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Determination of the date of the First Point of Aries held fixed using a combined method of Astronomy and Astrology

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Abstract

In the pre-era of the Global Navigation Satellite System (GNSS), Astronomy was the only technique available for the determination of position or Azimuth. Still, to understand the space-based technique, a good knowledge of Astronomy is necessary; the concept of the Celestial Sphere, Coordinates of Celestial Bodies, and the various categories of Time. The celestial coordinate systems are based on the fixed point in the space, the Vernal Equinox or the First Point of Aries(γ). This point is not static and has a backward movement of about 50 arc seconds per year. In the Eastern system of Astrology, this point is held fixed, but the date it was held fixed is uncertain. This article describes a method to determine this date by using Astronomical and Astrological calculations. According to the computations based on Julian days and the longitude of the Sun, it was found that the First Point of Aries was held fixed around 420 AD.

Keywords: Astronomy, Astrology, Precession of Equinox, First Point of Aries

1. Introduction

Astronomy is used to a great extent in the field of Surveying. Astronomy and Astrology were treated together until the 17^{th} century and Astronomy was treated as the foundation upon which Astrology could operate. Now they have come to be regarded as completely separate disciplines. Astronomy is the study of the universe and its contents outside of Earth's atmosphere. Astronomers examine the positions, motions, and properties of celestial objects through research and observations (Fricke, 1972; Neugebauer, 2012). Astrology, on the other hand, attempts to study how those positions, motions, and properties affect people and events on Earth. For several millennia, the desire to improve astrological predictions was one of the main motivations for astronomical observations and theories.

The celestial sphere is an imaginary sphere with the Earth at its center though the sky extends infinitely into space (Figure 1). There is no finite radius of this sphere which has two parts: the sphere or sky overhead that we can see from the Earth and the sphere which is below the circle of the horizon. Since the Earth, the center of the celestial sphere, rotates anti-clockwise direction (West to East), this imaginary sphere appears to be rotating clockwise direction, from East to West, in every twenty-four hours, so celestial bodies appear to rise in the East and set in the West. In celestial mechanics, the rising and setting of celestial bodies (sun, moon, stars, and planets) are determined by their positions on the celestial sphere. Their coordinates are given in two numbers: Declination and Right Ascension, like latitude and longitude on the Earth's surface. The origin of these coordinates is a fixed imaginary point on the celestial sphere known as the First Point of Aries γ, which creates an intersection of the celestial equator, an imaginary line around the middle of the celestial sphere, and the ecliptic, the apparent path of the Sun on the celestial sphere (Figure 1). The other fixed point which results from this intersection is the First point of Libra ().

The ecliptic is divided into 12 equal parts of 30 degrees each starting from the γ and names are assigned to each part which are the signs of zodiac (Figure 2). The first sign is Aries, and the twelfth sign is Pisces.

Although these two points are known to be fixed, they are not static in reality and have a backward movement of about 50 arc seconds per year and are referred to as the precession of the equinoxes (Biddle, 1969; Mueller, 1969). In the Eastern system of Astrology, the γ has been held fixed but the exact date when this was done is uncertain. Various Astrologers give different dates, which have led to variations in the

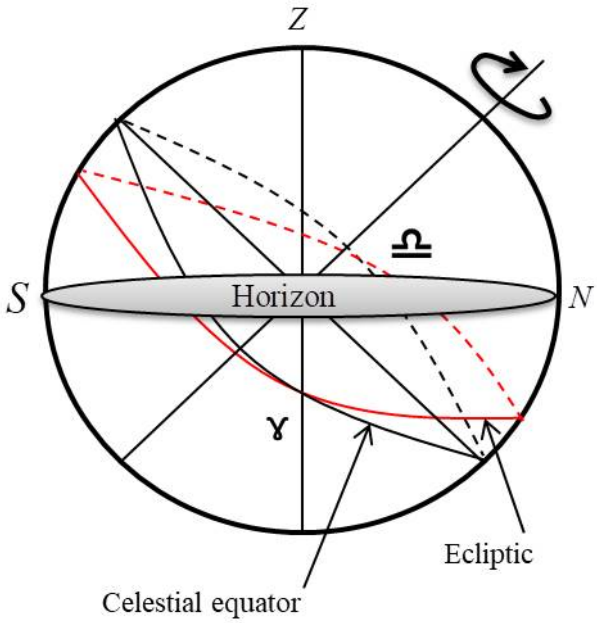

Figure 1: Celestial Sphere

computation of auspicious times, horoscopes and calendar preparations (Mukhopadhyay, 2003). This research paper indicates a method to determine this date using the combination of astronomical and astrological methods.

1.1 The Eastern Vs. Western Systems

There are two systems of astrology: Western and Eastern, and the latter is known as Vedic Astrology, or Jyotish, which started long ago (at least 5000 years ago) (Raman, 1935; Heindel, 1919). Due to the precession of the equinoxes each year, the two zodiacs have been moving apart over time. The western system relies upon the movable or Tropical zodiac, whereas the eastern or the Vedic system utilizes the fixed or Sidereal zodiac. This separation in astrology is known as Ayanamsa (Raman, 1935). This difference increases by around 50 arc seconds per year, and thus the movable zodiac (in the Western system) moves ahead of the fixed zodiac (in the Eastern system) about one full degree every 72 years.

2. Methodology

In order to find the date the γ is held fixed, an important astrological event of known auspicious times was considered and worked backward. Such a well-known event in the Eastern system is the Sinhala-Hindu New Year (the moment of completing a round around the Sun by the Earth). The Sun will be at the actual first point of Aries (γ) around 21st of March that is, at the Vernal Equinox. According to the Eastern System, the Sun has to travel further distance along the ecliptic, and the dawn of the New Year is at the precise moment when the Sun moves from the Zodiac Sign Pisces to Aries in the Fixed System. That is when the center of the Sun is at the Fixed First Point of Aries γ_F (Figure 3).

In the Eastern system, this date is around 13th or 14th April. That is on the cusp separating the Zodiac Signs Pisces and Aries (Figure 3). So, at this time, the Longitude (Long) of the Sun will be equal to the separation between the fixed and the actual First Points of Aries (Ayanamsa). Then, based on the computations of Velocity-Time diagram of the variation in Precession of Equinoxes, the year First Point of Aries held fixed was found. The computations adopted for this study were based on Julian dates in the Julian calendar.

The Julian calendar was established by Julius Caesar in the year 46BC, reaching its final form in about 8AD. However, to facilitate chronological reckoning, Astronomical dates beginning at Greenwich noon are numbered consecutively from an epoch sufficiently far back to cover all historical events. This is the Julian day number 0 assigned to the day starting at noon on January 1st 4713BC (Smith, 1988). It remained in general use in the West until 1582AD, when it was modified into the Gregorian calendar.

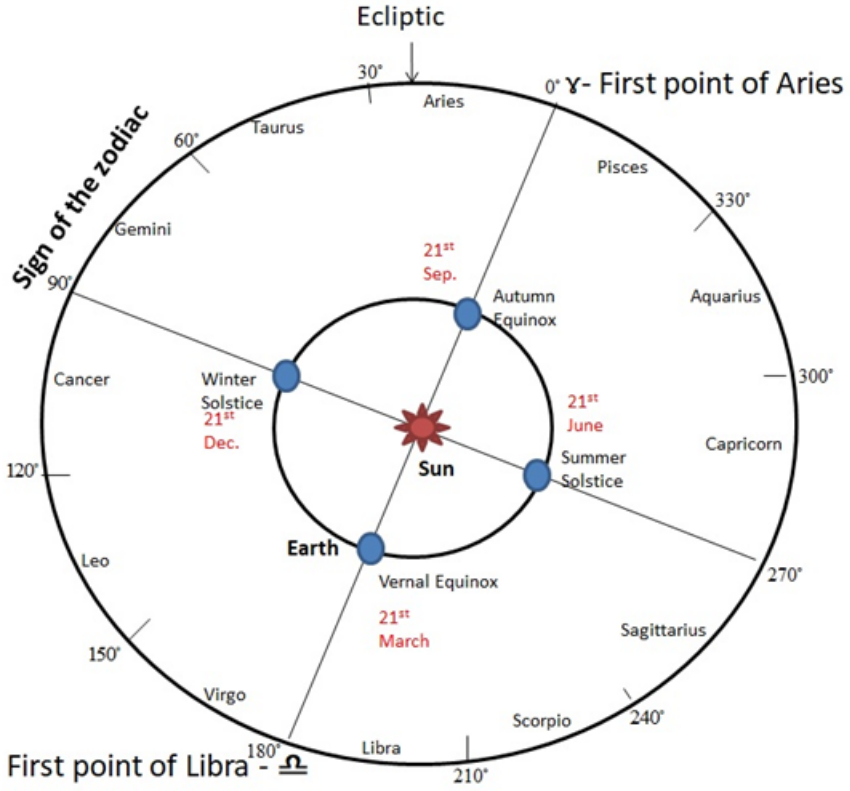

Figure 2: The path of the Sun on the celestial sphere (ecliptic) and the sign of the zodiac

3. Computations, Results and Discussion

3.1. Computation of Julian Dates (JD)

For the computation, an important astrological event of the known auspicious time was used, i.e., the Sinhala-Hindu New Year. Considering a specific example, the dawn of the New Year in 2009 was on the 14$^{\text{th}}$ of April at 0.47 am in the local standard time. That is 19.17 UT on 13$^{\text{th}}$ April (Sri Lanka is on 5.5 hours ahead of Greenwich). It is first necessary to transform the Calendar date 13$^{\text{th}}$ April 2009 UT 19.17 to JD.

Let Y be the year, M the month, D the day which will be a decimal number depending on the time. Here INT stands for Integer. Then

$$Y = 2009 : M = 4 : D = 13 + \frac{19}{24} + \frac{17}{6 \times 24} = 13.803$$

$$A = INT\left(\frac{Y}{100}\right) = INT\left(\frac{2009}{100}\right) = 20$$

Then,

$$B = 2 - A + INT\left(\frac{A}{4}\right) = 2 - 20 + INT\left(\frac{20}{4}\right) = -130$$

Julian Date (JD) gives (Smith, 1988; Biddle, 1969),

$$JD = INT(365.25(Y + 4716)) + INT(30.6(M + 1)) + D + B - 1524.5$$

$$JD = INT(365.25(2009 + 4716)) + INT(30.6 \times 5)) + 13.803 - 13 - 1524.5$$

$$JD = 2454935.303$$

This is the Julian date at which the Sun was at the fixed first point of Aries (γ_{F}). It is known as the JD when the center of the Sun is on the cusp separating Pisces and Aries. It is now necessary to find the Longitude of the Mean Sun.

3.2. Computation of Longitude (Long)

The Sun's ecliptic longitude is given by (Smith, 1988)

$$Long = 279.6966778 + 36000.76892T + 0.0003025T^2$$

degrees,
where T is the number of Julian centuries since

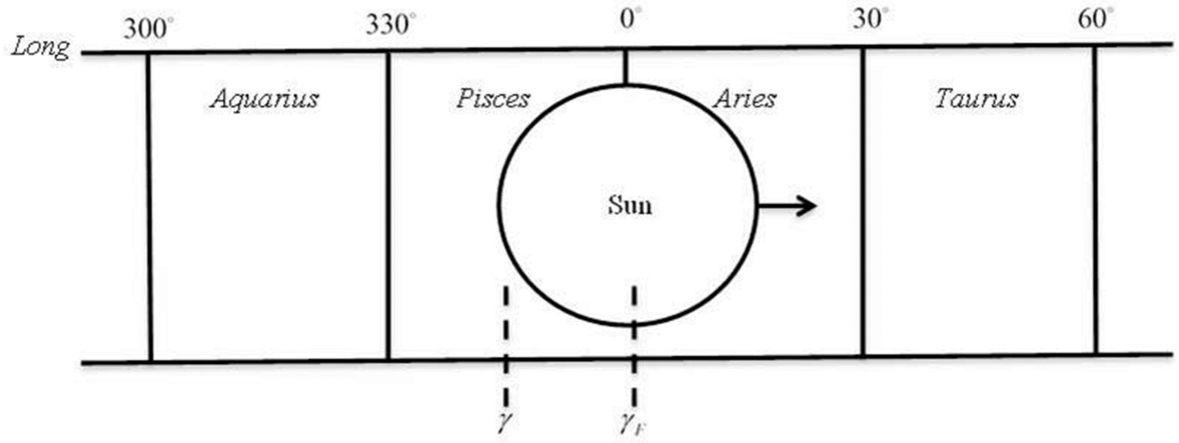

Figure 3: The dawn of the New Year, when the Sun moves from the Zodiac Sign Pisces to Aries

1900 January 0.5 (2 415 020.0 Julian days), i.e.

$$T = (JD - 2415020.0)/36525$$

Substituting to the above and neglecting the second term of T,

$$Long = 279.696678 + 0.9856473354 \times d$$

where d is the difference between the current JD and the JD at an epoch in 1900 1st of January at UT 12 hours (JD-2415020.0).

For epoch 13th April 2009 UT 19.17,

d=2454935.303-2415020.0=39915.303

$$\begin{aligned} Long &= 279^o.696678 + 0.9856473354 \times 39915.303 \\ &= 279^o.696678 + 102^o.412 \\ &= 22^o.10919 \end{aligned} \quad (1)$$

This is the ecliptic longitude of the Sun on 13th April 2009 at UT 19.17.

3.3. Computation of the Precession of the Equinoxes ($P^{"}$)

The rate of Precession in longitude is given by (Biddle, 1969),

$$p^{"} = 50^{"}.2564 + 0.0222 \times \frac{d}{36525}$$

It is required to calculate the distance the actual First Point of Aries (γ) has traveled back from the fixed Point (γ_F). First to calculate for 13th April 2009 at UT 19.17

Table 1: Precession of Equinoxes computed in past years

Year	d	p"
2009.2883	39915.303	50.2808
1900	0	50.2564
500	-511340.5	49.9456
400	-547864.5	49.9234

$$Y = 2009 + \frac{3}{12} + \frac{13.803}{(30 \times 12)} = 2009.0883$$

$$p^{"} = 50^{"}.2565 + \left(0.0222 \times \frac{d}{36525}\right)^{"}$$

$$= 50^{"}.2565 + \left(0.0222 \times \frac{39916.803}{36525}\right)^{"}$$

$$= 50^{"}.2808$$

We can use this formula to compute for periods even before 1900 AD, in which case d will be negative. Table 1 shows the $p^{"}$ computed for some selected years before and after 1900 AD.

Figure 4 shows the representation of this movement in a Velocity-Time graph.

An area enclosed by the graph and the time axis (in Julian days) will give the angular distance moved. The distance of the γ has moved with the averaged $P^{"}$ during the period 1900 to 2009.2883:

$$S1 = \frac{39915.303}{365.25} \times \frac{(50.2564 + 50.2807)}{(2 \times 3600)} = 1^{"}.5260$$

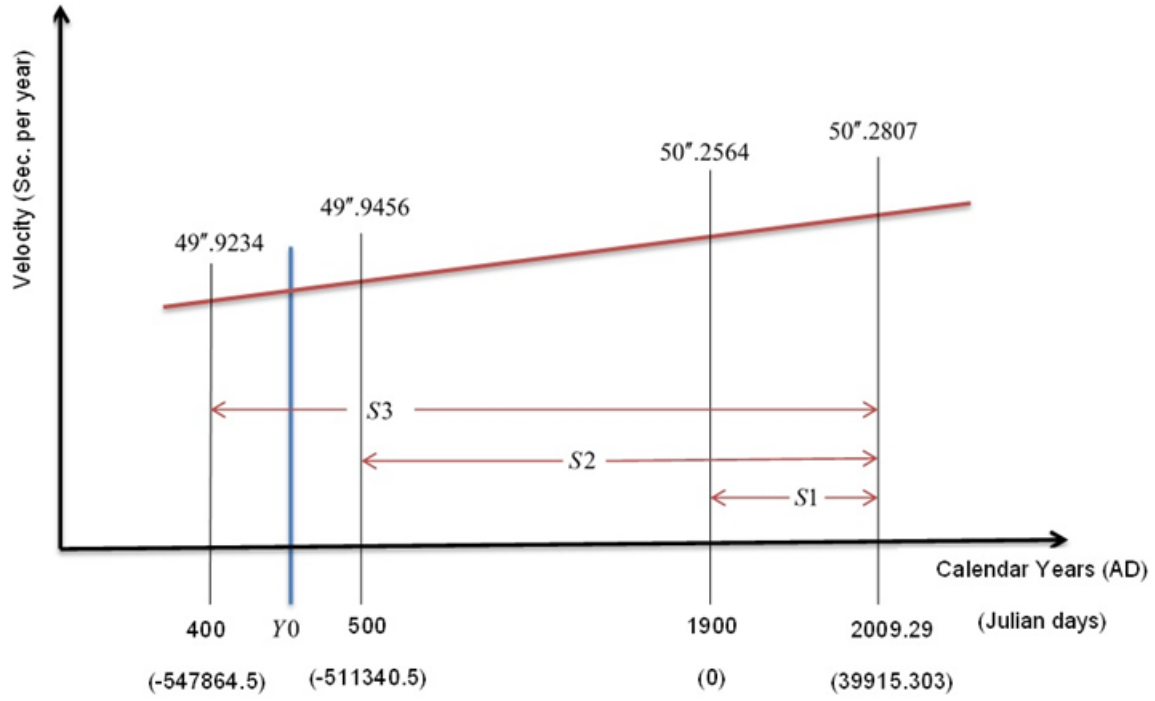

Figure 4: Velocity-Time diagram of the variation in Precession of Equinoxes

Similarly, the distance moved during the period 500 to 1900 AD

$$S2 = \frac{511340.5}{365.25} \times \frac{(50.2564 + 49.9456)}{(2 \times 3600)} = 19".4834$$

Also, the distance moved during the period 400 to 1900 AD

$$S3 = \frac{547864.5}{365.25} \times \frac{(50.2564 + 49.9234)}{(2 \times 3600)} = 20".8704$$

Therefore,

$$S1 + S2 = 1".5260 + 19".4834 = 21".009$$

$$S1 + S3 = 1".5260 + 20".8704 = 22".396$$

The longitude of the Sun at the fixed first point of Aries was $22^0.10919$, and it should be somewhere between 400 and 500 AD. Supposing the year the First Point of Aries was held fixed be Y_0,

$$(500 - Y_0) \times \frac{49.9456 + 49.9234}{2 \times 3600} + 21.009 = 22.101919$$

So,

$$Y_0 = 420.68$$

Therefore, the First Point of Aries was held fixed in the year 420 AD around the month of July/August.

Table 2: Computation of the Y_0 based on other years

Dawn of the New Year				Value of Y_0 Year
Year	Month	Date	Time (hh.mm)	
1937	April	13	13.13	422
1957	April	13	16.32	421
1977	April	13	19.35	421
1987	April	14	09.00	422
1997	April	13	22.51	421
2007	April	14	12.29	420
2020	April	13	20.33	421

3.4. Computation of Y_0 based on other years

Based on the times of dawn of the New Year in past years and the year 2020 (according to the published auspicious times), the value of Y_0 was calculated and shown in Table 2.

So, it is seen that if we consider the time of the dawn of the Sinhala-Hindu New Year, the First Point of Aries was held fixed around 420 AD.

4. Conclusion

Since long ago, astronomy has been treated as the foundation upon which astrology could operate. In this research, the time of the First Point of Aries

held fixed, which is the base of the Eastern system of astrology, was calculated using astronomical methods.

As a known astrological time, the dawn of the Sinhala-Hindu New Year which is a well-known event of Eastern Astrology was used. Calculations were based on Julian days and longitude of the Sun when it is on the separation of zodiac signs Pisces and Aries. It was mathematically proved that the First Point of Aries was held fixed in the year 420 AD around the month of July/August. It would be interesting to extend this computation for future auspicious times so that further confirmation of this date can be achieved.

The computation of the date the First Point of Aries held fixed is not readily available in the literature. Therefore, the information in this paper would be helpful to the precise computation of auspicious times, calendars, and horoscopes for Astrologers.

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