

## VALUE OF $\pi$ IN BHARATIAN MATHEMATICS

- Dr.M.L.RAJA, M.B.,B.S.,D.O.,\*

Value of  $\pi$  is a very essential and fundamental thing, in the calculations of area and circumference of circles. It was first calculated in our Nation, Bharat and from here only, it spread to the rest of the world. We can show the direct evidences found scattered in the ancient texts our Nation and also the evidences showing its applications in the day-to- day life by our ancestors.

### ANCIENT APPLICATIONS OF $\pi$ IN OUR NATION

Value of  $\pi$  is the basic and fundamental thing in the works of circular constructions, especially the constructions of Fire-Altars (Agnikunḍam), prevalent in our Nation Bharat, since Veda period itself. During the period of Veda, the period of remotest antiquity, the most ancient to all other civilization in the whole world, Agnikunḍam were constructed to perform Yajña, chanting mantra of Veda Samhita. For the construction of these Agnikunḍam, the exact measurement of Yajñabhūmi or the Yajñaṣālā is very much essential. For this, the exact measurements of each Agnikunḍam is absolutely required, because each Agnikunḍam is of different shape. For example, Agnitryam or Agnitretā or Tretāgni<sup>1</sup> (the three sacred fire), namely, Gārhapatyam, Āhavanīyam and Dakhināgni, differ in their shapes. Gārhapatyam is in circular shape, Āhavanīyam is of square shape where as Dakhināgni is in the shape of half elliptical circle. Since Gārhapatyam is in circular shape, the value of  $\pi$  is very much needed by our ancestors in that remote past, to construct these types circular shaped Fire Altars. For this and for the other calculations on different shapes of Agnikunḍam, our ancestors developed Jyāmiti, which is a branch of Mathematical Science. Actually from this meaningful Sanskrit word 'Jyāmiti' only, the Geometry, English or the Greek word for these calculations was derived. 'Jyā' means the Mother Earth and the 'miti' means the act of measuring, in Sanskrit. Therefore Jyāmiti means the measurement of land including the Yajñaṣālā, Agnikunḍam and for the construction of various buildings and other constructions. Here the methods and formulas for the measurements of circumferences and areas of various geometrical shapes are given. These are all given in the Śulbasūtra or Śulbasūtra of Kalpasūtra, one of the six Vedānga. For these measurements, our ancestors used the

ropes or cords. In Sanskrit, the act of measurement is also known as  $\text{\u094d}\text{\u094d}\text{\u094d}$  or  $\text{\u094d}\text{\u094d}$ . Since the ropes are used for measuring they are known as  $\text{\u094d}\text{\u094d}\text{\u094d}$  or  $\text{\u094d}\text{\u094d}\text{\u094d}$  or  $\text{\u094d}\text{\u094d}$  or  $\text{\u094d}\text{\u094d}$  and the  $\text{\u094d}\text{\u094d}$  (the formula) dealing with these are came to be known as  $\text{\u094d}\text{\u094d}\text{\u094d}$  or  $\text{\u094d}\text{\u094d}\text{\u094d}$ . These  $\text{\u094d}\text{\u094d}\text{\u094d}$  mentioned the value of  $\pi$  and other formulas for measurements and calculations. This is because our ancestors conducted the  $\text{\u094d}\text{\u094d}$  as their utmost Divine duty and for that, they were very much in need of these measurements and formulas. Thus, they developed all these formulas and methods and mentioned them in the  $\text{\u094d}\text{\u094d}\text{\u094d}$ . In the ancient sangam Literature of Tamilnadu, namely ‘Nedunalvaadai’,<sup>2</sup> of the famous Tamil poet Nakkeeranaar, mentioned about the construction of the palace for the Ancient Pandiya King ‘Thalaiyaalankaanathu Cheruvenra Nedunchezhiyan, using the ropes and the  $\text{\u094d}\text{\u094d}\text{\u094d}$ , the text of civil engineering, in the lines 72 to 100. We all know that only the necessity paves the way for the new inventions, creations and discoveries. It is not only Human beings, but all the living creatures have the Divine tendency to overcome the shortfalls, by way of developing new methods and innovations.

Further, we know that out of all the Nations in the whole world, it is Bharat only, even at the remotest ancient period of Veda itself, had the tradition of constructing the Agnikunḍam of various shapes and also had the  $\text{\u094d}\text{\u094d}\text{\u094d}$ , (Sthāpatya Veda – one of the UpaVeda) the text on Architecture. In the remotest past itself, we had the great civilization with buildings and monuments, even at a period prior to 6500 B.C., as proved recently with the under water excavations at the Gulf of Khambat in Gujarat. The pre-Harappan sites of the famous Sarswathi (Sindhu) civilization of North-West Bharat shows Agnikunḍam and  $\text{\u094d}\text{\u094d}\text{\u094d}$ , in almost all of its sites, which are more than 260 in number, spreading over a wide area from Baluchistan to Utharapradesh centered around with maximum sites at the banks of the dried up Saraswathi river. To name a few, one can mention the Archeologically proved sites at Kalibangan, Lothal, Mitathal, Desalpur, Banawali, Dholavira, Rakhigarhi, Harappa and Mohenjodaro.<sup>3</sup>

Besides, there are literary evidences for these  $\text{\u094d}\text{\u094d}$  and Agnityam (the three sacred fire), not only in Veda and in the post Vedic Literature, but also in the Sangam Literature of our beloved Tamil Language. The most ancient Pandiya King of Tamilnadu had conducted  $\text{\u094d}\text{\u094d}$  in large numbers and hence named as ‘Palyaagasaalai Mudukudumip Peruvazhuthi.’ Pal means many and more, Yaaga means  $\text{\u094d}\text{\u094d}$  and Saalai means  $\text{\u094d}\text{\u094d}\text{\u094d}$ . He was the ruler of the Ancient Tamilnadu, well south to

the present day Kanyakumari and this land with the ancient river Bahruli, had been submerged in the ocean, long ago. The Sangam literature, Puranaanooru <sup>4</sup> in the songs 9 and 15 mentioned these, in detail. Further Puranaanooru mentions the Agnitryam (the three sacred fire) as ‘Mutthee,’ in the 2<sup>nd</sup> song where it says that the Agnitryam was prevalent in our Nation from Himalayas to down south in Pothigai hills, during the period before Mahabharatha war (5144 years before present) itself. Even the lady poet Avvaiyar <sup>5</sup> mentions this Agnitryam in the 367<sup>th</sup> song of Puranaanooru.

Besides, the ancient Chola Kings also conducted Yajña. One of the ancient Chola King’s name is Raajasuuyam Vetta Perunarkilli, because he conducted the great Rājasūya Yajña. He was praised in the Sangam Literature Puranaanooru <sup>6</sup> in the songs 16,125,367 and 377. Even the famous and the great Karikal Peruvalatthaan, who ruled the Chola Kingdom when the Kaviri Poompattinam (Poompuhaar) was a big harbour, conducted the Yajña with Garuda śayanam. It was mentioned in the Puranaanooru <sup>7</sup> in the Song 224. Thus one can be very definite that from these indirect evidences of Literature and Archeology that the value of  $\pi$  was well known and used by our ancestors in their day-to-day life in constructing Agnikunḍam and Yajñaṣālā and other archeological structures, in the remotest antiquity, at a period when no architecture or any other construction existed in other parts of the world. Now the direct evidences for the value of  $\pi$ , found in various texts our Nation can be mentioned.

## DIRECT EVIDENCES

### 1. Śulbasūtra :-

Śulbasūtra are the part of the Kalpasūtra which are one of the six Vedānga namely, Śikshā, Vyākaraṇa, Nirukta, Śantas, Jyotisham and Kalpam. The Mānava Śulbasūtra of the Maitrāyaṇī śākha of Kṛṣṇa Yajur Veda, mentioned the value of  $\pi$  as 3.2, in the sloka 13<sup>th</sup> of the 11<sup>th</sup> chapter as,

“Vishkambhaḥ pañcabhāgaśca vishkambhstriguṇaśca yaḥ |

Sa maṇḍala pariḥshepo na vālamatiricyate ||”

Meaning:- 1. Vishkambhaḥ - Diameter, 2. maṇḍala pari – Circumference of a circle, 3. triguṇa - three times, 4. pañcabhāga – 1/5<sup>th</sup> part. Here the the value of  $\pi$  is expressed as the ratio between the circumference and the diameter of the circle i.e. three and 1/5<sup>th</sup> part of a diameter is the circumference. Thus the exact definition of  $\pi$  and the basic and fundamental understanding of the calculations of a circle is clearly expressed by our ancestors even at the period of Vedanga itself. So, not only the value

of  $\pi$ , but also the basic definition of  $\pi$  was first understood in our Nation only, in a very ancient period itself.

## 2. Āryabhaṭṭam:-

Āryabhaṭṭa mentioned the value of  $\pi$  as 3.1416, in the 10<sup>th</sup> Sloga of the Ganitādhyāya of his text Āryabhaṭṭam, written in 2741 B.C. as,

“Caturadhikam śatam aṣṭaguṇam dvāshashṭhistathā sahasrāṇām |

Ayuta dvaya Viśkambhasya āsannau vṛutta pariṇāhaḥ ||”

If the diameter is of 20,000 units, then the circumference will be approximately 62,832 units is the meaning. Here also the value of  $\pi$  is expressed as the ratio between the circumference and the diameter of a circle. Here Āryabhaṭṭa clearly mentioned it is only an approximate value and thus he had understood that  $\pi$  is not an integer and is only an irrational number, in a very much ancient period than that of western mathematicians.

## References

1. Deivathin Kural – The Voice of God, the speeches of the Paramacārya Jagatguru Sree Chandrasekara Saraswathi Swāmigal, R.Ganapathi, Vanathi Pathippagam Chennai, 1994, Volume -2, Pages 941 and 942.
2. Nedunalvaadai, Nakkeeranaar, Lines 72-100.
3. Sarasvati, Dr.S.Kalyanaraman, Babasaheb Apte Smarak Samiti Bangalore, 2003, Volume 3, Page 127.
4. Puranaanooru, Song 2, Lines 23 and 24.
5. Puranaanooru, Song 367, Line 13.
6. Puranaanooru, Songs 16,125,367 and 377
7. Puranaanooru, Song 224, Lines 8 and 9.