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*The Archaic and the Exotic: Studies in the History of Indian Astronomical Instruments* by Sreeramula Rajeswara Sarma

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*Reviewed by*

Toke L. Knudsen

SUNY College at Oneonta

[toke.knudsen@oneonta.edu](mailto:toke.knudsen@oneonta.edu)

*The Archaic and the Exotic: Studies in the History of Indian Astronomical Instruments* by Sreeramula Rajeswara Sarma is a collection of 15 papers published by the author in the period between 1986 and 2004, most of them during the 1990s. The 15 papers have not been changed since their original publication, except that each of them is accompanied by a note explaining where and when the article was originally published. In addition, a brief preface and a very useful index have been included. What unifies the papers is that they all deal with the history of astronomical instruments in India.

Sarma, a distinguished and world-renowned scholar of Sanskrit and the history of science in India, has a long and fruitful career behind him. One of the many investigations undertaken by Sarma during his career concerns the history of astronomical and time-measuring instruments in India. This thorough investigation, lasting over a decade and a half, focuses on roughly 430 instruments found in over 100 museums and collections in India, Europe, and North America. It is to culminate, as announced by Sarma in the first article of the volume, in a catalogue of Indian astronomical and time-measuring instruments, a catalogue that is presumably close to completion and publication at this point in time. So, it is hard to imagine a candidate better suited for scholarly writing on the history of astronomical instruments in India than Sarma.

The title of the volume derives from the two types of instruments found in the Indian astronomical tradition, both of which are discussed by Sarma in this volume. On the one hand, there are the instruments classified by Sarma as archaic and, on the other, those classified as exotic. The archaic instruments are the ones described

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in the traditional Sanskrit treatises on astronomy, more specifically, in the *yantra* (instrument) sections of these treatises, while the exotic instruments are those introduced into India from the west through the Islamic astronomical tradition. Sinking-bowl water clocks belong to the former category, while astrolabes and celestial globes belong to the latter. As Sarma explains in the preface to the volume, these two types of instruments are contradictory, yet complimentary. While the astronomers of India were quite willing—enthusiastic even—to embrace exotic instruments from foreign cultures (in this case, the Islamic culture to the west), they never abandoned the traditional instruments, even if they had become obsolete.

Sarma divides the 15 articles of the volume into four parts:

- ‘The Context’ (4 articles)
- ‘The Water Clock’ (4 articles)
- ‘The Astrolabe’ (5 articles)
- ‘The Celestial Globe’ (2 articles).

The first establishes the context for the investigation of Indian astronomical instruments. The second part deals with one of the archaic instruments, namely, the sinking-bowl type of water clock. The third part focuses on one of the exotic instruments, the astrolabe. In the fourth and final part, Sarma discusses another exotic instrument, the celestial globe. The volume contains numerous images of the instruments discussed, e.g., sinking-bowl water clocks, astrolabes, and celestial spheres, as well as images of Mughal miniature paintings. Having these images of the instruments available to the reader interested in their technical details adds an extra dimension to the volume and is very helpful.

The first part of the volume, as already noted, announces Sarma’s project of producing a catalogue of Indian astronomical and time-measuring instruments. This is a very important project. In other cultural areas, such as the West and the Islamic world, projects like this have already been undertaken; and there is a great number of valuable scholarly resources available on both medieval European and Islamic instruments as well as on the making of instruments. Moreover, though some of the studies of Islamic instruments cover instruments made in India—much of India was, after all, under Islamic rule for many centuries—the material is not based on actual examination of instruments themselves but rather on descriptions

published in notices; and, so, these resources are deficient as catalogues of Indian instruments. Thus, Sarma is filling a real gap in the scholarly literature on astronomical instruments and his careful examination of extant instruments only makes his study that much more important.

Regarding the focus of his study, Sarma notes in the preface to the volume that any investigation of instruments such as his must not only be based on literary sources but also on a study of extant specimens of the instruments. Sarma further notes that there is also a third source of information, namely, paintings. Depictions of astronomical instruments in Indian Mughal miniatures cast light on the history of instruments in India, in particular, on the interactions and exchanges between the indigenous and Islamic traditions of astronomy and astronomical instruments. Thus, for example, some of the volume's images of Mughal miniature paintings show groups of Muslim and Hindu astrologers working together to create precise horoscopes for notable births. These are the three sources utilized by Sarma in the studies collected here.

The first step that Sarma takes in his study is into the wealth of Sanskrit treatises on instruments. Brahmagupta (seventh century AD) is the first author of a Sanskrit astronomical treatise to give an extensive account of instruments. This account forms a section of his *Brāhmasphuṭasiddhānta*, one of the most important works in the Indian astronomical tradition. Following his lead, other astronomers, including the renowned Bhāskara II (12th century AD), included similar sections in their works. However, the contents of these sections, as is the case with Sanskrit treatises in general, are brief. Their general and terse accounts of astronomical instruments do not allow us to infer much about the variety of their execution—or even if their execution was ever tested in practice—or to draw conclusions about their geographical distribution. Later, from the 14th century and onwards, due to the influence of the Islamic astronomical tradition, Sanskrit treatises devoted entirely to instruments were composed. However, even when these are supplied with elaborate commentaries, they never come near to the level of detail found in the treatises of the Islamic astronomical tradition, which give precise and elaborate details on how to design and create instruments in practice. Even in

the case of Sanskrit treatises specifically on instruments, questions regarding the variety of construction and geographical distribution are difficult to answer from the texts alone—more sources are required.

As already noted, Sarma's approach to overcoming the difficulty of working exclusively with textual evidence is to investigate actual specimens of instruments and to look at depictions of instruments in art. Examining such specimens and depictions can help us overcome the brevity of the texts and thus allow us to come to a better understanding of the instruments in question. Conversely, textual evidence can help with identifying a particular instrument and dating its design.

To provide a practical example, Sarma relates a story from his own work that demonstrates how the combination of text, specimen, and art can lead to a greater understanding. He notes that several Mughal miniatures portray a circular hoop-like object in the hand of an astrologer, an instrument that appears to be a ring dial, which is a European instrument. But why would these miniatures portray astrologers carrying ring dials rather than astrolabes (which were lauded as the greatest of instruments in the Islamic astronomical tradition)? Also, since the ring dial was not known to the Islamic world, how did it find its way to India? Sarma found the answer to these questions when he was editing a Sanskrit text on instruments, the *Yantraprakāra* of Sawai Jai Singh (1688–1743). The text contains a description of the ring dial under its Sanskrit name *cūḍāyantra*. Sarma also became aware of the existence of the existence of two specimens kept at the Jaipur Observatory. When he examined them, he found that one of them had a tablet attached that had the name *cūḍāyantra* inscribed. Subsequently, when investigating the antecedents of the instrument, he found that it was known to many earlier Indian astronomers starting with Āryabhaṭa (*ca* 500 AD); and that it was called *valayayantra* by Varāhamihira (sixth century AD). The variants of this instrument, one of them called *cūḍāyantra*, are discussed by the astronomer Rāmacandra in his treatise *Yantraprakāśa*. Sarma, therefore, rightly concludes that the instrument portrayed in the Mughal miniatures is a traditional instrument, the *cūḍāyantra*, and not the European ring dial.

This example brings out the value of Sarma's approach clearly and it confirms my view that he has chosen the right approach in his

study. In the example given, we see a case where the combined study of Sanskrit astronomical texts, Mughal miniature paintings, and extant specimens of instruments testifies to the history and popularity of the ring dial in India. Throughout the articles of the volume, Sarma's observations and conclusions are enhanced by his ability to draw on different types of primary source material.

Many of the articles in the volume deal with technical aspects of particular instruments. The second article of the first part of the volume gives an overview of the astronomical instruments described in the *Brāhmasphuṭasiddhānta* of Brahmagupta. This includes a discussion of the perpetual-motion devices described by Brahmagupta, who held that mercury can overcome inertia and thus power a wheel to turn eternally. The third article in this part continues the discussion of these perpetual-motion devices. The fourth article is an interesting and valuable study of astronomical instruments in Mughal miniature paintings.

Many of the remaining articles of the volume deal with particular instruments such as the sinking-bowl water clock, the astrolabe, and the celestial globe. Much of the material is of a technical nature but the articles are still informative and readable for a reader without a background in ancient and medieval astronomy.

One of the most fascinating of these articles is the second of the third part, which is a study of a family of astrolabe makers based in the city of Lahore (now the capital of the Pakistani province of Punjab). This family produced a very large number of instruments; the earliest, an astrolabe dated AD 1567, was made by one Allāhdād, the first instrument maker in the family. Sarma carefully details how over three generations more than 100 instruments, many of them exquisite, were produced by just six members of this family.

Sarma's volume is full of information, both technical and non-technical, about Indian astronomical instruments. It provides a very valuable reference work for the researcher but is also easy to access for the non-specialist. One might have wished for more of a synthesis of the 15 articles than is provided in the brief, four-page preface. After all, the most recent of the articles is separated in time from the earliest of them by nearly two decades; so the inclusion of a longer introduction or a conclusion tying the articles together would have been

a welcome addition. However, the articles each stand well on their own and one does not lose sight of the thread binding them together.

Since the articles, all of which were originally independent articles, did not undergo any editing before being included in the volume, there is some repetition of material. This is unavoidable, of course. There are, however, occasional inconsistencies between the articles which ought to have been corrected. To give one example: in the 10th article [205], the number of astrolabes made by Muḥammad Muqīm of the family astrolabe makers in Lahore is given as ‘some 37’; but in article 14 [279] the number is said to be 32. These two articles were published in the same journal (*Studies in the History of Medicine and Science*) and in the same year (1994). Such inconsistencies are rare and minor though, and do not in any way detract from the main conclusions of the book.

Another problem concerns the images of the volume. In the first place, they are all black-and-white. In my view, color reproductions would have been preferable, especially in the case of the Mughal miniatures, even granted the various constraints that would presumably have made the volume more costly. Second, the quality of the images is poor. A higher resolution would have been immensely helpful in examining the images of specific instruments referred to in the text, as would have close-up images of important parts of the instruments. Many of the astrolabes have inscriptions (both in Arabic and Devanāgarī scripts); and while some of these are referred to and translated in the text, they are often very hard to read in the related images, which frustrates the reader with a background in the requisite languages. For example, Sarma describes an astrolabe created by Ḍiyā’ al-Dīn Muḥammad (17th century AD) that ended up in the possession of Sawai Jai Singh of Jaipur [233]. The king had a Sanskrit inscription made on the back crown of the astrolabe and he also had a copper plaque detailing how the instrument works attached to it. The Rājasthānī text of the plaque is translated in the text by Sarma [232] but the original text is very hard to make out from the image of the astrolabe. A closeup image of the inscription would have made this easier.

However, none of these issues—all of them minor—make me hesitate to recommend Sarma’s work highly to both the expert and the interested layman: it is a must for the scholar as well as an enlightening read for the non-expert. Indeed, this volume contains a valuable

account of the history of astronomy in India, including details of the people behind the tradition, be they astronomers, instrument makers, or patrons. In consequence, it is an indispensable reference for the history of astronomy and astronomical instruments in India. One hopes that Sarma will continue his excellent work on the history of Indian astronomy.