. Only 450 (or 5%) of the estimated 9,000 source-texts (which are available in manuscript form) have been edited and published so far.
2. Further, even among the 450 or so published works, only about 96 texts been seriously studied and explicated via translations and explanatory commentaries with a view to bring out their technical (mathematical-astronomical) content.
3. 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.

I. Estimates of the Manuscript Wealth of India

The first systematic survey of catalogues of Indian manuscripts in various repositories was published by Klaus Janert in 1965, where he estimated that the total number of Indian manuscripts could be more than one million:¹

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.

Janert also noted that:²

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.

As of date, the most comprehensive survey of the catalogues of Indian manuscripts is the one published by Subhash Biswas and M. K. Prajapati in 1998, and they estimated the total number of Indian manuscripts to be around 3.5 million, of which only about a million had been catalogued.³

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.

Biswas and Prajapati also presented the language-wise distribution of the catalogued manuscripts, which is given in Table1:⁴

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

¹ K. L. Janert, *An Annotated Bibliography of the Catalogues of Indian Manuscripts Part I*, Franz Steiner Verlag, Wiesbaden 1961, p. 9.

² Ibid. p. 9 *fn.*

³ S. C. Biswas and M. K. Prajapati, *Bibliographic Survey of Indian Manuscript Catalogues*, Eastern Book Linkers, Delhi 1998, p. xiv.

⁴ Ibid. p. xx.

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
Assamese	778	0.07
Others	114	0.01
Total	10,58,424	

Table 1: Language-wise distribution of the catalogued Indian manuscripts

In September 1998, while announcing the proposal to establish a National Mission for Manuscripts, the Press Information Bureau Report mentioned that there were around 30 million Indian manuscripts:⁵

A national mission is being set up for the preservation of hundreds and lakhs of manuscripts scattered all over the country. ... The mission is to be launched in three phases. The first phase will comprise compilation and publication of a directory of institutions/individuals possessing these manuscripts and collecting data on their historical importance and physical state and preservation facilities available. The second phase envisages analysis of the data collected in the first phase and physical verification and preparation of a national register of these manuscripts, which have national and international importance. The third stage will be digitalisation of these rare manuscripts in order to increase accessibility without physical handling.

More than 30 million manuscripts remain scattered all over the country. The Minister for Human Resource Development, Dr. Murli Manohar Joshi while chairing a meeting of the Advisory Board of National Library recently, expressed concern over this and said than to protect these, which are our cultural heritage, a national mission for their preservation must be set up.

In a review article on 'Indian Manuscripts' (written in 2011 and published in 2014) Dominik Wujastyk also concurred with this estimate of 30 million manuscripts – which, he notes, was also the estimate made by David Pingree:⁶

⁵ <http://pibarchive.nic.in/archive/releases98/1yr98/10998/r070998.html> (accessed on 15 March 2019).

⁶ D. Wujastyk, 'Indian Manuscripts', in J. B. Quenzer Ed. *Manuscript Cultures Mapping the Field*, De Gruyter, Berlin 2014, pp. 159-160. The figure of 30 million Indian manuscripts is also mentioned by Sheldon Pollock who contrasts it with the total of about 30,000 Greek manuscripts (covering the classical, Hellenistic and Byzantine periods) which are extant (S. Pollock, *The Language of Gods in the World of Men*, University of California Press, Berkeley 2006, p. 558 & fn).

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 about 50,000 manuscripts in the Sarasvati Mahal library in Thanjavur in the far South. Such examples are easily multiplied across the whole subcontinent. And these are only the public libraries with published catalogues. A one-year pilot field-survey by the National Mission for Manuscripts in Delhi, during 2004-2005, documented 650,000 manuscripts distributed across 35,000 repositories in the states of Orissa, Bihar and Uttar Pradesh, and field participants in that project report that they only scratched the surface. ...

The National Manuscripts Mission gives a more modest estimate of 10 million Indian manuscripts on its current webpage:⁷

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.

The Mission also gives the following summary of its performance so far, which mentions that over 4.2 million manuscripts have been documented:⁸

- 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.

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.

⁷ <https://www.namami.gov.in/national-mission-manuscripts> (accessed on 15 March 2019).

⁸ <https://www.namami.gov.in/performance-summary> (accessed on 15 March 2019).

II. The Distribution of Manuscripts over Different Disciplines

Catalogus Catalogorum and the New Catalogus Catalogorum

Many of the descriptive catalogues published by different manuscript repositories list the manuscripts in different disciplines separately; some of them may mention the discipline along with the title of each text, while listing its manuscripts. 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 1891-1903.⁹ Aufrecht's work was based on 94 catalogues and his first volume listed about 60,000 works and authors alphabetically, with appropriate catalogue references.

In 1935, the University of Madras initiated a programme of updating the Aufrecht's work, as many more catalogues had become available by then. A provisional fasciculus of the *New Catalogus Catalogorum* (NCC) was issued under the editorship of S. Kuppaswami Sastri in 1937. The first Volume (covering the letter 'a') appeared in 1949 under the editorship of C. Kunhan Raja with the assistance of V. Raghavan. In the 1950s the work got intensified and two Research Assistants (K. V. Sarma and C. S. Sundaram) were appointed to assist Raghavan. During 1966-69, a revised edition of Volume I was published along with Volumes II-IV (covering 'a' to 'gā') under the editorship of V. Raghavan. Volumes VI-XI (covering 'gā' to 'pa') were published during 1971-83 under the editorship of K. Kunjunn Raja. Volumes XII-XIV (covering 'pa' to 'bra') were published during 1988-2001 under the editorship of N. Veezhinathan. And, Volumes XV-XXXIX (covering 'bra' to 'su') have been published during 2007-15 under the editorship of Siniruddha Dash. The remaining couple of volumes are expected to be published shortly.

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 works and authors. The works have been classified under various subject heads which is reproduced in Table 2.

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.

⁹ T. Aufrecht, *Catalogus Catalogorum An Alphabetical Register of Sanskrit Works and Authors*, 3 Volumes, Leipzig 1891, 1896 and 1903.

Subjects

adv. —advaita.	med. —medicine.
alank. —alankāra.	mīm. —Mīmāṃsā (pūrva).
anu. adv. —annbhavādvaita.	ny. —nyāya.
Āpāst. —Āpastamba.	paur. —paurāṇika.
Āśval. —Āśvalāyana.	pr. —prayoga.
Av., Ath. v. —Atharvaveda.	rel. —religion.
Bhārad. —Bhāradvāja.	Ṛv. —Ṛgveda.
Bodh., Baudh. —Bodhāyana, Baudhāyana.	śai. —śaivism.
Br. —Brāhmaṇas	Śāṅkh. —Śāṅkhāyana.
Bud. —Buddhist.	śr. —Śrauta.
dh. —dharmaśāstra.	śrivaṣ. —śrivaṣṇava.
Dig. —Digambara.	sū. —sūtra.
Drāhyā. —Drāhyāyāṇīya.	Sv. —Sāmaveda.
dvai. —dvaita.	Śvet. —Śvetāmbara.
gr. —grammar.	Taitt. —Taittirīya.
grh. —gr̥hya.	Up(s). —Upaniṣad(s).
Hiraṇ., Hiraṇyak. —Hiraṇyakeśīya.	vaid. —vaidic.
iy. —jyotiṣa.	Vaikh. —Vaikhāṇasa.
Kaś. Sai. —Kaśmir Śaivism.	vaiś. —vaiśeṣika.
Kāty. —Kātyāyana.	vaiṣ. —vaiṣṇava.
Kṛ. Yv., Kṛṣṇ. Yv. —Kṛṣṇa Yajurveda.	Vāj. Va. —Vājasaneyā, Vājasaneyā
lex. —lexicon.	samhitā.
mā. —māhātmya.	ved. —vedic.
Mādh. —Mādhyaṇḍina.	viś. (v). adv. —viśiṣṭādvaita.
	Yv. —Yajurveda.

Table 2: Subject-heads used in *New Catalogue Catalogorum*

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 given in Table 3, has been worked out on the basis of this bibliometric analysis.¹⁰

From Table 3, we can 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. About 3,350 manuscripts (constituting 15.31% of the total) deal with medicine and about 1,250 manuscripts (5.71% of the total) are said to deal with Astrology. It is reported that there are about 120 manuscripts each on Astronomy and Mathematics and Chemistry, 100 on architecture and 40 on Chemistry.

¹⁰ K. C. Sellamutthu et al (Eds.), *A Union Catalogue of Tamil Manuscripts*, Vol. V, Tamil University, Thanjavur 1991, pp. 2148-2156.

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

Table 3: Subject-wise distribution of Tamil manuscripts

Survey of Sanskrit Manuscripts on Science in Kerala and Tamil Nadu by K. V. Sarma

During 1995-97, K. V. Sarma did a painstaking survey of 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'.¹¹ The Survey revealed that of the total of 150,000 manuscripts surveyed, 12,244 manuscripts (more than 8%) pertained to various sciences including Astrology (Jātakaskandha and Saṁhitāskandha of Jyotiṣa), Astronomy & Mathematics (Gaṇitaskandha of Jyotiṣa, which includes Mathematics also), Medicine (Āyurveda), Architecture (Śilpa-śāstra), Musicology (Saṅgīta-śāstra), Chemistry (Rasa-śāstra), Veterinary Science (Mṛga-śāstra) and Agriculture (Kṛṣi-śāstra).

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			

Table 4: Subject-wise distribution of Sanskrit manuscripts in Science in Kerala and Tamil Nadu

¹¹ K. V. Sarma, *Science Texts in Sanskrit in the Manuscript Repositories of Kerala and Tamil Nadu*, Rashtriya Sanskrit Sansthan, New Delhi 2002, p.15

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 total Sanskrit manuscripts on Science. Sarma's 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. In table 4, we have summarised the discipline-wise distribution of manuscripts and texts as found in the survey:¹²

III. Manuscripts and Source-works in Astronomy and Mathematics

Among the ancient Indian Sciences, Astronomy and Mathematics occupy a prime position along with the Sciences of Language and Health. All these Sciences are distinguished by an extensive textual tradition which goes back to the Vedic period and the tradition continued to flourish till at least the middle of the nineteenth century. As we saw above, a significant part of the great manuscript wealth of India pertains to these sciences, which have played an important role in the history of our civilisation.

Unlike in the case of other ancient sciences, the vast corpus of manuscripts in Astronomy and Mathematics has been extensively surveyed and documented by modern scholarship during the last fifty years. One of the earliest surveys of the manuscripts in Astronomy and Mathematics was conducted in early 1960s at the behest of the National Institute of Sciences of India (later named the Indian National Science Academy) by Samarendra Nath Sen with the assistance of Amulya Kumar Bag and Sreeramula Rajeswara Sarma.¹³ Their *Bibliography* 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. For each title, catalogue references were provided to the manuscripts, along with other details, wherever available. Since the information compiled was based only on 79 catalogues, this *Bibliography* should be considered as a preliminary survey of the vast corpus of manuscripts in the field of Astronomy and Mathematics.

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 1970-1994.¹⁴ The scope of the *Census* is outlined in the introduction to the first Volume:¹⁵

... *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 genethliology and other forms of horoscopic astrology, *gaṇita* or mathematics

¹²Ibid.

¹³ S. N. Sen, A. K. Bag and S. R. Sarma, *A Bibliography of Sanskrit Works on Astronomy and Mathematics*, National Institute of Sciences India, Delhi 1966.

¹⁴ D. Pingree, *Census of the Exact Sciences in Sanskrit Series A, Volumes I - V*, American Philosophical Society, Philadelphia 1970, 1971, 1976, 1981 and 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.

¹⁵ Ibid. Vol. I, 1970, p. viii.

and mathematical astronomy, and *samhitā* or divination. The related fields to which attention is paid in CESS are cosmology and geography (largely of the Jainas) and those aspects of *dharmasāstra* 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. ...

In the preface to the same volume, Pingree mentions that:¹⁶

... the individual to whom this cataloguer owes most is India's foremost student of Sanskrit manuscripts, Professor V. Raghavan of the University of Madras, who most generously made available his numerous handwritten catalogues of Indian and European collections. May this work prove as useful to the students of *jyotiḥśāstra* as Raghavan's *New Catalogous Catalogorum* is to the students of Sanskrit literature in general.

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.

In his survey of the literature on *jyotiḥśāstra*, published in 1981, Pingree himself estimated the total number of Sanskrit manuscripts pertaining to *jyotiḥśāstra* to be around 100,000.¹⁷

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,

¹⁶ Ibid. Vol. I, 1970, p. vii.

¹⁷ D. Pingree, *Jyotiḥśāstra Astral and Mathematical Literature*, Otto Harrassowitz, Wiesbaden 1981, p.118.

eighteenth, and nineteenth centuries; for manuscripts cannot long survive in India except under exceptional circumstances.

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.

Apart from the *Bibliography* of Sen and the five Volumes of the *Census* and the monograph on the literature on *jyotiḥśāstra* due to Pingree (cited above), the other important sources which provide us valuable information regarding the source-works in Indian Astronomy and Mathematics (and details regarding their published editions, translations, etc.), are the following:

- (i) Two monographs on Sanskrit Astronomical Tables in America and England by Pingree.¹⁸
- (ii) The seminal bibliography of the works of Kerala School of Astronomers by K. V. Sarma.¹⁹
- (iii) The survey of K. V. Sarma on the *Science Texts in the Manuscript Repositories of Kerala and Tamil Nadu* (cited above)

Here, we shall essentially make use of the above sources 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.

IV. Modern Scholarship in Indian Astronomy and Mathematics: An Assessment of its Progress over the last Two and a Half Centuries

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). In the initial period, most of the investigations were confined to the analysis and interpretation of Indian astronomical tables which had been transmitted to Europe from India (and

¹⁸ D. Pingree, *Sanskrit Astronomical tables in the United States*, American Philosophical Society, Philadelphia 1968; D. Pingree, *Sanskrit Astronomical Tables in England*, KSRI, Madras 1973.

¹⁹ K. V. Sarma, *A History of the Kerala School of Hindu Astronomy*, Vishveshvaranand Institute, Hoshiarpur 1972.

even Southeast Asia) during the course of the seventeenth and eighteenth centuries. More systematic studies of the source-works of Indian Astronomy and Mathematics began in the 1780s, some of which were published in the journal *Asiatic Researches* brought out by the Asiatic Society, established in Calcutta in 1784.

Source-works in Indian Astronomy and Mathematics Edited/Translated During 1800-1875

To start with, we consider the source-works which were edited/translated during the period 1800-1875. The first full-fledged translations of Indian Mathematics texts appeared during the decade, 1810-1820, starting with the translation of *Bījagaṇita* and *Līlāvātī* of Bhāskarācārya (c.1150), by E. Strachey and J. Taylor in 1813 and 1816. This was soon followed in 1817 by a more 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.²⁰ Colebrooke's work also included a translation of the Gaṇita and Kuṭṭaka chapters of the *Brāhmasphuṭasiddhānta* of Brahmagupta (c.628). In the meanwhile, there also appeared a brief translation, due to Benjamin Hyne, of the Geometry section of the Telugu work, *Pāvalūri Gaṇitamū* (which is said to be a translation of *Gaṇitasārasaṅgraha* of Mahāvīra (c.850)), by Mallāṇa (c.1100). However, for the next several decades, there seems to have been little progress in the translation of source-texts of Indian Mathematics, till George Thibaut took up the study of the *Śulvasūtras* in the 1870s.

Editions of Indian source-works started appearing in the 1830s. Here again, the Sanskrit texts of *Līlāvātī* 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. Another major publication in this series was the edition by H. Kern of the famous *Brhatsamhitā* of Varāhamihira (c.550). But the crowning achievement of this period was the publication from Leiden of an edition of the seminal text of Indian astronomy – the *Āryabhaṭīya* of Āryabhaṭa (c.499), along with the commentary *Bhaṭadīpikā* of the famous Kerala Astronomer Parameśvara (c.1430), by H. Kern in 1874.

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 Uḷlamuḍaiyān* (in Tamil) of Tirukkottiyūr 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

²⁰ H. T. Colebrooke, *Algebra with Arithmetic and Mensuration from the Sanscrit of Brahmagupta and Bhascara*, John Murray, London 1817.

Rev. Ebenezer Burgess, which was revised by William Dwight Whitney.²¹ 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. The other two works which were translated during this period were the *Br̥hatsamhitā* of Varāhamihira, which was translated by H. Kern during 1870-75, and the *Grahalāghava* of Gaṇeśa Daivajña (c.1520) which was published along with the *Udāharaṇa* of Viśvanātha (c.1600) and a Marathi Translation by K. S. Godbole and V. K. J. Gadre from Bombay in the 1870s.

Source-works in Indian Astronomy and Mathematics Edited/Translated During 1876-2019

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. The next seventy-odd years, 1876-1947, indeed saw a substantial increase in the number of source-works edited. 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 Sanskrit 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, whose 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. He also wrote a tract in Sanskrit, *Gaṇakatarāṅgiṇī*, on the lives of Indian Astronomers and Mathematicians.²² A really comprehensive history of Indian Astronomy was written in Marathi in 1895 by Sankara Balakrishna Dikshit, who took great pains to look through a large number of manuscripts and books to compile details of the works written by hundreds of Astronomers and Mathematicians from the ancient period to the modern times.²³ Incidentally, Dikshit mentions in his preface that the Aufrecht's *Catalogus Catalogorum* contains titles of 2,000 works of Indian Astronomy.

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 during the last two centuries. We have presented the detailed list in Appendix A. 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 66 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. These summary figures are given in Table 5, and the list of the titles translated is given in Tables 6A, 6B.

²¹ E. Burgess, *Translation of the Sūryasiddhānta with Notes and an Appendix*, American Oriental Society, New haven 1860. This work was first published in 1858 by the Journal of American Oriental Society.

²² Sudhakara Dvivedi, *Gaṇakatarāṅgiṇī*, Varanasi (1892)

²³ S. B. Dikshit, *Bhāratīya Sāstrācā Prācīna Āṇi Arvācīna Itihāsa* (in Marathi), Aryabhusan Press, Pune 1896. English Translation by R. V. Vaidya: *Bharatiya Jyotish Sastra*, 2 Volumes, Controller of Publications, Delhi, 1969, 1981.

Period	No of Source-works Edited	No. of Source-works Translated
1800-1875	15	10
1876-1947	About 135	20
1948-2019	About 300	66
Total	About 450	96

Table 5: Source-works of Indian Astronomy and Mathematics edited/translated during 1800-2019

Source-works of Indian Astronomy Which have been Edited/Translated	
Translated During 1800-1875	Translated During 1876-1947
<ol style="list-style-type: none"> 1. Vedāṅgajyotiṣa of Lagadha (c.1300-1100 BCE) 2. Bṛhatsamhitā of Varāhamihira (c.550 CE) 3. Brāhmasphuṭasiddhānta of Brahmagupta (c.628) (PART) 4. Sūryasiddhānta 5. Pāvalūriḡaṇitamamu (in Telugu) of Mallāṇa (c.1100) (PART) 6. Līlāvātī of Bhāskarācārya (c.1150) 7. Bījagaṇita of Bhāskarācārya (c.1150) 8. Siddhāntaśiromaṇi of Bhāskarācārya (c.1150) 9. Cūḍāmaṇi Uḷlamuḍaiyān (in Tamil) of Tirukkoṭṭiyūr Nambi (c.1234) 10. Grahalāghava of Gaṇeśa Daivajña (c.1520) 	<ol style="list-style-type: none"> 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. Khaṇḍakhādya of Brahmagupta (c.665) 11. Triśatikā of Śrīdhara (c.750) 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 Śātānanda (c.1099) 16. Makarandasāriṇī of Makaranda (1478) 17. Yantracintāmaṇi of Cakradhara (c.15th Century) 18. Tithicintāmaṇi of Gaṇeśa Daivajña (c.1530) 19. Sūryasiddhāntarahasya of Rāghavananda Śārman (c.1591) 20. Yantrarājaracanā of Savai Jayasimha (c.1725)
Edited During 1800-1875	
<ol style="list-style-type: none"> 1. Vedāṅgajyotiṣa of Lagadha (c.1300-1100 BCE) 2. Āryabhaṭīya of Āryabhaṭa (c.499 CE) 3. Bṛhatsamhitā of Varāhamihira (c.550) 4. Sūryasiddhānta 5. Līlāvātī of Bhāskarācārya (c.1150) 6. Bījagaṇita of Bhāskarācārya (c.1150) 7. Siddhāntaśiromaṇi of Bhāskarācārya (c.1150) 8. Mitākṣarā or Vāsanābhāṣya Autocommentary of Bhāskarācārya (c.1150) on Siddhāntaśiromaṇi 9. Cūḍāmaṇi Uḷlamuḍaiyān (in Tamil) of Tirukkoṭṭiyūr Nambi (c.1234) 10. Commentary on Vedāṅgajyotiṣa by Somākara (c.1350) 11. Bhaṭadīpikā on Āryabhaṭīya by Parameśvara (c.1430) 12. Grahalāghava of Gaṇeśa Daivajña (c.1520). 13. Commentary on Grahalāghava of Gaṇeśa Daivajña by Mallāri (c.1588) 14. Udāharāṇa on Grahalāghava of Gaṇeśa Daivajña by Viśvanātha (c.1600) 15. Gūḍhārthaprakāśaka on Sūryasiddhānta by Raṅganātha (c.1603) 	

Table 6A: List of source-works edited/translated during 1800-1875 and 1876-1947

Source-works of Indian Astronomy and Mathematics Translated During 1947-2019

<ol style="list-style-type: none"> 1. Parāśaratantra of Parāśara (c.1300-1100 BCE) 2. Kātyāyanaśulvasūtra 3. Bakṣālī Manuscript 4. Yavanaajātaka of Sphūjīdhvaja 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. Mahābhāskariya of Bhāskara I (c.620) 10. Brāhmasphuṭasiddhānta of Brahmagupta (c.628) 11. Āryabhaṭīyabhāṣya of Bhāskara I (c.629) 12. Laghubhāskariya of Bhāskara I (c.635) 13. Karaṇaratna of Devācārya (c.687) 14. Gaṇitapañcaviṃśī of Śrīdhara (c.750) 15. Pāṭīgaṇita of Śrīdhara (c.750) 16. Śiṣyadhīvr̥ddhida 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. Śulvadīpikā on Baudhāyanaśulvasūtra by Dvārakānātha Yajvan (c.12th century) 29. Pañcaviṃśatikā (c. 13th Century) 30. Gaṇitasārakaumudī (in Prākṛta) of Ṭhakkura Pherū (c.1320) 31. Gaṇitakaumudī of Nārāyaṇa Paṇḍita (c.1356) 32. Bījagaṇitāvataṃsa of Nārāyaṇa Paṇḍita (c.1356) (PART) 33. Yantrarāja of Mahendrasūri (c.1370) (PART) 34. Yantrādhikara of Padmanābha (c.1400) 35. Dhruvabhramaṇādhikara of Padmanābha (c.1400) (PART) 	<ol style="list-style-type: none"> 36. Sphuṭacandrāpti of Mādhava (c.1400) 37. Mahājyānayanaprakāra of Mādhava (c.1400) 38. Lagnaprakaraṇa of Mādhava (c.1400) (PART) 39. Grahaṇāṣṭaka of Parameśvara (c.1410) 40. Grahaṇamaṇḍana of Parameśvara (c. 1410) 41. Grahaṇanyāyadīpikā of Parameśvara (c.1432-33) 42. Goladīpikā II of Parameśvara (c.1432-33) 43. Goladīpikā I of Parameśvara (c. 1443-44) 44. Golasāra of Nīlakaṇṭha Somayājī (c.1500) 45. Tantrasaṅgraha of Nīlakaṇṭha Somayājī (c.1500) 46. Candracchāyāgaṇita of Nīlakaṇṭha Somayājī (c.1500) 47. Siddhāntadarpaṇa of Nīlakaṇṭha Somayājī (c.1500) 48. Autocommentary on Siddhāntadarpaṇa by Nīlakaṇṭha Somayājī (c.1500) 49. Grahasphuṭānāyane Vikṣepavāsanā of Nīlakaṇṭha Somayājī (c.1500) 50. Kuṭṭākāraśiromaṇi of Devarāja (c. 15th century) 51. Siddhāntasundara of Jñānarāja (c.1503) 52. Pratodayantra of Gaṇeśa Daivajña (c.1530) 53. Ekaviṃśatipraśnottara of Citrabhānu (c.1530) 54. Gaṇitayuktibhāṣā (in Malayalam) of Jyeṣṭhadeva (c.1530) 55. Sūryaprakāśa of Sūryadāsa on Bījagaṇita of Bhāskarācārya (c. 1538) 56. Buddhivilāsinī on Līlāvātī of Bhāskarācārya by Gaṇeśa Daivajña (c.1545) (PART) 57. Turīyayantraprakāśa of Bhūḍara (1572) 58. Karaṇapaddhati of Putumana Somayājī (c.1580) 59. Rāśīgolasphuṭanīti of Acyuta Piṣārati (c.1585) 60. Candrārākī of Dinakara (c.1589) 61. Bījapallava on Bījagaṇita of Bhāskarācārya by Kṛṣṇa Daivajña (c. 1600) (PART) 62. Sarvasiddhāntarāja of Nityānanda (c.1639) (PART) 63. Pāṭīsāra of Munīśvara (c.1650) (PART) 64. Karaṇakesarī of Bhāskara (c.1681) 65. Brahmatulyasāriṇī of Malūcakandra (c.17th Century) 66. Yantraprakāra of Savai Jayasimha (c.1725) 67. Sadratnamālā of Śaṅkaravarman (c.1819) 68. Siddhāntadarpaṇa of Candraśekhara Sāmanta (c.1869)
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Table 6B: List of Source-works translated during 1947-2019

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

As we saw, the period 1800-1875 saw several pioneering efforts to study the Indian tradition of Astronomy and Mathematics, but the overall number of source-texts which were edited or translated was indeed miniscule – 15 and 10, respectively, as noted in Table 5. An overview of what had been achieved by modern scholarship during the 19th century was presented by George Thibaut in 1899.²⁴

The next seventy-odd year period 1876-1947 did indeed see a significant increase both in the number of works edited and translated – 135 and 20, respectively, as noted in Table 5. Many more details of the concepts, techniques and achievements of Indian Mathematics had been unravelled by then and these were admirably summarised in the classic Volumes on the *History of Hindu Mathematics* by Bibhutibhusan Datta and Avadhesh Narayan Singh in the 1930s.²⁵ There is no similar overview of the state of our knowledge on Indian Astronomy in the 1930s – some idea can be had from the translation of *Khaṇḍakhādya* of Brahmagupta by Prabodhchandra Sengupta²⁶ and his introduction to the 1935 edition of the translation of *Sūryasiddhānta* by Burgess.²⁷

Compared to the state of our knowledge of Indian Astronomy and Mathematics in the 1940s, it may be said that substantial progress has been achieved in the last seventy years, mainly by the dedicated efforts of a large number scholars in studying, editing, translating and analysing the technical contents (mathematical and astronomical) of a number of important texts. As we noted in Table 5, during the period 1948-2019, it is estimated that nearly 300 source-works have been edited and 66 works have been translated – often with detailed explanatory notes. The impact of these editions/translations could already be seen in the review articles and books written on Indian Astronomy and Mathematics during the 1970s (or thereabout).²⁸

From the list of source-works translated during the period 1948-2019 as given in Appendix A, we can see that they include important works such as the *Śulvasūtras*, the *Bakṣāli Manuscript* and many seminal works of the renowned Astronomers/Mathematicians: Lagadha, Parāśara Sphūjīdhvaja, Āryabhaṭa, Varāhamihira, Bhāskara I, Brahmagupta, Devācārya, Śrīdhara, Lalla, Vateśvara,

²⁴ G. Thibaut, *Astronomie, Astrologie und Mathematik*, Karl J. Trubner, Strassburg 1899. There also the article, James Burgess, 'Notes on Hindu astronomy and the History of our Knowledge of it', *Journal of the Royal Society*, 25 (1893), pp. 717-761.

²⁵ B. B. Datta and A. N. Singh, *History of Hindu Mathematics A Source Book*, Parts I, II, Motilal Banarsi Das, Lahore 1935, 1938. In this context, we may also cite the important work of B. B. Datta: *The Science of the Śulba A Study in Early Hindu Geometry*, University of Calcutta, Calcutta 1932.

²⁶ P. C. Sengupta, *The Khaṇḍakhādya*, University of Calcutta, Calcutta 1934.

²⁷ P. C. Sengupta, 'Introduction', in P. Gangooly (Ed.), *Translation of Sūryasiddhānta by Ebenezer Burgess*, University of Calcutta, Calcutta 1935, pp. vii-li.

²⁸ See, for instance, the following:

1. C. N. Srinivasa Iyengar, *History of Indian Mathematics*, The World Press, Calcutta 1967.
2. D. M. Bose, S. N. Sen and B. V. Subbarayappa, *A Concise History of Science in India*, INSA, New Delhi 1971.
3. D. Pingree, "Mathematical Astronomy in India", in C. G. Gillespie (ed.), *Dictionary of Scientific Biography*, Vol. XV, New York 1978, pp. 533-633.
4. A. K. Bag, *Mathematics in Ancient and Medieval India*, Chowkhambha, Varanasi 1979.
5. T. A. Saraswati Amma, *Geometry in Ancient and Medieval India*, Motilal Banarsidas, Delhi 1979.
6. S. N. Sen and K. S. Shukla, (eds.), *History of Indian Astronomy*, Indian National Science Academy, New Delhi 1985.

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 Jayasimha, 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 books and monographs that have appeared since 1997,²⁹ and also in the various articles published in the two premier Indian Journals, *Indian Journal of History of Science* (published by the Indian National Academy of Sciences since 1966) and *Gaṇita Bhāratī* (published by the Indian Society of History of Mathematics since 1979).

²⁹ See, for instance, the following:

1. T. Hayashi, T. Kusuba and M. Yano, *Studies in Indian Mathematics: Series, π and Trigonometry* (in Japanese), Tokyo, 1997.
2. S. Paramesvaran, *The Golden age of Indian Mathematics*, Kochi 1998.
3. S. Balachandra Rao, *Indian Astronomy: An Introduction*, Universities Press, Hyderabad 2000.
4. M. S. Sriram, K. Ramasubramanian and M. D. Srinivas, Eds. *500 Years of Tantrasaṅgraha: A Landmark in the History of Astronomy*, IAS, Shimla 2002.
5. G. G. Emch, R. Sridharan and M. D. Srinivas (eds), *Contributions to History of Indian Mathematics*, Hindustan Book Agency, New Delhi 2005.
6. C. K. Raju, *Cultural Foundations of Mathematics: The Nature of Mathematical Proof and the Transmission of the Calculus from India to Europe in the 16th c. CE*, Pearson Education, Delhi 2007.
7. H. Selin and R. Narasimha (Eds.), *Encyclopaedia of Classical Indian Sciences*, Universities Press, Hyderabad 2007.
8. B. V. Subbarayappa, *The Tradition of Astronomy in India Jyotiṣśāstra*, Centre for Studies in Civilisations, New Delhi 2008.
9. S. R. Sarma, *The Archaic and the Exotic Studies in Indian Astronomical Instruments*, Manohar, New Delhi (2008).
10. J. V. Narlikar (Ed.), *Science in India*, Centre for Studies in Civilisations, New Delhi 2009.
11. S. Dash (Ed.), *Facets of Indian Astronomy A Collection of Articles of Prof. K. V. Sarma*, Rashtriya Sanskrit University, Tirupati 2009.
12. K. Plofker, *Mathematics in India*, Princeton University Press, Princeton, 2009.
13. C. S. Seshadri (Ed.), *Studies in the History of Indian Mathematics*, Hindustan Book Agency, New Delhi 2010.
14. T. Padmanabhan (Ed.), *Astronomy in India A Historical perspective*, INSA, New Delhi 2010.
15. C. Montelle, *Chasing Shadows Mathematics Astronomy and the Early History of Eclipse reckoning*, Johns Hopkins University Press, Baltimore (2011)
16. K. Ramasubramanian, M. D. Srinivas and M. S. Sriram, NPTEL Course on *Development of Mathematics in India from Vedic Period to Modern Times*, IIT Madras 2013 (<http://nptel.ac.in/courses/111101080/>)
17. I. Pingree and J. M. Steele (Eds.), *Pathways into the Study of Ancient Sciences Selected Essays by David Pingree*, The American Philosophical Society Press, Philadelphia 2014.
18. K. Ramasubramanian (Ed.), *Gaṇitānanda Selected Works of Radha Charan Gupta on History of Mathematics*, ISHM, New Delhi 2015.
19. G. G. Joseph, *Indian Mathematics Engaging the World from Ancient to Modern Times*, World Scientific, London 2016.
20. K. Ramasubramanian, A. Sule and M. Vahia (Eds.), *History of Indian Astronomy A Handbook*, IIT Mumbai 2016.
21. H. Selin (Ed.), *Encyclopaedia of the History of Science Technology and Medicine in the Non Western Cultures*, 3rd Ed., Springer, New York 2016.
22. P. P. Divakaran, *The Mathematics of India Concepts Methods Connections*, Hindustan Book Agency 2018. Rep Springer New York 2018.
23. A. Kolachana, K. Mahesh and K. Ramasubramanian (Eds.), *Studies in Indian Mathematics and Astronomy Selected Articles of Kripa Shankar Shukla*, Hindustan Book Agency, New Delhi 2019.
24. K. Ramasubramanian, T. Hayashi and C. Montelle (Eds.), *Bhāskara-prabhā*, Hindustan Book Agency, New Delhi 2019.
25. C. Montelle and K. Plofker, *Sanskrit Astronomical Tables*, Springer, New York 2019.

V. 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 have put together a representative list of 190 important source-works which are yet to be edited and published. This list is presented in Appendix B and we may note that, as per the details given in the bibliographies of Pingree and Sarma cited above, manuscripts of these works are listed in various catalogues. This 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.

In conclusion, we would like to emphasise 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:

1. 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.
2. Further, even among the 450 or so published works, only about 96 texts have been seriously studied and explicated via translations and explanatory commentaries with a view to bring out their technical (mathematical-astronomical) content.
3. 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.

Appendix A: Source-Works of Indian Astronomy and Mathematics which have been Translated

1. Vedāngajyotiṣa of Lagadha (c.1300-1100 BCE)
 - a. English Translation by Jervis (1836)
 - b. German Translation with Notes by Albrecht Weber (1862)
 - c. English Translation of a Portion with Notes by George Thibaut (1877)
 - d. Marathi Translation by J. B. Modak (1884)
 - e. English Translation with Notes by Lala Chotelala (1906)
 - f. English Translation with Notes by R. Shamasastri (1936)
 - g. Bengali Translation by Suresh Chandra Bhattacharya (1971)
 - h. English Translation with Notes by T. S. Kuppanna Sastri and K V. Sarma (1984)
 - i. English Translation with Notes by H. M. Jani (1985)
 - j. English Translation with Notes by P. V. Holay (1989-90)
 - k. Hindi Translation with Notes by S. A. Kaundinyayana (2005)
 - l. Kannada Translation with Notes by S. Balachandra Rao (2007)
2. Parāśaratantra of Parāśara (c.1300-1100 BCE)
 - a. English Translation of available portions with Notes by R. N. Iyengar (2013)
3. Baudhāyanaśulvasūtra (Prior to c.800 BCE)
 - a. English Translation with Notes by George Thibaut (1874-77)
 - b. Marathi Translation by R. P. Kulkarni (1978)
 - c. English Translation with Notes by S. N. Sen and A. K. Bag (1983)
 - d. French Translation with Notes by J. M. Delire (2016)
4. Āpastambaśulvasūtra (Prior to c.800 BCE)
 - a. German Translation by A. Burk (1901-2)
 - b. English Translation by Satya Prakash & R. S. Sarma (1968)
 - c. Marathi Translation by R. P. Kulkarni (1978)
 - d. Japanese Translation with Notes by Yosuke Ikari (1980)
 - e. English Translation with Notes S. N. Sen and A. K. Bag (1983)
5. Kātyāyanaśulvasūtra
 - a. English Translation of First Two Chapters by George Thibaut (1882)
 - b. English Translation with Notes by S. B. Khadilkar (1974)
 - c. Marathi Translation by R. P. Kulkarni (1978)
 - d. English Translation with Notes S. N. Sen and A. K. Bag (1983)
6. Mānavaśulvasūtra
 - a. English Translation with Notes by N. K. Majumdar (1922)
 - b. English Translation with Notes by J. M. Van Gelder (1963)
 - c. Marathi Translation by R. P. Kulkarni (1978)
 - d. English Translation with Notes S. N. Sen and A. K. Bag (1983)
7. Atharvaṅajyotiṣa
 - a. Hindi Translation by C. L. Sarma and O. N. Dvivedi
 - b. Hindi Translation with Notes by Abhaya Katyayana (2004)
8. Sūryaprajñapti (in Prākṛta)
 - a. Hindi Translation by Amolaka Rsi (1910)
9. Candraprajñapti (in Prākṛta)
 - a. Hindi Translation by Amolaka Rsi (1909)

10. Bakṣāli Manuscript
 - a. English Translation with Notes by T. Hayashi (1995)
11. Yavanajātaka of Sphūjīdhvaja
 - a. English Translation with Notes by D. Pingree (1978)
 - b. English Translation of Chapter 79 with Notes by B. Mak (2013)
12. Candravākya of Vararuci (c. 4th Century CE)
 - a. English Translation and Notes by K. Kunjinni Raja (1948)
 - b. English Translation and Notes by T. S. Kuppanna Sastri and K. V. Sarma (1962)
13. Tiloyapaṇṇatti (in Prakṛta) of Yativṛṣabha (c. 5th Century CE)
 - a. Hindi Tr. by Vishuddhamati Mataji (1984-86)
14. Āryabhaṭasiddhānta of Āryabhaṭa (c.499)
 - a. English Translation of Yantrādhyāya with Notes by Kripa Shankar Shukla (1967)
15. Āryabhaṭīya of Āryabhaṭa (c.499)
 - a. Telugu Commentary Sudhātaraṅga by Kodaṇḍarāma Siddhānti (Composed 1844, Published 1956)
 - b. Marathi Translation (1860)
 - c. French Translation of Gaṇitapāda with Notes by L. Rodet (1879)
 - d. Hindi Translation with Notes by Udaya Narayana Singh (1906)
 - e. English Translation of Gaṇitapāda by G. R. Kaye (1908)
 - f. English Translation with Notes by Baidyanath Rath Sastri (University of Chicago Dissertation, Unpublished 1924).
 - g. Malayalam Translation of Gitikāpāda by Kolatheri Sankara menon (1927)
 - h. English Translation with Notes by P. C. Sengupta (1927).
 - i. English Translation with Notes by W. E. Clark (1930).
 - j. Hindi Translation by B. Mishra (1966)
 - k. German Translation by Kurt Elfering (1975)
 - l. English Translation with Notes by K. S. Shukla and K. V. Sarma (1976)
 - m. Hindi Translation by R. N. Rai (1976)
 - n. Kannada Translation by N. K. Narasimha Murthy (1978)
 - o. Japanese Translation with Notes by Michio Yano (1980)
 - p. Malayalam Translation by P. S. Purushottaman Namputiri
 - q. Kannada Translation with Notes by S. Balachandra Rao (2015)
16. Pañcasiddhāntikā of Varāhamihira (c.550)
 - a. English Translation with Notes by George Thibaut and Sudhakara Dvivedi (1889)
 - b. English Translation with Notes by O. Neugebauer and D. Pingree (1970-71)
 - c. English Translation with Notes by T. S. Kuppanna Sastri and K. V. Sarma (1985)
17. Bṛhatsamhitā of Varāhamihira (c.550)
 - a. English Translation with Notes by H. Kern (1870-75)
 - b. Marathi Translation (1873)
 - c. Hindi Translation with Notes by Balasastri Prabhu (1880)
 - d. Hindi Translation by Durgaprasada (1884)
 - e. English Translation with Notes by N. Chidambara Iyer (1884-85)
 - f. Bengali Translation by Rasikamohan Chattopadhyaya (1890)
 - g. Hindi Translation by Baladev Prasad Mishra (1897)
 - h. Bengali Translation by Dhirananda Kavyanidhi (1910)

- i. English Translation with Notes by V. Subrahmanya Sastri and M. Ramakrishna Bhat (1947)
 - j. Malayalam Translation by P. S. Purushottamana nambutiri (1955)
 - k. Hindi Translation with Notes by Achyutananda Jha (1959)
 - l. English Translation with Notes by M. Ramakrishna Bhat (1981-82)
18. Paitāmahāsiddhānta of Viṣṇudharmottarapurāṇa
- a. Translation with Notes by D. Pingree (1967-68)
19. Mahābhāskarīya of Bhāskara I (c.620)
- a. English Translation with Notes by Kripa Shankar Shukla (1960)
20. Brāhmasphuṭasiddhānta of Brahmagupta (c.628)
- a. English Translation of Gaṇitādhyāya and Kuṭṭakādhyāya with Notes by H. T. Colebrooke (1817)
 - b. Hindi Translation with Notes by R. S. Sharma (1966)
21. Āryabhaṭīyabhāṣya of Bhāskara I (629)
- a. English Translation of Gaṇitapāda with Notes by A. Keller (2006)
22. Laghubhāskarīya of Bhāskara I (c.635)
- a. English Translation with Notes by Kripa Shankar Shukla (1963)
23. Khaṇḍakhādyaka of Brahmagupta (c.665)
- a. English Translation with Notes by P. C. Sengupta (1934)
 - b. English Translation with Notes by Bina Chatterjee (1970)
24. Karaṇaratna of Devācārya (c.687)
- a. English Translation with Notes by Kripa Shankar Shukla (1979)
25. Sūryasiddhānta
- a. Bengali Translation (1842)
 - b. French Translation of two Chapters by J. M. F. Guerin (1847)
 - c. English Translation by with Notes Burgess and Whitney (1860)
 - d. English Translation by Bāpū Deva Śāstri (1861)
 - e. Bengali Translation by Rasika Mohan Chattopadhyaya (1887)
 - f. Hindi Translation with Notes by Baladev Prasad Misra (1896)
 - g. Hindi Translation by Uday Narayan Singh (1903)
 - h. Hindi Translation by Girija Prasad Divedi (1906)
 - i. Bengali Translation by Swami Vigyanananda and Hariprasad Chattopadhyaya (1909)
 - j. Hindi Translation with Notes by Mahavir Prasad Srivastava (1940)
 - k. Malayalam Translation by P. S. Purushottaman Nambutiri (1950)
 - l. English Translation with Notes by A. K. Chakravarty (2001)
 - m. English Translation by Bimalananda Saraswati (2007)
26. Gaṇitapañcaviṃśī of Śrīdhara (c.750)
- a. English Translation with Notes by D. Pingree (1989)
 - b. English Translation with Notes by Kripa Shankar Shukla (2017)
27. Pāṭīgaṇita of Śrīdhara (c.750)
- a. English Translation with Notes by Kripa Shankar Shukla (1959)
 - b. Russian Translation with Notes by A. Volodarskii (1966)
28. Triśatikā of Śrīdhara (c.750)

- a. English Translation of a portion by N. Ramanujacarya and G.R. Kaye (1912-13)
 - b. Hindi Translation with Notes by Sudyumna Acharya (2004)
29. Śiṣyadhīvrddhida of Lalla (c.750)
- a. English Translation with Notes by Bina Chatterjee (1981)
30. Dhavalā (in Prākṛta) of Vīrasena (c.800) on Ṣaṭkhaṇḍāgama of Puṣpadanta and Bhūtabali
- a. Hindi Translation by Hiralal Jain (1940-50)
31. Gaṇitasārasaṅgraha of Mahāvīra (850)
- a. English Translation with Notes by M. Rangacharya (1912)
 - b. Hindi Translation with Notes by L. C. Jain (1963)
 - c. Kannada Translation with Notes by Padmavatamma (2000)
32. Vāsanābhāṣya on Brāhmasphuṭasiddhānta of Brahmagupta by Pṛthūdakasvāmi (860)
- a. English Translation of Chapter XXI with Notes by S. Ikeyama (2003)
33. Vaṭeśvara Siddhānta of Vaṭeśvara (c.904)
- a. Hindi Translation of first three Chapters with Notes by R. S. Sharma and Mukund Mishra (1962)
 - b. English Translation with Notes by Kripa Shankar Shukla (1985-6)
34. Laghumānasa of Muñjāla (c.932)
- a. English Translation with Notes by N. K. Majumdar (1944)
 - b. English Translation with Notes by Kripa Shankar Shukla (1990)
35. Mahāsiddhānta of Āryabhaṭa II (c.950)
- a. English Translation of the Grahagaṇita part with Notes by S. R. Sarma (1966)
36. Karaṇatilaka of Vijayanandi (c.966)
- a. English Translation of Al Biruni's Arabic Translation (Ghurrat al Zijat) with Notes by S. S. H. Rizvi (1963)
 - b. English Translation of Al Biruni's Arabic Translation (Ghurrat al Zijat) with Notes by Quraishi (1978)
37. Trilokasāra (in Prākṛta) of Nemicandra (c.975)
- a. Hindi Translation by Vishuddhamati (1975)
38. Dhīkoṭīdakaraṇa of Śrīpati (c.1039)
- a. English Translation with Notes by K. S. Shukla (1969)
39. Siddhāntaśekhara of Śrīpati (c.1039)
- a. English Translation of the Vyakta and Avyakta-Gaṇita Chapters by K. N. Sinha (1986-89)
40. Gaṇitatilaka of Śrīpati (c.1039)
- a. English Translation by Kripa Nath Sinha (1982)
41. Bhāsvatī of Śatānanda (c.1099)
- a. Hindi Translation with Notes by Matriprasada Pandeya (1917)
42. Pāvalūrigaṇitam (in Telugu) of Mallāṇa (c.1100)
- a. English Translation of Geometry portion by Benjamin Hyne (1814)

43. *Līlavatī* of Bhāskarācārya (c.1150)
- a. English Translation with Notes by J. Taylor (1816)
 - b. English Translation with Notes by H. T. Colebrooke (1817)
 - c. Telugu Translation with Notes Tadakamalla Venkata Krishnarav (1863)
 - d. Hindi Translation (1876)
 - e. Marathi Translation with Notes by V. P. Khanapurkar (1897)
 - f. Hindi Translation with Notes by R. S. Sarma (1905)
 - g. Telugu Translation by V. Lakshminarayana Sastri (1934)
 - h. Telugu Translation with Notes by P. Krishnamurthy Sastri (1936)
 - i. Malayalam Translation by P. K. Koru (1954)
 - j. Hindi Translation with Notes by Lashan Lal Jha (1961)
 - k. Kannada Translation with Notes by K. S. Nagarajan (1961)
 - l. Hindi Translation with Notes by Sita Rama Jha (1970)
 - m. Marathi Translation with Notes by N. H. Phadke (1971)
 - n. Hindi Translation by Ramajanma Mishra (1971)
 - o. Japanese Translation with Notes by Takao Hayashi (1980)
 - p. English Translation with Notes by K. S. Patwardhan, S. A. Naimpally and S. L. Singh (2001)
 - q. French Translation of some Chapters with Notes by Francois Patte (2004)
 - r. English Translation with Notes by A. B. Padmanabha Rao (2014, 2016)
44. *Bījagaṇita* of Bhāskarācārya (c.1150)
- a. English Translation (of the Persian Translation Ata Alla Rushdi in 1634) by E. Strachey with Notes by S. Davis (1813)
 - b. English Translation with Notes by H. T. Colebrooke (1817)
 - c. German Translation of some Chapters with Notes by H. Brockhous (1852)
 - d. Marathi Translation with Notes by V. P. Khanapurkar (1913)
 - e. Hindi Translation with Notes by Durgaprasada Dviveda (1917)
 - f. Hindi Translation by Visuddhananda Gaur (1943)
 - g. Hindi Translation with Notes by Achyutananda Jha (1949)
 - h. Malayalam Translation by P. K. Koru (1960)
 - i. Hindi Translation by Ramajanma Mishra (1971)
 - j. English Translation by S. Abhayankar (1980)
 - k. Hindi Translation with Notes by Devachandra Jha (1983)
 - l. French Translation with Notes of some Chapters by Francois Patte (2004)
 - m. English Translation with Notes by V. B. Panicker (2006)
 - n. English Translation with Notes by T. Hayashi (2009)
45. *Siddhāntaśiromaṇi* of Bhāskarācārya (c.1150)
- a. Marathi Translation *Siddhāntaśiromaṇiprakāśa* (1837)
 - b. Latin Translation of *Grahagaṇitādhyāya* by E. Roer (1844)
 - c. English Translation of *Golādhyāya* by Lancelot Wilkinson and Bāpū Deva Śāstri (1861)
 - d. Bengali Translation of *Golādhyāya* with notes by Rasika Mohana Chattopadhyaya (1887)
 - e. Hindi Translation with Notes by Uday Narayan Singh (1905)
 - f. Hindi Translation with Notes by Girija Prasada Dvivedin (1911, 1926)
 - g. Marathi Translation with Notes by V. M. Khanapurkar (1911-13)
 - h. Bengali Translation of *Golādhyāya* with Notes by Radhavallabha (1921-26)
 - i. Hindi Translation with Notes by Kedara Datta Joshi (1961-64, 1988)
 - j. English Translation of *Grahagaṇitādhyāya* with Notes by Dhulipala Arka Somayaji (1981)
46. *Vāsanābhāṣya* Autocommentary of Bhāskarācārya on *Bījagaṇita* (c.1150)

- a. English Translation with Notes by T. Hayashi (2009)
47. Mītakṣarā or Vāsanābhāṣya Autocommentary of Bhāskarācārya on Siddhantaśiromaṇi (c.1150)
- a. English Translation of the Vāsanābhāṣya on two chapters of Grahagaṇitādhyāya by Bimalananda Sarasawati (2007)
48. Karaṇakutūhala of Bhāskarācārya (c.1183)
- a. English Translation with Notes by S. Balachandra Rao and S. K. Uma (2008)
49. Śulvadīpikā on Baudhāyanaśulvasūtra by Dvārakānātha Yajvan (c.12th century)
- a. French Translation with Notes by J. M. Delire (2016)
50. Cūḍamaṇi Uḷḷamuḍaiyān (in Tamil) of Tirukkoṭṭiyūr Nambi (c.1234)
- a. English Translation with Notes by Hoisington (1848)
51. Pañcaviṃśatikā (c. 13th Century)
- a. English Translation with Notes by T. Hayashi (1991)
52. Gaṇitasārakaumudī (in Prākṛta) of Ṭhakkura Pherū (c.1320)
- a. English Translation with Notes by SAKHYA (S. R. Sarma, T. Kusuba, T. Hayashi and M. Yano) (2009)
53. Gaṇitakaumudī of Nārāyaṇa Paṇḍita (c.1356)
- a. Japanese Translation of Chapter 14 by T. Hayashi (1986)
- b. English Translation of Chapters 13, 14, with Notes by T. Kusuba (Brown University Dissertation, Unpublished 1993)
- c. English Translation with Notes by Parmanand Singh (1998-2002)
54. Bījagaṇitāvataṃsa of Nārāyaṇa Paṇḍita (c.1356)
- a. English Translation of a portion with Notes by T. Hayashi (2004)
55. Yantrarāja of Mahendrasūri (1370)
- a. English Translation of Chapters 1, 2 by S. R. Sarma (2012)
56. Yantrādhikāra of Padmanābha (1400)
- a. English Translation with Notes by Y. Ohashi (1997)
57. Dhruvabhramaṇādhikāra of Padmanābha (1400)
- a. English Translation of a portion with Notes by S. R. Sarma (2012)
58. Sphuṭacandrāpti of Mādhava (c.1400)
- a. English Translation with Notes by K. V. Sarma (1973)
59. Mahājyānayanaprakāra of Mādhava (c.1400)
- a. Eng. Translation with Notes by D. Gold and D. Pingree (1991)
60. Madhyamānayanaprakāra of Mādhava (c.1400)
- a. Eng. Translation with Notes by U. K. V. Sarma, Venkateswara Pai and K. Ramasubramanian (2011)
61. Lagnaprakaraṇa of Mādhava (c.1400)
- a. English Translation with Notes of Some Chapters by A. Kolachana (I. I. T. Bombay Dissertation, Unpublished 2018)

62. Grahaṇāṣṭaka of Parameśvara (c.1411)
 - a. English Translation by K. V. Sarma (1958-59)
63. Grahaṇamaṇḍana of Parameśvara (c. 1411)
 - a. English Translation with Notes by K. V. Sarma (1965)
64. Grahaṇanyāyadīpikā of Parameśvara (c.1432-33)
 - a. English Translation with Notes by K. V. Sarma (1966)
65. Goladīpikā II of Parameśvara (c.1432-33)
 - a. English Translation with Notes by Sho Hirose (University of Paris Dissertation, Unpublished 2017)
66. Goladīpikā I of Parameśvara (c. 1443-44)
 - a. English Translation with Notes by K. V. Sarma (1957)
67. Makarandasāriṇī of Makaranda (1478)
 - a. Hindi Translation with Notes by Gangadhara Tandon (1935)
 - b. Hindi Translation with Notes by Ramajanma Mishra (1982)
68. Yantracintāmaṇi of Cakradhara (c.15th Century)
 - a. Hindi Translation with Notes by Bhagirathi Prasada Sarman (1883)
 - b. Hindi Translation with Notes by Sundaradeva Sarman (1898)
69. Tantrasaṅgraha of Nīlakaṇṭha Somayājī (c.1500)
 - a. English Translation with Notes by V. S. Narasimhan (1998-99)
 - b. English Translation with Notes by K. Ramasubramanian and M. S Sriram (2011)
70. Candracchāyāgaṇita by Nīlakaṇṭha Somayājī (c.1500)
 - a. English Translation by K. V. Sarma (1976)
71. Siddhāntadarpaṇa of Nīlakaṇṭha Somayājī (c.1500)
 - a. English Translation with Notes by K. V. Sarma (1976)
72. Autocommentary on Siddhāntadarpaṇa by Nīlakaṇṭha Somayājī (c.1500)
 - a. English Translation with Notes K. Mahesh (I. I. T. Bombay Dissertation, Unpublished 2009)
73. Grahasphuṭānayanane Vikṣepavāsānā of Nīlakaṇṭha Somayājī (c.1500)
 - a. English Translation with Notes by K. Ramasubramanian and M. S Sriram (2011)
74. Kuṭṭākāraśiromaṇi of Devarāja (c. 15th century)
 - a. English Translation with Notes by T. Hayashi (2011)
75. Siddhāntasundara of Jñānarāja (c.1503)
 - a. English Translation with Notes by Toke Knudsen (2014)
76. Grahalāghava of Gaṇeśa Daivajña (c.1520)
 - a. Marathi Translation with Notes by K. S. Godbole and V. S. J. Gadre (1873)
 - b. Bengali Translation with Notes by Rasika Mohan Chattopadhyaya (1887)
 - c. Hindi Translation with Notes by Jiyarama Sastri and Ramesvara Bhatta (1899)
 - d. Telugu Translation with Notes by Mangipudi Virayya Siddhantigar (1917)

- e. Hindi Translation with Notes by Sitarama Jha (1941)
 - f. Hindi Translation with Notes by Yugesvara Jha Sastri (1946)
 - g. Hindi Translation with Notes by Ramachandra Pandeya (1976)
 - h. Hindi Translation with Notes by Kedaradatta Joshi (1983)
 - i. Hindi Translation with Notes by Brahmananda Tripathi (1987)
 - j. Hindi Translation with Notes by Ramasvarupa Bambai (1987)
 - k. English Translation with Notes by S. Balachandra Rao and S. K. Uma (2006)
77. Tithicintāmaṇi of Gaṇeśa Daivajña (c.1530)
- a. Hindi Translation with notes by Matriprasada Pandeya (1938)
 - b. Eng. Translation with Notes by S. Ikeyama and K. Plofker (2001)
78. Pratodayantra of Gaṇeśa Daivajña (c.1530)
- a. English Translation with Notes by Shakti Dhara Sarma (1982)
79. Ekaviṃśatipraśnottara of Citrabhānu (c.1530)
- a. English Translation with Notes by T. Hayashi and Y. Kusuba (1998)
80. Gaṇitayuktibhāṣā (in Malayalam) of Jyeṣṭhadeva (c.1530)
- a. Malayalam Commentary of Gaṇita section by Ramavarma Maru Thampuran and Akhilesvara Aiyar (1948)
 - b. English Translation With Notes by K. V. Sarma, K. Ramasubramanian, M. D. Srinivas and M. S. Sriram (2008)
81. Sūryaparakāśa on Bījagaṇita of Bhāskarācārya by Sūryadāsa (c. 1538)
- a. English Translation of Chapters 1-4 with Notes by Pushpa Kumari Jain (2001)
82. Buddhivilāsinī on Līlāvātī of Bhāskarācārya by Gaṇeśa Daivajña (c.1545)
- a. English Translation of selected portions by K. Ramakalyani (Madras University Dissertation, Unpublished 2016)
83. Turīyayantraparakāśa of Bhūdara (1572)
- a. English Translation with Notes by SAKHYA (S. R. Sarma, T. Kusuba, T. Hayashi and M. Yano) (2014)
84. Karaṇapaddhati of Putumana Somayājī (c.1580)
- a. Malayalam Translation with Notes by P. K. Koru (1953)
 - b. English Translation with Notes by R. Venkatesvara Pai, K. Ramasubramanian, M. S. Sriram and M. D. Srinivas (2017)
85. Rāśigolasphuṭanīti of Acyuta Piṣāraṭi (c.1585)
- a. English Translation by K. V. Sarma (1977)
86. Candrārki of Dinakara (c.1589)
- a. English Translation of portion with Notes by A. Kolachana, C. Montelle, J. Dhammaloka, K. Melnad, K. Mahesh, P. Vyas, K. Ramasubramanian, M. S. Sriram and Venkatesvara Pai (2018)
87. Bījapallava on Bījagaṇita of Bhāskarācārya by Kṛṣṇa Daivajña (c. 1600)
- a. English Translation of some Portions by M. D. Srinivas (1987)
 - b. English Translation of some Portions by Sita Sundarram (2012)
88. Sūryasiddhāntarahasya of Rāghavānanda Śarman (c.1591)
- a. Bengali Translation with Notes by Rajanikanta Vidyavinoda (1915)

89. Sarvasiddhāntarāja of Nityānanda (c.1639)
 - a. English Translation of the Trigonometry Section with Notes by C. Montelle, K. Ramasubramanian and J. Dhammaloka (2016-18)
 - b. Eng. Translation of the Golādhya with Notes by Anuj Misra (University of Canterbury Dissertation, Unpublished 2016)
90. Pāṭisāra of Munīśvara (c.1650)
 - a. English Translation of Chapters 1, 2, with Notes by Parmanand Singh and Balesvara Singh (2004-5)
91. Karaṇakesarī of Bhāskara (c.1681)
 - a. English Translation with Notes by C. Montelle and K. Plofker (2014)
92. Brahmatulyasāriṇī of Malūkacandra (17th Century)
 - a. English Translation with Notes by C. Montelle and K. Plofker (2015)
93. Yantrarājaraṇā of Savai Jayasimha (c.1725)
 - a. English Translation with Notes by A. F. Garret and C. Guleri (1924)
94. Yantraprakāra of Savai Jayasimha (c. 1725)
 - a. English Translation with Notes by S. R. Sarma (1989)
95. Sadratnamālā of Śaṅkaravarman (1819)
 - a. English Translation with Notes by S. Madhavan (2011)
96. Siddhāntadarpaṇa of Candraśekhara Sāmanta (1869)
 - a. Oriya Translation with Notes by Pandit B. Sastri (1976)
 - b. Hindi Translation by A. K. Upadhyaya (1996)
 - c. English Translation with Notes by A. K. Upadhyaya (1996)

Appendix B: Some Important Source-works of Indian Astronomy and Mathematics which are yet to be Edited and Published

1. Vṛddhagargasamhitā
2. Gargasamhitā
3. Prakāṭārthadīpikā on Uttarabhāga of Horāśāstra of Parāśara by Govindasvāmi (c.800 CE)
4. Vāsanābhāṣya on Brāhmasphuṭasiddhānta by Pṛthūdaka (c.860)
5. Commentary on Laghumānasa by Praśastidhara (c.958)
6. Commentary on Khaṇḍakhādyaka of Brahmagupta by Varuṇa (c.1044)
7. Commentary on Khaṇḍakhādyaka of Brahmagupta by Someśvara (c.1050)
8. Sundarī on Laghubhāskariya of Bhāskara I by Udayadivākara (c.1073)
9. Pāvalūriḡaṇitamū (in Telugu) of Mallaṇa (c.1100)
10. Commentary on Sūryasiddhānta by Mallikārjuna Sūri (c.1178)
11. Commentary on Sūryasiddhānta by Caṇḍeśvara (c.1185)
12. Commentary on Laghumānasa by Sūryadevayajvan (c.1191)
13. Giragaspuṭam (in Tamil) of Tirukkottī Nambi (c.1234)
14. Sūryasiddhāntapradīpa of Bhāskara Yogin (c.1235)
15. Karaṇakaṇṭhīraṇa of Keśavārka (c.1250)

16. Bālabodha (in Kannada) on Gaṇitasārasaṅgraha of Mahāvīra by Daivajña Vallabha (c. 13th century)
17. Vārṣikatantra of Viḍḍaṇācārya (c.1300)
18. Bhūgolanirṇaya with Autocommentary Bhūgolaprakāśa of Vedāntadeśika (c.1300)
19. Subodha on Bhāsvatī of Śātānanda by Kuvera Śarman (c.1307)
20. Mahādevasāriṇī of Mahādeva (c.1316)
21. Grahasiddhi of Mahādeva (c.1316)
22. Kāmadhenu of Mahādeva (1357)
23. Brahmātulyabhāṣya on Karaṇakutūhala of Bhāskarācārya by Ekanātha (c.1370)
24. Karaṇakaṇṭhīrava or Karaṇakesarī of Īśvara (c.1375)
25. Vāsanārṇava on Sūryasiddhānta by Madanapāla (c.1375)
26. Jyotirājakaraṇa of Jyotirāja (c.1382)
27. Bhaṭapradīpa on Āryabhaṭīya by Bhūtaviṣṇu (c. 14th cent)
28. Gurukāṭākṣa on Sūryasiddhānta by Bhūtaviṣṇu (c. 14th cent)
29. Gaṇakopakāriṇī on Sūryasiddhānta by Colasūrī (c.14th Century)
30. Gūḍhārhadīpikā on Somasiddhānta by Nṛsimha (c.1400)
31. Nārmadī on Karaṇakutūhala of Bhāskarācārya by Padmanābha (c.1400)
32. Yantraratnāvalī with Autocommentary of Padmanābha (c.1400)
33. Aḡaṇitagrahacāra of Mādhava (c.1410)
34. Lagnaprakaraṇa of Mādhava (c.1410)
35. Bhaṭātulya of Dāmodara (c.1417)
36. Sūryātulya of Dāmodara (c.1417)
37. Gaṇitāmṛtasāgarī on Līlāvātī by Gaṅgādhara (c.1420)
38. Candracchāyāgaṇita by Parameśvara (c.1430)
39. Commentary on Vyatīpātāṣṭaka by Parameśvara (c.1430)
40. Vākyakaraṇa by Parameśvara (c.1430)
41. Vivaraṇa on Līlāvātī by Parameśvara (c.1430)
42. Cāndramāna of Gaṅgādhara (c.1434)
43. Subodhinī on Sūryasiddhānta by Rāmakṛṣṇa Ārādhyā (c.1472)
44. Commentary on Bhaṭaparakāśa of Sūryadevyajvan by Yallayya (c.1480)
45. Kalpavallī on Sūryasiddhānta by Yallayya (c.1480)
46. Kalpalatā on Laghumānasa by Yallayya (c.1480)
47. Āndhraṭīkā on Grahacandrikāgaṇita of Ākhaṇḍāla Perājyosyalu by Appayya (c.1491)
48. Bālabodhinī on Bhāsvatī of Śātānanda by Balabhadra (c. 1495)
49. Grahakautuka of Keśava (c.1496)
50. Sudhīraṅjanī of Keśava (c.1496)
51. Commentary on Sūryasiddhānta by Sundararāja (c.1500)
52. Bījādhyāya of Jñānarāja (c.1503)
53. Ratnamālā on Bhāsvatī of Śātānanda by Acyutabhaṭṭa (c.1505)
54. Ṭīkā on Līlāvātī by Lakṣmīdāsa (c.1501)
55. Gaṇitatattvacintāmaṇi on Siddhāntaśiromaṇi of Bhāskarācārya by Lakṣmīdāsa (c.1501)
56. Uparāgadarpaṇa of Tippasūrī (c.1507)
57. Jyotiṣavākya of Gopendra Tipparāja (c.1520)
58. Tantraratna of Gopendra Tipparāja (c.1520)
59. Pātasāriṇī of Gaṇeśa (c.1525)
60. Cābukayantra of Gaṇeśa (c.1525)
61. Sudhīraṅjanayantra of Gaṇeśa (c.1525)

62. Jyotiḥsārasaṅgraha of Gaurīnātha Śarman (c.1528)
63. Uparāgakriyākrama of Nārayaṇa (c.1525)
64. Commentary on Siddhāntasundara of Jñānarāja by Cintāmaṇi (c.1530)
65. Grahagaṇitakalpataru with Autocommentary by Gopīrāja Paṇḍita (c.1540)
66. Vilāsavatī on Yantrarāja of Mahendra Sūri by Gopīrāja (c.1540)
67. Commentary on Lilāvati by Sūryadāsa (c.1540)
68. Commentary on Bījagaṇita by Sūryadāsa (c.1540)
69. Grahakaumudī of Nṛsimha (c.1548)
70. Kheṭamuktāvalī of Nṛsimha (c.1548)
71. Ayanacalanādigaṇita (in Malayalam) of Śaṅkara of Mahiṣamaṅgalam (c. 1540)
72. Candragaṇitakrama (in Malayalam) of Śaṅkara of Mahiṣamaṅgalam (c. 1540)
73. Pañcabodhagaṇitasāra (in Malayalam) of Śaṅkara of Mahiṣamaṅgalam (c. 1540)
74. Pancbodhakriyākrama (in Malayalam) of Śaṅkara of Mahiṣamaṅgalam (c. 1540)
75. Kriyākālāpa by Śaṅkara Vāriyar (c.1550)
76. Karaṇasāra with Autocommentary by Śaṅkara Vāriyar (c.1550)
77. Laghuvivṛti on Pañcabodha by Śaṅkara Vāriyar (c.1550)
78. Candracchāyāgaṇita of Putumana Somayājī (c.1570)
79. Apamādinirṇaya of Putumana Somayājī (c.1570)
80. Candracchāyāgaṇitadaśaka of Putumana Somayājī (c.1570)
81. Grahaṇagaṇita of Putumana Somayājī (c.1570)
82. Grahaṇāṣṭaka of Putumana Somayājī (c.1570)
83. Nyāyaratna of Putumana Somayājī (c.1570)
84. Pañcabodha of Putumana Somayājī (c.1570)
85. Pañcabodhāṣṭaka of Putumana Somayājī (c.1570)
86. Uparāgagaṇita of Putumana Somayājī (c.1570)
87. Veṅvārohāṣṭaka of Putumana Somayājī (c.1570)
88. Vivaraṇa on Sūryasiddhānta by Bhūdara (c.1572)
89. Turīyayantraprakāśa by Bhūdara (c.1572)
90. Tithisāriṇī by Dinakara (c.1578)
91. Kheṭasiddhi by Dinakara (c.1578)
92. Commentary on Grahalāghava by Dinakara (c.1578)
93. Saurabhāṣya on Sūryasiddhānta by Nṛsimha Daivajña (c.1586)
94. Ṭikā on Tithicintāmaṇi by Nṛsimha Daivajña (c.1586)
95. Manoramā on Grahalāghava by Gaṅgādhara (c.1586)
96. Parvadvayasādhana of Mallāri (c.1588)
97. Makarandapañcāṅgopapatti of Dhunḍhīrāja (c.1590)
98. Rāmavinoda of Rāma (c.1590)
99. Uparāgakriyākrama of Acyuta Piṣāraṭi (c.1593)
100. Commentary on Āryabhaṭīya by Raghunātharāja (c.1597)
101. Laghukaraṇa of Bhāvasadāśiva Bhaṭṭa (c.1598)
102. Grahagaṇitabhāskara by Tamma Yajvan (c.1599)
103. Kāmadoḡdhīrī on Sūryasiddhānta by Tamma Yajvan (c.1599)
104. Commentary on Karaṇakutūhala of Bhāskarācārya by Viśvanātha (c.1600)
105. Udāharaṇa on Sūryasiddhānta by Viśvanātha (c.1600)
106. Mitāṅkagaṇita by Viśvanātha (c.1600)
107. Gaṇakaparakāśa by Ekanātha (c.1600)
108. Tithikalpadruma of Kalyāṇa (c.1605)

109. Viṣṇukaraṇa of Viṣṇu (c.1608)
110. Dṛkkaraṇa of Jyeṣṭhadeva (1608)
111. Pañcāṅgaśiromaṇi of Tripurāri (c.1627)
112. Vivaraṇa on Grahatantra of Ahobalanātha by Venkaṭa Yajvan (c.1627)
113. Siddhāntabindu of Nityānanda (c.1628)
114. Sarvasiddhāntarāja of Nityānanda (c.1628)
115. Grahasāriṇī of Gaṅgādhara (c.1630)
116. Commentary on Bījagaṇita of Bhāskarācārya by Bhāskara (c.1632)
117. Udāhṛti on Grahalāghava of Gaṇeśa by Nārāyaṇa (c.1635)
118. Jagadbhūṣaṇī of Haridatta (1638)
119. Commentary on Līlāvati of Bhāskarācārya by Vīreśvara (1638)
120. Commentary on Jyotpatti of Bhāskarācārya by Vīreśvara (1638)
121. Grahavidyādhara of Vidyādhara (c.1638)
122. Pañcāṅgacvidyādhari of Vidyādhara (c.1638)
123. Nisṛṣṭārthadūti on Līlāvati of Bhāskarācārya by Munīśvara (c.1640)
124. Ekanāthamukhabhañjana by Munīśvara (c.1640)
125. Mītabhāṣiṇī on Līlāvati of Bhāskarācārya by Raṅganātha (c.1640)
126. Siddhāntacūḍāmaṇi of Raṅganātha (c.1640)
127. Siddhāntasāra with Newārīṭikā by Viṣṇusimha (c.1641)
128. Khecaradīpikā of Kalyāṇa (c.1649)
129. Karaṇaśārdula of Kalyāṇa (c.1649)
130. Khetaplava of Vīrasimha (c.1650)
131. Āryasiddhāntatulyakaraṇa of Vīrasimha (c.1650)
132. Anūpamahodadhi of Vīrasimha (c.1650)
133. Grahaprakāśa of Devadatta (c.1662)
134. Grahaprabodhasāriṇī of Yādava (c.1663)
135. Tithidarpaṇa of Murāri (c.1665)
136. Laghutithidarpaṇa of Murāri (c.1665)
137. Bhadrādīpagaṇita (in Malayalam) by Itakramañceri Nampūtiri (c.1665)
138. Commentary on Bhāsvati of Śātānanda by Gaṅgādhara (c.1674)
139. Gaṇitasāroddhāra of Ānandamuni (c.1674)
140. Jyotpattisāra of Vidyānātha Sūri (c.1675)
141. Vijayarāghavīya of Venkaṭeśa (c.1675)
142. Commentary on Bhāsvati of Śātānanda by Kuvera Mīśra (c.1685)
143. Gaṇitāmṛtalahaṛi on Līlāvati of Bhāskarācārya by Rāmakṛṣṇa (c.1687)
144. Bījaprabodha on Bījagaṇita of Bhāskarācārya by Rāmakṛṣṇa (c.1687)
145. Commentary on Gaṇitādhyāya of Siddhāntaśiromaṇi of Bhāskarācārya by Rāmakṛṣṇa (c.1687)
146. Daivajñamanollāsa (in Telugu) on Laghumānasa of Muñjāla by Ayyālu Bālaya Somayājīn (c.1695)
147. Manorañjana on Līlāvati of Bhāskarācārya by Rāmakṛṣṇa Deva (c. 17th Century)
148. Grahasiddhi of Trivikrama (c.1713)
149. Bhramasāriṇī of Trivikrama (c.1713)
150. Tithisāriṇī of Trivikrama (c.1713)
151. Kiraṇāvali on Sūryasiddhānta by Dādābhaṭṭa (c.1719)
152. Turīyayantrotpatti of Dādābhaṭṭa (c.1719)
153. Gaṇitārṇava of Nāmanārya (c.1720)

154. Sūryasiddhāntavyākhyā of Jagannātha (c.1720)
155. Yantrasāra of Jagannātha (c.1720)
156. Gaṇitarāja of Kevalarāma Pañcānana (c.1728)
157. Tithisāriṇī of Kevalarāma Pañcānana (c.1728)
158. Dṛkpaśasāriṇī of Kevalarāma Pañcānana (c.1728)
159. Rekhāpradīpa of Kevalarāma Pañcānana (c.1728)
160. Jayavinodasāriṇī of Savai Jayasimha (c.1730)
161. Pañcāṅgādhikāra of Savai Jayasimha (c.1730)
162. Inakularājatejonidhi by Tulajārāja (c.1730)
163. Vākyaṃṛta by Tulajārāja (c.1730)
164. Dhruvabhramaṇa of Lakṣmīpati (c.1740)
165. Sāmrāṭyantra of Lakṣmīpati (c.1740)
166. Grahadarpaṇa of Bālānanda (c.1740)
167. Bhāsvatyudāharaṇa of Kamalanārāyaṇa (c.1740)
168. Khetatantra of Nandisūri (c.1747)
169. Jyotiśśāstrasaṅgraha by Āḷavañceri Tamparākkāl (c.1750)
170. Saṅgrahasādhanakriyā (Sanskrit and Malayalam) by Āḷavañceri Tamparākkāl (c.1750)
171. Karaṇadarpaṇa of Bhāradvājadvija (c.1750)
172. Grahaṇādarśa of Budhasimha Śarman (c.1764)
173. Karaṇavaiṣṇava of Śāṅkara (c.1766)
174. Grahaṇapaddhati of Nandarāma Miśra (c.1770)
175. Goladarpaṇa of Nandarāma Miśra (c.1770)
176. Yantrasāra of Nandarāma Miśra (c.1770)
177. Grahāgama of Govindasūnu (c.1773)
178. Golānanda of Cintāmaṇi Dīkṣita (c.1775)
179. Pattraprakāśa of Viśrāma Śukla (c.1777)
180. Yantrarājakaḷpa of Mathurānātha Śukla (c.1782)
181. Jyotiḥsiddhāntasāra of Mathurānātha Śukla (c.1782)
182. Kaṇakkuśāstram (in Malayalam) by Koccukṛṣṇan Āsān (Kṛṣṇadāsa) (c.1790)
183. Pañcabodha (in Malayalam) by Koccukṛṣṇan Āsān (Kṛṣṇadāsa) (c.1790)
184. Commentary on Āryabhaṭīya (in Malayalam) by Koccukṛṣṇan Āsān (Kṛṣṇadāsa) (c.1790)
185. Āryabhaṭīyavyākhyā (in Sanskrit and Malayalam) by Ghaṭigopa (c.1800)
186. Ganitāṃṛta of Abbayakavi (c.1807)
187. Mihiraprakāśa of Kulānanda (c.1810)
188. Grahaprakāśa of Kāśīnātha (c.1813)
189. Siddhantarāja of Bālakṛṣṇa Vedavṛkṣa (c.1820)
190. Karaṇabhūṣaṇa of Cunnīrāma (c.1837)