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Book Review

Indian Astronomy – Concepts and Procedures

S Balachandra Rao, M.P. Birla Institute of Management, Associate Bharatiya Vidya Bhavan, 43, Race Course Road, Bengaluru- 560 001, 2014, pages xiv+332, Price: Rs. 450/- (Foreign USD 45).

India has a long and rich tradition in astronomy with its roots embedded in remote antiquity. The earliest astronomical references are found in *Ṛg-Veda* in the context of calendar development. The post-vedic period shows the growth of mathematical astronomy beyond its original engagement with time-reckoning to the study of planetary motion along with that of the Sun and the Moon. Putting all of this in a single book is a challenging task. The author has done it judiciously by tracing the initial development in the chapter on 'Introduction', followed by the modern concepts in spherical astronomy before going into the detailed methods developed by the Indian astronomers of the *siddhāntic* period for computing the *pañcāṅga,* mean and true places of the planets, eclipses and transits etc. The book is intended for students and general readers, but researchers and *pañcāṅga* makers will equally benefit from it.

The first chapter on historical survey contains astronomical concepts found in Vedas and *Vedāṅga Jyotiṣa* such as equinoxes and solstices and their connection with the seasons, the intercalary month and finer details of the luni-solar Indian calendar. It names the eighteen traditional *siddhāntas* out of which, only five were extant at the time of Varāhmihira (505 AD). The author deals with Aryabhaṭa I and his works in some more detail and provides a list of famous Indian astronomers and their works from 5th to 19th century AD, which includes the *siddhāntas* proper and the simplified texts called *tantra* and *karaṇa.* The chapter highlights the unbroken continuity of tradition in Indian astronomy from the Vedic to the present time.

Chapters 2 and 3 contain the modern concepts of celestial coordinate system, general precession and how it was dealt in ancient Indian texts in terms of the quantity called *ayanāṃśa* to fix the zero point for measuring the *nirayaṇa* (sidereal) longitudes of the celestial bodies.The sidereal system of Indian astronomy based on the 27 *nakṣatras* (Lunar Mansions) is explained in Chapter 4. Chapters 5, 6 and 7 are devoted to Indian calendar. The time units of Day, Month and the Year and their different variations in the Indian system such as *sāvana* and *nakṣatra dīn, saura* (solar) and *candra* (lunar) *māsa*, *nirayaṇa* and *sāyana* solar years, lunar year and luni-solar calendar with intercalary months etc. are explained in terms of modern astronomical definitions and periods. Indian eras are discussed in Chapter 6. *Kaliyuga,* generally attributed to Āryabhaṭa I, is the most commonly used era for astronomical computing in the Indian texts of *siddhāntic* and later period. The author points to an important fact that Āryabhaṭa I does not use the specific word *kaliyuga* and the same may have been in vogue before him, although no records of the same are extant. In this context, Meghnad Saha and Lahiri[1]

have shown that the presently used date of *Kaliyuga* beginning (midnight of 17-18 February 3102 BC) fits perfectly the date obtained by backward extrapolation using the mean positions given in the two systems of Āryabhaṭa I, i.e. *ārdha-rātrika* and *audayika,* in spite of the fact that his constants were in error compared to actual values determined from modern astronomy. Saha observes "It is thus clear that the beginning of the Hindu astronomical *Kaliyuga* was the result of a back calculation wrong in its data, and was thus started wrongly". In any case, use of an era beginning is a matter of convention and it need not be identified with a specific event.

The *Kali* beginning is widely used as the starting epoch for calculation of *ahargaṇa*, i.e. the total number of civil days elapsed for computing the mean positions of planets for a given date. Detailed method to find *ahargaṇa* for any date and its conversion to other calendric dates is given under Chapter 8.

Āryabhaṭa set the basic principles for computing mean and true positions of the planets that have been followed in all subsequent works. His methods are based on the hypotheses that the mean planets revolved in geocentric circular orbits, the true planets moved in epicycles and eccentrics and that all planets have equal linear motion in their orbits. Later, Muñjala (932 AD) introduced the correction known as 'evection' and Bhāskara II(1114 AD) added the correction 'variation' to the lunar motion. The methods to compute the mean positions of the Sun, Moon, Moon's apogee and node and five planets are provided under Chapter 9 and true positions under Chapters 10 and 11 along with explanation of the phenomena in terms of the modern heliocentric concepts. Methods of determining the north-south line, latitude of a place, time of sunrise and its location on the horizon and *lagna* (ascendant) are given in Chapter 12. Computation of the eclipses of the Moon and the Sun in the Indian system and transits and occultations is covered under Chapters 13 to 18. In the true Indian astronomical tradition of reconciling the computed results with the observations, the author has provided in Chapter 19 corrections in the constants for computing practically all the parameters to obtain results that match modern values.

Publication of the book is timely as absence of a scholarly work cum 'working manual' of this kind has been felt for long. The book has made exhaustive study of the original literature on Indian astronomy and will be indispensable for students, researchers and serious enthusiasts working in the field of traditional Indian astronomy.

A K Bhatnagar
Additional Director General
of Meteorology (Retd.)
Former Director
Positional Astronomy Centre
Email: bhatnagar.ashok@gmail.com

1. Saha M N. and Lahiri N C. Report of the Calendar Reform Committee, Council of Scientific and Industrial Research, New Delhi, p. 254 (1955).