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BOOK REVIEW

History of Indian astronomy: The Tirvalore tables by Anil Narayanan, Kindle Direct Publishing, 2022, pages, 518, price Rs.1250/-

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Guillaume Joseph Hyacinthe Jean-Baptiste LeGentil is remembered as an unfortunate astronomer in the annals of the history of astronomy. However, as it turns out, European astronomers were very fortunate. They got the first report on the astronomical traditions of the Indians through him. *The Tirvalour Tables* transformed their views of Indian astronomy—they could understand the concepts in their language.

The credit for this mammoth task goes to Monsieur LeGentil, who spent 11 years wandering in India and around the Indian Ocean. The English translations had to wait for another century. The report by astronomer Helen Sawyer Hogg (100 years ago) declares that his expedition 'probably never will be another astronomical expedition in terms of duration and severity, and also, anguish.'

The purpose of the visit of LeGentil was to observe the transit of Venus slated for June 1761 and 1769. It aimed to solve one of the 'noblest problems' of astronomy, as George Airy pointed out. A slight deviation from the review may not be out of place here. Edmund Halley had observed the transit of Mercury in 1677 and had realized its potential to establish the yardstick of all distances in astronomy, the Astronomical Unit. He had also learned the disadvantages in observations posed by the small dot on the surface of the bright sun. Venus would have provided a better opportunity, and he calculated the nearest transit events. However, they are not as frequent as those of Mercury—almost a century apart. He published his ideas, alerting the astronomers of the next generation, and declared that this was the only opportunity to accurately get the sun-earth distance (parallax), the Astronomical Unit. His predictions gained tremendous importance, and (European) astronomers sent expeditions to cover the event from as extensive a longitude range as possible. The French dispatched 35-year-old LeGentil to India to carry out observations at Pondicherry; others in the campaign were Father Chappe to Siberia; Father Pingre to Rodrigues Island, near Madagascar, and Mason to the Cape of Good Hope, in South Africa. He set out almost a year in advance in May 1760, anticipating some hurdles along the long voyage around the African continent, which turned out to be real, though not by natural calamities. He was stranded in Mauritius (French Isles) for a couple of months. A war broke out between the French and British, and he could not deport to Pondicherry as planned. He did observe the transit from the ship. The location on the sea, whose unknown longitude rendered the observation useless for any calculation.

LeGentil stayed back for another eight years to record the 1769 event. The hurdles were too many—he decided on Manila but was denied permission to enter. Then hearing the news that Pondicherry was back with the French, he journeyed back and landed there. He set up the observatory on the top of a ruined depot used for storing explosives. He started his regular observations with an estimation of the latitude and longitude of Pondicherry. He had a yearlong wait for the event, which he used successfully to understand the roots of Indian astronomy, which he had already from previous travelers.

It brings us to the content of the book under review. The Indian astronomical texts can be broadly classified into treatises (*siddhānta*) and manuals (*karaṇa*). The latter is helpful for day-to-day calculations aimed at those who have learned the theory already and are routinely preparing almanacs. The tables which LeGentil gathered belong to this category. It is indeed hard to understand the concealed theoretical concepts in this text. He had engaged a person (Jnana Muthu) to teach him to use the tables. Still, he could not get the theory because of the communication gap (basically the language) or the teacher's reluctance. He struggled hard and extracted the basis of the intriguing formulae. He had a great appreciation for the teachers and writes:

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> They perform their calculations with a singular speed and ease, without a pen or pencil. They replace writing with cowries (a shell), which they place on a table, like our tokens, and most often on the ground. This method of calculating seems to me to have its advantages in that it is much more prompt and expeditious than ours. But at the same time, it has a very great inconvenience. There is no way of going back on the calculations, much less keeping them since we erase them as we advance. If we have, unfortunately, made a mistake, we must start again from the beginning.
>
> But it is very rare that they are mistaken. They work with a singular coolness; a calmness and tranquillity of which we are incapable, which enables them to avoid the mistakes which we Europeans would not fail to make in their place. It therefore appears that we must, among other things, keep each one to our method. It seems that theirs was made only for them...

He describes the procedures with utmost clarity since he was trying to aim at European readers. The book describes the step-by-step process for the calculation of eclipses, like fixing the true positions from mean positions of the sun, the moon, and the node (*Rāhu*), the calculation of the possibility of eclipses, the instant of conjunction, the magnitude of the eclipse and finally the timings. He also demonstrates the details of calculations and offers a convincing explanation for the errors.

It is not an easy task since the techniques used in Siddhāntic texts are quite different from the conventional European texts (This is the same difficulty faced by the students of the present generation after having been taught the basics from European methods). We often come across the remark, 'I wonder why the Indians followed such an indirect method'.

LeGentil was a keen observer of the skies and nature in general. He spent every day of the eight years to record all that he saw. It is fascinating to see our culture, tradition, flora, and fauna through his eyes. He transmitted the saga of his adventures and fortunes to Europe in four volumes–in French. There were attempts to translate them to English now and then though in parts. Helen Hogg pointed out a couple of inaccuracies in the translation. The details of his narratives remained elusive to English readers, and Anil Narayanan has unveiled them now.

The book has a good number of chapters following the historical developments. The first part describes the setup for the travel explaining the emergence of accurate determination of the AU. It is followed by the travel details and depiction of LeGentil's ambitions and helplessness. The second part addresses the tables. There is extensive coverage of the methods adopted by Indian astronomers, especially the use of the tables. The rules for computations are called *vākyās*. As per the scheme in the original text, the angle and time measurements and epoch calculations are explained. The innumerable number of tables seem to have confused him. But he was determined to learn the technique.

Details of the calculations of the eclipses of December 23, 1768, August 30, 1765, and October 17, 1762 are provided step by step. The solar eclipse requires the method of iteration, and these steps are also included. He concludes –

> ...we do not find any other eastern nation other than the Indians, not even among the Chinese, from whom we take the pleasure of discovering the ancient roots of astronomy – such are the obvious traces of the great antiquity of this science in India.

All the details are supplemented with apt drawings. He is astonished at the skill that has roots set 1700 years ago and remarks:

> The death of this Prince Salivaganam would therefore fall in the year 78 AD, which seems to prove that from that time the Brahmins were in this part of India, and that they already knew how to calculate the eclipses of the Sun and the Moon at a time when the north of Europe was still plunged in the darkness of ignorance and barbarism'.

LeGentil has identified the four different periodicities associated with the moon as the basis of the different corrections that are applied. Such a deduction will be very helpful in understanding the complex procedures in texts.

There are many other details on his estimates of the longitudes and latitudes by different methods, observations of the comet, comparison with Chaldean astronomy, and the like. He mentions that the only aspect of European astronomy that surprised the Brahmins was that he could predict the arrival and positions of the comet, a concept they were unaware of.

LeGentil makes specific observations on the 1700-year tradition and assigns superiority over the methods from China. His conclusions on the length of the day, advantages of the luni-solar calendars, precision corrections, and the concealed ideas on elliptical orbits for planets must have taken the Europeans by surprise.

He goes on to describe the surroundings of Pondicherry—the prevalent political situation, the tradition of the local people (for example, walking on the fire as part of the ritual), the education system at schools—all enjoyable to read. There is a reference to Hyder Ali (Tipu Sultan's father) and related political matters.

There are many other exciting observations by LeGentil—he has listed the 27 asterisms. He writes:

> The Indian Zodiac of 27 divisions bears the stamp of great antiquity, which, being related to the movement of the moon, is the most natural and probably the first Zodiac to have been created.

There are details on the stars with drawings for the individual groups. It is not possible to infer if the illustrations are from the original text or added by the author (Anil Narayanan). It is true with some other drawings also. He refers explicitly to identifying (an animal for) Aries with a brown dog and opines that Greeks may have chosen a ram in the absence of such an animal. It hints at the possibility of the 12 zodiacal names being carried forward from India to the West. It should be interesting to trace the origin of this word and the brown dog species.

There are some points to be noted for future editions/prints. The copy received for review does not have the publisher's name or the price. There are no contact details to buy or discuss the book with the author. The same is the case with the artist who drew elegant drawings (whether in the original manuscript or Anil Narayanan got it drawn). Perhaps this is a print-on-order version. Therefore, the next version can incorporate these details as well as the minor points listed below:

Using units h:m:s for time measures and angles :':" is conventional. The latter is written as arcminutes and arcseconds to avoid confusion between time and angle measures. Here, in this text, the two get mixed up. One has to cross-check at every mention of units.

Again, it is a convention to use fonts in italics for quotes—in this text, annotations are presented in italics. They may be separated as footnotes so the reading flow is not obstructed.

Some annotations do not seem justifiable, but there is no mechanism to convey or discuss these points to the author these points.

Many technical terms have reached this book through the longest possible route–Sanskrit to Tamil to French to English and back to Sanskrit—in the process, they appear distorted; for example, *vikṣepa* is written *vicchepa*—these may be corrected.

Many results appear as tables. It is not clear whether LeGentil or Anil Narayanan prepared them. An indication of this can be used for correcting typos in numerals.

Bringing LeGentil's work from French to English is an excellent effort. Some more details on the location of the observation, and methods employed for observation would be of great interest. The specific location, if available in the log book with latitude and longitude needs to be identified so that the authorities can be requested to erect a plaque at the spot commemorating his contribution to astronomy (perhaps in the White Town of Pondicherry).

Overall, it is also a very excellent authoritative source for disciplines other than astronomy. We should congratulate the author Anil Narayanan for bringing several forgotten astronomical aspects from the 'Carnatic' to light. He has rendered the impressions of LeGentil in the best possible way. Today's readers have lost touch with the methodology adopted by the Indian astronomers and mathematicians and like the struggles of LeGentil to understand the cryptic verses of *karaṇa* texts. Therefore, this book will be a great boon for the next generation and those historians working on astronomy sources from South India.