



KP Ayanamsa–An Analysis

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KP Ayanamsa–An Analysis

Part - 1

Date: 14-04-2020

POST 1 (Preface)

Mr.D.Senthilathiban, a kp astrologr, had recently published a book titled "Study of KP Ayanamsa with modern precession theories" (182 pages). It is available as a free eBook and any one can use "Google Search" to download and read. I strongly believe that this research work may bring the long standing confusions and disputes around ayanamsa which is haunting the KP community for more than 45 years, to an end. Upon request from some of the co-members of 'Astro wonder tamil ' astrology group, I took upon the task of explaining the essential features of the said book in tamil language, in a simple way so that everyone including a kp beginner can easily understand the intricacy of ayanamsa and its calculations. It contained 66 postings (75 pages) in all. My work was well received by the tamil members. Encouraged by their overwhelming response, I have now decided to translate the same into English for the benefit of all others. This script covers Newcomb precession theory, lacuna in various ayanamsa systems being followed by the present day KP followers, IAU's (International Astronomers Union) modern precession theories including Nutation and the formula to calculate ayanamsa and few worked examples. I trust that anyone can easily follow and understand.

Alongside, I have included my own short summary of great personalities like CG Rajan, BV Raman, NC Lahiri and also Newcomb as additional information. Also I have recalled certain incidents happened in the history of the post KSK period. (They are not part of Mr.D.Senthilathiban's book)

Readers are encouraged to contact me or Mr.D.Senthilathiban through the details given below and discuss if you have any questions or doubt.

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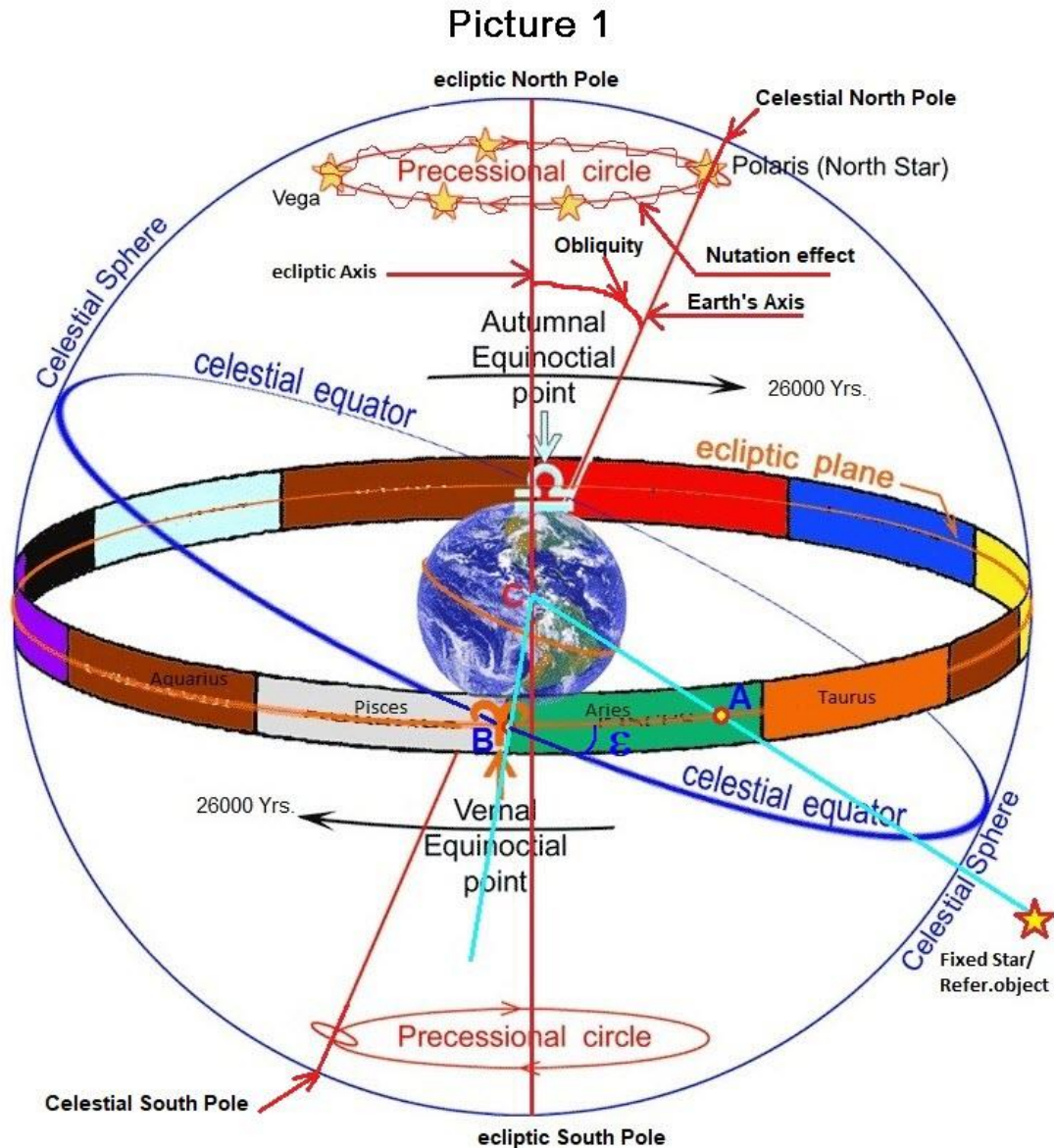
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POST 2

The Celestial Sphere given below is an assumption of an imaginary sphere around the earth and assuming planets and stars are fixed on that imaginary sphere.



If we extend the earth equator on the same plane all the way to the Celestial Sphere, in other words, if we draw an equator line on the Celestial Sphere which is in parallel to the earth's equator, it is called Celestial Equator. In the same picture, if we assume that the earth is static and Sun circles around the earth, we can get the path of the Sun, which is called Ecliptic.

The Zodiac is assumed on this Ecliptic. The axis from the center of the earth to the Ecliptic plane is called Ecliptic Axis. If we extend the Ecliptic Axis, it intersects the Celestial Sphere in two points. The point on the upper side is called North Pole and the opposite point in the lower side is called South Pole. At the same time, the Celestial Equator and Ecliptic intersects in two points. One is called as First Point of Aries (γ) and the other one is called as First Point of Libra (ω). The angle between the Celestial Sphere and Ecliptic is called as Obliquity.

POST 3

In the above picture, if we set a fixed referential star and draw a straight line between the star and the center of Celestial Sphere (It is shown in purple colour with the star on the bottom right corner), the same line intercepts the ecliptic at point A. The year when that point intersects at First Point of Aries (γ) is 291 AD, as recommended by Sri Krishnamurti. Let us assume that because of the "Effect of Ayana", this point is slowly moving backwards on the Ecliptic and now at point B on Year 2019, we can see in the picture that the straight line that connects the fixed star to the Center of the Celestial Sphere is moving backwards. The angle between A and B is called "Ayanamsa". The distance it moved between March, 291 and 2019 is approximately 24 degrees.

Western astrologers use the Moving Zodiac and Sayana Positions (or) Tropical Positions of the planets for their astronomy and astrology. It may be kept in mind that instruments used in Astronomical laboratories can measure only the tropical (Sayana) longitude of celestial bodies. But, the Indian vedic astrology uses Fixed Zodiac or the Sidereal Zodiac. To obtain the fixed zodiac positions for the planets and houses, the value of Ayanamsa must be calculated and subtracted from the Tropical Positions. The result is the planetary degree-minutes positions based on the fixed star.

POST 4

One of the important question still in debate is, when did the Zodiac start moving and how fast it moves per year. Ancient Indian astronomers including Varahamikar and Aryabhata, 20th Century astronomers and western experts have done serious research on this phenomenon and submitted their findings at various period of times.

Unfortunately, there was not one answer, but every one had their own. Due to this difference of opinions, the astrologers' community was unable to make a decision to follow one but they use the best from available, that appears to be correct to their intuition. On this ground, Mr.B.V.Raman accepted 397 AD as the Zero Ayanamsa Year while Mr.N.C.Lahiri took 285 AD and Mr.K.S.Krishnamurti fixed 291 AD. Westerns used the Sayana system and they have less worry about this ayanamsa.

POST 5

With the advent of astrology software in the beginning of 21st century, the necessity of manual calculations for the preparation of horoscope, has become redundant. Taking advantage of this facility, Teachers of astrology normally skip teaching basics including ayanamsa part, to suit their convenience. So no wonder that the present day astrologers lack sufficient (or nil) knowledge on this subject and hence I have thrown some light on the same. Mr.Senthilathiban had analysed the Ayanamsa used by the famous Astrologer & Mathematician Mr.C.G.Rajan, Astronomer & Mathematician Mr.N.C.Lahiri in his book. The modern astrologers have very less chance to read about Mr.C.G.Rajan, Mr.N.C.Lahiri, Mr.B.V.Raman and Mr.Newcomb and it is my pleasure to give brief general information about them.

POST 6

NewComb [1835 – 1909]

His full name is Simon NewComb, an American citizen born in Canada in 1835 AD. His work continued till 1909 AD. He seems to have little conventional schooling other than from his father. He went to proper schooling first at the age of 19 and later graduated (B.Sc) in Harvard university at the age of 23. He studied privately mathematics and physics. Later he became professor of Mathematics and Astronomer at the United States Naval Observatory, Washington DC. In 1877 he became director of Nautical Almanac Office. He authored number of popular science books and science fiction novel, apart from books on astronomy. He held chairs in both Private and in Government. Based on the rules defined in his research work, the first American Ephemeris and Nautical Almanac was published and duly recognized by American Government. British Government followed suit and published their Ephemeris on the same lines

IAU (International Astronomical Union) also endorsed his research papers and rules. For more than 50 years, all countries across the globe published their Ephemerides based on his theories only. Only after 1975, IAU made a small change in the Precession recommended by Newcomb, based on their research and collection of data. Till such time, Newcomb's recommendations were in practice. In later years in India, Mr.C.G.Rajan and Mr.N.C.Lahiri followed the recommendations of Newcomb to calculate their Ayanamsa values.

POST 7

C.G. Rajan

In the beginning of the 20th century, India was blessed with a Trinity in Astrology which includes Mr.C.G.Rajan, Mr.B.V.Raman and Mr.K.S.Krishnamurti. The foremost among them was Mr.C.G.Rajan. His full name is C.Govinda Rajan. He was born on 05-JUL-1894. He graduated in Mathematics, (BA) during the period of British Ruling. He was an exponent in Mathematics, Astronomy and Astrology coupled with enough command in English which gave him the freedom to write many books both in Tamil and English.

During his time, Panchang makers in India were forced to depend on the Western almanacs and facing difficulties in acquiring data from them and convert it to sidereal system. Mr. Rajan took initiative and managed to contact the American Naval Academy in the year 1920 and arranged to get copies of original astronomical research papers of Newcomb from them. After extensive study of those materials, he developed complete formulae, required for making Indian Panchang which were easily understandable. He then published his work in his book, titled "Raja Jothida Ghanitham or Siddhanta Sironmani". This book was published both in English and Tamil language in the year 1933. He also released another book that includes the planetary positions for 6000 years covering 3000 BC to 3000 AD. High value of accuracy found in his system, was very much appreciated even by western scientists. He adopted Newcomb precession theory for calculation of ayanamsa in all his works.

POST 8

He had written many books on astrology both in English and Tamil language besides books on different topics. During his time, Rajan published a yearly Panchang in the name of "Aananda Bothini" (trikannitha based) which was very popular in the middle of 20th

century. Mr. Rajan was the first person to convene an astrological conference in Pune, to analyse the dissonance in regional Panchangs. He arranged to bring eminent mathematicians and astrologers from all over India for this occasion and debated for two days. Based on the outcome of the above conference, Rajan had made a small correction in his Ayanamsa calculations. Rajan's contribution to the Indian Astrological community is invaluable and unparalleled. The preface written by him in his book "Raja jyothida Ghanitham" is attached as **Annexure-1** to enable the readers to realize the hard work and dedication exhibited by him. He, being a selfless, hard working and dedicated soul who left treasures and wealth of knowledge for Indian Astrological posterity should in no doubt, be called as "Father of Modern Indian Astrology".

POST 9

N.C.Lahiri [1906 – 1980]

Mr. Nirmal Chandra Lahiri was also an exponent in Mathematics and Astronomy. It appears that he did not involve in Astrology. He published Lahiri Ephemeris which is very popular in India even today and used by many astrologers across the country. He was the first Indian, to represent India in IAU. In the 1953's, Indian Prime Minister Mr. Javaharlal Nehru formed the 'Callender Reform Committee' and appointed Lahiri as secretary. This committee under the leadership of Lahiri, made an extensive research on the Ayanamsa and gave the final recommendations to the Government of India. Based on this, the Government of India has been publishing its Indian Ephemeris and Nautical Almanac (IENA) in English and in the name of "Rastriya Panchang" in 12 popular Indian regional languages, from 1958 to till date. The IENA name was changed in 1979 as 'Indian Astronomical Ephemeris'. Both works are still being published by Positional Astronomy Center, Calcutta, India.

POST10

B.V.Raman [1912 – 1998]

The name Bangalore Venkat Raman was very popular in the Astrology World both in India and abroad in the 20th century. When astrology was considered as a "superstition", B.V.Raman made efforts to take the facts to people that astrology is also based on science and revived the fame of Astrology and Astrologers. Astrological community is indebted to him for restoring Astrology a noble place.

Mr.Raman travelled across the globe to many countries including Germany, England, France, Italy, Austria, Holland, Canada, Japan and America, addressing universities, Medical associations, Educational & cultural Institutions on different aspects of Astrology, Hindu Astronomy, Philosophy and Indian culture. He also established institutions in many countries to teach Traditional Indian Vedic Astrology. His accurate prediction on the end of World War II, had earned him many laurels. Upon an invitation, from the United Nations, America, in 1970. he delivered a lecture on "Relevance of Astrology in Modern Times" which was well received and appreciated by all members of the UN.

BVR had published hundreds of articles and books. Between 1936 and 1998, he ran his monthly 'Astrological Magazine' successfully. Apart from "Life Time Achievement Award for Services to the Cause of Astrology", he was offered several other awards also during his life time. His period could be considered as the "Golden Time of Astrology". B.V.Raman based his entire work on the traditional texts and did not use the Newcomb recommendations for his Ayanamsa calculations and hence Mr.Senthilathiban did not include Raman's ayanamsa for analysis in this book.

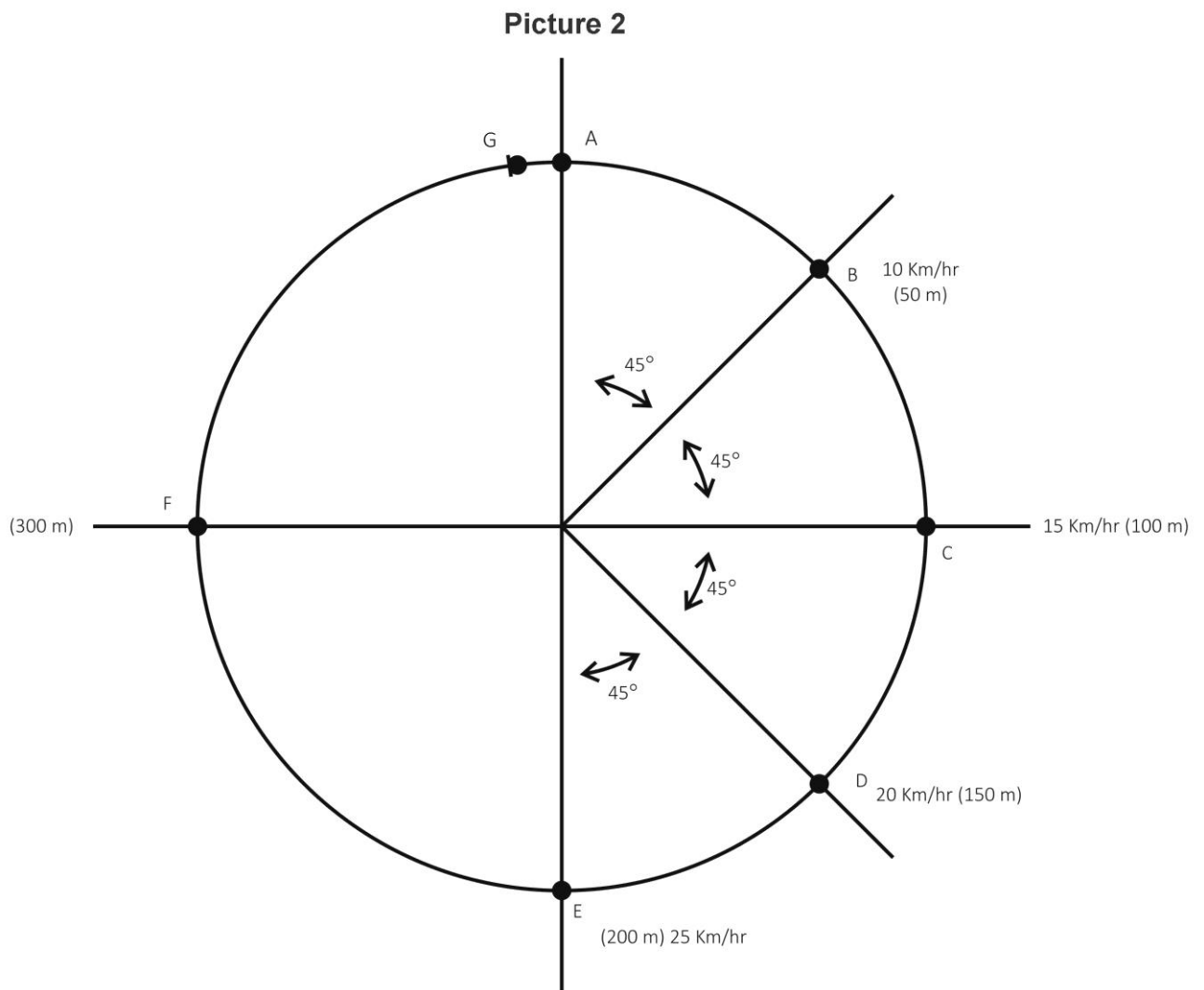
POST 11

So far, I have brought to the attention of the members some information that are not part of Mr.Senthilathiban's book. I believe, these informations are helpful when you read his book. Mr.Senthilathiban has gone on details in his book about the Newcomb recommendations, Formule to calculate Ayanamsa for any given time based on Newcomb rules, Rashtirya Panchang, Analysis of Ayanamsa of C.G.Rajan, N.C.Lahiri and K.S.Krishnamurti, updated Rate of Precession by International Astronomical Union in 1976 and 2006, Formule to calculate Ayanamsa based on the updated precession model, comparison of Ayanamsa values of the above mentioned popular methods, issues in modern KP Ayanamsas, Nutation details to calculate True Ayanamsa, Nutation in Obliquity to calculate House Cusps. We will discuss one by one in the following posts.

POST12

There are two main parameters in the formula to calculate the Ayanamsa. One is the Rate of Precession (amount of distance the point moves per year) and the other one is Precession (the distance, the point moved). The beginner (in astrology) should understand

this clearly before moving into details. I try to explain using a simple example here for the benefit of them.



In the above picture-2, assume that an athlete is running in a 400-meter track. The track is approximately circular in shape. The track is designed in such a way that if he runs the circle and completes one round, he would have covered a distance of 400m in total.

Here A is the starting point and G is the point where 400m ends. In the circle (track), the point B is at 50m, C is at 100m, D is at 150m, E is at 200m and F is at 300m. When the athlete starts running, he gradually increases his speed. Let us assume that his speed at the points B, C, D and E are 10, 15, 20 and 25 km/hour respectively.

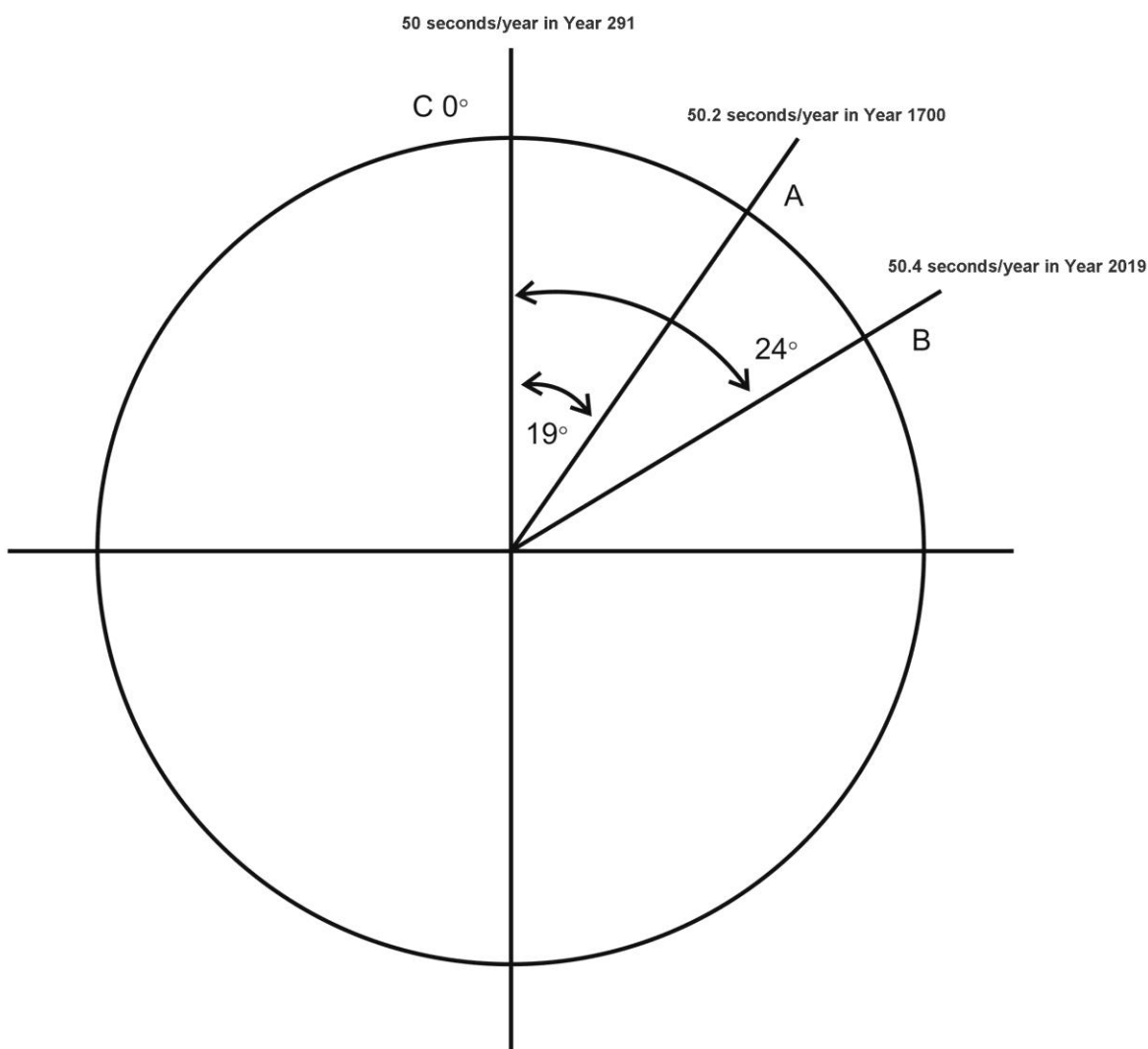
When the athlete crosses point B, his speed is 10km/h and distance covered in the circle is 50m. If we measure this in degree, it is 45 degrees. (To complete 400 meters, he has to complete a circle of 360 degrees). When he crosses 100 meters (point C), he would have run 90 degrees. In the same way, 180 degrees when he is at 200m (point E) and 270

degrees when he is at 300m (point F). When he arrives at 360 degrees (Point G), he completes 400m in total.

POST13

As explained above, when an object is moving in a circle, the distance can be measured at a given point at a given time by angle in degrees.

Picture 3



Now, look at the above picture-3. Replace the track and the athlete with the Zodiac. Assume that, point C is where the Zero Starting Point of both Sidereal and Tropical zodiacs at year 291. Like the Athlete, the Tropical Zodiac is slowly moving on the circle. Also, the moving speed is increasing every year slightly (detailed explanations later). For example, at point C (Year 291), its moving speed is 50 seconds per year. Assume that, on 1700 AD, it arrives at point A. At the same time, its moving speed is 50.2 seconds per year and the

distance it moved (from year 291) is 19 degrees. Then, 2019 AD, the same parameters may be 50.4 seconds per year and the distance crossed may be 24 degrees (Point B).

In the above explanation, the speed 50 seconds, 50.2 seconds and 50.4 seconds are termed as Rate of Precession. The respective angular distance 0 deg 19 degrees, 24 degrees are called Precession (or) Ayanamsa.

POST 14

I would like to share few more information about the ayanamsa.

It has been couple of billion years since the earth was formed. There has been no clue anywhere in our ancient texts on exactly when the Zodiac first started moving backwards. It appeared that it has been moving continuously backwards for several million years. If we assume that if the rate of precession is 50 seconds approximately per year, it will take 72 years for the precession to move by 1 degree. For the precession to complete 360 degrees, it would take 26,000 years. So, it starts in one point and circles around and comes back to the same point in 26,000 years. Since the creation of earth, it would have completed several such circles. The current cycle could have begun in the year 291 AD (21-3-291 09:39 IST). At that date, the Sun is positioned in Aries at 0 degree in both Tropical and Sidereal Zodiacs, that is Ayanamsa value on that particular time is 00.00.00. One should not think that the backward moving cycles began only in the year 291 AD. There were many cycles completed before that. With all these assumptions, we may conclude that the current cycle may end probably in 26291 AD and the ayanamsa value will again begin from 00.00.00.

POST 15

The above process appears to have been accepted by the scientists and some of our old texts. But Surya Siddhantha (SS) and Vedic texts are of different opinions.

According to Surya Siddhanta, the precession starts from the zero degree and moves 27 degrees towards West, in about 1800 years. From there, the movement is in reverse direction and comes back to the starting point zero degree, in another 1800 years. From the zero point, the movement continues now towards Eastend of 27 degrees and comes back, taking 3600 years (1800 + 1800). So, the movement of Zodiac acts like a

pendulum in a clock. To complete one cycles, it takes around 7200 years. This is the theory adapted by Surya Siddhanta. Currently, the validity of this theory can be verified only in the year 2225 AD (approximately). As on today in 2019, the precession is about 24 degrees. It will take another 3 degrees to reach the 27th degree mark in another 216 years (3×72). So, $2019 + 216 = 2225$ AD, and then its direction has to be reversed as per SS. Only our future generation will have the chance to confirm the correctness of the theory of surya siddhantha.

POST 16

So far, I have dealt upon, some of the fundamental concepts in the astrology. Now, let us move on to the essential features of Mr.Senthilathiban's book.

Let us start from Newcomb. Simon Newcomb, in his research papers, explored thoroughly and formed accurate formulae for the rate of precession, planetary positions and transits. Many countries adapted his recommendations and prepared their almanacs for several decades. Now we take a close look at the Rate of Precession in Newcomb's point of view.

Newcomb definition of Precession includes two main elements.

- 1. Rate of Precession (B) in 1900 is 50.2564 seconds.**
- 2. The above Rate is increasing by 0.0002225 seconds per year.**

The year referred to by Newcomb is the Besselian Year(B), and not the Julian Year as we use now. The Besselian year can also be called as Tropical Year. From 1984, the IAU retired the usage of Besselian Year System and started using Julian Year System for their calculations.

POST 17

Besselian Year is said to have 365.242198781 days per year and Julian Year 365.25 days per year. So, any execution of Newcomb formula must use the Besselian Year System.

It may be noted that the work of Newcomb, does not have any other reference, other than mentioned above and nothing about Zero Year of Ayanamsa. It is to be stated here

that the Zero Ayanamsa Year as 291 AD, was chosen by Mr.K.S.Krishnamurti for his system based on his own research and intuition.

POST 18

According to Newcomb, the rate of precession is increasing by 0.0002225 seconds per year. But in practice, the American Ephemeris and Nautical Almanac, Lahiri Panchang and IENA (Indian Ephemerids and Nautical Almanac) have taken only 0.000222 seconds for their calculations (6 digits only). Hence for uniformity, Mr.Senthilathiban used the same value in his mathematical executions in his book.

Having known the value of Rate of Precession, for the year 1900, one can find Rate of Precession for any year using the following formula.

Rate of Precession = $50.2564 + (Y - 1900) \times 0.000222$ sec/year.

Y = Required Year for which Rate of Precession needs to be found.

For example, let us find the Rate of Precession for Year 1850.

Rate of Precession = $50.2564 + (1850 - 1900) \times 0.000222$

Rate of Precession = 50.2453 sec/year.

The readers can use the above formula to find the Rate of Precession for Years 1950 & 2000 and verify the results against 50.2675, 50.2786 respectively.

POST19

we know that all the Newcomb work is based on Besselian Year System and interestingly, this is the Year System followed widely during Mr.K.S.K period. There is only a slight difference between the Besselian System and the Julian System which we are all aware of. (Ref. Post 17). So, when one uses the Newcomb theory today, one has to be very careful on the Year System to be used.

Mr.K.S.K did not give any clear explanation or reference to the Newcomb rules in his entire work, except in KP.Reader-1 where he mentioned that his rate of precession is using Newcomb. So, after his time, his followers did not pay much attention to learn the Newcomb theories properly and it resulted in more than one KP Ayanamsas within the KP System.

So, MR.D.Senthilathiban believes, it would enhance the KP System to next level in 21st century only when every KP Astrologer must be aware of the Newcomb's original theories and ayanamsa calculations based on the same. Also, the astrologer must be able to analyze the changes in the ayanamsa values given by the softwares and give utmost importance to the accuracy of the ayanamsa value which is possible only when they are properly educated.

POST 20

Now, we can calculate the ayanamsa for a given year based on Newcomb theory.

The founder of KP System, Mr.KSK recommended the Year 291 AD as the Zero Ayanamsa Year. If we want to go still precisely, the longitude of Sun is 00.00.00 at 21-03-291 @ 04-09 (Universal Time). So, we need to use this DateTime as a base, to calculate the ayanamsa values of other years.

Newcomb theory is based on Year B1900 (Besselian). So Many of the writers follow a process of first calculating the ayanamsa for B1900 and use the same to find the ayanamsa values of required years.

The general formula to calculate the ayanamsa value for any year based on B1900, using Newcomb's parameters would be as follows.

The general Precession Rate for any year based on B1900 epoch

$$P_c = 50.2564 + 0.000222 \times T \text{ seconds}$$

Integrating the above equation with respect to T we get Ayanamsa for any year

$$PC = C + (50.2564 \times T) + (0.000222 \times (T \times T) / 2)$$

$$PC = C + (50.2564 \times T) + (0.000111 \times (T \times T))$$

PC = Precession (Ayanamsa) in seconds for Required Year (Besselian)

C = Ayanamsa in Seconds for 1900 (B)

T = Required Year(B) – 1900

Now the same above formula can be used to find the ayanamsa for B1900. As we know that the ayanamsa value for 291 AD is Zero, we can assign that value zero to PC and find the value of C.

The Besselian value of the exact time of Zero Ayanamsa (21-03-291 @09-39 IST) is 291.21645153698 Years. (Clue to find equivalent Besselian value for any given Date/time, is explained in the later chapter.) Using this Besselian Year value, we can calculate the ayanamsa for B1900 as follows.

POST 21

$$T = (291.21645153698 - 1900) = (-1608.78354846302)$$

So,

$$0 = C + \{50.2564 \times (-1608.78354846302)\} + \{0.000111 \times (-1608.78354846302) \times (-1608.78354846302)\}$$

$$C = 80564.38104 \text{ seconds} = 22 \text{ deg } 22 \text{ min } 44.38 \text{ sec.}$$

Thus The ayanamsa value of B1900 is 22 D -22 M- 44.38 S or (80564.38104 sec)

Using the above ayanamsa value for B 1900, one can find ayanamsa value for any year before or after B1900 using the following formula.

$$\underline{PC \text{ (sec)} = 80564.38104 + (50.2564 \times T) + (0.000111 \times T \times T)}$$

$$\underline{T = (\text{Required Year (B)} - 1900)}$$

The result obtained is in seconds. It needs to be converted in to Degrees-Minutes-Seconds. In the next post, let us calculate a ayanamsa value for a year using the B1900 Ayanamsa value.

POST 22

Let us find the ayanamsa value for 01-01-2000, 05.30 PM IST using the above formula.

Note:

Here, I would like to remind again the readers, one important point. Besselian year(B) 1900 is actually refers to 31-12-1899,19:31:28 Universal Time, (And not the callender year) which is equal to 01-01-1900, 01:01:28 IST. So, we need to first find out how many days passed since 01-01-1900, 01:01:28 to the Date/Time value for which the ayanams has to be found.

And then, number of days passed must be divided by 365.242198781 to get the Besselian Year because one Besselian year contains 365.242198781 days. The result would be the T value which can be used in the given formula.

Now, let us proceed with the calculations to find out ayanamsa for 01-01-2000, 05.30 PM IST.

POST 23

First step is to find the value of T as explained in the previous post.

T is the Besselian Years between 01-01-1900, 01:01:28 IST and the DateTime for which Ayanamsa is to be calculated ie: 01-01-2000, 05:30:00 PM IST. We first calculate the number of days and then divide by 365.242198781 to get the Besselian Years.

There are 100 years between 01-01-1900 01:01:28 IST and 01-01-2000 01:01:28 IST. In between, there are 24 leap months. (note that 1900 is not a leap year)

So, the total days are $(100 \times 365) + 24 = 36524$ days.

This is only up to time 01:01:28 on 01-01-2000. Our target time is 05:30:00 PM IST on the same day. So the time interval between the two has to be taken into.

$17:30:00 - 01:01:28 = 16:28:32$.

Convert this value into days as follows:

$16.4755 \div 24 = 0.6864814815$ days.

So the total days passed between the two datetimes are

$36524 + 0.6864814815 = 36524.6864814815$ days.

Now, find T value

$T = 36524.6864814815 / 365.242198781$ (one B year is = 365.242198781 days)

$T = 100.0012775177$ (B)

Substitue this value of T in the formula, we get,

$$80564.38104 + (50.2564 \times 100.0013) + (0.000111 \times 100.0013 \times 100.0013)$$

$$80564.38104 + 5025.70420 + 1.11002 = 85591.19526 \text{ seconds.}$$

$$= 23 \text{ Degrees } 46 \text{ Minutes } 31.19526 \text{ Seconds}$$

So, the ayanamsa value on 01-01-2000, 05:30:00 IST is 23-46-31.

POST 24

In the above example, we used the year B1900 as basis in the formula, to calculate the ayanamsa value for 01-01-2000, 05:30:00 IST. At the same time, it may be understood that it is not the only option for us. The formula can be altered suitably for any year base. The reader can choose the year, he feels comfortable with and can use that Year(B) as a base year. For example, here are four more formulæ listed with different base years, which will ultimately give the same results. The option is yours.

$$(1) \text{ B1800 (Base Year) } = (20-58-59.85) + (50.2342 \times T + 0.000111 \times T \times T)$$

$$(2) \text{ B1850 (Base Year) } = (21-40-51.84) + (50.2453 \times T + 0.000111 \times T \times T)$$

$$(3) \text{ B1950 (Base Year) } = (23-04-37.48) + (50.2675 \times T + 0.000111 \times T \times T)$$

$$(4) \text{ B2000 (Base Year) } = (23-46-31.23) + (50.2786 \times T + 0.000111 \times T \times T)$$

The final ayanamsa answer will be the same regardless of which base year formula is used. If you take a close look at the formulæ listed above, you can observe that there are 2 elements which are common in all. One is the Ayanamsa value and the other one is the corresponding Rate of Precession, for the chosen year, appearing in the formula.

For example, in the formula (3) above, with B1950 as base year, the first value 23-04-37.48 indicates the Ayanamsa for that Year B1950 and 50.2675 is the Rate of Precession for that Year.

The (Equivalent) calendar dates for the above mentioned Besselian years are:

$$(1) \text{ B1800: } 31-12-1799, 14.14.50 \text{ (UT)}$$

$$(2) \text{ B1850: } 31-12-1849, 16-53-09 \text{ (UT)}$$

$$(3) \text{ B1950: } 31-12-1949, 22.09.47 \text{ (UT)}$$

$$(4) \text{ B2000: } 01-01-2000, 00-48-05 \text{ (UT)}$$

UT: Universal Time. (IST= UT + 05-30 Hours)

Note: These dates and times are required to calculate T.

POST 25

Now let us work out Ayanamsa for the date/time 01-01-2019, 09 AM (IST), using the formula 4 (B2000 as base) as a practical exercise.

First we have to calculate the value of T.

The starting time for B2000 is 01-01-2000 00:48:05 UT. Which is 01-01-2000, (00:48:05 + 05:30:00) = 01-01-2000, 06:18:05 IST.

To use the formula based on B2000, we need to find the total number of days elapsed between 01-01-2000, 06:18:05 IST and 01-01-2019, 09:00:00 IST and then convert it into Besselian Years. The steps are follows:

- (1) Total years between 01-01-2000, 06:18:05 and 01-01-2019 06:18:05 are 19 including 5 Leap years. So the total days between the two datetimes are $(19 \times 365) + 5 = 6940$ days.
- (2) The time interval between 01-01-2019, 06:18:05 and 01-01-2019 09:00:00(Our chosen time) is 02:41:55, which is 2.6986111 hours. If we convert it into days, then $2.6986111 / 24 = 0.11244$ days. So, the total days between 01-01-2000 06:18:05 and 01-01-2019 09:00:00 are $6940 + 0.11244 = 6940.11244$ days.
- (3) i.e $T = 6940.11244 / 365.242198781$ (One B year = 365.242198781 days), So the value of $T = 19.0013981495$ years (B)
- (4) Substituting this T value in the B2000 formula, we get the following:

$$\begin{aligned} & (23-46-31.23) + (50.2786 \times 19.0013981495) (+) [0.000111 \times 19.0013981495 \times \\ & 19.0013981495] \\ & = (23-46-31.23) + [955.3636969995 \text{ sec} + 0.0400768976 \text{ sec}] \\ & = 23-46-31.23 + (955.4037738971 \text{ sec}) \\ & = 23-46-31.23 + 00-15-55.40 \\ & = 24-02-26.63 \end{aligned}$$

∴ The ayanamsa value on 01-01-2019, 09:00:00 AM (IST) is = 24d-02m-26.63s.

POST 26

The readers are requested to calculate ayanamsa for the same 01-01-2019,09:00:00 AM(IST)time, using different base year formulæ given in post 24 and verify the answer, which should be 24-02-26.63.

Eventhough B1800, B1900 and B2000 are apparently somewhat easy to be held as base years for ayanamsa calculation, it is not compulsory. The reader can use any year in between, calculate ayanamsa for that year and then keep that as base year for future calculations. For example, the Zero ayanamsa date time of 21-03-291, 09:39:00 can also be used as base year. As we have seen before, the Precession and Rate of Precession must be known to construct the formula. We all know the Ayanamsa at 21-03-291 09:39:00(ist) is Zero. Rate of Precession must be calculated using the formula given in Post 18 as follows.

Formula = $50.2564 + (Y - 1900) \times 0.000222 \text{ sec/year}$. (Y = Required (B) Year)

The corresponding Besselian Years for Zero Ayanamsa Date / Time 21-03-291 09:39:00 is 291.21645153698. Substituting this value for Y in the above formula, we get

Rate of Precession = $50.2564 + [(Y - 1900) \times 0.000222.]$ Seconds

= $50.2564 + [(291.1645153698 - 1900) \times 0.000222.]$

= $50.2564 + [-1608.7835484630 \times 0.000222]$

= $50.2564 - 0.3571499478 = 49.8992500522$ Seconds

So the final formula to be used, if one has to choose Zero Ayanamsa Year as base year is as follows:

Ayanamsa for Required Date/Time = $0 + (49.8992500522 \times T) + (0.000111 \times T \times T)$

T is the time interval between between 21-03-291, 09:39:00 (IST) and the Date/Time for which ayanamsa is to be calculated, in Besselian years.

(End of Part 1)

Annexure 1

Preface

from

Raja Jothida Ganitham (or) Siddanda Sironmani

by

C.G.Rajan

PREFACE.

I was drawn to the amateur study of Hindu astrology about two decades ago as the result of the amateur study and practice of the same by my father and eldest brother, who were trained in the art of prediction by a maternal uncle of my father. Till a few years afterwards, I was a staunch believer in the accuracy of indigenous Vakya Ganitha Panchang, following in my belief the foot steps of my relatives referred to above. My faith in it was suddenly shaken when to my astonishment, I noticed, on one evening in the western horizon, the two bright moving luminaries of Jupiter and Venus occupying positions * relatively to themselves contrary to the positions given in the Vakya Ganitha Panchang which was followed in my family till then. I had consequently taken to the study of Hindu Astronomy, prompted by a desire to calculate planetary positions myself. My study of European Astronomy as a part of the University Syllabus for the Mathematics course of B.A. Degree afforded me ample opportunities to study the ground work of astronomy and this, combined with the facilities and help that I had secured then and there from the authorities of the observatories of Madras and Washington in the United States of America in respect of the right kind of books dealing with the Modern Astronomical tables, had enabled me to make a comparative study of Hindu astronomical tables and European astronomical tables. I was convinced thereby that the Hindu Astronomical tables are far inferior to the European astronomical tables in point of their accuracy. The ever-growing tendency now-a-days even among the most orthodox communities of Indians to go in for western tables at least for horoscope-reading and social functions (though not for such religious services as appear to be impregnable citadels founded upon strong and age-long Vakya Panchang traditions) and the tendency of the Vakya and Siddhanta almanac-makers to embody in their Panchangs the data about the occurrence of eclipses as calculated from European tables are a proof positive in themselves that the Indian astronomical tables are defective and require recasting and improvement in the light of numerous astronomical discoveries made since the days of the theories on which the Siddhantas (from which the Vakya Ganitha Tables were evolved) were formulated and written. The fundamental concepts and theories of Hindu Astronomy and European astronomy are so divergent that it is an Herculean, if

* Not entirely due to Parallax.

N.B.—This book is published in English and Tamil separately. The tables being common to English and Tamil editions, have been provided with headings both in English and Tamil to avoid printing cost. Readers of the English edition are requested to ignore the headings in Tamil.

not a well-nigh impossible, task to raise Hindu astronomy to the same level of Modern European Astronomy in respect of accuracy by making scientific corrections which will be tenable for some centuries at least and without running the risk of seriously jeopardising Hindu astronomy in its identity. There are some European astronomical tables which enable the calculation of planetary positions correct even to the second decimal place of seconds of arc, but so far as I know, they are either very costly (the cost coming upto about one hundred rupees) or in the German and French languages which even many of the English knowing population do not know. It has therefore been my desire for some years past to produce a cheap and convenient book of planetary tables in the wide-spread language of English, and also in Tamil to enable the public to calculate easily planetary positions correct to the nearest minute of arc without going through the laborious, tedious and yet inaccurate methods of the Siddhantas and to set at rest once for all, if possible, the controversy that very often rages in the most orthodox temples about the exact beginning and ending moments of a tithi to determine when a religious festival should commence. These I consider to be the only justification for the introduction of this book to the public.

(2) The list of the important books that I have consulted is given at the end of this book. As regards the Sun, Mars, Mercury Jupiter, Venus and Saturn, I have adopted the Equations given in the *Astronomical Papers* prepared for the use of the *American Ephemeris and Nautical Almanac* Vols. VI and VII by Professor Simon Newcomb and George William Hill † for the Mean longitudes of the Sun and its perigee and for the mean longitudes of the other planets and of their nodes, and perigees with Ross's correction to Newcomb's equation wherever necessary. I have also pressed into my service the equations given in them for some of the important inequalities including those caused by *Planetary Perturbations* † and for the *Reduction to the ecliptic*, keeping always in view my object of aiming at accuracy to the nearest minute of arc. The arguments for the tables of the *Equation of the Centre*, *Secular Variations*, *Logarithm of Radius Vector* and its *Secular variation* are expressed in those volumes in terms of days but I have given my arguments in terms of degrees of the mean anomaly to suit my purpose of securing uniformity and convenience. I have constructed altogether original tables from the equations employed by me. I have framed an equation for the *Great Inequality* (or *Long Period Inequality*) of *Jupiter and Saturn* from the equations given for them in the *Astronomical Tables* containing the *Tables of Jupiter Saturn and Uranus* by M. A. Bouvard (a French Book). For ready use, I have calculated the values of the *Great*

NOTE.—* The tables of Newcomb and Hill in the *Astronomical Papers of the American Ephemeris and Nautical Almanac* are still being used for the preparation of *Greenwich Nautical Almanac*—Vide pages 757 and 766 of *Greenwich Nautical Almanac* for 1933.

Inequalities of Jupiter and Saturn for the years from 1800 A.D. to 2100 A.D. and given them in Table No. 8. For other years outside this limit, the values have to be calculated from the equations given at the foot of Table No. 8. To determine the inequality caused by the perturbation of Saturn by Uranus, I have employed the equation given by Simon Newcomb for the mean longitude of Uranus. As for the Moon, I have employed the equations given for the mean longitudes of the Moon, its *Node* and *Perigee* by Mr. E. W. Brown in his "Tables of the Motion of the Moon" and extracted in the Nautical Almanac and Astronomical Ephemeris for the year 1925. As Mr. Brown's book* costing over four pounds sterling was not available to me for loan, I have adopted the equations given in P. A. Hansen's Tables De La Lune (Tables of the Moon with Neisson's corrections to Hansen's Tables) for the *perturbations* including Equation, Variation, and Annual Equation caused to the Moon. With the help of the equations referred to above, I have constructed original tables. European Almanac or Ephemeris usually gives only the mean longitude of the *Nodes* of the Moon, while I have added an equation to calculate their true longitudes from their mean longitudes and shown also how to calculate them from the first principles.

As regards Nutation, it is made up of several independent motions of the Earth's axis and the most important of them is the "*Lunar Nutation*". The total quantity of the Lunar Nutation in longitude ranges from $+17^{\circ}.639$ to $-17^{\circ}.639$ and the total quantity of the Solar Nutation due to the action of the Sun ranges from $+1^{\circ}.454$ to $-1^{\circ}.454$. I have taken into account the greatest component quantity of $-17^{\circ}.234 \sin \Omega$ which is the Nutation in Longitude due to the action of the Moon and rejected the other component quantities which are very small. The error in doing so will range between the negligible limit of $+1^{\circ}.454$ and $-1^{\circ}.454$, in as much as the total Nutational correction ranges between $+19^{\circ}.093$ and $-19^{\circ}.093$ according to the equations employed by Simon Newcomb. I have prepared table No. 8 of the Sun from the quantity of $-17^{\circ}.234 \sin \Omega$ and employed the correction for Nutation in the case of the Sun and Rahu and Ketu only. I have not embodied, in the illustrative examples for the other planets, the correction for Nutation which is $-12'$ as worked out in the Example for the Sun. On the whole, the correction for Nutation can be safely ignored for all the planets if the reader or computer does not require accuracy to the nearest second of arc and wants to avoid additional labour of calculation. If however he wants to employ the correction for Nutation also, he has to calculate it from table 8 of the Sun as shown in the case of the Sun and add it *algebraically* to the mean longitude denoted by *L* in Part I of the illustrative examples for the several

* The other books, except Surya Siddhanta by Burgess, mentioned in the Bibliography, being my own copies, are with me and I shall feel highly obliged if any one can sell me even a second hand copy of Surya Siddhanta by Burgess and Siddhanta Sironmani of Bhaskara by Lancelot Wilkinson.

planets. I have also added two sections, one on "the Siderial Time" and the other on the occurrence of eclipses. To calculate siderial time sufficiently accurate for astrological purposes, I have evolved the necessary tables for the period from 1800 A. D. to 3100 A. D. from the equation given by Simon Newcomb in the Astronomical Papers. For other periods, the table No. (1) in this section can be constructed from the equation given in the first paragraph of this section. I have ignored Nutation in the calculation of the Siderial Time as the error thereby does not exceed $1^{\circ}.168$ (being equal to the Nutation in longitude multiplied by the cosine of the obliquity and reduced to time *i.e.*, $=19^{\circ}.093 \times 0.9174 \div 15$) seconds of time in Right Ascension or 1.168 seconds of time in Siderial Time. If however the computer wants to embody the Nutational correction also, he has to calculate it from table 8 of the Sun as before, and multiply it by 0.9174 and divide the product by 15 to get Siderial time in seconds of time and add it algebraically to the final result got for Siderial time for any given moment for any place. In the illustrative example for siderial time, $-12^{\circ} \times 0.9174 \div 15 = -0.73$ seconds of time has to be added algebraically to the final result of $23 \text{ hrs.}-0 \text{ ms.}-24.53$ seconds of Siderial Time. If we do so, we get $23 \text{ hrs.}-0 \text{ ms.}-23.8$ seconds. In omitting small quantities on the score that they are negligible, I have always had in my view the object of simplifying calculation and also the purpose for which, or the degree of accuracy to which, we require our calculation and in this, I have followed the precedent of no less an authority than Simon Newcomb who says thus:—"in the following expressions (*i.e.*, expressions for Nutation) I have included all the terms of which the coefficients exceed $0^{\circ}.006$. Below this limit, it does not seem necessary to go, as no astronomical result *will be practically affected by a small error* in the assumed nutation...". To preclude the contingency of my tables becoming approximate for distant periods, I have given, wherever necessary, tables of Secular Variation which will keep the tables sufficiently accurate even to distant dates. As regards the occurrence of eclipses, I have consulted the "Recurrence of Solar Eclipses in the Astronomical Papers Vol. I" by Simon Newcomb and R. Buchanan's Mathematical Theory of Eclipses and could not consult Oppolzer's "Kanon der Finsternisse" as it is in German which I do not know and as I could not get it also being very costly. Though Buchanan's book gives the ecliptic limits with reference to the Moon's latitude, I have calculated the ecliptic limits with reference to the difference in longitude between the Moon and its Node and given them along with the ecliptic limits in terms of the Moon's latitude to enable indigenous Panchang makers and chronologists to determine the occurrence of eclipses with reference to longitude. The tables in this book cover the period from 3200 B.C. to 3100 A.D. so that this book will be useful to chronologists and almanac-makers. As regards the *Heliacal Rising and Setting* of a heavenly body, they belong to *Old Astronomy* rather

than to *Modern Astronomy*. The discovery of telescope has made them a thing of the past. They depend on the conditions of the optical power of the sight of the observer's eyes and the atmospheric conditions determining the clearness of the sky. These two factors are very uncertain and varying. Hence the heliacal rising and setting are not *exact* astronomical phenomena. I have not therefore dealt with them in this book. They depend also on the latitude of the observer and the elongation of the planets from the Sun. Those who are interested in them are recommended to follow the directions given in chapter IX and X of "*Surya Siddhanta*" which are extracted and given in the foot-note for easy reference in the case of the planets only.* I have added three appendices containing information which will be very useful to astrologers, such as the Conversion of Right Ascension and Declination into Celestial Longitude and Latitude, Apparent time, Mean time, Local time and Standard time, the rising and setting of Heavenly bodies including the Sun and the planets and the rising and setting of Zodiacal Signs and the calculation of the Lagna (Ascendant) and the Bhavachakra. In this connection I have to state that I have great pleasure to acknowledge my indebtedness to the books referred to above as having been consulted by me.

3. The books referred to above stop with the calculation of the heliocentric positions of Mars, Mercury, Jupiter, Venus, Saturn (Uranus and Neptune) and do not proceed further with the calculation of their geocentric positions. To facilitate the computer of planetary geocentric positions, I have produced a separate book entitled "Conversion of Heliocentric Co-ordinates into Geocentric Co-ordinates-containing tables for converting Heliocentric longitude and latitude into Geocentric Tropical longitude and latitude and into Indian Siderial longitude" and it is bound with this book for the sake of convenience. The attention of the reader is invited to the preface (of that book) in which it is stated that (1) that book is specially designed to be useful both to those who know the application of logarithmic tables and to those who are ignorant of logarithm and that that book contains also four ready-reckoner tables to convert Tropical longitude and latitude into Indian Polar Longitude and Polar Latitude and to find Hindu Kranti (*i.e.*, Hindu Declination) and European Declination. In the case of Mars, Mercury, Jupiter, Venus and Saturn, the computer, after arriving at their Heliocentric longitude, latitude and logarithm of Radius Vector or simply Radius Vector and also the geocentric longitude of the Sun and its Radius Vector—all according to the rules of this book—has to follow the instructions given in

* The planets are visible to the naked eye when their elongations (*i.e.*, their distances from the Sun in degrees of time) are less than the figures given below. The heliacal setting can be calculated from these limits and the calculation will be sufficiently accurate for estimating the effects of *Ashangatha* planets, for doing the process of *Ashangatha* *Haranam* and for determining *Upakarma*, etc.

The Moon...12°	Venus...8° or 10°
Mars...17°	Jupiter...11°
Mercury...12° or 14°	Saturn...15°

process of *Ashangatha* *Haranam* and for determining *Upakarma*, etc.

the separate book to compute their geocentric positions. In following this method, I have followed the method of European astronomers.

4. From two-fold considerations, I have adopted the method of arriving at the tropical (*i.e.*, Sayana) longitude and tropical latitude first instead of getting the Nirayana longitude first, by making the necessary correction for Ayanamsa in the several tables giving the mean longitudes. To take the Tropical (or Sayana) mean longitudes first and then to apply the necessary corrections ensures much more accuracy—a circumstance which no less an Indian astronomer than the famous Bhaskara of Siddhanta Siromani had admitted as being more accurate. Further, the question of Ayanamsa is still considered a moot one and several schools of thought follow different quantities of Ayanamsa. I have therefore purposely followed the Sayana measure first to deduce from it the Nirayana measure subsequently so that the accuracy of calculation may not be seriously affected and so that the several schools of Ayanamsa may apply their own Ayanamsa quantity and get at the Nirayana longitude which they consider to be correct. I have devoted also, in the separate book referred to above, a section to the question of Ayanamsa, determining in it, from the first principles in some cases, the several quantities of Ayanamsa which have their own votaries or protagonists. The Ayanamsa Tables 1*b* and 1*c* in it are so designed that they can be used by all schools of thought about Ayanamsa.

5. I shall now enable the reader to have an idea of the degree of accuracy of my tables by instituting a comparison with European Almanacs, the accuracy of which, is undoubtedly beyond question as admitted by many. In the illustrative examples, I have calculated the positions of the planets at 5-30 p.m. Standard Time on 16-12-1924 A.D. at Madras.

COMPARATIVE TABLE NO. 1.

At 5-30 p.m. (Standard Time) on 16-12-1924 at Madras
(*i.e.*, at Noon on 16-12-1924 at Greenwich).

Names of Planets.	Heliocentric Longitude.		Heliocentric Latitude.		Logarithm of Radius Vector.	
	Our results.	Nautical Almanac results.	Our results.	Nautical Almanac results.	Our results.	Nautical Almanac results.
Mars ...	40-40-5	40-39-50	0-16-3 S	0-16-4 S	10.16291	10.16291
Mercury.	28-42-55	28-42-36	2-15-27 S	2-15-33 S	9.51276	9.51276
Jupiter ...	270-36-34	270-36-7	0-13-44 N	0-12-25 N	10.71906	10.72026
Venus ...	188-50-5	188-50-23	3-7-42 N	3-7-43 N	9.85777	9.85775
Saturn ...	216-42-42	216-42-18	2-25-15 N	2-25-4 N	10.99347	10.99194

PLANETARY TABLES

COMPARATIVE TABLE No. 2.

At 5-30 p.m. (Standard Time) on 16-12-1924 at Madras
(i.e., at Noon on 16-12-1924 at Greenwich).

Names of Planets.	Geocentric Tropical Longitude.		Geocentric Tropical Latitude.	
	Our results.	Nautical Almanac results.	Our results.	Nautical Almanac results.
	° ' "	° ' "	° ' "	° ' "
Sun ...	264 17	264 17	0 0	0 0
Moon ...	140 50	140 49	0 32N	0 33N
Mars ...	358 14	358 14	0 23S	0 23S
Mercury ...	282 50	282 50	0 52S	0 51S
Jupiter ...	269 36	269 36	0 12N	0 11N
Venus ...	233 24	233 24	1 40N	1 40N
Saturn ...	220 39	220 40	2 16N	2 16N
Rahu ...	136 27	136 27	0 0	0 0*
Ketu ...	316 27	316 27	0 0	0 0*

Sidereal Time :—Our result is 17 hrs.-39 ms.-23.65 sds. as against the Nautical Almanac result of 17 hrs.-39 ms.-23.75 sds. as shown below :—

Hr. M. Sds.

Sum of items up to 1900 A.D., 356 days in page 2	is	17	39	24.38
of the Section on Sidereal Time				
	Nutation	...	—	0	0	0.73
	Total	...		17	39	23.65

These two comparative tables clearly show that our results agree fairly well with the results of the Nautical Almanac and that our tables are sufficiently accurate. In a small volume of this kind, it is absolutely impossible to make our results agree with the results of the European Almanacs to the nearest second, as the European Almanacs employ innumerable equations resulting in the laboriously calculated tables to arrive at their results. *My object is to make my book popular and useful*

* The longitudes of Rahu and Ketu are mean longitudes. The latitudes of Rahu and Ketu are always zero.

both to an expert calculator and to the mechanical worker who does not know much of mathematics beyond the four fundamental rules of Arithmetic namely addition, subtraction, multiplication, and division and at the same time to aim at a moderate degree of accuracy which is sufficient for astrological and chronological purposes. To this end in view, I have given also many tables to reduce the calculation to one of a mechanical nature securing considerable ease in practical working; for, otherwise, any book is bound to get into the limbo of oblivion except with the investigating scholars.

There now remains the pleasant duty of gratefully acknowledging the kind help that I have received from various quarters without which I venture to say that I would not have produced this book. In the first place, I have to thank the staff of the Madras Observatory and in particular Messrs. C. Chengalvaraya Mudaliar and A.A. Narayana Ayyar B.A. (now pensioner) who were exceedingly kind to me in allowing me free access to the observatory of Madras from about 1920 A.D. to consult books on the subject whenever necessary. I have next to thank with very great pleasure the invaluable help and instructions that I have been off and on receiving from 1920 A.D. from the staff and the Superintendent of the United States Naval Observatory, Washington, who were kind enough to clear my doubts whenever I had difficulty to understand the Astronomical Papers of the American Ephemeris and who were also kind to send me free of cost Astronomical Papers Vol. III parts I and V and Vol. V, parts I and II. I take this opportunity to thank also some of my well-wishers whose kind correspondence with me has equipped me with such experience as has been utilised by me in the preparation of this book.

Last but not least is the task of thanking those who were responsible for bringing this book out of the press, despite the special difficulties of printing a book of this nature involving figure-work and enormous labour and expenditure. I heartily thank my eldest brother Mr. C. Appaswamy Mudaliar (a Government pensioner) and his son Mr. C. Viswanatha Mudaliar for their having corrected the proof and pushed the work through the press and for their invaluable help in the construction and preparation of the tables. The readers are specially requested to carry out the corrections given in the Errata list before they proceed to read the book proper; otherwise, they may find it difficult to follow the illustrative examples given. Lastly, I crave the indulgence of the reader to excuse clerical errors and print-mistakes in the book and also any slip of the hand in working out the illustrative examples and to take into account only the methods for guidance in the illustrative examples even if there be any slips of the hand in them.

I have chosen to style this work a Siddhanta and a Graha Karana as well, as I consider that it partakes of the character of both a Siddhanta and a Karana. I have dedicated this work to the loving memory of the ancient and modern astronomers of the East and the West in token of my humble admiration of their intellectual qualities which are par excellence. The undersigned, (C. G. Rajan whose full name is C. Govinda Rajan, a Vethala Mudaliar of Sigamani Maharishi Gotram, aged thirty six years,) ventures to place this work before the public, in the hope that the Almighty will make it useful to astronomers, astrologers, Panchang-makers and chronologists and make him realise that he has done his duty to his countrymen. Salutation to ancient and modern astronomers.

7, Venkatesa Maistry Street,
Near Krishnappa Naick Tank,
Sowcarpet Posts
MADRAS.
9th February 1933, A.D.

C. G. RAJAN.