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Contribution of Kerala scholars to astronomy and mathematics

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Abstract

There was an unbroken continuity in the succession of the Kerala astronomers by the guru shisya parampara. There is a record of the line of tradition which extends from the 13 to 17 centuries after Christ like Govinda Bhattatiri (1237-95) grandfather of parameshwara (13-14 century) Nilakantha somayaji (1444-1545). Jyeshthadevi (1500-1600), Acyutha pisharati (1550-1621).

The list can be given up to prince Rajaraja Varma (vidwan Karindran cerunni Koyittampuram kilimanur) 1812-46. Sharma points out rightly that importance of the continuity of tradition in a practical demonstrative discipline like astronomy at a time when there was not a proliferation of printed books and was self-evident.

The astronomers of Kerala were adherents of the Aryabhata system. But on course of time they recognized variations between the computed and observed positions of planets as also in the timings of eclipses. This widening difference, between computations and observations, necessitated corrections in the erstwhile followed elements of the Aryabhata school. The efforts of the Kerala mathematicians have generally been directed towards the revision supplementation and correction of Aryabhata astronomy and mathematics to yield richer and more accurate results.

Keyword: Computations, variations, positions, supplementation

Introduction

It was said that after the contribution of Bhāskara II to Indian astronomy and mathematics, there was no progress or achievement in this field as an exceptional case a tremendous and vigorous development happened in the southern parts of Kerala. This was strengthened by the statements of Western Indologists. Prof. K V Sharma states that a scholar by name of G.R. Kaye, "After the time of Bhāskara (born A.D.1114) no Indian mathematical work of historical value or interest is known" (Indian Mathematics, Calcutta 1915, p 24), another scholar by name A.B.Keith " After Bhāskara no progress can be recorded in Indian Astronomy " (A History of Indian Literature, Oxford 1929, p 523), likewise another scholar by name A Macdonell – "The last eminent Indian Astronomer was Bhāskarachārya born in 1114 AD (A History of Sanskrit Literature, Indian reprint, Delhi 1962, p 370)

Unfortunately, D. Arka Somayaji, who has done good work on *Bhaskara's siddhānta Śīromani* remarks "Bhāskara's is the last name in the field. Barring several commentators, no name worthy of mention is there in India after Bhāskara". (A Critical Study of the Ancient Hindu Astronomy, Dharwad, 1971, p3)

The achievements of Kerala mathematicians in respect of the famous constant π were brought to the notice of scholars, both Indian and Western, by Charles M Whish who presented a paper on the subject before the Royal Asiatic Society of Great Britain and Ireland in 1835 in his paper, On the Hindu Quadrature of the Circle, Whish brought to the light the remarkable contributions to mathematics contained in the four famous Kerala works:- *Tantra Saṅgraha*, *Yukti bhāṣā*, *Kraṇa Paddhati* and *Sadratnamālā*, which were published in the transactions in 1835).

The famous works of Kerala Astronomers

Many original texts on astronomy dealing with all the important topics of the subject were identified and some of the works belong to the tantra type of astronomical treatises which adopt the beginning of the present Kaliyuga as the epoch for all computations.

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The bulk of the original texts are, however, of the Karana type which uses a convenient contemporary date as the epoch. The main aim of this type of astronomical text is:

- 1) To simplify computations
- 2) To ensure greater accuracy of results to coincide with observations.

Apart from these original texts, many number of commentaries on the famous classical astronomical treatises are also famous and valuable. Since Kerala astronomers belong to the Aryabhata school, most of the commentaries are on the Aryabhatiyam and also on the *Maha* and the *LaghūBhāskariyam* of Bhāskara I.

The other classical astronomical texts, which were popular in Kerala and carry valuable commentaries are the *Sūryasiddhanta* and Manjula's *Laghūmanasam*. The most popular textbook on mathematics has been the *Līlāvati* of *Bhāskara II* for which a least a dozen commentaries by the Kerala mathematicians are on record.

1. Haridatta and his works

A significant event in the annals of Kerala astronomy was the promulgation, in 683 A.D. of the *parahita* system of *Haridatta* (c650-700) through his *Grahachara nibhandhaana* and *mahamarga nibandhana*. The important event is recorded in several works later. Tradition says that the inauguration of the new system took place on the occasion of the twelve yearly *MahaMakha* festival held a *Tirunavay* on the Malabar coast. He made computations easier by specifying simple multipliers and divisors. The use of the *Ktapayadi* system in preference of Aryabhata's inconvenient letter-numerals, made his composition elegant and easy to memorize.

Haridatta introduced the unique system of enunciating graded tables of the sines of the arcs of anomaly (*manda-ya*) and of conjunction (*shigra-jya*) at intervals $3^{\circ}45'$, to facilitate the computation of the true positions of the planets.

2. Parameshvara

Parameshvara was one of the foremost astronomers of Kerala and the founder of the famous *Ḍṛk* system. He was a *Ṛgvedin* of the *Aśvalāyana Sūtra* and the *Bhrugu gotra*. *Parameshvan* hailed from the village of *Aśvatta grāma* (Alattur in Malayalam) and his house *Vāṭaṣṛeṇi* (*Vāṭaṣṛeṇi* in Malayalam) was situated on the confluence of the *Nila* river with the Arabian sea. Parameshvara was a highly dedicated observer of the astronomical events. He carried out continuous observations of eclipses over a period of 55 years before enunciating his rules and corrections for the computations of eclipses. *Parameshvara* has recorded the details of the eclipses, he observed in his *Siddhanta-dipika*, a super commentary on the *Mahabhaskariyam*.

Paramesvara was a prolific writer, and author of about 30 works. Among his original writings on astronomy might be mentioned (1) the *Ḍṛggaṇitam* (1430), (2) three works on spheres, *Gol-Dipika* 1 to 111 (1443), (3) three works on improved computations and rationale of eclipses are *Grahaṇaṣṭaka*, *Grahana Mandana* and *Grahaṇa nyaya Dipika*, (4) a text on the computation of the moon shadow, entitled *Candra cchaya gaṇitam* and (5) a rationale on the computation of mnemonic tables, *vakyakarana*.

Paramesvara has written excellent commentaries on 1) the *Aryabhatiyam* 2) the *Mahabhaskariyam* and 3) the *Laghūbhaskariyam* of *Bhaskaracharya* 1 4) The *Sūryasiddhanta* 5) The *Laghū manasam* of *Manjula* 6) the *Līlāvati* of *Bhaskara II* 7) *Vyatiparastaka* and 8) *Goladipika*

1. His commentaries are valuable. Two of his works on astronomy the *vakyadipika* and *Bhadipika* are yet to be traced.

3. Govindaswamin (c800-850)

Govindaswamin was one of the greatest exponents of *Bhaskara I* and of the *Aryabhatan* school. He elaborates *bhasya* on the *Mahabhaskariyam* contains new ideas and mathematical elaborations some of which are recognized and expounded in the modern mathematical style. Still, his contribution remains to be fully understood and made intelligible to the modern students. An original work of his astronomy and mathematics which is referred to as *Govindākṛti*, is yet to be recovered.

4. Nīlakaṇṭha Somayāji (1444-1545)

Nīlakaṇṭha one of the great astronomers and perhaps the best exponent of the *Aryabhatan* school, in the light of his and his predecessor's observations, is referred to with the title *Somayāji* or *samasut*. He belonged to the *Gargya gotra* and was a follower of the *Āśvalāyana sūtra* of the *Rgveda*. *Nīlakaṇṭha* was born on June 17, 1444 Wednesday *Nīlakaṇṭha* was a resident of *Tikkantiyur*, Sanskritized into *Sri kunda pura* near *Tirur*, *ponnai* taluk, South Malabar. *Nīlakaṇṭha* was trained under two teachers, *Ravi* who taught him *Vedanta*, and *Damodara* who trained him thoroughly in the intricacies of astronomy and mathematics.

Nīlakaṇṭha composed two major works 1) the *Tantrasaṅgraha* and 2) the *Bhashya* on the *Āryabhatiyam* and his other works are 3) *Golasara* 4) the *Siddhānta darsana* and 5) *candracchāyā gaṇitam*

The *Tantrasaṅgraha* is divided into eight chapters comprising 432 verses. This is a major work of *Nīlakaṇṭha* and an erudite treatise on astronomy *Nīlakaṇṭha*'s *Bhasya* on the *Āryabhatiyam* is an elaborate commentary on the cryptic and aphorism-like text of *Aryabhata* (476 A.D.). A perusal of the commentary will substantiate *Nīlakaṇṭha*'s pride in designating this work as a *Mahabhasya*.

The lucid manner in which difficult concepts are made clear, the wealth of quotations the results of his investigations, and the comparative studies presented therein amply justify the appellation *Mahabhasya* which *Nīlakaṇṭha* has given to his commentary on the *Āryabhatiyam*.

5. Kriyākramakarī

The *Kriyākramakarī* is a very detailed commentary on the popular mathematical text *Līlāvati* of *Bhāskara II* (1114 A.D.). It is a joint production of two mathematicians of Kerala, *Śāṅkara Vāriyar* (1500-60) and *Nārāyaṇa* of the *Mahiṣa maṅgalam* family (1494-1570)

The specialty of the *Kriyākramakarī* lies in its endeavoring to analyze mathematical theories and to supply the rationale behind the numerous formulae set out in the *Līlāvati* of *Bhāskara II*. This exhaustive commentary is especially valuable to the historians of Indian mathematics and astronomy, especially of the Kerala school, for the profuse references it contains to the earlier authors and authorities, some of which are now lost, and for the theories and procedures enunciated in the *Kriyākramakarī*.

Śāṅkara Vāriyar is said to have composed his part of the commentary up to the verse 199 of the *Līlāvati*. His commentary was interrupted by some other engagement. *Śāṅkara Vāriyar* is equally famous for his commentary *Laghuvivṛti* on the *Tantrasaṅgraha* of *Nilakaṇṭha*. *Nārāyaṇa*

completed the *Kriyākramakarī* by writing his part of the commentary from where Śaṅkara Vāriyar had left.

It is very much interesting that results on progressions, proved geometrically, in the *Kriyākramakarī* readers are referred to the enlightened work of T.A. Sarasvati Amma, Geometry in Ancient and Medieval India, Motilal Banarasidas, 1973.

6. Yuktibhāṣā

Jyeṣṭhadeva (c1500-1610) has the distinction of being the author of the popular Malayalam text. *yuktibhāṣā* or *Gaṇita nyāya saṅgraha* which forms an elaborate and systematic exposition of the rationales of mathematics in its first part and of astronomy in the second part.

The Sanskrit version of the Malayalam work, known as *Gaṇita nyāya saṅgraha* or *yuktibhāṣā* is, in all probability Jyeṣṭhadeva's work. He was a pupil of Damodara of Vaṭāśreṇi and was a member of the *parañhoṭtu* family of Ālattūr in south Malabar. *Acyuta Piṣāraṭi* mentions him as his teacher in reverential terms. M Whish records a tradition that the author of the *yuktibhāṣā* was the author also of the *Dṛkkaraṇa*, a comprehensive metrical treatise in Malayalam on astronomy.

7. Karaṇapaddhati

The *Karaṇapaddhati* is a comprehensive ten-chapter treatise on astronomy by an anonymous Somayāji of the putumana or putuvana family of Trichur. The availability of manuscripts of *Karaṇapaddhati* in Tamil and Telugu scripts indicates its popularity in those regions as well. The work carries commentaries in Malayalam, Sanskrit, and Tamil. The date of composition of the text is said to be given in the form of the chronogram, *gaṇitam etat samyak* which corresponds to April 4, 1733, Saturday. Putumana Somataji is said to have composed some more works on astronomy that as the Nyāyaratna. The *Veṅvāṅrohāṣṭaka*, which is a manual for accurately determining the position of the moon at short intervals of time, the pañcabodha III the *Grahaṇagaṇita IV*, and the *Grahaṇāṣṭaka II*

8. Sadratnamālā

The *Sadratnamālā* is a book of six chapters, is a compendium of the Kerala school of Mathematics and Astronomy. This work was composed by the astute astronomer, Prince Śaṅkara Varmā known as *Appu Tampuran*. He belonged to the royal house of *Kaṭattanāṭ* in north Malabar. The date of composition of the *Sadratnamālā* is indicated by the chronogram, *lokambe siddhisevye* which corresponds to December 10, 1819, Friday. The author himself has written an elaborate commentary on his work which, however, extends only up to verse 32 of the last chapter.

Conclusion

The contribution of Kerala scholars to maths and astronomy is remarkable in the light of many scholars. The innovation made by them is respected and incorporated even today's learning. The Kerala astronomers adopt coining beautiful letter combinations to represent members according to the very convenience of the *Kaṭapayādī* system. They choose the words in such a way that they represent the required numbers unambiguously, the words are highly meaningful and fit in correctly with the chosen meter.

The astronomers of Kerala were adherents of the Aryabhata system. But over time, they recognized variations between computed and observed positions of planets as well as in the timings of eclipses. This widening differences between

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