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# NILA SCHOOL OF MATHEMATICS WITH SPECIAL REFERENCE TO THE WORKS OF NILAKANTHA

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## ABSTRACT

*As in many other knowledge systems, India has also made commendable contribution to the realm of mathematics. The historians of mathematics strongly believed that after the period of Bhaskara II could not establish any progress in the mathematical activity in India .But in Kerala, many mathematical works and commentaries were written. Most of them were in the form of manuscripts. Recently few claims have been made by researchers on the discoveries made by Kerala mathematicians .The most important claim is that the calculus has been discovered for the first time, almost 250 years before sir Isaac Newton, who has been credited with the discovery of calculus. The few very famous names of the great Kerala mathematics scholars are Madhavacharya, Sankara Varman, Achyuthapisharoti, Puthumanasomayagi, Govinda Swamy, Parameshwaracharya, Nilakanta Somayaji....They have discovered many theorems. Many of the mares now known in the name of Newton, Gauss, Taylor, Gregory, Lebinitz and Demoiver. These were discovered and written minimum 250 to 700 years before western scientists, by the Kerala Mathematicians in their Sanskrit books which are available even now in the printed form with English translations. It is not complicated to find out the period of the Kerala Mathematicians for proving who has discovered for the first time and published them. The knowledge of Ka ta pa yaadi number and Bhoothasankhya systems which were commonly used in these books for presenting the mathematical data and theorems. Thus a number of excellent original texts and commentaries have been produced during that period of Mādhava of Sangamagrāma (1340-1425 A.D), who is known as Golavid, enunciated a formula for finding the circumference of a circle to an advanced degree of accuracy. The Kriyākramakari commentary of Lilāvati written by Śankara and Nārāyana discusses this result in detail1. Yuktibhāsa, the very famous old Malayalam work has given a geometrical proof for this infinite series. Vataśśeri Parameśvara (1360-1455 A.D), the disciple of Mādhava, was the author of several astronomical works include Digganita, Grahasamamdana, and commentaries on aryabhatiya, Mahābhāskaraya, Sūryasiddhānta, Lilāvati etc. The other prominent figure Nilakantha Somayājin was the author of the famous work Tantrasangraha and aryabhasyyabhāsya. He elaborately explains the formula for the sum of infinite convergent geometrical progression, while discussing about the derivation of an arc of a circle in terms of chord. The Kerala School had also produced great savants like Putumana Somayājin, Sankara Vāriyar and Sankara Varman. There were a plenty of manuscript collections in the Nampūtiri families in Kerala. The main objective of the present study will be to analyse the major contributions of mathematicians in Kerala.*

***Keywords:*** Nila School; Nilakanta; Thantrasangraha

## INTRODUCTION

The Nila- Mathematical village in Kerala in the past, nowadays more commonly known as the river Bharata, is the second longest river in Kerala. A far back as records and communal memory go, it has

been that stage in which the cultural, intellectual and the political history of Kerala, attaining great prominence during the reign of the Zamorin (Samuthiri) dynasty ruling from Kozhikode(Calicut). They were great patrons of scholarship, maintaining a royal academy in the capital and generally continuing a much earlier tradition of supporting centres of learning. It is tempting to suppose that such a centre existed in the Nilaregion, acting as the focus for the teaching anddoing of mathematical and observational astronomy [3]

The main mathematical villages are on the bank of Nila, extending from Tirunavaya (situated right on the river) to Trikkandiyur (10 kms to the North) with tripangode and Alathiyur to the west of this north south axis. Two other villages, Shukapuram to the south of the river Trikkudaveli (50kms upstream to the east), the natal villages of Chitrabhanu and Sankara Variyer- (Ancient Kerala Mathematicians) respectively. It is to be noted that every one of these villages has a major temple. Temple served as educational, social cultural centres in the past [3]

## REVIEW OF LITERATURE

Ranjan Roy (2011) conducted a study on historical mathematics of the last few centuries. He discusses about power series in Kerala in the 15th century. Vijaya kumar murthy (2007) conducted a study on a brief history of Indian mathematics. From this study, he discusses about Kerala School of Mathematics, discovery of the value of pie, infinite series expansion of Madhava and his followers George Gheverghese Joseph(2002) disputes that with facts and goes into the indigenous origins of the Kerala school of Mathematics which flourished from the 14th century starting with Madhava of sangamagrama with ending with Sankara Varman around 1804sJJo' Connos& EF Robertson (2000) conducted a study about outstanding contributions made by Indian mathematicians over many hundred years. He was pointed out the importance of sulbasuthras, vedic mathematics, sphericala stronomy etc.

## OBJECTIVES OF THE STUDY

In Kerala the period between the 14th and 16th centuries marked a high point in the indigenous development of Mathematics. The works of many mathematicians that have so far been analysed of such high level, that it is though these may be missing links between the classical period and medieval period of Kerala. The main objectives of the present study will be

1. To analyse the major contributions of Mathematicians in Kerala
2. To find out and analyse the mathematical works of Nilakantha Somayaji
3. To find out and analyse the old Malayalam and Sanskrit works in mathematics.

## Contribution of Nilakantha

The central figure of this Nila School- keeper of the Nila School was Nilakantha, has been an emblematic representative for the generations that followed. Nilakantha's life is relatively well documented in his own writings as well as in his contemporise and disciples. He was born in Trikkandiyur in Kelallur mana in 1444.

The main contribution of Nilakantha was the book of Tantrasangraha[5] written in AD 1500. It was a relatively compact work of 432 two line verses divided in to 8 chapters. The chapter heading make it clear that it was meant mainly as an astronomical compendium. It is based on the epicyclical and eccentric models of planetary motion. The first two chapters deal with the motions and longitude of the planet. The third chapter Treatise on shadow deals with various problems related with the Sun's positions on the celestial sphere, including the relationship of its expression in the three system of co ordinates, namely ecliptic, equatorial and horizontal co ordinates. [1]

The fourth and fifth chapters are Treatise on the lunar eclipse and solar eclipse. The sixth chapter deals with the complete deviation of the longitudes of the sun and the Moon. The seventh chapter On visibility computation discusses the rising and setting of the moon and planets. The final chapter On

elevation of the lunar curps examine the size of the part of the moon which is illuminated by the Sun and gives a graphical representation of it.

The tantrasangraha is very important in terms of the mathematics Nilakanta uses. He uses the results discovered by Madhava-founder of Nila School and it is an important source of the remarkable mathematical results which he discovered. However, Nilakantha does not just use Madhava's results, he extends them and improves them. Nilakantha derived the series expansion $\tan^{-1}x = x-x^3/3+x^5/5-x^7/7+.....$ by obtaining an appropriate expression for an arc of the circumference of a circle and then considering the limit.An interesting feature of his work was his introduction of several additional series for $\prod/4 = 1-1/3+1/5-1/7+.....$ Nilakanta certainly could not have said as he did about the theorem of the diagonal in Pythagoras theorem, that they should be "self evident to the intelligent". There are also few explanations of the logic of what is being attempted and accomplished, especially in the purely mathematical parts.[2]

The Tantrasangraha is not only work of Nilakantha. He also wrote Golasara which is written in fifty six Sanskrit verses and shows how mathematical computations are used to calculate astronomical data. The Siddanta Darpana is written in thirty two Sanskrit verses and describes a planetary model. The Candrachayaganita is written in thirty one Sanskrit verses and explains the computational methods used to calculate the moon's Zenith distance.[3] Later in his old age, Nilakantha wrote a commentary, Aryabhatiyabhasya, on the three substantive chapters of Aryabhatiya. This is an extensive Sanskrit prose and full of insight that are found nowhere else-perhaps the most profound of Nilakantha's work. Nilakantha's well known remark on the irrationality of $\prod$ and his turning of Aryabhata's appropriate treatment of the difference equation for the sine into an exact one.[4] The other major work of Nilakantha was Grahasputanayane Vikshepavasana describes the geometrical pictures of planetary motion that follows from his revised planetary theory, according to which the five planets Mercury, Venus, Mars, Jupiter and Saturn move in eccentric of orbits(inclined to the ecliptic)around the Sun which in turn goes around the earth[2].

## CONCLUSION

There were a plenty of manuscript collections in the Namputhiri families and Variar families in Kerala. Some portions of this became destroyed due to the adverse climatic conditions and carelessness on the part of custodians. Fortunately some unearthed manuscripts traced out the contribution made by the Kerala mathematicians. Thus the new phase of Indian mathematical tradition was born. Even though social circumstances and the foreign assaults caused inversely the growth and development of intellectual activities all over India, Keralites were interested in various scientific disciplines especially in astronomy and mathematics. Thus a number of excellent original texts and commentaries have been produced during that period. The study of the history of Kerala School of Mathematics and its contributions are the thrust areas as which require special mention. It may reveal vibrant thoughts to the mathematical world. It was generally believed that all science had been developed in Europe. But the mathematical scholars of Kerala challenge the very foundations of the Eurocentric ideology. There has also been occasional evidence of European scholars taking results from Indian works and presenting them as their own. It is a very fact that , many of the key results of Mathematics, some of which are at the very 'core' of modern day mathematics, are of Indian origin.

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