

# THE ORIGIN OF DIVIDING A CIRCLE INTO 360 PARTS

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## Abstract

The circle is a fundamental geometrical shape and commonly seen in Nature. Naturally, the angular division of a circle into 360 degrees is also important and forms the basis of angular measurement. The history of the 360 degree division is so ancient that it is difficult to discover the real origin. This paper seeks to uncover some of the ancient references. It is possible that 360 relates to the Sun's circuit, when observed from Earth. In this study we explore various measurements and systems used by ancient civilizations to calculate the time taken by sun to complete its circuit – the year. In the Rig veda - the oldest Vedic text, there are clear references (1.164.48) to a chakra or wheel of 360 spokes placed in the sky. *"Twelve are its fellies. The wheel is one. It has three naves. Who has understood it?"* It is these hymns, of the great Rishi Dirghatamas, that clearly show the ancient Indians dividing the year into twelve rasis (months), consisting of 30 days each, forming the 360 days - the number of spokes in this chakra (Wheel). Dirghatamas also prepared a table for dividing these 360 parts into smaller parts known as talpara, vikala (second), kala (minute), bhaga (degree) and more.

Key words: Circle, Degrees, Rig Veda, Dirghatamas

## 1 Introduction

The Circle is a fundamental geometrical shape which is commonly seen in nature. The angular division of circle into 360 parts, degrees forms the basis of measuring circular objects or angular measurement. The history of the 360 degree division is so ancient that it is difficult to pinpoint the real origin. This paper tries to highlight the ancient references about dividing a circle into 360 parts.

### 1.1 The need

Ancient peoples tracked the movement of planets, sun, moon, and so on, to evaluate time, climatatic and religious festivals. This was a socio economic requirement for those people. Based on the position of these celestial bodies people assessed the time elapsed, since sunrise, moonrise, etc., and they charted the recurrence of events such as eclipses, full moon, and such like. With these recurring events people constructed calendars. People watched the Sun, Moon, and the five visible planets (Mercury, Venus, Mars, Jupiter, and Saturn), primarily for omens. They tried to understand the motions physically. They noticed the circular track of the Sun's annual path across the sky and knew that it took about 360 days to complete one year's circuit. Consequently, they divided the circular path into 360 parts to track each day's passage of the Sun's annual journey.

## 1.2 Sumerians and Babylonians

Babylonia was an ancient post-Sumer civilization that originated in the central-southern region of Mesopotamia. Normally it was stated that the Sumerians had a calendar, dating from 2400 BC that divided the year into 12 months of 30 days each, that is, 360 days. It was during the reign of Nebuchadnezzar (605-562 BC) in the Chaldean dynasty in Babylon that the circle was divided into 360 degrees. This was because the Chaldeans had calculated by observation and inference that a complete year consists 360 days. One more reason for the basis of angular measure for the Babylonians was the angle at each of the corners of an equilateral triangle. They did not have decimal fractions and thus found it difficult to deal with remainders when performing division. So they agreed to divide the corner of an equilateral triangle into 60 degrees, because 60 could be divided by 2, 3, 4, 5 and 6 without remainder.

## 1.3 Egyptian

The Egyptian calendar, established several thousand years before the common era, was the first calendar known to use a year of 365 days, approximately equal to the solar year. In addition to this civil calendar, the ancient Egyptians simultaneously maintained a second calendar based upon the phases of the moon.

## 1.4 Roman

The Romans borrowed parts of their earliest known calendar from the Greeks. The calendar consisted of 10 months in a year of 304 days. The Romans seem to have ignored the remaining 61 days, which fell in the middle of winter. The 10 months were named Martius, Aprilis, Maius, Junius, Quintilis, Sextilis, September, October, November, and December. The last six names were taken from the words for five, six, seven, eight, nine, and ten. Romulus, the legendary first ruler of Rome, is supposed to have introduced this calendar in the 700s B.C.E.

According to tradition, the Roman ruler Numa Pompilius added January and February to the calendar. This made the Roman year 355 days long. To make the calendar correspond approximately to the solar year, Numa also ordered the addition every other year of a month called Mercedinus. Mercedinus was inserted after February 23 or 24, and the last days of February were moved to the end of Mercedinus. In years when it was inserted, Mercedinus added 22 or 23 days to the year. Julius Caesar added a month of 31 days during 44BCE, July, named after him and later, in 8BCE, Augustus Caesar added one more month, August, to make it a 12 month Calendar.

## 2 Indian system

*Twelve are the fellies, and the wheel is single; three are the naves. What man hath understood it? Therein are set together spokes three hundred and sixty, which in no-wise can be loosened.*

Dirghatamas - Rigveda 1.164.48; Samvalsara Kala Chakram

The twelve fellies represent the twelve months in a year, and 360 spokes represent the days. Three naves represent three regions, heaven, mid-air and terrestrial. They also represent three

periods of a day for Somayajna in which soma juice is offered three times during the period of one day and one night. With this it clearly explains a day period of one sunrise to next sunrise.

The Indian classification is based on the apparent movement of celestial bodies as viewed from Earth. Indians used observational astronomy, as observed from Earth, to track celestial bodies, including the Sun moon, stars, etc.

The Sun is called "Divakara" meaning, 'maker of day'. It also causes changes of climate.

As viewed from the Earth the Sun orbits around the earth in circle through 12 celestial segments called Rasis, or months, and so completes one year. Indians assigned different names to the Sun whilst in different Rasis, commencing from "Medam" or Aries. Brihat Samhita explains these twelve names as Dhata, Mitra, Aryama, Rudra, Varuna, Surya, Bhaga, Vivaswan, Pusa, Savita, Twasta and Visnu.

In the Bhuta Sankhya system also the Sun means "twelve".

In each Rasi the Sun spends 30 days so that the full circle is completed in 360 days. Indians called it Savana Varsa, solistic motion of Sun. The Savana year is used particularly for sacrificial purpose, mainly for Soma Yajna. The period between two consecutive sunrises is known as a Savana day. During the Soma Yajna soma juice is offered three times during the period of one day and night. The Soma sacrifice which is completed in 24 hours is known as 'Aha'.

In the Vedas, according to the Bharatheya Jyotisha Sastra, a group of six such Aha is known as Shadaha. Five such Shadaha make one Masa or month.

We can relate this division of the Sun's orbit to 12 rasis to 360 degrees. Our earlier calculation of a year was 360 days but this was later corrected based on further observations.

Indian astronomers correlated measurement of time and space by the same designations which were later accepted in other world cultures.

*One year is 12 months, having 30 days in a month each. Nadi is one day and 60 Vinadikas is 1 Nadi.*

Aryabhatiyam: 3.1,2

## **2.1 Similarities of division of time and space**

1 Year = 12 Months                      1 Rotation = 12 Rasis

1 Month = 30 Days                      1 Rasi = 30 Bhagas/Degrees

1 Day = 60 Nadikas                      1 Degree=60 Kala/ Minutes

1 Nadika = 60 Vinadikas              1 Minute = 60 Vikala/ Seconds (1 Vikala = 60 Tatpara)

1 day was divided into 24 Horas. The Hora is derived from Ahorathram.

## 2.2 The concept of 7 days in a week and the logic of its naming

Ancient astronomers considered the seven planets as masters of Hora. Saturn, Jupiter, Mars, Sun, Venus, Mercury, and the Moon, which are in order of distance from the Earth, are assigned lordship of one hora each in a block of Seven horas. The cycle is repeated at regular intervals of 7 horas each. In a day of 24 horas, the above cycle is repeated three times and the next day commences with fourth Horadhipa in the above order. This is repeated indefinitely. Aryabhateeyam 3.16 explains this.

*The days are named after the first Horadhipa after sunrise (6 to 7am) and will be the Dinadhipas (master of that day).*

On Saturday the first hora after sunrise will be Saturn, so it is known as Sanivara/Saturday.

The fourth in the above order is Sun which will be the master of the first hora after sunrise the next day. Hence the day after Saturday is Ravi Vara, Sunday, as it is the Dinadhipa - master of the day.

## 2.3 An Interesting correlation

*Pranenithy kala bhu*

Aryabhatiyam 1.6

With the time of one respiration, the earth moves through 1 minute (angular)

Or the earth rotates through 1 Kala/minute (angle) in 4 seconds.

Time for 1 degree rotation of earth =  $4 \times 60 \text{ sec} = 4 \text{ min}$

Time for 360 rotation =  $360 \times 4 \text{ min} = 24 \text{ hrs/1 day}$

## 2.4 Indian Calendar

Based on the astronomical statements contained in the Vedic texts, the scholar Dr Jacobi states, "The age of Rig veda as estimated to be BCE 4500". Vedanga Jyotisha is the oldest astronomical text in Sanskrit and reckoned to date from 1400 BCE. It forms the basis of calendars used by Indians.

From the Vedic period itself Indians were using a 12 month calendar. They specifically divided the year into 12 months of 30 days and 24 hours in each day. Indian Lunar months are named after the fixed Nakshatras at or near which the moon is full during that month. For example, the month is named Chaitra or Karthika according as the full moon in the month is found to be near the star Chitra or Karthika respectively. The interval between two full moons is 29 days, 12 hrs, 44 min, 2,87 sec (synodical lunar month). The other system was the Siderial lunar month, based on the time taken for the moon to arrive at a particular star again, which is 27 days, 7 hrs 43 min and 11.5 sec. There is a difference of 2 days 5hrs 0min and 51.37 sec.

## 2.5 Inspiration of Indian systems in Modern Gregorian Calendar

When Pope Gregory XIII decided to revise Julian calendar he appointed a committee. The German Jesuit astronomer and mathematician Christopher Clavius (1538- 1555) was there in

the committee. Clavius is the first person in Europe who introduced angular measurement tables in decimal notation. Clavius got his inspiration from works of the Portuguese mathematician Pedro Nunes (1502- 1578). He found mathematical solutions for ship navigation, etc. We should note that during these periods, according to historical evidence, the presence of Portuguese sailors, as well as Jesuit priests who were mathematicians, in Kerala, South West India, were well established. So the Kerala system was possibly a leading light in modern Calendar.

### **3 Conclusion**

Indians were using a systematic Kala Chakra, division of time in a samvalsara, to measure time. They were used as reference to measure duration, short, like the time for a breath, to long, such as a yuga or maha yuga.

We can clearly find out the systematic division of time only in Indian Texts like Vedas and Astronomical texts like Vedanga Jyotisha.

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