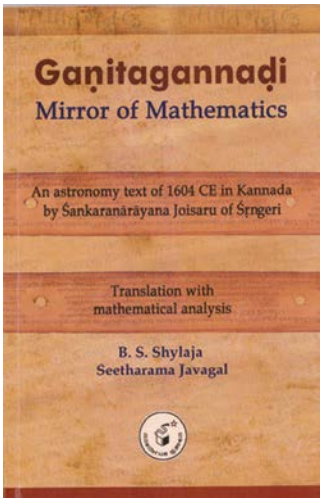

Gaṇitagannaḍi – Mirror of Mathematics: An Astronomy Text of 1604 CE in Kannada by Śankaranārāyaṇa Joisaru of Śṛngeri. Translation with mathematical analysis by B. S. Shylaja and Seetharama Javagal. Navakarnataka Publications Private Limited, Embassy Centre, Crescent Road, Bengaluru 560 001. 2021. iv + 220 pages. Price: Rs 299.

Astronomy has a long tradition in India with the lunisolar calendar and secular changes in solstices noted in the Vedic Saṃhitās, and *Vedānga Jyotiṣa* traditionally attributed to Lagadha who lived during the Vedic period. Indian mathematics originated in two paradigms of Vedic studies – Jyotiṣa and Kalpa (depending on whether mathematics was applied to planetary ephemerides or ceremonial constructions respectively). Mathematical methods to compute planetary ephemerides and phenomena, including eclipses and conjunctions were developed as Siddhānta during the post-Vedic period. Nearly a score of siddhāntas, including indigenous as well as foreign theories find traditional mention, though only five are elaborated in texts by celebrated authors since Aryabhaṭa, Lāṭadeva and Varāhamihira (5th–6th century CE). The most popular Siddhānta is *Sūryasiddhānta* whose primary author is not known, though the beginning verses state that it was revealed by Sūrya (the Sun God) through a human intermediary to an Asura named Maya.

The term 'Gaṇitam' is used interchangeably with Jyotiṣa, probably because it first states the number of revolutions of planets in a long measure of time (Mahāyuga = 4.32 million years or Kalpa = 1000 Mahāyugas) in order to gain accuracy of many significant figures in their apparent orbital periods. Next, the astronomical phenomena for any day are computed accurately counting the number (ahargaṇa) of civil days elapsed since the beginning of Mahāyuga or Kalpa and removing the completed periods of revolution. Siddhānta texts were supplemented by Karaṇa texts that provide approximations valid for a period and simplify calculations utilizing a more recent initial point in time such as the beginning of Kaliyuga, so that smaller numbers are used in computations.

Primary texts are versified in metres (Chandas) which help memorizing and accurate preservation since the order of long and short syllables is extremely rigid. Composing in metric form demands a choice of synonyms and rearrangement of word order. A novice student needs an expert teacher who places the words back in a logical order (anvaya) and explains the meaning (artha). When writing became popular beginning about 6th century CE, the primary texts and commentaries composed by many scholars were inscribed in manuscripts which helped self-study. Most commentaries known are written in Sanskrit, while several in Malayalam and a few in other regional languages are also known. Many manuscripts may have decayed and lost; several surviving ones need to be identified, preserved, edited and published expeditiously since the medium on which manuscripts are inscribed (such as palm leaves) is subject to further decay.

This book by B. S. Shylaja and Seetharama Javagal brings to light hitherto unpublished work by Śankaranārāyaṇa Joisaru of Śṛngeri named *Gaṇitagannaḍi* (mirror to Gaṇitam) written in 1604. It is a commentary in Kannada on *Vārṣikatantra* composed in Sanskrit verse by Viddaṇācārya (14th century CE). *Vārṣikatantra* (annual computation) belongs to the Karaṇa category following *Sūryasiddhānta* and was popular in South India. The word 'annual' is used since calculations are made for any desired Kali year, the formula for converting Śaka year to Kali year being provided early in the text.

Javagal has traced his family genealogy beginning with Dēvaru Joisaru (c. 1500 CE). The author of *Gaṇitagannaḍi* is the grandson of Dēvaru Joisaru. Thirteen generations ending with the grandfather of Javagal were traditional astronomers (Joisaru) and have preserved many palm-leaf manuscripts on a range of subjects. Javagal's grandfather donated a large number of manuscripts to Śṛngeri Mutt to make them accessible and retained a few as family heritage. Javagal is an engineer by training and obtained an M.A. degree in Sanskrit in his later years with the intention of preserving the heritage manuscripts. He has also taken steps towards conservation of the manuscript and digitizing the text. He has transcribed a bundle of six manuscripts in astronomy and started publishing them collaboratively, *Gaṇitagannaḍi* being the second publication. Shylaja is an astronomer by training, a science popularizer and planetarian, with research interest in the history of Indian astronomy. She has utilized evidence based on texts, inscriptions and temple architecture in her research on history.

The original manuscript of *Gaṇitagannaḍi* was written in Nandināgari script prevalent in some parts of southern India. This script differs significantly from the modern form of Devanāgari and Javagal had to learn it. The evolution of the script over centuries is another reason why the original texts need to be transcribed to modern scripts with necessary interpolation where an original letter may have deteriorated on the palm leaf. The book under review transliterates the Sanskrit verses of *Vārṣikatantra* to Devanāgari and the matter in Kannada to its modern script. It is interesting to note that though a single script was used in the original manuscript, the Sanskrit verses accurately use the nasal (anunāsika) ṅ, ñ, ṇ, n, m in conjuncts with plosive (sparśa) consonants, whereas they are replaced by ṃ in Kannada modern usage.

The book is divided into eight chapters in the manner of Siddhānta texts. (1) Dhruvādhikāra (procedure of obtaining ahargaṇa count of days from the fiducial point in time and computing mean positions of planets). (2) Grahasphuṭādhikara (procedure to convert the mean positions to true positions). (3) Chāyādhyāya (conversion of true position with respect to the reference location of Ujjain and reference equinox to the local position with current equinox; the latitude is determined from the equinoctial shadow or chāyā of a gnomon). (4) Grahaṇādhikāra (calculations of lunar and solar eclipses). (5) Parilekhana (drawing the geometrical representation of eclipses and comparing the calculations with actual observations). (6) Pātādhyāya (computation of conjunction of Sun and Moon). (7) Udayāstamaya (rise, set and conjunctions of planets). (8) Śṛingonnati (computations of lunar phases using the cusps of illuminated portion as reference). Joisaru explains the meaning of Sanskrit verses in Kannada, stating that the explanation of mathematics takes precedence over grammar. His commentary often refers to terms and concepts

from *Sūryasiddhānta*. Joisaru also provides some corrections and improvements devised by him to the procedures of *Vārṣikatantra*.

It may be noted that the term 'Graha' refers to the Sun, Moon and five planets visible to the naked eye, and also Chāyāgraha (shadow planet or imaginary points) such as Rāhu (ascending node of Moon's orbit around the Earth in the ecliptic plane) and Śīghrocca (apogee) of a planet, all of which move with respect to the background of stars in apparent orbits.

The commentary in Kannada is translated into English by Shylaja and Javagal, who also analyse each procedure, rationalize and point out areas where Joisaru has made his own innovative contribution, and often compare with other well-known works. The analysis is made using current notations and methods of arithmetic, spherical trigonometry, series expansions, etc. The book flows smoothly through the Sanskrit verses from *Vārṣikatantra*, Kannada commentary of *Gaṇitagannaḍi* and authors' English translation with analysis. While it does not aim to critically edit *Vārṣikatantra*, a comparison is made with *Tantradarpaṇa*, Sanskrit commentary of the same work written by Joisaru before the Kannada commentary and additional verses found are incorporated at appropriate locations.

As the authors point out, *Gaṇitagannaḍi* is not a primer: it assumes sufficient knowledge of terminology and methodology of Siddhantic astronomy. Likewise, the book under review also requires some prior knowledge of the both the Siddhantic and modern concepts in positional astronomy. The book stems from earlier research publications, and hence it is a reference work for advanced students and scholars. On the other hand, the first 35 pages of the book are easy to read and informative. Following a short foreword on behalf of the Kulapati of the family, Javagal's Preface explains Jyotiṣa as a Vedānga (part of Vedic studies), and briefs on Siddhānta Jyotiṣa, Śṛngeri Jyotiṣka lineage, the manuscripts in its possession and status of preservation and publication. This is followed by a brief on *Gaṇitagannaḍi* apparently by both the authors, and Shylaja's independent brief in Kannada. While a reader with the knowledge of Kannada would enjoy Shylaja's beautiful prose as well as the original work of Joisaru, others can skip the Kannada part and study the English translation and analysis. Those who are familiar with Sanskrit and Devanāgari script will enjoy the original verses of Viddanācārya (Chandas name is provided against each verse) and Sanskrit quotes. Those who wish to delve deeper will find the bibliography at the end to guide them; most of the works listed are referred in the book. A glossary of Sanskrit terms with their meaning in English is compiled, which contains a few words in English to Sanskrit order probably by oversight.

The Bhūtasankhya system of enumerating integers to help versifying numbers according to desired metres is explained with examples used in the original manuscript. All the Bhūtasankhyas used in the text are listed along with their numeral equivalent in the appendix. The alternative method of Kaṭapayādi numerals widely used in South India is referred in the text, but not fully explained since it is not relevant to the book. There is a verse index for the 127 verses of *Vārṣikatantra.* This is followed by a general index that provides the chapter numbers of where a technical term (Sanskrit or English) appears. It would have helped to add page numbers too, since some chapters are long counting all pages of translation and discussion.

The language and the fonts used make this book an easy read. One quibble I have is about the spaces between words that are at times missing and often too long, especially when fonts change. The diacritical marks used in the transliteration of Sanskrit words need a check. The low cost of the book offsets these minor editorial errors, and readers will be grateful to the authors and publishers for making this important historical document accessible to all.

The book is recommended for the astronomy and Indian heritage sections of all libraries. I encourage everyone interested in the historical development of science in India to read the book. It will whet the appetite of novice students who may then move on to read other works by a few researchers in the country who are bringing to light Indian heritage through evidence-based studies.

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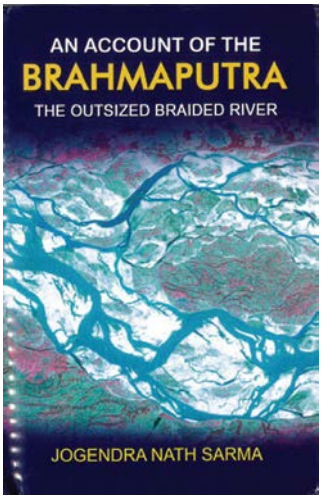

An Account of the Brahmaputra: The Outsized Braided River. Jogendra Nath Sarma. Purbanchal Prakash, H. No. 2, Sewjee Path, Dr B. N. Saikia Path, Wireless, Guwahati 781 006. 2022. 356 pages. Price: Rs 700.

Rivers with their freshwater resources constitute one of the most significant natural systems that are required for the sustenance of human populations, as well as for several other species that occur in the terrestrial biosphere. River basins occupy almost 70% of the land area such as the Amazon, Nile, Congo, Mississippi, Murray-Darling and Lena amongst others, and the Asian large rivers such as the Indus, Ganga, Brahmaputra, Godavari and the Yangtze. The large river systems and their complex networks are responsible for sculpting and creating the topography of extensive swathes of land that constitute the terrestrial ecosystems, and continue to be increasingly populated by human beings. Many of these large river systems are transboundary, and research on them is driven by their economic importance as borne out by the major developmental activities in riverscapes related to power generation, irrigation and inland waterways for navigation. Another aspect that commands attention is the understanding and mitigation of natural hazards that are associated with large river basins. We have to minimize the losses that accrue year after year because of floods, bank erosion and channel shifting.

It is noteworthy that river basins are home to about 40% of the world population, which essentially makes them coupled social–environmental systems that have come under considerable anthropogenic pressure. These systems in several parts of the world are stressed. The unprecedented population