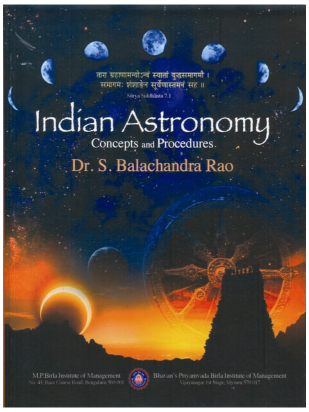

Indian Astronomy: Concepts and Procedures. S. Balachandra Rao. M.P. Birla Institute of Management, Bharatiya Vidya Bhavan, #43, Race Course Road, Bengaluru 560 001. 2014. xiv + 328 pp. Price: Rs 450/US$ 45.

The year 2014, celebrated as the 900th birth anniversary of Bhaskaracharya, brought to light many hitherto unknown aspects of Indian astronomy. It paved the way for many conferences at the national and international level. It also brought out many publications which proved an unbroken link in the astronomy tradition although historians of the earlier era had assumed that studies had come to a standstill after Bhaskaracharya.

In this background, a book like the one under review provides a good basic tool for understanding the evolution of astronomical procedures. Balachandra Rao has over a dozen publications on various aspects of Indian astronomy – his strength is in the actual computations. He has developed various algorithms based on the methods described in the texts of the medieval period and applied them successfully to compute celestial events like eclipses and transits.

The book, as indicated by the title, discusses the concepts and procedures for getting the positions of the Sun, Moon, the five *taaraagrahas* (planets which look like stars) and the nodes of the Moon. Here, a text from 10th century and another from the 16th century have been chosen to demonstrate how the procedures have evolved over centuries. The first five chapters describe the fundamental concepts without which further computational techniques cannot be understood. This is essential even for a person well trained in spherical astronomy because the notations and formulae are expressed in a different style compared to modern texts.

Many of the earlier works and translations of astronomical works in Sanskrit have covered all aspects. The procedures described in almost all the books are mainly aimed at obtaining three parameters essential for any calculation – the direction, time and position. In this book, the same tradition is followed; consequences of the motion of individual bodies are explained. The major difference is with reference to events like conjunctions, transits and occultations which are not as well studied as the lunar and solar eclipses. For any astronomer they serve as test cases. However, there is a discussion on the mutual conjunction of planets (as *yuddha* or *samaagama*) in one of the old texts – the *Surya Siddhanta*, which is highlighted on the cover page of this book. Chapters 15 and 16 provide the details of the procedure for calculating the possibility of occurrences and timings of the events. Occultation of stars is difficult to calculate because it demands the precise positions of the Moon as well as the star to be known. This automatically implies their knowledge on precession and other corrections for all solar-system bodies.

There is a new and interesting addition to the traditional pattern of books in the last few chapters. It deals with the astronomical tables, which have not been studied in great detail so far. The traditional calendar makes use of 'sarinis' which are tabulated versions of constants and corrections for a given epoch. *Makaranda Sarini* is one such text dated to 1478 CE. These tables provide the ending moments of *thithi* (lunar phase), *nakshatra* (position in the zodiac) and *yoga* (another entity related to the position of the Moon relative to *Rahu*, the ascending node).

The tables also provide the longitudes of all planets, the corrections to be applied to get the true position of any celestial body on account of the motion of the Earth and for its elliptical orbit. Other extrapolated entries include the transit of the Sun into the zodiacal constellations as well as to the (zone designated by) *nakshatras*, the declination of the Sun, the latitude of the Moon, and angular diameters of the Sun and the Moon. The last two quantities are used to calculate the size of the shadow as desired for the calculation of eclipses and transits. Several commentators have worked out the details of the method of calculation in subsequent years. The computed and observed measures were continuously monitored to update the tables almost every year. These tables were and are being used in and around *Kaasi* (Banaras).

Balachandra Rao's team has identified two such *Sarinis* which were in use in Karnataka and Andhra Pradesh. The tables of Pratibhagi Padakaani (one of the texts discussed in this book) start from the beginning of Kali era and extend to 20 lakh days (two million). Quite interestingly, these tabulations of the mean positions and corrections for the Moon, Sun and planets are available for thousands of days. In fact, it extends to 100,000 days in steps of 10 days. From the daily positions and *aharganas*, it is possible to calculate the revolution period quite precisely and fix the location on the celestial sphere.

The details provided in these *Sarinis* thus bear testimony to the observational skills.

In this context, it is worthy to know how the actual observations were carried out – a point which has remained mysterious to date. An instrument used to measure the altitudes of planets and stars is called *palabha*, the description of which finds a place in almost all texts. However, we need a proof for the following:

(1) The corrections as available from time to time and from place to place.

(2) The use of an instrument to carry out observations.

(3) The actual corrections that are listed out based on these observations.

A book entitled *Sarini*, discussed in the book.

This is the first time that such a direct evidence has been identified in a manuscript. *Grahaganita padakani*, dated 1712 CE, has the script in nagari but the numerals are in Kannada script. The tables provide the mean motion of planets to one crore (ten million) days. Although the name of the place of origin of the text itself is not explicitly mentioned, the 'aksaliptah' is mentioned as 842′17″, which is equal to 14°02′17″. In another context, 'Lankodaya Visuvachchaayangula' is mentioned as three *angulas*. This is the shadow (of a 12″ gnomon) on the day of equinox. This also gives a value of 14° as the latitude of the place. The place can be identified with a small village called *Tyagarthi* and the *Sarini* is identified as tables of *Tyagarthi*.

Considering that there are hardly any evidences of direct observational reports in the texts of the medieval period, this is a significant discovery and should have been highlighted in the preface itself. It is suggested that the subsequent editions of the book highlight this on the back cover or in the preface.

Balachandra Rao further describes examples from the *vakya* system, which is mysterious for a first-time reader. The book has been published at a time when the tradition of *vakya* itself has been lost. Before they are completely forgotten, efforts like the ones in this book are needed to pass on our heritage to the next generation.

This book is a must for all youngsters, enthusiasts and also to those who downplay the observational skills of ancient Indian astronomers.

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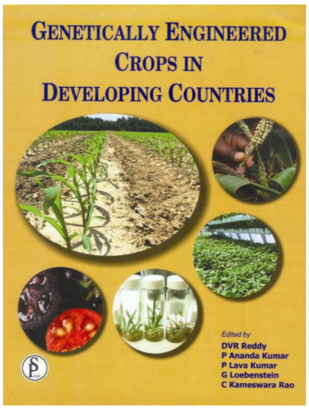

Genetically Engineered Crops in Developing Countries. D. V. R. Reddy *et al.* (eds). Studium Press LLC, P.O. Box 722200, Houston, TX 77072, USA. 2015. xviii + 405 pp. Price not mentioned.

The global area under transgenic or genetically engineered (GE) crops has grown rapidly since their introduction nearly two decades ago, and now occupies more than 181.5 m ha across 28 countries, of which 20 are developing nations (C. James, 2014, ISAAA Brief 49). The worldwide acreage under GE crops has increased more than hundred-fold from a modest 1.7 m ha in 1996 to 181.5 m ha in 2014, covering nearly 10% of the Earth's arable land and making genetic engineering the fastest adopted crop technology in recent times. World over, about 18 million farmers are cultivating several GE crops, including soybean, maize, cotton, canola, sugar beet, papaya, squash, tomato, sweet pepper and alfalfa. The traits are mainly herbicide tolerance and insect resistance. Among the developing countries, Brazil has the largest area (42.2 m ha), followed by Argentina (24.3 m ha) and India (11.6 m ha). The only GE crop that has been deregulated in India is the insect-resistant *Bt* cotton (*Bt* represents the bacterium *Bacillus thuringiensis*, one or more genes from which are inserted into the cotton plant to impart resistance to insect pest attack). In the 13 years since its commercialization in 2002, there has been a phenomenal 230-fold increase in area. Both production and yield have increased and India – once a cotton-importing country – is now an exporter. There is also a long pipeline of products, both in India and other developing countries.

Notwithstanding the above, transgenic crops have not received universal welcome. There is a trail of chequered – and acrimonious – history across the globe. Opposition is mainly centred on the following issues: (a) safety to humans and animals as food and feed; (b) safety of non-target organisms (biodiversity), soil and water; (c) the perception that the technology push is mainly industry-driven and consequently the fear of industry taking an exploitative hold over world agriculture and (d) ideological discomfort with scientists 'playing god'. All these have added up into a no-holds-barred 'war' against them. The sad result is that GE science has been maligned and misinterpreted, often deliberately. Consequently, public opinion is wholly against GE crops in several countries across the European Union and Africa, and opposition is spreading in other countries such as the Philippines and India. Although *Bt* cotton got through in India, *Bt* brinjal (eggplant) was successfully blocked, with an indefinite moratorium placed on it. It does not help that scientists are not eager public communicators and thus activists have successfully hijacked the agenda. This book aims to 'provide reviews on the scientific position on various issues related to the development and deployment of GE crops, in the hope this will promote informed decisions by all stakeholders'.

The book is organized under 13 contributed chapters. The first two chapters lay a good foundation on what is to follow. Chapter 1 on the socio-economic impact of GE technologies, responds to some commonly held 'stylized charges' about GE crops: that the choice of crops goes beyond the four – soybean, maize, cotton and canola (in fact, there are over 25 approved crops of food and non-food usage); that the product range extends beyond herbicide/insect resistance towards disease and drought tolerance, and moving into the next level with modified product quality. However, the charge that a few multinational companies dominate the field with too many patents, mergers and acquisitions still holds good. Available evidence shows that the private sector is far ahead (with 300 GE technologies) of the public sector (35 technologies). The obvious answer is to aggressively fund public sector institutions to promote products of crucial importance to resource-poor farmers, forge creative public–private partnerships and directly purchase technologies where possible. Chapter 2 discusses specific issues concerning development, deployment and biosecurity regulation of GE crops, including, *inter alia*, biosafety evaluation, environmental safety, biosecurity regimen in India and global activism. Pointing out that GE crops and products have gained farmer and consumer acceptance over 18 years, the chapter argues that biosecurity regulatory regimes are scientifically sound, robust

Diseases and crops targeted for genetic engineering disease resistance. Banana xanthomonas wilt-affected banana.