

## BOOK REVIEWS

S. Balachandra Rao, *Indian Astronomy : An Introduction*, Universities Press, Hyderabad, 2000, xiv + 207 pages. Rs. 190.

Reviewed by Michio Yano\*

Like the *Indian Mathematics and Astronomy* by the same author, this book is addressed to the students and general readers in India who are not familiar with the achievements of their ancestors. As the title of the book suggests, this is not a "history" of Indian astronomy. Historical account is allotted only to the first chapter. The rest of the book is a skilful elucidation of the traditional Indian astronomy. Chapters 2 to 6 make an introduction to the basic system of Indian astronomy and chapters 7 to 12 are on specific topics of the traditional Indian astronomy arranged in the order which is usually found in classical Sanskrit texts on mathematical astronomy.

The author begins with a brief "Historical Introduction" (Chapter 1). He seems to be very keen to avoid the recent disputes over the origin and antiquity of Indian astronomy. This can be seen from his careful attitude of refraining from giving his own judgment concerning some controversial issues. For instance, when he says "The generally agreed upon period of the *Vedāṅgajyotiṣa* is between the 12th and 14th centuries BC," it is not clear whether he accepts this opinion or not. From my point of view, we must at least distinguish the date of the text containing the old traditions from the date of the "origin" of the traditions themselves. The author also mentions a theory that the *nakṣatra* system originated in around 4000 BC, since the *nakṣatra* Agraahāyaṇa (later Mṛgaśiras) was the asterism in which the Sun was at the time of equinox. But again he does not explicitly say whether he agrees with this theory or not, probably he is careful not to be criticized from either of the two camps, one which claims the high antiquity

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of Indian astronomy, and the other which does not admit it.

Compared with the primitive level of the *Vedāṅgajyotiṣa*, the *Siddhānta* texts beginning with the *Āryabhaṭīya* show a remarkable progress in mathematical astronomy. But the author does not give a word to the main reason of the progress — introduction of the Hellenistic astronomy to India. From the reviewer's point of view, admitting the indebtedness to foreign influence is not a shame at all. Rather it is through a careful study of foreign elements in Indian mathematical astronomy that we truly appreciate the original Indian contribution. Thus, for instance, if the author had added just a few lines saying that the Greek chord table was transmitted to India and was improved to the sine table with some ingenious modifications, the reader would have acquired better insight in history.

Concerning this general outline of history, I want to repeat what I have said in my review of the author's previous book: (1) It is true that Āryabhaṭa used the word *āsanna* ("approximately") for his excellent value  $\pi \approx 62832/20000$  but there is no evidence to show that  $\pi$  was regarded as *irrational* by Āryabhaṭa himself. (2) The author's claim that Kerala astronomer Nīlakaṇṭha tried to construct a new geometrical model in which the effects of two epicycles, i.e. *mandavṛtta* and *śighravṛtta* were represented in a unified system, but the result cannot be called "heliocentric" in a proper terminology. In modern interpretation, the *śighra* epicycle represents the solar orbit and the *manda* epicycle explains the anomaly due to the combined eccentricities of the Sun and the planet. Thus we can say that Nīlakaṇṭha's model was closer to Tycho Brahe's partial heliocentric model than to the Copernican model.

In the second chapter explanations of elemental concepts are given, such as celestial sphere, diurnal motion, great circle, celestial equator, etc. From the presentation in this chapter we judge that the author has a long experience of teaching astronomy to undergraduate students who are not familiar with the basic technical terms of astronomy. His explanation of the celestial sphere, for instance, is very useful for me in giving lectures in the classroom.

In the third chapter several co-ordinate systems are explained. The

reader is informed of the very important concept of *ayanamśa*, namely, the difference of tropical (*sa-ayana*) longitude which is measured from the vernal equinox and the sidereal (*nir-ayana*) longitude which is measured from the fixed point *meṣādi* on the ecliptic. The difference is again explained from different angles in sections 3.6 to 3.9. Concerning the co-ordinate systems, an important system is missing in this book—that of polar longitude and polar latitude. Since this co-ordinate system was used in *siddhānta* text when they gave the positions of *nakṣatras*, it should have been explained either in this chapter or in the next chapter which is on “*Rāśi* and *Nakṣatra* Systems”. This would be interesting to the readers because the same co-ordinate system was used by the Greek astronomer Hipparchos as well as in Chinese astronomy.

The fifth chapter is on “Time in Indian Astronomy”. Here also neatly and skilfully explained are basic concepts such as civil day, sidereal day, solar month, lunar month, solar year, civil year, luni-solar year, and intercalary month (*adhimāsa*). The omitted month (*kṣayamāsa*), the opposite concept of the intercalary month, is also well explained in section 5.6. This topic reveals the very theoretical nature of Indian calendar. In China, for example, even though it was known that the omission of a month is theoretically possible, it was not put into practice. The Yuga-Kalpa system is explained in section 5.8 (by mistake, section 5.7 is missing). A brief explanation of five kinds of Indian eras is given in section 5.9.

Chapter 6 is entitled “Calendars and the Indian *Pañcāṅga*”. After explaining the Gregorian calendar, the author explains all the elements of Indian calendar which are given in the traditional *Pañcāṅgas*. The sixty *saṃvatsaras* (Jovian years) in table 6.1 are actually those belonging to the South Indian system. Since the traditional Indian calendar is closely related with Hindu festivals, the dates of important festivals are given on pages 61 to 62. It would have been more convenient if they were given in a tabular form. The author also spared a small section (6.4) to Islamic calendar.

In sections 6.5 to 6.11 the five elements of *Pañcāṅga* are explained, namely, *tithi*, *nakṣatra*, *yoga*, *karana*, and *vāra*. The author gives the examples of these items according to the 1990 version of the *Rāṣṭrīya-Pañcāṅga*, a publication of the Government of India. This is somewhat strange to me, because the computation of this government *Pañcāṅga* is based on modern

astronomy. The author should have given the same example according to the *Sūryasiddhānta*, especially because he could easily do it by the computer program he has appended at the end of the book. With the help of my former student I wrote a similar program by Pascal and Perl and I found that the results I got from the *Sūryasiddhānta* were not much different from those based on the *Rāṣṭrīya-Pañcāṅga*.

The remaining six chapters are very faithful representation of the traditional Indian astronomy. Thus I had an impression as if I were reading an English version of a classical Sanskrit text. The author consistently refers to the five planets by Sanskrit names, without using English equivalents; thus he uses *Kuja* (for Mars), *Budha* (for Mercury), *Guru* (for Jupiter), *Śukra* (for Venus), and *Śani* (for Saturn).

Giving examples (*udāharāṇa* or *uddeśaka*) was one of the important teaching methods in Indian mathematics, as is seen in Bhāskara's *Līlāvātī*, but we do not have many records of actual examples in Sanskrit astronomical texts. The author of this book, however, gives a working example of each topic for the time around the vernal equinox of AD 1991, probably the time when he first began writing this book. These examples are quite useful. I have checked almost all the examples and found very few errors.

The seventh chapter is on the mean positions of the Sun, Moon and planets as the function of the accumulated days (*ahargaṇa*) since the Kali yuga epoch. Then follows the correction due to the difference of the locality from Ujjain, the prime meridian in ancient India. Algorithms are skilfully explained and an example is given for each planet in all the topics.

The eighth chapter is on the true positions of the Sun and Moon. In order to convert mean positions to true ones, the epicycle model was used in *Siddhānta* texts. Although the author does not mention, this is one of the most important devices which were transmitted from Greek astronomy. The explanation is again very skilful, but unfortunately the only figure used in this chapter is not correctly drawn, because the line from the centre of the epicycle to the true Sun (or Moon) does not appear to be parallel to the apsidal line.

In the last part of this chapter an interesting remark is given concerning the further corrections for the Moon besides the equation of centre. The effect of “evection”, which was known to Ptolemy, was first noticed by Mañjula (AD 932) in India. The author also refers to “variation” of 39'30”, but does not say whether it was known to Indian astronomers or not, and the author skips to the topic of the “annual equation” which was independently discovered by Candrasēkhara Sāmanta in the nineteenth century.

In Chapter 9 the Indian method of computing true positions of the five planets is explained. The method consists of two corrections which are to be applied to the mean position. One was called the *manda* correction which takes into consideration, in modern words, the combined effects of the eccentricities of the Sun and the planet, the other was *Śighra* correction which explains the irregular appearance of planets' motion, again in modern words, due to their motion around the Sun. Again the only figure in this chapter is not correctly drawn, since E, M', and M do not appear to be on the same straight line. The application of these two corrections was not straightforward and different rules were given according to texts. What the author gives here is based on the *Sūryasiddhānta*, according to which the process is expressed in the modern notation as:

$$\lambda_1 = \bar{\lambda} + \frac{1}{2}\sigma_1$$

$$\lambda_2 = \lambda_1 + \frac{1}{2}\mu_1$$

$$\lambda_3 = \lambda_1 + \mu_2$$

$$\lambda_4 = \lambda_3 + \sigma_2$$

Where  $\sigma_1$  and  $\mu_1$  are the *śighra* correction and the *manda* correction respectively, which are also corrected successively. The last result  $\lambda_4$  is regarded as the longitude of “the true planet”. This kind of iterative method (*asakṛtkarma*) is characteristic of Indian astronomy. It would have been more convenient for the modern reader if the author had compared the results thus obtained with those computed by modern astronomy. Once Prof. O. Neugebauer tried to explain the motivation of “halving” the equations, but

he was not really successful, as I realized from the personal correspondence with Dr Yukio Ohashi.

The tenth chapter is on the topic which is traditionally categorized as *tripraśna*, or “three questions”, i.e., questions on direction, place and time. The final object is to determine the *lagna* or the ascending point of the ecliptic which is a vital point in the horoscopic astrology. In order to reach the goal several preliminary problems are solved by means of a graphical representation called *chedyaka*. This chapter is also very well written.

The last two chapters are on eclipses, namely chapter 11 on lunar eclipses and chapter 12 on solar eclipses. For each chapter an example is given and the reader is told that the results agree very well with those of the modern astronomy.

At the end of the book several computer programs are given. The programs are written by the BASIC language. The programs would have been appreciated very much ten years ago when the language was popular. Unfortunately, however, today not many readers will be able to confirm the correctness of the programs by running them on old computers. Of course this is not the fault of the author of this excellent book. From my viewpoint, this is the best introduction to traditional Indian astronomy ever written in English.

Arun Kumar Biswas, *Gleanings of the Past and the Science Movement*, The Asiatic Society, Calcutta, 2000.

Reviewed by Deepak Kumar\*

In 1885 the Indian National Congress was established and we all know its political significance. Nine years earlier Dr. Mahendralal Sircar, an unorthodox medical practitioner in Calcutta, through years of petitions and appeals and collecting small donations, had established a scientific institution called Indian Association for Cultivation of Science (IACS).

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Through this he hoped to instil scientific temper and creative thinking among his fellow-countrymen who had lost their autonomy and virility for some reasons. This was a cultural response, no less significant than the political one that came little later. This was the beginning of a science movement and its pioneers were Dr. Mahendralal Sircar (1833-1904) and Father Eugene Lafont (1837-1908). Professor Biswas has made a special study of both of them. The volume under review is neither hagiography nor biography. It is a product of love, woven with care and concern. From the point of view of historical source material, for the first time the Sircar diaries have come to light. The diary moves like a mirror of its time and people.

The volume is divided into six chapters. Chapter I refers to the pre IACS period (1873-1875). The entries in the diary for this period are not really interesting but the editor has compensated with a nice and focussed introduction. The second section dealing with 1876-1883 is much more interesting. This section reveals Dr. Sircar's world view and his professional as well as family life. Mahendralal was a visionary. He had "a taste for science" and wanted everyone to develop it. Even in colonial conditions he hoped that science would have "her votaries by thousands and hundreds of thousands". He asked "is this a dream? Yes, it is but it is one of those dreams which can be willed into a reality. Give me money and I can show you that though yet a dream, it can be made as much a reality as anything in nature" (M. L. Sircar, *The Indian Association for Cultivation of Science*, Calcutta, 1877, pp. 72-73). Professor Biswas claims that he has discovered new facts through the diaries; for example, the tiff between Mahendralal and Rajendralal Mitra. But can these be seen as minor episodes?

Chapter III covers the IACS movement during 1884-1894 as reflected in Mahendralal's son Amrital's diaries. Here again the discovery of "new" facts has been claimed. Not entries in this diary per se but the introduction and annotations given by Prof. Biswas that makes this chapter readable. Several personalities of the period come alive. Much more interesting and relevant is Chapter IV where the saint Ramakrishna and his doctor Mahendralal argue with each other on several occasions. This has aptly

been termed “a dialogue between science and religion”. Mahendralal was an iconoclast, if not an atheist. The differences between the two were wide and deep, yet both explored and respected each other. The saint’s concepts of *gyan* and *vigyan* were related to God alone and were different from the doctor’s notions of knowledge and science. Mahendralal did not deny the existence of God but recognised a distinct autonomy in human endeavour. He argued, “a person is like a cow, tied with a post by a piece of rope, being free to move only within the circle circumscribed by the length of that rope”. How remarkable, even Sri Ramakrishna was touched by the metaphor. Similarly Mahendralal was impressed when the saint talked of the “cooling” influence of *bhakti* (devotion) which “freezes” consciousness into “ice” which in turn can be melted by the “heat” of *gyan*. His disciple Vivekananda was to use scientific terminologies more frequently and in him the author finds the flowering of Mahendralal’s ideas. But on the notion of incarnation and divinity, the doctor was firm and forthright. Only egotists would claim divinity for themselves. He said, “to crave for or to accept Divine honours at other men’s hands, is lack of true piety and therefore, a corruption of the heart”. In Mahendralal faith and reason coalesced. His critical observations even Vivekananda would not contest. Both chafed at superstitions and caste system, etc. This chapter is simply the best; cogently argued and properly substantiated.

The next section deals with the dawn of nationalist science in India. Here you have the usual stuff on J. C. Bose as an icon of national science, and a useful critique of the politico-educational scenario. Here Sircar as an educationist gets his due share. His disappointments are duly recorded and explained. Sircar remained unshaken in his long-cherished views but he did grow despondent towards the end of his life. He was actually aware of the failures in the movement he had so optimistically and enthusiastically launched. As the author rightly puts it, the obstacles were threefold: (a) lack of awareness regarding the nature of problem from which many citizens (not excluding Mahendralal) suffered, (b) lack of educational infrastructure in the country, and (c) lack of political independence to mobilise the financial resources. Dr. Sircar would not bank upon the government, he

would rather appeal to his own countrymen to help realise his dream. Very few could understand and appreciate his ethereal longings. Yet his labours did not go in vain. Before his death in 1904 he could see and appreciate the worth of J. C. Bose, P. C. Ray and Asutosh Mukherjee. Later came C. V. Raman who vindicated the founder's faith in posterity. His institution still survives though on government doles which probably he would not have approved. He wanted his IACS to be a combination of both the Royal Society and the Royal Institution. He raised questions which are more relevant today than in colonial times. Professor Biswas deserves congratulations for reminding us the relevance of an almost forgotten yet outstanding nationalist. Curiously enough, the jacket cover does not carry the name of the person to whom every single page of this book is devoted.