Astronomy and Mathematics in Ancient India / Astronomie et mathématiques de l'Inde Ancienne. Actes de la journée d'études organisée le 24 avril 2009 à l'Université Libre de Bruxelles edited by J. M. Delire

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Astronomy and Mathematics in Ancient India is a collection of seven articles by prominent scholars in the field with a preface by J. M. Delire, the volume's editor. The articles all came out of presentations given at a colloquium held at the Université Libre de Bruxelles in Brussels, Belgium on 24 April 2009, attended by an international group of scholars. Of the seven articles, three are in French and four are in English.

As is noted by Delire, the history of astronomy and mathematics in India (taken in the following to indicate all of South Asia, not just the country of that name) is a field that has not received sufficient study. Indeed, it is easy to point to major works that have not yet been been edited or have been edited poorly or which have been edited but not yet translated or studied; and it is similarly easy to point to studies that should be carried out. As such, the volume is a most welcome contribution to the field. It is an important addition as well in that it explores important questions in the field and makes the latest research on them accessible to the scholarly community.

While the articles are each concerned with Indian astronomy and mathematics, they vary greatly when it comes to both topic and period. Included among them are topics such as the parameters of planetary motion in the sixth century AD, prosody in the 14th century AD, and a series for π in the 14th to 16th centuries AD. This, of course, is not a problem in itself. Astronomy and mathematics have been practiced in South Asia for millennia, so it is natural to have a multitude of topics covering many periods. In fact, one strength in this regard is that the reader gets a glimpse of how multifaceted the field of astronomy and mathematics in India is. The choice of topics

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furthermore allows the reader to see how the study of mathematics in India, including important results in mathematics, takes place outside the formal boundaries of the field of mathematics. However, the volume leaves the articles in isolation: it would have strengthened the volume if the articles had been tied together by means of common themes in an introduction or, perhaps, in a concluding chapter. Likewise, an index and a bibliography would have been very helpful to the reader as well. That said, the articles are important contributions to the field of the history of astronomy and mathematics in India, and the volume is recommended for anyone with an interest in, and some knowledge of, Indian mathematics and astronomy. (A layman without such knowledge would likely find the articles hard to penetrate).

The first article of the volume, entitled 'The Reality of Indian Astronomy', is by R. Mercier. In it, Mercier revisits an old and contentious debate from the 1970s between Roger Billard and David Pingree about how the parameters in the Indian model for planetary motion were arrived at. More specifically, Mercier follows Billard in employing mathematical models in an investigation of the parameters of the Indian astronomical tradition. The discussion revolves around the question of whether Indian astronomers, notably Āryabhaṭa, arrived at their parameters through direct observation or by other means. Relying on mathematical analyses to near exclusion of other facets of the context is tricky. Mathematical analyses do have their place and can be useful, of course, but they are just one tool to bring light to the bigger picture when investigating astronomical parameters and dating astronomical texts.

The second article, in French and entitled 'Entre astronomie et mathématiques, les découvertes indiennes en trigonométrie. La construction des tables de sinus et quelques méthodes d'interpolation', is by Jean Michel Delire, the editor of the volume. The use of what we today call trigonometric functions is an essential part of Indian astronomy. Without it, a true planetary position cannot be computed from the planet's mean position. In order to compute sines and other trigonometric functions, the Indian tradition employs tables of sines. These tables are accompanied by interpolation schemes that allow the user to compute values not tabulated. Delire investigates how tables of sines are constructed and the different ways in which interpolation is used to arrive at intermediary values.

The third article, also in French and entitled 'Mathématiques et scolastique dans l'Inde médiévale. L'example du *Haricarita* de Parameśvara Bhaṭṭa', is

by Pierre-Sylvain Filiozat. The *Haricarita* is an interesting text. Filiozat does not present the whole work but goes over a number of verses to demonstrate how they each have two layers of meaning. The first, and most obvious, layer of meaning narrates stories about the childhood of the god Kṛṣṇa. The second layer of meaning, accessible only to a specialist, contains astronomical information encoded in the so-called *kaṭapayādi* system, in which each Sanskrit syllable corresponds to a numerical value. Sanskrit verses with more than one layer of meaning are found in the writings of other Indian astronomers as well, notably Jñānarāja and his son Sūryadāsa. Such verses naturally span multiple genres of Sanskrit literature.

The fourth article, entitled '*Yantrarāja* for Dāmodara: The Earliest Extant Sanskrit Astrolabe', is by Sreeramula Rajeswara Sarma. Here Sarma studies and describes the earliest extant Sanskrit astrolabe. This astrolabe was produced in Ahmedabad in India for a certain Dāmodara and is now in a private collection in Brussels, Belgium. The question of its date and authenticity has been subject of controversy and to settle it Sarma accompanies his discussion of the instrument with a close reading of one of the early Indian works on the astrolabe, namely, the *Yantrarāja* of Mahendra Sūri. Sarma masterfully connects instructions given in the text with features of the physical astrolabe. The article furthermore includes eight images of the astrolabe, all of which are clear with legible writing.

The fifth article, entitled 'Indian Planetary Models: Āryabhaṭa to Nīlakaṇṭha', is by K. Ramasubramanian. The article deals with the planetary model of the Indian astronomical tradition. In particular, he gives a thorough discussion of the planetary model given by Nīlakaṇṭha in his commentary on the *Āryabhaṭīya* of Āryabhaṭa. Nīlakaṇṭha presents modifications to the standard model. Ramasubramanian masterfully discusses these modifications and also touches on why they were presented by Nīlakaṇṭha. However, the reason for doing so is not entirely clear and more studies of this question are needed to understand it fully.

The sixth article, in French and entitled 'Rythmes et algorithms. Le génie mathématique indien', is by François Patte. It explores the application of a mathematical rule in prosody. More specifically, the rule is a combinatorial one from the works of Bhāskara II, which was developed further by various commentators. This is an excellent example of a problem arising outside the field of mathematics that is solved by a mathematical analysis and rule.

The seventh and final article, entitled 'Mādhava Series for π and Its Fast Convergent Approximations', is by K. Mahesh, Venketeswara Pai R., and K. Ramasubramanian. The article explores a number of series for π from the Kerala school of astronomy and mathematics, which flourished between the 14th and 16th centuries AD. The series and the corrections to them offered by members of the Kerala school are incredibly sophisticated. Add to this that they worked without the help of the symbolic notation available to modern mathematicians. The Kerala mathematicians understanding of the series for π is impressive: the authors cite a passage by Nīlakaṇṭha which in modern terminology implies that π is an irrational number. Yet, while the authors address *how* the Kerala mathematicians took up the question of the series for π, they do not speculate on *why* they did this: it would indeed be interesting to learn why the school devoted so much time and effort to this topic.

As I have said, the present volume is a most welcome and important contribution to the field of the history of astronomy and mathematics in India. It should be noted, though, that the language used could have been more gentle at places. Scholars sometimes disagree and scholarly disagreements can get heated. Still, in a published volume, it is best to moderate one's language and to adopt a respectful tone in order to ensure that the discussion becomes more constructive overall. Depicting one renowned scholar as lacking 'scientific intelligence' and being reluctant to abandon 'cherished views' [26], and another well-known scholar as displaying 'a fundamental unwillingness to apply scientific arguments' [36], as is done in this volume, does not seem productive. The discussion is an important one but it is best carried out by debating the arguments without such comments about individual scholars. That said, the volume is a valuable contribution to the field and is strongly recommended.