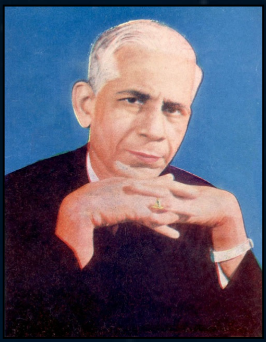

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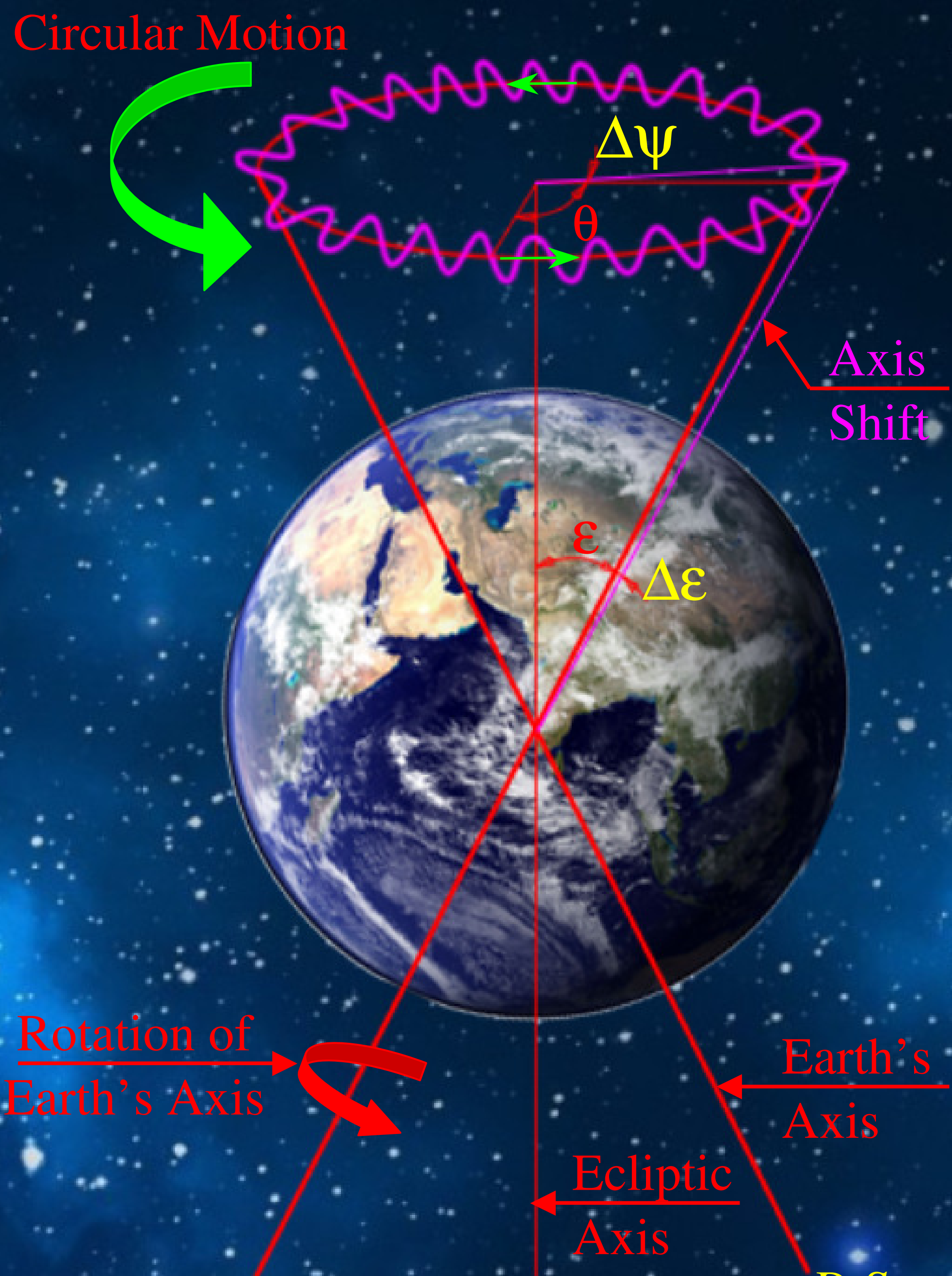
(Includes Rajan, Lahiri &Rashtriya Panchang)



D.Senthilathiban

Study of KP Ayanamsa with Modern Precession Theories (Includes Rajan, Lahiri &Rashtriya Panchang)

By
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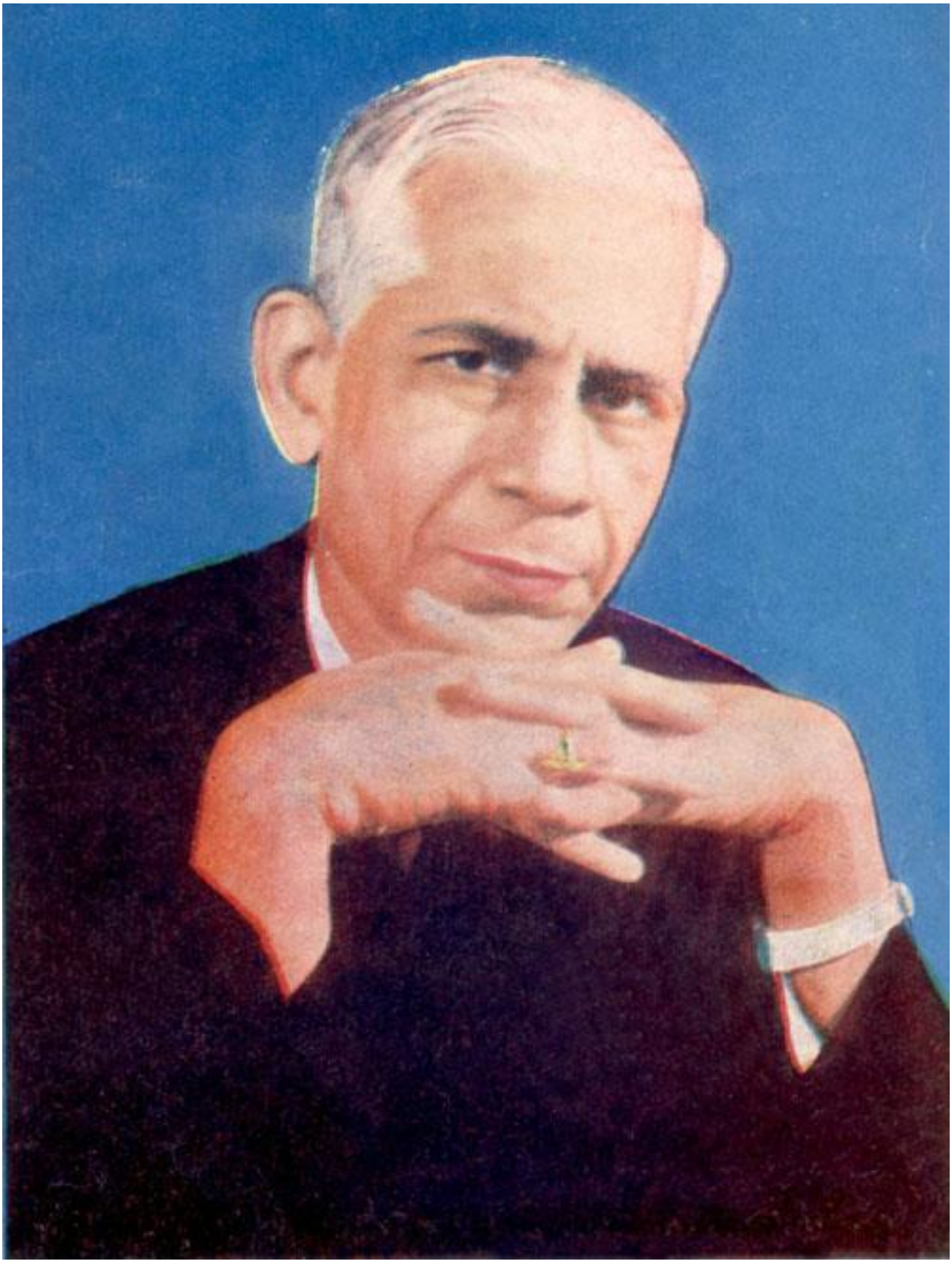

Founder: Krishnamurti Padhdhati

Sothida Mannan, Jyothish Marthand
Prof. K.S.Krishnamurti 1908-1972

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Foreword

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At the outset let me wish all the readers a good day.

I have known the author of this book, Mr.Senthilathiban for the past year and half, as a co-member of a Tamil Astrology Group, led by Mr.TKP.Gopal,Salem,an eminent KP Astrologer.In the group, we use to exchange views on all Astrological matters apart from analysis of any individual Horoscope as opted by members. Mr.Senthilathiban use to participate in all such discussion without fail. His arguments and counters in such debates would be very interesting, meaningful supported by scientific/Astronomical proof and evidences. He would come out with details required out of him in no time, by browsing through the web sites. He is never afraid of ventilating his views, often blended with punching remarks, humour, sarcasm or satire. Above all he has got a flair for research-oriented writings. All these traits in him, perhaps had drawn me closure to him in course of time. So when he told me about his idea of writing an article on Ayanamsa, I was very glad and encouraged him to go ahead, pledging my support.

He proceeded and just took about three months to complete his assignment. I was rather thrilled after going through the contents of the book (originally intended to be an article of few pages, ended as a book of more than 100 pages.) as it is replete with in-depth description of all elements of Ayanamsa. Further, this book reveals not only the author's proficiency in mathematical/ Astronomical derivations but also unveils his hard work, commitment and dedication. True to his good intention, he has not priced this book and can be downloaded free from website.

To start with, Mr.Senthilathiban clearly explained the Newcomb precession theory, adaptable to any year of reference and worked out the general formula for calculating "Ayanamsa" for any given moment of time (date).

He has made detailed study of the Ayanamsa formula and the corresponding derived values of Mr.C.G.Rajan, N.C.Lahri and K.S.krishnamurti and brought out to the attention of the readers, the lacunae found in the respective system, apart from making a comparative study of these three along with modern precessional values and presented with suitable graphical charts and tables, for better understanding.

He has also explained explicitly, the modern precession theories, IAU 1976 and IAU 2006 models and tabulated the Ayanamsa values derived, based upon them. He has made critical analysis of the articles written by eminent KP astrologers (1) Sri M.G.G.Nayar (2) Dr.K.Balachandran and (3) the contents of Universal Table of Houses prepared by Prof.S.Balasundaram (co-authored by Mr.A.R.Raichur) & published by Mr.K.Hariharan (4) Krishman Table of Houses, published by Mr. K.Subramaniam and recorded the merits / demerits in them.

Most important and very useful topic he has touched upon is "nutation (true ayanamsa and true obliquity)" which I believe, most of the present day Astrologers have not heard of. Sri.C.G.Rajan as early as the year 1933 in his book "Raja Jyothida Ganitham", has comprehensively described and stressed upon the importance of taking into account Nutation values for accurate results. Subsequently N.C.Lahiri also published regularly in his ephemeris True Ayanamsa values (along with Mean Ayanamsa) and true Obliquity value(along with Mean Obliquity). Unfortunately, Majority population of Astrological community did not pay attention to and ignored this vital point over the years with Sri KSK, being no exception.

It must be remembered that accuracy is the hallmark of KP system (That is what all KP followers boast off while claiming superiority over other systems) and even one second (angular) can make a difference. A section of the KP astrologers, when confronted, place an argument that even a difference of about 4 to 5 minutes (in Ayanamsa value), do not really matter except in border line cases. I disagree with them as I find no merit in it. In the first place, what is the need for such a compromise, when your computer gives you the planetary and cuspal positions (upto millisecond accuracy) in no time, for all categories of Horoscopes. I for one, strongly recommend the use of True Ayanamsa values only, for erecting Horoscope to get accurate results. It may be recalled that Sri M.G.G.Nayar, in his article "Krishnamurti Ayanamsa" appeared in Astrology & Athrishta magazine 1980 May issue, had dealt with Nutation and suggested it's inclusion, for getting better results. Now in this book, Mr.Senthilathiban has explained in greater details about Nutation and furnished the Astronomical formula for computation of the same, for any given moment of time, which can be used by software developers to get true Ayanamsa and true Obliquity.

All the Astrological softwares now available in market, which facilitates KP system, provide more than one Ayanamsa (ie: KP old, KP new, KP straight line or Refined) leaving the choice to the user. Unsure of the correct one, most of the KP Astrologers opt for one among them, more out of blind faith rather than of any reasoning. I feel that had Guruji, Sri KSK gone on record, explaining the Newcomb original precession theory and the corresponding one-line formula, for calculating Ayanamsa for any year therein in his Reader1, the whole confusion would not have surfaced at all.

So the consequence of one small omission on the part of Sri KSK, resulted in a controversy which not only the post KP followers could not solve even after countless discussions and debates over the past four decades but also gave room for ridicule by others (Other than KP users). One of the reasons for this stalemate,I feel is lack of interest in KP followers, borne out of insufficient knowledge on the subject of Ayanamsa(Astronomy). Now this book offers a golden opportunity for all, not only to enrich their knowledge but also provides clarity to select the correct one. Let us not forget that there can be only one correct answer (value) for a mathematical equation, a simple logic and commonsense, which applies to Ayanamsa also.

I now appeal to all my fellow KP followers to get united, hold thorough discussions at the appropriate forums, Identify the correct Ayanamsa to be used in future, insist the respective software provider to incorporate the same in their module (with provision to choose true Ayanamsa/Obliquity). If this to fructify, everyone should come forward with open mind (shedding any ego) and approach the problem with wisdom and not with passion, to arrive at an unanimous solution, acceptable to all.

The success of such an initiative does not stop with the fixing of the correct Ayanamsa alone. Every KP follower should vow to abide by the unanimous decision taken collectively, use only the recommended Ayanamsa in all future calculations so that Horoscope cast by any one, located anywhere in the World (for any given birth time) would remain same upto sub sub sub level and also the dasa balance.

This accomplishment alone could be considered as the real homage paid by KP followers to the great and illustrious person Sri K.S.Krishnamurti, who has left behind a very rich legacy to the Astrological community.

Let God Uchishta Maha Ganapathi and the Devine soul of Guruji Sri KSK bless the KP fraternity, to achieve this great goal. Before I conclude, let me wish Mr.Senthilathiban success in all his future endeavours.

Good luck to all.

Date: August 01, 2019 By
Place: Chennai, INDIA V.Subramanian

Preface

Spherical Astronomy, the most interesting subject that I had enjoyed as part of my under-graduation in Civil Engineering. Having acquired masters in Structural Engineering and leading a professional life as a successful consultant in the engineering & construction field, the bond with astronomy developed a passion in me for learning Astrology. My natural appetite for mathematics and the astronomical knowledge from academics make the complex models of Astronomy and Astrology lucid. Astrology slowly became part of my life as I began to study books written by greats in this domain. The decision to undergo rigorous training in this subject led me to ***KP Stellar Astrological Research Institute, Chennai, India*** where I learned the Krishnamurti Padhdhati (KP astrology system) from Mr.***K.Hariharan***, son of the founder of KP System Shri.***K.S.Krishnamurti*** (KSK).

In the process of exploring KP fundamentals, I studied KP readers extensively. While KP foundation is built on year 291 AD (year of coincidence of zodiacs) and the Annual Precession Rate 50.2388475", the values in ayanamsa table given in KP Reader1 for the years 1840 to 2001, do not corroborate with the parameters recommended by KSK.

I also came across few leading KP Astrologers and their followers set this ayanamsa table aside and derive the ayanamsa value by adding the precession value of 50.2388475" starting from the year 291 to the year of calculation. It is currently being identified as KP Straight Line or KP Refined ayanamsa. It differs 5 to 6 minutes with KSK's recommended ayanamsa table in KP Reader1.

It was not over yet, in 2003, the KP world encountered another ayanamsa, identified as KP New based on Mr.Dr.Balachandran's article published in KP & Astrology year book 2003. With this new ayanamsa, the KP astrologers are left with 3 choices. They are in distress to choose the correct one to meet their expectations as there is an uncertainty on which on is most accurate. Though everyone is aware of the need for accurate calculation of this fundamental element of KP System, a solution that is acceptable to the community is yet to be arrived at. Despite there have been several debates over this issue, the period of stalemate continues till date.

This situation ignited my natural desire to provide solutions to complex problems. I decided to research this area to find the core for the benefits of KP Astrology Society. I have furnished more details related to this in Chapter(2) "History and Details".

For this project, I have gone through the astronomical research papers written by ***Simon NewComb*** (1835AD -1909AD), the most honored and unparalleled American scientist & astronomer of his time. NewComb defined the formula for the precession value around 1900 AD that has been used by Astronomy Societies across the world for more than half century. These research papers were used by renowned Indian Astrologer and Mathematician ***C.G.Rajan***, in the early part of 20th century (1930). I carefully studied the work of C.G.Rajan, Ephemeris references from ***N.C.Lahiri***, Astrological magazines published by ***B.V.Raman*** in the 1960s. Unlimited internet references including the papers of authorized precession formulas from IAU(International Astronomical Union), IAU1976 and IAU2006 are also part of my research.

I have analyzed in detail, the ayanamsa of KP, other popular ayanamsas of C.G.Rajan, N.C.Lahiri & IENA (Rashtriya Panchang). The detailed comparison is given in this book with my findings. Since Dr.B.V.Raman's Ayanamsa does not use Newcomb precession theory, it is not part of the analysis. I have also explained the IAU1976 and IAU2006 precession models along with proper derivations. The graphical representation of Precession Rate and Precession (Ayanamsa) Equations are discussed in detail.

Another important and an integral component of Ayanamsa is '***Nutation***'. The value of **'*Nutation in longitude*'** when added to mean Ayanamsa gives **'*True Ayanamsa*'**. Though there had been occasion in the past when a few senior KP Astrologers did mention and briefly discussed about true Ayanamsa, still it did not gain due importance among KP community and ultimately ignored by individuals and many KP software developers as well. When the mindset of people is such that even five to six minutes difference in Ayanamsa value would not affect the results alarmingly, then there is no wonder that they consider plus or minus 19 seconds of nutation in longitude effect to be inconsequential. But to those who desire to compute cuspal and planetary positions very accurately I strongly recommend to them to adopt true Ayanamsa only, for calculations. I have dealt with this part exhaustively in this book.

My appeal to the readers is that Astronomy forms the foundation of Astrology. Astronomy being a science, cannot be dealt with probability, inference or faith. In today's world, the astronomical data collected through satellite and modern sophisticated instruments (0.001 arcSeconds accuracy level) are subjected to through scrutiny by scientists before they are made available to the public. They can be considered more reliable. It is imperative for us, the Astrologers, to be prepared and accept the updates every now and then, provided by the Astronomical Science to ensure Astrology to be properly tuned in accordance with Astronomy. In this connection, I would like to draw the attention of the readers to words of Shri.KSK reproduced in Chapter(9) 'Recommendations'.

I concluded the work with clear formulas to calculate Ayanamsas based on three Precession Models (NewComb, IAU1976, IAU2006) for KP, C.G.Rajan, N.C.Lahiri and IENA/Rashtriya Panchang for the respective year of coincidence advocated by the authors. Accordingly, I have also presented the tables for the Mean Ayanamsa values for the years between 1800 and 2399 using the current Precession Model (IAU2006) adopted by IAU. An example calculation to find Mean and True Ayanamsa/Obliquity for KP System as per the IAU2006/IAU2000A models are also given.

I am very grateful to Mr.V.Subramanian, Chennai, senior KP astrologer who has guided me from the very beginning by providing information from old references. Despite his age, he visited libraries many times to compile the wealth of information. Further, he accepted my request to write foreword to this book. I am very thankful to him for all his help. I also thank Mr.C.Muthusamy, a great friend and astrologer in Pollachi, India for his support and guidance on details from KP Readers and other references. Without their support, I could not have achieved my current level of success. My revered thanks to USA Library for providing one of the main references "***Raja Jyothida Ganitham by C.G.Rajan***" used for writing this book and the online sites that provided various details in different perspectives.

Humbly I would like to state here that the numerous articles have been written by eminent scholars on Ayanamsa front. They appeared over the past four decades in various Astrological magazines. Their approaches to solve the problem relied more on faith than science. Here I have made a sincere attempt to address the issues through pure astronomical science and mathematics.

My primary objective of writing this book is to provide KP Astrologers, the elucidation of the complex Ayanamsa structure in order for them to understand the intricacies of it. I believe it not only help them to accurately draft horoscopes but also effectively contribute their arguments in debates.

Note to Readers:

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I welcome feedback from the readers, which may be sent to my Email address, WhatsApp Number given below.

GOOD LUCK TO ALL!!

Date: August 05, 2019

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About the Author

D.Senthilathiban

I was born at Pollachi, a town located in the western ghats of state of Tamil Nadu, India. I went to school in various cities in the State before I enrolled myself in PSG College of Technology, Bharathiar University, Coimbatore, India for under-graduation in the field of Civil Engineering and further moved to obtain Master's Degree in Structural Engineering in the year 1993. Started my career as an Engineering Consultant in Chennai, I got the opportunities to work in various Engineering Consulting and Construction companies in India and foreign lands. My professional career is compiled of 27 years of experience in Oil & Gas, Petrochemical, Power and Chemical Projects. I am presently working in South Korea as a Senior Civil/Structural Engineer in Energy Division of a MNC company and providing Project Management Consultancy Services to one of the UAE government company's project.

Having a passion for Astrology, Astronomy and Programming for many years, I developed the habit of reading lot of books on the subjects. Fortunately, I had part of astronomy as a subject in my academic syllabus that helped me understanding the subject in depth. When I reached the point to learn astrology professionally, I joined the KP Stellar Astrological Research Institute, Chennai, India where I had undergone rigorous training from Mr.K.Hariharan (son of KSK) in KP Astrology System for four years from 1998 to 2001. I have given various lectures on Astronomy and Astrology in the Asian Astrologers Meet conducted by the Institution. From 2009, I have been a regular member of various online groups in the world of KP Astrology. I engage myself more frequently in astrological discussions and debates. I am currently a member of the Astro Wonder WhatsApp group (both Tamil and English).

My skills in computer programming gives me the freedom and independency when there is a demand for coding either in Engineering or in Astronomy/Astrology. I write my own programming models for testing and verifying data. Apart from the learnings, I contributed many astrology articles published in various Journals and eMagazines. Some of my published articles are listed below for reference.

1. A code on “Fast String Searching & Cyclic Redundancy Check (CRC) checksum in Visual Basic” is submitted to PSC (planet source code) for Website Population.

2. A code on “RP_CLOCK in Visual Basic” is submitted to K_P_SYSTEM (Yahoo astrology discussion Group) for Group members use & Website Population.

3. An article on “Trigonometry behind the House Cusps” Published in Journal for Advancement of Stellar Astrology (JASA) Vol.1 (2)-Sept-Oct 2011 Pages 43-77

1. Introduction

In this book, the KP Ayanamsa, recommended by Shri.K.S.Krishnamurti(KSK) based on NewComb Theory and the Precession Models adopted by IAU (International Astronomical Union) are studied and discussed in details with Modern Precession Theories. The foundation for the development of KP Ayanamsa is analyzed and findings are presented in this book. Comparisons between KP Ayanamsa with Lahiri and G.G.Rajan including mathematical formulations of equations as per various Precession Models are also shown here.

The most important point I have brought out is the use of ***True Ayanamsa*** and ***True Obliquity*** (which most KP astrologers have undervalued). The ***Nutation in longitude*** value that alters the Ayanamsa Value can not be ignored, especially in KP System where the ***accuracy*** is its hallmark. I wondered how this important component did not attract KSK when C.G.Rajan (very popular mathematician and eminent astrologer of 20th century) whom he referred to in his book, had explained the details of Nutation as early as year 1933. The ***Nutation*** value is the correction factor used in calculating ***True Ayanamsa*** and ***True Obliquity***. In this book, I have explained both and the factors affecting it.

2. History and Details

In the month of August 2018, Mr.V.Subramanian, a senior KP astrologer who is a member of AstroWonder WhatsApp Tamil group in which I am currently a member too, presented an article about Ayanamsa (Precession) topic. My disagreement in his conclusions led us to lot of debates on this topic. I tried to raise questions about the source of the Newcomb's Precession adopted in KP System and the astronomical/scientific basis behind the parameters used in the equations associated with it. I also get help of the emergence of modern precession theories adopted by IAU that updated Newcomb’s theories based on the modern ground telescope readings, satellite data and mathematical models. The following details are observed in my research.

1) The actual Newcomb’s general precession rate for the tropical year 1900 is 50.2564” Ref.[4,46]). But there is no evidence found in Newcomb’s works for General Precession value 50.2388475” as mentioned by KSK in his KP Reader-1 Book Ref.[18]. ***KSK neither mentioned about the specific year for which his Precession value refers to nor this value changes every year***. Further findings are discussed in Chapter(3) ‘Newcomb’s Precession and scope’.

   In the year 1980, M.G.G Nayar in his article Ref.[20] states that he could not be able to trace basis for the values mentioned by KSK in his Reader1 book. Further in the year 2003, K.Balachandran has written an article Ref.[17] in support of KP Ayanamsa tabulated in KP Reader1. In his article he simply followed the mathematical principles shown by M.G.G Nayar except that K.Balachandran very tactfully substituted 50.2388475” for 50.2564”. ***It is to be pointed out that reference year adopted by K.Balachandran for 50.2388475” is completely wrong*** and the details are discussed in Chapter(3).

2) KP Ayanamsa given in Reader1 appears to have been derived from C.G.Rajan’s table provided in his book Ref.[12]. The comparison between C.G.Rajan’s and Lahiri’s Ayanamsa are also presented in Chapter(7) ‘Findings and Discussion’.

3) Newcomb in his works never mentioned anywhere 291 as the Year of coincidence (Zero Ayanamsa Year), as most of the KP followers’ believing otherwise. In fact, S.P.Khuller in his

book 'True Astrology' Ref.[56] expressed that Zero Ayanamsa year 291, relates to Newcomb. His presumption is incorrect.

The intersection point between celestial equator and ecliptic (called first point of Aries ♈) moves counterclockwise (retrograde) direction every year by an amount called precession (Ayanamsa). The difference in celestial bodies, cusps positional longitude against Tropical Zodiac (Sayana/ Moving Zodiac in Western Astrology) and Sidereal zodiac (Nirayana or Fixed zodiac in Indian Hindu astrology) was Zero in the year 291 AD as advocated by KSK. It is found that the Ayanamsa Table given in KP Reader1 was first published in Astrology and Athrishta August & September 1963 Edition Ref.[42,43], presented without any scientific/Astronomical basis with reference to Newcomb's General Precession Rate and also for Zero Ayanamsa year. Further, to the Author's best of his knowledge, there is no scientific/astronomical evidence found neither in KSK's monthly magazines nor in his readers to support his theory of Newcomb's General Precession rate of 50.2388475" and Zero Ayanamsa Year as 291AD. However, KSK has stated in his Astrology and Athrishta August 1965 Ref.[36] magazine(1) under chapter 'Questions and Answers' and also in Reader1(2) as given below.

================================Quote==================================

(1) The editor will prove, through the columns of this magazine, how his is correct and hence anything else is incorrect when opportunity arises.

(2) Let me state that the difference between what I follow, what Lahiri and C.G.Rajan follow are negligible. I can advise my followers to take that Ayanamsa which I have given in this book and when time permits in my Magazine Astrology and Athrishta I will surly prove that what is published in this book is very correct and the proof that I will be giving by using stellar system will convince one and all.

==============================UnQuote================================

The above statements by KSK can be interpreted as that his proof would be based on the stellar system, using natal charts/horoscopes only and not on the basis of astronomical science. In my opinion, the author who developed the table of ayanamsa values from the year 1840 to 2000, should have been able to provide instantly, the method on how the values were derived. Instead he advised the readers to wait. Incidentally, D.V.Ketkar in his article Ref.[53] published in B.V.Raman's Astrological Magazine May 1963 (reproduced in August 1999 edition and in Modern Astrological Magazine March 2019 edition) has given some astronomical proof for Zero Ayanamsa (precession) year as 291 AD. So it may be inferred that KSK would have taken a leaf from Ketkar's article.

4) For the astronomical calculation purpose, Newcomb's General Precession was derived based on Besselian epoch and Tropical year (consisting of 365.242198781 days. Ref.[46]). But the modern astronomical calculations are based on Julian Epoch and Julian Year (consisting of 365.25 days).

As per the online resources, IAU decided at their general assembly of 1976 that the new standard epoch of J2000.0 (prefix J implies Julian) should be used from the Year 1984, as reference for astronomical calculation. Before that, B1950.0 (prefix B implies Besselian) seems to have been the standard. It is evident that there is a small difference in days between Julian Year and Tropical Year which works out to 0.007801219 days (365.25 - 365.242198781) Per Year. Due to this difference, the days elapsed from 291AD to 2018 would workout to 13.472705213 days and so on. Hence while calculating Ayanamsa based on Julian Year/Epoch, the Precession Rate given for Tropical Year shall be adjusted, to avoid accumulation of error. This vital point has not been taken into account at all by KSK, Nayar, Balchandran (Ref.[17,18,20]). Moreover, all the calculations by them are based on calendar year rather than Tropical/Julian year as per Newcomb's formula.

5) It is noted that KSK did use in his work the available astronomical/scientific general precession theory (by Simon Newcomb) followed during his period in the American ephemeris for nautical almanac [AENA] around the beginning of 20th Century till his demise 30-Mar-1972 (of course with lot of modifications and misleading statements). Subsequently based on the modern ground telescope readings, satellite data, more mathematical models were derived and new theories had emerged by modifying/superseding Newcomb's precession theory, accounting dynamic motion of ecliptic pole, dynamic motion of the celestial pole due to Luni-Solar Perturbations, dynamic nature in precession, changes from Besselian to Julian epoch etc.

   IAU, at their general assembly of 1976 decided to implement the general Precession Rate for the Julian epoch J2000.0 to be 5029.0966" per Julian century (Ref.[15]), for the purpose of astronomical calculation. The scribe has verified the above and noticed that this value has been implemented in AENA from 1984 onwards(Ref.[47]). The same IAU at their general assembly of 2006, reduced above value to 5028.796195" (Ref.[14]) per Julian century and implemented then onwards (Ref.[48]) till date.

   To the best of the Author's knowledge, no study has been done till date, the impact of above modern Precession theories on "KP Ayanamsa"(Of course one author discussed Chitra based Ayanamsa with modern theories in his book published in the year 2016 Ref.[3]).

6) As per the astronomical data, the sayana sun will appear at first point of Aries ♈ Zero degree around 21 March every year. Hence the date of coincidence for sayana and nirayana zodiac(Zero Ayanamsa) in the year 291AD should have been considered as 21 March, 291(Ref.[9]) for calculating KP Ayanamsa. It is observed that the software mentioned in V.Subramanian's article (Ref.[7]) shows the date of Zero Ayanamsa for 'KP Enhanced', somewhat around 14 August 292 instead of 21 March 291.

7) The following details are given by KSK in his KP Reader-1 Book as shown below.

   ================================Quote================================

Aryabhata	=	46.3"
Parasara	=	46.5"
Varahamihira	=	50.0"
KRISHNAMURI follows the figure given by NEWCOMB	**=**	***50.2388475"***
Surya Siddhanta	=	54.0"
Bhaskara	=	59.9"

   If you want ayanamsa from the years beyond 2001, for ***each year add at the rate of 50.2388475 secs***.
   ===============================UnQuote===============================

   The above underlined statements implies that the rate of Ayanamsa is constant but it is not true as per Newcomb's formula Ref.[4,46], resulting in introduction of more than one Ayanamsa like "KP Straight line", "KP Refined", etc. by later KP followers.

   A similar question was raised by Mr.V.Subramanian in his article too published in KP & Astrology Year book 2019 (Ref.[7]). As we are members of the same WhatsApp discussion group, while he was about to complete his article (Ref.[7]), I had discussed and provided him ample evidences for the original source for the Newcomb's General Precession, parameters involving in General Precession, history behind "KP Ayanamsa", modern Precession theories emerged after KSK's demise and latest Precession values adopted by IAU. Unfortunately, his article went to publishing even before he got a chance to include it. His article limited its scope to the specific category of "KP Enhanced" which is used in the software mentioned in his article. He has mentioned that "Enhanced" is the one advocated by KSK, which is found incorrect statement due to Zero Ayanamsa date not in-line with KSK's recommendation(see point6 above). The article went on to discuss the changes required in the software. This was a little disappointing to me, but it was also an inspiration. The efforts I made during this time made me think of writing this book and include all my findings. I approached Mr.V.Subramanian, Chennai, expressed my wish to explore this subject in depth and submit my work on Ayanamsa in an effort to clear the difference of opinions on this subject. He is pleased and encouraged me to take this mission. He also promised to provide all the necessary help on this project.

It is pertinent to note for all our analysis and prediction in Hindu Vedic astrology and KP in particular, precise Ayanamsa value is the most important for fixing nirayana position of house cusps & planetary positions. Many ready reckoners and computer software are available in the market nowadays, obviously becoming the barriers for the growth of knowledge, in modern-day astrologers in the field of Astronomy and Mathematics.

The use of distorted version of original formula of Newcomb by KSK / K.Balachandran(Ref.[17,18]) in computing Ayanamsa values, has prompted me to bring fourth to KP followers the impact of such variations, elaborated in Chapter(3) 'Newcomb's Precession and scope'.

3. Newcomb's Precession and Scope

For Ayanamsa computation, Julian Days (JD) is used as one of the auxiliary parameter and the definition, procedure, mathematical formulae associated for calculating JD for the given Calendar Date is not considered under this book's scope. However, the equations relating the Julian Days (JD), Besselian Epoch (Tropical Year), Julian Epoch (Julian Year), Number of days per Julian Year/ Century (DJ) and Number of Days Per Besselian (Tropical) Year/ Century (DB) are given below.

i) Besselian Epoch (Tropical Year)

Besselian Year/Century BY for any given JD (Julian days) can be calculated using below Equation (Ref.[35]),

$$BY = BE_0 + \left(\frac{JD - JD_0}{DB} \right) \quad \text{-----------Eqn.[b1]}$$

Where

BE_0 = Besselian Year [or] Century (=1900(or)19.0 for B1900) (Prefix 'B' means Besselian)

JD_0 = Julian Days for the Epoch B1900

= 2415020.31352 days(for the Date 00 Jan 1900 19:31:28 hrs UT, Standard Besselian Epoch)

DB = Number of days (= 365.242198781 per Besselian Year [or] 36524.2198781 per Besselian Century)

Substituting in the above Eqn.(b1) we get,

$$BY = BE_0 + \left(\frac{JD - 2415020.31352}{DB} \right) \ \text{Ref. B1900} \quad \text{-----------Eqn.[b2]}$$

If Time duration 'T' is measured in Besselian (Tropical) Year/Century from the reference epoch B1900 (Prefix 'B' indicates Besselian) to any given Besselian Year/Century 'BY', we can write

$T = BY - BE_0$ in Years (or) in Centuries

Form the above Eqn.(b2), T can be written as,

$$T = \left(\frac{JD - 2415020.31352}{DB} \right)$$ -----------Eqn.[b3]

ii) Julian Epoch (Julian Year)

Julian Year/Century JY for any given JD (Julian Days) can be calculated using below Equation,

$$JY = JE_0 + \left(\frac{JD - JD_0}{DJ} \right)$$ -----------Eqn.[j1]

Where

JE_0 = Julian Year [or] Century (=1900(or)19.0 for J1900) & 2000(or)20 for J2000) (Prefix 'J' means Julian)

JD_0 = Julian Days for the Epoch Year JE_0

= 2415020.0 days (For J1900, Date 00 Jan 1900 12:00 hrs UT, Standard Epoch by IAU 1955)

= 2451545.0 days (For J2000, Date 01 Jan 2000 12:00 hrs UT, Standard Epoch by IAU 1976)

DJ = Number of days (= 365.25 per Julian Year [or] = 36525 per Julian Century)

Substituting in the above Eqn.(j1) we get,

$$JY = JE_0 + \left(\frac{JD - 2415020}{DJ} \right) \text{ Ref. J1900 (or) } JY = JE_0 + \left(\frac{JD - 2451545}{DJ} \right) \text{ Ref. J2000}$$ -----------Eqn.[j2]

If Time duration 'T' is measured in Julian Year from the reference epoch JE_0 (Prefix 'J' indicates Julian) to any given Julian Year/Century 'JY', we can write

T= JY- JE_0 in Years (or) in Centuries

Form the above Eqn.(j1), T can be written as,

$$T = \left(\frac{JD - JD_0}{DJ} \right)$$ -----------Eqn.[j3]

Where

JD_0 = Julian Days for the reference Epoch Year JE_0 as defined above

The above equations are widely used for the computation of Precession Rate and Ayamansa as explained in Chapter(4) 'Calculation of KP Ayanamsa' and further as discussed in the respective chapters/ captions of this book. Before discussing the details of scope, let us see the parameters and equations that are associated with Newcomb's Precession.

As per Newcomb's definition given in Indian Ephemeris and nautical almanac (IENA)1960 Ref.[51], The annual general precession in longitude (p) is a function of annual Luni-solar precession on ecliptic (ψ) and annual planetary precession on equator(λ'). The precession equations with respect to tropical year 'T' from the epoch B1900 (Prefix 'B' indicates Besselian Year) are given below.

$$\psi = 50.3708 + 0.000050 * T \text{ (Seconds)}$$ -----------Eqn.[a]

$$\lambda' = 0.1247 - 0.000188 * T \text{ (Seconds)}$$ -----------Eqn.[b]

$$p = \psi - \lambda' \text{Cos } \varepsilon \text{ (Seconds)}$$ -----------Eqn.[c]

Where ε is the obliquity given by the following equation

$$\varepsilon = 23°27'08.26'' - 0.46845''T - 5.9x10^{-7}''T^2 + 1.81x10^{-9}''T^3$$ -----------Eqn.[d]

Substituting the Eqn.(a,b) and ε obliquity value for B1900 (T = 0) from Eqn.(d) in Eqn.(c) we get

$$p = 50.3708 + 0.000050 * T - (0.1247 - 0.000188 * T) \text{ Cos } 23°27'8.26''$$

$$p = 50.3708 + 0.000050 * T - (0.1144 - 0.0001725 * T)$$

$$p = 50.2564 + 0.0002225 * T \text{ (Seconds)}$$ -----------Eqn.[e]

The Newcomb's annual general precession in longitude (p) given in IENA1960 from epoch B1900 is
$p = 50.2564 + 0.000222 * T$ (Seconds) -----------Eqn.[f]
Where
$T = (BY - B1900)$;
BY = Besselian Year (Tropical Year);
B1900 = Besselian Year 1900

However, if 'T' is measured in Julian Year from the epoch J1900 (Prefix 'J' indicates Julian Year), then the annual general precession in longitude (p) given in Eqn.(e) shall be modified for the difference in days between the epochs J1900 and B1900 and for the difference in number of days per year between the Julian and Besselian Year (Tropical Year) as given below.

a) Modification for the difference in days between the epochs J1900 and B1900

Julian Days (JD) for the epoch J1900 = 2415020.00000 days
(For 00 Jan 1900@12:00 hrs UT (or) 31 Dec 1899@12:00 hrs UT, As per standard Epoch by IAU 1955)
Julian Days (JD) for the epoch B1900 = 2415020.31352 days
(For 00 Jan 1900@19:31:28 hrs UT (or) 31 Dec 1899@19:31:28 hrs UT, As per standard Besselian Epoch)

The difference in days between the epochs J1900 and B1900=0.31352 days; which means that the reference date for J1900 is shorter than the reference date for B1900 by 0.31352 days. Thus the modification can be given by the following calculation.

Using Eqn.(e), Precession rate in tropical year for the date corresponding to J1900 is given by

$$p = 50.2564 - 0.0002225 * \frac{0.31352}{365.242198781}$$

$$p = 50.25639981 \text{ (Seconds)}$$

Since the difference in days is very small, the modification in Precession Rate in tropical year for the date corresponding to J1900 workout negligible change in decimal places. However, to avoid loss of significant digits in final equation, this modified value is used for further modification given below

b) Modification for difference in number of days between the Julian and Besselian (Tropical) Year

$$p = \left(\frac{365.25}{365.242198781}\right) * (50.25639981) + 0.0002225 * T$$

$$p = 1.0000213559 * 50.25639981 + 0.0002225 * T$$

$$p = 50.257473244 + 0.0002225 * T \ (Seconds) \qquad \text{-----------Eqn.[g]}$$

Where
$T = (JY - J1900)$;
JY = Julian Year;
J1900 = Julian Year 1900
It is noticed that Newcomb's annual general precession in longitude (p) given in IENA 1960 for 'T' measured in Julian Year from the epoch J1900 agrees with above Eqn.(g)'s first term and second term values up to significant decimal places shown in below Eqn.(g')

$$p = 50.2575 + 0.000222 * T \ (Seconds) \qquad \text{-----------Eqn.[g']}$$

Using Eqn.(g') the rate of Precession for any Julian year 'T' from J2000 can be computed as
$p = 50.2797 + 0.000222 * T$ (Seconds) -----------Eqn.[g'']

The Eqn.(e,f) mentioned above are found in C.G.Rajan's Ayanamsa Calculation given in his book Ref.[34], Ref.[41] & The American Ephemeris and Nautical Almanac for the year 1916 Ref.[46] respectively.

Using the Eqn.(e) the rate of Precession for any tropical year 'T' from B1850 can be computed as

$$p = 50.2453 + 0.0002225 * T \text{ (Seconds)} \qquad \text{-----------Eqn.[h]}$$

Where

$T = (BY - B1850)$;

BY = Besselian Year (Tropical Year);

B1850 = Besselian Year 1850

The Eqn.(h) is also found in some of the text books and Article Ref.[6,41,13].

Precession rate 50.2388475" given by KSK in his reader1 book is further investigated with the above Eqn.(e,f,g,h) and found that using Eqn.(h) for the Year 1821 Besselian (Tropical) Year yields exactly the same value proposed by him as shown below.

$$p = 50.2453 + 0.0002225 * (1821 - 1850)$$
$$p = 50.2453 - 0.0064525$$
$$p = 50.2388475 \text{ (Seconds)}$$

Thus Precession Rate given by KSK in his reader1 book is as per Newcomb's theory for year B1821, but why he selected this specific year's Precession Rate as base, is not known. KSK neither provided any scientific/Astronomical proof nor justification and kept the readers ignorant. Thus his statement about adding Ayanamsa at the rate of 50.2388475" for each year from year 2001, is incorrect as mentioned earlier. Therefore, the reference year 1900 used in K.Balachandran's article for the Precession Rate 50.2388475" is ***completely wrong and stands to be rejected.*** The reference year 1900 used in Nayar's article for the Precession Rate 50.2564" is correct except the details explained under the Chapter(7) 'Findings and Discussions'.

Using KSK's proposed Precession Rate and the corresponding reference Year B1821, the Newcomb's equation for the general Precession Rate for any tropical year can be considered as

$$p = 50.2388475 + 0.0002225 * T \qquad \text{-----------Eqn.[i]}$$

Where

$T = (BY - B1821)$;

BY = Besselian Year (Tropical Year);

B1821 = Besselian Year 1821

However, if 'T' is measured in Julian Year from the epoch J1821 (Prefix 'J' indicates Julian Year), then the annual general precession in longitude (p) given in Eqn.(i) shall be modified for the difference in days between the epochs J1821 and B1821 and for the difference in number of days per year between the Julian and Besselian Year (Tropical Year) as given below.

i) Modification for the difference in days between the epochs J1821 and B1821

Julian Days (JD) for the epoch J1821 = 2386165.2500000 days (See case 'A' Chapter(4))
Julian Days (JD) for the epoch B1821 = 2386166.1798163 days (See case 'B' Chapter(4))

The difference in days between the epochs J1821 and B1821=0.9298163 days; which means that the reference date for J1821 is shorter than the reference date for B1821 by 0.9298163 days. Thus the modification can be given by the following calculation.

Using Eqn.(i), Precession Rate in tropical year for the date corresponding to J1821 is given by

$$p = 50.2388475 - 0.0002225 * \frac{0.9298163}{365.242198781}$$

$$p = 50.238846693 \text{ (Seconds)}$$

Since the difference in days is very small, the modification in Precession Rate in tropical year for the date corresponding to J1821 workout negligible change in decimal places. However, to avoid loss of significant digits in final equation, this modified value is used for further modification given below

ii) Modification for difference in number of days between the Julian and Besselian (Tropical) Year

$$p = \left(\frac{365.25}{365.242198781}\right) * (50.238846693) + 0.0002225 * T$$

$$p = 1.0000213559 * 50.238846693 + 0.0002225 * T$$

$$p = 50.23992 + 0.0002225 * T\,(Seconds) \quad \text{-----------Eqn.[j]}$$

Where

$T = (JY - J1821)$;

JY = Julian Year;

J1821 = Julian Year 1821

As a scope, In this book the study of "KP Ayanamsa" considering 21 March 291 04:09 hrs UT (Saturday) when Sun was at First Point of Aries (♈) Zero degree Sayana longitude as per Ref.[9] is considered as Zero Ayanamsa base year with following methods/theories of Case (A to F) are used to calculate Ayanamsa of various years. Comparison are made with values calculated based on the modern latest Precession Theory Case (E) with other methods/theories described below (A,B,C,D,F). C.G.Rajan's, Lahiri's & IENA's Ayanamsa including nutation also discussed in Chapter(7)'Findings and Discussion'.

A) Newcomb's Precession Rate for J1821.0 epoch is 50.23992" per Julian year (Option-1).
B) Newcomb's Precession Rate for B1821.0 epoch is 50.2388475" per Tropical year (Option-2).
C) Newcomb's Precession Rate for B1900.0 epoch is 50.2564" per Tropical year.
D) Lieske's et.al Precession Rate (IAU1976) for J2000.0 epoch is 5029.0966" per Julian Century
E) Capitaine's et.al Precession Rate (IAU2006) for J2000.0 epoch is 5028.796195" per Julian century
F) M.G.G Nayar's article Ref.[20] (Considered for comparison).

4. Calculation of KP Ayanamsa

For the above cases (A to E) equations associated with Ayanamsa are derived using mathematical calculus in this Chapter. However, the same can be derived using circular equations of motion explained under the Chapter(7) 'Findings and Discussions' for a typical case. The notations pA, pB, pC, pD and pE used in below equations represents Precession Rate for the Case A, B, C, D and E respectively. Similarly, the notation PA, PB, PC, PD, PE and PF represents Precession (Ayanamsa) for the Case A, B, C, D, E and F respectively.

A) Ayanamsa based on NewComb's J1821 epoch Precession Rate per Julian year (Option-1)

The general precession rate for any Julian year is considered as (From Eqn.(j))

$$pA = 50.23992 + 0.0002225 * T \qquad \text{-----------Eqn.[1]}$$

Where
T= JY-J1821
JY = Julian Year.
pA = precession rate for the year JY in Seconds
J1821 = Julian Year 1821
Integrating the above Eqn.(1) with respect to 'T' we get,

$$PA = C + 50.23992 * T + 0.0002225 * \frac{T^2}{2}$$

$$PA = C + 50.23992 * T + 0.00011125 * T^2 \qquad \text{-----------Eqn.[2]}$$

Where
C = Constant
'C' can be found by substituting PA=0 for JY=21 March 291@ 04:09hrs in the above Eqn.(2)
Julian days (JD2) For the date 21 Mar 291@ 04:09 hrs UT = 1827424.67291667 days
Using above Eqn.(j1), for Julian Year J1821, We get,

$$(1821 - 1900) = \left(\frac{JD1 - 2415020}{365.25} \right)$$

JD1 = 2386165.25 days (For 30 Dec 1820 18:00 hrs UT)
Similar to Eqn.(j3), we can write,

$$T = \left(\frac{JD2 - JD1}{365.25} \right) \qquad \text{-----------Eqn.[3]}$$

By substituting JD1, JD2 values in above Eqn.(3) we get,

$$T = \left(\frac{1827424.67291667 - 2386165.25}{365.25} \right)$$

$$T = -1529.74832877024 \text{ Julian Years}$$
$$JY = 291.251671122976 \text{ Julian Years}$$

Substituting T in above Eqn.(2) and PA=0 We get
C = 76594.0942006826 Seconds
C = 21:16:34.0942 Degrees (Ayanamsa for the date 30 Dec 1820 18:00 hrs UT, JD = 2386165.25 days)

$$PA = 76594.094201 + 50.23992 * T + 0.00011125 * T^2 (\textit{Seconds}) \qquad \text{-----------Eqn.[4]}$$

B) Ayanamsa based on NewComb's B1821 epoch Precession rate per Tropical year (Option-2)

The general precession rate for any tropical year is considered as (From Eqn.(i))

$$pB = 50.2388475 + 0.0002225 * T \qquad \text{-----------Eqn.[5]}$$

Where
T= BY-B1821
BY = Besselian Year (Tropical Year)
pB = precession rate for the tropical year BY in Seconds
B1821 = Besselian Year 1821
Integrating the above Eqn.(5) with respect to 'T' we get,

$$PB = C + 50.2388475 * T + 0.0002225 * \frac{T^2}{2}$$

$$PB = C + 50.2388475 * T + 0.00011125 * T^2$$ -----------Eqn.[6]

Where

C = Constant

'C' can be found by substituting PB=0 for BY=21 March 291 @ 04:09hrs in the above Eqn.(6)

JD2 = 1827424.67291667 days (For 21 Mar 291 @ 04:09 hrs UT)

Using above Eqn.(b2) We get Julian Days (JD1) corresponding to Besselian Year B1821 as,

$$(1821 - 1900) = \left(\frac{JD1 - 2415020.31352}{365.242198781} \right)$$

JD1 = 2386166.1798163 days (For 31 Dec 1820 @ 16:18:56 hrs UT)

Similar to Eqn.(b2), we can write,

$$BY = 1821 + \frac{JD2 - JD1}{365.242198781}$$

Thus we get,

$$BY = 1821 + \left(\frac{1827424.67291667 - 2386166.1798163}{365.242198781} \right)$$

$$BY = 1821 - 1529.78354846301$$

$$BY = 291.21645153699 \text{ Besselian Years}$$

$$T = -1529.78354846301 \text{ Besselian Years}$$

Substituting T in above Eqn.(6) and PB=0 We get

C = 76594.2109545443 Seconds

C = 21:16:34.211 Deg (Ayanamsa for date 31 Dec 1820 16:18:56 hrs UT, JD = 2386166.1798163 days)

$$PB = 76594.21096 + 50.2388475 * T + 0.00011125 * T^2 \, (\textit{Seconds})$$ -----------Eqn.[7]

C) Ayanamsa based on Newcomb's B1900 epoch Precession Rate per Tropical year

The general precession rate for any year is considered as (From Eqn.(e))

$$pC = 50.2564 + 0.0002225 * T$$ -----------Eqn.[8]

Where

T= BY-B1900

BY = Besselian Year (Tropical Year).

pC = precession rate for the year BY in Seconds

B1900 = Besselian Year 1900

Integrating the above Eqn.(8) with respect to 'T' we get,

$$PC = C + 50.2564 * T + 0.0002225 * \frac{T^2}{2}$$

$$PC = C + 50.2564 * T + 0.00011125 * T^2$$ -----------Eqn.[9]

Where

C = Constant

'C' can be found by substituting PB=0 for BY=21 March 291@ 04:09hrs in the above Eqn.(9)

JD2 = 1827424.67291667 days (For 21 Mar 291 @ 04:09 hrs UT)

From the above Eqn.(b2), We get Besselian Year(BY) for Julian Days JD2 as,

$$BY = 1900 + \left(\frac{1827424.67291667 - 2415020.31352}{365.242198781} \right)$$

$$BY = 1900 - 1608.78354846302$$

$BY = 291.2164515369 8\text{ Besselian Years}$
$T = -1608.7835484630 2\text{ Besselian Years}$

Substituting T in above Eqn.(9) and PC=0 We get
C = 80563.7339987061 Seconds
C = 22:22:43.734 Deg (Ayanamsa for date 31 Dec 1899 19.52448 hrs UT, JD = 2415020.31352 days)

$$PC = 80563.7339987 1 + 50.2564 * T + 0.00011125 * T^2 (Seconds)$$ -----------Eqn.[10]

D) Ayanamsa based on Lieske's et.al Precession Rate (IAU1976)

Partial derivate of numerical expression given for precession Term $\overline{p}_A$ in Table 5 of Ref.[15] with respect to 't' for t=0 gives general Precession Rate (say 'pD') for any Julian Century 'T' as

$$pD = 5029.0966 + 2.22226 * T - 4.2x10^{-5} * T^2$$ -----------Eqn.[11]

Second order term in above equation will give negligible fraction, hence ignoring it we get,

$$pD = 5029.0966 + 2.22226 * T$$ -----------Eqn.[12]

Where
T = for any Julian Year JY from J2000 in Julian Centuries.
pD = precession rate for the year JY in Seconds Per Julian Century
J2000 = Julian Year 2000
Integrating the above Eqn.(12) with respect to 'T' we get,

$$PD = C + 5029.0966 * T + 2.22226 * \frac{T^2}{2}$$

$$PD = C + 5029.0966 * T + 1.11113 * T^2$$ -----------Eqn.[13]

Where
C = Constant
'C' can be found by substituting PD=0 for JY=21 March 291 04:09hrs in the above Eqn.(13)
JD1 = 2451545.0 days (For 01 Jan 2000 @ 12:00 hrs UT As per standard Epoch by Definition)
JD2 = 1827424.67291667 days (For 21 Mar 291 @ 04:09 hrs UT)
From Eqn.(j3) we can write,

$$T = \left(\frac{JD2 - JD1}{36525} \right)$$

By substituting JD1, JD2 values in above Eqn. we get

$$T = \left(\frac{1827424.67291667 - 2451545}{36525} \right)$$

$T = -17.0874832877025\text{ Julian Centuries}$
$JY = 2.9125167122975\text{ Julian Centuries}$

Substituting T in above Eqn.(13) and PD=0 We get
C = 85610.1740505159 Seconds
C = 23:46:50 Degrees (Ayanamsa for the date 01 Jan 2000@12:00 hrs UT, JD = 2451545.0 days)

$$PD = 85610.1740505159 + 5029.0966 * T + 1.11113 * T^2 (Seconds)$$ -----------Eqn.[14]

E) Ayanamsa based on Capitaine's et.al Precession Rate (IAU2006)

The general precession for any year as per Ref.[14]

$$PE = 5028.796195 * T + 1.1054348 * T^2 + 7.964x10^{-5} * T^3 + 2.3857x10^{-5} * T^4 + 3.83x10^{-8} * T^5$$ --[15]

Ignoring 3rd order term and above, differentiating remaining terms of the above Eqn.(15) with respect to 'T' and, we get precession rate per Julian Century,

$$pE = 5028.796195 + 2.2108696 * T \quad \text{-----------Eqn.[16]}$$

Where

pE = Precession Rate for the year JY in Seconds per Julian Century

In above Eqn.(15) 3rd order term and above will give negligible fraction, hence ignoring them and introducing constant term 'C' to account for Zero Ayanamsa Year value we get,

$$PE = C + 5028.796195 * T + 1.1054348 * T^2 \quad \text{-----------Eqn.[17]}$$

Where

T = for any Julian Year JY from J2000 in Julian Centuries.

PE = precession for the year JY in Seconds

J2000 = Julian Year 2000

C = Constant

'C' can be found by substituting PE=0 for JY=21 March 291@04:09hrs in the above Eqn.(17)

JD1 = 2451545.0 days (For 01 Jan 2000 @12:00 hrs UT as per standard Epoch by Definition)

JD2 = 1827424.67291667 days (For 21 Mar 291 04:09 hrs UT)

From Eqn.(j3) we can write,

$$T = \left(\frac{JD2 - JD1}{36525}\right)$$

By substituting JD1, JD2 values in above Eqn. we get

$$T = \left(\frac{1827424.67291667 - 2451545}{36525}\right)$$

$$T = -17.0874832877025 \text{ Julian Centuries}$$

$$JY = 2.91251671 22975 \text{ Julian Centuries}$$

Substituting T in above Eqn.(17) and PE=0 We get

C = 85606.70378147 Seconds

C = 23:46:47 Degrees (Ayanamsa for the date 01 Jan 2000@12:00 hrs UT, JD = 2451545.0 days)

$$PE = 85606.70378147 + 5028.796195 * T + 1.1054348 * T^2 \,(\textit{Seconds}) \quad \text{-----------Eqn.[18]}$$

F) Ayanamsa as per M.G.G Nayar's article Ref.[20]

Ayanamsa with reference to date 15 Apr 1900 @ 00:00 hrs UT is given in his 'Formula G' as

$$PF = 80578.3181 + 50.256511 * T + 0.000111 * T^2 \,(\textit{Seconds}) \quad \text{-----------Eqn.[19]}$$

Where

PF = Ayanamsa (Precession) for the year Y on 15 April @ 00:00 UT in Seconds

T = Y-1900; Year offset on 15 April of Year Y and 1900.

5. Comparison of Various KP Ayanamsa

Using the above formulae, Ayanamsa of the respective theories/models are calculated and tabulated below along with the difference between E and (A, B, C, D, F) beginning from year 500 to 2200.

A) Newcomb's Precession Rate for J1821.0 epoch is 50.23992" per Julian year.
B) Newcomb's Precession Rate for B1821.0 epoch is 50.2388475" per Tropical year.
C) Newcomb's Precession Rate for B1900.0 epoch is 50.2564" per Tropical year.
D) Lieske's et.al Precession Rate (IAU1976) for J2000.0 epoch is 5029.0966" per Julian Century
E) Capitaine's et.al Precession Rate (IAU2006) for J2000.0 epoch is 5028.796195" per Julian century
F) M.G.G Nayar's article Ref.[20] (Considered for comparison).

Table 1: Ayanamsa of the respective theories & Difference in Ayanamsa

	Ayanamsa (As on 15th April)						Difference in Ayanamsa				
Year	**(A)**	**(B)**	**(C)**	**(D)**	**(E)**	**(F)**	**(E)-(A)**	**(E)-(B)**	**(E)-(C)**	**(E)-(D)**	**(E)-(F)**
yyyy	d:m:s	d:m:s	d:m:s	d:m:s	d:m:s	d:m:s	Sec.	Sec.	Sec.	Sec.	Sec.
500	02:53:57	02:53:57	02:53:57	02:54:00	02:54:00	02:53:57	2.2	2.2	2.2	-0.2	2.8
600	04:17:13	04:17:13	04:17:13	04:17:17	04:17:16	04:17:12	3.2	3.2	3.2	-0.4	3.9
700	05:40:31	05:40:31	05:40:31	05:40:36	05:40:35	05:40:30	4.2	4.2	4.2	-0.5	4.9
800	07:03:51	07:03:51	07:03:51	07:03:57	07:03:56	07:03:50	5.2	5.2	5.2	-0.7	6.0
900	08:27:14	08:27:14	08:27:14	08:27:21	08:27:20	08:27:13	6.2	6.2	6.2	-0.9	7.0
1000	09:50:38	09:50:38	09:50:38	09:50:46	09:50:45	09:50:37	7.2	7.2	7.2	-1.0	8.0
1100	11:14:05	11:14:05	11:14:05	11:14:14	11:14:13	11:14:04	8.1	8.1	8.2	-1.2	9.0
1200	12:37:34	12:37:34	12:37:34	12:37:45	12:37:43	12:37:33	9.1	9.1	9.1	-1.4	10.1
1300	14:01:05	14:01:05	14:01:05	14:01:17	14:01:15	14:01:04	10.0	10.0	10.0	-1.6	11.1
1400	15:24:39	15:24:39	15:24:39	15:24:52	15:24:50	15:24:38	10.9	10.9	11.0	-1.9	12.0
1500	16:48:15	16:48:15	16:48:15	16:48:29	16:48:27	16:48:13	11.8	11.8	11.9	-2.1	13.0
1600	18:11:51	18:11:51	18:11:51	18:12:06	18:12:04	18:11:51	12.7	12.7	12.7	-2.4	12.6
1700	19:35:31	19:35:31	19:35:31	19:35:48	19:35:45	19:35:31	13.6	13.6	13.6	-2.6	13.5
1800	20:59:14	20:59:14	20:59:14	20:59:31	20:59:28	20:59:14	14.4	14.4	14.5	-2.9	14.3
1810	21:07:36	21:07:36	21:07:36	21:07:53	21:07:50	21:07:36	14.5	14.5	14.6	-2.9	14.3
1820	21:15:58	21:15:58	21:15:58	21:16:16	21:16:13	21:15:59	14.6	14.6	14.6	-2.9	14.5
1830	21:24:21	21:24:21	21:24:21	21:24:38	21:24:35	21:24:21	14.7	14.7	14.7	-3.0	14.5
1840	21:32:43	21:32:43	21:32:43	21:33:01	21:32:58	21:32:43	14.8	14.8	14.8	-3.0	14.6
1841	21:33:33	21:33:33	21:33:33	21:33:51	21:33:48	21:33:34	14.8	14.8	14.8	-3.0	14.6
1842	21:34:24	21:34:24	21:34:24	21:34:41	21:34:38	21:34:24	14.8	14.8	14.8	-3.0	14.6
1843	21:35:14	21:35:14	21:35:14	21:35:32	21:35:29	21:35:14	14.8	14.8	14.8	-3.0	14.6
1844	21:36:04	21:36:04	21:36:04	21:36:22	21:36:19	21:36:04	14.8	14.8	14.9	-3.0	14.7
1845	21:36:54	21:36:54	21:36:54	21:37:12	21:37:09	21:36:55	14.8	14.8	14.9	-3.0	14.7
1846	21:37:45	21:37:45	21:37:45	21:38:02	21:37:59	21:37:45	14.8	14.8	14.9	-3.0	14.6
1847	21:38:35	21:38:35	21:38:35	21:38:53	21:38:50	21:38:35	14.8	14.8	14.9	-3.0	14.6
1848	21:39:25	21:39:25	21:39:25	21:39:43	21:39:40	21:39:25	14.8	14.8	14.9	-3.0	14.7
1849	21:40:15	21:40:15	21:40:15	21:40:33	21:40:30	21:40:16	14.8	14.9	14.9	-3.0	14.7
1850	21:41:06	21:41:06	21:41:06	21:41:23	21:41:20	21:41:06	14.9	14.9	14.9	-3.0	14.7
1851	21:41:56	21:41:56	21:41:56	21:42:14	21:42:11	21:41:56	14.9	14.9	14.9	-3.0	14.6
1852	21:42:46	21:42:46	21:42:46	21:43:04	21:43:01	21:42:46	14.9	14.9	14.9	-3.0	14.8
1853	21:43:36	21:43:36	21:43:36	21:43:54	21:43:51	21:43:37	14.9	14.9	14.9	-3.0	14.7
1854	21:44:27	21:44:27	21:44:27	21:44:45	21:44:41	21:44:27	14.9	14.9	14.9	-3.0	14.7
1855	21:45:17	21:45:17	21:45:17	21:45:35	21:45:32	21:45:17	14.9	14.9	14.9	-3.0	14.7
1856	21:46:07	21:46:07	21:46:07	21:46:25	21:46:22	21:46:07	14.9	14.9	15.0	-3.1	14.8
1857	21:46:57	21:46:57	21:46:57	21:47:15	21:47:12	21:46:57	14.9	14.9	15.0	-3.1	14.8
1858	21:47:48	21:47:48	21:47:48	21:48:06	21:48:02	21:47:48	14.9	14.9	15.0	-3.1	14.7
1859	21:48:38	21:48:38	21:48:38	21:48:56	21:48:53	21:48:38	14.9	14.9	15.0	-3.1	14.7
1860	21:49:28	21:49:28	21:49:28	21:49:46	21:49:43	21:49:28	14.9	14.9	15.0	-3.1	14.8
1861	21:50:18	21:50:18	21:50:18	21:50:36	21:50:33	21:50:18	14.9	15.0	15.0	-3.1	14.8
1862	21:51:09	21:51:09	21:51:09	21:51:27	21:51:24	21:51:09	15.0	15.0	15.0	-3.1	14.8
1863	21:51:59	21:51:59	21:51:59	21:52:17	21:52:14	21:51:59	15.0	15.0	15.0	-3.1	14.8
1864	21:52:49	21:52:49	21:52:49	21:53:07	21:53:04	21:52:49	15.0	15.0	15.0	-3.1	14.9
1865	21:53:39	21:53:39	21:53:39	21:53:57	21:53:54	21:53:39	15.0	15.0	15.0	-3.1	14.8

	Ayanamsa (As on 15th April)						Difference in Ayanamsa				
Year	**(A)**	**(B)**	**(C)**	**(D)**	**(E)**	**(F)**	**(E)-(A)**	**(E)-(B)**	**(E)-(C)**	**(E)-(D)**	**(E)-(F)**
yyyy	d:m:s	d:m:s	d:m:s	d:m:s	d:m:s	d:m:s	Sec.	Sec.	Sec.	Sec.	Sec.
1866	21:54:30	21:54:30	21:54:30	21:54:48	21:54:45	21:54:30	15.0	15.0	15.0	-3.1	14.8
1867	21:55:20	21:55:20	21:55:20	21:55:38	21:55:35	21:55:20	15.0	15.0	15.0	-3.1	14.8
1868	21:56:10	21:56:10	21:56:10	21:56:28	21:56:25	21:56:10	15.0	15.0	15.1	-3.1	14.9
1869	21:57:00	21:57:00	21:57:00	21:57:18	21:57:15	21:57:00	15.0	15.0	15.1	-3.1	14.9
1870	21:57:51	21:57:51	21:57:51	21:58:09	21:58:06	21:57:51	15.0	15.0	15.1	-3.1	14.9
1871	21:58:41	21:58:41	21:58:41	21:58:59	21:58:56	21:58:41	15.0	15.0	15.1	-3.1	14.8
1872	21:59:31	21:59:31	21:59:31	21:59:49	21:59:46	21:59:31	15.0	15.0	15.1	-3.1	15.0
1873	22:00:21	22:00:21	22:00:21	22:00:39	22:00:36	22:00:21	15.0	15.1	15.1	-3.1	14.9
1874	22:01:12	22:01:12	22:01:12	22:01:30	22:01:27	22:01:12	15.1	15.1	15.1	-3.1	14.9
1875	22:02:02	22:02:02	22:02:02	22:02:20	22:02:17	22:02:02	15.1	15.1	15.1	-3.1	14.9
1876	22:02:52	22:02:52	22:02:52	22:03:10	22:03:07	22:02:52	15.1	15.1	15.1	-3.1	15.0
1877	22:03:42	22:03:42	22:03:42	22:04:01	22:03:57	22:03:42	15.1	15.1	15.1	-3.1	15.0
1878	22:04:33	22:04:33	22:04:33	22:04:51	22:04:48	22:04:33	15.1	15.1	15.1	-3.1	14.9
1879	22:05:23	22:05:23	22:05:23	22:05:41	22:05:38	22:05:23	15.1	15.1	15.1	-3.1	14.9
1880	22:06:13	22:06:13	22:06:13	22:06:31	22:06:28	22:06:13	15.1	15.1	15.2	-3.1	15.0
1881	22:07:03	22:07:03	22:07:03	22:07:22	22:07:18	22:07:03	15.1	15.1	15.2	-3.1	15.0
1882	22:07:54	22:07:54	22:07:54	22:08:12	22:08:09	22:07:54	15.1	15.1	15.2	-3.1	15.0
1883	22:08:44	22:08:44	22:08:44	22:09:02	22:08:59	22:08:44	15.1	15.1	15.2	-3.1	15.0
1884	22:09:34	22:09:34	22:09:34	22:09:52	22:09:49	22:09:34	15.1	15.2	15.2	-3.1	15.1
1885	22:10:24	22:10:24	22:10:24	22:10:43	22:10:40	22:10:24	15.1	15.2	15.2	-3.1	15.0
1886	22:11:15	22:11:15	22:11:15	22:11:33	22:11:30	22:11:15	15.2	15.2	15.2	-3.1	15.0
1887	22:12:05	22:12:05	22:12:05	22:12:23	22:12:20	22:12:05	15.2	15.2	15.2	-3.1	15.0
1888	22:12:55	22:12:55	22:12:55	22:13:13	22:13:10	22:12:55	15.2	15.2	15.2	-3.1	15.1
1889	22:13:45	22:13:45	22:13:45	22:14:04	22:14:01	22:13:46	15.2	15.2	15.2	-3.1	15.1
1890	22:14:36	22:14:36	22:14:36	22:14:54	22:14:51	22:14:36	15.2	15.2	15.2	-3.1	15.1
1891	22:15:26	22:15:26	22:15:26	22:15:44	22:15:41	22:15:26	15.2	15.2	15.2	-3.2	15.0
1892	22:16:16	22:16:16	22:16:16	22:16:35	22:16:31	22:16:16	15.2	15.2	15.3	-3.2	15.1
1893	22:17:06	22:17:06	22:17:06	22:17:25	22:17:22	22:17:07	15.2	15.2	15.3	-3.2	15.1
1894	22:17:57	22:17:57	22:17:57	22:18:15	22:18:12	22:17:57	15.2	15.2	15.3	-3.2	15.1
1895	22:18:47	22:18:47	22:18:47	22:19:05	22:19:02	22:18:47	15.2	15.2	15.3	-3.2	15.1
1896	22:19:37	22:19:37	22:19:37	22:19:56	22:19:52	22:19:37	15.2	15.3	15.3	-3.2	15.2
1897	22:20:27	22:20:27	22:20:27	22:20:46	22:20:43	22:20:28	15.2	15.3	15.3	-3.2	15.2
1898	22:21:18	22:21:18	22:21:18	22:21:36	22:21:33	22:21:18	15.3	15.3	15.3	-3.2	15.1
1899	22:22:08	22:22:08	22:22:08	22:22:26	22:22:23	22:22:08	15.3	15.3	15.3	-3.2	15.1
1900	22:22:58	22:22:58	22:22:58	22:23:17	22:23:13	22:22:58	15.3	15.3	15.3	-3.2	15.1
1901	22:23:48	22:23:48	22:23:48	22:24:07	22:24:04	22:23:49	15.3	15.3	15.3	-3.2	15.1
1902	22:24:39	22:24:39	22:24:39	22:24:57	22:24:54	22:24:39	15.3	15.3	15.3	-3.2	15.0
1903	22:25:29	22:25:29	22:25:29	22:25:47	22:25:44	22:25:29	15.3	15.3	15.3	-3.2	15.0
1904	22:26:19	22:26:19	22:26:19	22:26:38	22:26:34	22:26:19	15.3	15.3	15.4	-3.2	15.1
1905	22:27:09	22:27:09	22:27:09	22:27:28	22:27:25	22:27:10	15.3	15.3	15.4	-3.2	15.1
1906	22:28:00	22:28:00	22:28:00	22:28:18	22:28:15	22:28:00	15.3	15.3	15.4	-3.2	15.1
1907	22:28:50	22:28:50	22:28:50	22:29:08	22:29:05	22:28:50	15.3	15.3	15.4	-3.2	15.0
1908	22:29:40	22:29:40	22:29:40	22:29:59	22:29:56	22:29:40	15.3	15.4	15.4	-3.2	15.2

	Ayanamsa (As on 15th April)						Difference in Ayanamsa				
Year	**(A)**	**(B)**	**(C)**	**(D)**	**(E)**	**(F)**	**(E)-(A)**	**(E)-(B)**	**(E)-(C)**	**(E)-(D)**	**(E)-(F)**
yyyy	d:m:s	d:m:s	d:m:s	d:m:s	d:m:s	d:m:s	Sec.	Sec.	Sec.	Sec.	Sec.
1909	22:30:30	22:30:30	22:30:30	22:30:49	22:30:46	22:30:31	15.3	15.4	15.4	-3.2	15.1
1910	22:31:21	22:31:21	22:31:21	22:31:39	22:31:36	22:31:21	15.4	15.4	15.4	-3.2	15.1
1911	22:32:11	22:32:11	22:32:11	22:32:29	22:32:26	22:32:11	15.4	15.4	15.4	-3.2	15.1
1912	22:33:01	22:33:01	22:33:01	22:33:20	22:33:17	22:33:01	15.4	15.4	15.4	-3.2	15.2
1913	22:33:51	22:33:51	22:33:51	22:34:10	22:34:07	22:33:52	15.4	15.4	15.4	-3.2	15.2
1914	22:34:42	22:34:42	22:34:42	22:35:00	22:34:57	22:34:42	15.4	15.4	15.4	-3.2	15.1
1915	22:35:32	22:35:32	22:35:32	22:35:51	22:35:47	22:35:32	15.4	15.4	15.5	-3.2	15.1
1916	22:36:22	22:36:22	22:36:22	22:36:41	22:36:38	22:36:22	15.4	15.4	15.5	-3.2	15.2
1917	22:37:12	22:37:12	22:37:12	22:37:31	22:37:28	22:37:13	15.4	15.4	15.5	-3.2	15.2
1918	22:38:03	22:38:03	22:38:03	22:38:21	22:38:18	22:38:03	15.4	15.4	15.5	-3.2	15.2
1919	22:38:53	22:38:53	22:38:53	22:39:12	22:39:08	22:38:53	15.4	15.4	15.5	-3.2	15.2
1920	22:39:43	22:39:43	22:39:43	22:40:02	22:39:59	22:39:43	15.4	15.5	15.5	-3.2	15.3
1921	22:40:34	22:40:34	22:40:33	22:40:52	22:40:49	22:40:34	15.4	15.5	15.5	-3.2	15.2
1922	22:41:24	22:41:24	22:41:24	22:41:42	22:41:39	22:41:24	15.5	15.5	15.5	-3.2	15.2
1923	22:42:14	22:42:14	22:42:14	22:42:33	22:42:29	22:42:14	15.5	15.5	15.5	-3.2	15.2
1924	22:43:04	22:43:04	22:43:04	22:43:23	22:43:20	22:43:05	15.5	15.5	15.5	-3.2	15.3
1925	22:43:55	22:43:55	22:43:55	22:44:13	22:44:10	22:43:55	15.5	15.5	15.5	-3.2	15.3
1926	22:44:45	22:44:45	22:44:45	22:45:04	22:45:00	22:44:45	15.5	15.5	15.5	-3.3	15.3
1927	22:45:35	22:45:35	22:45:35	22:45:54	22:45:51	22:45:35	15.5	15.5	15.6	-3.3	15.2
1928	22:46:25	22:46:25	22:46:25	22:46:44	22:46:41	22:46:26	15.5	15.5	15.6	-3.3	15.3
1929	22:47:16	22:47:16	22:47:16	22:47:34	22:47:31	22:47:16	15.5	15.5	15.6	-3.3	15.3
1930	22:48:06	22:48:06	22:48:06	22:48:25	22:48:21	22:48:06	15.5	15.5	15.6	-3.3	15.3
1931	22:48:56	22:48:56	22:48:56	22:49:15	22:49:12	22:48:56	15.5	15.5	15.6	-3.3	15.3
1932	22:49:46	22:49:46	22:49:46	22:50:05	22:50:02	22:49:47	15.5	15.6	15.6	-3.3	15.4
1933	22:50:37	22:50:37	22:50:37	22:50:56	22:50:52	22:50:37	15.5	15.6	15.6	-3.3	15.4
1934	22:51:27	22:51:27	22:51:27	22:51:46	22:51:42	22:51:27	15.6	15.6	15.6	-3.3	15.3
1935	22:52:17	22:52:17	22:52:17	22:52:36	22:52:33	22:52:17	15.6	15.6	15.6	-3.3	15.3
1936	22:53:08	22:53:08	22:53:07	22:53:26	22:53:23	22:53:08	15.6	15.6	15.6	-3.3	15.4
1937	22:53:58	22:53:58	22:53:58	22:54:17	22:54:13	22:53:58	15.6	15.6	15.6	-3.3	15.4
1938	22:54:48	22:54:48	22:54:48	22:55:07	22:55:04	22:54:48	15.6	15.6	15.6	-3.3	15.4
1939	22:55:38	22:55:38	22:55:38	22:55:57	22:55:54	22:55:38	15.6	15.6	15.7	-3.3	15.3
1940	22:56:29	22:56:29	22:56:29	22:56:48	22:56:44	22:56:29	15.6	15.6	15.7	-3.3	15.5
1941	22:57:19	22:57:19	22:57:19	22:57:38	22:57:34	22:57:19	15.6	15.6	15.7	-3.3	15.4
1942	22:58:09	22:58:09	22:58:09	22:58:28	22:58:25	22:58:09	15.6	15.6	15.7	-3.3	15.4
1943	22:58:59	22:58:59	22:58:59	22:59:18	22:59:15	22:59:00	15.6	15.6	15.7	-3.3	15.4
1944	22:59:50	22:59:50	22:59:50	23:00:09	23:00:05	22:59:50	15.6	15.7	15.7	-3.3	15.5
1945	23:00:40	23:00:40	23:00:40	23:00:59	23:00:56	23:00:40	15.6	15.7	15.7	-3.3	15.5
1946	23:01:30	23:01:30	23:01:30	23:01:49	23:01:46	23:01:30	15.7	15.7	15.7	-3.3	15.4
1947	23:02:20	23:02:20	23:02:20	23:02:39	23:02:36	23:02:21	15.7	15.7	15.7	-3.3	15.4
1948	23:03:11	23:03:11	23:03:11	23:03:30	23:03:26	23:03:11	15.7	15.7	15.7	-3.3	15.5
1949	23:04:01	23:04:01	23:04:01	23:04:20	23:04:17	23:04:01	15.7	15.7	15.7	-3.3	15.5
1950	23:04:51	23:04:51	23:04:51	23:05:10	23:05:07	23:04:51	15.7	15.7	15.7	-3.3	15.5
1951	23:05:41	23:05:41	23:05:41	23:06:00	23:05:57	23:05:42	15.7	15.7	15.8	-3.3	15.5

	Ayanamsa (As on 15th April)						Difference in Ayanamsa				
Year	**(A)**	**(B)**	**(C)**	**(D)**	**(E)**	**(F)**	**(E)-(A)**	**(E)-(B)**	**(E)-(C)**	**(E)-(D)**	**(E)-(F)**
yyyy	d:m:s	d:m:s	d:m:s	d:m:s	d:m:s	d:m:s	Sec.	Sec.	Sec.	Sec.	Sec.
1952	23:06:32	23:06:32	23:06:32	23:06:51	23:06:48	23:06:32	15.7	15.7	15.8	-3.3	15.6
1953	23:07:22	23:07:22	23:07:22	23:07:41	23:07:38	23:07:22	15.7	15.7	15.8	-3.3	15.5
1954	23:08:12	23:08:12	23:08:12	23:08:31	23:08:28	23:08:12	15.7	15.7	15.8	-3.3	15.5
1955	23:09:03	23:09:03	23:09:02	23:09:22	23:09:18	23:09:03	15.7	15.7	15.8	-3.3	15.5
1956	23:09:53	23:09:53	23:09:53	23:10:12	23:10:09	23:09:53	15.7	15.7	15.8	-3.3	15.6
1957	23:10:43	23:10:43	23:10:43	23:11:02	23:10:59	23:10:43	15.7	15.8	15.8	-3.3	15.6
1958	23:11:33	23:11:33	23:11:33	23:11:52	23:11:49	23:11:34	15.8	15.8	15.8	-3.3	15.6
1959	23:12:24	23:12:24	23:12:24	23:12:43	23:12:39	23:12:24	15.8	15.8	15.8	-3.3	15.5
1960	23:13:14	23:13:14	23:13:14	23:13:33	23:13:30	23:13:14	15.8	15.8	15.8	-3.4	15.6
1961	23:14:04	23:14:04	23:14:04	23:14:23	23:14:20	23:14:04	15.8	15.8	15.8	-3.4	15.6
1962	23:14:54	23:14:54	23:14:54	23:15:14	23:15:10	23:14:55	15.8	15.8	15.8	-3.4	15.6
1963	23:15:45	23:15:45	23:15:45	23:16:04	23:16:00	23:15:45	15.8	15.8	15.8	-3.4	15.6
1964	23:16:35	23:16:35	23:16:35	23:16:54	23:16:51	23:16:35	15.8	15.8	15.9	-3.4	15.7
1965	23:17:25	23:17:25	23:17:25	23:17:44	23:17:41	23:17:25	15.8	15.8	15.9	-3.4	15.7
1966	23:18:16	23:18:16	23:18:15	23:18:35	23:18:31	23:18:16	15.8	15.8	15.9	-3.4	15.6
1967	23:19:06	23:19:06	23:19:06	23:19:25	23:19:22	23:19:06	15.8	15.8	15.9	-3.4	15.6
1968	23:19:56	23:19:56	23:19:56	23:20:15	23:20:12	23:19:56	15.8	15.8	15.9	-3.4	15.7
1969	23:20:46	23:20:46	23:20:46	23:21:06	23:21:02	23:20:47	15.8	15.9	15.9	-3.4	15.7
1970	23:21:37	23:21:37	23:21:37	23:21:56	23:21:52	23:21:37	15.9	15.9	15.9	-3.4	15.7
1971	23:22:27	23:22:27	23:22:27	23:22:46	23:22:43	23:22:27	15.9	15.9	15.9	-3.4	15.6
1972	23:23:17	23:23:17	23:23:17	23:23:37	23:23:33	23:23:17	15.9	15.9	15.9	-3.4	15.8
1973	23:24:07	23:24:07	23:24:07	23:24:27	23:24:23	23:24:08	15.9	15.9	15.9	-3.4	15.7
1974	23:24:58	23:24:58	23:24:58	23:25:17	23:25:14	23:24:58	15.9	15.9	15.9	-3.4	15.7
1975	23:25:48	23:25:48	23:25:48	23:26:07	23:26:04	23:25:48	15.9	15.9	15.9	-3.4	15.7
1976	23:26:38	23:26:38	23:26:38	23:26:58	23:26:54	23:26:38	15.9	15.9	16.0	-3.4	15.8
1977	23:27:29	23:27:29	23:27:29	23:27:48	23:27:44	23:27:29	15.9	15.9	16.0	-3.4	15.8
1978	23:28:19	23:28:19	23:28:19	23:28:38	23:28:35	23:28:19	15.9	15.9	16.0	-3.4	15.7
1979	23:29:09	23:29:09	23:29:09	23:29:28	23:29:25	23:29:09	15.9	15.9	16.0	-3.4	15.7
1980	23:29:59	23:29:59	23:29:59	23:30:19	23:30:15	23:30:00	15.9	15.9	16.0	-3.4	15.8
1981	23:30:50	23:30:50	23:30:50	23:31:09	23:31:06	23:30:50	15.9	16.0	16.0	-3.4	15.8
1982	23:31:40	23:31:40	23:31:40	23:31:59	23:31:56	23:31:40	16.0	16.0	16.0	-3.4	15.8
1983	23:32:30	23:32:30	23:32:30	23:32:50	23:32:46	23:32:30	16.0	16.0	16.0	-3.4	15.8
1984	23:33:21	23:33:21	23:33:20	23:33:40	23:33:37	23:33:21	16.0	16.0	16.0	-3.4	15.9
1985	23:34:11	23:34:11	23:34:11	23:34:30	23:34:27	23:34:11	16.0	16.0	16.0	-3.4	15.8
1986	23:35:01	23:35:01	23:35:01	23:35:20	23:35:17	23:35:01	16.0	16.0	16.0	-3.4	15.8
1987	23:35:51	23:35:51	23:35:51	23:36:11	23:36:07	23:35:51	16.0	16.0	16.0	-3.4	15.8
1988	23:36:42	23:36:42	23:36:42	23:37:01	23:36:58	23:36:42	16.0	16.0	16.1	-3.4	15.9
1989	23:37:32	23:37:32	23:37:32	23:37:51	23:37:48	23:37:32	16.0	16.0	16.1	-3.4	15.9
1990	23:38:22	23:38:22	23:38:22	23:38:42	23:38:38	23:38:22	16.0	16.0	16.1	-3.4	15.9
1991	23:39:12	23:39:12	23:39:12	23:39:32	23:39:28	23:39:13	16.0	16.0	16.1	-3.4	15.8
1992	23:40:03	23:40:03	23:40:03	23:40:22	23:40:19	23:40:03	16.0	16.0	16.1	-3.4	15.9
1993	23:40:53	23:40:53	23:40:53	23:41:12	23:41:09	23:40:53	16.0	16.1	16.1	-3.5	15.9
1994	23:41:43	23:41:43	23:41:43	23:42:03	23:41:59	23:41:43	16.1	16.1	16.1	-3.5	15.9

	Ayanamsa (As on 15th April)						Difference in Ayanamsa				
Year	**(A)**	**(B)**	**(C)**	**(D)**	**(E)**	**(F)**	**(E)-(A)**	**(E)-(B)**	**(E)-(C)**	**(E)-(D)**	**(E)-(F)**
yyyy	d:m:s	d:m:s	d:m:s	d:m:s	d:m:s	d:m:s	Sec.	Sec.	Sec.	Sec.	Sec.
1995	23:42:33	23:42:33	23:42:33	23:42:53	23:42:50	23:42:34	16.1	16.1	16.1	-3.5	15.9
1996	23:43:24	23:43:24	23:43:24	23:43:43	23:43:40	23:43:24	16.1	16.1	16.1	-3.5	16.0
1997	23:44:14	23:44:14	23:44:14	23:44:34	23:44:30	23:44:14	16.1	16.1	16.1	-3.5	15.9
1998	23:45:04	23:45:04	23:45:04	23:45:24	23:45:20	23:45:05	16.1	16.1	16.1	-3.5	15.9
1999	23:45:55	23:45:55	23:45:55	23:46:14	23:46:11	23:45:55	16.1	16.1	16.1	-3.5	15.9
2000	23:46:45	23:46:45	23:46:45	23:47:05	23:47:01	23:46:45	16.1	16.1	16.2	-3.5	16.0
2001	23:47:35	23:47:35	23:47:35	23:47:55	23:47:51	23:47:35	16.1	16.1	16.2	-3.5	16.0
2002	23:48:25	23:48:25	23:48:25	23:48:45	23:48:42	23:48:26	16.1	16.1	16.2	-3.5	16.0
2003	23:49:16	23:49:16	23:49:16	23:49:35	23:49:32	23:49:16	16.1	16.1	16.2	-3.5	15.9
2004	23:50:06	23:50:06	23:50:06	23:50:26	23:50:22	23:50:06	16.1	16.1	16.2	-3.5	16.0
2005	23:50:56	23:50:56	23:50:56	23:51:16	23:51:12	23:50:56	16.1	16.2	16.2	-3.5	16.0
2006	23:51:47	23:51:47	23:51:47	23:52:06	23:52:03	23:51:47	16.2	16.2	16.2	-3.5	16.0
2007	23:52:37	23:52:37	23:52:37	23:52:57	23:52:53	23:52:37	16.2	16.2	16.2	-3.5	16.0
2008	23:53:27	23:53:27	23:53:27	23:53:47	23:53:43	23:53:27	16.2	16.2	16.2	-3.5	16.1
2009	23:54:17	23:54:17	23:54:17	23:54:37	23:54:34	23:54:18	16.2	16.2	16.2	-3.5	16.1
2010	23:55:08	23:55:08	23:55:08	23:55:27	23:55:24	23:55:08	16.2	16.2	16.2	-3.5	16.0
2011	23:55:58	23:55:58	23:55:58	23:56:18	23:56:14	23:55:58	16.2	16.2	16.2	-3.5	16.0
2012	23:56:48	23:56:48	23:56:48	23:57:08	23:57:05	23:56:48	16.2	16.2	16.3	-3.5	16.1
2013	23:57:39	23:57:39	23:57:39	23:57:58	23:57:55	23:57:39	16.2	16.2	16.3	-3.5	16.1
2014	23:58:29	23:58:29	23:58:29	23:58:49	23:58:45	23:58:29	16.2	16.2	16.3	-3.5	16.1
2015	23:59:19	23:59:19	23:59:19	23:59:39	23:59:35	23:59:19	16.2	16.2	16.3	-3.5	16.0
2016	24:00:09	24:00:09	24:00:09	24:00:29	24:00:26	24:00:10	16.2	16.2	16.3	-3.5	16.2
2017	24:01:00	24:01:00	24:01:00	24:01:20	24:01:16	24:01:00	16.2	16.3	16.3	-3.5	16.1
2018	24:01:50	24:01:50	24:01:50	24:02:10	24:02:06	24:01:50	16.2	16.3	16.3	-3.5	16.1
2019	24:02:40	24:02:40	24:02:40	24:03:00	24:02:57	24:02:40	16.3	16.3	16.3	-3.5	16.1
2020	24:03:31	24:03:31	24:03:31	24:03:50	24:03:47	24:03:31	16.3	16.3	16.3	-3.5	16.2
2021	24:04:21	24:04:21	24:04:21	24:04:41	24:04:37	24:04:21	16.3	16.3	16.3	-3.5	16.2
2022	24:05:11	24:05:11	24:05:11	24:05:31	24:05:27	24:05:11	16.3	16.3	16.3	-3.5	16.1
2023	24:06:01	24:06:01	24:06:01	24:06:21	24:06:18	24:06:02	16.3	16.3	16.3	-3.5	16.1
2024	24:06:52	24:06:52	24:06:52	24:07:12	24:07:08	24:06:52	16.3	16.3	16.4	-3.5	16.2
2025	24:07:42	24:07:42	24:07:42	24:08:02	24:07:58	24:07:42	16.3	16.3	16.4	-3.5	16.2
2026	24:08:32	24:08:32	24:08:32	24:08:52	24:08:49	24:08:32	16.3	16.3	16.4	-3.5	16.2
2027	24:09:23	24:09:23	24:09:22	24:09:42	24:09:39	24:09:23	16.3	16.3	16.4	-3.6	16.2
2028	24:10:13	24:10:13	24:10:13	24:10:33	24:10:29	24:10:13	16.3	16.3	16.4	-3.6	16.3
2029	24:11:03	24:11:03	24:11:03	24:11:23	24:11:20	24:11:03	16.3	16.4	16.4	-3.6	16.2
2030	24:11:53	24:11:53	24:11:53	24:12:13	24:12:10	24:11:54	16.3	16.4	16.4	-3.6	16.2
2031	24:12:44	24:12:44	24:12:44	24:13:04	24:13:00	24:12:44	16.4	16.4	16.4	-3.6	16.2
2032	24:13:34	24:13:34	24:13:34	24:13:54	24:13:50	24:13:34	16.4	16.4	16.4	-3.6	16.3
2033	24:14:24	24:14:24	24:14:24	24:14:44	24:14:41	24:14:24	16.4	16.4	16.4	-3.6	16.3
2034	24:15:15	24:15:15	24:15:15	24:15:35	24:15:31	24:15:15	16.4	16.4	16.4	-3.6	16.3
2035	24:16:05	24:16:05	24:16:05	24:16:25	24:16:21	24:16:05	16.4	16.4	16.4	-3.6	16.2
2036	24:16:55	24:16:55	24:16:55	24:17:15	24:17:12	24:16:55	16.4	16.4	16.5	-3.6	16.3
2037	24:17:45	24:17:45	24:17:45	24:18:05	24:18:02	24:17:46	16.4	16.4	16.5	-3.6	16.3

	Ayanamsa (As on 15th April)						Difference in Ayanamsa				
Year	**(A)**	**(B)**	**(C)**	**(D)**	**(E)**	**(F)**	**(E)-(A)**	**(E)-(B)**	**(E)-(C)**	**(E)-(D)**	**(E)-(F)**
yyyy	d:m:s	d:m:s	d:m:s	d:m:s	d:m:s	d:m:s	Sec.	Sec.	Sec.	Sec.	Sec.
2038	24:18:36	24:18:36	24:18:36	24:18:56	24:18:52	24:18:36	16.4	16.4	16.5	-3.6	16.3
2039	24:19:26	24:19:26	24:19:26	24:19:46	24:19:42	24:19:26	16.4	16.4	16.5	-3.6	16.3
2040	24:20:16	24:20:16	24:20:16	24:20:36	24:20:33	24:20:16	16.4	16.4	16.5	-3.6	16.4
2041	24:21:07	24:21:07	24:21:07	24:21:27	24:21:23	24:21:07	16.4	16.4	16.5	-3.6	16.4
2042	24:21:57	24:21:57	24:21:57	24:22:17	24:22:13	24:21:57	16.4	16.5	16.5	-3.6	16.3
2043	24:22:47	24:22:47	24:22:47	24:23:07	24:23:04	24:22:47	16.5	16.5	16.5	-3.6	16.3
2044	24:23:38	24:23:38	24:23:37	24:23:58	24:23:54	24:23:38	16.5	16.5	16.5	-3.6	16.4
2045	24:24:28	24:24:28	24:24:28	24:24:48	24:24:44	24:24:28	16.5	16.5	16.5	-3.6	16.4
2046	24:25:18	24:25:18	24:25:18	24:25:38	24:25:35	24:25:18	16.5	16.5	16.5	-3.6	16.4
2047	24:26:08	24:26:08	24:26:08	24:26:28	24:26:25	24:26:08	16.5	16.5	16.5	-3.6	16.3
2048	24:26:59	24:26:59	24:26:59	24:27:19	24:27:15	24:26:59	16.5	16.5	16.5	-3.6	16.5
2049	24:27:49	24:27:49	24:27:49	24:28:09	24:28:05	24:27:49	16.5	16.5	16.6	-3.6	16.4
2050	24:28:39	24:28:39	24:28:39	24:28:59	24:28:56	24:28:39	16.5	16.5	16.6	-3.6	16.4
2055	24:32:51	24:32:51	24:32:51	24:33:11	24:33:07	24:32:51	16.6	16.6	16.6	-3.6	16.4
2060	24:37:02	24:37:02	24:37:02	24:37:22	24:37:19	24:37:02	16.6	16.6	16.6	-3.7	16.6
2065	24:41:14	24:41:14	24:41:14	24:41:34	24:41:30	24:41:14	16.6	16.6	16.7	-3.7	16.6
2070	24:45:25	24:45:25	24:45:25	24:45:45	24:45:42	24:45:25	16.7	16.7	16.7	-3.7	16.6
2075	24:49:36	24:49:36	24:49:36	24:49:57	24:49:53	24:49:37	16.7	16.7	16.8	-3.7	16.6
2080	24:53:48	24:53:48	24:53:48	24:54:09	24:54:05	24:53:48	16.8	16.8	16.8	-3.7	16.8
2085	24:58:00	24:58:00	24:57:59	24:58:20	24:58:16	24:58:00	16.8	16.8	16.9	-3.7	16.8
2090	25:02:11	25:02:11	25:02:11	25:02:32	25:02:28	25:02:11	16.8	16.8	16.9	-3.7	16.8
2095	25:06:22	25:06:22	25:06:22	25:06:43	25:06:39	25:06:23	16.9	16.9	16.9	-3.8	16.8
2100	25:10:34	25:10:34	25:10:34	25:10:55	25:10:51	25:10:34	16.9	16.9	17.0	-3.8	16.8
2105	25:14:45	25:14:45	25:14:45	25:15:06	25:15:02	25:14:46	17.0	17.0	17.0	-3.8	16.8
2110	25:18:57	25:18:57	25:18:57	25:19:18	25:19:14	25:18:57	17.0	17.0	17.1	-3.8	16.8
2115	25:23:08	25:23:08	25:23:08	25:23:29	25:23:25	25:23:09	17.0	17.0	17.1	-3.8	16.8
2120	25:27:20	25:27:20	25:27:20	25:27:41	25:27:37	25:27:20	17.1	17.1	17.1	-3.8	17.0
2125	25:31:32	25:31:32	25:31:31	25:31:53	25:31:49	25:31:32	17.1	17.1	17.2	-3.9	17.0
2130	25:35:43	25:35:43	25:35:43	25:36:04	25:36:00	25:35:43	17.2	17.2	17.2	-3.9	17.0
2135	25:39:55	25:39:55	25:39:54	25:40:16	25:40:12	25:39:55	17.2	17.2	17.3	-3.9	17.0
2140	25:44:06	25:44:06	25:44:06	25:44:27	25:44:23	25:44:06	17.2	17.2	17.3	-3.9	17.2
2145	25:48:18	25:48:18	25:48:18	25:48:39	25:48:35	25:48:18	17.3	17.3	17.3	-3.9	17.2
2150	25:52:29	25:52:29	25:52:29	25:52:51	25:52:47	25:52:29	17.3	17.3	17.4	-3.9	17.2
2155	25:56:41	25:56:41	25:56:41	25:57:02	25:56:58	25:56:41	17.4	17.4	17.4	-4.0	17.2
2160	26:00:52	26:00:52	26:00:52	26:01:14	26:01:10	26:00:53	17.4	17.4	17.5	-4.0	17.4
2165	26:05:04	26:05:04	26:05:04	26:05:25	26:05:21	26:05:04	17.4	17.4	17.5	-4.0	17.4
2170	26:09:16	26:09:16	26:09:16	26:09:37	26:09:33	26:09:16	17.5	17.5	17.5	-4.0	17.4
2175	26:13:27	26:13:27	26:13:27	26:13:49	26:13:45	26:13:27	17.5	17.5	17.6	-4.0	17.4
2180	26:17:39	26:17:39	26:17:39	26:18:00	26:17:56	26:17:39	17.6	17.6	17.6	-4.0	17.5
2185	26:21:50	26:21:50	26:21:50	26:22:12	26:22:08	26:21:50	17.6	17.6	17.7	-4.0	17.5
2190	26:26:02	26:26:02	26:26:02	26:26:24	26:26:20	26:26:02	17.6	17.6	17.7	-4.1	17.6
2195	26:30:14	26:30:14	26:30:13	26:30:35	26:30:31	26:30:14	17.7	17.7	17.7	-4.1	17.6
2200	26:34:25	26:34:25	26:34:25	26:34:47	26:34:43	26:34:25	17.7	17.7	17.8	-4.1	17.6

In the above Table1, Ayanamsa calculated (A to E) are rounded up to seconds. However, the difference in Ayanamsa (in Seconds) shown, are calculated directly from the respective formulae.

6. Graph for the Difference in KP Ayanamsa

The above calculated difference in Ayanamsa are plotted with 'Year' as Horizontal axis, difference in Ayanamsa (in Seconds) as Vertical Axis and presented in below graph. The Graph Nos. (1) To (5) represents (E)-(A), (E)-(B), (E)-(C), (E)-(D) and (E)-(F) respectively.

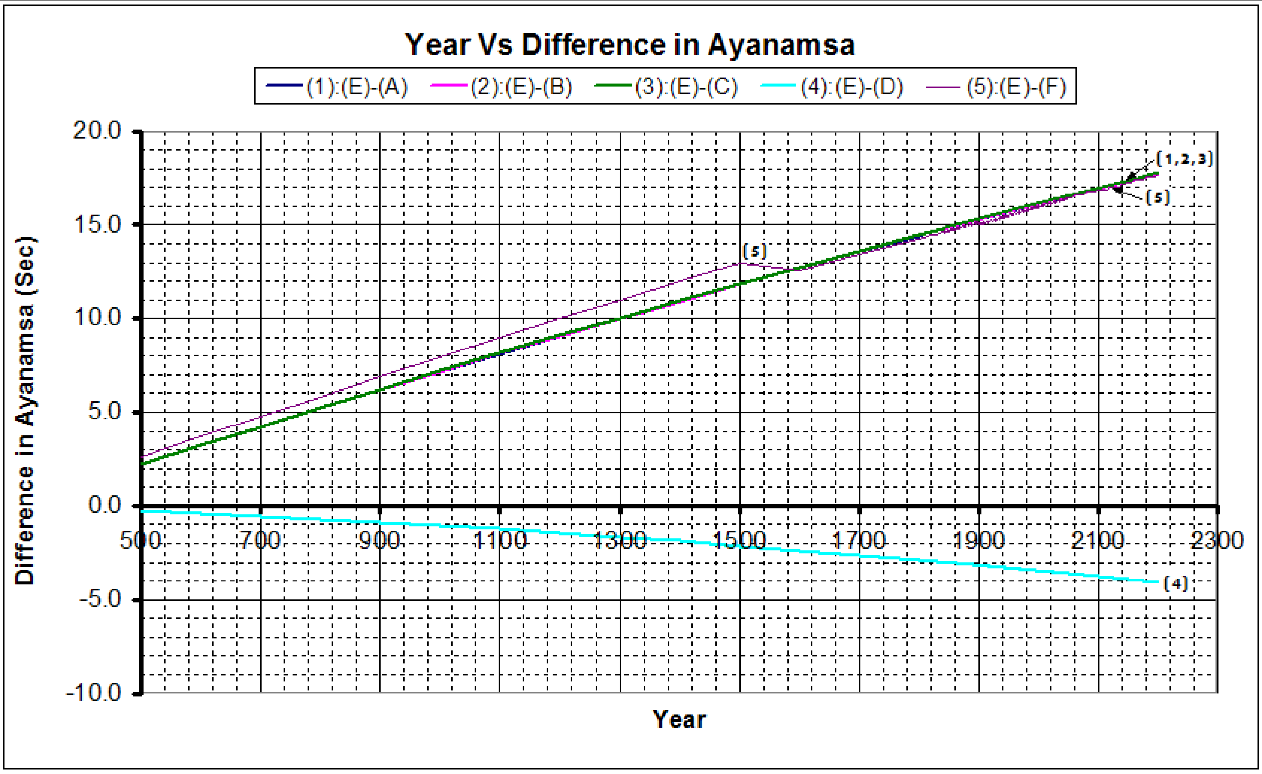

Chart 1:Year Vs Difference in Ayanamsa

7. Findings and Discussion

7.1 K.Balachandran & MGG Nayar's Article

K.Balachandran has mentioned in his article that he had liberally copied chapter and verse of MGG Nayar. It may be noted that Nayar has taken 50.2564" in the formula he has used (which is exactly correct as per Newcomb's formula). But K.Balachandran has substituted 50.2388475" for 50.2564" keeping all other mathematical steps intact. This is totally incorrect and stands to be rejected outright.

Zero Ayanamsa date considered in this book is 21 March 291 @ 04:09hrs UT (Saturday). The corresponding Besselian Year will workout 291.21645153698 (79.057235 days). In the above articles Zero Ayanamsa date is taken as 23 Mar 291@ 02:51 Hrs UT and Besselian Year derived as 291.2222AD (81.1568 days).

Firstly, this kind of difference can be possible when different Ephemeris are used which are developed using different mathematical model, astronomical formulae for calculating the sayana (Tropical) longitude of the Planets.

Secondly, Nayar used the calendar year directly instead of Besselian Epoch/Year.

Thirdly, the formula to calculate Ayanamsa has been derived using the “sum of arithmetical series” concept. Hence, the coefficient for first term ‘T’ in the formula, has come as (a-d/2) instead of ‘a’ using direct integration over the function with variable ‘T’.

Alternatively from the below Figure: 1 we can notice that the earth’s axis rotates in a circular motion in a tilted condition with an angle of around 23.45° (called obliquity ‘ε’) and the angular displacement θ marked represents the Precession. Hence Precession (Ayanamsa) can be considered as analogous to the circular motion and equation of circular motion can be used to represent Precession Rate and Precession (Ayanamsa) for any given time interval ‘T’

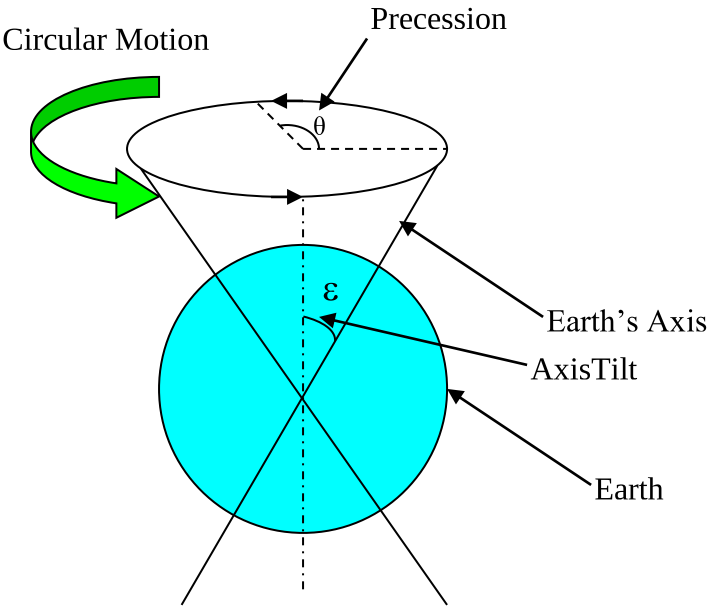

Figure: 1 Precession of the earth’s Axis

The Equations of Circular motion is

$$\omega_t = \omega_0 + \alpha * T$$ -----------Eqn.[20]

$$\theta_t = \omega_0 * T + \frac{1}{2}\alpha * T^2$$ -----------Eqn.[21]

Where

$T =$ Time interval

$\omega_0 =$ Angular Velocity (Initial)

$\omega_t =$ Angular Velocity at Time interval ‘T’

$\alpha =$ Angular acceleration

$\theta_t =$ Angular displacement for time interval ‘T’

Let me consider Case(C) of Chapter(4) as an example. Substituting Precession rate value (i,e., 50.2564” for Year 1900) for Angular Velocity (Initial) ω_0, Coefficient of time interval ‘T’ used in Precession Rate equation (i.e.,0.0002225) for Angular acceleration α, p_t (Precession Rate for time interval ‘T’) for ω_t , P_t (Precession/Ayanamsa for time interval ‘T’) for θ_t in above Eqn.(20,21) respectively, we get the following equations

$$p_t = 50.2564 + 0.0002225 * T$$ -----------Eqn.[22]

$$P_t = 50.2564 * T + \frac{1}{2} 0.0002225 * T^2$$

$$P_t = 50.2564 * T + 0.00011125 * T^2$$ -----------Eqn.[23]

The above Eqn.(22,23) are same as Eqn.(9,10) respectively except constant Term used in Eqn.(10) which is applicable for Eqn.(23) also. However as per the equation proposed by Nayar based on sum of arithmetical series, we get the Ayanamsa equation as below

$$P_t = \left(a - \frac{d}{2} \right) n + \frac{1}{2} d * n^2$$ -----------Eqn.[24]

Substituting a= 50.256622(=50.2564+0.000222 for n=1,i.e., 1st Term); d=0.000222; n = T

$$P_t = 50.256511 * T + 0.000111 * T^2$$ -----------Eqn.[25]

From the coefficient of first order term 'T' in Eqn.(23,25), it is very clear that equation proposed by Nayar has some fraction change which may give error when the period is very high. It is noticed that the sum of arithmetical series to the terms was implemented by C.G.Rajan in his Ayanamsa calculation Ref.[34] in the year 1933 and Nayar used the same approach with slight modification without mentioning the source of original concept.

Similarly using the theory of circular motion, equations associated with other methods/ theories can be obtained. However as mentioned in the beginning of this book and from modern precession theories, it has some dynamic motion and they are represented in polynomial equations above second order. Hence, when more precise values are required higher order term can be considered but for our astrological purpose up to second order term is adequate.

It is surprised to note that though Nayar has made good study in his article in the year 1980 about KP Ayanamsa, his Article didn't attract importance, among the KP community. Subsequently in 2003, K.Balachandran has copied same approach of Nayar except substituting 50.2388475" for Precession Rate in place of 50.2564", which is completely wrong. But unfortunately his article gained popularity leading to, inclusion of his formula in KP Softwares. It may also be noted, Nayar discarded the straight-line approach calculation (given under column termed 'A' in his article). Further Nayar's contention that 50.2388475" as 'Average Precession Rate' cannot be accepted, as it didn't agree with Newcomb's theory. Probably he would have used the above term to safeguard KSK's reputation. However, it is pertinent to note that Nayar has remarked in his article as below

==============================Quote==================================

I was, However, reluctant to revert to Krishnamurti Ayanamsa until I found some scientific support for the Ayanamsa tabulated in the Krishnamurti Padhdhati Readers.

=============================Unquote=================================

7.2 Study from Graphical Results

From Chart 1 graph No.(5), It is noticed that the Ayanamsa values calculated using the formula presented in Nayar's article, from year 500 to 1500, deviates from the one calculated for Newcomb's Julian Epoch graph No.(1), Newcomb's Besselian Epoch graph No.(2) and Newcomb's Besselian Epoch graph No.(3) by about 1 Second. At around 1580 it intersects the graph No.(1), (2), (3) lines and then onwards it goes closer to graph (1), (2) & (3) by about 0.2

Seconds. Because the difference in days for Zero Ayanamsa date between Nayar's calculation and the one given in this book for Case(A), (B) & (C) is negligible. Also the value for the term 'd' substituted in his equation is very small compared to the value for 'a' hence the term '(a-d/2)' nearly equal to 'a' as shown in Eqn.(23,25) above.

Even though the deviation is small, the line trend behavior for Case(F) compared to Case(A), (B) & (C) line are found different / erroneous. This is due to the days calculated from Zero Ayanamsa reference date are based on calendar year in Case(F) instead of either Julian Year or Besselian (Tropical) Year as shown for Case(A), (B) & (C).

From above Chart 1, graph No.(1) Newcomb's Julian Epoch, graph No.(2) Newcomb's Besselian Epoch and graph No.(3) Newcomb's Besselian Epoch are completely matches each other, because theoretically all the three Cases are equivalent to each other. That is Case(A) and Case(C) are derived from same basic Precession Rate equation of tropical year base given by Newcomb having two different reference year for which the Precession Rate, constant term 'C' are calculated/adjusted accordingly. Case(B) is derived from same basic Precession Rate equation of tropical year base given by Newcomb by adjusting the Precession Rate for the days difference between the reference Epoch dates, difference in number of days per Julian and Besselian(Tropical) year accordingly the constant term 'C' also calculated.

With respect to Ayanamsa calculated based modern latest IAU2006 precession theories Case(E), all the other Ayanamsa values particularly for Case (A, B, C and F) gradually diverges linearly from year 500 and at around Year 1900 reaches 15" difference up to 18" in the Year 2200. Hence for the following years the difference will keep accumulating and the deviation can go beyond tolerable limits. However, Ayanamsa values calculated for Case(D) not having significant divergence just 4" up to Year 2200.

7.3 Discussion on C.G.Rajan's Ayanamsa

A brief study has been made on C.G.Rajan's Ayanamsa and the findings are discussed below. The Precession Rate, Ayanamsa (for Rajan) are denoted by pG and PG respectively. Rajan in his book Ref.[12] on Page 10 Table7 has given the incremental/ decremental component '±a' for calculating Ayanamsa values from year 1840A.D to 2000A.D by keeping year 1925A.D as reference for which the Ayanamsa value is 22:40:39.Zero increment/decrement for the Tamil calendar date 1st of Chitra i.e., when Nirayana sun longitude is Zero in Aries or in other words the sayana sun longitude is 22:40:39 corresponding date is 13 April 1925 @3:06:17 UT as per Swiss Ephemeris for the year 1925 Ref.[8]. For all the succeeding years from 1926A.D to 2000A.D component '+a' (increment) and preceding years from 1840A.D to 1924A.D component '-a' (decrement) shall be applied. The same table is presented in his another book 'Planetary Tables (for 6300 years)'Ref.[34] on Page 34,35 Table1(b) published in 1933.

Even though Rajan mentioned the Rate of Precession from 1800A.D to 2000 A.D is equal to 50 Seconds per year, the actual increment value given are calculated based on the NewComb's Precession Rate and using the sum of arithmetical series to the terms in calendar year explained in his another book 'Planetary Tables(for 6300 years)'Ref.[34] published in 1933 as given below.

Using same general Precession Rate Eqn.(e) given above, he calculated the Precession rate with reference to the Year 1925A.D as

$$p = 50.26196 + 0.0002225 * n \qquad \text{-----------Eqn.[26]}$$

Formula for the sum of the arithmetical series is given by (Vide any book on Algebra)

$$S = \left(a - \frac{d}{2} \right) n + \left(\frac{d}{2} \right) * n^2$$ -----------Eqn.[27]

Where
S= Sum of the terms
n = No of terms
a = 1^{st} term of the series
d = common difference between any two consecutive terms
From Eqn.(26), when n=1 we get p as (that is Precession offset for Year 1926A.D as)

$$p = 50.2621825$$ -----------Eqn.[28]

From Eqn.(26), when n=-1 we get p as (that is Precession offset for Year 1924A.D as)

$$p = 50.2617375$$ -----------Eqn.[29]

From Eqn.(27), when n=1 we get sum of S as

$$S = a$$ -----------Eqn.[30]

General equation for Ayanamsa for any Year from 1925A.D is given by

$$P = C \pm S$$ -----------Eqn.[31]

Substituting Eqn.(27) in above Eqn.(31) We get

$$P = C \pm \left[\left(a - \frac{d}{2} \right) n + \left(\frac{d}{2} \right) * n^2 \right]$$ -----------Eqn.[32]

Where
$n = (|Y - 1925|)$ Number of years calculated as absolute difference from 1925A.D
Y = any calendar Year 'Y'
a = 50.2621825 for any Year 'Y' after 1925A.D (From Eqn.(30) & Eqn.(28))
= 50.2617375 for any Year 'Y' before 1925A.D (From Eqn.(30) & Eqn.(29))
d = 0.0002225
In ±, Use +ve for any Year 'Y' after 1925A.D and -ve for any Year 'Y' before 1925A.D
C = 22:40:39 Deg (See quote and further explanation given below)

Rajan states in his book Ref.[34]

===============================Quote===============================

Ever since the employment of the results of Nautical Almanac by Indian astronomers and almanac makers, there has been an attempt to find out the exact quantity of Ayanamsa and several conferences were held in Poona and other places to determine the correct quantity. Owing to Several reasons chief of which are (1) the inaccuracy of Indian Astronomy, (2) Ignorance of the period during which a particular kind of Astronomical text book was in vogue, (3) the inaccuracy of the Indian astronomical instruments employed, it does not appear to be possible with the information available at present to determine the exact quantity of Ayanamsa. In the fourth and latest conference of 1925A.D, referred to above, after considering several Ayanamsa quantities presented before them, the Ayanamsa which was worked out (by Mr.R.N.Apte,M.A., Professor of Mathematics, Rajaram College, Kolhapur) by taking the moment of Mesha Sankranthi according to Surya Siddhanta and following almost exactly the lines of argument set forth in Section 5(1), was adopted. That Ayanamsa was 22°40'39" for 1925A.D

==============================UnQuote==============================

Also Rajan states that it was decided in the conference that the above Ayanamsa has to be used (in the circumstances of uncertainty about the precise Ayanamsa) unless and until it is rejected by such a future conference is 22°40'39" for 1925A.D, and the equation for Ayanamsa for any n^{th} year from 1925A.D is as given above.

Further the concept used for calculation of Ayanamsa is found from Section 5(1) of Rajan's book Ref.[34] that the difference in longitudes of the Sun at a particular moment according to Surya Siddhanda and the Nautical Almanac of Greenwich shall give the Ayanamsa for that particular moment. Rajan calculated the moment (time) of Mesha Sankranthi (Sun at First Point of Aries Zero Degree 0°0'0") according to Surya Siddhanta for the date 13-04-1925 at Lanka (The meridian line connecting north, south pole of earth passing through the place Ujjain of geographic longitude 75°46'06" East intersects at a point on Equator called Lanka) of Hindu Astronomy and for the corresponding time at Greenwich the Sun's Sayana longitude is calculated from Nautical Almanac of Greenwich. The difference in longitudes of the Sun is considered as Ayanamsa for that particular moment.

It is evident from above Eqn.(26) that Rajan has considered the Precession Rate for the beginning of the year 1925 as base instead of Precession Rate corresponding to particular moment (time) of Mesha Sankranthi that is 13 April 1925. Due to this, small difference may be noticed when C.G.Rajan's Ayanamsa is calculated using the principles explained under the Chapter(4) 'Calculation of KP Ayanamsa' for Case(C) as given below.

As given above, Sayana longitude of Sun 22:40:39 corresponding to date is 13 April 1925 @3:06:17 UT as per Swiss Ephemeris for the year 1925 Ref.[8].
Julian Days (JD) for the date 13 April 1925 @3:06:17 UT = 2424253.62936343 days

Substituting the JD in Eqn.(b2) we get Besselian year as

$$BY = 1900 + \left(\frac{2424253.62936343 - 2415020.31352}{365.242198781} \right)$$

$$BY = 1900 + 25.27998099411$$

$$BY = 1925.27998099411$$

Using the general Precession Rate Eqn.(e), we get Precession Rate with reference to the above Besselian (Tropical) Year 1925.27998099411 as

$$pG = 50.2620248 + 0.0002225 * T \qquad \text{-----------Eqn.[33]}$$

Where
T= BY-B1925.27998099411
BY = Besselian Year (Tropical Year).
pG = precession rate for the year BY in Seconds
B1925.27998099411 = 1925.27998099411 Besselian Years
Integrating the above Eqn.(33) with respect to 'T' we get,

$$PG = C + 50.2620248 * T + 0.0002225 * \frac{T^2}{2}$$

$$PG = C + 50.2620248 * T + 0.00011125 * T^2 \qquad \text{-----------Eqn.[34]}$$

Where
C = Constant
= 81639 Seconds (=22°40'39" for Year 1925A.D as mentioned above)

$$PG = 81639 + 50.2620248 * T + 0.00011125 * T^2 (Seconds) \qquad \text{-----------Eqn.[35]}$$

Zero Ayanamsa date can be found by solving above quadratic Eqn.(35) for PG=0 and we get,
T= -1630.14989581085 Besselian (Tropical) Year.
Adding this with above reference Year, we get Besselian epoch for Zero Ayanamsa date as,
BY=1925.27998099411-1630.14989581085
= 295.13008518326 Besselian (Tropical) Year

Substituting BY in Eqn.(b2) we get Julian days (JD) as,

$$295.13008518326 = 1900 + \frac{\text{JD} - 2415020.31352}{365.242198781}$$

$$\text{JD} = 1828854.09707486 \text{ Julian Days}$$

From above Julian days the corresponding Date works out to 17 Feb 295@14:19:47UT

Alternative1:(With reference to Besselian Epoch B1900 and 'T' measured in Tropical Year)

The Ayanamsa equation with reference to Besselian Epoch B1900 ('T' measured in Tropical Year) by using the Eqn.(9) can be found by solving the constant 'C' as follows

Substituting JD=1828854.09707486 (Date 17 Feb 295@14:19:47UT) in Eqn.(b3) we get,

$$\text{T} = -1604.86991481673 \text{ Besselian Years}$$

Substituting T in Eqn.(9) and PC=0 We get
C = 80368.4480589079 Seconds
C = 22:19:28.4481 Deg (Ayanamsa for date 31 Dec 1899 19.52448 hrs UT, JD = 2415020.31352 days)

$$\text{PG} = 80368.4480589 1 + 50.2564 * \text{T} + 0.00011125 * \text{T}^2 (\textit{Seconds}) \qquad \text{-----------Eqn.[36]}$$

Alternative2:(With reference to Julian Epoch J1900 and 'T' measured in Julian Year)

The Ayanamsa equation with reference to Julian Epoch J1900 can be found by integrating the Eqn.(g) (reference to J1900) with respect to 'T'(measured in Julian Year) we get,

$$\text{P} = \text{C} + 50.257473 24 * \text{T} + 0.00011125 * T^2 (\textit{Seconds}) \qquad \text{-----------Eqn.[37]}$$

Substituting JD=1828854.09707486 (Date 17 Feb 295@14:19:47UT) in Eqn.(j3) we get,

$$\text{T} = -1604.83477871359 \text{ Julian Years}$$

Substituting T in above Eqn.(37) and P=0 We get
C = 80368.4171641193 Seconds
C = 22:19:28.4172 Deg (Ayanamsa for date 00 Jan 1900 12:00 hrs UT, JD = 2415020.0 days)

$$\text{PG} = 80368.41716412 + 50.25747324 * \text{T} + 0.00011125 * \text{T}^2 (\textit{Seconds}) \qquad \text{-----------Eqn.[38]}$$

Alternative3:(With reference to Julian Epoch J2000 and 'T' measured in Julian Year)

The Ayanamsa equation with reference to Julian Epoch J2000 can be found by finding the precession rate with reference to J2000 using Eqn.(g) and integrating it with respect to 'T' (measured in Julian Year) we get as given below,

$$p = 50.279723 24 + 0.0002225 * T (\textit{Seconds}) \qquad \text{-----------Eqn.[39]}$$

$$\text{P} = \text{C} + 50.27972324 * \text{T} + 0.00011125 * T^2 (\textit{Seconds}) \qquad \text{-----------Eqn.[40]}$$

Substituting JD=1828854.09707486 (Date 17 Feb 295@14:19:47UT) in above Eqn.(j3) we get,

$$\text{T} = -1704.83477871359 \text{ Julian Years}$$

Substituting T in above Eqn.(40) and P=0 We get
C = 85395.2769881193 Seconds
C = 23:43:15.276988 Deg (Ayanamsa for date 01 Jan 2000 12:00 hrs UT, JD = 2451545 days)

$$PG = 85395.276988 + 50.279723244 * T + 0.00011125 * T^2 (Seconds) \quad \text{-----------Eqn.[41]}$$

Similarly,
For KSK's Ayanamsa alternative equation for Eqn.(10) with reference to Julian Epoch J1900 & J2000 can be found by calculating 'T' corresponding to the Zero Ayanamsa date (21 Mar 291 @04:09 hrs UT) and substituting 'T' with P=0 in above Eqn.(37,40) we get the Ayanamsa equations of the respective case as below.

Alternative (k1):(With reference to Julian Epoch J1900 and 'T' measured in Julian Year)

Substituting JD=1827424.67291667 days (Date 21 Mar 291 04:09 hrs UT) in Eqn.(j3) (with reference Epoch J1900) we get,

$T = -1608.74832877024$ Julian Years
Substituting T in above Eqn.(37) and P=0 We get
C = 80563.7031636981 Seconds
C = 22:22:43.7031637 Deg (Ayanamsa for date 00 Jan 1900 12:00 hrs UT, JD = 2415020.0 days)

$$PC = 80563.7031637 + 50.257473244 * T + 0.00011125 * T^2 (Seconds) \quad \text{-----------Eqn.[42]}$$

Alternative (k2):(With reference to Julian Epoch J2000 and 'T' measured in Julian Year)

Substituting JD=1827424.67291667 days (Date 21 Mar 291 04:09 hrs UT) in Eqn.(j3) (with reference Epoch J2000) we get,

$T = -1708.74832877024$ Julian Years
Substituting T in above Eqn.(40) and P=0 We get
C = 85590.5629876981 Seconds
C = 23:46:30.5629877 Deg (Ayanamsa for date 01 Jan 2000 12:00 hrs UT, JD = 24151545 days)

$$PC = 85590.5629877 + 50.279723244 * T + 0.00011125 * T^2 (Seconds) \quad \text{-----------Eqn.[43]}$$

It is evident from the above, the statement given in Rajan's book Ref.[12] on Page 110, 111 that the values are for the Tamil calendar date 1st of Chitra i.e, on the 13th or 14th of April is correct or valid for specific range of calendar years only as the Tamil calendar date 1st of Chitra is related with specific date/time corresponding to Zero Degree Nirayana longitude of Sun in Aries Sign which will vary because of the change in Ayanamsa. For example, In the Year 291, 1st of Chitra fell on 21 March 291. Now for Year 2019, 1st of Chitra fell on 14 April 2019(Ref.[38]). Hence it is appropriate to fix anyone reference date/time and the Ayanamsa at specific date/time of each calendar year can be given/considered.

The difference in Ayanamsa between Eqn.(42,38) for the epoch J1900.0 works out to 195.2859995788" (80563.7031636981- 80368.4171641193). This difference is due to the accumulation of Ayanamsa from 21 March 291@04:09:00UT to 17 February 295@14:19:47UT and in degrees it is around 0°3'15.29".

Similarly, The difference in Ayanamsa between Eqn.(10,36) for the epoch B1900.0 works out to 195.2859397982" (80563.7339987061- 80368.4480589079) and in degrees it is around 0°3'15.29".

In the same way, The difference in Ayanamsa between Eqn.(43,41) for the epoch J2000.0 works out to 195.2859997" (85590.5629876981 - 85395.2769881193) and in degrees it is around 0°3'15.29".

However the difference in Ayanamsa between KSK's values given in Reader1 Book and C.G.Rajan's values given in his book Ref.[12] is found to be 0°2'00.00" almost from Year 1840 to 2000 (see comparison shown in Table 27,Table 29) which doesn't agree with the value given above (or even closely enough).This shows that KSK has not calculated the Ayanamsa values strictly using Newcomb's Precession formula using his parameters 50.2388475 Seconds and 291A.D. The tabulated values given in KP reader1 book appeared to be slightly manipulated version of C.G.Rajan's Table (Ref.[12]).

7.3.1 Rajan's Ayanamsa as per IAU1976 Precession Theory

Substituting JD=1828854.09707486 (Date 17 Feb 295@14:19:47UT) in Eqn.(j3) (With reference to J2000) we get,

$T = -17.0483477871359 \text{ Julian Centuries}$

Substituting T in Eqn.(13) and PD=0 We get

C = 85414.8422216185 Seconds

C = 23:43:34.842222 Deg (Ayanamsa for date 01 Jan 2000 12:00 hrs UT, JD = 2451545 days)

$$PG = 85414.842222 + 5029.0966 * T + 1.11113 * T^2 (\mathit{Seconds}) \qquad \text{-----------Eqn.[44]}$$

From Eqn.(41,44) the difference in Ayanamsa for J2000 Epoch is found to be 19.565234 seconds (85414.842222 -85395.276988). This difference will increase when 'T' increases.

7.3.2 Rajan's Ayanamsa as per IAU2006 Precession Theory

Substituting JD=1828854.09707486 (Date 17 Feb 295@14:19:47UT) in Eqn.(j3) (With reference to J2000) we get,

$T = -17.0483477871359 \text{ Julian Centuries}$

Substituting T in above Eqn.(17) and PE=0 We get

C = 85411.3761007249 Seconds

C = 23:43:31.376101 Deg (Ayanamsa for date 01 Jan 2000 12:00 hrs UT, JD = 2451545 days)

$$PG = 85411.376101 + 5028.796195 * T + 1.1054348 * T^2 (\mathit{Seconds}) \qquad \text{-----------Eqn.[45]}$$

From Eqn.(41,45) the difference in Ayanamsa for J2000 Epoch is found to be 16.099113 seconds (85411.376101 -85395.276988). This difference will increase when 'T' increases.

7.4 Discussion on Lahiri's Ayanamsa

A brief study has been made on Lahiri's Ayanamsa and the findings are discussed below. The Precession Rate, Ayanamsa (for Lahiri) are denoted by pH and PH respectively. Similarly, Ayanamsa deduced from Lahiri's formula for KSK's, Rajan's are denoted by PK and PG respectively.

From Lahiri's Indian ephemeris 2004 Ref.[31] the Mean Ayanamsa (I have explained about Mean/True Ayanamsa in later Chapter) for the date on 1 Jan 2004 for 00:00Hrs ET (Ephemeris Time) or 5:29:00 A.M IST(Indian Standard Time) is given as 23°54'46.62" & for 01 Jan 2003 for 00:00Hrs ET (Ephemeris Time) 23°53'56.33" degrees.

The time give above is Ephemeris Time and not Universal Time (UT). The relationship between the E.T (Ephemeris Time) and Universal Time (U.T) is given by the Equation (as per IENA 1973) E.T = U.T + ΔT, ΔT is the correction for reduction of U.T to E.T. Here ΔT=1min, Hence the above value given for 1 Jan 2003 can be considered for 00:00 hrs U.T.

Julian Days (JD) for the date 1 Jan 2003 @00:00Hrs UT = 2452640.5 Days
Substituting the above JD value in Eqn.(b2) we get T from Besselian Epoch B1900 as
$\mathrm{BY} = 2003.00065711344$ Besselian Year
$\mathrm{T} = 103.00065711344$

Substituting 'T' in Eqn.(f) we get precession rate with reference to B2003.00065711344 as,
$\mathrm{p} = 50.279266615 + 0.000222 * \mathrm{T}$ (Seconds) -----------Eqn.[46]
Integrating the above Eqn.(46) with respect to 'T' we get,

$$\mathrm{PH} = \mathrm{C} + 50.279266615 * \mathrm{T} + 0.000222 * \frac{\mathrm{T}^2}{2}$$

$$\mathrm{PH} = \mathrm{C} + 50.279266615 * \mathrm{T} + 0.000111 * \mathrm{T}^2 \quad \text{-----------Eqn.[47]}$$

Where
C = Constant (Mean Ayanamsa for the date 1 Jan 2003 00:00 hrs UT, JD = 2452640.5 days)
= 86036.33 Seconds (23°53'56.33", From Lahiri's Ephemeris 2004 as mentioned above)

Substituting 'C' in above Eqn.(47) we get,

$$\mathrm{PH} = 86036.33 + 50.279266615 * \mathrm{T} + 0.000111 * \mathrm{T}^2 \,(Seconds) \quad \text{-----------Eqn.[48]}$$

Zero Mean Ayanamsa date can be found by solving above quadratic Eqn.(48) for PH=0 and we get,
T= -1717.68275057671 Besselian Year.
Adding this with above reference Year, we get Besselian epoch for Zero Ayanamsa date as,
BY= 2003.00065711344 -1717.68275057671
= 285.31790653673 Besselian Year

Substituting BY in Eqn.(b2), we get Julian days (JD) as,

$$285.31790653673 = 1900 + \left(\frac{\mathrm{JD} - 2415020.31352}{365.242198781} \right)$$

$\mathrm{JD} = 1825270.27537117$ Julian Days
From above Julian days, Zero Mean Ayanamsa Date works out to <u>26 Apr 285@ 18:36:32UT</u>

<u>**Alternative1**:(With reference to Julian Epoch J1900 and 'T' measured in Julian Year)</u>

The Ayanamsa equation with reference to Julian Epoch J1900 can be found by integrating the Eqn.(g') (reference to J1900) with respect to 'T' (measured in Julian Year) we get,

$$\mathrm{P} = \mathrm{C} + 50.2575 * \mathrm{T} + 0.000111 * T^2 \,(Seconds) \quad \text{-----------Eqn.[49]}$$

To find out 'T' corresponding to Date 26 April 285@18:36:32UT, Substituting JD=18252702.7537117 in Eqn.(j3)(With reference to J1900) we get,
$\mathrm{T} = -1614.64674778817$ Julian Years

Substituting T in above Eqn.(49) and P=0 We get
C = 80858.7225896282 Seconds
C = 22:27:38.72259 Deg (Ayanamsa for date 00 Jan 1900 12:00 hrs UT, JD = 2415020.0 days)

$$\mathrm{PH} = 80858.72259 + 50.2575 * \mathrm{T} + 0.000111 * \mathrm{T}^2 \,(Seconds) \quad \text{-----------Eqn.[50]}$$

Alternative2:(With reference to Besselian Epoch B1900 and 'T' measured in Tropical Year)

The Ayanamsa equation with reference to Besselian Epoch B1900 can be found by integrating the above Eqn.(f) (reference to B1900) with respect to 'T' (measured in Tropical Year) we get,

$P = C + 50.2564 * T + 0.000111 * T^2$ (Seconds) -----------Eqn.[51]

Substituting JD=18252702.7537117(Date 26 April 285@18:36:32UT)in Eqn.(b3)(With reference to B1900) we get,

$T = -1614.68209346545$ Besselian Years

Substituting T in above Eqn.(51) and P=0 We get

C = 80858.7101548488 Seconds

C = 22:27:38.71016 Deg (Ayanamsa for date 31 Dec 1899 19.52448 hrs UT, JD = 2415020.31352 days)

$PH = 80858.71016 + 50.2564 * T + 0.000111 * T^2 (Seconds)$ -----------Eqn.[52]

Alternative3:(With reference to Julian Epoch J2000 and 'T' measured in Julian Year)

The Ayanamsa equation with reference to Julian Epoch J2000 can be found by finding the precession rate with reference to J2000 using Eqn.(g') and integrating it with respect to 'T' (measured in Julian Year) we get as given below,

$p = 50.2797 + 0.000222 * T (Seconds)$ -----------Eqn.[53]

$P = C + 50.2797 * T + 0.000111 * T^2 (Seconds)$ -----------Eqn.[54]

Substituting JD=18252702.7537117(Date 26 April 285@18:36:32UT) in Eqn.(j3)(With reference to J2000) we get,

$T = -1714.64674778598$ Julian Years

Substituting T in above Eqn.(54) and P=0 We get

C = 85885.5825895189 Seconds

C = 23:51:25.58259 Deg (Ayanamsa for date 01 Jan 2000 12:00 hrs UT, JD = JD = 24151545 days)

$PH = 85885.58259 + 50.2797 * T + 0.000111 * T^2 (Seconds)$ -----------Eqn.[55]

One of the renowned KP Astrologer TinWin has written an article on 'Reference Corner: KP Ayanamsas' in KP_Ezine (Ref.[39]).

In the above article, what he has mentioned as Lahiri's Ayanamsa formula is incorrect because annual Precession rate adjustment 'A' needs to be divided by 2 (Which is missing, perhaps typographical error). Tinwin has referred to the textbook "Notable Persons & KP" Ref.[33] in connection to his article.

In this textbook ("Notable Persons & KP") rate of Precession for the n^{th} year before 1900 (where 'n' is equal to 1900 minus the year in question) with reference to 15 April 1900 is given as (50.2564 – n* 0.000222) Seconds and Ayanamsa for same reference date (for any year before 1900) given as (80890.1535 + 50.256289n + $0.000111n^2$) Seconds. The algebraic concept used to formulate this equation can be seen in C.G.Rajan's Ayanamsa Calculation Eqn.(32). That is the values 50.256289, 0.000111 represents '(a-d/2)' and '(d/2)' terms in Eqn.(32) respectively. Taking a=50.2564, d=0.000222 we can show that '(a-d/2)'=50.256289(50.2564 – 0.5* 0.000222) & '(d/2)'=0.000111(0.000222/2).

It is incorrect to take it for 15 April 1900 reference date, because the precession rate 50.2564 is for Besselian epoch B1900 (Date 31 Dec 1899 @ 19.52448 hrs UT) in Tropical Year (365.242198781 days) and not for mean solar days of 365.25 as mentioned by the author (which is actually for Julian Year). Thus the Ayanamsa values for April 15 of every year given in 'Universal tables of Houses' (UTOH) Ref.[57] Table-X (which is referred to in the above book) is ***completely wrong***. Also basis for the value 80890.1535 seconds adopted in the above equation is not clearly specified. Nevertheless, the Author had acknowledged that values given in UTOH differ by few "seconds" only, from the Ayanamsa values recommended by IENA (Rashtriya Panchang) perhaps to justify his errors. The error could be, I guess the Constant Ayanamsa value adopted may be True Ayanamsa instead of Mean Ayanamsa. I have discussed about True & Mean Ayanamsa in my Chapter(7.6) 'Discussion on Nutation'.

Using Eqn.(50,52,55), we can find Lahiri's Ayanamsas ('Δ' delta) respectively for Zero Ayanamsa date of KSK & C.G.Rajan. By subtracting these 'Δ' delta values from the constant 'C' value in Eqn.(50,52,55), we can get Ayanamsa Equation for the respective case as given below.

7.4.1 Lahiri's Ayanamsa for KSK's Zero Ayanamsa Date (21 Mar 291@04:09 hrs UT)

7.4.1.1 With reference to Julian Epoch J1900 and 'T' measured in Julian Year

Substituting JD = 1827424.67291667 (Date 21 Mar 291 04:09 hrs UT)in Eqn.(j3)(With reference to J1900) we get,
T= -1608.74832877024 Julian Years

Substituting T in above Eqn.(50) and we get
PH = <u>294.3293584</u> Seconds (00:04:54.33 Deg)
= (Lahiri's Ayanamsa for date 21 Mar 291@04:09 hrs UT)
Subtracting above value from Eqn.(50) we get KP Ayanamsa

$$PK = 80564.39323 + 50.2575 * T + 0.000111 * T^2 \, (Seconds)$$ -----------Eqn.[56]

7.4.1.2 With reference to Besselian Epoch B1900 and 'T' measured in Tropical Year

Substituting JD = 1827424.67291667 (Date 21 Mar 291 04:09 hrs UT) in Eqn.(b3) we get,
T= -1608.78354846301 Besselian Years

Substituting T in above Eqn.(52) and we get
PH = 294.3291152 Seconds (00:04:54.33 Deg)
= (Lahiri's Ayanamsa for date 21 Mar 291@04:09 hrs UT)
Subtracting above value from Eqn.(52) we get KP Ayanamsa

$$PK = 80564.38104 + 50.2564 * T + 0.000111 * T^2 \, (Seconds)$$ -----------Eqn.[57]

It is noticed that the Eqn.(57) mostly agrees with Eqn.(10) given above up to significant decimal place values of each terms of the equations except a small difference in constant term found 0.6470458" (80564.38104-80563.733999), due to the small difference in decimal place values used for the coefficient of 'T^2' term as 0.000111 and 0.00011125 in respective Equations. From the above, KSK's Ayanamsa is found less than Lahiri's Ayanamsa by 0°4'54.33" Degree.

7.4.1.3 With reference to Julian Epoch J2000 and 'T' measured in Julian Year

Substituting JD = 1827424.67291667 (Date 21 Mar 291 04:09 hrs UT)in Eqn.(j3)(With reference to J2000) we get,
T=-1708.74832877024 Julian Years

Substituting T in above Eqn.(55) and we get
PH = 294.3293584 Seconds (00:04:54.33 Deg)
= (Lahiri's Ayanamsa for date 21 Mar 291@04:09 hrs UT)
Subtracting above value from Eqn.(55) we get KP Ayanamsa

$$PK = 85591.25323 + 50.2797 * T + 0.000111 * T^2 (\textit{Seconds})$$ -----------Eqn.[58]

7.4.2 Lahiri's Ayanamsa for Rajan's Zero Ayanamsa Date (17 Feb 295@14:19:47UT)

7.4.2.1 With reference to Julian Epoch J1900 and 'T' measured in Julian Year

Substituting JD=1828854.09707486 (Date 17 Feb 295@14:19:47UT) in Eqn.(j3) (With reference to J1900) we get,
T= -1604.83477871359 Julian Years
Substituting T in above Eqn.(50) and we get
PH = 489.618607 Seconds (00:08:09.62 Deg)
= (Lahiri's Ayanamsa for date 17 Feb 295@14:19:47UT)
Subtracting above value from Eqn.(50) we get Rajan's Ayanamsa

$$PG = 80369.10398 + 50.2575 * T + 0.000111 * T^2 (\textit{Seconds})$$ -----------Eqn.[59]

It is noticed that the Eqn.(59) mostly agrees with Eqn.(38) given above up to significant decimal place values of the each terms of the equations except a small difference in constant term found 0.68682" (80369.10398-80368.41716), due to the small difference in decimal place values used for the coefficient of 'T^2' term as 0.000111 and 0.00011125 and for 'T' term as 50.2575 (rounding off values used) and 50.25747324 in respective Equations. From the above, the Rajan's Ayanamsa is found less than Lahiri's Ayanamsa by 0°8'9.62" Degree.

7.4.2.2 With reference to Besselian Epoch B1900 and 'T' measured in Tropical Year

Substituting JD=1828854.09707486 (Date 17 Feb 295@14:19:47UT) in Eqn.(b3) we get,
T=-1604.86991481673 Besselian Years
Substituting T in above Eqn.(52) and we get
PH = 489.618199 Seconds (00:08:09.62 Deg)
= (Lahiri's Ayanamsa for date 17 Feb 295@14:19:47UT)
Subtracting above value from Eqn.(52) we Get Rajan's Ayanamsa

$$PG = 80369.09196 + 50.2564 * T + 0.000111 * T^2 (\textit{Seconds})$$ -----------Eqn.[60]

It is noticed that the Eqn.(60) mostly agrees with Eqn.(36) given above up to significant decimal place values of the each terms of the equations except a small difference in constant term found 0.64390" (80369.09196-80368.44806), due to the small difference in decimal place values used for the coefficient of 'T^2' term as 0.000111 and 0.00011125 and for 'T' term as 50.2575 (rounding of values used) and 50.25747324 in respective Equations. From the above, the Rajan's Ayanamsa is found less than Lahiri's Ayanamsa by 0°8'9.62" Degree.

7.4.2.3 With reference to Julian Epoch J2000 and 'T' measured in Julian Year

Substituting JD=1828854.09707486 (Date 17 Feb 295@14:19:47UT) in Eqn.(j3) (With reference to J2000) we get,
T= -1704.83477871359 Julian Years
Substituting T in above Eqn.(55) and we get
PH = 489.618607 Seconds (00:08:09.62 Deg)
= (Lahiri's Ayanamsa for date 17 Feb 295@14:19:47UT)
Subtracting above value from Eqn.(55) we get Rajan's Ayanamsa

$$\text{PG} = 85395.96398 + 50.2797 * \text{T} + 0.000111 * \text{T}^2 (\textit{Seconds}) \qquad \text{-----------Eqn.[61]}$$

Thus, Rajan's Ayanamsa is found to be less than KSK's by 0°3'15.29" Degree (0°8'9.62"-0°4'54.33"). As discussed earlier above, the difference in Ayanamsa between KSK's values given in Reader1 and C.G.Rajan's values given in his book Ref.[12] is found to be 0°2'00.00" almost from Year 1840 to 2000 which doesn't match values derived above (0°3'15.29" Degree).

7.4.3 Lahiri's Ayanamsa as per IAU1976 Precession Theory

Substituting JD=18252702.7537117(Date 26 April 285@18:36:32UT)in Eqn.(j3) (With reference to J2000) we get,
$\text{T} = -17.1464674778598 \text{ Julian Centuries}$
Substituting T in Eqn.(13) and PD=0 We get
C = 85904.5675782574 Seconds
C = 23:51:44.567578 Deg (Ayanamsa for date 01 Jan 2000 12:00 hrs UT, JD = 2451545 days)

$$\text{PH} = 85904.567578 + 5029.0966 * \text{T} + 1.11113 * \text{T}^2 (\textit{Seconds}) \qquad \text{-----------Eqn.[62]}$$

From Eqn.(55,62) the difference in Ayanamsa for J2000 Epoch is found 18.984988 seconds (85904.567578 - 85885.58259). This difference will increase when 'T' increases.

7.4.4 Lahiri's Ayanamsa as per IAU2006 Precession Theory

Substituting JD=18252702.7537117(Date 26 April 285@18:36:32UT)in Eqn.(j3) (With reference to J2000) we get,
$\text{T} = -17.1464674778598 \text{ Julian Centuries}$
Substituting T in Eqn.(17) and PE=0 We get
C = 85901.091090166 Seconds
C = 23:51:41.091090 Deg (Ayanamsa for date 01 Jan 2000 12:00 hrs UT, JD = 2451545 days)

$$\text{PH} = 85901.091090 + 5028.796195 * \text{T} + 1.1054348 * \text{T}^2 (\textit{Seconds}) \qquad \text{-----------Eqn.[63]}$$

From Eqn.(55,63) the difference in Ayanamsa for J2000 Epoch is found 15.5085 Seconds (85901.091090 - 85885.58259). This difference will increase when 'T' increases.

7.5 Discussion on Indian Ephemeris Nautical Almanac's / Rashtriya Panchang's Ayanamsa

A brief study has been made on IENA's Ayanamsa and the findings are discussed below. The Precession Rate, Ayanamsa (for IENA) are denoted by pI and PI respectively.

From IENA 1973 Ref.[52], Mean Ayanamsa for the date 1 Jan 1950@5h29.3m A.M IST (equal to 05:29:18 hrs Indian Standard Time corresponding to 0hrs ET) is given as 23°09'30.79" degrees. Similar to the discussion made for Lahiri's Ayanamsa calculation, the above value can be considered for 00:00 hrs U.T

Julian Days (JD) for 1 January 1950 @ 00:00 UT = 2433282.5 Julian Days
Substituting JD=2433282.5 days in Eqn.(j2) we get, JY= 1950.0
Using Eqn.(g') for Newcomb's annual general precession in longitude (p) given in IENA1960 for 'T' measured in Julian Year from the epoch J1900, we get the general precession rate with reference to Julian year J1950.0 as

$$pI = 50.2686 + 0.000222 * T$$ -----------Eqn.[64]

Where
T= JY-J1950
JY = Julian Year.
pI = precession rate for the year JY in Seconds
J1950 = Julian Year 1950
Integrating the above Eqn.(64) with respect to 'T' we get,

$$PI = C + 50.2686 * T + 0.000222 * \frac{T^2}{2}$$

$$PI = C + 50.2686 * T + 0.000111 * T^2$$ -----------Eqn.[65]

Where
C = Constant (= Mean Ayanamsa for the date 1 Jan 1950 00:00 hrs UT, JD = 2433282.5 days)
= 83370.79 Seconds (=23°09'30.79", From IENA 1973 as mentioned above)
Substituting 'C' in above Eqn.(65) we get,

$$PI = 83370.79 + 50.2686 * T + 0.000111 * T^2 \,(\textit{Seconds})$$ -----------Eqn.[66]

Zero Mean Ayanamsa date can be found by solving above quadratic Eqn.(66) for PI=0 and we get,
T= -1664.62500209142 Julian Year.
Adding this with above reference Year, we get Julian epoch for Zero Ayanamsa date as,
JY=1950.0-1664.62500209142
= 285.37499790858 Julian Year
Substituting JY in Eqn.(j1) (with reference to J1900) we get Julian days (JD) as,

$$285.37499790858 = 1900 + \left(\frac{JD - 2415020}{365.25}\right)$$

$$JD = 1825278.21798611 \text{ Julian Days}$$

From above Julian days, the corresponding Zero Ayanamsa Date works out to 4 May 285@ 17:13:54UT

Alternative1:(With reference to Julian Epoch J1900 and 'T' measured in Julian Year)

Substituting JD=1825278.21798611 (Date 4 May 285@17:13:54UT) in Eqn.(j3) (With reference to J1900) we get,

$$T = -1614.62500209142 \text{ Julian Years}$$

Substituting T in Eqn.(49) and P=0 We get
C = 80857.6375 Seconds
C = 22:27:37.6375 Deg (Ayanamsa for date 00 Jan 1900 12:00 hrs UT, JD = 2415020.0 days)

$$PI = 80857.6375 + 50.2575 * T + 0.000111 * T^2 \,(\textit{Seconds})$$ -----------Eqn.[67]

Alternative2:(With reference to Besselian Epoch B1900 and 'T' measured in Tropical Year)

Substituting JD=1825278.21798611 (Date 4 May 285@17:13:54UT) in Eqn.(b3) (With reference to B1900) we get,

$$T = -1614.66034730423 \text{ Besselian Years}$$

Substituting T in Eqn.(51) and P=0 We get
C = 80857.6250661359 Seconds

C = 22:27:37.6251 Deg (Ayanamsa for date 31 Dec 1899 19.52448 hrs UT, JD = 2415020.31352 days)

$PI = 80857.6251 + 50.2564 * T + 0.000111 * T^2 (Seconds)$ -----------Eqn.[68]

Alternative3:(With reference to Julian Epoch J2000 and 'T' measured in Julian Year)

Substituting JD=1825278.21798611 (Date 4 May 285@17:13:54UT) in Eqn.(j3) (With reference to J2000) we get,

$T = -1714.62500209142$ Julian Years

Substituting T in Eqn.(54) and P=0 We get

C = 85884.4975 Seconds

C = 23:51:24.4975 Deg (Ayanamsa for date 01 Jan 2000 12:00 hrs UT, JD = JD = 24151545 days)

$PI = 85884.4975 + 50.2797 * T + 0.000111 * T^2 (Seconds)$ -----------Eqn.[69]

It is noticed from the Eqn.(50,67), for the epoch J1900, the IENA's Ayanamsa is found less than Lahiri's Ayanamsa by 1.08509" Seconds(80858.72259-80857.6375).Similarly,

From the Eqn.(52,68), for the epoch B1900, the difference is 1.08506" Seconds (80858.71016 - 80857.6251).

From the Eqn.(55,69), for the epoch J2000, the difference is 1.08509" Seconds (=80885.58259 - 85884.4975).

This difference may be due to the correction value of 0.658" adopted from 1985 (as mentioned on Page(5) of Lahiri's Indian ephemeris 2004) in the tropical longitude (Ayanamsa) of initial point for the reference date 21 March@1956 0Hrs as 23°15'0.658" degrees against the value adopted by the IENA given as 23°15'0.000" degrees. It is noticed that Ayanamsa for the same date 21 March 1956 @ 00:00Hrs UT (JD =2435553.5 Days) calculated using the above Eqn.(50,67) works out to 23°14'44.43" degrees and 23°14'43.35" degrees respectively. Which are less by 0°0'16.23"(23°15'0.658"-23°14'44.43") and 0°0'16.65"(23°15'0.000"- 23°14'43.35") of the respective reference Ayanamsa value of the same reference date. This difference of 16" maybe due to the Nutation in longitude [See Chapter(7.6)] correction and hence the tropical longitude of initial point for the reference date given by Lahiri, IENA may be True Ayanamsa. Readers may please note that all the Ayanamsa equations derived above by me are for the Mean Ayanamsa only.

The relationship between the Mean Ayanamsa, True Ayanamsa and the Nutation in longitude for any epoch is given by the equation shown below (As per IENA 1973)

True Ayanamsa = Mean Ayanamsa + Nutation in longitude

A brief comparison between the IENA's Mean Ayanamsa calculated using Eqn.(67) & values published in Rashtriya Panchangs (Ref.[37,38]) are given below.

Sr.No (A)	Date @00:00 Hrs UT (B)	IENA (C)	Rashtriya Panch. (D)	Difference (C)-(D)
(1)	22 March 2018	24°06'40.58"	24°06'29.00"	**0°0'11.58"**
(2)	22 March 2019	24°07'30.83"	24°07'16.00"	**0°0'14.83"**
	Difference (2)-(1)	**0°0'50.25"**	**0°0'47.00"**	

From the table shown above It may be noticed that the difference in Mean Ayanamsa between IENA, Rashtriya Panchang for year 2018 is 0°0'11.58" and same difference for the year 2019 is 0°0'14.83". Further the difference(2)-(1) for IENA and Rashtriya Panch. is equal to 0°0'50.25" and 0°0'47.00" respectively. On any account, the Mean Ayanamsa Value Per Year cannot be less than 50" approx. beyond Year 1900. Going by Eqn.(g'), this value must have been 0°0'50.30" degrees. Owing to these glaring discrepancies, I infer, the Ayanamsa value published in Indian Rashtriya Panchang referred to above years should have been True Ayanamsa values.

7.5.1 IENA's Ayanamsa as per IAU1976 Precession Theory

Substituting JD =1825278.21798611 (Date 4 May 285@17:13:54UT) in Eqn.(j3) (With reference to J2000) we get,

$T = -17.146250209142$ Julian Centuries

Substituting T in Eqn.(13) and PD=0 We get

C = 85903.4822521785 Seconds

C = 23:51:43.482252 Deg (Ayanamsa for date 01 Jan 2000 12:00 hrs UT, JD = JD = 24151545 days)

$PI = 85903.482252 + 5029.0966 * T + 1.11113 * T^2 (\mathit{Seconds})$ -----------Eqn.[70]

From Eqn.(69,70) the difference in Ayanamsa for J2000 Epoch is found 18.984752 seconds (85903.482252 - 85884.4975). This difference will increase when 'T' increases.

7.5.2 IENA's Ayanamsa as per IAU2006 Precession Theory

Substituting JD =1825278.21798611 (Date 4 May 285@17:13:54UT) in Eqn.(j3) (With reference to J2000) we get,

$T = -17.146250209142$ Julian Centuries

Substituting T in Eqn.(17) and PE=0 We get

C = 85900.005786942 Seconds

C = 23:51:40.005787 Deg (Ayanamsa for date 01 Jan 2000 12:00 hrs UT, JD = 2451545 days)

$PI = 85900.005787 + 5028.796195 * T + 1.1054348 * T^2 (\mathit{Seconds})$ -----------Eqn.[71]

From Eqn.(69,71) the difference in Ayanamsa for J2000 Epoch is found 15.508287 Seconds (85900.005787 - 85884.4975). This difference will increase when 'T' increases.

7.6 Discussion on Nutation

Nutation is a phenomenon which causes the orientation of the axis of rotation of object (Earth) vary over time, due to gravitational forces of other nearby celestial bodies, acting upon the spinning object (Earth). The effect of nutation is twofold. 1) Changes the General Precession in longitude (θ) and 2) changes the obliquity (ε) of earth axis. They are indicated by (Δψ) and (Δε) respectively. Therefore, we can write,

True Ayanamsa (θ') = Mean Ayanamsa (θ) + Nutation in longitude (Δψ) -----------Eqn.[n]

True Obliquity (ε') = Mean Obliquity (ε) + Nutation in Obliquity (Δε) -----------Eqn.[o]

Nutation in Obliquity(Δε), Nutation in longitude(Δψ) are correlated to Syanana (Tropical) longitude of Cuspal Positions and Ayanamsa respectively. So I have further discussed Nutation in longitude (Δψ) for the purpose of calculation of True Ayamansa and Nutation in Obliquity(Δε) in Chapter(7.6.6). This phenomenon is explained pictorially for better clarity given below.

Similar to the Figure: 1 for precession in earth axis, In below Figure: 2 & Figure: 3 we can notice that the earth's axis rotates in a circular motion in a tilted condition with an angle ε (mean obliquity) and the angular displacement θ (mean Ayanamsa) marked represents the precession. Due to the gravitational forces of other nearby celestial bodies acting upon the spinning Earth, the axis tilts causing change in General Precession in longitude (θ), obliquity angle (ε) to the value called Nutation in longitude (Δψ) and Nutation in obliquity (Δε) respectively as marked.

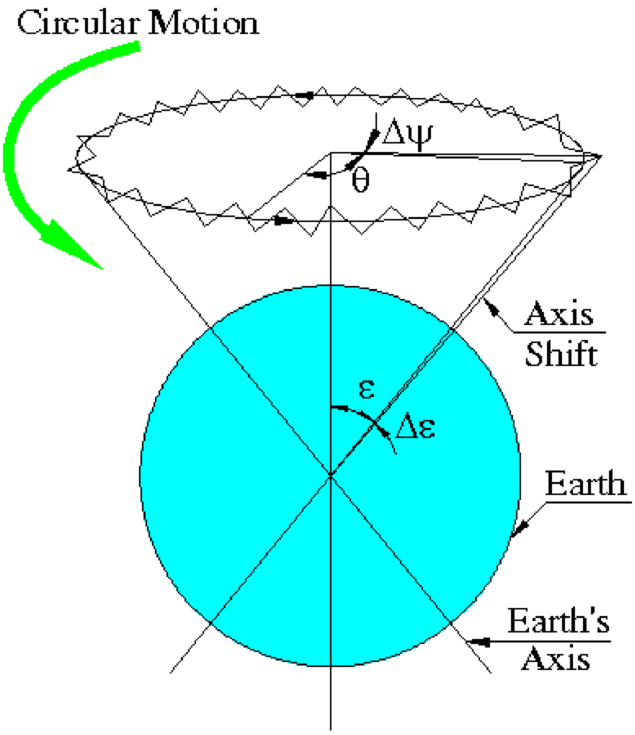

Figure: 2 Nutation in Longitude & Obliquity
(Elevation)

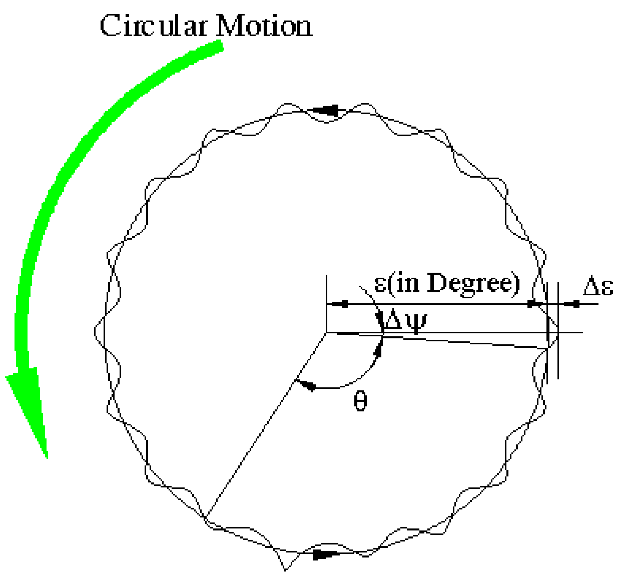

Figure: 3 Nutation in Longitude & Obliquity
(Top_View)

Readers to note that two components namely Mean Obliquity (ε) and Nutation in Obliquity (Δε) marked in Figure: 3 above are symbolic only, to represent the Mean and True (Shifted) position of the earth's Axis for the Epoch in question on the representative plane. Actually it shall mean the angle subtended at the center of the earth with respect to vertical, it's change in angle as shown in Figure: 2 and shall not be taken literal mean of figure shown like a radial distance etc.,

There are many theories for Nutation in Longitude, developed/modified by various authors from the end of 19th century to recent year. Some of the significant theories are listed below

(A) Simon NewComb 1895 Ref.[2,40,44] (consisting of 26 Luni-Solar terms)

(B) E.W.Woolard 1953 Ref.[5,54] (fundamental arguments corrected for amendment to Brown's Table Ref.[45] consisting of 69 Luni-solar Terms adopted by IAU1964 & IENA 1960)

(C) IAU1980 Nutation Theory Seidelmann (1982) Ref.[1] (Consisting of 106 Luni-Solar terms Developed by Wahr(1981) Ref.[49] based on the Previous work by Kinoshita(1977) and Gilbert and Dziewonski(1975))

(D) IAU2000A Nutation Model Ref.[50] (Consisting of 1365 terms resulting 0.2 milliArcSeconds level Developed by Mathews et al. (2002) often referred to as MBH2000), based on Souchay et al.(1999)

(E) IAU2000B Nutation Model (is same as (D) above but an abridged version of the full 1365 Terms IAU2000A Nutation Model Consisting of 77 terms smaller than IAU1980 Nutation Model resulting 1 milliarcsecond level. hence it is not considered in this book's scope)

IERS Conventions 2003 Ref.[16] provides explanation on Precession, Nutation and it's combination of model to be used (Namely, IAU2006 Precession Model with IAU2000 Nutation Model, IAU1976 Precession Model with IAU1980 Nutation Model), compatibility between the models and corrections to be applied (to the latest Nutation model with previously developed Precession model etc.,). However, for our Astrological purpose, it is enough to consider terms contributing Nutation in Longitude up to 0.01 Seconds. Though IAU2000A Nutation model has 14 fundamental arguments it is enough for our astrological purpose to consider only fundamental luni-solar arguments commonly used in above-mentioned Models and the same is given below.

Fundamental luni-solar arguments (l, l', F, D, ☊), Mean elements of Moon (☽, π, ☊) and Sun (L, π')

l = The mean anomaly of the Moon (= ☽ - π)

l'= The mean anomaly of the Sun (= L-π')

F= The mean argument of latitude of the Moon (= ☽ - ☊)

D= The mean elongation of the Moon from the Sun (= ☽ - L)

☊ = Mean longitude of the Moon's mean ascending Node (in Vedic Called 'Rahu'[Mean])

☽ = Mean longitude of the Moon (= F + ☊)

π = Mean longitude of Moon's Perigee (= ☽ - l)

L = Mean longitude of the Sun (=☽ - D)

π' =Mean longitude of Sun's Perigee (= L – l')

All these elements can be calculated for any Julian or Besselian (Tropical) century 'T' (computed with reference to J2000 or J1900 or B1900) using the polynomial equations having terms up to 3rd or 4th order of 'T' and with reference Epoch as given below.

$f_1(T) = A_0 + A_1 * T + A_2 * T^2 + A_3 * T^3 + A_4 * T^4$ Julian century 'T'& Ref. J2000 -----------Eqn.[72]

$f_2(T) = B_0 + B_1 * T + B_2 * T^2 + B_3 * T^3 + B_4 * T^4$ Julian century 'T'& Ref. J1900 ----------Eqn.[73]

$f_3(T) = C_0 + C_1 * T + C_2 * T^2 + C_3 * T^3 + C_4 * T^4$ Besselian century 'T'& Ref. B1900 ------Eqn.[74]

Table 2: Coefficient of the Fundamental Arguments (With Ref. J2000 & 'T' in Julian century)

Argument	A_0	A_1	A_2	A_3	A_4	Remarks
J2000(IAU 2000A Nutation Model)						
l (=☽ - π)	485868.249036	1717915923.2178	31.8792	0.051635	-0.00024470	
l' (=L- π')	1287104.793050	129596581.0481	-0.5532	0.000136	-0.00001149	
F (=☽ - ☊)	335779.526232	1739527262.8478	-12.7512	-0.001037	0.00000417	
D (=☽ - L)	1072260.703690	1602961601.2090	-6.3706	0.006593	-0.00003169	
☊	450160.398036	-6962890.5431	7.4722	0.007702	-0.00005939	
☽ (=F + ☊)	785939.924268	1732564372.3047	-5.2790	0.006665	-0.00005522	
L(=☽ - D)	1009679.220578	129602771.0957	1.0916	0.000072	-0.00002353	
π'(=L - *l*')	1018574.427528	6190.0476	1.6448	-0.000064	-0.00001204	
π(=☽ - *l*)	300071.675232	14648449.0869	-37.1582	-0.04497	0.00018948	
J2000(IAU 1980 Nutation Model)						
l (=☽ - π)	485866.733	1717915922.6330	31.310	0.064	0	
l' (=L- π')	1287099.804	129596581.2240	-0.577	-0.012	0	
F (=☽ - ☊)	335778.877	1739527263.1370	-13.257	0.011	0	
D (=☽ - L)	1072261.307	1602961601.3280	-6.891	0.019	0	
☊	450160.280	-6962890.5390	7.455	0.008	0	
☽ (=F + ☊)	785939.157	1732564372.5980	-5.802	0.019	0	
L(=☽ - D)	1009677.850	129602771.2700	1.089	0.000	0	
π'(=L - *l*')	1018578.046	6190.0460	1.666	0.012	0	
π(=☽ - *l*)	300072.424	14648449.9650	-37.112	-0.045	0	
J2000(Derived from IAU1964 Nutation Model-E.W.Woolard 1953)						
l (=☽ - π)	485866.5218	1717915923.1254	33.2454	0.0518	0	
l' (=L- π')	1287091.548	129596577.9840	-0.576	-0.012	0	
F (=☽ - ☊)	335782.1788	1739527267.4164	-11.5636	-0.0012	0	
D (=☽ - L)	1072260.967	1602961600.8604	-5.1496	0.0068	0	
☊	450156.048	-6962896.2460	7.504	0.008	0	
☽ (=F + ☊)	785938.2268	1732564371.1704	-4.0596	0.0068	0	
L(=☽ - D)	1009677.260	129602770.3100	1.09	0	0	
π'(=L - *l*')	1018585.712	6192.3260	1.666	0.012	0	
π(=☽ - *l*)	300071.705	14648448.0450	-37.305	-0.045	0	
J2000(Derived from Nutation Model-Newcomb)						
l (=☽ - π)	485866.5218	1717915923.1254	33.2454	0.0518	0	
l' (=L- π')	1287091.5480	129596577.9840	-0.5760	-0.0120	0	
F (=☽ - ☊)	335796.5788	1739527267.4164	-11.5636	-0.0012	0	
D (=☽ - L)	1072317.7578	1602961659.0924	8.0214	0.0068	0	
☊	450152.0780	-6962897.4460	7.6040	0.0080	0	
☽ (=F + ☊)	785995.0168	1732564429.4004	9.1104	0.0068	0	
L(=☽ - D)	1009677.2590	129602770.3080	1.0890	0.0000	0	
π'(=L - *l*')	1018585.6720	6192.3260	1.6660	0.0120	0	
π(=☽ - *l*)	300059.5250	14648441.3250	-37.3750	-0.0450	0	

Note:

1. All the above equation gives respective fundamental argument values in Seconds.
2. For Example, mean anomaly of the Moon *l*(T) from J2000 (IAU 2000A Nutation Model) is given by

$$l(T) = 485868.249036 + 17179159232178*T + 31.8792*T^2 + 0.051635*T^3 - 0.00024470*T^4$$

Table 3: Coefficient of the Fundamental Arguments (With Ref. J1900 & 'T' in Julian century)

Argument	B_0	B_1	B_2	B_3	B_4	Remarks
J1900(Derived from IAU 2000A Nutation Model)						
l (=☽ - π)	1065976.858557	1717915859.6153	31.72283	0.0526138	-0.0002447	
l' (=L- π')	1290523.191603	129596582.1550	-0.55368	0.00018196	-0.00001149	
F (=☽ - ☊)	40503.928273	1739527288.3471	-12.7481	-0.00105368	0.00000417	
D (=☽ - L)	1262653.117465	1602961613.9701	-6.39057	0.00671976	-0.00003169	
☊	933058.405575	-6962905.4642	7.448738	0.00793956	-0.00005939	
☽ (=F + ☊)	973562.333848	1732564382.8829	-5.29933	0.00688588	-0.00005522	
L(=☽ - D)	1006909.216383	129602768.9128	1.091243	0.00016612	-0.00002353	
π'(=L - *l*')	1012386.024780	6186.7579	1.64492	-0.00001584	-0.00001204	
π(=☽ - *l*)	1203585.475291	14648523.2676	-37.0222	-0.04572792	0.00018948	
J1900(Derived from IAU 1980 Nutation Model)						
l (=☽ - π)	1065975.346	1717915860.2050	31.118	0.064	0	
l' (=L- π')	1290518.015	129596582.3420	-0.541	-0.012	0	
F (=☽ - ☊)	40502.472	1739527289.6840	-13.29	0.011	0	
D (=☽ - L)	1262653.069	1602961615.1670	-6.948	0.019	0	
☊	933058.266	-6962905.4250	7.431	0.008	0	
☽ (=F + ☊)	973560.738	1732564384.2590	-5.859	0.019	0	
L(=☽ - D)	1006907.669	129602769.0920	1.089	0	0	
π'(=L - *l*')	1012389.654	6186.7500	1.63	0.012	0	
π(=☽ - *l*)	1203585.392	14648524.0540	-36.977	-0.045	0	
J1900(IAU1964 Nutation Model-E.W.Woolard 1953)						
l (=☽ - π)	1065976.59	1717915856.7900	33.09	0.0518	0	
l' (=L- π')	1290513.00	129596579.1000	-0.54	-0.012	0	
F (=☽ - ☊)	40503.20	1739527290.5400	-11.56	-0.0012	0	
D (=☽ - L)	1262654.95	1602961611.1800	-5.17	0.0068	0	
☊	933059.79	-6962911.2300	7.48	0.008	0	
☽ (=F + ☊)	973562.99	1732564379.3100	-4.08	0.0068	0	
L(=☽ - D)	1006908.04	129602768.1300	1.09	0	0	
π'(=L - *l*')	1012395.04	6189.0300	1.63	0.012	0	
π(=☽ - *l*)	1203586.40	14648522.5200	-37.17	-0.045	0	
J1900(Nutation Model-Newcomb)						
l (=☽ - π)	1065976.59	1717915856.7900	33.090	0.0518	0	
l' (=L- π')	1290513.00	129596579.1000	-0.540	-0.0120	0	
F (=☽ - ☊)	40517.60	1739527290.5400	-11.560	-0.0012	0	
D (=☽ - L)	1262666.68	1602961643.0700	8.001	0.0068	0	
☊	933057.12	-6962912.6300	7.580	0.0080	0	
☽ (=F + ☊)	973574.72	1732564411.2000	9.090	0.0068	0	
L(=☽ - D)	1006908.04	129602768.1300	1.089	0.0000	0	
π'(=L - *l*')	1012395.00	6189.0300	1.630	0.0120	0	
π(=☽ - *l*)	1203580.87	14648515.9400	-37.240	-0.0450	0	

Note:

1. All the above equation gives respective fundamental argument values in Seconds.
2. For Example, mean anomaly of the Moon *l*(T) from J1900 (NewComb's Nutation Model) is given by

$$l(\mathrm{T}) = 1065976.59 + 17179158567900 * \mathrm{T} + 33.090 * \mathrm{T}^2 + 0.0518 * \mathrm{T}^3 + 0.0000 * \mathrm{T}^4$$

Table 4: Coefficient of the Fundamental Arguments (With Ref. B1900 & 'T' in Tropical century)

Argument	C_0	C_1	C_2	C_3	C_4	Remarks
B1900(Derived from IAU 2000A Nutation Model)						
l (=☽ - π)	1080722.949729	1717879167.3835	31.72147	0.05261042	-0.00024468	
l' (=L- π')	1291635.611053	129593814.1568	-0.55365	0.00018195	-0.00001149	
F (=☽ - ☊)	55435.525678	1739490134.5253	-12.7475	-0.00105361	0.00000417	
D (=☽ - L)	1276412.474755	1602927376.9964	-6.3903	0.00671933	-0.00003169	
☊	932998.638015	-6962756.7463	7.44842	0.00793905	-0.00005938	
☽ (=F + ☊)	988434.163693	1732527377.7790	-5.2991	0.00688544	-0.00005522	
L(=☽ - D)	1008021.688938	129600000.7826	1.091196	0.00016611	-0.00002353	
π'(=L - *l'*)	1012386.077886	6186.6257	1.644849	-0.00001584	-0.00001204	
π(=☽ - *l*)	1203711.213964	14648210.3954	-37.0206	-0.04572498	0.00018946	
B1900(Derived from IAU 1980 Nutation Model)						
l (=☽ - π)	1080721.437178	1717879167.9732	31.11667	0.0639959	0	
l' (=L- π')	1291630.434452	129593814.3439	-0.54098	-0.01199923	0	
F (=☽ - ☊)	55434.069416	1739490135.8622	-13.2894	0.0109993	0	
D (=☽ - L)	1276412.426299	1602927378.1933	-6.9477	0.01899878	0	
☊	932998.498441	-6962756.7071	7.430683	0.00799949	0	
☽ (=F + ☊)	988432.567857	1732527379.1550	-5.85875	0.01899878	0	
L(=☽ - D)	1008020.141557	129600000.9617	1.088953	0	0	
π'(=L - *l'*)	1012389.707105	6186.6179	1.629931	0.01199923	0	
π(=☽ - *l*)	1203711.130679	14648211.1818	-36.9754	-0.04499712	0	
B1900(Derived from IAU1964 Nutation Model-E.W.Woolard 1953)						
l (=☽ - π)	1080722.681148	1717879164.5583	33.08859	0.05179668	0	
l' (=L- π')	1291625.419424	129593811.1019	-0.53998	-0.01199923	0	
F (=☽ - ☊)	55434.797423	1739490136.7182	-11.5595	-0.00119992	0	
D (=☽ - L)	1276414.307265	1602927374.2064	-5.16978	0.00679956	0	
☊	933000.022391	-6962762.5120	7.479681	0.00799949	0	
☽ (=F + ☊)	988434.819814	1732527374.2062	-4.07983	0.00679956	0	
L(=☽ - D)	1008020.512549	129599999.9998	1.089953	0	0	
π'(=L - *l'*)	1012395.093125	6188.8978	1.629931	0.01199923	0	
π(=☽ - *l*)	1203712.138666	14648209.6478	-37.1684	-0.04499712	0	
B1900(Derived from Nutation Model-Newcomb)						
l (=☽ - π)	1080722.681148	1717879164.5583	33.08859	0.05179668	0	
l' (=L- π')	1291625.419424	129593811.1019	-0.53998	-0.01199923	0	
F (=☽ - ☊)	55449.197423	1739490136.7182	-11.55951	-0.00119992	0	
D (=☽ - L)	1276426.037539	1602927406.0959	8.00066	0.00679956	0	
☊	932997.352379	-6962763.9120	7.57968	0.00799949	0	
☽ (=F + ☊)	988446.550087	1732527406.0957	9.08961	0.00679956	0	
L(=☽ - D)	1008020.512549	129599999.9998	1.08895	0.00000000	0	
π'(=L - *l'*)	1012395.053125	6188.8978	1.62993	0.01199923	0	
π(=☽ - *l*)	1203706.608610	14648203.0680	-37.23841	-0.04499712	0	

Note:

1. All the above equation gives respective fundamental argument values in Seconds.
2. For Example, mean anomaly of the Moon *l*(T) from B1900 (NewComb's Nutation Model) is given by
   $l(\mathrm{T}) = 1080722.681148 + 17178791645583 * \mathrm{T} + 33.08859 * \mathrm{T}^2 + 0.05179668 * \mathrm{T}^3 + 0.0000 * \mathrm{T}^4$

7.6.1 Comparison of Fundamental arguments of Nutation Models (Ref. to J2000 Epoch)

The recent Nutation Model IAU2000A (with Reference to J2000 Epoch) is compared with other Nutation Models and the differences in Coefficient Values are tabulated below.

Table 5: Differences in Coefficient Values of the Fundamental Arguments (Ref. J2000 Epoch)

δ**Argument**	**A_0**	**A_1**	**A_2**	**A_3**	**A_4**	**Remarks**
J2000(IAU 2000A Nutation Model)-J2000(IAU 1980 Nutation Model)						Chart 2
δ*l*	1.516036	0.5848	0.5692	-0.012365	-0.00024470	(1)
δ*l*'	4.989050	-0.1759	0.0238	0.012136	-0.00001149	(2)
δF	0.649232	-0.2892	0.5058	-0.012037	0.00000417	(3)
δD	-0.603310	-0.1190	0.5204	-0.012407	-0.00003169	(4)
δ☊	0.118036	-0.0041	0.0172	-0.000298	-0.00005939	(5)
δ☽	0.767268	-0.2933	0.5230	-0.012335	-0.00005522	(6)
δL	1.370578	-0.1743	0.0026	0.000072	-0.00002353	(7)
δπ'	-3.618472	0.0016	-0.0212	-0.012064	-0.00001204	(8)
δπ	-0.748768	-0.8781	-0.0462	0.000030	0.00018948	(9)
J2000(IAU 2000A Nutation Model)-J2000(Derived from IAU1964 Nutation Model-E.W.Woolard 1953)						Chart 3
δ*l*	1.727236	0.0924	-1.3662	-0.000165	-0.00024470	(1)
δ*l*'	13.245050	3.0641	0.0228	0.012136	-0.00001149	(2)
δF	-2.652568	-4.5686	-1.1876	0.000163	0.00000417	(3)
δD	-0.263110	0.3486	-1.2210	-0.000207	-0.00003169	(4)
δ☊	4.350036	5.7029	-0.0318	-0.000298	-0.00005939	(5)
δ☽	1.697468	1.1343	-1.2194	-0.000135	-0.00005522	(6)
δL	1.960578	0.7857	0.0016	0.000072	-0.00002353	(7)
δπ'	-11.284472	-2.2784	-0.0212	-0.012064	-0.00001204	(8)
δπ	-0.029768	1.0419	0.1468	0.000030	0.00018948	(9)
J2000(IAU 2000A Nutation Model)-J2000(Derived from Nutation Model-Newcomb)						Chart 4
δ*l*	1.727236	0.0924	-1.3662	-0.000165	-0.00024470	(1)
δ*l*'	13.245050	3.0641	0.0228	0.012136	-0.00001149	(2)
δF	-17.052568	-4.5686	-1.1876	0.000163	0.00000417	(3)
δD	-57.054110	-57.8834	-14.3920	-0.000207	-0.00003169	(4)
δ☊	8.320036	6.9029	-0.1318	-0.000298	-0.00005939	(5)
δ☽	-55.092532	-57.0957	-14.3894	-0.000135	-0.00005522	(6)
δL	1.961578	0.7877	0.0026	0.000072	-0.00002353	(7)
δπ'	-11.244472	-2.2784	-0.0212	-0.012064	-0.00001204	(8)
δπ	12.150232	7.7619	0.2168	0.000030	0.00018948	(9)

Using the above differences in Coefficient Values each Argument's element value in seconds is calculated for the Julian Year 1800 to 2500 and plotted in a Graph to see the change in the values over a period of time and the findings are discussed further below.

Table 6: Chart2: J2000(IAU 2000A Nutation Model) - J2000(IAU 1980 Nutation Model)

Julian Year	'T' in Julian Centuries	δ*l* (1)	δ*l'* (2)	δF (3)	δD (4)	δ☊ (5)	δ☽ (6)	δL (7)	δπ' (8)	δπ (9)
1800.000	-2	2.718	5.339	3.347	1.815	0.196	3.544	1.729	-3.610	0.825
1805.000	-1.95	2.628	5.332	3.226	1.699	0.193	3.419	1.719	-3.613	0.790
1810.000	-1.9	2.541	5.326	3.107	1.586	0.189	3.296	1.710	-3.615	0.755
1815.000	-1.85	2.458	5.319	2.992	1.476	0.186	3.177	1.701	-3.618	0.720
1820.000	-1.8	2.377	5.312	2.879	1.369	0.182	3.061	1.692	-3.620	0.684
1825.000	-1.75	2.300	5.305	2.769	1.265	0.179	2.948	1.683	-3.622	0.648
1830.000	-1.7	2.226	5.297	2.662	1.164	0.176	2.837	1.674	-3.623	0.612
1835.000	-1.65	2.154	5.289	2.558	1.065	0.173	2.730	1.665	-3.625	0.576
1840.000	-1.6	2.087	5.282	2.456	0.970	0.169	2.626	1.656	-3.626	0.539
1845.000	-1.55	2.022	5.274	2.358	0.877	0.166	2.524	1.647	-3.627	0.502
1850.000	-1.5	1.960	5.265	2.262	0.788	0.164	2.425	1.638	-3.628	0.465
1855.000	-1.45	1.901	5.257	2.169	0.701	0.161	2.330	1.628	-3.629	0.428
1860.000	-1.4	1.846	5.249	2.079	0.617	0.158	2.237	1.619	-3.629	0.391
1865.000	-1.35	1.794	5.240	1.991	0.536	0.155	2.147	1.610	-3.630	0.353
1870.000	-1.3	1.744	5.231	1.906	0.458	0.153	2.059	1.601	-3.630	0.315
1875.000	-1.25	1.698	5.222	1.825	0.383	0.150	1.975	1.592	-3.630	0.277
1880.000	-1.2	1.655	5.213	1.745	0.310	0.148	1.894	1.583	-3.630	0.239
1885.000	-1.15	1.615	5.204	1.669	0.241	0.146	1.815	1.574	-3.630	0.200
1890.000	-1.1	1.578	5.195	1.595	0.174	0.144	1.739	1.565	-3.630	0.161
1895.000	-1.05	1.544	5.186	1.524	0.110	0.142	1.666	1.556	-3.630	0.122
1900.000	-1	1.513	5.177	1.456	0.048	0.140	1.596	1.547	-3.629	0.083
1905.000	-0.95	1.485	5.167	1.391	-0.010	0.138	1.528	1.538	-3.629	0.044
1910.000	-0.9	1.460	5.158	1.328	-0.066	0.136	1.464	1.529	-3.628	0.004
1915.000	-0.85	1.438	5.148	1.268	-0.119	0.134	1.402	1.521	-3.628	-0.036
1920.000	-0.8	1.419	5.139	1.210	-0.169	0.132	1.343	1.512	-3.627	-0.076
1925.000	-0.75	1.403	5.129	1.156	-0.216	0.131	1.287	1.503	-3.627	-0.116
1930.000	-0.7	1.390	5.120	1.104	-0.261	0.129	1.233	1.494	-3.626	-0.157
1935.000	-0.65	1.380	5.110	1.054	-0.303	0.128	1.182	1.485	-3.625	-0.197
1940.000	-0.6	1.373	5.101	1.007	-0.342	0.127	1.134	1.476	-3.624	-0.239
1945.000	-0.55	1.369	5.091	0.963	-0.378	0.126	1.089	1.467	-3.624	-0.280
1950.000	-0.5	1.367	5.081	0.922	-0.412	0.124	1.046	1.458	-3.623	-0.321
1955.000	-0.45	1.369	5.072	0.883	-0.443	0.123	1.006	1.450	-3.622	-0.363
1960.000	-0.4	1.374	5.062	0.847	-0.472	0.122	0.969	1.441	-3.622	-0.405
1965.000	-0.35	1.382	5.053	0.813	-0.497	0.122	0.935	1.432	-3.621	-0.447
1970.000	-0.3	1.392	5.044	0.782	-0.520	0.121	0.903	1.423	-3.621	-0.489
1975.000	-0.25	1.406	5.034	0.753	-0.541	0.120	0.873	1.414	-3.620	-0.532
1980.000	-0.2	1.422	5.025	0.727	-0.559	0.120	0.847	1.406	-3.620	-0.575
1985.000	-0.15	1.441	5.016	0.704	-0.574	0.119	0.823	1.397	-3.619	-0.618
1990.000	-0.1	1.463	5.007	0.683	-0.586	0.119	0.802	1.388	-3.619	-0.661
1995.000	-0.05	1.488	4.998	0.665	-0.596	0.118	0.783	1.379	-3.619	-0.705
2000.000	0	1.516	4.989	0.649	-0.603	0.118	0.767	1.371	-3.618	-0.749
2005.000	0.05	1.547	4.980	0.636	-0.608	0.118	0.754	1.362	-3.618	-0.793
2010.000	0.1	1.580	4.972	0.625	-0.610	0.118	0.743	1.353	-3.619	-0.837
2015.000	0.15	1.617	4.963	0.617	-0.609	0.118	0.735	1.344	-3.619	-0.882
2020.000	0.2	1.656	4.955	0.612	-0.606	0.118	0.729	1.336	-3.619	-0.926
2025.000	0.25	1.698	4.947	0.608	-0.601	0.118	0.726	1.327	-3.620	-0.971
2030.000	0.3	1.742	4.939	0.608	-0.593	0.118	0.726	1.319	-3.620	-1.016
2035.000	0.35	1.790	4.931	0.609	-0.582	0.119	0.728	1.310	-3.621	-1.062

Julian Year	'T' in Julian Centuries	δ*l* (1)	δ*l*' (2)	δF (3)	δD (4)	δ☊ (5)	δ☽ (6)	δL (7)	δπ' (8)	δπ (9)
2040.000	0.4	1.840	4.923	0.614	-0.568	0.119	0.733	1.301	-3.622	-1.107
2045.000	0.45	1.893	4.916	0.620	-0.553	0.120	0.740	1.293	-3.623	-1.153
2050.000	0.5	1.949	4.909	0.630	-0.534	0.120	0.750	1.284	-3.624	-1.199
2055.000	0.55	2.008	4.902	0.641	-0.513	0.121	0.762	1.276	-3.626	-1.246
2060.000	0.6	2.069	4.895	0.655	-0.490	0.122	0.777	1.267	-3.628	-1.292
2065.000	0.65	2.133	4.888	0.672	-0.464	0.123	0.794	1.258	-3.630	-1.339
2070.000	0.7	2.200	4.882	0.691	-0.436	0.123	0.814	1.250	-3.632	-1.386
2075.000	0.75	2.270	4.876	0.712	-0.405	0.124	0.836	1.241	-3.634	-1.433
2080.000	0.8	2.342	4.870	0.735	-0.372	0.126	0.861	1.233	-3.637	-1.481
2085.000	0.85	2.417	4.864	0.761	-0.336	0.127	0.888	1.224	-3.640	-1.528
2090.000	0.9	2.494	4.859	0.790	-0.298	0.128	0.918	1.216	-3.643	-1.576
2095.000	0.95	2.574	4.854	0.821	-0.257	0.129	0.950	1.207	-3.646	-1.624
2100.000	1	2.657	4.849	0.854	-0.214	0.131	0.985	1.199	-3.650	-1.673
2105.000	1.05	2.743	4.845	0.889	-0.169	0.132	1.022	1.190	-3.654	-1.721
2110.000	1.1	2.831	4.840	0.927	-0.121	0.134	1.061	1.182	-3.658	-1.770
2115.000	1.15	2.922	4.837	0.967	-0.071	0.136	1.103	1.174	-3.663	-1.819
2120.000	1.2	3.016	4.833	1.010	-0.018	0.137	1.147	1.165	-3.668	-1.869
2125.000	1.25	3.112	4.830	1.055	0.037	0.139	1.194	1.157	-3.673	-1.918
2130.000	1.3	3.210	4.827	1.102	0.094	0.141	1.243	1.148	-3.679	-1.968
2135.000	1.35	3.312	4.825	1.151	0.154	0.143	1.294	1.140	-3.685	-2.018
2140.000	1.4	3.416	4.823	1.203	0.216	0.145	1.348	1.132	-3.691	-2.068
2145.000	1.45	3.522	4.821	1.257	0.280	0.147	1.404	1.123	-3.698	-2.118
2150.000	1.5	3.631	4.820	1.313	0.347	0.149	1.462	1.115	-3.705	-2.169
2155.000	1.55	3.743	4.819	1.371	0.416	0.152	1.523	1.107	-3.712	-2.220
2160.000	1.6	3.857	4.818	1.432	0.487	0.154	1.586	1.098	-3.720	-2.271
2165.000	1.65	3.973	4.818	1.495	0.561	0.156	1.651	1.090	-3.728	-2.322
2170.000	1.7	4.092	4.818	1.560	0.637	0.159	1.719	1.082	-3.736	-2.373
2175.000	1.75	4.214	4.819	1.628	0.715	0.161	1.789	1.074	-3.745	-2.425
2180.000	1.8	4.338	4.820	1.697	0.796	0.164	1.861	1.065	-3.755	-2.477
2185.000	1.85	4.465	4.822	1.769	0.879	0.167	1.936	1.057	-3.765	-2.529
2190.000	1.9	4.594	4.824	1.843	0.964	0.170	2.013	1.049	-3.775	-2.581
2195.000	1.95	4.726	4.826	1.919	1.051	0.172	2.092	1.041	-3.786	-2.634
2200.000	2	4.860	4.829	1.998	1.141	0.175	2.173	1.033	-3.797	-2.686
2205.000	2.05	4.996	4.833	2.078	1.232	0.178	2.257	1.024	-3.808	-2.739
2210.000	2.1	5.135	4.837	2.161	1.326	0.181	2.342	1.016	-3.821	-2.793
2215.000	2.15	5.276	4.841	2.246	1.422	0.184	2.430	1.008	-3.833	-2.846
2220.000	2.2	5.420	4.846	2.333	1.521	0.188	2.521	1.000	-3.846	-2.899
2225.000	2.25	5.566	4.852	2.422	1.621	0.191	2.613	0.992	-3.860	-2.953
2230.000	2.3	5.715	4.858	2.513	1.724	0.194	2.708	0.984	-3.874	-3.007
2235.000	2.35	5.866	4.864	2.607	1.829	0.198	2.805	0.976	-3.889	-3.061
2240.000	2.4	6.019	4.871	2.702	1.936	0.201	2.903	0.967	-3.904	-3.116
2245.000	2.45	6.175	4.879	2.800	2.045	0.205	3.005	0.959	-3.920	-3.170
2250.000	2.5	6.333	4.887	2.900	2.157	0.208	3.108	0.951	-3.936	-3.225
2255.000	2.55	6.493	4.896	3.001	2.270	0.212	3.213	0.943	-3.953	-3.280
2260.000	2.6	6.656	4.905	3.105	2.386	0.216	3.321	0.935	-3.970	-3.335
2265.000	2.65	6.821	4.915	3.211	2.503	0.219	3.431	0.927	-3.988	-3.390
2270.000	2.7	6.988	4.926	3.319	2.623	0.223	3.542	0.919	-4.007	-3.446
2275.000	2.75	7.158	4.937	3.429	2.745	0.227	3.656	0.911	-4.026	-3.501
2280.000	2.8	7.330	4.949	3.541	2.869	0.231	3.772	0.903	-4.046	-3.557

Julian Year	**'T' in Julian Centuries**	**δ*l* (1)**	**δ*l'* (2)**	**δF (3)**	**δD (4)**	**δ☊ (5)**	**δ☽ (6)**	**δL (7)**	**δπ' (8)**	**δπ (9)**
2285.000	2.85	7.504	4.961	3.655	2.995	0.235	3.890	0.895	-4.066	-3.613
2290.000	2.9	7.680	4.974	3.771	3.123	0.239	4.010	0.887	-4.087	-3.670
2295.000	2.95	7.859	4.988	3.889	3.254	0.243	4.133	0.879	-4.109	-3.726
2300.000	3	8.040	5.002	4.009	3.386	0.248	4.257	0.871	-4.131	-3.783
2305.000	3.05	8.223	5.017	4.131	3.520	0.252	4.383	0.863	-4.154	-3.840
2310.000	3.1	8.408	5.033	4.255	3.656	0.256	4.511	0.855	-4.178	-3.896
2315.000	3.15	8.595	5.049	4.381	3.795	0.261	4.642	0.847	-4.202	-3.954
2320.000	3.2	8.785	5.066	4.509	3.935	0.265	4.774	0.839	-4.227	-4.011
2325.000	3.25	8.977	5.084	4.639	4.077	0.270	4.909	0.831	-4.253	-4.068
2330.000	3.3	9.171	5.103	4.771	4.222	0.274	5.045	0.823	-4.279	-4.126
2335.000	3.35	9.367	5.122	4.905	4.368	0.279	5.183	0.816	-4.306	-4.184
2340.000	3.4	9.566	5.142	5.040	4.516	0.283	5.324	0.808	-4.334	-4.242
2345.000	3.45	9.766	5.162	5.178	4.666	0.288	5.466	0.800	-4.362	-4.300
2350.000	3.5	9.969	5.184	5.318	4.818	0.293	5.610	0.792	-4.392	-4.358
2355.000	3.55	10.173	5.206	5.459	4.972	0.297	5.757	0.784	-4.422	-4.417
2360.000	3.6	10.380	5.229	5.602	5.128	0.302	5.905	0.776	-4.452	-4.475
2365.000	3.65	10.589	5.252	5.748	5.286	0.307	6.055	0.768	-4.484	-4.534
2370.000	3.7	10.800	5.277	5.895	5.446	0.312	6.207	0.760	-4.516	-4.593
2375.000	3.75	11.013	5.302	6.044	5.608	0.317	6.361	0.753	-4.549	-4.652
2380.000	3.8	11.228	5.328	6.194	5.772	0.322	6.516	0.745	-4.583	-4.712
2385.000	3.85	11.445	5.355	6.347	5.937	0.327	6.674	0.737	-4.618	-4.771
2390.000	3.9	11.664	5.382	6.502	6.105	0.332	6.834	0.729	-4.653	-4.830
2395.000	3.95	11.885	5.411	6.658	6.274	0.337	6.995	0.721	-4.689	-4.890
2400.000	4	12.108	5.440	6.816	6.445	0.343	7.158	0.714	-4.726	-4.950
2405.000	4.05	12.334	5.470	6.976	6.618	0.348	7.324	0.706	-4.764	-5.010
2410.000	4.1	12.561	5.501	7.138	6.793	0.353	7.491	0.698	-4.803	-5.070
2415.000	4.15	12.790	5.533	7.301	6.969	0.358	7.659	0.690	-4.843	-5.130
2420.000	4.2	13.021	5.566	7.466	7.148	0.364	7.830	0.682	-4.883	-5.191
2425.000	4.25	13.254	5.599	7.633	7.328	0.369	8.003	0.675	-4.925	-5.251
2430.000	4.3	13.488	5.634	7.802	7.510	0.374	8.177	0.667	-4.967	-5.312
2435.000	4.35	13.725	5.669	7.973	7.694	0.380	8.353	0.659	-5.010	-5.372
2440.000	4.4	13.964	5.705	8.145	7.879	0.385	8.531	0.651	-5.054	-5.433
2445.000	4.45	14.204	5.743	8.319	8.067	0.391	8.710	0.644	-5.099	-5.494
2450.000	4.5	14.447	5.781	8.495	8.256	0.396	8.891	0.636	-5.145	-5.555
2455.000	4.55	14.691	5.820	8.673	8.447	0.402	9.075	0.628	-5.192	-5.617
2460.000	4.6	14.937	5.860	8.852	8.639	0.408	9.259	0.620	-5.239	-5.678
2465.000	4.65	15.185	5.901	9.033	8.833	0.413	9.446	0.613	-5.288	-5.739
2470.000	4.7	15.435	5.942	9.215	9.029	0.419	9.634	0.605	-5.338	-5.801
2475.000	4.75	15.687	5.985	9.400	9.227	0.424	9.824	0.597	-5.388	-5.862
2480.000	4.8	15.940	6.029	9.586	9.427	0.430	10.016	0.589	-5.440	-5.924
2485.000	4.85	16.195	6.074	9.773	9.628	0.436	10.209	0.582	-5.492	-5.986
2490.000	4.9	16.452	6.120	9.963	9.830	0.442	10.404	0.574	-5.546	-6.048
2495.000	4.95	16.711	6.167	10.154	10.035	0.447	10.601	0.566	-5.600	-6.110
2500.000	5	16.971	6.214	10.346	10.241	0.453	10.799	0.558	-5.656	-6.172
	Max	**16.971**	**6.214**	**10.346**	**10.241**	**0.453**	**10.799**	**1.729**	**-3.610**	**0.825**
	Min	**1.367**	**4.818**	**0.608**	**-0.610**	**0.118**	**0.726**	**0.558**	**-5.656**	**-6.172**

Table 7:Chart3: J2000(IAU 2000A Nutation Model) - J2000(Derived from IAU1964 Nutation Model-E.W.Woolard 1953)

Julian Year	'T' in Julian Centuries	δ*l* (1)	δ*l'* (2)	δF (3)	δD (4)	δ☊ (5)	δ☽ (6)	δL (7)	δπ' (8)	δπ (9)
1800.000	-2	-3.925	7.111	1.733	-5.843	-7.182	-5.449	0.395	-6.716	-1.524
1805.000	-1.95	-3.650	7.267	1.739	-5.585	-6.890	-5.151	0.434	-6.833	-1.501
1810.000	-1.9	-3.382	7.422	1.739	-5.332	-6.599	-4.860	0.473	-6.949	-1.477
1815.000	-1.85	-3.121	7.578	1.734	-5.086	-6.308	-4.574	0.512	-7.066	-1.453
1820.000	-1.8	-2.867	7.733	1.722	-4.846	-6.017	-4.295	0.551	-7.182	-1.428
1825.000	-1.75	-2.620	7.888	1.705	-4.612	-5.726	-4.022	0.590	-7.298	-1.402
1830.000	-1.7	-2.379	8.042	1.681	-4.384	-5.436	-3.755	0.629	-7.413	-1.375
1835.000	-1.65	-2.146	8.197	1.652	-4.162	-5.145	-3.494	0.668	-7.529	-1.348
1840.000	-1.6	-1.919	8.351	1.616	-3.946	-4.855	-3.239	0.707	-7.644	-1.320
1845.000	-1.55	-1.699	8.505	1.575	-3.736	-4.565	-2.990	0.746	-7.759	-1.291
1850.000	-1.5	-1.486	8.659	1.528	-3.533	-4.275	-2.747	0.785	-7.874	-1.261
1855.000	-1.45	-1.280	8.813	1.474	-3.335	-3.985	-2.511	0.824	-7.989	-1.231
1860.000	-1.4	-1.080	8.967	1.415	-3.144	-3.696	-2.280	0.863	-8.103	-1.200
1865.000	-1.35	-0.888	9.120	1.350	-2.959	-3.406	-2.056	0.903	-8.218	-1.168
1870.000	-1.3	-0.702	9.274	1.279	-2.779	-3.117	-1.838	0.942	-8.332	-1.136
1875.000	-1.25	-0.523	9.427	1.202	-2.606	-2.828	-1.626	0.981	-8.446	-1.102
1880.000	-1.2	-0.351	9.580	1.119	-2.439	-2.539	-1.420	1.020	-8.560	-1.068
1885.000	-1.15	-0.186	9.733	1.030	-2.279	-2.250	-1.220	1.059	-8.674	-1.034
1890.000	-1.1	-0.028	9.886	0.936	-2.124	-1.961	-1.026	1.098	-8.788	-0.998
1895.000	-1.05	0.124	10.039	0.835	-1.975	-1.673	-0.838	1.137	-8.902	-0.962
1900.000	-1	0.269	10.192	0.728	-1.833	-1.384	-0.656	1.176	-9.015	-0.925
1905.000	-0.95	0.406	10.344	0.616	-1.696	-1.096	-0.481	1.216	-9.129	-0.887
1910.000	-0.9	0.537	10.497	0.497	-1.566	-0.808	-0.311	1.255	-9.242	-0.848
1915.000	-0.85	0.662	10.650	0.373	-1.441	-0.520	-0.148	1.294	-9.356	-0.809
1920.000	-0.8	0.779	10.802	0.242	-1.323	-0.233	0.010	1.333	-9.469	-0.769
1925.000	-0.75	0.889	10.955	0.106	-1.211	0.055	0.161	1.372	-9.583	-0.729
1930.000	-0.7	0.993	11.107	-0.037	-1.105	0.343	0.306	1.411	-9.696	-0.687
1935.000	-0.65	1.090	11.260	-0.185	-1.006	0.630	0.445	1.451	-9.809	-0.645
1940.000	-0.6	1.180	11.412	-0.339	-0.912	0.917	0.578	1.490	-9.922	-0.602
1945.000	-0.55	1.263	11.565	-0.499	-0.824	1.204	0.705	1.529	-10.036	-0.558
1950.000	-0.5	1.339	11.717	-0.665	-0.743	1.491	0.825	1.568	-10.149	-0.514
1955.000	-0.45	1.409	11.870	-0.837	-0.667	1.777	0.940	1.607	-10.262	-0.469
1960.000	-0.4	1.472	12.022	-1.015	-0.598	2.064	1.049	1.647	-10.376	-0.423
1965.000	-0.35	1.528	12.175	-1.199	-0.535	2.350	1.151	1.686	-10.489	-0.376
1970.000	-0.3	1.577	12.328	-1.389	-0.478	2.636	1.247	1.725	-10.603	-0.329
1975.000	-0.25	1.619	12.480	-1.585	-0.427	2.922	1.338	1.764	-10.716	-0.281
1980.000	-0.2	1.654	12.633	-1.786	-0.382	3.208	1.422	1.804	-10.830	-0.232
1985.000	-0.15	1.683	12.786	-1.994	-0.343	3.494	1.500	1.843	-10.943	-0.183
1990.000	-0.1	1.704	12.939	-2.208	-0.310	3.779	1.572	1.882	-11.057	-0.132
1995.000	-0.05	1.719	13.092	-2.427	-0.284	4.065	1.638	1.921	-11.171	-0.081
2000.000	0	1.727	13.245	-2.653	-0.263	4.350	1.697	1.961	-11.284	-0.030
2005.000	0.05	1.728	13.398	-2.884	-0.249	4.635	1.751	2.000	-11.398	0.023
2010.000	0.1	1.723	13.552	-3.121	-0.240	4.920	1.799	2.039	-11.513	0.076
2015.000	0.15	1.710	13.705	-3.365	-0.238	5.205	1.840	2.078	-11.627	0.130
2020.000	0.2	1.691	13.859	-3.614	-0.242	5.489	1.876	2.118	-11.741	0.184
2025.000	0.25	1.665	14.013	-3.869	-0.252	5.774	1.905	2.157	-11.856	0.240
2030.000	0.3	1.632	14.167	-4.130	-0.268	6.058	1.928	2.196	-11.970	0.296
2035.000	0.35	1.592	14.321	-4.397	-0.291	6.342	1.945	2.236	-12.085	0.353

Julian Year	'T' in Julian Centuries	δ*l* (1)	δ*l*' (2)	δF (3)	δD (4)	δ☊ (5)	δ☽ (6)	δL (7)	δπ' (8)	δπ (9)
2040.000	0.4	1.546	14.475	-4.670	-0.319	6.626	1.956	2.275	-12.200	0.410
2045.000	0.45	1.492	14.630	-4.949	-0.354	6.910	1.961	2.314	-12.315	0.469
2050.000	0.5	1.432	14.784	-5.234	-0.394	7.193	1.960	2.354	-12.430	0.528
2055.000	0.55	1.365	14.939	-5.525	-0.441	7.477	1.952	2.393	-12.546	0.588
2060.000	0.6	1.291	15.094	-5.821	-0.494	7.760	1.939	2.433	-12.662	0.648
2065.000	0.65	1.210	15.250	-6.124	-0.552	8.043	1.920	2.472	-12.778	0.710
2070.000	0.7	1.122	15.405	-6.432	-0.617	8.326	1.894	2.511	-12.894	0.772
2075.000	0.75	1.028	15.561	-6.747	-0.689	8.609	1.862	2.551	-13.010	0.834
2080.000	0.8	0.927	15.717	-7.067	-0.766	8.892	1.824	2.590	-13.127	0.898
2085.000	0.85	0.818	15.873	-7.394	-0.849	9.174	1.780	2.630	-13.244	0.962
2090.000	0.9	0.703	16.030	-7.726	-0.939	9.457	1.730	2.669	-13.361	1.027
2095.000	0.95	0.582	16.187	-8.064	-1.034	9.739	1.674	2.708	-13.478	1.093
2100.000	1	0.453	16.344	-8.409	-1.136	10.021	1.612	2.748	-13.596	1.159
2105.000	1.05	0.318	16.502	-8.759	-1.244	10.303	1.544	2.787	-13.714	1.226
2110.000	1.1	0.175	16.659	-9.115	-1.357	10.584	1.469	2.827	-13.832	1.294
2115.000	1.15	0.026	16.817	-9.477	-1.477	10.866	1.389	2.866	-13.951	1.363
2120.000	1.2	-0.130	16.976	-9.845	-1.603	11.147	1.302	2.906	-14.070	1.432
2125.000	1.25	-0.293	17.134	-10.219	-1.736	11.428	1.210	2.945	-14.189	1.503
2130.000	1.3	-0.463	17.294	-10.598	-1.874	11.709	1.111	2.985	-14.309	1.573
2135.000	1.35	-0.639	17.453	-10.984	-2.018	11.990	1.006	3.024	-14.429	1.645
2140.000	1.4	-0.823	17.613	-11.376	-2.169	12.271	0.895	3.064	-14.549	1.717
2145.000	1.45	-1.013	17.773	-11.773	-2.326	12.551	0.778	3.103	-14.670	1.791
2150.000	1.5	-1.210	17.933	-12.177	-2.488	12.832	0.655	3.143	-14.791	1.864
2155.000	1.55	-1.414	18.094	-12.586	-2.657	13.112	0.525	3.182	-14.912	1.939
2160.000	1.6	-1.625	18.256	-13.002	-2.832	13.392	0.390	3.222	-15.034	2.014
2165.000	1.65	-1.842	18.417	-13.423	-3.013	13.671	0.248	3.261	-15.156	2.091
2170.000	1.7	-2.067	18.579	-13.851	-3.200	13.951	0.101	3.301	-15.278	2.167
2175.000	1.75	-2.298	18.742	-14.284	-3.394	14.231	-0.053	3.341	-15.401	2.245
2180.000	1.8	-2.536	18.905	-14.723	-3.593	14.510	-0.213	3.380	-15.525	2.323
2185.000	1.85	-2.782	19.068	-15.168	-3.799	14.789	-0.379	3.420	-15.649	2.403
2190.000	1.9	-3.034	19.232	-15.619	-4.010	15.068	-0.551	3.459	-15.773	2.482
2195.000	1.95	-3.292	19.397	-16.076	-4.228	15.347	-0.729	3.499	-15.898	2.563
2200.000	2	-3.558	19.561	-16.539	-4.452	15.625	-0.913	3.539	-16.023	2.645
2205.000	2.05	-3.831	19.727	-17.008	-4.682	15.904	-1.104	3.578	-16.148	2.727
2210.000	2.1	-4.110	19.892	-17.482	-4.918	16.182	-1.300	3.618	-16.275	2.810
2215.000	2.15	-4.396	20.059	-17.963	-5.160	16.460	-1.503	3.657	-16.401	2.893
2220.000	2.2	-4.689	20.225	-18.450	-5.409	16.738	-1.712	3.697	-16.528	2.978
2225.000	2.25	-4.989	20.393	-18.942	-5.663	17.016	-1.927	3.737	-16.656	3.063
2230.000	2.3	-5.296	20.560	-19.441	-5.924	17.293	-2.147	3.776	-16.784	3.149
2235.000	2.35	-5.610	20.729	-19.945	-6.191	17.571	-2.374	3.816	-16.913	3.236
2240.000	2.4	-5.931	20.898	-20.455	-6.463	17.848	-2.608	3.856	-17.042	3.323
2245.000	2.45	-6.258	21.067	-20.972	-6.742	18.125	-2.847	3.895	-17.172	3.411
2250.000	2.5	-6.593	21.237	-21.494	-7.027	18.402	-3.092	3.935	-17.302	3.500
2255.000	2.55	-6.934	21.408	-22.022	-7.319	18.678	-3.344	3.975	-17.433	3.590
2260.000	2.6	-7.282	21.579	-22.556	-7.616	18.955	-3.601	4.014	-17.564	3.681
2265.000	2.65	-7.637	21.750	-23.096	-7.919	19.231	-3.865	4.054	-17.696	3.772
2270.000	2.7	-7.999	21.923	-23.642	-8.229	19.507	-4.135	4.094	-17.829	3.864
2275.000	2.75	-8.368	22.095	-24.194	-8.544	19.783	-4.411	4.134	-17.962	3.957
2280.000	2.8	-8.744	22.269	-24.752	-8.866	20.059	-4.693	4.173	-18.096	4.051

Julian Year	'T' in Julian Centuries	δ*l* (1)	δ*l'* (2)	δF (3)	δD (4)	δ☊ (5)	δ☽ (6)	δL (7)	δπ' (8)	δπ (9)
2285.000	2.85	-9.126	22.443	-25.315	-9.194	20.334	-4.981	4.213	-18.230	4.145
2290.000	2.9	-9.516	22.618	-25.885	-9.528	20.610	-5.275	4.253	-18.365	4.240
2295.000	2.95	-9.912	22.793	-26.461	-9.868	20.885	-5.576	4.292	-18.501	4.336
2300.000	3	-10.316	22.969	-27.042	-10.214	21.160	-5.882	4.332	-18.637	4.433
2305.000	3.05	-10.726	23.146	-27.629	-10.567	21.434	-6.195	4.372	-18.774	4.531
2310.000	3.1	-11.143	23.323	-28.223	-10.925	21.709	-6.514	4.412	-18.912	4.629
2315.000	3.15	-11.567	23.501	-28.822	-11.290	21.983	-6.839	4.451	-19.050	4.728
2320.000	3.2	-11.998	23.680	-29.427	-11.661	22.258	-7.170	4.491	-19.189	4.828
2325.000	3.25	-12.436	23.860	-30.038	-12.038	22.532	-7.507	4.531	-19.329	4.929
2330.000	3.3	-12.881	24.040	-30.656	-12.421	22.806	-7.850	4.571	-19.469	5.031
2335.000	3.35	-13.332	24.220	-31.279	-12.810	23.079	-8.199	4.610	-19.610	5.133
2340.000	3.4	-13.791	24.402	-31.908	-13.205	23.353	-8.555	4.650	-19.752	5.236
2345.000	3.45	-14.257	24.584	-32.542	-13.606	23.626	-8.916	4.690	-19.894	5.340
2350.000	3.5	-14.729	24.767	-33.183	-14.014	23.899	-9.284	4.730	-20.038	5.445
2355.000	3.55	-15.209	24.951	-33.830	-14.428	24.172	-9.658	4.769	-20.182	5.550
2360.000	3.6	-15.695	25.136	-34.483	-14.847	24.444	-10.038	4.809	-20.326	5.657
2365.000	3.65	-16.188	25.321	-35.141	-15.273	24.717	-10.424	4.849	-20.472	5.764
2370.000	3.7	-16.688	25.507	-35.806	-15.705	24.989	-10.816	4.889	-20.618	5.872
2375.000	3.75	-17.196	25.694	-36.476	-16.143	25.261	-11.215	4.929	-20.765	5.981
2380.000	3.8	-17.710	25.881	-37.152	-16.588	25.533	-11.619	4.968	-20.913	6.090
2385.000	3.85	-18.231	26.070	-37.835	-17.038	25.805	-12.030	5.008	-21.062	6.201
2390.000	3.9	-18.759	26.259	-38.523	-17.495	26.076	-12.447	5.048	-21.211	6.312
2395.000	3.95	-19.294	26.449	-39.217	-17.957	26.348	-12.869	5.088	-21.361	6.424
2400.000	4	-19.836	26.640	-39.917	-18.426	26.619	-13.299	5.128	-21.512	6.537
2405.000	4.05	-20.384	26.832	-40.623	-18.901	26.889	-13.734	5.167	-21.664	6.651
2410.000	4.1	-20.940	27.024	-41.335	-19.382	27.160	-14.175	5.207	-21.817	6.765
2415.000	4.15	-21.503	27.218	-42.053	-19.869	27.430	-14.622	5.247	-21.971	6.881
2420.000	4.2	-22.073	27.412	-42.777	-20.363	27.701	-15.076	5.287	-22.125	6.997
2425.000	4.25	-22.650	27.607	-43.506	-20.862	27.971	-15.536	5.327	-22.281	7.114
2430.000	4.3	-23.233	27.803	-44.242	-21.368	28.241	-16.001	5.366	-22.437	7.232
2435.000	4.35	-23.824	28.000	-44.983	-21.879	28.510	-16.473	5.406	-22.594	7.351
2440.000	4.4	-24.422	28.198	-45.731	-22.397	28.780	-16.951	5.446	-22.752	7.470
2445.000	4.45	-25.026	28.397	-46.484	-22.921	29.049	-17.436	5.486	-22.911	7.591
2450.000	4.5	-25.638	28.596	-47.244	-23.452	29.318	-17.926	5.526	-23.071	7.712
2455.000	4.55	-26.257	28.797	-48.009	-23.988	29.586	-18.422	5.565	-23.232	7.834
2460.000	4.6	-26.882	28.998	-48.780	-24.530	29.855	-18.925	5.605	-23.393	7.957
2465.000	4.65	-27.515	29.201	-49.557	-25.079	30.123	-19.434	5.645	-23.556	8.081
2470.000	4.7	-28.154	29.404	-50.340	-25.634	30.391	-19.949	5.685	-23.720	8.206
2475.000	4.75	-28.801	29.609	-51.129	-26.194	30.659	-20.470	5.724	-23.884	8.331
2480.000	4.8	-29.455	29.814	-51.924	-26.761	30.927	-20.997	5.764	-24.050	8.458
2485.000	4.85	-30.115	30.020	-52.725	-27.335	31.194	-21.530	5.804	-24.216	8.585
2490.000	4.9	-30.783	30.228	-53.531	-27.914	31.461	-22.070	5.844	-24.384	8.713
2495.000	4.95	-31.458	30.436	-54.344	-28.499	31.728	-22.616	5.884	-24.552	8.842
2500.000	5	-32.139	30.645	-55.163	-29.091	31.995	-23.167	5.923	-24.722	8.972
	Max	**1.728**	**30.645**	**1.739**	**-0.238**	**31.995**	**1.961**	**5.923**	**-6.716**	**8.972**
	Min	**-32.139**	**7.111**	**-55.163**	**-29.091**	**-7.182**	**-23.167**	**0.395**	**-24.722**	**-1.524**

Table 8: Chart4: J2000(IAU 2000A Nutation Model) - J2000(Derived from Nutation Model-Newcomb)

Julian Year	'T' in Julian Centuries	δ*l* (1)	δ*l'* (2)	δF (3)	δD (4)	δ☊ (5)	δ☽ (6)	δL (7)	δπ' (8)	δπ (9)
1800.000	-2	-3.925	7.111	-12.667	1.146	-6.012	1.541	0.396	-6.676	-2.504
1805.000	-1.95	-3.650	7.267	-12.661	1.094	-5.640	1.529	0.435	-6.793	-2.159
1810.000	-1.9	-3.382	7.422	-12.661	0.970	-5.270	1.444	0.474	-6.909	-1.812
1815.000	-1.85	-3.121	7.578	-12.666	0.774	-4.900	1.287	0.513	-7.026	-1.465
1820.000	-1.8	-2.867	7.733	-12.678	0.507	-4.531	1.058	0.551	-7.142	-1.117
1825.000	-1.75	-2.620	7.888	-12.695	0.167	-4.163	0.758	0.590	-7.258	-0.768
1830.000	-1.7	-2.379	8.042	-12.719	-0.244	-3.795	0.385	0.629	-7.373	-0.417
1835.000	-1.65	-2.146	8.197	-12.748	-0.728	-3.428	-0.060	0.668	-7.489	-0.065
1840.000	-1.6	-1.919	8.351	-12.784	-1.284	-3.061	-0.576	0.707	-7.604	0.287
1845.000	-1.55	-1.699	8.505	-12.825	-1.911	-2.695	-1.165	0.746	-7.719	0.641
1850.000	-1.5	-1.486	8.659	-12.872	-2.610	-2.330	-1.825	0.786	-7.834	0.996
1855.000	-1.45	-1.280	8.813	-12.926	-3.382	-1.966	-2.557	0.825	-7.949	1.352
1860.000	-1.4	-1.080	8.967	-12.985	-4.225	-1.602	-3.362	0.864	-8.063	1.709
1865.000	-1.35	-0.888	9.120	-13.050	-5.141	-1.239	-4.238	0.903	-8.178	2.067
1870.000	-1.3	-0.702	9.274	-13.121	-6.128	-0.876	-5.186	0.942	-8.292	2.427
1875.000	-1.25	-0.523	9.427	-13.198	-7.187	-0.514	-6.206	0.981	-8.406	2.787
1880.000	-1.2	-0.351	9.580	-13.281	-8.318	-0.153	-7.298	1.020	-8.520	3.148
1885.000	-1.15	-0.186	9.733	-13.370	-9.521	0.208	-8.462	1.059	-8.634	3.511
1890.000	-1.1	-0.028	9.886	-13.464	-10.796	0.568	-9.698	1.098	-8.748	3.875
1895.000	-1.05	0.124	10.039	-13.565	-12.144	0.927	-11.006	1.137	-8.862	4.239
1900.000	-1	0.269	10.192	-13.672	-13.563	1.286	-12.386	1.176	-8.975	4.605
1905.000	-0.95	0.406	10.344	-13.784	-15.054	1.644	-13.838	1.216	-9.089	4.972
1910.000	-0.9	0.537	10.497	-13.903	-16.616	2.001	-15.362	1.255	-9.202	5.340
1915.000	-0.85	0.662	10.650	-14.027	-18.251	2.357	-16.957	1.294	-9.316	5.709
1920.000	-0.8	0.779	10.802	-14.158	-19.958	2.713	-18.625	1.333	-9.429	6.080
1925.000	-0.75	0.889	10.955	-14.294	-21.737	3.069	-20.365	1.372	-9.543	6.451
1930.000	-0.7	0.993	11.107	-14.437	-23.588	3.424	-22.176	1.411	-9.656	6.823
1935.000	-0.65	1.090	11.260	-14.585	-25.510	3.778	-24.060	1.451	-9.769	7.197
1940.000	-0.6	1.180	11.412	-14.739	-27.505	4.131	-26.015	1.490	-9.882	7.571
1945.000	-0.55	1.263	11.565	-14.899	-29.572	4.484	-28.043	1.529	-9.996	7.947
1950.000	-0.5	1.339	11.717	-15.065	-31.710	4.836	-30.142	1.568	-10.109	8.323
1955.000	-0.45	1.409	11.870	-15.237	-33.921	5.187	-32.313	1.608	-10.222	8.701
1960.000	-0.4	1.472	12.022	-15.415	-36.203	5.538	-34.557	1.647	-10.336	9.080
1965.000	-0.35	1.528	12.175	-15.599	-38.558	5.888	-36.872	1.686	-10.449	9.460
1970.000	-0.3	1.577	12.328	-15.789	-40.984	6.237	-39.259	1.725	-10.563	9.841
1975.000	-0.25	1.619	12.480	-15.985	-43.483	6.586	-41.718	1.765	-10.676	10.223
1980.000	-0.2	1.654	12.633	-16.186	-46.053	6.934	-44.249	1.804	-10.790	10.607
1985.000	-0.15	1.683	12.786	-16.394	-48.695	7.282	-46.852	1.843	-10.903	10.991
1990.000	-0.1	1.704	12.939	-16.608	-51.410	7.628	-49.527	1.883	-11.017	11.376
1995.000	-0.05	1.719	13.092	-16.827	-54.196	7.975	-52.274	1.922	-11.131	11.763
2000.000	0	1.727	13.245	-17.053	-57.054	8.320	-55.093	1.962	-11.244	12.150
2005.000	0.05	1.728	13.398	-17.284	-59.984	8.665	-57.983	2.001	-11.358	12.539
2010.000	0.1	1.723	13.552	-17.521	-62.986	9.009	-60.946	2.040	-11.473	12.929
2015.000	0.15	1.710	13.705	-17.765	-66.060	9.353	-63.981	2.080	-11.587	13.319
2020.000	0.2	1.691	13.859	-18.014	-69.206	9.695	-67.087	2.119	-11.701	13.711
2025.000	0.25	1.665	14.013	-18.269	-72.424	10.038	-70.266	2.159	-11.816	14.104
2030.000	0.3	1.632	14.167	-18.530	-75.714	10.379	-73.516	2.198	-11.930	14.498
2035.000	0.35	1.592	14.321	-18.797	-79.076	10.720	-76.839	2.238	-12.045	14.893

Julian Year	'T' in Julian Centuries	δ*l* (1)	δ*l*' (2)	δF (3)	δD (4)	δ☊ (5)	δ☽ (6)	δL (7)	δπ' (8)	δπ (9)
2040.000	0.4	1.546	14.475	-19.070	-82.510	11.060	-80.233	2.277	-12.160	15.290
2045.000	0.45	1.492	14.630	-19.349	-86.016	11.400	-83.699	2.317	-12.275	15.687
2050.000	0.5	1.432	14.784	-19.634	-89.594	11.738	-87.238	2.356	-12.390	16.085
2055.000	0.55	1.365	14.939	-19.925	-93.244	12.077	-90.848	2.396	-12.506	16.485
2060.000	0.6	1.291	15.094	-20.221	-96.965	12.414	-94.530	2.435	-12.622	16.885
2065.000	0.65	1.210	15.250	-20.524	-100.759	12.751	-98.284	2.475	-12.738	17.287
2070.000	0.7	1.122	15.405	-20.832	-104.625	13.087	-102.110	2.514	-12.854	17.690
2075.000	0.75	1.028	15.561	-21.147	-108.562	13.423	-106.008	2.554	-12.970	18.094
2080.000	0.8	0.927	15.717	-21.467	-112.572	13.758	-109.978	2.593	-13.087	18.499
2085.000	0.85	0.818	15.873	-21.794	-116.653	14.092	-114.020	2.633	-13.204	18.905
2090.000	0.9	0.703	16.030	-22.126	-120.807	14.426	-118.134	2.673	-13.321	19.312
2095.000	0.95	0.582	16.187	-22.464	-125.032	14.759	-122.320	2.712	-13.438	19.720
2100.000	1	0.453	16.344	-22.809	-129.330	15.091	-126.578	2.752	-13.556	20.129
2105.000	1.05	0.318	16.502	-23.159	-133.699	15.422	-130.908	2.792	-13.674	20.540
2110.000	1.1	0.175	16.659	-23.515	-138.140	15.753	-135.309	2.831	-13.792	20.951
2115.000	1.15	0.026	16.817	-23.877	-142.654	16.084	-139.783	2.871	-13.911	21.364
2120.000	1.2	-0.130	16.976	-24.245	-147.239	16.413	-144.328	2.911	-14.030	21.777
2125.000	1.25	-0.293	17.134	-24.619	-151.896	16.742	-148.946	2.950	-14.149	22.192
2130.000	1.3	-0.463	17.294	-24.998	-156.626	17.070	-153.635	2.990	-14.269	22.608
2135.000	1.35	-0.639	17.453	-25.384	-161.427	17.398	-158.397	3.030	-14.389	23.025
2140.000	1.4	-0.823	17.613	-25.776	-166.300	17.725	-163.230	3.070	-14.509	23.443
2145.000	1.45	-1.013	17.773	-26.173	-171.245	18.051	-168.136	3.109	-14.630	23.862
2150.000	1.5	-1.210	17.933	-26.577	-176.262	18.377	-173.113	3.149	-14.751	24.282
2155.000	1.55	-1.414	18.094	-26.986	-181.351	18.701	-178.162	3.189	-14.872	24.703
2160.000	1.6	-1.625	18.256	-27.402	-186.512	19.026	-183.283	3.229	-14.994	25.126
2165.000	1.65	-1.842	18.417	-27.823	-191.745	19.349	-188.477	3.269	-15.116	25.549
2170.000	1.7	-2.067	18.579	-28.251	-197.050	19.672	-193.742	3.308	-15.238	25.974
2175.000	1.75	-2.298	18.742	-28.684	-202.427	19.994	-199.079	3.348	-15.361	26.399
2180.000	1.8	-2.536	18.905	-29.123	-207.876	20.316	-204.488	3.388	-15.485	26.826
2185.000	1.85	-2.782	19.068	-29.568	-213.397	20.637	-209.969	3.428	-15.609	27.254
2190.000	1.9	-3.034	19.232	-30.019	-218.990	20.957	-215.522	3.468	-15.733	27.683
2195.000	1.95	-3.292	19.397	-30.476	-224.654	21.276	-221.147	3.508	-15.858	28.113
2200.000	2	-3.558	19.561	-30.939	-230.391	21.595	-226.843	3.548	-15.983	28.545
2205.000	2.05	-3.831	19.727	-31.408	-236.200	21.913	-232.612	3.587	-16.108	28.977
2210.000	2.1	-4.110	19.892	-31.882	-242.081	22.231	-238.453	3.627	-16.235	29.410
2215.000	2.15	-4.396	20.059	-32.363	-248.033	22.548	-244.366	3.667	-16.361	29.845
2220.000	2.2	-4.689	20.225	-32.850	-254.058	22.864	-250.350	3.707	-16.488	30.280
2225.000	2.25	-4.989	20.393	-33.342	-260.154	23.179	-256.407	3.747	-16.616	30.717
2230.000	2.3	-5.296	20.560	-33.841	-266.323	23.494	-262.536	3.787	-16.744	31.155
2235.000	2.35	-5.610	20.729	-34.345	-272.564	23.808	-268.736	3.827	-16.873	31.594
2240.000	2.4	-5.931	20.898	-34.855	-278.876	24.122	-275.009	3.867	-17.002	32.034
2245.000	2.45	-6.258	21.067	-35.372	-285.261	24.434	-281.353	3.907	-17.132	32.475
2250.000	2.5	-6.593	21.237	-35.894	-291.717	24.747	-287.770	3.947	-17.262	32.918
2255.000	2.55	-6.934	21.408	-36.422	-298.246	25.058	-294.258	3.987	-17.393	33.361
2260.000	2.6	-7.282	21.579	-36.956	-304.846	25.369	-300.819	4.027	-17.524	33.806
2265.000	2.65	-7.637	21.750	-37.496	-311.518	25.679	-307.451	4.067	-17.656	34.252
2270.000	2.7	-7.999	21.923	-38.042	-318.263	25.988	-314.155	4.107	-17.789	34.698
2275.000	2.75	-8.368	22.095	-38.594	-325.079	26.297	-320.932	4.148	-17.922	35.146
2280.000	2.8	-8.744	22.269	-39.152	-331.967	26.605	-327.780	4.188	-18.056	35.596

Julian Year	**'T' in Julian Centuries**	**δ*l* (1)**	**δ*l*' (2)**	**δF (3)**	**δD (4)**	**δ☊ (5)**	**δ☽ (6)**	**δL (7)**	**δπ' (8)**	**δπ (9)**
2285.000	2.85	-9.126	22.443	-39.715	-338.928	26.912	-334.700	4.228	-18.190	36.046
2290.000	2.9	-9.516	22.618	-40.285	-345.960	27.219	-341.692	4.268	-18.325	36.497
2295.000	2.95	-9.912	22.793	-40.861	-353.064	27.524	-348.756	4.308	-18.461	36.950
2300.000	3	-10.316	22.969	-41.442	-360.240	27.830	-355.892	4.348	-18.597	37.403
2305.000	3.05	-10.726	23.146	-42.029	-367.489	28.134	-363.100	4.388	-18.734	37.858
2310.000	3.1	-11.143	23.323	-42.623	-374.809	28.438	-370.380	4.428	-18.872	38.314
2315.000	3.15	-11.567	23.501	-43.222	-382.201	28.741	-377.732	4.469	-19.010	38.771
2320.000	3.2	-11.998	23.680	-43.827	-389.665	29.044	-385.156	4.509	-19.149	39.229
2325.000	3.25	-12.436	23.860	-44.438	-397.201	29.345	-392.652	4.549	-19.289	39.689
2330.000	3.3	-12.881	24.040	-45.056	-404.809	29.647	-400.220	4.589	-19.429	40.149
2335.000	3.35	-13.332	24.220	-45.679	-412.489	29.947	-407.860	4.629	-19.570	40.611
2340.000	3.4	-13.791	24.402	-46.308	-420.242	30.247	-415.572	4.669	-19.712	41.073
2345.000	3.45	-14.257	24.584	-46.942	-428.066	30.546	-423.356	4.710	-19.854	41.537
2350.000	3.5	-14.729	24.767	-47.583	-435.962	30.844	-431.212	4.750	-19.998	42.002
2355.000	3.55	-15.209	24.951	-48.230	-443.930	31.142	-439.139	4.790	-20.142	42.469
2360.000	3.6	-15.695	25.136	-48.883	-451.970	31.438	-447.139	4.830	-20.286	42.936
2365.000	3.65	-16.188	25.321	-49.541	-460.082	31.735	-455.211	4.871	-20.432	43.405
2370.000	3.7	-16.688	25.507	-50.206	-468.266	32.030	-463.355	4.911	-20.578	43.874
2375.000	3.75	-17.196	25.694	-50.876	-476.522	32.325	-471.570	4.951	-20.725	44.345
2380.000	3.8	-17.710	25.881	-51.552	-484.849	32.619	-479.858	4.991	-20.873	44.817
2385.000	3.85	-18.231	26.070	-52.235	-493.249	32.913	-488.218	5.032	-21.022	45.290
2390.000	3.9	-18.759	26.259	-52.923	-501.721	33.205	-496.649	5.072	-21.171	45.765
2395.000	3.95	-19.294	26.449	-53.617	-510.265	33.497	-505.153	5.112	-21.321	46.240
2400.000	4	-19.836	26.640	-54.317	-518.881	33.789	-513.729	5.153	-21.472	46.717
2405.000	4.05	-20.384	26.832	-55.023	-527.569	34.079	-522.376	5.193	-21.624	47.195
2410.000	4.1	-20.940	27.024	-55.735	-536.329	34.369	-531.096	5.233	-21.777	47.674
2415.000	4.15	-21.503	27.218	-56.453	-545.161	34.658	-539.887	5.273	-21.931	48.154
2420.000	4.2	-22.073	27.412	-57.177	-554.064	34.947	-548.751	5.314	-22.085	48.636
2425.000	4.25	-22.650	27.607	-57.906	-563.040	35.234	-557.686	5.354	-22.241	49.118
2430.000	4.3	-23.233	27.803	-58.642	-572.088	35.522	-566.694	5.394	-22.397	49.602
2435.000	4.35	-23.824	28.000	-59.383	-581.208	35.808	-575.773	5.435	-22.554	50.087
2440.000	4.4	-24.422	28.198	-60.131	-590.400	36.094	-584.925	5.475	-22.712	50.573
2445.000	4.45	-25.026	28.397	-60.884	-599.663	36.378	-594.148	5.515	-22.871	51.061
2450.000	4.5	-25.638	28.596	-61.644	-608.999	36.663	-603.443	5.556	-23.031	51.549
2455.000	4.55	-26.257	28.797	-62.409	-618.407	36.946	-612.811	5.596	-23.192	52.039
2460.000	4.6	-26.882	28.998	-63.180	-627.887	37.229	-622.250	5.636	-23.353	52.530
2465.000	4.65	-27.515	29.201	-63.957	-637.439	37.511	-631.762	5.677	-23.516	53.022
2470.000	4.7	-28.154	29.404	-64.740	-647.062	37.792	-641.345	5.717	-23.680	53.516
2475.000	4.75	-28.801	29.609	-65.529	-656.758	38.073	-651.001	5.758	-23.844	54.010
2480.000	4.8	-29.455	29.814	-66.324	-666.526	38.353	-660.728	5.798	-24.010	54.506
2485.000	4.85	-30.115	30.020	-67.125	-676.366	38.632	-670.527	5.838	-24.176	55.003
2490.000	4.9	-30.783	30.228	-67.931	-686.277	38.910	-680.399	5.879	-24.344	55.502
2495.000	4.95	-31.458	30.436	-68.744	-696.261	39.188	-690.342	5.919	-24.512	56.001
2500.000	5	-32.139	30.645	-69.563	-706.317	39.465	-700.357	5.959	-24.682	56.502
	Max	**1.728**	**30.645**	**-12.661**	**1.146**	**39.465**	**1.541**	**5.959**	**-6.676**	**56.502**
	Min	**-32.139**	**7.111**	**-69.563**	**-706.317**	**-6.012**	**-700.357**	**0.396**	**-24.682**	**-2.504**

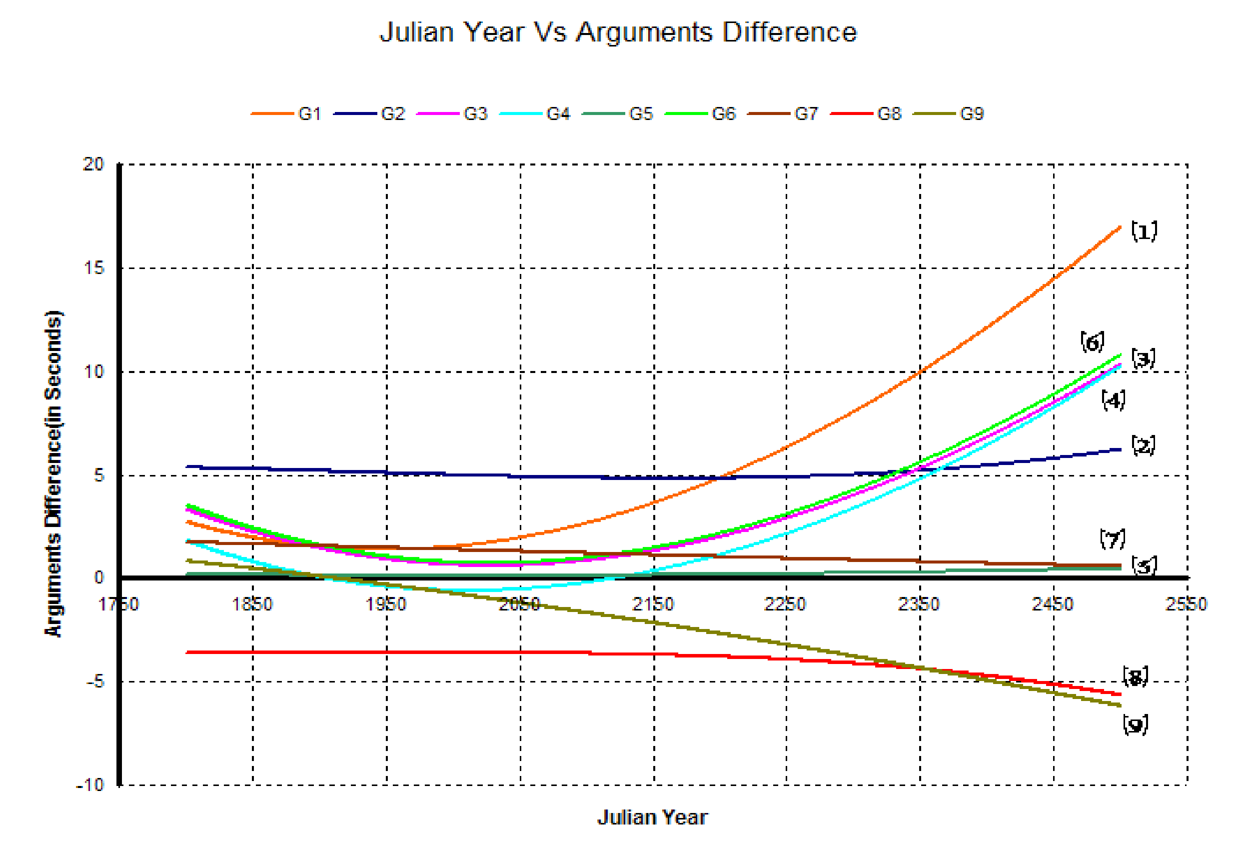

Chart 2: J2000(IAU 2000A Nutation Model)-J2000(IAU 1980 Nutation Model)

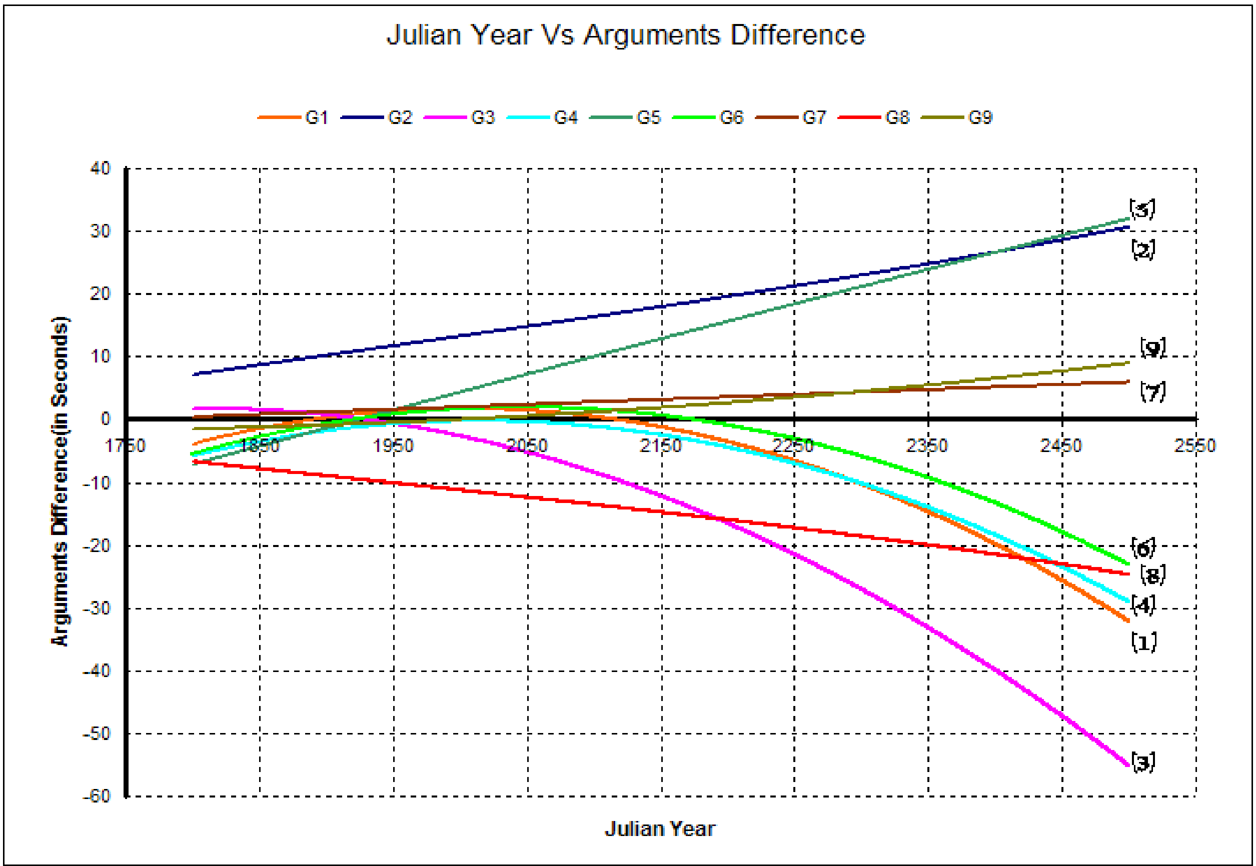

Chart 3: J2000(IAU 2000A Nutation Model)-J2000(Derived from IAU1964 Nutation Model-E.W.Woolard 1953)

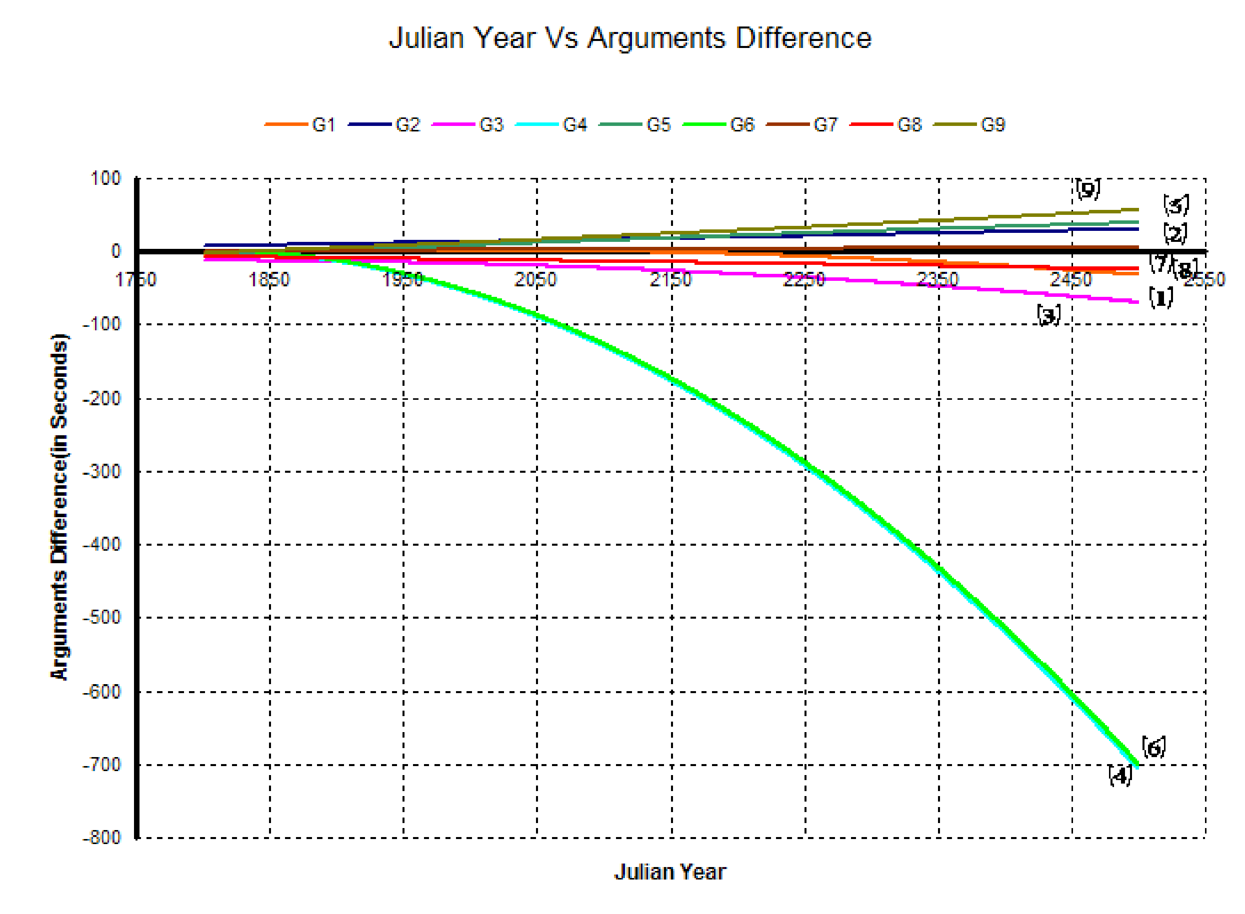

Chart 4: J2000(IAU 2000A Nutation Model)-J2000(Derived from Nutation Model-Newcomb)

From Chart 2:(With Reference to J2000)

The Maximum positive variation in the fundamental arguments found in the range of 17 Seconds for the mean anomaly of the Moon (l = ☽ - π) and similarly maximum negative variation is found in the range of -7 Seconds for the Mean longitude of Sun's Perigee (π = ☽ - l) and all other fundamental arguments lies within these limits for the range of epoch considered. These variations are insignificant to give major difference for Nutation in Longitude between IAU2000A & IAU1980 Nutation Models.

From Chart 3: (With Reference to J2000)

The Maximum positive variation in the fundamental arguments found in the range of 32 Seconds for the Mean longitude of the Moon's mean ascending Node(☊) and similarly maximum negative variation is found in the range of -55 Seconds for the mean anomaly of the Sun (l'= L-π') and all other fundamental arguments lies within these limits for the range of epoch considered. These variations are insignificant to give major difference for Nutation in Longitude between IAU2000A & IAU1964 Nutation Models.

From Chart 4: (With Reference to J2000)

The Maximum positive variation in the fundamental arguments found in the range of 57 Seconds for the Mean longitude of Sun's Perigee (π' = L – l') similarly maximum negative variation is found in the range of -706 Seconds for the mean elongation of the Moon from the Sun (D= ☽ - L) and all other fundamental arguments lies within these limits for the range of epoch considered. These variations are insignificant to give major difference in Nutation in Longitude between IAU2000A & NewComb's Nutation Models.

7.6.2 Comparison of Fundamental arguments of Nutation Models (Ref. to J1900 Epoch)

The recent Nutation Model IAU2000A (with Reference to J1900 Epoch derived from J2000 Epoch) is compared with other Nutation Models and the differences in Coefficient Values are tabulated below.

Table 9: Differences in Coefficient Values of the Fundamental Arguments (Ref. J1900 Epoch)

δ**Argument**	B_0	B_1	B_2	B_3	B_4	**Remarks**
J1900(Derived from IAU 2000A Nutation Model)-J1900(Derived from IAU 1980 Nutation Model)						Chart 5
δ*l*	1.512556	-0.5897	0.6048	-0.011386	-0.00024470	(1)
δ*l*'	5.176603	-0.1870	-0.0127	0.012182	-0.00001149	(2)
δF	1.456273	-1.3369	0.5419	-0.012054	0.00000417	(3)
δD	0.048465	-1.1969	0.5574	-0.012280	-0.00003169	(4)
δ☊	0.139575	-0.0392	0.0177	-0.000060	-0.00005939	(5)
δ☽	1.595848	-1.3761	0.5597	-0.012114	-0.00005522	(6)
δL	1.547383	-0.1792	0.0022	0.000166	-0.00002353	(7)
δπ'	-3.629220	0.0079	0.0149	-0.012016	-0.00001204	(8)
δπ	0.083292	-0.7864	-0.0452	-0.000728	0.00018948	(9)
J1900(Derived from IAU 2000A Nutation Model)-J1900(IAU1964 Nutation Model-E.W.Woolard 1953)						Chart 6
δ*l*	0.268557	2.8253	-1.3672	0.000814	-0.00024470	(1)
δ*l*'	10.191603	3.0550	-0.0137	0.012182	-0.00001149	(2)
δF	0.728273	-2.1929	-1.1881	0.000146	0.00000417	(3)
δD	-1.832535	2.7901	-1.2206	-0.000080	-0.00003169	(4)
δ☊	-1.384425	5.7658	-0.0313	-0.000060	-0.00005939	(5)
δ☽	-0.656152	3.5729	-1.2193	0.000086	-0.00005522	(6)
δL	1.176383	0.7828	0.0012	0.000166	-0.00002353	(7)
δπ'	-9.015220	-2.2721	0.0149	-0.012016	-0.00001204	(8)
δπ	-0.924709	0.7476	0.1478	-0.000728	0.00018948	(9)
J1900(Derived from IAU 2000A Nutation Model)-J1900(Nutation Model-Newcomb)						Chart 7
δ*l*	0.268557	2.8253	-1.3672	0.000814	-0.00024470	(1)
δ*l*'	10.191603	3.0550	-0.0137	0.012182	-0.00001149	(2)
δF	-13.671727	-2.1929	-1.1881	0.000146	0.00000417	(3)
δD	-13.562535	-29.0999	-14.3916	-0.000080	-0.00003169	(4)
δ☊	1.285575	7.1658	-0.1313	-0.000060	-0.00005939	(5)
δ☽	-12.386152	-28.3171	-14.3893	0.000086	-0.00005522	(6)
δL	1.176383	0.7828	0.0022	0.000166	-0.00002353	(7)
δπ'	-8.975220	-2.2721	0.0149	-0.012016	-0.00001204	(8)
δπ	4.605291	7.3276	0.2178	-0.000728	0.00018948	(9)

Using the above differences in Coefficient Values each Argument's element value is calculated for the Julian Year 1800 to 2500 and plotted in a Graph to see the change in the values over a period of time and the findings are discussed further below.

Table 10:Chart5: J1900(Derived from IAU 2000A Nutation Model)-J1900(Derived from IAU 1980 Nutation Model)

Julian Year	'T' in Julian Centuries	δ*l* (1)	δ*l'* (2)	δF (3)	δD (4)	δ☊ (5)	δ☽ (6)	δL (7)	δπ' (8)	δπ (9)
1800.000	-1	2.718	5.339	3.347	1.815	0.196	3.544	1.729	-3.610	0.825
1805.000	-0.95	2.628	5.332	3.226	1.699	0.193	3.419	1.719	-3.613	0.790
1810.000	-0.9	2.541	5.326	3.107	1.586	0.189	3.296	1.710	-3.616	0.755
1815.000	-0.85	2.458	5.319	2.992	1.476	0.186	3.177	1.701	-3.618	0.720
1820.000	-0.8	2.377	5.312	2.879	1.369	0.182	3.061	1.692	-3.620	0.684
1825.000	-0.75	2.300	5.305	2.769	1.265	0.179	2.948	1.683	-3.622	0.648
1830.000	-0.7	2.226	5.297	2.662	1.164	0.176	2.838	1.674	-3.623	0.612
1835.000	-0.65	2.154	5.289	2.558	1.065	0.173	2.730	1.665	-3.625	0.576
1840.000	-0.6	2.087	5.282	2.456	0.970	0.169	2.626	1.656	-3.626	0.539
1845.000	-0.55	2.022	5.274	2.357	0.877	0.166	2.524	1.647	-3.627	0.502
1850.000	-0.5	1.960	5.265	2.262	0.788	0.164	2.425	1.638	-3.628	0.465
1855.000	-0.45	1.901	5.257	2.169	0.701	0.161	2.330	1.628	-3.629	0.428
1860.000	-0.4	1.846	5.249	2.079	0.617	0.158	2.237	1.619	-3.629	0.391
1865.000	-0.35	1.794	5.240	1.991	0.536	0.155	2.147	1.610	-3.630	0.353
1870.000	-0.3	1.744	5.231	1.906	0.458	0.153	2.059	1.601	-3.630	0.315
1875.000	-0.25	1.698	5.222	1.825	0.383	0.150	1.975	1.592	-3.630	0.277
1880.000	-0.2	1.655	5.213	1.745	0.310	0.148	1.894	1.583	-3.630	0.239
1885.000	-0.15	1.615	5.204	1.669	0.241	0.146	1.815	1.574	-3.630	0.200
1890.000	-0.1	1.578	5.195	1.595	0.174	0.144	1.739	1.565	-3.630	0.161
1895.000	-0.05	1.544	5.186	1.524	0.110	0.142	1.666	1.556	-3.630	0.122
1900.000	0	1.513	5.177	1.456	0.048	0.140	1.596	1.547	-3.629	0.083
1905.000	0.05	1.485	5.167	1.391	-0.010	0.138	1.528	1.538	-3.629	0.044
1910.000	0.1	1.460	5.158	1.328	-0.066	0.136	1.464	1.529	-3.628	0.004
1915.000	0.15	1.438	5.148	1.268	-0.119	0.134	1.402	1.521	-3.628	-0.036
1920.000	0.2	1.419	5.139	1.210	-0.169	0.132	1.343	1.512	-3.627	-0.076
1925.000	0.25	1.403	5.129	1.156	-0.216	0.131	1.287	1.503	-3.627	-0.116
1930.000	0.3	1.390	5.120	1.104	-0.261	0.129	1.233	1.494	-3.626	-0.157
1935.000	0.35	1.380	5.110	1.054	-0.303	0.128	1.182	1.485	-3.625	-0.198
1940.000	0.4	1.373	5.101	1.007	-0.342	0.127	1.134	1.476	-3.624	-0.239
1945.000	0.45	1.369	5.091	0.963	-0.378	0.126	1.089	1.467	-3.624	-0.280
1950.000	0.5	1.367	5.081	0.922	-0.412	0.124	1.046	1.458	-3.623	-0.321
1955.000	0.55	1.369	5.072	0.883	-0.443	0.123	1.006	1.450	-3.622	-0.363
1960.000	0.6	1.374	5.062	0.847	-0.472	0.122	0.969	1.441	-3.622	-0.405
1965.000	0.65	1.382	5.053	0.813	-0.497	0.122	0.935	1.432	-3.621	-0.447
1970.000	0.7	1.392	5.044	0.782	-0.520	0.121	0.903	1.423	-3.621	-0.490
1975.000	0.75	1.406	5.034	0.753	-0.541	0.120	0.873	1.414	-3.620	-0.532
1980.000	0.8	1.422	5.025	0.727	-0.559	0.119	0.847	1.406	-3.620	-0.575
1985.000	0.85	1.441	5.016	0.704	-0.574	0.119	0.823	1.397	-3.619	-0.618
1990.000	0.9	1.463	5.007	0.683	-0.586	0.119	0.802	1.388	-3.619	-0.661
1995.000	0.95	1.488	4.998	0.665	-0.596	0.118	0.783	1.379	-3.619	-0.705
2000.000	1	1.516	4.989	0.649	-0.603	0.118	0.767	1.371	-3.618	-0.749
2005.000	1.05	1.547	4.980	0.636	-0.608	0.118	0.754	1.362	-3.618	-0.793
2010.000	1.1	1.580	4.972	0.625	-0.610	0.118	0.743	1.353	-3.619	-0.837
2015.000	1.15	1.617	4.963	0.617	-0.610	0.118	0.735	1.344	-3.619	-0.882
2020.000	1.2	1.656	4.955	0.612	-0.606	0.118	0.729	1.336	-3.619	-0.926
2025.000	1.25	1.698	4.947	0.608	-0.601	0.118	0.726	1.327	-3.620	-0.971
2030.000	1.3	1.742	4.939	0.608	-0.593	0.118	0.726	1.318	-3.620	-1.016
2035.000	1.35	1.790	4.931	0.609	-0.582	0.119	0.728	1.310	-3.621	-1.062
2040.000	1.4	1.840	4.923	0.614	-0.569	0.119	0.733	1.301	-3.622	-1.108

Julian Year	'T' in Julian Centuries	δ*l* (1)	δ*l'* (2)	δF (3)	δD (4)	δ☊ (5)	δ☽ (6)	δL (7)	δπ' (8)	δπ (9)
2045.000	1.45	1.893	4.916	0.620	-0.553	0.120	0.740	1.293	-3.623	-1.153
2050.000	1.5	1.949	4.909	0.630	-0.534	0.120	0.750	1.284	-3.624	-1.200
2055.000	1.55	2.008	4.902	0.641	-0.513	0.121	0.762	1.275	-3.626	-1.246
2060.000	1.6	2.069	4.895	0.655	-0.490	0.122	0.777	1.267	-3.628	-1.292
2065.000	1.65	2.133	4.888	0.672	-0.464	0.122	0.794	1.258	-3.630	-1.339
2070.000	1.7	2.200	4.882	0.690	-0.436	0.123	0.814	1.250	-3.632	-1.386
2075.000	1.75	2.269	4.876	0.712	-0.405	0.124	0.836	1.241	-3.634	-1.433
2080.000	1.8	2.342	4.870	0.735	-0.372	0.125	0.861	1.233	-3.637	-1.481
2085.000	1.85	2.417	4.864	0.761	-0.336	0.127	0.888	1.224	-3.640	-1.529
2090.000	1.9	2.494	4.859	0.790	-0.298	0.128	0.918	1.216	-3.643	-1.577
2095.000	1.95	2.574	4.854	0.821	-0.257	0.129	0.950	1.207	-3.646	-1.625
2100.000	2	2.657	4.849	0.854	-0.214	0.131	0.985	1.199	-3.650	-1.673
2105.000	2.05	2.743	4.845	0.889	-0.169	0.132	1.022	1.190	-3.654	-1.722
2110.000	2.1	2.831	4.840	0.927	-0.121	0.134	1.061	1.182	-3.658	-1.771
2115.000	2.15	2.922	4.837	0.967	-0.071	0.135	1.103	1.173	-3.663	-1.820
2120.000	2.2	3.015	4.833	1.010	-0.018	0.137	1.147	1.165	-3.668	-1.869
2125.000	2.25	3.112	4.830	1.054	0.037	0.139	1.194	1.157	-3.673	-1.918
2130.000	2.3	3.210	4.827	1.102	0.094	0.141	1.243	1.148	-3.679	-1.968
2135.000	2.35	3.312	4.825	1.151	0.154	0.143	1.294	1.140	-3.685	-2.018
2140.000	2.4	3.415	4.823	1.203	0.216	0.145	1.348	1.131	-3.691	-2.068
2145.000	2.45	3.522	4.821	1.257	0.280	0.147	1.404	1.123	-3.698	-2.119
2150.000	2.5	3.631	4.820	1.313	0.347	0.149	1.462	1.115	-3.705	-2.169
2155.000	2.55	3.742	4.819	1.371	0.416	0.151	1.523	1.106	-3.712	-2.220
2160.000	2.6	3.856	4.818	1.432	0.487	0.154	1.586	1.098	-3.720	-2.271
2165.000	2.65	3.973	4.818	1.495	0.561	0.156	1.652	1.090	-3.728	-2.322
2170.000	2.7	4.092	4.818	1.560	0.637	0.158	1.719	1.082	-3.736	-2.374
2175.000	2.75	4.214	4.819	1.627	0.715	0.161	1.789	1.073	-3.745	-2.425
2180.000	2.8	4.338	4.820	1.697	0.796	0.164	1.861	1.065	-3.755	-2.477
2185.000	2.85	4.465	4.822	1.769	0.878	0.166	1.936	1.057	-3.765	-2.529
2190.000	2.9	4.594	4.824	1.843	0.963	0.169	2.013	1.049	-3.775	-2.582
2195.000	2.95	4.725	4.826	1.919	1.051	0.172	2.092	1.040	-3.786	-2.634
2200.000	3	4.859	4.829	1.998	1.140	0.175	2.173	1.032	-3.797	-2.687
2205.000	3.05	4.996	4.833	2.078	1.232	0.178	2.257	1.024	-3.808	-2.740
2210.000	3.1	5.135	4.837	2.161	1.326	0.181	2.343	1.016	-3.821	-2.793
2215.000	3.15	5.276	4.841	2.246	1.422	0.184	2.431	1.008	-3.833	-2.846
2220.000	3.2	5.420	4.846	2.333	1.520	0.187	2.521	0.999	-3.846	-2.900
2225.000	3.25	5.566	4.852	2.422	1.621	0.190	2.613	0.991	-3.860	-2.954
2230.000	3.3	5.715	4.858	2.513	1.724	0.194	2.708	0.983	-3.874	-3.008
2235.000	3.35	5.866	4.864	2.606	1.829	0.197	2.805	0.975	-3.889	-3.062
2240.000	3.4	6.019	4.871	2.702	1.936	0.201	2.904	0.967	-3.904	-3.116
2245.000	3.45	6.175	4.879	2.800	2.045	0.204	3.005	0.959	-3.920	-3.171
2250.000	3.5	6.333	4.887	2.899	2.156	0.208	3.108	0.951	-3.936	-3.226
2255.000	3.55	6.493	4.896	3.001	2.270	0.211	3.214	0.943	-3.953	-3.281
2260.000	3.6	6.656	4.905	3.105	2.385	0.215	3.321	0.935	-3.970	-3.336
2265.000	3.65	6.820	4.915	3.211	2.503	0.219	3.431	0.927	-3.988	-3.391
2270.000	3.7	6.988	4.926	3.319	2.623	0.223	3.543	0.918	-4.007	-3.447
2275.000	3.75	7.157	4.937	3.429	2.745	0.227	3.657	0.910	-4.026	-3.502
2280.000	3.8	7.329	4.949	3.541	2.869	0.231	3.773	0.902	-4.046	-3.558
2285.000	3.85	7.503	4.961	3.655	2.995	0.235	3.891	0.894	-4.066	-3.614

Julian Year	**'T' in Julian Centuries**	**δ*l* (1)**	**δ*l*' (2)**	**δF (3)**	**δD (4)**	**δ☊ (5)**	**δ☽ (6)**	**δL (7)**	**δπ' (8)**	**δπ (9)**
2290.000	3.9	7.680	4.974	3.771	3.123	0.239	4.011	0.886	-4.087	-3.671
2295.000	3.95	7.858	4.988	3.889	3.253	0.243	4.133	0.878	-4.109	-3.727
2300.000	4	8.039	5.002	4.009	3.385	0.247	4.257	0.870	-4.131	-3.784
2305.000	4.05	8.222	5.017	4.131	3.519	0.251	4.384	0.862	-4.154	-3.840
2310.000	4.1	8.408	5.033	4.255	3.656	0.255	4.512	0.854	-4.178	-3.897
2315.000	4.15	8.595	5.049	4.381	3.794	0.260	4.642	0.846	-4.202	-3.955
2320.000	4.2	8.785	5.066	4.509	3.934	0.264	4.775	0.839	-4.227	-4.012
2325.000	4.25	8.977	5.084	4.639	4.077	0.269	4.909	0.831	-4.253	-4.069
2330.000	4.3	9.171	5.102	4.770	4.221	0.273	5.045	0.823	-4.279	-4.127
2335.000	4.35	9.367	5.121	4.904	4.367	0.278	5.184	0.815	-4.306	-4.185
2340.000	4.4	9.565	5.141	5.040	4.515	0.282	5.324	0.807	-4.334	-4.243
2345.000	4.45	9.766	5.162	5.177	4.666	0.287	5.467	0.799	-4.363	-4.301
2350.000	4.5	9.968	5.183	5.317	4.818	0.292	5.611	0.791	-4.392	-4.359
2355.000	4.55	10.173	5.205	5.458	4.972	0.297	5.757	0.783	-4.422	-4.418
2360.000	4.6	10.380	5.228	5.602	5.128	0.301	5.905	0.775	-4.453	-4.477
2365.000	4.65	10.589	5.252	5.747	5.286	0.306	6.055	0.767	-4.484	-4.535
2370.000	4.7	10.799	5.276	5.894	5.446	0.311	6.207	0.759	-4.516	-4.594
2375.000	4.75	11.012	5.302	6.043	5.607	0.316	6.361	0.752	-4.549	-4.653
2380.000	4.8	11.227	5.328	6.194	5.771	0.321	6.517	0.744	-4.583	-4.713
2385.000	4.85	11.445	5.354	6.346	5.936	0.326	6.675	0.736	-4.618	-4.772
2390.000	4.9	11.664	5.382	6.501	6.104	0.331	6.834	0.728	-4.653	-4.832
2395.000	4.95	11.885	5.410	6.657	6.273	0.336	6.996	0.720	-4.690	-4.891
2400.000	5	12.108	5.440	6.815	6.444	0.341	7.159	0.712	-4.727	-4.951
2405.000	5.05	12.333	5.470	6.975	6.617	0.347	7.324	0.705	-4.765	-5.011
2410.000	5.1	12.560	5.501	7.137	6.792	0.352	7.491	0.697	-4.803	-5.071
2415.000	5.15	12.789	5.533	7.300	6.968	0.357	7.660	0.689	-4.843	-5.132
2420.000	5.2	13.020	5.565	7.466	7.147	0.362	7.831	0.681	-4.884	-5.192
2425.000	5.25	13.253	5.599	7.633	7.327	0.368	8.003	0.673	-4.925	-5.253
2430.000	5.3	13.488	5.633	7.801	7.509	0.373	8.177	0.666	-4.967	-5.313
2435.000	5.35	13.725	5.669	7.972	7.693	0.379	8.353	0.658	-5.010	-5.374
2440.000	5.4	13.963	5.705	8.144	7.878	0.384	8.531	0.650	-5.054	-5.435
2445.000	5.45	14.204	5.742	8.318	8.066	0.390	8.711	0.642	-5.099	-5.496
2450.000	5.5	14.446	5.780	8.494	8.255	0.395	8.892	0.634	-5.145	-5.557
2455.000	5.55	14.690	5.819	8.672	8.446	0.401	9.075	0.627	-5.192	-5.618
2460.000	5.6	14.937	5.859	8.851	8.638	0.406	9.260	0.619	-5.240	-5.680
2465.000	5.65	15.185	5.900	9.032	8.832	0.412	9.447	0.611	-5.288	-5.741
2470.000	5.7	15.434	5.942	9.214	9.028	0.417	9.635	0.603	-5.338	-5.803
2475.000	5.75	15.686	5.985	9.399	9.226	0.423	9.825	0.596	-5.389	-5.864
2480.000	5.8	15.939	6.029	9.585	9.426	0.429	10.017	0.588	-5.440	-5.926
2485.000	5.85	16.194	6.073	9.772	9.627	0.434	10.210	0.580	-5.493	-5.988
2490.000	5.9	16.451	6.119	9.962	9.829	0.440	10.405	0.572	-5.546	-6.050
2495.000	5.95	16.710	6.166	10.152	10.034	0.446	10.602	0.565	-5.601	-6.112
2500.000	6	16.971	6.214	10.345	10.240	0.452	10.800	0.557	-5.656	-6.174
	Max	**16.971**	**6.214**	**10.345**	**10.240**	**0.452**	**10.800**	**1.729**	**-3.610**	**0.825**
	Min	**1.367**	**4.818**	**0.608**	**-0.610**	**0.118**	**0.726**	**0.557**	**-5.656**	**-6.174**

Table 11: Chart6: J1900(Derived from IAU 2000A Nutation Model)-J1900(IAU1964 Nutation Model-E.W.Woolard 1953)

Julian Year	**'T' in Julian Centuries**	**δ*l* (1)**	**δ*l*' (2)**	**δF (3)**	**δD (4)**	**δ☊ (5)**	**δ☽ (6)**	**δL (7)**	**δπ' (8)**	**δπ (9)**
1800.000	-1	-3.925	7.111	1.733	-5.843	-7.182	-5.448	0.395	-6.716	-1.524
1805.000	-0.95	-3.650	7.267	1.739	-5.585	-6.890	-5.151	0.434	-6.833	-1.501
1810.000	-0.9	-3.382	7.422	1.739	-5.332	-6.599	-4.859	0.473	-6.950	-1.477
1815.000	-0.85	-3.121	7.577	1.734	-5.086	-6.308	-4.574	0.512	-7.066	-1.453
1820.000	-0.8	-2.867	7.733	1.722	-4.846	-6.017	-4.295	0.551	-7.182	-1.428
1825.000	-0.75	-2.620	7.888	1.705	-4.612	-5.726	-4.022	0.590	-7.298	-1.402
1830.000	-0.7	-2.379	8.042	1.681	-4.384	-5.436	-3.755	0.629	-7.413	-1.375
1835.000	-0.65	-2.146	8.197	1.652	-4.162	-5.145	-3.494	0.668	-7.529	-1.348
1840.000	-0.6	-1.919	8.351	1.616	-3.946	-4.855	-3.239	0.707	-7.644	-1.320
1845.000	-0.55	-1.699	8.505	1.575	-3.736	-4.565	-2.990	0.746	-7.759	-1.291
1850.000	-0.5	-1.486	8.659	1.528	-3.533	-4.275	-2.747	0.785	-7.874	-1.261
1855.000	-0.45	-1.280	8.813	1.474	-3.335	-3.985	-2.511	0.824	-7.989	-1.231
1860.000	-0.4	-1.080	8.967	1.415	-3.144	-3.696	-2.280	0.863	-8.103	-1.200
1865.000	-0.35	-0.888	9.120	1.350	-2.959	-3.406	-2.056	0.903	-8.218	-1.168
1870.000	-0.3	-0.702	9.274	1.279	-2.779	-3.117	-1.838	0.942	-8.332	-1.136
1875.000	-0.25	-0.523	9.427	1.202	-2.606	-2.828	-1.626	0.981	-8.446	-1.102
1880.000	-0.2	-0.351	9.580	1.119	-2.439	-2.539	-1.420	1.020	-8.560	-1.068
1885.000	-0.15	-0.186	9.733	1.030	-2.279	-2.250	-1.220	1.059	-8.674	-1.034
1890.000	-0.1	-0.028	9.886	0.936	-2.124	-1.961	-1.026	1.098	-8.788	-0.998
1895.000	-0.05	0.124	10.039	0.835	-1.975	-1.673	-0.838	1.137	-8.902	-0.962
1900.000	0	0.269	10.192	0.728	-1.833	-1.384	-0.656	1.176	-9.015	-0.925
1905.000	0.05	0.406	10.344	0.616	-1.696	-1.096	-0.481	1.216	-9.129	-0.887
1910.000	0.1	0.537	10.497	0.497	-1.566	-0.808	-0.311	1.255	-9.242	-0.848
1915.000	0.15	0.662	10.650	0.373	-1.441	-0.520	-0.148	1.294	-9.356	-0.809
1920.000	0.2	0.779	10.802	0.242	-1.323	-0.233	0.010	1.333	-9.469	-0.769
1925.000	0.25	0.889	10.955	0.106	-1.211	0.055	0.161	1.372	-9.583	-0.729
1930.000	0.3	0.993	11.107	-0.037	-1.105	0.342	0.306	1.411	-9.696	-0.687
1935.000	0.35	1.090	11.260	-0.185	-1.006	0.630	0.445	1.451	-9.809	-0.645
1940.000	0.4	1.180	11.412	-0.339	-0.912	0.917	0.578	1.490	-9.922	-0.602
1945.000	0.45	1.263	11.565	-0.499	-0.824	1.204	0.705	1.529	-10.036	-0.558
1950.000	0.5	1.339	11.717	-0.665	-0.743	1.491	0.825	1.568	-10.149	-0.514
1955.000	0.55	1.409	11.870	-0.837	-0.667	1.777	0.940	1.607	-10.262	-0.469
1960.000	0.6	1.472	12.022	-1.015	-0.598	2.064	1.049	1.647	-10.376	-0.423
1965.000	0.65	1.528	12.175	-1.199	-0.535	2.350	1.151	1.686	-10.489	-0.376
1970.000	0.7	1.577	12.328	-1.389	-0.478	2.636	1.247	1.725	-10.603	-0.329
1975.000	0.75	1.619	12.480	-1.585	-0.427	2.922	1.338	1.764	-10.716	-0.281
1980.000	0.8	1.654	12.633	-1.786	-0.382	3.208	1.422	1.803	-10.830	-0.232
1985.000	0.85	1.683	12.786	-1.994	-0.343	3.494	1.500	1.843	-10.943	-0.183
1990.000	0.9	1.704	12.939	-2.208	-0.310	3.779	1.572	1.882	-11.057	-0.133
1995.000	0.95	1.719	13.092	-2.427	-0.284	4.065	1.638	1.921	-11.171	-0.082
2000.000	1	1.727	13.245	-2.653	-0.263	4.350	1.697	1.961	-11.284	-0.030
2005.000	1.05	1.728	13.398	-2.884	-0.249	4.635	1.751	2.000	-11.398	0.023
2010.000	1.1	1.723	13.552	-3.121	-0.241	4.920	1.799	2.039	-11.513	0.076
2015.000	1.15	1.710	13.705	-3.365	-0.238	5.205	1.840	2.078	-11.627	0.130
2020.000	1.2	1.691	13.859	-3.614	-0.242	5.489	1.876	2.118	-11.741	0.184
2025.000	1.25	1.665	14.013	-3.869	-0.252	5.774	1.905	2.157	-11.856	0.240
2030.000	1.3	1.632	14.167	-4.130	-0.268	6.058	1.928	2.196	-11.970	0.296
2035.000	1.35	1.592	14.321	-4.397	-0.291	6.342	1.945	2.236	-12.085	0.353
2040.000	1.4	1.546	14.475	-4.670	-0.319	6.626	1.956	2.275	-12.200	0.410

Julian Year	**'T' in Julian Centuries**	**δ*l* (1)**	**δ*l*' (2)**	**δF (3)**	**δD (4)**	**δ☊ (5)**	**δ☽ (6)**	**δL (7)**	**δπ' (8)**	**δπ (9)**
2045.000	1.45	1.492	14.630	-4.949	-0.354	6.910	1.961	2.314	-12.315	0.469
2050.000	1.5	1.432	14.784	-5.234	-0.394	7.193	1.960	2.354	-12.430	0.528
2055.000	1.55	1.365	14.939	-5.525	-0.441	7.477	1.952	2.393	-12.546	0.588
2060.000	1.6	1.291	15.094	-5.821	-0.494	7.760	1.939	2.432	-12.662	0.648
2065.000	1.65	1.210	15.250	-6.124	-0.553	8.043	1.920	2.472	-12.778	0.709
2070.000	1.7	1.122	15.405	-6.433	-0.618	8.326	1.894	2.511	-12.894	0.771
2075.000	1.75	1.028	15.561	-6.747	-0.689	8.609	1.862	2.551	-13.010	0.834
2080.000	1.8	0.927	15.717	-7.067	-0.766	8.892	1.824	2.590	-13.127	0.898
2085.000	1.85	0.818	15.873	-7.394	-0.849	9.174	1.781	2.629	-13.244	0.962
2090.000	1.9	0.703	16.030	-7.726	-0.939	9.456	1.731	2.669	-13.361	1.027
2095.000	1.95	0.582	16.187	-8.064	-1.034	9.739	1.674	2.708	-13.478	1.092
2100.000	2	0.453	16.344	-8.409	-1.136	10.021	1.612	2.748	-13.596	1.159
2105.000	2.05	0.317	16.502	-8.759	-1.244	10.302	1.544	2.787	-13.714	1.226
2110.000	2.1	0.175	16.659	-9.115	-1.358	10.584	1.470	2.827	-13.832	1.294
2115.000	2.15	0.026	16.817	-9.477	-1.478	10.865	1.389	2.866	-13.951	1.363
2120.000	2.2	-0.130	16.976	-9.845	-1.604	11.147	1.302	2.906	-14.070	1.432
2125.000	2.25	-0.293	17.134	-10.219	-1.736	11.428	1.210	2.945	-14.189	1.502
2130.000	2.3	-0.463	17.294	-10.599	-1.874	11.709	1.111	2.985	-14.309	1.573
2135.000	2.35	-0.639	17.453	-10.984	-2.019	11.990	1.006	3.024	-14.429	1.645
2140.000	2.4	-0.823	17.613	-11.376	-2.169	12.270	0.895	3.064	-14.549	1.717
2145.000	2.45	-1.013	17.773	-11.774	-2.326	12.551	0.778	3.103	-14.670	1.790
2150.000	2.5	-1.210	17.933	-12.177	-2.489	12.831	0.655	3.143	-14.791	1.864
2155.000	2.55	-1.414	18.094	-12.587	-2.657	13.111	0.525	3.182	-14.912	1.939
2160.000	2.6	-1.625	18.256	-13.002	-2.832	13.391	0.390	3.222	-15.034	2.014
2165.000	2.65	-1.842	18.417	-13.423	-3.013	13.671	0.248	3.261	-15.156	2.090
2170.000	2.7	-2.067	18.579	-13.851	-3.201	13.951	0.101	3.301	-15.278	2.167
2175.000	2.75	-2.298	18.742	-14.284	-3.394	14.230	-0.053	3.340	-15.401	2.245
2180.000	2.8	-2.537	18.905	-14.723	-3.593	14.509	-0.213	3.380	-15.525	2.323
2185.000	2.85	-2.782	19.068	-15.168	-3.799	14.789	-0.379	3.419	-15.649	2.402
2190.000	2.9	-3.034	19.232	-15.619	-4.011	15.067	-0.551	3.459	-15.773	2.482
2195.000	2.95	-3.293	19.396	-16.076	-4.228	15.346	-0.729	3.499	-15.898	2.563
2200.000	3	-3.558	19.561	-16.539	-4.452	15.625	-0.913	3.538	-16.023	2.644
2205.000	3.05	-3.831	19.727	-17.008	-4.682	15.903	-1.104	3.578	-16.148	2.726
2210.000	3.1	-4.110	19.892	-17.483	-4.919	16.181	-1.300	3.617	-16.275	2.809
2215.000	3.15	-4.396	20.059	-17.963	-5.161	16.460	-1.503	3.657	-16.401	2.893
2220.000	3.2	-4.690	20.225	-18.450	-5.409	16.737	-1.711	3.697	-16.528	2.977
2225.000	3.25	-4.990	20.393	-18.942	-5.664	17.015	-1.926	3.736	-16.656	3.062
2230.000	3.3	-5.297	20.560	-19.441	-5.924	17.293	-2.147	3.776	-16.784	3.148
2235.000	3.35	-5.610	20.729	-19.945	-6.191	17.570	-2.374	3.816	-16.913	3.235
2240.000	3.4	-5.931	20.897	-20.456	-6.464	17.847	-2.607	3.855	-17.042	3.322
2245.000	3.45	-6.258	21.067	-20.972	-6.743	18.124	-2.847	3.895	-17.172	3.411
2250.000	3.5	-6.593	21.237	-21.494	-7.028	18.401	-3.092	3.934	-17.302	3.500
2255.000	3.55	-6.934	21.407	-22.022	-7.319	18.678	-3.344	3.974	-17.433	3.589
2260.000	3.6	-7.282	21.578	-22.556	-7.616	18.954	-3.601	4.014	-17.564	3.680
2265.000	3.65	-7.637	21.750	-23.096	-7.920	19.230	-3.865	4.053	-17.696	3.771
2270.000	3.7	-7.999	21.922	-23.642	-8.229	19.506	-4.135	4.093	-17.829	3.863
2275.000	3.75	-8.368	22.095	-24.194	-8.545	19.782	-4.411	4.133	-17.962	3.956
2280.000	3.8	-8.744	22.269	-24.752	-8.867	20.058	-4.693	4.173	-18.096	4.050
2285.000	3.85	-9.127	22.443	-25.316	-9.195	20.333	-4.981	4.212	-18.230	4.144

Julian Year	'T' in Julian Centuries	δ*l* (1)	δ*l'* (2)	δF (3)	δD (4)	δ☊ (5)	δ☽ (6)	δL (7)	δπ' (8)	δπ (9)
2290.000	3.9	-9.516	22.618	-25.885	-9.529	20.609	-5.275	4.252	-18.365	4.240
2295.000	3.95	-9.913	22.793	-26.461	-9.869	20.884	-5.575	4.292	-18.501	4.336
2300.000	4	-10.316	22.969	-27.043	-10.215	21.159	-5.882	4.331	-18.637	4.432
2305.000	4.05	-10.726	23.146	-27.630	-10.567	21.434	-6.195	4.371	-18.774	4.530
2310.000	4.1	-11.143	23.323	-28.223	-10.926	21.708	-6.513	4.411	-18.912	4.628
2315.000	4.15	-11.567	23.501	-28.823	-11.291	21.983	-6.838	4.451	-19.050	4.727
2320.000	4.2	-11.998	23.680	-29.428	-11.661	22.257	-7.169	4.490	-19.189	4.827
2325.000	4.25	-12.436	23.859	-30.039	-12.038	22.531	-7.506	4.530	-19.329	4.928
2330.000	4.3	-12.881	24.039	-30.656	-12.421	22.805	-7.850	4.570	-19.469	5.030
2335.000	4.35	-13.333	24.220	-31.279	-12.810	23.078	-8.199	4.610	-19.610	5.132
2340.000	4.4	-13.791	24.402	-31.908	-13.206	23.352	-8.554	4.649	-19.752	5.235
2345.000	4.45	-14.257	24.584	-32.543	-13.607	23.625	-8.916	4.689	-19.895	5.339
2350.000	4.5	-14.730	24.767	-33.184	-14.015	23.898	-9.284	4.729	-20.038	5.444
2355.000	4.55	-15.209	24.951	-33.831	-14.428	24.171	-9.658	4.769	-20.182	5.549
2360.000	4.6	-15.695	25.135	-34.483	-14.848	24.444	-10.038	4.808	-20.327	5.656
2365.000	4.65	-16.189	25.321	-35.142	-15.274	24.716	-10.424	4.848	-20.472	5.763
2370.000	4.7	-16.689	25.507	-35.806	-15.706	24.988	-10.816	4.888	-20.618	5.871
2375.000	4.75	-17.196	25.693	-36.477	-16.144	25.260	-11.214	4.928	-20.765	5.980
2380.000	4.8	-17.710	25.881	-37.153	-16.588	25.532	-11.619	4.967	-20.913	6.089
2385.000	4.85	-18.231	26.070	-37.835	-17.039	25.804	-12.029	5.007	-21.062	6.200
2390.000	4.9	-18.759	26.259	-38.524	-17.495	26.075	-12.446	5.047	-21.211	6.311
2395.000	4.95	-19.294	26.449	-39.218	-17.958	26.346	-12.869	5.087	-21.362	6.423
2400.000	5	-19.836	26.640	-39.918	-18.427	26.617	-13.298	5.126	-21.513	6.536
2405.000	5.05	-20.385	26.831	-40.624	-18.902	26.888	-13.733	5.166	-21.665	6.649
2410.000	5.1	-20.941	27.024	-41.336	-19.383	27.159	-14.174	5.206	-21.817	6.764
2415.000	5.15	-21.504	27.217	-42.054	-19.870	27.429	-14.622	5.246	-21.971	6.879
2420.000	5.2	-22.073	27.412	-42.777	-20.363	27.700	-15.075	5.286	-22.126	6.996
2425.000	5.25	-22.650	27.607	-43.507	-20.863	27.970	-15.535	5.325	-22.281	7.113
2430.000	5.3	-23.234	27.803	-44.243	-21.369	28.239	-16.001	5.365	-22.437	7.230
2435.000	5.35	-23.825	28.000	-44.984	-21.880	28.509	-16.473	5.405	-22.594	7.349
2440.000	5.4	-24.422	28.198	-45.732	-22.398	28.778	-16.951	5.445	-22.752	7.469
2445.000	5.45	-25.027	28.396	-46.485	-22.922	29.047	-17.435	5.484	-22.911	7.589
2450.000	5.5	-25.639	28.596	-47.245	-23.452	29.316	-17.925	5.524	-23.071	7.710
2455.000	5.55	-26.257	28.797	-48.010	-23.989	29.585	-18.422	5.564	-23.232	7.832
2460.000	5.6	-26.883	28.998	-48.781	-24.531	29.854	-18.924	5.604	-23.394	7.955
2465.000	5.65	-27.515	29.200	-49.558	-25.080	30.122	-19.433	5.643	-23.556	8.079
2470.000	5.7	-28.155	29.404	-50.341	-25.635	30.390	-19.948	5.683	-23.720	8.204
2475.000	5.75	-28.802	29.608	-51.130	-26.195	30.658	-20.469	5.723	-23.885	8.329
2480.000	5.8	-29.455	29.814	-51.925	-26.762	30.925	-20.996	5.763	-24.050	8.456
2485.000	5.85	-30.116	30.020	-52.726	-27.336	31.193	-21.530	5.803	-24.217	8.583
2490.000	5.9	-30.784	30.227	-53.533	-27.915	31.460	-22.069	5.842	-24.384	8.711
2495.000	5.95	-31.458	30.436	-54.345	-28.500	31.727	-22.615	5.882	-24.553	8.840
2500.000	6	-32.140	30.645	-55.164	-29.092	31.994	-23.167	5.922	-24.722	8.970
	Max	**1.728**	**30.645**	**1.739**	**-0.238**	**31.994**	**1.961**	**5.922**	**-6.716**	**8.970**
	Min	**-32.140**	**7.111**	**-55.164**	**-29.092**	**-7.182**	**-23.167**	**0.395**	**-24.722**	**-1.524**

Table 12: Chart7: J1900(Derived from IAU 2000A Nutation Model)-J1900(Nutation Model-Newcomb)

Julian Year	'T' in Julian Centuries	δ*l* (1)	δ*l'* (2)	δF (3)	δD (4)	δ☊ (5)	δ☽ (6)	δL (7)	δπ' (8)	δπ (9)
1800.000	-1	-3.925	7.111	-12.667	1.146	-6.012	1.542	0.396	-6.676	-2.504
1805.000	-0.95	-3.650	7.267	-12.661	1.094	-5.640	1.529	0.435	-6.793	-2.159
1810.000	-0.9	-3.382	7.422	-12.661	0.970	-5.270	1.444	0.474	-6.910	-1.812
1815.000	-0.85	-3.121	7.577	-12.666	0.774	-4.900	1.287	0.512	-7.026	-1.465
1820.000	-0.8	-2.867	7.733	-12.678	0.507	-4.531	1.058	0.551	-7.142	-1.117
1825.000	-0.75	-2.620	7.888	-12.695	0.167	-4.163	0.758	0.590	-7.258	-0.768
1830.000	-0.7	-2.379	8.042	-12.719	-0.244	-3.795	0.385	0.629	-7.373	-0.417
1835.000	-0.65	-2.146	8.197	-12.748	-0.728	-3.428	-0.060	0.668	-7.489	-0.065
1840.000	-0.6	-1.919	8.351	-12.784	-1.284	-3.061	-0.576	0.707	-7.604	0.287
1845.000	-0.55	-1.699	8.505	-12.825	-1.911	-2.695	-1.165	0.746	-7.719	0.641
1850.000	-0.5	-1.486	8.659	-12.872	-2.610	-2.330	-1.825	0.786	-7.834	0.996
1855.000	-0.45	-1.280	8.813	-12.926	-3.382	-1.966	-2.557	0.825	-7.949	1.352
1860.000	-0.4	-1.080	8.967	-12.985	-4.225	-1.602	-3.362	0.864	-8.063	1.709
1865.000	-0.35	-0.888	9.120	-13.050	-5.141	-1.239	-4.238	0.903	-8.178	2.067
1870.000	-0.3	-0.702	9.274	-13.121	-6.128	-0.876	-5.186	0.942	-8.292	2.427
1875.000	-0.25	-0.523	9.427	-13.198	-7.187	-0.514	-6.206	0.981	-8.406	2.787
1880.000	-0.2	-0.351	9.580	-13.281	-8.318	-0.153	-7.298	1.020	-8.520	3.148
1885.000	-0.15	-0.186	9.733	-13.370	-9.521	0.208	-8.462	1.059	-8.634	3.511
1890.000	-0.1	-0.028	9.886	-13.464	-10.796	0.568	-9.698	1.098	-8.748	3.875
1895.000	-0.05	0.124	10.039	-13.565	-12.144	0.927	-11.006	1.137	-8.862	4.239
1900.000	0	0.269	10.192	-13.672	-13.563	1.286	-12.386	1.176	-8.975	4.605
1905.000	0.05	0.406	10.344	-13.784	-15.054	1.644	-13.838	1.216	-9.089	4.972
1910.000	0.1	0.537	10.497	-13.903	-16.616	2.001	-15.362	1.255	-9.202	5.340
1915.000	0.15	0.662	10.650	-14.027	-18.251	2.357	-16.957	1.294	-9.316	5.709
1920.000	0.2	0.779	10.802	-14.158	-19.958	2.713	-18.625	1.333	-9.429	6.080
1925.000	0.25	0.889	10.955	-14.294	-21.737	3.069	-20.365	1.372	-9.543	6.451
1930.000	0.3	0.993	11.107	-14.437	-23.588	3.423	-22.176	1.411	-9.656	6.823
1935.000	0.35	1.090	11.260	-14.585	-25.510	3.778	-24.060	1.451	-9.769	7.197
1940.000	0.4	1.180	11.412	-14.739	-27.505	4.131	-26.015	1.490	-9.882	7.571
1945.000	0.45	1.263	11.565	-14.899	-29.572	4.484	-28.043	1.529	-9.996	7.947
1950.000	0.5	1.339	11.717	-15.065	-31.710	4.836	-30.142	1.568	-10.109	8.323
1955.000	0.55	1.409	11.870	-15.237	-33.921	5.187	-32.313	1.608	-10.222	8.701
1960.000	0.6	1.472	12.022	-15.415	-36.203	5.538	-34.557	1.647	-10.336	9.080
1965.000	0.65	1.528	12.175	-15.599	-38.558	5.888	-36.872	1.686	-10.449	9.460
1970.000	0.7	1.577	12.328	-15.789	-40.984	6.237	-39.259	1.725	-10.563	9.841
1975.000	0.75	1.619	12.480	-15.985	-43.483	6.586	-41.718	1.765	-10.676	10.223
1980.000	0.8	1.654	12.633	-16.186	-46.053	6.934	-44.249	1.804	-10.790	10.606
1985.000	0.85	1.683	12.786	-16.394	-48.695	7.282	-46.852	1.843	-10.903	10.991
1990.000	0.9	1.704	12.939	-16.608	-51.410	7.628	-49.527	1.883	-11.017	11.376
1995.000	0.95	1.719	13.092	-16.827	-54.196	7.974	-52.274	1.922	-11.131	11.763
2000.000	1	1.727	13.245	-17.053	-57.054	8.320	-55.093	1.962	-11.244	12.150
2005.000	1.05	1.728	13.398	-17.284	-59.984	8.665	-57.983	2.001	-11.358	12.539
2010.000	1.1	1.723	13.552	-17.521	-62.986	9.009	-60.946	2.040	-11.473	12.928
2015.000	1.15	1.710	13.705	-17.765	-66.060	9.352	-63.981	2.080	-11.587	13.319
2020.000	1.2	1.691	13.859	-18.014	-69.207	9.695	-67.087	2.119	-11.701	13.711
2025.000	1.25	1.665	14.013	-18.269	-72.425	10.037	-70.266	2.159	-11.816	14.104
2030.000	1.3	1.632	14.167	-18.530	-75.714	10.379	-73.516	2.198	-11.930	14.498
2035.000	1.35	1.592	14.321	-18.797	-79.076	10.720	-76.839	2.238	-12.045	14.893
2040.000	1.4	1.546	14.475	-19.070	-82.510	11.060	-80.233	2.277	-12.160	15.290

Julian Year	'T' in Julian Centuries	δ*l* (1)	δ*l'* (2)	δF (3)	δD (4)	δ☊ (5)	δ☽ (6)	δL (7)	δπ' (8)	δπ (9)
2045.000	1.45	1.492	14.630	-19.349	-86.016	11.399	-83.699	2.316	-12.275	15.687
2050.000	1.5	1.432	14.784	-19.634	-89.594	11.738	-87.238	2.356	-12.390	16.085
2055.000	1.55	1.365	14.939	-19.925	-93.244	12.077	-90.848	2.395	-12.506	16.485
2060.000	1.6	1.291	15.094	-20.221	-96.965	12.414	-94.530	2.435	-12.622	16.885
2065.000	1.65	1.210	15.250	-20.524	-100.759	12.751	-98.284	2.475	-12.738	17.287
2070.000	1.7	1.122	15.405	-20.833	-104.625	13.087	-102.110	2.514	-12.854	17.690
2075.000	1.75	1.028	15.561	-21.147	-108.562	13.423	-106.008	2.554	-12.970	18.093
2080.000	1.8	0.927	15.717	-21.467	-112.572	13.758	-109.978	2.593	-13.087	18.498
2085.000	1.85	0.818	15.873	-21.794	-116.653	14.092	-114.020	2.633	-13.204	18.904
2090.000	1.9	0.703	16.030	-22.126	-120.807	14.425	-118.134	2.672	-13.321	19.311
2095.000	1.95	0.582	16.187	-22.464	-125.032	14.758	-122.320	2.712	-13.438	19.720
2100.000	2	0.453	16.344	-22.809	-129.330	15.091	-126.578	2.752	-13.556	20.129
2105.000	2.05	0.317	16.502	-23.159	-133.699	15.422	-130.907	2.791	-13.674	20.539
2110.000	2.1	0.175	16.659	-23.515	-138.141	15.753	-135.309	2.831	-13.792	20.951
2115.000	2.15	0.026	16.817	-23.877	-142.654	16.083	-139.783	2.871	-13.911	21.363
2120.000	2.2	-0.130	16.976	-24.245	-147.239	16.413	-144.328	2.910	-14.030	21.777
2125.000	2.25	-0.293	17.134	-24.619	-151.897	16.742	-148.946	2.950	-14.149	22.192
2130.000	2.3	-0.463	17.294	-24.999	-156.626	17.070	-153.635	2.990	-14.269	22.607
2135.000	2.35	-0.639	17.453	-25.384	-161.427	17.398	-158.397	3.030	-14.389	23.024
2140.000	2.4	-0.823	17.613	-25.776	-166.300	17.724	-163.230	3.069	-14.509	23.442
2145.000	2.45	-1.013	17.773	-26.174	-171.245	18.051	-168.136	3.109	-14.630	23.861
2150.000	2.5	-1.210	17.933	-26.577	-176.262	18.376	-173.113	3.149	-14.751	24.282
2155.000	2.55	-1.414	18.094	-26.987	-181.351	18.701	-178.162	3.189	-14.872	24.703
2160.000	2.6	-1.625	18.256	-27.402	-186.512	19.025	-183.283	3.228	-14.994	25.125
2165.000	2.65	-1.842	18.417	-27.823	-191.745	19.349	-188.476	3.268	-15.116	25.549
2170.000	2.7	-2.067	18.579	-28.251	-197.050	19.672	-193.742	3.308	-15.238	25.973
2175.000	2.75	-2.298	18.742	-28.684	-202.427	19.994	-199.079	3.348	-15.361	26.399
2180.000	2.8	-2.537	18.905	-29.123	-207.876	20.315	-204.488	3.388	-15.485	26.826
2185.000	2.85	-2.782	19.068	-29.568	-213.397	20.636	-209.969	3.428	-15.609	27.254
2190.000	2.9	-3.034	19.232	-30.019	-218.990	20.956	-215.522	3.467	-15.733	27.683
2195.000	2.95	-3.293	19.396	-30.476	-224.655	21.276	-221.146	3.507	-15.858	28.113
2200.000	3	-3.558	19.561	-30.939	-230.391	21.595	-226.843	3.547	-15.983	28.544
2205.000	3.05	-3.831	19.727	-31.408	-236.200	21.913	-232.612	3.587	-16.108	28.976
2210.000	3.1	-4.110	19.892	-31.883	-242.081	22.230	-238.453	3.627	-16.235	29.410
2215.000	3.15	-4.396	20.059	-32.363	-248.033	22.547	-244.366	3.667	-16.361	29.844
2220.000	3.2	-4.690	20.225	-32.850	-254.058	22.863	-250.350	3.707	-16.488	30.280
2225.000	3.25	-4.990	20.393	-33.342	-260.155	23.179	-256.407	3.747	-16.616	30.717
2230.000	3.3	-5.297	20.560	-33.841	-266.323	23.494	-262.536	3.787	-16.744	31.155
2235.000	3.35	-5.610	20.729	-34.345	-272.564	23.808	-268.736	3.827	-16.873	31.594
2240.000	3.4	-5.931	20.897	-34.856	-278.876	24.121	-275.009	3.867	-17.002	32.034
2245.000	3.45	-6.258	21.067	-35.372	-285.261	24.434	-281.353	3.907	-17.132	32.475
2250.000	3.5	-6.593	21.237	-35.894	-291.717	24.746	-287.770	3.947	-17.262	32.917
2255.000	3.55	-6.934	21.407	-36.422	-298.246	25.057	-294.258	3.987	-17.393	33.361
2260.000	3.6	-7.282	21.578	-36.956	-304.846	25.368	-300.818	4.027	-17.524	33.805
2265.000	3.65	-7.637	21.750	-37.496	-311.519	25.678	-307.451	4.067	-17.656	34.251
2270.000	3.7	-7.999	21.922	-38.042	-318.263	25.987	-314.155	4.107	-17.789	34.698
2275.000	3.75	-8.368	22.095	-38.594	-325.080	26.296	-320.931	4.147	-17.922	35.146
2280.000	3.8	-8.744	22.269	-39.152	-331.968	26.604	-327.779	4.187	-18.056	35.595
2285.000	3.85	-9.127	22.443	-39.716	-338.928	26.911	-334.700	4.227	-18.190	36.045

Julian Year	**'T' in Julian Centuries**	**δ*l* (1)**	**δ*l'* (2)**	**δF (3)**	**δD (4)**	**δ☊ (5)**	**δ☽ (6)**	**δL (7)**	**δπ' (8)**	**δπ (9)**
2290.000	3.9	-9.516	22.618	-40.285	-345.960	27.218	-341.692	4.267	-18.325	36.496
2295.000	3.95	-9.913	22.793	-40.861	-353.065	27.524	-348.756	4.307	-18.461	36.949
2300.000	4	-10.316	22.969	-41.443	-360.241	27.829	-355.892	4.347	-18.597	37.402
2305.000	4.05	-10.726	23.146	-42.030	-367.489	28.133	-363.100	4.388	-18.734	37.857
2310.000	4.1	-11.143	23.323	-42.623	-374.809	28.437	-370.380	4.428	-18.872	38.313
2315.000	4.15	-11.567	23.501	-43.223	-382.202	28.740	-377.732	4.468	-19.010	38.770
2320.000	4.2	-11.998	23.680	-43.828	-389.666	29.043	-385.156	4.508	-19.149	39.228
2325.000	4.25	-12.436	23.859	-44.439	-397.202	29.345	-392.652	4.548	-19.289	39.688
2330.000	4.3	-12.881	24.039	-45.056	-404.810	29.646	-400.220	4.588	-19.429	40.148
2335.000	4.35	-13.333	24.220	-45.679	-412.490	29.946	-407.860	4.628	-19.570	40.610
2340.000	4.4	-13.791	24.402	-46.308	-420.242	30.246	-415.572	4.669	-19.712	41.072
2345.000	4.45	-14.257	24.584	-46.943	-428.066	30.545	-423.355	4.709	-19.855	41.536
2350.000	4.5	-14.730	24.767	-47.584	-435.962	30.843	-431.211	4.749	-19.998	42.001
2355.000	4.55	-15.209	24.951	-48.231	-443.930	31.141	-439.139	4.789	-20.142	42.468
2360.000	4.6	-15.695	25.135	-48.883	-451.970	31.438	-447.139	4.829	-20.287	42.935
2365.000	4.65	-16.189	25.321	-49.542	-460.082	31.734	-455.210	4.870	-20.432	43.403
2370.000	4.7	-16.689	25.507	-50.206	-468.266	32.029	-463.354	4.910	-20.578	43.873
2375.000	4.75	-17.196	25.693	-50.877	-476.522	32.324	-471.570	4.950	-20.725	44.344
2380.000	4.8	-17.710	25.881	-51.553	-484.850	32.618	-479.858	4.990	-20.873	44.816
2385.000	4.85	-18.231	26.070	-52.235	-493.250	32.911	-488.217	5.031	-21.022	45.289
2390.000	4.9	-18.759	26.259	-52.924	-501.722	33.204	-496.649	5.071	-21.171	45.763
2395.000	4.95	-19.294	26.449	-53.618	-510.266	33.496	-505.152	5.111	-21.322	46.239
2400.000	5	-19.836	26.640	-54.318	-518.882	33.787	-513.728	5.151	-21.473	46.716
2405.000	5.05	-20.385	26.831	-55.024	-527.570	34.078	-522.375	5.192	-21.625	47.194
2410.000	5.1	-20.941	27.024	-55.736	-536.330	34.368	-531.095	5.232	-21.777	47.673
2415.000	5.15	-21.504	27.217	-56.454	-545.161	34.657	-539.887	5.272	-21.931	48.153
2420.000	5.2	-22.073	27.412	-57.177	-554.065	34.946	-548.750	5.313	-22.086	48.634
2425.000	5.25	-22.650	27.607	-57.907	-563.041	35.233	-557.686	5.353	-22.241	49.117
2430.000	5.3	-23.234	27.803	-58.643	-572.089	35.520	-566.693	5.393	-22.397	49.601
2435.000	5.35	-23.825	28.000	-59.384	-581.209	35.807	-575.772	5.433	-22.554	50.086
2440.000	5.4	-24.422	28.198	-60.132	-590.401	36.092	-584.924	5.474	-22.712	50.572
2445.000	5.45	-25.027	28.396	-60.885	-599.664	36.377	-594.147	5.514	-22.871	51.059
2450.000	5.5	-25.639	28.596	-61.645	-609.000	36.661	-603.443	5.554	-23.031	51.548
2455.000	5.55	-26.257	28.797	-62.410	-618.408	36.945	-612.810	5.595	-23.192	52.038
2460.000	5.6	-26.883	28.998	-63.181	-627.888	37.228	-622.250	5.635	-23.354	52.529
2465.000	5.65	-27.515	29.200	-63.958	-637.440	37.510	-631.761	5.675	-23.516	53.021
2470.000	5.7	-28.155	29.404	-64.741	-647.063	37.791	-641.344	5.716	-23.680	53.514
2475.000	5.75	-28.802	29.608	-65.530	-656.759	38.071	-651.000	5.756	-23.845	54.009
2480.000	5.8	-29.455	29.814	-66.325	-666.527	38.351	-660.727	5.796	-24.010	54.505
2485.000	5.85	-30.116	30.020	-67.126	-676.367	38.631	-670.526	5.837	-24.177	55.002
2490.000	5.9	-30.784	30.227	-67.933	-686.278	38.909	-680.398	5.877	-24.344	55.500
2495.000	5.95	-31.458	30.436	-68.745	-696.262	39.187	-690.341	5.917	-24.513	55.999
2500.000	6	-32.140	30.645	-69.564	-706.318	39.464	-700.357	5.958	-24.682	56.500
	Max	**1.728**	**30.645**	**-12.661**	**1.146**	**39.464**	**1.542**	**5.958**	**-6.676**	**56.500**
	Min	**-32.140**	**7.111**	**-69.564**	**-706.318**	**-6.012**	**-700.357**	**0.396**	**-24.682**	**-2.504**

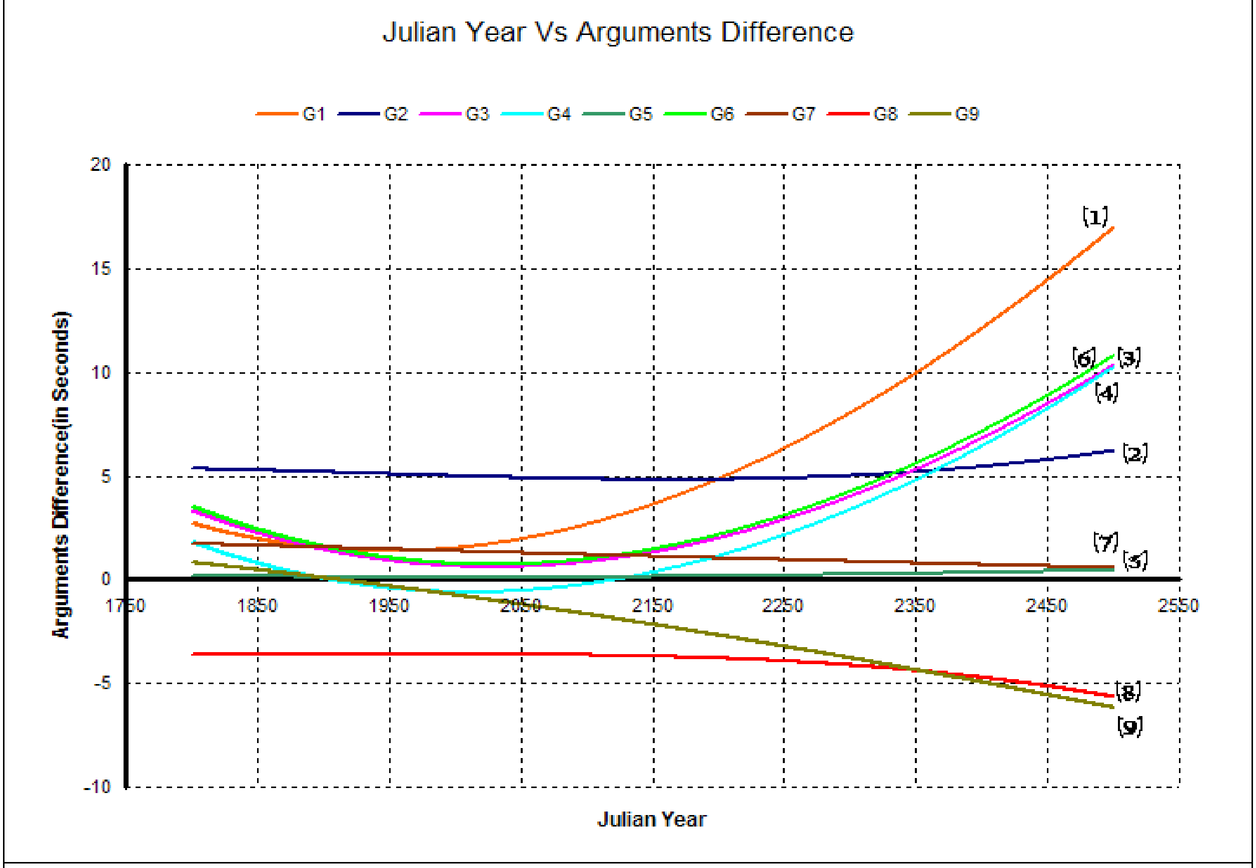

Chart 5: J1900(Derived from IAU 2000A Nutation Model)-J1900(Derived from IAU 1980 Nutation Model)

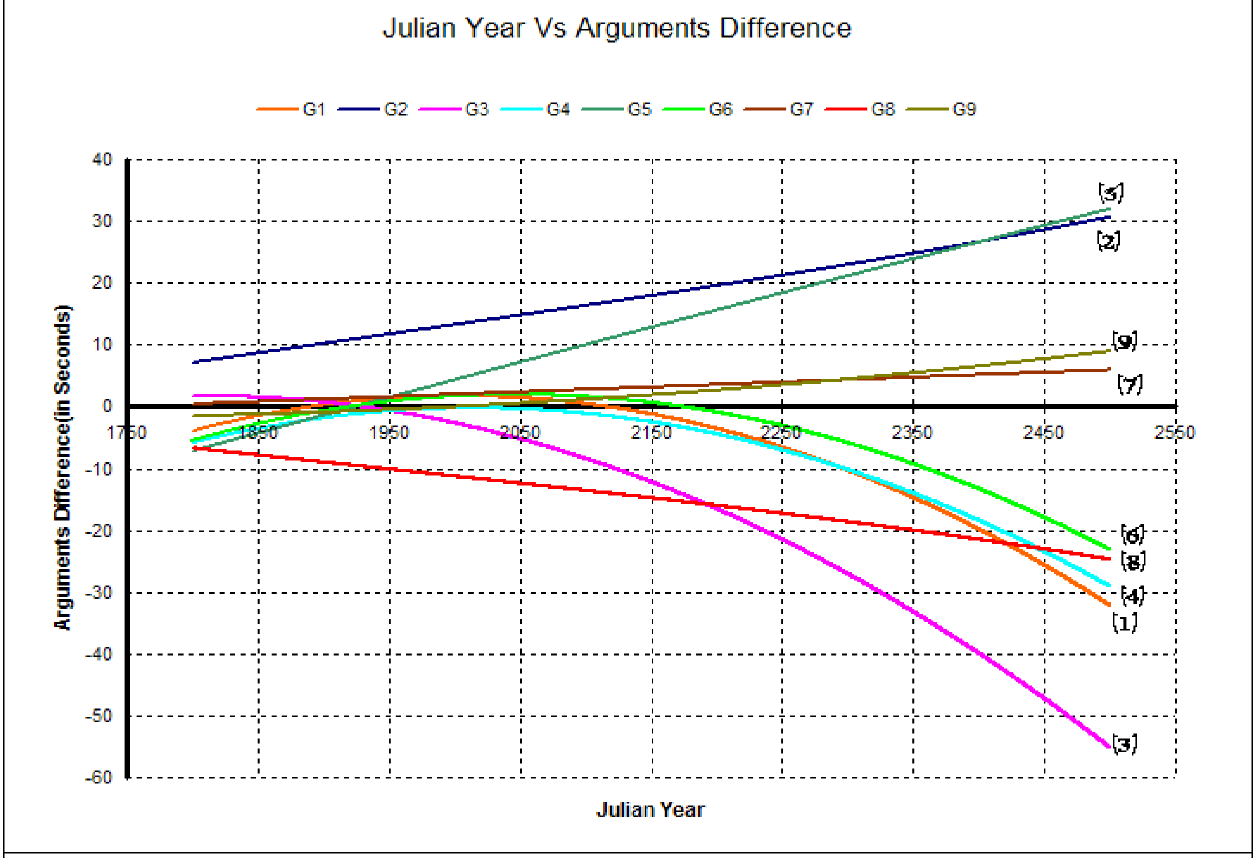

Chart 6: J1900(Derived from IAU 2000A Nutation Model)-J1900(IAU1964 Nutation Model-E.W.Woolard 1953)

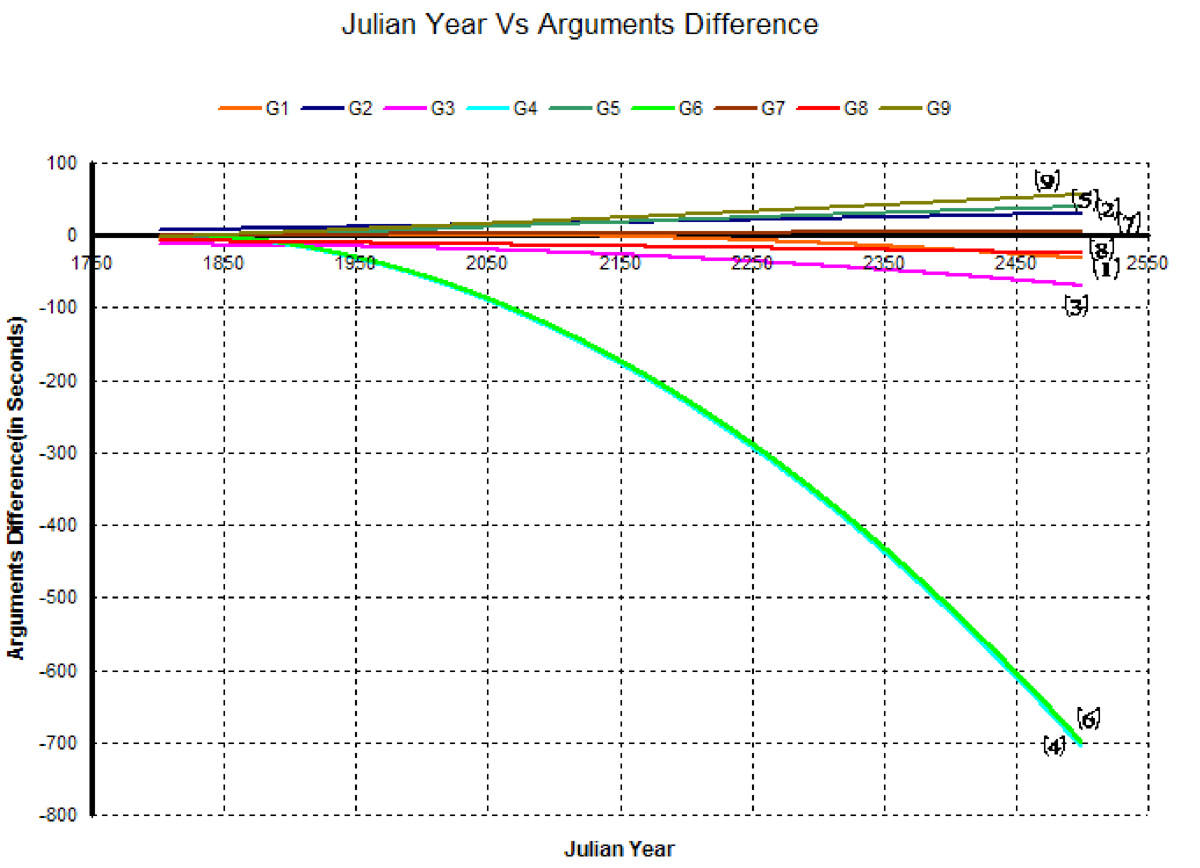

Chart 7: J1900(Derived from IAU 2000A Nutation Model)-J1900(Nutation Model-Newcomb)

From Chart 5: (With Reference to J1900)

The Maximum positive variation in the fundamental arguments found in the range of 17 Seconds for the mean anomaly of the Moon (l = ☽ - π) and similarly maximum negative variation is found in the range of -7 Seconds for the Mean longitude of Sun's Perigee (π = ☽ - l) and all other fundamental arguments lies within these limits for the range of epoch considered. These variations are insignificant to give major difference for Nutation in Longitude between IAU2000A & IAU1980 Nutation Models. Also notice Chart 5 is same as Chart 2 shown above.

From Chart 6: (With Reference to J1900)

The Maximum positive variation in the fundamental arguments found in the range of 32 Seconds for the Mean longitude of the Moon's mean ascending Node(☊) and similarly maximum negative variation is found in the range of -55 Seconds for the mean anomaly of the Sun (l'= L-π') and all other fundamental arguments lies within these limits for the range of epoch considered. These variations are insignificant to give major difference for Nutation in Longitude between IAU2000A & IAU1964 Nutation Models. Also notice Chart 6 is same as Chart 3 shown above.

From Chart 7: (With Reference to J1900)

The Maximum positive variation in the fundamental arguments found in the range of 57 Seconds for the Mean longitude of Sun's Perigee (π' = L – l') similarly maximum negative variation is found in the range of -706 Seconds for the mean elongation of the Moon from the Sun (D= ☽ - L) and all other fundamental arguments lies within these limits for the range of epoch considered. These variations are insignificant to give major difference in Nutation in Longitude between IAU2000A & NewComb's Nutation Models. Also notice Chart 7 is same as Chart 4 shown above.

7.6.3 Comparison of Fundamental arguments of Nutation Models (Ref. to B1900 Epoch)

The recent Nutation Model IAU2000A (with Reference to B1900 Epoch derived from J2000 Epoch) is compared with other Nutation Models and the differences in Coefficient Values are tabulated below.

Table 13: Differences in Coefficient Values of the Fundamental Arguments (Ref. B1900 Epoch)

δArgument	**C_0**	**C_1**	**C_2**	**C_3**	**C_4**	**Remarks**
B1900(Derived from IAU 2000A Nutation Model)-B1900(Derived from IAU 1980 Nutation Model)						Chart 8
δ*l*	1.512552	-0.5897	0.6048	-0.011385	-0.00024468	(1)
δ*l*'	5.176601	-0.1870	-0.0127	0.012181	-0.00001149	(2)
δF	1.456262	-1.3369	0.5419	-0.012053	0.00000417	(3)
δD	0.048456	-1.1969	0.5574	-0.012279	-0.00003169	(4)
δ☊	0.139574	-0.0392	0.0177	-0.000060	-0.00005938	(5)
δ☽	1.595836	-1.3760	0.5596	-0.012113	-0.00005522	(6)
δL	1.547381	-0.1792	0.0022	0.000166	-0.00002353	(7)
δπ'	-3.629220	0.0079	0.0149	-0.012015	-0.00001204	(8)
δπ	0.083285	-0.7864	-0.0452	-0.000728	0.00018946	(9)
B1900(Derived from IAU 2000A Nutation Model)-B1900(Derived form IAU1964 Nutation Model-E.W.Woolard 1953)						Chart 9
δ*l*	0.268581	2.8252	-1.3671	0.000814	-0.00024468	(1)
δ*l*'	10.191629	3.0549	-0.0137	0.012181	-0.00001149	(2)
δF	0.728255	-2.1929	-1.1880	0.000146	0.00000417	(3)
δD	-1.832510	2.7900	-1.2205	-0.000080	-0.00003169	(4)
δ☊	-1.384376	5.7657	-0.0313	-0.000060	-0.00005938	(5)
δ☽	-0.656121	3.5728	-1.2193	0.000086	-0.00005522	(6)
δL	1.176389	0.7828	0.0012	0.000166	-0.00002353	(7)
δπ'	-9.015239	-2.2721	0.0149	-0.012015	-0.00001204	(8)
δπ	-0.924702	0.7476	0.1478	-0.000728	0.00018946	(9)
B1900(Derived from IAU 2000A Nutation Model)-B1900(Derived from Nutation Model-Newcomb)						Chart 10
δ*l*	0.268581	2.8252	-1.3671	0.000814	-0.00024468	(1)
δ*l*'	10.191629	3.0549	-0.0137	0.012181	-0.00001149	(2)
δF	-13.671745	-2.1929	-1.1880	0.000146	0.00000417	(3)
δD	-13.562784	-29.0995	-14.3910	-0.000080	-0.00003169	(4)
δ☊	1.285636	7.1657	-0.1313	-0.000060	-0.00005938	(5)
δ☽	-12.386395	-28.3167	-14.3887	0.000086	-0.00005522	(6)
δL	1.176389	0.7828	0.0022	0.000166	-0.00002353	(7)
δπ'	-8.975239	-2.2721	0.0149	-0.012015	-0.00001204	(8)
δπ	4.605354	7.3275	0.2178	-0.000728	0.00018946	(9)

Using the above differences in Coefficient Values each Argument's element value is calculated for the Besselian Year Corresponding to Julian Year 1800 to 2500 and plotted in a Graph to see the change in the values over a period of time and the findings are discussed further below.

Table 14: Chart8: B1900(Derived from IAU 2000A Nutation Model)-B1900(Derived from IAU 1980 Nutation Model)

Besselian Year	**'T'in Topical Centuries**	**δ*l* (1)**	**δ*l*' (2)**	**δF (3)**	**δD (4)**	**δ☊ (5)**	**δ☽ (6)**	**δL (7)**	**δπ' (8)**	**δπ (9)**
1799.997006	-1.000030	2.718	5.339	3.347	1.815	0.196	3.544	1.729	-3.610	0.825
1804.997113	-0.950029	2.628	5.332	3.226	1.699	0.193	3.419	1.719	-3.613	0.790
1809.997219	-0.900028	2.541	5.326	3.107	1.586	0.189	3.296	1.710	-3.615	0.755
1814.997326	-0.850027	2.458	5.319	2.992	1.476	0.186	3.177	1.701	-3.618	0.720
1819.997433	-0.800026	2.377	5.312	2.879	1.369	0.182	3.061	1.692	-3.620	0.684
1824.997540	-0.750025	2.300	5.305	2.769	1.265	0.179	2.948	1.683	-3.622	0.648
1829.997646	-0.700024	2.226	5.297	2.662	1.164	0.176	2.837	1.674	-3.623	0.612
1834.997753	-0.650022	2.154	5.289	2.558	1.065	0.173	2.730	1.665	-3.625	0.576
1839.997860	-0.600021	2.087	5.282	2.456	0.970	0.169	2.626	1.656	-3.626	0.539
1844.997967	-0.550020	2.022	5.274	2.358	0.877	0.166	2.524	1.647	-3.627	0.502
1849.998074	-0.500019	1.960	5.265	2.262	0.788	0.164	2.425	1.638	-3.628	0.465
1854.998180	-0.450018	1.901	5.257	2.169	0.701	0.161	2.330	1.628	-3.629	0.428
1859.998287	-0.400017	1.846	5.249	2.079	0.617	0.158	2.237	1.619	-3.629	0.391
1864.998394	-0.350016	1.794	5.240	1.991	0.536	0.155	2.147	1.610	-3.630	0.353
1869.998501	-0.300015	1.744	5.231	1.906	0.458	0.153	2.059	1.601	-3.630	0.315
1874.998608	-0.250014	1.698	5.222	1.825	0.383	0.150	1.975	1.592	-3.630	0.277
1879.998714	-0.200013	1.655	5.213	1.745	0.310	0.148	1.894	1.583	-3.630	0.239
1884.998821	-0.150012	1.615	5.204	1.669	0.241	0.146	1.815	1.574	-3.630	0.200
1889.998928	-0.100011	1.578	5.195	1.595	0.174	0.144	1.739	1.565	-3.630	0.161
1894.999035	-0.050010	1.544	5.186	1.524	0.110	0.142	1.666	1.556	-3.630	0.122
1899.999142	-0.000009	1.513	5.177	1.456	0.048	0.140	1.596	1.547	-3.629	0.083
1904.999248	0.049992	1.485	5.167	1.391	-0.010	0.138	1.528	1.538	-3.629	0.044
1909.999355	0.099994	1.460	5.158	1.328	-0.066	0.136	1.464	1.529	-3.628	0.004
1914.999462	0.149995	1.438	5.148	1.268	-0.119	0.134	1.402	1.521	-3.628	-0.036
1919.999569	0.199996	1.419	5.139	1.210	-0.169	0.132	1.343	1.512	-3.627	-0.076
1924.999676	0.249997	1.403	5.129	1.156	-0.216	0.131	1.287	1.503	-3.627	-0.116
1929.999782	0.299998	1.390	5.120	1.104	-0.261	0.129	1.233	1.494	-3.626	-0.157
1934.999889	0.349999	1.380	5.110	1.054	-0.303	0.128	1.182	1.485	-3.625	-0.197
1939.999996	0.400000	1.373	5.101	1.007	-0.342	0.127	1.134	1.476	-3.624	-0.239
1945.000103	0.450001	1.369	5.091	0.963	-0.378	0.126	1.089	1.467	-3.624	-0.280
1950.000210	0.500002	1.367	5.081	0.922	-0.412	0.124	1.046	1.458	-3.623	-0.321
1955.000316	0.550003	1.369	5.072	0.883	-0.443	0.123	1.006	1.450	-3.622	-0.363
1960.000423	0.600004	1.374	5.062	0.847	-0.472	0.122	0.969	1.441	-3.622	-0.405
1965.000530	0.650005	1.382	5.053	0.813	-0.497	0.122	0.935	1.432	-3.621	-0.447
1970.000637	0.700006	1.392	5.044	0.782	-0.520	0.121	0.903	1.423	-3.621	-0.489
1975.000744	0.750007	1.406	5.034	0.753	-0.541	0.120	0.873	1.414	-3.620	-0.532
1980.000850	0.800009	1.422	5.025	0.727	-0.559	0.120	0.847	1.406	-3.620	-0.575
1985.000957	0.850010	1.441	5.016	0.704	-0.574	0.119	0.823	1.397	-3.619	-0.618
1990.001064	0.900011	1.463	5.007	0.683	-0.586	0.119	0.802	1.388	-3.619	-0.661
1995.001171	0.950012	1.488	4.998	0.665	-0.596	0.118	0.783	1.379	-3.619	-0.705
2000.001278	1.000013	1.516	4.989	0.649	-0.603	0.118	0.767	1.371	-3.618	-0.749
2005.001384	1.050014	1.547	4.980	0.636	-0.608	0.118	0.754	1.362	-3.618	-0.793
2010.001491	1.100015	1.580	4.972	0.625	-0.610	0.118	0.743	1.353	-3.619	-0.837
2015.001598	1.150016	1.617	4.963	0.617	-0.609	0.118	0.735	1.344	-3.619	-0.882
2020.001705	1.200017	1.656	4.955	0.612	-0.606	0.118	0.729	1.336	-3.619	-0.926
2025.001811	1.250018	1.698	4.947	0.608	-0.601	0.118	0.726	1.327	-3.620	-0.971
2030.001918	1.300019	1.742	4.939	0.608	-0.593	0.118	0.726	1.319	-3.620	-1.016
2035.002025	1.350020	1.790	4.931	0.609	-0.582	0.119	0.728	1.310	-3.621	-1.062

Besselian Year	'T'in Topical Centuries	δ*l* (1)	δ*l*' (2)	δF (3)	δD (4)	δ☊ (5)	δ☽ (6)	δL (7)	δπ' (8)	δπ (9)
2040.002132	1.400021	1.840	4.923	0.614	-0.568	0.119	0.733	1.301	-3.622	-1.107
2045.002239	1.450022	1.893	4.916	0.620	-0.553	0.120	0.740	1.293	-3.623	-1.153
2050.002345	1.500023	1.949	4.909	0.630	-0.534	0.120	0.750	1.284	-3.624	-1.199
2055.002452	1.550025	2.008	4.902	0.641	-0.513	0.121	0.762	1.276	-3.626	-1.246
2060.002559	1.600026	2.069	4.895	0.655	-0.490	0.122	0.777	1.267	-3.628	-1.292
2065.002666	1.650027	2.133	4.888	0.672	-0.464	0.123	0.794	1.258	-3.630	-1.339
2070.002773	1.700028	2.200	4.882	0.691	-0.436	0.123	0.814	1.250	-3.632	-1.386
2075.002879	1.750029	2.270	4.876	0.712	-0.405	0.124	0.836	1.241	-3.634	-1.433
2080.002986	1.800030	2.342	4.870	0.735	-0.372	0.126	0.861	1.233	-3.637	-1.481
2085.003093	1.850031	2.417	4.864	0.761	-0.336	0.127	0.888	1.224	-3.640	-1.528
2090.003200	1.900032	2.494	4.859	0.790	-0.298	0.128	0.918	1.216	-3.643	-1.576
2095.003307	1.950033	2.574	4.854	0.821	-0.257	0.129	0.950	1.207	-3.646	-1.624
2100.003413	2.000034	2.657	4.849	0.854	-0.214	0.131	0.985	1.199	-3.650	-1.673
2105.003520	2.050035	2.743	4.845	0.889	-0.169	0.132	1.022	1.190	-3.654	-1.721
2110.003627	2.100036	2.831	4.840	0.927	-0.121	0.134	1.061	1.182	-3.658	-1.770
2115.003734	2.150037	2.922	4.837	0.967	-0.071	0.136	1.103	1.174	-3.663	-1.819
2120.003841	2.200038	3.016	4.833	1.010	-0.018	0.137	1.147	1.165	-3.668	-1.869
2125.003947	2.250039	3.112	4.830	1.055	0.037	0.139	1.194	1.157	-3.673	-1.918
2130.004054	2.300041	3.210	4.827	1.102	0.094	0.141	1.243	1.148	-3.679	-1.968
2135.004161	2.350042	3.312	4.825	1.151	0.154	0.143	1.294	1.140	-3.685	-2.018
2140.004268	2.400043	3.416	4.823	1.203	0.216	0.145	1.348	1.132	-3.691	-2.068
2145.004375	2.450044	3.522	4.821	1.257	0.280	0.147	1.404	1.123	-3.698	-2.118
2150.004481	2.500045	3.631	4.820	1.313	0.347	0.149	1.462	1.115	-3.705	-2.169
2155.004588	2.550046	3.743	4.819	1.371	0.416	0.152	1.523	1.107	-3.712	-2.220
2160.004695	2.600047	3.857	4.818	1.432	0.487	0.154	1.586	1.098	-3.720	-2.271
2165.004802	2.650048	3.973	4.818	1.495	0.561	0.156	1.651	1.090	-3.728	-2.322
2170.004909	2.700049	4.092	4.818	1.560	0.637	0.159	1.719	1.082	-3.736	-2.373
2175.005015	2.750050	4.214	4.819	1.628	0.715	0.161	1.789	1.074	-3.745	-2.425
2180.005122	2.800051	4.338	4.820	1.697	0.796	0.164	1.861	1.065	-3.755	-2.477
2185.005229	2.850052	4.465	4.822	1.769	0.879	0.167	1.936	1.057	-3.765	-2.529
2190.005336	2.900053	4.594	4.824	1.843	0.964	0.170	2.013	1.049	-3.775	-2.581
2195.005443	2.950054	4.726	4.826	1.919	1.051	0.172	2.092	1.041	-3.786	-2.634
2200.005549	3.000055	4.860	4.829	1.998	1.141	0.175	2.173	1.033	-3.797	-2.686
2205.005656	3.050057	4.996	4.833	2.078	1.232	0.178	2.257	1.024	-3.808	-2.739
2210.005763	3.100058	5.135	4.837	2.161	1.326	0.181	2.342	1.016	-3.821	-2.793
2215.005870	3.150059	5.276	4.841	2.246	1.422	0.184	2.430	1.008	-3.833	-2.846
2220.005977	3.200060	5.420	4.846	2.333	1.521	0.188	2.521	1.000	-3.846	-2.899
2225.006083	3.250061	5.566	4.852	2.422	1.621	0.191	2.613	0.992	-3.860	-2.953
2230.006190	3.300062	5.715	4.858	2.513	1.724	0.194	2.708	0.984	-3.874	-3.007
2235.006297	3.350063	5.866	4.864	2.607	1.829	0.198	2.805	0.976	-3.889	-3.061
2240.006404	3.400064	6.019	4.871	2.702	1.936	0.201	2.903	0.967	-3.904	-3.116
2245.006510	3.450065	6.175	4.879	2.800	2.045	0.205	3.005	0.959	-3.920	-3.170
2250.006617	3.500066	6.333	4.887	2.900	2.157	0.208	3.108	0.951	-3.936	-3.225
2255.006724	3.550067	6.493	4.896	3.001	2.270	0.212	3.213	0.943	-3.953	-3.280
2260.006831	3.600068	6.656	4.905	3.105	2.386	0.216	3.321	0.935	-3.970	-3.335
2265.006938	3.650069	6.821	4.915	3.211	2.503	0.219	3.431	0.927	-3.988	-3.390
2270.007044	3.700070	6.988	4.926	3.319	2.623	0.223	3.542	0.919	-4.007	-3.446
2275.007151	3.750072	7.158	4.937	3.429	2.745	0.227	3.656	0.911	-4.026	-3.501
2280.007258	3.800073	7.330	4.949	3.541	2.869	0.231	3.772	0.903	-4.046	-3.557

Besselian Year	'T'in Topical Centuries	δ*l* (1)	δ*l'* (2)	δF (3)	δD (4)	δ☊ (5)	δ☽ (6)	δL (7)	δπ' (8)	δπ (9)
2285.007365	3.850074	7.504	4.961	3.655	2.995	0.235	3.890	0.895	-4.066	-3.613
2290.007472	3.900075	7.680	4.974	3.771	3.123	0.239	4.010	0.887	-4.087	-3.670
2295.007578	3.950076	7.859	4.988	3.889	3.254	0.243	4.133	0.879	-4.109	-3.726
2300.007685	4.000077	8.040	5.002	4.009	3.386	0.248	4.257	0.871	-4.131	-3.783
2305.007792	4.050078	8.223	5.017	4.131	3.520	0.252	4.383	0.863	-4.154	-3.840
2310.007899	4.100079	8.408	5.033	4.255	3.656	0.256	4.511	0.855	-4.178	-3.896
2315.008006	4.150080	8.595	5.049	4.381	3.795	0.261	4.642	0.847	-4.202	-3.954
2320.008112	4.200081	8.785	5.066	4.509	3.935	0.265	4.774	0.839	-4.227	-4.011
2325.008219	4.250082	8.977	5.084	4.639	4.077	0.270	4.909	0.831	-4.253	-4.068
2330.008326	4.300083	9.171	5.103	4.771	4.222	0.274	5.045	0.823	-4.279	-4.126
2335.008433	4.350084	9.367	5.122	4.905	4.368	0.279	5.183	0.816	-4.306	-4.184
2340.008540	4.400085	9.566	5.142	5.040	4.516	0.283	5.324	0.808	-4.334	-4.242
2345.008646	4.450086	9.766	5.162	5.178	4.666	0.288	5.466	0.800	-4.362	-4.300
2350.008753	4.500088	9.969	5.184	5.318	4.818	0.293	5.610	0.792	-4.392	-4.358
2355.008860	4.550089	10.173	5.206	5.459	4.972	0.297	5.757	0.784	-4.422	-4.417
2360.008967	4.600090	10.380	5.229	5.602	5.128	0.302	5.905	0.776	-4.452	-4.475
2365.009074	4.650091	10.589	5.252	5.748	5.286	0.307	6.055	0.768	-4.484	-4.534
2370.009180	4.700092	10.800	5.277	5.895	5.446	0.312	6.207	0.760	-4.516	-4.593
2375.009287	4.750093	11.013	5.302	6.044	5.608	0.317	6.361	0.753	-4.549	-4.652
2380.009394	4.800094	11.228	5.328	6.194	5.772	0.322	6.516	0.745	-4.583	-4.712
2385.009501	4.850095	11.445	5.355	6.347	5.937	0.327	6.674	0.737	-4.618	-4.771
2390.009608	4.900096	11.664	5.382	6.502	6.105	0.332	6.834	0.729	-4.653	-4.830
2395.009714	4.950097	11.885	5.411	6.658	6.274	0.337	6.995	0.721	-4.689	-4.890
2400.009821	5.000098	12.108	5.440	6.816	6.445	0.343	7.158	0.714	-4.726	-4.950
2405.009928	5.050099	12.334	5.470	6.976	6.618	0.348	7.324	0.706	-4.764	-5.010
2410.010035	5.100100	12.561	5.501	7.138	6.793	0.353	7.491	0.698	-4.803	-5.070
2415.010142	5.150101	12.790	5.533	7.301	6.969	0.358	7.659	0.690	-4.843	-5.130
2420.010248	5.200102	13.021	5.566	7.466	7.148	0.364	7.830	0.682	-4.883	-5.191
2425.010355	5.250104	13.254	5.599	7.633	7.328	0.369	8.003	0.675	-4.925	-5.251
2430.010462	5.300105	13.488	5.634	7.802	7.510	0.374	8.177	0.667	-4.967	-5.312
2435.010569	5.350106	13.725	5.669	7.973	7.694	0.380	8.353	0.659	-5.010	-5.372
2440.010675	5.400107	13.964	5.705	8.145	7.879	0.385	8.531	0.651	-5.054	-5.433
2445.010782	5.450108	14.204	5.743	8.319	8.067	0.391	8.710	0.644	-5.099	-5.494
2450.010889	5.500109	14.447	5.781	8.495	8.256	0.396	8.891	0.636	-5.145	-5.555
2455.010996	5.550110	14.691	5.820	8.673	8.447	0.402	9.075	0.628	-5.192	-5.617
2460.011103	5.600111	14.937	5.860	8.852	8.639	0.408	9.259	0.620	-5.239	-5.678
2465.011209	5.650112	15.185	5.901	9.033	8.833	0.413	9.446	0.613	-5.288	-5.739
2470.011316	5.700113	15.435	5.942	9.215	9.029	0.419	9.634	0.605	-5.338	-5.801
2475.011423	5.750114	15.687	5.985	9.400	9.227	0.424	9.824	0.597	-5.388	-5.862
2480.011530	5.800115	15.940	6.029	9.586	9.427	0.430	10.016	0.589	-5.440	-5.924
2485.011637	5.850116	16.195	6.074	9.773	9.628	0.436	10.209	0.582	-5.492	-5.986
2490.011743	5.900117	16.452	6.120	9.963	9.830	0.442	10.404	0.574	-5.546	-6.048
2495.011850	5.950119	16.711	6.167	10.154	10.035	0.447	10.601	0.566	-5.600	-6.110
2500.011957	6.000120	16.971	6.214	10.346	10.241	0.453	10.799	0.558	-5.656	-6.172
	Max	**16.971**	**6.214**	**10.346**	**10.241**	**0.453**	**10.799**	**1.729**	**-3.610**	**0.825**
	Min	**1.367**	**4.818**	**0.608**	**-0.610**	**0.118**	**0.726**	**0.558**	**-5.656**	**-6.172**

Table 15: Chart9: B1900(Derived from IAU 2000A Nutation Model)-B1900(Derived form IAU1964 Nutation Model-E.W.Woolard 1953)

Besselian Year	'T'in Topical Centuries	δ*l* (1)	δ*l'* (2)	δF (3)	δD (4)	δ☊ (5)	δ☽ (6)	δL (7)	δπ' (8)	δπ (9)
1799.997006	-1.000030	-3.925	7.111	1.733	-5.843	-7.182	-5.449	0.395	-6.716	-1.524
1804.997113	-0.950029	-3.650	7.267	1.739	-5.585	-6.890	-5.151	0.434	-6.833	-1.501
1809.997219	-0.900028	-3.382	7.422	1.739	-5.332	-6.599	-4.860	0.473	-6.949	-1.477
1814.997326	-0.850027	-3.121	7.578	1.734	-5.086	-6.308	-4.574	0.512	-7.066	-1.453
1819.997433	-0.800026	-2.867	7.733	1.722	-4.846	-6.017	-4.295	0.551	-7.182	-1.428
1824.997540	-0.750025	-2.620	7.888	1.705	-4.612	-5.726	-4.022	0.590	-7.298	-1.402
1829.997646	-0.700024	-2.379	8.042	1.681	-4.384	-5.436	-3.755	0.629	-7.413	-1.375
1834.997753	-0.650022	-2.146	8.197	1.652	-4.162	-5.145	-3.494	0.668	-7.529	-1.348
1839.997860	-0.600021	-1.919	8.351	1.616	-3.946	-4.855	-3.239	0.707	-7.644	-1.320
1844.997967	-0.550020	-1.699	8.505	1.575	-3.736	-4.565	-2.990	0.746	-7.759	-1.291
1849.998074	-0.500019	-1.486	8.659	1.528	-3.533	-4.275	-2.747	0.785	-7.874	-1.261
1854.998180	-0.450018	-1.280	8.813	1.474	-3.335	-3.985	-2.511	0.824	-7.989	-1.231
1859.998287	-0.400017	-1.080	8.967	1.415	-3.144	-3.696	-2.280	0.863	-8.103	-1.200
1864.998394	-0.350016	-0.888	9.120	1.350	-2.959	-3.406	-2.056	0.903	-8.218	-1.168
1869.998501	-0.300015	-0.702	9.274	1.279	-2.779	-3.117	-1.838	0.942	-8.332	-1.136
1874.998608	-0.250014	-0.523	9.427	1.202	-2.606	-2.828	-1.626	0.981	-8.446	-1.102
1879.998714	-0.200013	-0.351	9.580	1.119	-2.439	-2.539	-1.420	1.020	-8.560	-1.068
1884.998821	-0.150012	-0.186	9.733	1.030	-2.279	-2.250	-1.220	1.059	-8.674	-1.034
1889.998928	-0.100011	-0.028	9.886	0.936	-2.124	-1.961	-1.026	1.098	-8.788	-0.998
1894.999035	-0.050010	0.124	10.039	0.835	-1.975	-1.673	-0.838	1.137	-8.902	-0.962
1899.999142	-0.000009	0.269	10.192	0.728	-1.833	-1.384	-0.656	1.176	-9.015	-0.925
1904.999248	0.049992	0.406	10.344	0.616	-1.696	-1.096	-0.481	1.216	-9.129	-0.887
1909.999355	0.099994	0.537	10.497	0.497	-1.566	-0.808	-0.311	1.255	-9.242	-0.848
1914.999462	0.149995	0.662	10.650	0.373	-1.441	-0.520	-0.148	1.294	-9.356	-0.809
1919.999569	0.199996	0.779	10.802	0.242	-1.323	-0.233	0.010	1.333	-9.469	-0.769
1924.999676	0.249997	0.889	10.955	0.106	-1.211	0.055	0.161	1.372	-9.583	-0.729
1929.999782	0.299998	0.993	11.107	-0.037	-1.105	0.343	0.306	1.411	-9.696	-0.687
1934.999889	0.349999	1.090	11.260	-0.185	-1.006	0.630	0.445	1.451	-9.809	-0.645
1939.999996	0.400000	1.180	11.412	-0.339	-0.912	0.917	0.578	1.490	-9.922	-0.602
1945.000103	0.450001	1.263	11.565	-0.499	-0.824	1.204	0.705	1.529	-10.036	-0.558
1950.000210	0.500002	1.339	11.717	-0.665	-0.743	1.491	0.825	1.568	-10.149	-0.514
1955.000316	0.550003	1.409	11.870	-0.837	-0.667	1.777	0.940	1.607	-10.262	-0.469
1960.000423	0.600004	1.472	12.022	-1.015	-0.598	2.064	1.049	1.647	-10.376	-0.423
1965.000530	0.650005	1.528	12.175	-1.199	-0.535	2.350	1.151	1.686	-10.489	-0.376
1970.000637	0.700006	1.577	12.328	-1.389	-0.478	2.636	1.247	1.725	-10.603	-0.329
1975.000744	0.750007	1.619	12.480	-1.585	-0.427	2.922	1.338	1.764	-10.716	-0.281
1980.000850	0.800009	1.654	12.633	-1.786	-0.382	3.208	1.422	1.804	-10.830	-0.232
1985.000957	0.850010	1.683	12.786	-1.994	-0.343	3.494	1.500	1.843	-10.943	-0.183
1990.001064	0.900011	1.704	12.939	-2.208	-0.310	3.779	1.572	1.882	-11.057	-0.132
1995.001171	0.950012	1.719	13.092	-2.427	-0.284	4.065	1.638	1.921	-11.171	-0.081
2000.001278	1.000013	1.727	13.245	-2.653	-0.263	4.350	1.697	1.961	-11.284	-0.030
2005.001384	1.050014	1.728	13.398	-2.884	-0.249	4.635	1.751	2.000	-11.398	0.023
2010.001491	1.100015	1.723	13.552	-3.121	-0.240	4.920	1.799	2.039	-11.513	0.076
2015.001598	1.150016	1.710	13.705	-3.365	-0.238	5.205	1.840	2.078	-11.627	0.130
2020.001705	1.200017	1.691	13.859	-3.614	-0.242	5.489	1.876	2.118	-11.741	0.184
2025.001811	1.250018	1.665	14.013	-3.869	-0.252	5.774	1.905	2.157	-11.856	0.240
2030.001918	1.300019	1.632	14.167	-4.130	-0.268	6.058	1.928	2.196	-11.970	0.296
2035.002025	1.350020	1.592	14.321	-4.397	-0.291	6.342	1.945	2.236	-12.085	0.353

Besselian Year	'T'in Topical Centuries	δ*l* (1)	δ*l*' (2)	δF (3)	δD (4)	δ☊ (5)	δ☽ (6)	δL (7)	δπ' (8)	δπ (9)
2040.002132	1.400021	1.546	14.475	-4.670	-0.319	6.626	1.956	2.275	-12.200	0.410
2045.002239	1.450022	1.492	14.630	-4.949	-0.354	6.910	1.961	2.314	-12.315	0.469
2050.002345	1.500023	1.432	14.784	-5.234	-0.394	7.193	1.960	2.354	-12.430	0.528
2055.002452	1.550025	1.365	14.939	-5.525	-0.441	7.477	1.952	2.393	-12.546	0.588
2060.002559	1.600026	1.291	15.094	-5.821	-0.494	7.760	1.939	2.433	-12.662	0.648
2065.002666	1.650027	1.210	15.250	-6.124	-0.552	8.043	1.920	2.472	-12.778	0.710
2070.002773	1.700028	1.122	15.405	-6.432	-0.617	8.326	1.894	2.511	-12.894	0.772
2075.002879	1.750029	1.028	15.561	-6.747	-0.689	8.609	1.862	2.551	-13.010	0.834
2080.002986	1.800030	0.927	15.717	-7.067	-0.766	8.892	1.824	2.590	-13.127	0.898
2085.003093	1.850031	0.818	15.873	-7.394	-0.849	9.174	1.780	2.630	-13.244	0.962
2090.003200	1.900032	0.703	16.030	-7.726	-0.939	9.457	1.730	2.669	-13.361	1.027
2095.003307	1.950033	0.582	16.187	-8.064	-1.034	9.739	1.674	2.708	-13.478	1.093
2100.003413	2.000034	0.453	16.344	-8.409	-1.136	10.021	1.612	2.748	-13.596	1.159
2105.003520	2.050035	0.318	16.502	-8.759	-1.244	10.303	1.544	2.787	-13.714	1.226
2110.003627	2.100036	0.175	16.659	-9.115	-1.357	10.584	1.469	2.827	-13.832	1.294
2115.003734	2.150037	0.026	16.817	-9.477	-1.477	10.866	1.389	2.866	-13.951	1.363
2120.003841	2.200038	-0.130	16.976	-9.845	-1.603	11.147	1.302	2.906	-14.070	1.432
2125.003947	2.250039	-0.293	17.134	-10.219	-1.736	11.428	1.210	2.945	-14.189	1.503
2130.004054	2.300041	-0.463	17.294	-10.598	-1.874	11.709	1.111	2.985	-14.309	1.573
2135.004161	2.350042	-0.639	17.453	-10.984	-2.018	11.990	1.006	3.024	-14.429	1.645
2140.004268	2.400043	-0.823	17.613	-11.376	-2.169	12.271	0.895	3.064	-14.549	1.717
2145.004375	2.450044	-1.013	17.773	-11.773	-2.326	12.551	0.778	3.103	-14.670	1.791
2150.004481	2.500045	-1.210	17.933	-12.177	-2.488	12.832	0.655	3.143	-14.791	1.864
2155.004588	2.550046	-1.414	18.094	-12.586	-2.657	13.112	0.525	3.182	-14.912	1.939
2160.004695	2.600047	-1.625	18.256	-13.002	-2.832	13.392	0.390	3.222	-15.034	2.014
2165.004802	2.650048	-1.842	18.417	-13.423	-3.013	13.671	0.248	3.261	-15.156	2.091
2170.004909	2.700049	-2.067	18.579	-13.851	-3.200	13.951	0.101	3.301	-15.278	2.167
2175.005015	2.750050	-2.298	18.742	-14.284	-3.394	14.231	-0.053	3.341	-15.401	2.245
2180.005122	2.800051	-2.536	18.905	-14.723	-3.593	14.510	-0.213	3.380	-15.525	2.323
2185.005229	2.850052	-2.782	19.068	-15.168	-3.799	14.789	-0.379	3.420	-15.649	2.403
2190.005336	2.900053	-3.034	19.232	-15.619	-4.010	15.068	-0.551	3.459	-15.773	2.482
2195.005443	2.950054	-3.292	19.397	-16.076	-4.228	15.347	-0.729	3.499	-15.898	2.563
2200.005549	3.000055	-3.558	19.561	-16.539	-4.452	15.625	-0.913	3.539	-16.023	2.645
2205.005656	3.050057	-3.831	19.727	-17.008	-4.682	15.904	-1.104	3.578	-16.148	2.727
2210.005763	3.100058	-4.110	19.892	-17.482	-4.918	16.182	-1.300	3.618	-16.275	2.810
2215.005870	3.150059	-4.396	20.059	-17.963	-5.160	16.460	-1.503	3.657	-16.401	2.893
2220.005977	3.200060	-4.689	20.225	-18.450	-5.409	16.738	-1.712	3.697	-16.528	2.978
2225.006083	3.250061	-4.989	20.393	-18.942	-5.663	17.016	-1.927	3.737	-16.656	3.063
2230.006190	3.300062	-5.296	20.560	-19.441	-5.924	17.293	-2.147	3.776	-16.784	3.149
2235.006297	3.350063	-5.610	20.729	-19.945	-6.191	17.571	-2.374	3.816	-16.913	3.236
2240.006404	3.400064	-5.931	20.898	-20.455	-6.463	17.848	-2.608	3.856	-17.042	3.323
2245.006510	3.450065	-6.258	21.067	-20.972	-6.742	18.125	-2.847	3.895	-17.172	3.411
2250.006617	3.500066	-6.593	21.237	-21.494	-7.027	18.402	-3.092	3.935	-17.302	3.500
2255.006724	3.550067	-6.934	21.408	-22.022	-7.319	18.678	-3.344	3.975	-17.433	3.590
2260.006831	3.600068	-7.282	21.579	-22.556	-7.616	18.955	-3.601	4.014	-17.564	3.681
2265.006938	3.650069	-7.637	21.750	-23.096	-7.919	19.231	-3.865	4.054	-17.696	3.772
2270.007044	3.700070	-7.999	21.923	-23.642	-8.229	19.507	-4.135	4.094	-17.829	3.864
2275.007151	3.750072	-8.368	22.095	-24.194	-8.544	19.783	-4.411	4.134	-17.962	3.957
2280.007258	3.800073	-8.744	22.269	-24.752	-8.866	20.059	-4.693	4.173	-18.096	4.051

Besselian Year	'T'in Topical Centuries	δ*l* (1)	δ*l*' (2)	δF (3)	δD (4)	δ☊ (5)	δ☽ (6)	δL (7)	δπ' (8)	δπ (9)
2285.007365	3.850074	-9.126	22.443	-25.315	-9.194	20.334	-4.981	4.213	-18.230	4.145
2290.007472	3.900075	-9.516	22.618	-25.885	-9.528	20.610	-5.275	4.253	-18.365	4.240
2295.007578	3.950076	-9.912	22.793	-26.461	-9.868	20.885	-5.576	4.292	-18.501	4.336
2300.007685	4.000077	-10.316	22.969	-27.042	-10.214	21.160	-5.882	4.332	-18.637	4.433
2305.007792	4.050078	-10.726	23.146	-27.629	-10.567	21.434	-6.195	4.372	-18.774	4.531
2310.007899	4.100079	-11.143	23.323	-28.223	-10.925	21.709	-6.514	4.412	-18.912	4.629
2315.008006	4.150080	-11.567	23.501	-28.822	-11.290	21.983	-6.839	4.451	-19.050	4.728
2320.008112	4.200081	-11.998	23.680	-29.427	-11.661	22.258	-7.170	4.491	-19.189	4.828
2325.008219	4.250082	-12.436	23.860	-30.038	-12.038	22.532	-7.507	4.531	-19.329	4.929
2330.008326	4.300083	-12.881	24.040	-30.656	-12.421	22.806	-7.850	4.571	-19.469	5.031
2335.008433	4.350084	-13.332	24.220	-31.279	-12.810	23.079	-8.199	4.610	-19.610	5.133
2340.008540	4.400085	-13.791	24.402	-31.908	-13.205	23.353	-8.555	4.650	-19.752	5.236
2345.008646	4.450086	-14.257	24.584	-32.542	-13.606	23.626	-8.916	4.690	-19.894	5.340
2350.008753	4.500088	-14.729	24.767	-33.183	-14.014	23.899	-9.284	4.730	-20.038	5.445
2355.008860	4.550089	-15.209	24.951	-33.830	-14.428	24.172	-9.658	4.769	-20.182	5.550
2360.008967	4.600090	-15.695	25.136	-34.483	-14.847	24.444	-10.038	4.809	-20.326	5.657
2365.009074	4.650091	-16.188	25.321	-35.141	-15.273	24.717	-10.424	4.849	-20.472	5.764
2370.009180	4.700092	-16.688	25.507	-35.806	-15.705	24.989	-10.816	4.889	-20.618	5.872
2375.009287	4.750093	-17.196	25.694	-36.476	-16.143	25.261	-11.215	4.929	-20.765	5.981
2380.009394	4.800094	-17.710	25.881	-37.152	-16.588	25.533	-11.619	4.968	-20.913	6.090
2385.009501	4.850095	-18.231	26.070	-37.835	-17.038	25.805	-12.030	5.008	-21.062	6.201
2390.009608	4.900096	-18.759	26.259	-38.523	-17.495	26.076	-12.447	5.048	-21.211	6.312
2395.009714	4.950097	-19.294	26.449	-39.217	-17.957	26.348	-12.869	5.088	-21.361	6.424
2400.009821	5.000098	-19.836	26.640	-39.917	-18.426	26.619	-13.299	5.128	-21.512	6.537
2405.009928	5.050099	-20.384	26.832	-40.623	-18.901	26.889	-13.734	5.167	-21.664	6.651
2410.010035	5.100100	-20.940	27.024	-41.335	-19.382	27.160	-14.175	5.207	-21.817	6.765
2415.010142	5.150101	-21.503	27.218	-42.053	-19.869	27.430	-14.622	5.247	-21.971	6.881
2420.010248	5.200102	-22.073	27.412	-42.777	-20.363	27.701	-15.076	5.287	-22.125	6.997
2425.010355	5.250104	-22.650	27.607	-43.506	-20.862	27.971	-15.536	5.327	-22.281	7.114
2430.010462	5.300105	-23.233	27.803	-44.242	-21.368	28.241	-16.001	5.366	-22.437	7.232
2435.010569	5.350106	-23.824	28.000	-44.983	-21.879	28.510	-16.473	5.406	-22.594	7.351
2440.010675	5.400107	-24.422	28.198	-45.731	-22.397	28.780	-16.951	5.446	-22.752	7.470
2445.010782	5.450108	-25.026	28.397	-46.484	-22.921	29.049	-17.436	5.486	-22.911	7.591
2450.010889	5.500109	-25.638	28.596	-47.244	-23.452	29.318	-17.926	5.526	-23.071	7.712
2455.010996	5.550110	-26.257	28.797	-48.009	-23.988	29.586	-18.422	5.565	-23.232	7.834
2460.011103	5.600111	-26.882	28.998	-48.780	-24.530	29.855	-18.925	5.605	-23.393	7.957
2465.011209	5.650112	-27.515	29.201	-49.557	-25.079	30.123	-19.434	5.645	-23.556	8.081
2470.011316	5.700113	-28.154	29.404	-50.340	-25.634	30.391	-19.949	5.685	-23.720	8.206
2475.011423	5.750114	-28.801	29.609	-51.129	-26.194	30.659	-20.470	5.724	-23.884	8.331
2480.011530	5.800115	-29.455	29.814	-51.924	-26.761	30.927	-20.997	5.764	-24.050	8.458
2485.011637	5.850116	-30.115	30.020	-52.725	-27.335	31.194	-21.530	5.804	-24.216	8.585
2490.011743	5.900117	-30.783	30.228	-53.531	-27.914	31.461	-22.070	5.844	-24.384	8.713
2495.011850	5.950119	-31.458	30.436	-54.344	-28.499	31.728	-22.616	5.884	-24.552	8.842
2500.011957	6.000120	-32.139	30.645	-55.163	-29.091	31.995	-23.167	5.923	-24.722	8.972
	Max	**1.728**	**30.645**	**1.739**	**-0.238**	**31.995**	**1.961**	**5.923**	**-6.716**	**8.972**
	Min	**-32.139**	**7.111**	**-55.163**	**-29.091**	**-7.182**	**-23.167**	**0.395**	**-24.722**	**-1.524**

Table 16: Chart10: B1900(Derived from IAU 2000A Nutation Model)-B1900(Derived from Nutation Model-Newcomb)

Besselian Year	'T'in Topical Centuries	δ*l* (1)	δ*l'* (2)	δF (3)	δD (4)	δ☊ (5)	δ☽ (6)	δL (7)	δπ' (8)	δπ (9)
1799.997006	-1.000030	-3.925	7.111	-12.667	1.146	-6.012	1.541	0.396	-6.676	-2.504
1804.997113	-0.950029	-3.650	7.267	-12.661	1.094	-5.640	1.529	0.435	-6.793	-2.159
1809.997219	-0.900028	-3.382	7.422	-12.661	0.970	-5.270	1.444	0.474	-6.909	-1.812
1814.997326	-0.850027	-3.121	7.578	-12.666	0.774	-4.900	1.287	0.513	-7.026	-1.465
1819.997433	-0.800026	-2.867	7.733	-12.678	0.507	-4.531	1.058	0.551	-7.142	-1.117
1824.997540	-0.750025	-2.620	7.888	-12.695	0.167	-4.163	0.758	0.590	-7.258	-0.768
1829.997646	-0.700024	-2.379	8.042	-12.719	-0.244	-3.795	0.385	0.629	-7.373	-0.417
1834.997753	-0.650022	-2.146	8.197	-12.748	-0.728	-3.428	-0.060	0.668	-7.489	-0.065
1839.997860	-0.600021	-1.919	8.351	-12.784	-1.284	-3.061	-0.576	0.707	-7.604	0.287
1844.997967	-0.550020	-1.699	8.505	-12.825	-1.911	-2.695	-1.165	0.746	-7.719	0.641
1849.998074	-0.500019	-1.486	8.659	-12.872	-2.610	-2.330	-1.825	0.786	-7.834	0.996
1854.998180	-0.450018	-1.280	8.813	-12.926	-3.382	-1.966	-2.557	0.825	-7.949	1.352
1859.998287	-0.400017	-1.080	8.967	-12.985	-4.225	-1.602	-3.362	0.864	-8.063	1.709
1864.998394	-0.350016	-0.888	9.120	-13.050	-5.141	-1.239	-4.238	0.903	-8.178	2.067
1869.998501	-0.300015	-0.702	9.274	-13.121	-6.128	-0.876	-5.186	0.942	-8.292	2.427
1874.998608	-0.250014	-0.523	9.427	-13.198	-7.187	-0.514	-6.206	0.981	-8.406	2.787
1879.998714	-0.200013	-0.351	9.580	-13.281	-8.318	-0.153	-7.298	1.020	-8.520	3.148
1884.998821	-0.150012	-0.186	9.733	-13.370	-9.521	0.208	-8.462	1.059	-8.634	3.511
1889.998928	-0.100011	-0.028	9.886	-13.464	-10.796	0.568	-9.698	1.098	-8.748	3.875
1894.999035	-0.050010	0.124	10.039	-13.565	-12.144	0.927	-11.006	1.137	-8.862	4.239
1899.999142	-0.000009	0.269	10.192	-13.672	-13.563	1.286	-12.386	1.176	-8.975	4.605
1904.999248	0.049992	0.406	10.344	-13.784	-15.054	1.644	-13.838	1.216	-9.089	4.972
1909.999355	0.099994	0.537	10.497	-13.903	-16.616	2.001	-15.362	1.255	-9.202	5.340
1914.999462	0.149995	0.662	10.650	-14.027	-18.251	2.357	-16.957	1.294	-9.316	5.709
1919.999569	0.199996	0.779	10.802	-14.158	-19.958	2.713	-18.625	1.333	-9.429	6.080
1924.999676	0.249997	0.889	10.955	-14.294	-21.737	3.069	-20.365	1.372	-9.543	6.451
1929.999782	0.299998	0.993	11.107	-14.437	-23.588	3.424	-22.176	1.411	-9.656	6.823
1934.999889	0.349999	1.090	11.260	-14.585	-25.510	3.778	-24.060	1.451	-9.769	7.197
1939.999996	0.400000	1.180	11.412	-14.739	-27.505	4.131	-26.015	1.490	-9.882	7.571
1945.000103	0.450001	1.263	11.565	-14.899	-29.572	4.484	-28.043	1.529	-9.996	7.947
1950.000210	0.500002	1.339	11.717	-15.065	-31.710	4.836	-30.142	1.568	-10.109	8.323
1955.000316	0.550003	1.409	11.870	-15.237	-33.921	5.187	-32.313	1.608	-10.222	8.701
1960.000423	0.600004	1.472	12.022	-15.415	-36.203	5.538	-34.557	1.647	-10.336	9.080
1965.000530	0.650005	1.528	12.175	-15.599	-38.558	5.888	-36.872	1.686	-10.449	9.460
1970.000637	0.700006	1.577	12.328	-15.789	-40.984	6.237	-39.259	1.725	-10.563	9.841
1975.000744	0.750007	1.619	12.480	-15.985	-43.483	6.586	-41.718	1.765	-10.676	10.223
1980.000850	0.800009	1.654	12.633	-16.186	-46.053	6.934	-44.249	1.804	-10.790	10.607
1985.000957	0.850010	1.683	12.786	-16.394	-48.695	7.282	-46.852	1.843	-10.903	10.991
1990.001064	0.900011	1.704	12.939	-16.608	-51.410	7.628	-49.527	1.883	-11.017	11.376
1995.001171	0.950012	1.719	13.092	-16.827	-54.196	7.975	-52.274	1.922	-11.131	11.763
2000.001278	1.000013	1.727	13.245	-17.053	-57.054	8.320	-55.093	1.962	-11.244	12.150
2005.001384	1.050014	1.728	13.398	-17.284	-59.984	8.665	-57.983	2.001	-11.358	12.539
2010.001491	1.100015	1.723	13.552	-17.521	-62.986	9.009	-60.946	2.040	-11.473	12.929
2015.001598	1.150016	1.710	13.705	-17.765	-66.060	9.353	-63.981	2.080	-11.587	13.319
2020.001705	1.200017	1.691	13.859	-18.014	-69.206	9.695	-67.087	2.119	-11.701	13.711
2025.001811	1.250018	1.665	14.013	-18.269	-72.424	10.038	-70.266	2.159	-11.816	14.104
2030.001918	1.300019	1.632	14.167	-18.530	-75.714	10.379	-73.516	2.198	-11.930	14.498
2035.002025	1.350020	1.592	14.321	-18.797	-79.076	10.720	-76.839	2.238	-12.045	14.893

Besselian Year	'T'in Topical Centuries	δ*l* (1)	δ*l*' (2)	δF (3)	δD (4)	δ☊ (5)	δ☽ (6)	δL (7)	δπ' (8)	δπ (9)
2040.002132	1.400021	1.546	14.475	-19.070	-82.510	11.060	-80.233	2.277	-12.160	15.290
2045.002239	1.450022	1.492	14.630	-19.349	-86.016	11.400	-83.699	2.317	-12.275	15.687
2050.002345	1.500023	1.432	14.784	-19.634	-89.594	11.738	-87.238	2.356	-12.390	16.085
2055.002452	1.550025	1.365	14.939	-19.925	-93.244	12.077	-90.848	2.396	-12.506	16.485
2060.002559	1.600026	1.291	15.094	-20.221	-96.965	12.414	-94.530	2.435	-12.622	16.885
2065.002666	1.650027	1.210	15.250	-20.524	-100.759	12.751	-98.284	2.475	-12.738	17.287
2070.002773	1.700028	1.122	15.405	-20.832	-104.625	13.087	-102.110	2.514	-12.854	17.690
2075.002879	1.750029	1.028	15.561	-21.147	-108.562	13.423	-106.008	2.554	-12.970	18.094
2080.002986	1.800030	0.927	15.717	-21.467	-112.572	13.758	-109.978	2.593	-13.087	18.499
2085.003093	1.850031	0.818	15.873	-21.794	-116.653	14.092	-114.020	2.633	-13.204	18.905
2090.003200	1.900032	0.703	16.030	-22.126	-120.807	14.426	-118.134	2.673	-13.321	19.312
2095.003307	1.950033	0.582	16.187	-22.464	-125.032	14.759	-122.320	2.712	-13.438	19.720
2100.003413	2.000034	0.453	16.344	-22.809	-129.330	15.091	-126.578	2.752	-13.556	20.129
2105.003520	2.050035	0.318	16.502	-23.159	-133.699	15.422	-130.908	2.792	-13.674	20.540
2110.003627	2.100036	0.175	16.659	-23.515	-138.140	15.753	-135.309	2.831	-13.792	20.951
2115.003734	2.150037	0.026	16.817	-23.877	-142.654	16.084	-139.783	2.871	-13.911	21.364
2120.003841	2.200038	-0.130	16.976	-24.245	-147.239	16.413	-144.328	2.911	-14.030	21.777
2125.003947	2.250039	-0.293	17.134	-24.619	-151.896	16.742	-148.946	2.950	-14.149	22.192
2130.004054	2.300041	-0.463	17.294	-24.998	-156.626	17.070	-153.635	2.990	-14.269	22.608
2135.004161	2.350042	-0.639	17.453	-25.384	-161.427	17.398	-158.397	3.030	-14.389	23.025
2140.004268	2.400043	-0.823	17.613	-25.776	-166.300	17.725	-163.230	3.070	-14.509	23.443
2145.004375	2.450044	-1.013	17.773	-26.173	-171.245	18.051	-168.136	3.109	-14.630	23.862
2150.004481	2.500045	-1.210	17.933	-26.577	-176.262	18.377	-173.113	3.149	-14.751	24.282
2155.004588	2.550046	-1.414	18.094	-26.986	-181.351	18.701	-178.162	3.189	-14.872	24.703
2160.004695	2.600047	-1.625	18.256	-27.402	-186.512	19.026	-183.283	3.229	-14.994	25.126
2165.004802	2.650048	-1.842	18.417	-27.823	-191.745	19.349	-188.477	3.269	-15.116	25.549
2170.004909	2.700049	-2.067	18.579	-28.251	-197.050	19.672	-193.742	3.308	-15.238	25.974
2175.005015	2.750050	-2.298	18.742	-28.684	-202.427	19.994	-199.079	3.348	-15.361	26.399
2180.005122	2.800051	-2.536	18.905	-29.123	-207.876	20.316	-204.488	3.388	-15.485	26.826
2185.005229	2.850052	-2.782	19.068	-29.568	-213.397	20.637	-209.969	3.428	-15.609	27.254
2190.005336	2.900053	-3.034	19.232	-30.019	-218.990	20.957	-215.522	3.468	-15.733	27.683
2195.005443	2.950054	-3.292	19.397	-30.476	-224.654	21.276	-221.147	3.508	-15.858	28.113
2200.005549	3.000055	-3.558	19.561	-30.939	-230.391	21.595	-226.843	3.548	-15.983	28.545
2205.005656	3.050057	-3.831	19.727	-31.408	-236.200	21.913	-232.612	3.587	-16.108	28.977
2210.005763	3.100058	-4.110	19.892	-31.882	-242.081	22.231	-238.453	3.627	-16.235	29.410
2215.005870	3.150059	-4.396	20.059	-32.363	-248.033	22.548	-244.366	3.667	-16.361	29.845
2220.005977	3.200060	-4.689	20.225	-32.850	-254.058	22.864	-250.350	3.707	-16.488	30.280
2225.006083	3.250061	-4.989	20.393	-33.342	-260.154	23.179	-256.407	3.747	-16.616	30.717
2230.006190	3.300062	-5.296	20.560	-33.841	-266.323	23.494	-262.536	3.787	-16.744	31.155
2235.006297	3.350063	-5.610	20.729	-34.345	-272.564	23.808	-268.736	3.827	-16.873	31.594
2240.006404	3.400064	-5.931	20.898	-34.855	-278.876	24.122	-275.009	3.867	-17.002	32.034
2245.006510	3.450065	-6.258	21.067	-35.372	-285.261	24.434	-281.353	3.907	-17.132	32.475
2250.006617	3.500066	-6.593	21.237	-35.894	-291.717	24.747	-287.770	3.947	-17.262	32.918
2255.006724	3.550067	-6.934	21.408	-36.422	-298.246	25.058	-294.258	3.987	-17.393	33.361
2260.006831	3.600068	-7.282	21.579	-36.956	-304.846	25.369	-300.819	4.027	-17.524	33.806
2265.006938	3.650069	-7.637	21.750	-37.496	-311.518	25.679	-307.451	4.067	-17.656	34.252
2270.007044	3.700070	-7.999	21.923	-38.042	-318.263	25.988	-314.155	4.107	-17.789	34.698
2275.007151	3.750072	-8.368	22.095	-38.594	-325.079	26.297	-320.932	4.148	-17.922	35.146
2280.007258	3.800073	-8.744	22.269	-39.152	-331.967	26.605	-327.780	4.188	-18.056	35.596

Besselian Year	'T' in Topical Centuries	δ*l* (1)	δ*l'* (2)	δF (3)	δD (4)	δ☊ (5)	δ☽ (6)	δL (7)	δπ' (8)	δπ (9)
2285.007365	3.850074	-9.126	22.443	-39.715	-338.928	26.912	-334.700	4.228	-18.190	36.046
2290.007472	3.900075	-9.516	22.618	-40.285	-345.960	27.219	-341.692	4.268	-18.325	36.497
2295.007578	3.950076	-9.912	22.793	-40.861	-353.064	27.524	-348.756	4.308	-18.461	36.950
2300.007685	4.000077	-10.316	22.969	-41.442	-360.240	27.830	-355.892	4.348	-18.597	37.403
2305.007792	4.050078	-10.726	23.146	-42.029	-367.489	28.134	-363.100	4.388	-18.734	37.858
2310.007899	4.100079	-11.143	23.323	-42.623	-374.809	28.438	-370.380	4.428	-18.872	38.314
2315.008006	4.150080	-11.567	23.501	-43.222	-382.201	28.741	-377.732	4.469	-19.010	38.771
2320.008112	4.200081	-11.998	23.680	-43.827	-389.665	29.044	-385.156	4.509	-19.149	39.229
2325.008219	4.250082	-12.436	23.860	-44.438	-397.201	29.345	-392.652	4.549	-19.289	39.689
2330.008326	4.300083	-12.881	24.040	-45.056	-404.809	29.647	-400.220	4.589	-19.429	40.149
2335.008433	4.350084	-13.332	24.220	-45.679	-412.489	29.947	-407.860	4.629	-19.570	40.611
2340.008540	4.400085	-13.791	24.402	-46.308	-420.242	30.247	-415.572	4.669	-19.712	41.073
2345.008646	4.450086	-14.257	24.584	-46.942	-428.066	30.546	-423.356	4.710	-19.854	41.537
2350.008753	4.500088	-14.729	24.767	-47.583	-435.962	30.844	-431.212	4.750	-19.998	42.002
2355.008860	4.550089	-15.209	24.951	-48.230	-443.930	31.142	-439.139	4.790	-20.142	42.469
2360.008967	4.600090	-15.695	25.136	-48.883	-451.970	31.438	-447.139	4.830	-20.286	42.936
2365.009074	4.650091	-16.188	25.321	-49.541	-460.082	31.735	-455.211	4.871	-20.432	43.405
2370.009180	4.700092	-16.688	25.507	-50.206	-468.266	32.030	-463.355	4.911	-20.578	43.874
2375.009287	4.750093	-17.196	25.694	-50.876	-476.522	32.325	-471.570	4.951	-20.725	44.345
2380.009394	4.800094	-17.710	25.881	-51.552	-484.849	32.619	-479.858	4.991	-20.873	44.817
2385.009501	4.850095	-18.231	26.070	-52.235	-493.249	32.913	-488.218	5.032	-21.022	45.290
2390.009608	4.900096	-18.759	26.259	-52.923	-501.721	33.205	-496.649	5.072	-21.171	45.765
2395.009714	4.950097	-19.294	26.449	-53.617	-510.265	33.497	-505.153	5.112	-21.321	46.240
2400.009821	5.000098	-19.836	26.640	-54.317	-518.881	33.789	-513.729	5.153	-21.472	46.717
2405.009928	5.050099	-20.384	26.832	-55.023	-527.569	34.079	-522.376	5.193	-21.624	47.195
2410.010035	5.100100	-20.940	27.024	-55.735	-536.329	34.369	-531.096	5.233	-21.777	47.674
2415.010142	5.150101	-21.503	27.218	-56.453	-545.161	34.658	-539.887	5.273	-21.931	48.154
2420.010248	5.200102	-22.073	27.412	-57.177	-554.064	34.947	-548.751	5.314	-22.085	48.636
2425.010355	5.250104	-22.650	27.607	-57.906	-563.040	35.234	-557.686	5.354	-22.241	49.118
2430.010462	5.300105	-23.233	27.803	-58.642	-572.088	35.522	-566.694	5.394	-22.397	49.602
2435.010569	5.350106	-23.824	28.000	-59.383	-581.208	35.808	-575.773	5.435	-22.554	50.087
2440.010675	5.400107	-24.422	28.198	-60.131	-590.400	36.094	-584.925	5.475	-22.712	50.573
2445.010782	5.450108	-25.026	28.397	-60.884	-599.663	36.378	-594.148	5.515	-22.871	51.061
2450.010889	5.500109	-25.638	28.596	-61.644	-608.999	36.663	-603.443	5.556	-23.031	51.549
2455.010996	5.550110	-26.257	28.797	-62.409	-618.407	36.946	-612.811	5.596	-23.192	52.039
2460.011103	5.600111	-26.882	28.998	-63.180	-627.887	37.229	-622.250	5.636	-23.353	52.530
2465.011209	5.650112	-27.515	29.201	-63.957	-637.439	37.511	-631.762	5.677	-23.516	53.022
2470.011316	5.700113	-28.154	29.404	-64.740	-647.062	37.792	-641.345	5.717	-23.680	53.516
2475.011423	5.750114	-28.801	29.609	-65.529	-656.758	38.073	-651.001	5.758	-23.844	54.010
2480.011530	5.800115	-29.455	29.814	-66.324	-666.526	38.353	-660.728	5.798	-24.010	54.506
2485.011637	5.850116	-30.115	30.020	-67.125	-676.366	38.632	-670.527	5.838	-24.176	55.003
2490.011743	5.900117	-30.783	30.228	-67.931	-686.277	38.910	-680.399	5.879	-24.344	55.502
2495.011850	5.950119	-31.458	30.436	-68.744	-696.261	39.188	-690.342	5.919	-24.512	56.001
2500.011957	6.000120	-32.139	30.645	-69.563	-706.317	39.465	-700.357	5.959	-24.682	56.502
	Max	**1.728**	**30.645**	**-12.661**	**1.146**	**39.465**	**1.541**	**5.959**	**-6.676**	**56.502**
	Min	**-32.139**	**7.111**	**-69.563**	**-706.317**	**-6.012**	**-700.357**	**0.396**	**-24.682**	**-2.504**

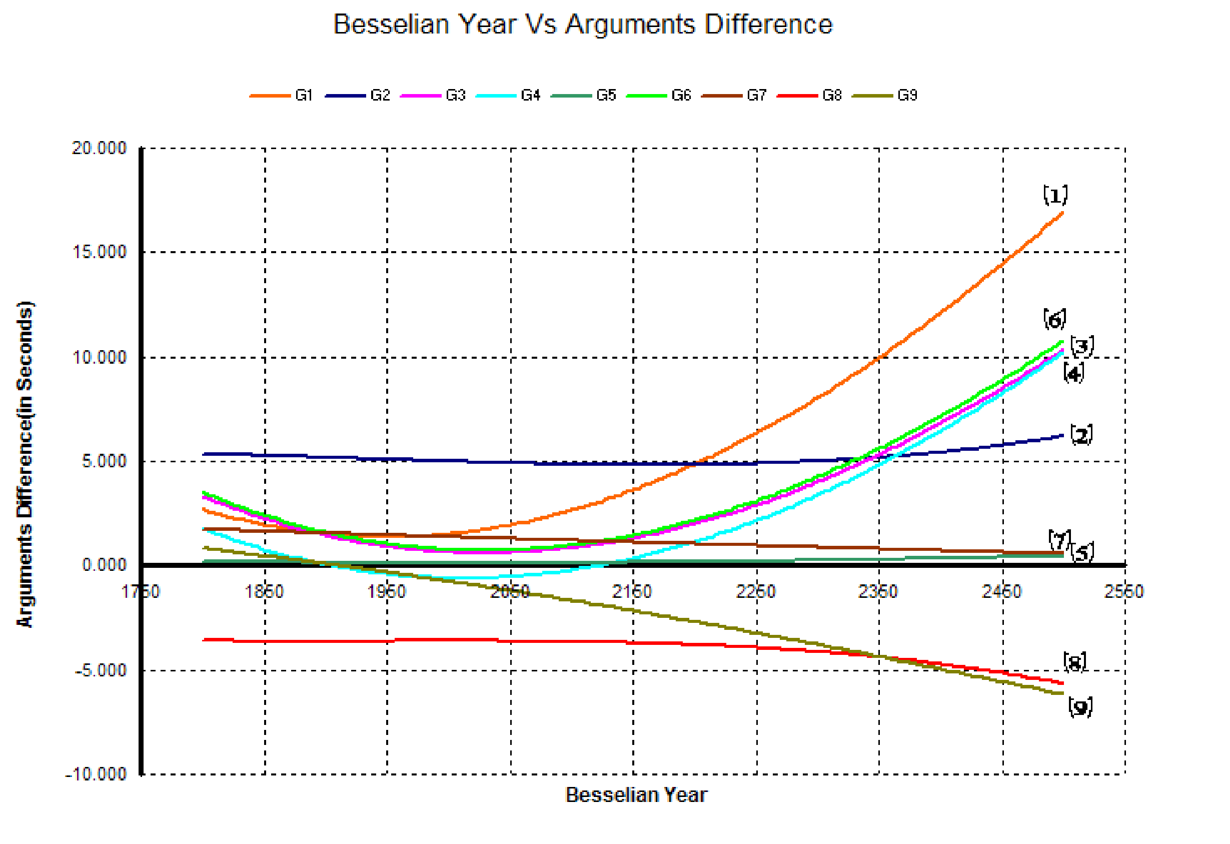

Chart 8: B1900(Derived from IAU 2000A Nutation Model)-B1900(Derived from IAU 1980 Nutation Model)

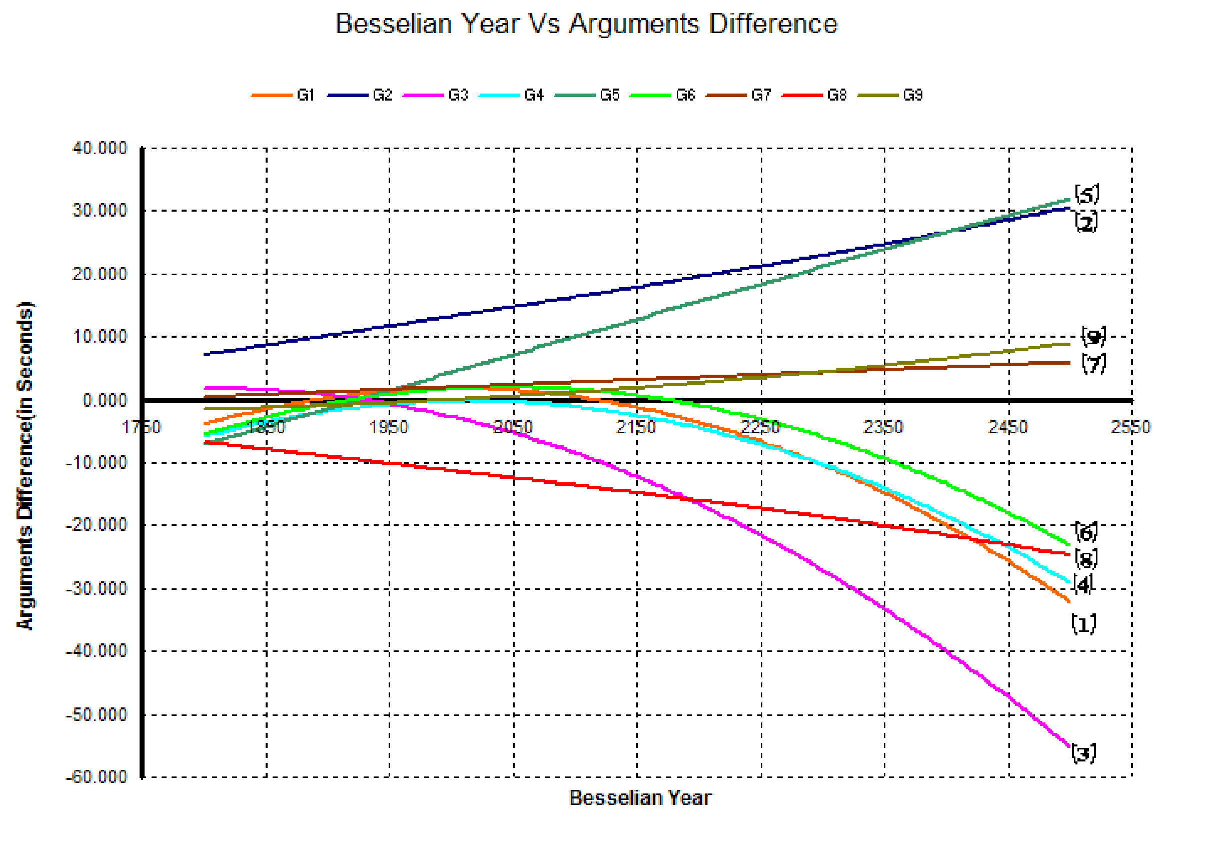

Chart 9: B1900(Derived from IAU 2000A Nutation Model)-B1900(Derived from IAU1964 Nutation Model-E.W.Woolard 1953)

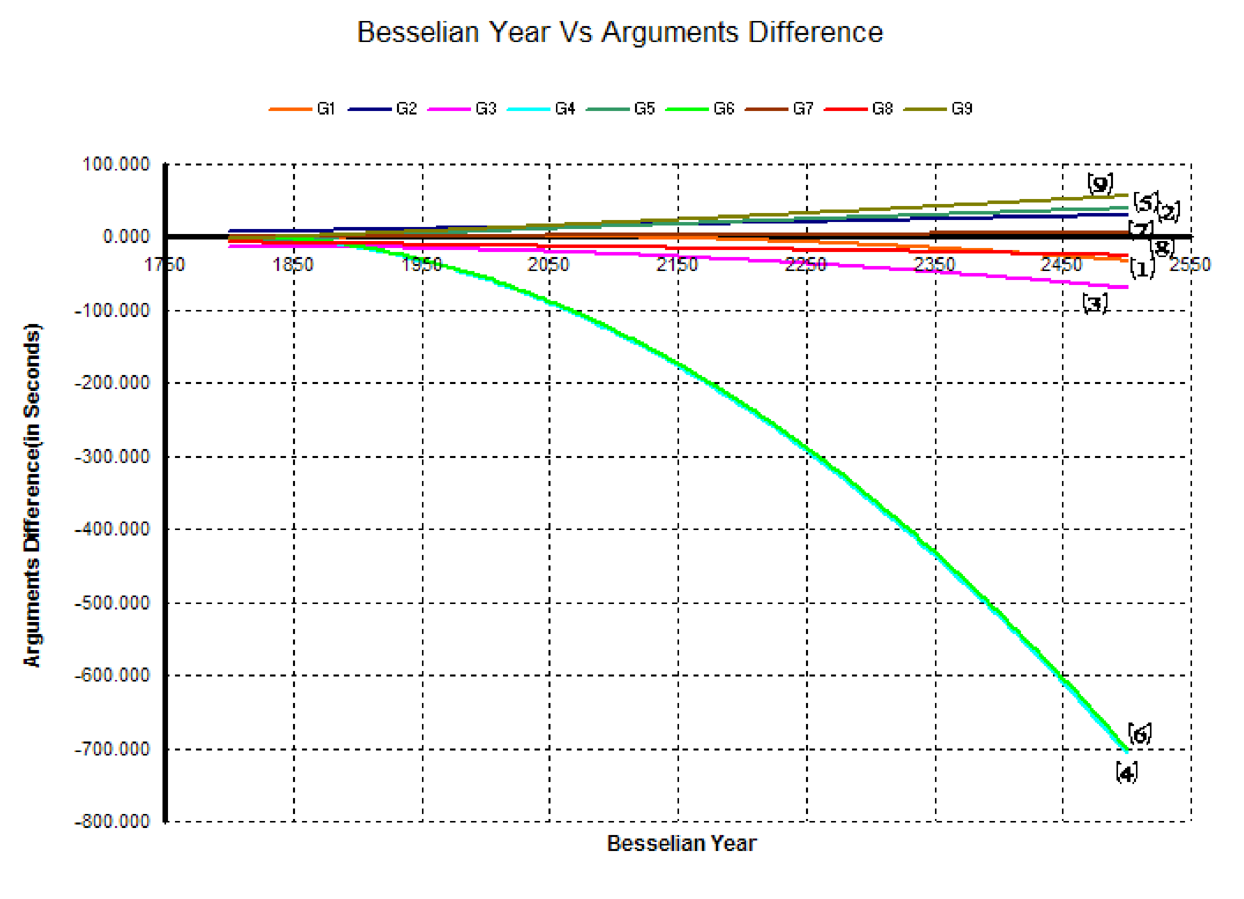

Chart 10: B1900(Derived from IAU 2000A Nutation Model)-B1900(Derived from Nutation Model-Newcomb)

From Chart 8: (With Reference to B1900)

The Maximum positive variation in the fundamental arguments found in the range of 17 Seconds for the mean anomaly of the Moon (l = ☽ - π) and similarly maximum negative variation is found in the range of -7 Seconds for the Mean longitude of Sun's Perigee (π = ☽ - l) and all other fundamental arguments lies within these limits for the range of epoch considered. These variations are insignificant to give major difference for Nutation in Longitude between IAU2000A & IAU1980 Nutation Models. Also notice Chart8 is same as Chart2,5 shown above.

From Chart 9: (With Reference to B1900)

The Maximum positive variation in the fundamental arguments found in the range of 32 Seconds for the Mean longitude of the Moon's mean ascending Node(☊) and similarly maximum negative variation is found in the range of -55 Seconds for the mean anomaly of the Sun (l'= L-π') and all other fundamental arguments lies within these limits for the range of epoch considered. These variations are insignificant to give major difference for Nutation in Longitude between IAU2000A & IAU1964 Nutation Models. Also notice Chart 9 is same as Chart3,6 shown above.

From Chart 10: (With Reference to B1900)

The Maximum positive variation in the fundamental arguments found in the range of 57 Seconds for the Mean longitude of Sun's Perigee(π'=L– l') similarly maximum negative variation is found in the range of -706 Seconds for the mean elongation of the Moon from the Sun (D= ☽ - L) and all other fundamental arguments lies within these limits for the range of epoch considered. These variations are insignificant to give major difference in Nutation in Longitude between IAU2000A & NewComb's Nutation Models. Also notice Chart 10 is same as Chart4,7 shown above.

7.6.4 Calculation for Nutation in longitude (Δψ)

For the purpose of calculation of Nutation in longitude (Δψ) the following Models are considered.

(A) Simon NewComb's Nutation Model (1895)
(B) IAU1964 Nutation Model [E.W.Woolard 1953]
(C) IAU1980 Nutation Model [Seidelmann(1982); Wahr(1981)]
(D) IAU2000A Nutation Model [Mathews et al., 2002]

In all the above, few numbers of pre-selected significant Terms of having same fundamental arguments of respective models, contributing Nutation in Longitude up to 0.01 Seconds, are shown in below Table17 in descending order, based on absolute values of coefficients. Any of the following two equations can be used for calculation of Nutation in longitude (Δψ).

(1) Nutation in longitude $(\Delta\psi) = \sum_{i=1}^{n} C_i \text{ Sin}\,\phi_i$ -----------Eqn.[75]

(2) Nutation in longitude $(\Delta\psi) = \sum_{i=1}^{n} C_i \text{ Sin}\,\theta_i$ -----------Eqn.[76]

Where,
n = Number of Terms
C_i = Coefficients given in below table (in Seconds)
ϕ = Angular values for the Epoch in question found using fundamental Arguments given below.
θ = Angular values for the Epoch in question found using fundamental Arguments given below.

Readers may note that the fundamental arguments given below for angle 'θ' are derived by using the relationship equations between the fundamental luni-solar arguments (l, l', F, D, ☊), Mean elements of Moon (☽, π, ☊) and Sun (L, π') as given in the beginning of this chapter. Hence the angle 'ϕ' and 'θ' calculated shall theoretically give the same values only.

Table 17: Coefficients (C_i) Values for different Nutation Models

Term No.	Fundamental Arguments	Fundamental Arguments	Coefficients C_i (in Seconds)				Remarks
			NewComb	IAU1964	IAU1980	IAU2000A	
i	ϕ_i	θ_i	(A)	(B)	(C)	(D)	
1	☊	☊	-17.234	-17.2327	-17.1996	-17.2064161	
2	2(F- D + ☊)	2L	-1.272	-1.2729	-1.3187	-1.3170906	
3	2(F + ☊)	**2☽**	-0.204	-0.2037	-0.2274	-0.2276413	
4	**2☊**	**2☊**	0.209	0.2088	0.2062	0.2074554	
5	*l'*	L - π'	0.126	0.1261	0.1426	0.1475877	
6	*l*	☽ - π	0.068	0.0675	0.0712	0.0711159	
7	*l'*+2(F- D + ☊)	3L - π'	-0.050	-0.0497	-0.0517	-0.0516821	
8	2F + ☊	**2☽** - ☊	-0.034	-0.0342	-0.0386	-0.0387298	
9	*l*+2(F + ☊)	**3☽** - π	-0.026	-0.0261	-0.0301	-0.0301461	
10	-*l'*+2(F- D + ☊)	L + π'	0.021	0.0214	0.0217	0.0215829	
11	2D - *l*	☽ + π - 2L	0.015	0.0149	0.0158	0.0156994	
12	2(F- D) + ☊	2L - ☊	0.012	0.0124	0.0129	0.0128227	
13	-*l*+2(F + ☊)	☽ + π	0.011	0.0114	0.0123	0.0123457	
14	☊	☊	-0.017*T	-0.01737*T	-0.01742*T	-0.0174666*T	

As per the definitions given in above Nutation Theories, NewComb's and IAU1964 models are provided with J1900 reference Epoch and the remaining (IAU1980, IAU2000A) are provided with J2000 reference Epoch. The angles calculated using the any of the Eqn.(72,73,74) of respective reference Epoch, should yield the same values for the Epoch in question (can be seen from above charts 2 to 10 results) as they are derived (shifted) from the given reference Epoch to required reference Epoch mathematically to yield same results.

However, the Term No.14 Coefficient (C_{14}) given in above Table 17 has a function of the Julian Centuries 'T' measured with respect to reference Epoch (J1900 or J2000) of respective models. Hence while calculating the Nutation in Longitude with other than the basic reference Epoch of the Model, it should be adjusted, to account for the shift from the actual reference Epoch of the models to reference Epoch considered. To establish the relationship between the Epochs, numbers of Julian days to be considered are given below.

Julian Days (JD) for J2000 Epoch = 2451545 Days
Julian Days (JD) for J1900 Epoch = 2415020 Days
Julian Days (JD) for B1900 Epoch = 2415020.31352 Days

Substituting Julian Days of J1900 & J2000 with DE=365.25 Days Per Julian Year in Eqn.(j2),

$$T_{J2000} = T_{J1900} + \left(\frac{2451545 - 2415020}{365.25}\right)$$

$T_{J2000} = T_{J1900} + J100.00$ In Julian Years (Prefix 'J' indicates Julian)

$T_{J20} = T_{J19} + J1.00$ In Julian Centuries -----------Eqn.[77]

Substituting Julian Days of J2000 & B1900 with DE=365.25 Days Per Julian Year in Eqn.(j2),

$$T_{J2000} = T_{J(B1900)} + \left(\frac{2451545 - 2415020.31352}{365.25}\right)$$

$T_{J2000} = T_{J(B1900)} + J99.999141629 0216$ In Julian Years

$T_{J20} = T_{J(B19)} + J0.99999141629 0216$ In Julian Centuries -----------Eqn.[78]

Modifying the above Eqn.(78) for difference in number of days between the Julian and Besselian (Tropical) Year, we get,

$$T_{J20} = \left(\frac{365.242198781}{365.25}\right) T_{B19} + J0.9999914 16290216 \text{ (Prefix 'J' indicates Julian)}$$

$T_{J20} = 0.99997864142642 * T_{B19} + J0.99999141629 0216$ In Julian Centuries -----------Eqn.[79]

Equating Eqn.(77,78) we get,

$T_{J19} = T_{J(B19)} - J8.5837097 8372461 * 10^{-6}$ In Julian Centuries -----------Eqn.[80]

Modifying the above Eqn.(80) for difference in number of days between the Julian and Besselian (Tropical) Year, we get,

$$T_{J19} = \left(\frac{365.242198781}{365.25}\right) T_{B19} - J8.5837097 8372461 * 10^{-6} \text{ (Prefix 'J' indicates Julian)}$$

$T_{J19} = 0.99997864142642 * T_{B19} - J8.58370978372461 * 10^{-6}$ In Julian Centuries-----------Eqn.[81]

Where

T_{J2000} , T_{J20} are Time measured in Julian Year, Julian Centuries With reference to J2000 Epoch
T_{J1900} , T_{J19} are Time measured in Julian Year, Julian Centuries With reference to J1900 Epoch
$T_{J(B1900)}$, $T_{J(B19)}$ are Time measured in Julian Year, Julian Centuries With reference to B1900 Epoch
T_{B19} Time measured in Besselian(Tropical) Centuries With reference to B1900 Epoch

Using Eqn.(77,79,81) the Coefficients Term 14 given in above Table 17, can be Adjusted as shown in below Table. (Terms from 1 to 13 are retained and modified 14th Term is included)

Table 18: Coefficients (C_i) Values for different Nutation Models

Term No.	**Fundamental Arguments**	**Fundamental Arguments**	**Coefficients C_i (in Seconds)**				**Remarks Ref. Epoch**
			NewComb	**IAU1964**	**IAU1980**	**IAU2000A**	
i	ϕ_i	θ_i	**(A)**	**(B)**	**(C)**	**(D)**	
1	☊	☊	-17.234	-17.2327	-17.1996	-17.2064161	See Note (1)
2	2(F- D + ☊)	2L	-1.272	-1.2729	-1.3187	-1.3170906	See Note (1)
3	2(F + ☊)	2☽	-0.204	-0.2037	-0.2274	-0.2276413	See Note (1)
4	2☊	2☊	0.209	0.2088	0.2062	0.2074554	See Note (1)
5	*l'*	L - π'	0.126	0.1261	0.1426	0.1475877	See Note (1)
6	*l*	☽ - π	0.068	0.0675	0.0712	0.0711159	See Note (1)
7	*l'*+2(F- D + ☊)	3L - π'	-0.050	-0.0497	-0.0517	-0.0516821	See Note (1)
8	2F + ☊	2☽ - ☊	-0.034	-0.0342	-0.0386	-0.0387298	See Note (1)
9	*l*+2(F + ☊)	3☽ - π	-0.026	-0.0261	-0.0301	-0.0301461	See Note (1)
10	-*l'*+2(F- D + ☊)	L + π'	0.021	0.0214	0.0217	0.0215829	See Note (1)
11	2D - *l*	☽ + π - 2L	0.015	0.0149	0.0158	0.0156994	See Note (1)
12	2(F- D) + ☊	2L - ☊	0.012	0.0124	0.0129	0.0128227	See Note (1)
13	-*l*+2(F + ☊)	☽ + π	0.011	0.0114	0.0123	0.0123457	See Note (1)
14	☊	☊	-0.017*T +0.017	-0.01737*T +0.01737	-0.01742*T +0.0000	-0.0174666*T +0.0000	See Note (2)
14	☊	☊	-0.017*T +0.000	-0.01737*T +0.0000	-0.01742*T -0.01742	-0.0174666*T -0.0174666	See Note (3)
14	☊	☊	-0.017*T +1.459x10^{-6}	-0.01737*T +1.491x10^{-6}	-0.01742*T -0.01742	-0.01746662*T -0.0174665	See Note (4)

Note:

(1) Any Reference Epoch and Corresponding 'T' measured in respective centuries shall be used. That is for J20, J19 'T' measured in Julian Centuries (JC) and B19 'T' measured in Tropical Centuries (TC). The Fundamental Arguments shall be calculated using the Equations having corresponding Reference Epoch & 'T' measured in respective centuries of the Equations.

(2) J20 Reference Epoch and 'T' measured in Julian Centuries (JC). The Fundamental Arguments shall be calculated using the Eqn.(70).

(3) J19 Reference Epoch and 'T' measured in Julian Centuries (JC). The Fundamental Arguments shall be calculated using the Eqn.(71).

(4) B19 Reference Epoch and 'T' measured in Tropical Centuries (TC). The Fundamental Arguments shall be calculated using the Eqn.(72).

(5) Whichever Equation is used for calculating Fundamental Arguments, use the Term 14 (consisting of 2 Sub Terms due to change in Ref.Epoch) having same Reference Epoch & 'T' measured in same centuries while including its contribution for Nutation in Longitude. However, Term 14 can give 0.17Seconds when T=10 Centuries which is 1000 Years, hence this Term may be ignored from adding its contribution for Nutation in Longitude.

(6) When considering all 13th Terms the Nutation in Longitude may go up to ±19.3 Seconds.

It is found in Nayar's article that only First 2 terms are explained and others terms are ignored.

7.6.5 Comparison of Nutation Models

The recent Nutation Model IAU2000A's (with Reference to J2000 Epoch) coefficients C_i of the terms are compared with respective coefficients of other Nutation Model's Terms and the differences in Coefficient Values are tabulated below.

Table 19: Difference in Coefficients (C_i) Values for different Models (with Ref: IAU2000A)

Term	Fundamental	Fundamental	Difference in Coefficients Values δC_i (in Seconds)			Remarks
No.	Arguments	Arguments	IAU2000A-Newcomb	IAU2000A-IAU1964	IAU2000A-IAU1980	Ref. Epoch
i	ϕ_i	θ_i	(11)=(D)-(A)	(12)=(D)-(B)	(13)=(D)-(C)	
1	☊	☊	0.0275839	0.0262839	-0.0068161	See Note (1)
2	2(F- D + ☊)	2L	-0.0450906	-0.0441906	0.0016094	See Note (1)
3	2(F + ☊)	2☽	-0.0236413	-0.0239413	-0.0002413	See Note (1)
4	2☊	2☊	-0.0015446	-0.0013446	0.0012554	See Note (1)
5	l'	L - π'	0.0215877	0.0214877	0.0049877	See Note (1)
6	l	☽ - π	0.0031159	0.0036159	-0.0000841	See Note (1)
7	l'+2(F- D + ☊)	3L - π'	-0.0016821	-0.0019821	0.0000179	See Note (1)
8	2F + ☊	2☽ - ☊	-0.0047298	-0.0045298	-0.0001298	See Note (1)
9	l+2(F + ☊)	3☽ - π	-0.0041461	-0.0040461	-0.0000461	See Note (1)
10	-l'+2(F- D + ☊)	L + π'	0.0005829	0.0001829	-0.0001171	See Note (1)
11	2D - l	☽ + π - 2L	0.0006994	0.0007994	-0.0001006	See Note (1)
12	2(F- D) + ☊	2L - ☊	0.0008227	0.0004227	-0.0000773	See Note (1)
13	-l+2(F + ☊)	☽ + π	0.0013457	0.0009457	0.0000457	See Note (1)
14	☊	☊	-0.0004666*T -0.0170	-0.0000966*T -0.01737	-0.0000466*T +0.0000	See Note (2)
14	☊	☊	-0.0004666*T -0.0174666	-0.0000966*T -0.0174666	-0.0000466*T -0.0000466	See Note (3)
14	☊	☊	-0.00046662*T -0.0174679	-0.00009662*T -0.017468	-0.00004662*T -0.0000465	See Note (4)

Note:

Note (1) to (4) descriptions are same as the notes given for the respective note numbers of the previous Table 18 as given above.

From the above table, it is very clear that the difference in Nutation in longitude ($\Delta\psi$) can vary maximum of 0.0276 Seconds for 1st term of IAU2000A – NewComb's Model. The absolute sum of the difference in Coefficient Values up to 13 terms works out to around 0.137, 0.134, 0.016 Seconds for IAU2000A – NewComb, IAU2000A – IAU1964 and IAU2000A – IAU1980 Models respectively. These differences are insignificant to our astrological calculation while calculating the True Ayanamsa of the Epoch in Question. However, we have seen earlier that the maximum difference in fundamental arguments calculated for the selected Julian Years, range 1800 to 2500 was found to be 706 Seconds (See Charts 2 to 10). To find the combined effect of difference in Coefficient Values C_i and difference in Fundamental Arguments, the difference and the Nutation in longitude ($\Delta\psi$) (in Seconds) considering all 14 Terms are calculated for same Julian Years range 1800 to 2500(Equivalent to Tropical Years) shown in below Table 20,Table 21.

It is to be noted that Moon, Sun and Moon's Ascending Node (Vedic name 'Rahu') takes around 28 days, 365.25 days, 18.6 Years to complete one revolution in zodiac respectively. Thus the Nutation in longitude ($\Delta\psi$) can vary dynamically (See daily values @ 00:00Hrs U.T for a Typical Year 1960 given in following Table 22) within a Month/Year and hence it can't be linearly interpolated. (From any given, Yearly or even Monthly interval data).

Table 20: The difference in Nutation in longitude (Δψ) (in Seconds) with respect to IAU2000A Model

Julian	Reference Epoch J2000			Reference Epoch J1900			Reference Epoch B1900			Besselian
Year	NewComb	IAU1964	IAU1980	NewComb	IAU1964	IAU1980	NewComb	IAU1964	IAU1980	Year
1800	0.0476	0.0469	-0.0028	0.0471	0.0468	-0.0029	0.0471	0.0468	-0.0029	1799.997006
1805	0.0030	0.0052	0.0046	0.0038	0.0054	0.0047	0.0038	0.0054	0.0047	1804.997113
1810	-0.0102	-0.0105	0.0027	-0.0098	-0.0105	0.0027	-0.0098	-0.0105	0.0027	1809.997219
1815	0.0502	0.0483	-0.0076	0.0493	0.0481	-0.0077	0.0493	0.0481	-0.0077	1814.997326
1820	0.0253	0.0250	-0.0009	0.0252	0.0250	-0.0009	0.0252	0.0250	-0.0009	1819.997433
1825	-0.0223	-0.0203	0.0061	-0.0214	-0.0201	0.0062	-0.0214	-0.0201	0.0062	1824.997540
1830	0.0297	0.0293	-0.0016	0.0296	0.0292	-0.0016	0.0296	0.0292	-0.0016	1829.997646
1835	0.0420	0.0398	-0.0065	0.0411	0.0396	-0.0066	0.0411	0.0396	-0.0066	1834.997753
1840	-0.0130	-0.0118	0.0006	-0.0126	-0.0117	0.0006	-0.0126	-0.0117	0.0006	1839.997860
1845	0.0052	0.0068	0.0067	0.0060	0.0069	0.0068	0.0060	0.0069	0.0068	1844.997967
1850	0.0410	0.0400	-0.0055	0.0405	0.0399	-0.0056	0.0405	0.0399	-0.0056	1849.998074
1855	0.0034	0.0019	-0.0049	0.0026	0.0018	-0.0050	0.0026	0.0018	-0.0050	1854.998180
1860	0.0016	0.0027	0.0032	0.0022	0.0029	0.0033	0.0022	0.0029	0.0033	1859.998287
1865	0.0253	0.0273	0.0047	0.0259	0.0274	0.0048	0.0259	0.0274	0.0048	1864.998394
1870	0.0140	0.0113	-0.0078	0.0132	0.0111	-0.0078	0.0132	0.0111	-0.0078	1869.998501
1875	0.0075	0.0072	-0.0026	0.0072	0.0071	-0.0026	0.0072	0.0071	-0.0026	1874.998608
1880	0.0251	0.0271	0.0057	0.0260	0.0272	0.0057	0.0260	0.0272	0.0057	1879.998714
1885	0.0050	0.0049	0.0009	0.0051	0.0049	0.0009	0.0051	0.0049	0.0009	1884.998821
1890	0.0129	0.0110	-0.0079	0.0120	0.0108	-0.0080	0.0120	0.0108	-0.0080	1889.998928
1895	0.0361	0.0359	0.0002	0.0362	0.0359	0.0002	0.0362	0.0359	0.0002	1894.999035
1900	0.0004	0.0026	0.0066	0.0013	0.0028	0.0067	0.0013	0.0028	0.0067	1899.999142
1905	0.0007	-0.0007	-0.0036	0.0004	-0.0007	-0.0036	0.0004	-0.0007	-0.0036	1904.999248
1910	0.0433	0.0417	-0.0057	0.0425	0.0416	-0.0058	0.0425	0.0416	-0.0058	1909.999355
1915	0.0154	0.0164	0.0019	0.0159	0.0165	0.0019	0.0159	0.0165	0.0019	1914.999462
1920	-0.0211	-0.0202	0.0059	-0.0203	-0.0200	0.0060	-0.0203	-0.0200	0.0060	1919.999569
1925	0.0355	0.0347	-0.0068	0.0349	0.0345	-0.0069	0.0349	0.0345	-0.0069	1924.999676
1930	0.0348	0.0336	-0.0035	0.0343	0.0335	-0.0036	0.0343	0.0335	-0.0036	1929.999782
1935	-0.0224	-0.0212	0.0038	-0.0216	-0.0211	0.0039	-0.0216	-0.0211	0.0039	1934.999889
1940	0.0087	0.0101	0.0031	0.0091	0.0102	0.0031	0.0091	0.0102	0.0031	1939.999996
1945	0.0479	0.0460	-0.0078	0.0470	0.0458	-0.0079	0.0470	0.0458	-0.0079	1945.000103
1950	-0.0074	-0.0076	-0.0020	-0.0076	-0.0076	-0.0020	-0.0076	-0.0076	-0.0020	1950.000210
1955	-0.0066	-0.0051	0.0059	-0.0056	-0.0050	0.0060	-0.0056	-0.0050	0.0060	1955.000316
1960	0.0393	0.0401	-0.0009	0.0393	0.0401	-0.0009	0.0393	0.0401	-0.0009	1960.000423
1965	0.0145	0.0126	-0.0075	0.0136	0.0125	-0.0075	0.0136	0.0125	-0.0075	1965.000530
1970	-0.0036	-0.0040	0.0004	-0.0034	-0.0040	0.0005	-0.0034	-0.0040	0.0005	1970.000637
1975	0.0273	0.0301	0.0066	0.0282	0.0303	0.0067	0.0282	0.0303	0.0067	1975.000744
1980	0.0245	0.0231	-0.0050	0.0240	0.0230	-0.0051	0.0240	0.0230	-0.0051	1980.000850
1985	0.0058	0.0042	-0.0054	0.0051	0.0040	-0.0055	0.0051	0.0040	-0.0055	1985.000957
1990	0.0312	0.0321	0.0029	0.0319	0.0322	0.0030	0.0319	0.0322	0.0030	1990.001064
1995	0.0179	0.0192	0.0053	0.0185	0.0193	0.0053	0.0185	0.0193	0.0053	1995.001171
2000	0.0108	0.0091	-0.0079	0.0101	0.0090	-0.0080	0.0101	0.0090	-0.0080	2000.001278
2005	0.0371	0.0355	-0.0025	0.0367	0.0354	-0.0025	0.0367	0.0354	-0.0025	2005.001384
2010	0.0209	0.0227	0.0050	0.0217	0.0229	0.0051	0.0217	0.0229	0.0051	2010.001491
2015	-0.0037	-0.0034	0.0014	-0.0034	-0.0034	0.0015	-0.0034	-0.0034	0.0015	2015.001598
2020	0.0368	0.0346	-0.0077	0.0359	0.0344	-0.0078	0.0359	0.0344	-0.0078	2020.001705
2025	0.0316	0.0317	-0.0006	0.0316	0.0317	-0.0007	0.0316	0.0317	-0.0007	2025.001811
2030	-0.0159	-0.0146	0.0063	-0.0149	-0.0144	0.0063	-0.0149	-0.0144	0.0063	2030.001918
2035	0.0170	0.0173	-0.0030	0.0168	0.0172	-0.0030	0.0168	0.0172	-0.0030	2035.002025
2040	0.0425	0.0406	-0.0063	0.0416	0.0405	-0.0064	0.0416	0.0405	-0.0064	2040.002132

Julian	Reference Epoch J2000			Reference Epoch J1900			Reference Epoch B1900			Besselian
Year	NewComb	IAU1964	IAU1980	NewComb	IAU1964	IAU1980	NewComb	IAU1964	IAU1980	Year
2045	-0.0120	-0.0117	0.0010	-0.0116	-0.0116	0.0011	-0.0116	-0.0116	0.0011	2045.002239
2050	-0.0089	-0.0065	0.0058	-0.0081	-0.0063	0.0059	-0.0081	-0.0063	0.0059	2050.002345
2055	0.0426	0.0415	-0.0062	0.0421	0.0413	-0.0062	0.0421	0.0413	-0.0062	2055.002452
2060	0.0017	0.0009	-0.0047	0.0011	0.0008	-0.0048	0.0011	0.0008	-0.0048	2060.002559
2065	-0.0151	-0.0141	0.0032	-0.0143	-0.0140	0.0033	-0.0143	-0.0140	0.0033	2065.002666
2070	0.0273	0.0294	0.0038	0.0278	0.0295	0.0039	0.0278	0.0295	0.0039	2070.002773
2075	0.0208	0.0192	-0.0083	0.0200	0.0190	-0.0084	0.0200	0.0190	-0.0084	2075.002879
2080	-0.0092	-0.0105	-0.0023	-0.0095	-0.0105	-0.0023	-0.0095	-0.0105	-0.0023	2080.002986
2085	0.0231	0.0258	0.0054	0.0240	0.0260	0.0055	0.0240	0.0260	0.0055	2085.003093
2090	0.0267	0.0267	-0.0001	0.0268	0.0267	-0.0001	0.0268	0.0267	-0.0001	2090.003200
2095	0.0031	0.0008	-0.0079	0.0021	0.0007	-0.0080	0.0021	0.0007	-0.0080	2095.003307
2100	0.0293	0.0295	0.0001	0.0295	0.0295	0.0001	0.0295	0.0295	0.0001	2100.003413
2105	0.0297	0.0315	0.0067	0.0306	0.0317	0.0068	0.0306	0.0317	0.0068	2105.003520
2110	0.0066	0.0057	-0.0047	0.0063	0.0056	-0.0047	0.0063	0.0056	-0.0047	2110.003627
2115	0.0334	0.0310	-0.0055	0.0326	0.0308	-0.0055	0.0326	0.0308	-0.0055	2115.003734
2120	0.0403	0.0416	0.0023	0.0409	0.0417	0.0024	0.0409	0.0417	0.0024	2120.003841
2125	-0.0004	0.0007	0.0053	0.0003	0.0008	0.0054	0.0003	0.0008	0.0054	2125.003947
2130	0.0264	0.0241	-0.0072	0.0257	0.0240	-0.0073	0.0257	0.0240	-0.0073	2130.004054
2135	0.0470	0.0466	-0.0033	0.0465	0.0465	-0.0034	0.0465	0.0465	-0.0034	2135.004161
2140	0.0020	0.0029	0.0043	0.0029	0.0031	0.0044	0.0029	0.0031	0.0044	2140.004268
2145	0.0012	0.0021	0.0021	0.0015	0.0022	0.0021	0.0015	0.0022	0.0021	2145.004375
2150	0.0478	0.0458	-0.0079	0.0469	0.0457	-0.0080	0.0468	0.0457	-0.0080	2150.004481
2155	0.0083	0.0082	-0.0015	0.0082	0.0082	-0.0015	0.0082	0.0082	-0.0015	2155.004588
2160	-0.0152	-0.0130	0.0055	-0.0143	-0.0128	0.0056	-0.0143	-0.0128	0.0056	2160.004695
2165	0.0319	0.0315	-0.0018	0.0318	0.0314	-0.0018	0.0318	0.0314	-0.0018	2165.004802
2170	0.0176	0.0167	-0.0074	0.0167	0.0165	-0.0074	0.0167	0.0165	-0.0074	2170.004909
2175	-0.0152	-0.0147	0.0002	-0.0149	-0.0147	0.0003	-0.0149	-0.0147	0.0003	2175.005015
2180	0.0143	0.0165	0.0062	0.0151	0.0167	0.0063	0.0151	0.0167	0.0063	2180.005122
2185	0.0245	0.0237	-0.0060	0.0240	0.0236	-0.0061	0.0240	0.0236	-0.0061	2185.005229
2190	-0.0085	-0.0100	-0.0053	-0.0093	-0.0101	-0.0053	-0.0093	-0.0101	-0.0053	2190.005336
2195	0.0149	0.0170	0.0026	0.0155	0.0171	0.0027	0.0155	0.0171	0.0027	2195.005443
2200	0.0246	0.0254	0.0046	0.0251	0.0255	0.0046	0.0251	0.0255	0.0046	2200.005549
2205	0.0008	-0.0011	-0.0083	0.0000	-0.0013	-0.0084	0.0000	-0.0013	-0.0084	2205.005656
2210	0.0205	0.0205	-0.0029	0.0201	0.0204	-0.0029	0.0201	0.0204	-0.0029	2210.005763
2215	0.0359	0.0373	0.0054	0.0368	0.0374	0.0055	0.0368	0.0375	0.0055	2215.005870
2220	0.0009	0.0008	0.0004	0.0010	0.0009	0.0005	0.0010	0.0009	0.0005	2220.005977
2225	0.0234	0.0210	-0.0079	0.0224	0.0208	-0.0080	0.0224	0.0208	-0.0080	2225.006083
2230	0.0491	0.0500	-0.0004	0.0492	0.0501	-0.0004	0.0492	0.0501	-0.0004	2230.006190
2235	0.0065	0.0076	0.0063	0.0074	0.0077	0.0064	0.0074	0.0077	0.0064	2235.006297
2240	0.0103	0.0086	-0.0036	0.0101	0.0085	-0.0036	0.0101	0.0085	-0.0036	2240.006404
2245	0.0540	0.0536	-0.0063	0.0531	0.0534	-0.0064	0.0531	0.0534	-0.0064	2245.006510
2250	0.0216	0.0220	0.0016	0.0221	0.0221	0.0016	0.0221	0.0221	0.0016	2250.006617
2255	-0.0097	-0.0088	0.0055	-0.0090	-0.0087	0.0056	-0.0090	-0.0087	0.0056	2255.006724
2260	0.0450	0.0436	-0.0069	0.0444	0.0435	-0.0069	0.0444	0.0435	-0.0069	2260.006831
2265	0.0315	0.0314	-0.0042	0.0309	0.0312	-0.0042	0.0309	0.0312	-0.0042	2265.006938
2270	-0.0120	-0.0106	0.0032	-0.0112	-0.0104	0.0033	-0.0112	-0.0104	0.0033	2270.007044
2275	0.0197	0.0196	0.0032	0.0201	0.0197	0.0033	0.0201	0.0197	0.0033	2275.007151
2280	0.0360	0.0355	-0.0085	0.0351	0.0353	-0.0086	0.0351	0.0353	-0.0086	2280.007258
2285	-0.0058	-0.0055	-0.0025	-0.0060	-0.0055	-0.0025	-0.0060	-0.0055	-0.0025	2285.007365
2290	0.0062	0.0075	0.0056	0.0071	0.0077	0.0057	0.0071	0.0077	0.0057	2290.007472

Julian	Reference Epoch J2000			Reference Epoch J1900			Reference Epoch B1900			Besselian
Year	NewComb	IAU1964	IAU1980	NewComb	IAU1964	IAU1980	NewComb	IAU1964	IAU1980	Year
2295	0.0285	0.0287	-0.0012	0.0285	0.0287	-0.0012	0.0285	0.0287	-0.0012	2295.007578
2300	0.0025	0.0013	-0.0079	0.0016	0.0011	-0.0080	0.0016	0.0011	-0.0080	2300.007685
2305	0.0079	0.0093	-0.0003	0.0081	0.0093	-0.0003	0.0081	0.0093	-0.0003	2305.007792
2310	0.0251	0.0259	0.0066	0.0260	0.0261	0.0067	0.0260	0.0261	0.0067	2310.007899
2315	0.0038	0.0027	-0.0055	0.0033	0.0026	-0.0056	0.0033	0.0026	-0.0056	2315.008006
2320	0.0124	0.0125	-0.0060	0.0116	0.0123	-0.0061	0.0116	0.0123	-0.0061	2320.008112
2325	0.0371	0.0378	0.0026	0.0378	0.0379	0.0027	0.0378	0.0379	0.0027	2325.008219
2330	0.0006	0.0011	0.0048	0.0012	0.0013	0.0048	0.0012	0.0013	0.0048	2330.008326
2335	0.0110	0.0093	-0.0081	0.0102	0.0092	-0.0081	0.0102	0.0092	-0.0081	2335.008433
2340	0.0470	0.0478	-0.0033	0.0465	0.0477	-0.0033	0.0465	0.0477	-0.0033	2340.008540
2345	0.0149	0.0155	0.0046	0.0158	0.0157	0.0047	0.0158	0.0157	0.0047	2345.008646
2350	-0.0066	-0.0076	0.0014	-0.0063	-0.0075	0.0015	-0.0063	-0.0075	0.0015	2350.008753
2355	0.0485	0.0486	-0.0085	0.0475	0.0484	-0.0085	0.0475	0.0484	-0.0085	2355.008860
2360	0.0347	0.0348	-0.0011	0.0346	0.0348	-0.0011	0.0346	0.0348	-0.0011	2360.008967
2365	-0.0155	-0.0152	0.0059	-0.0146	-0.0150	0.0060	-0.0146	-0.0150	0.0060	2365.009074
2370	0.0306	0.0302	-0.0030	0.0305	0.0301	-0.0030	0.0305	0.0301	-0.0030	2370.009180
2375	0.0477	0.0478	-0.0070	0.0468	0.0476	-0.0071	0.0468	0.0476	-0.0071	2375.009287
2380	-0.0060	-0.0053	0.0004	-0.0056	-0.0052	0.0004	-0.0056	-0.0052	0.0004	2380.009394
2385	0.0068	0.0066	0.0061	0.0076	0.0068	0.0062	0.0076	0.0068	0.0062	2385.009501
2390	0.0467	0.0470	-0.0068	0.0461	0.0468	-0.0068	0.0461	0.0468	-0.0068	2390.009608
2395	0.0083	0.0085	-0.0053	0.0076	0.0084	-0.0054	0.0076	0.0084	-0.0054	2395.009714
2400	0.0011	0.0012	0.0031	0.0019	0.0014	0.0031	0.0019	0.0014	0.0031	2400.009821
2405	0.0318	0.0327	0.0037	0.0323	0.0328	0.0037	0.0323	0.0328	0.0037	2405.009928
2410	0.0193	0.0186	-0.0087	0.0185	0.0184	-0.0088	0.0185	0.0184	-0.0088	2410.010035
2415	0.0046	0.0054	-0.0030	0.0043	0.0054	-0.0031	0.0043	0.0054	-0.0031	2415.010142
2420	0.0295	0.0297	0.0055	0.0304	0.0299	0.0056	0.0304	0.0299	0.0056	2420.010248
2425	0.0140	0.0139	-0.0004	0.0141	0.0139	-0.0004	0.0141	0.0139	-0.0004	2425.010355
2430	0.0103	0.0105	-0.0086	0.0094	0.0103	-0.0087	0.0094	0.0103	-0.0087	2430.010462
2435	0.0365	0.0364	-0.0001	0.0366	0.0365	-0.0001	0.0366	0.0365	-0.0001	2435.010569
2440	0.0116	0.0122	0.0063	0.0125	0.0124	0.0064	0.0125	0.0124	0.0064	2440.010675
2445	0.0031	0.0024	-0.0049	0.0028	0.0023	-0.0050	0.0028	0.0023	-0.0050	2445.010782
2450	0.0404	0.0410	-0.0063	0.0395	0.0408	-0.0064	0.0395	0.0408	-0.0064	2450.010889
2455	0.0258	0.0260	0.0019	0.0264	0.0261	0.0019	0.0264	0.0261	0.0019	2455.010996
2460	-0.0140	-0.0145	0.0052	-0.0133	-0.0144	0.0053	-0.0133	-0.0144	0.0053	2460.011103
2465	0.0339	0.0345	-0.0080	0.0332	0.0343	-0.0081	0.0332	0.0343	-0.0081	2465.011209
2470	0.0415	0.0417	-0.0038	0.0410	0.0416	-0.0039	0.0409	0.0416	-0.0039	2470.011316
2475	-0.0140	-0.0142	0.0038	-0.0132	-0.0140	0.0039	-0.0132	-0.0140	0.0039	2475.011423
2480	0.0099	0.0103	0.0019	0.0103	0.0104	0.0020	0.0103	0.0104	0.0020	2480.011530
2485	0.0517	0.0520	-0.0086	0.0508	0.0518	-0.0087	0.0508	0.0518	-0.0087	2485.011637
2490	-0.0002	0.0003	-0.0023	-0.0004	0.0003	-0.0023	-0.0004	0.0003	-0.0023	2490.011743
2495	-0.0057	-0.0061	0.0057	-0.0047	-0.0060	0.0058	-0.0047	-0.0060	0.0058	2495.011850
2500	0.0434	0.0444	-0.0023	0.0433	0.0444	-0.0023	0.0433	0.0444	-0.0023	2500.011957
Max	**0.0540**	**0.0536**	**0.0067**	**0.0531**	**0.0534**	**0.0068**	**0.0531**	**0.0534**	**0.0068**	
Min	**-0.0224**	**-0.0212**	**-0.0087**	**-0.0216**	**-0.0211**	**-0.0088**	**-0.0216**	**-0.0211**	**-0.0088**	

From the above table the maximum difference considering all models found 0.05 Seconds only. Since the above values are calculated with 5 Years interval it is possible that in between these interval periods the maximum difference may reach up to 0.137 Seconds for Newcomb/IAU1964 as explained above which are insignificant. Hence any Model given above can be selected for our calculation but recommended to use the latest one with first 10 terms, which is adequate.

Table 21: The Nutation in longitude (Δψ) (in Seconds)

Julian	Reference Epoch J2000				Reference Epoch J1900				Reference Epoch B1900				Besselian
Year	(A)	(B)	(C)	(D)	(A)	(B)	(C)	(D)	(A)	(B)	(C)	(D)	Year
1800	-8.566	-8.565	-8.515	-8.518	-8.584	-8.584	-8.534	-8.537	-8.584	-8.584	-8.534	-8.537	1799.997006
1805	15.562	15.560	15.561	15.565	15.593	15.591	15.592	15.596	15.593	15.591	15.592	15.596	1804.997113
1810	6.170	6.170	6.156	6.159	6.181	6.182	6.168	6.171	6.181	6.182	6.168	6.171	1809.997219
1815	-16.179	-16.178	-16.122	-16.130	-16.213	-16.212	-16.156	-16.164	-16.213	-16.212	-16.156	-16.164	1814.997326
1820	-1.391	-1.391	-1.365	-1.365	-1.395	-1.395	-1.368	-1.369	-1.395	-1.395	-1.368	-1.369	1819.997433
1825	17.333	17.331	17.305	17.311	17.367	17.366	17.339	17.346	17.367	17.366	17.339	17.346	1824.997540
1830	-1.609	-1.609	-1.578	-1.580	-1.613	-1.613	-1.583	-1.584	-1.613	-1.613	-1.583	-1.584	1829.997646
1835	-16.020	-16.018	-15.972	-15.978	-16.053	-16.052	-16.006	-16.012	-16.053	-16.052	-16.006	-16.012	1834.997753
1840	6.041	6.040	6.028	6.028	6.053	6.052	6.040	6.040	6.053	6.052	6.040	6.040	1839.997860
1845	15.856	15.854	15.854	15.861	15.886	15.885	15.885	15.892	15.886	15.885	15.885	15.892	1844.997967
1850	-9.151	-9.150	-9.104	-9.110	-9.169	-9.169	-9.124	-9.129	-9.169	-9.169	-9.124	-9.129	1849.998074
1855	-12.578	-12.577	-12.570	-12.575	-12.604	-12.603	-12.597	-12.601	-12.604	-12.603	-12.597	-12.601	1854.998180
1860	12.723	12.722	12.722	12.725	12.748	12.748	12.747	12.751	12.748	12.748	12.747	12.751	1859.998287
1865	10.897	10.895	10.917	10.922	10.917	10.915	10.938	10.942	10.917	10.915	10.938	10.942	1864.998394
1870	-14.807	-14.804	-14.785	-14.793	-14.837	-14.835	-14.816	-14.824	-14.837	-14.835	-14.816	-14.824	1869.998501
1875	-6.139	-6.139	-6.129	-6.131	-6.152	-6.152	-6.142	-6.145	-6.152	-6.152	-6.142	-6.145	1874.998608
1880	16.972	16.970	16.991	16.997	17.004	17.003	17.025	17.030	17.004	17.003	17.025	17.030	1879.998714
1885	3.200	3.200	3.204	3.205	3.205	3.205	3.209	3.210	3.205	3.205	3.209	3.210	1884.998821
1890	-16.832	-16.830	-16.811	-16.819	-16.866	-16.865	-16.846	-16.854	-16.866	-16.865	-16.846	-16.854	1889.998928
1895	1.797	1.797	1.833	1.833	1.800	1.800	1.836	1.836	1.800	1.800	1.836	1.836	1894.999035
1900	17.341	17.339	17.335	17.341	17.374	17.373	17.369	17.375	17.374	17.373	17.369	17.375	1899.999142
1905	-5.001	-5.000	-4.997	-5.001	-5.012	-5.010	-5.007	-5.011	-5.012	-5.010	-5.007	-5.011	1904.999248
1910	-14.898	-14.896	-14.849	-14.854	-14.929	-14.928	-14.880	-14.886	-14.929	-14.928	-14.880	-14.886	1909.999355
1915	9.107	9.106	9.120	9.122	9.124	9.124	9.138	9.140	9.124	9.124	9.138	9.140	1914.999462
1920	14.010	14.009	13.983	13.989	14.037	14.037	14.011	14.017	14.037	14.037	14.011	14.017	1919.999569
1925	-11.645	-11.644	-11.602	-11.609	-11.669	-11.668	-11.627	-11.634	-11.669	-11.668	-11.627	-11.634	1924.999676
1930	-10.042	-10.041	-10.004	-10.007	-10.063	-10.063	-10.026	-10.029	-10.063	-10.063	-10.026	-10.029	1929.999782
1935	14.507	14.506	14.481	14.484	14.536	14.535	14.510	14.514	14.536	14.535	14.510	14.514	1934.999889
1940	8.034	8.033	8.040	8.043	8.049	8.048	8.055	8.058	8.049	8.048	8.055	8.058	1939.999996
1945	-15.751	-15.749	-15.695	-15.703	-15.783	-15.782	-15.728	-15.736	-15.783	-15.782	-15.728	-15.736	1945.000103
1950	-3.304	-3.304	-3.309	-3.311	-3.311	-3.311	-3.317	-3.319	-3.311	-3.311	-3.317	-3.319	1950.000210
1955	17.402	17.400	17.389	17.395	17.436	17.435	17.424	17.430	17.436	17.435	17.424	17.430	1955.000316
1960	0.287	0.287	0.328	0.327	0.286	0.286	0.327	0.326	0.286	0.286	0.327	0.326	1960.000423
1965	-16.610	-16.608	-16.588	-16.595	-16.644	-16.642	-16.622	-16.630	-16.644	-16.642	-16.622	-16.630	1965.000530
1970	4.517	4.517	4.512	4.513	4.525	4.526	4.521	4.522	4.525	4.526	4.521	4.522	1970.000637
1975	16.810	16.808	16.831	16.838	16.842	16.840	16.864	16.870	16.842	16.840	16.864	16.870	1975.000744
1980	-7.786	-7.784	-7.755	-7.760	-7.802	-7.800	-7.772	-7.777	-7.802	-7.800	-7.772	-7.777	1980.000850
1985	-13.640	-13.638	-13.629	-13.634	-13.668	-13.667	-13.658	-13.663	-13.668	-13.667	-13.658	-13.663	1985.000957
1990	11.797	11.797	11.826	11.829	11.820	11.820	11.849	11.852	11.820	11.820	11.849	11.852	1990.001064
1995	12.226	12.225	12.239	12.245	12.248	12.248	12.263	12.268	12.248	12.248	12.263	12.268	1995.001171
2000	-13.931	-13.928	-13.911	-13.919	-13.959	-13.957	-13.940	-13.948	-13.959	-13.957	-13.940	-13.948	2000.001278
2005	-7.437	-7.435	-7.397	-7.399	-7.453	-7.451	-7.413	-7.416	-7.453	-7.451	-7.413	-7.416	2005.001384
2010	16.419	16.418	16.435	16.440	16.451	16.450	16.468	16.473	16.451	16.450	16.468	16.473	2010.001491
2015	4.896	4.897	4.893	4.894	4.905	4.906	4.902	4.903	4.905	4.906	4.902	4.903	2015.001598
2020	-16.551	-16.548	-16.505	-16.513	-16.584	-16.582	-16.540	-16.548	-16.584	-16.582	-16.540	-16.548	2020.001705
2025	0.124	0.124	0.156	0.155	0.123	0.123	0.155	0.154	0.123	0.123	0.155	0.154	2025.001811
2030	17.474	17.473	17.452	17.459	17.508	17.508	17.487	17.493	17.508	17.508	17.487	17.493	2030.001918
2035	-3.130	-3.129	-3.109	-3.112	-3.137	-3.137	-3.116	-3.119	-3.137	-3.137	-3.116	-3.119	2035.002025
2040	-15.588	-15.586	-15.539	-15.545	-15.621	-15.619	-15.572	-15.578	-15.621	-15.619	-15.572	-15.578	2040.002132

Julian	Reference Epoch J2000				Reference Epoch J1900				Reference Epoch B1900				Besselian
Year	(A)	(B)	(C)	(D)	(A)	(B)	(C)	(D)	(A)	(B)	(C)	(D)	Year
2045	7.438	7.438	7.425	7.426	7.452	7.453	7.440	7.441	7.452	7.453	7.440	7.441	2045.002239
2050	15.188	15.186	15.174	15.180	15.216	15.216	15.204	15.210	15.216	15.216	15.204	15.210	2050.002345
2055	-10.322	-10.319	-10.271	-10.277	-10.343	-10.341	-10.293	-10.299	-10.343	-10.341	-10.293	-10.299	2055.002452
2060	-11.592	-11.590	-11.585	-11.590	-11.616	-11.615	-11.610	-11.614	-11.616	-11.615	-11.610	-11.614	2060.002559
2065	13.664	13.664	13.646	13.649	13.691	13.691	13.674	13.677	13.691	13.691	13.674	13.677	2065.002666
2070	9.778	9.778	9.804	9.808	9.796	9.796	9.822	9.826	9.796	9.796	9.822	9.826	2070.002773
2075	-15.406	-15.403	-15.375	-15.384	-15.437	-15.435	-15.407	-15.415	-15.437	-15.435	-15.407	-15.415	2075.002879
2080	-4.927	-4.925	-4.934	-4.936	-4.937	-4.935	-4.944	-4.947	-4.937	-4.935	-4.944	-4.947	2080.002986
2085	17.485	17.484	17.504	17.509	17.519	17.518	17.538	17.544	17.519	17.518	17.538	17.544	2085.003093
2090	1.933	1.934	1.962	1.962	1.935	1.937	1.965	1.965	1.935	1.937	1.965	1.965	2090.003200
2095	-16.950	-16.947	-16.938	-16.946	-16.984	-16.982	-16.973	-16.981	-16.984	-16.982	-16.973	-16.981	2095.003307
2100	3.239	3.240	3.268	3.268	3.244	3.245	3.274	3.274	3.244	3.245	3.274	3.274	2100.003413
2105	17.401	17.401	17.426	17.432	17.434	17.434	17.459	17.466	17.434	17.434	17.459	17.466	2105.003520
2110	-6.382	-6.379	-6.367	-6.372	-6.395	-6.392	-6.381	-6.385	-6.395	-6.392	-6.381	-6.385	2110.003627
2115	-14.356	-14.353	-14.317	-14.322	-14.386	-14.383	-14.347	-14.352	-14.386	-14.383	-14.347	-14.352	2115.003734
2120	10.642	10.642	10.681	10.683	10.662	10.663	10.701	10.704	10.662	10.663	10.701	10.704	2120.003841
2125	13.337	13.338	13.334	13.339	13.362	13.364	13.360	13.365	13.362	13.364	13.360	13.365	2125.003947
2130	-12.820	-12.815	-12.783	-12.791	-12.846	-12.842	-12.810	-12.817	-12.846	-12.842	-12.810	-12.817	2130.004054
2135	-8.744	-8.742	-8.693	-8.697	-8.763	-8.762	-8.713	-8.716	-8.763	-8.762	-8.713	-8.716	2135.004161
2140	15.606	15.606	15.605	15.609	15.636	15.637	15.635	15.640	15.636	15.637	15.635	15.640	2140.004268
2145	6.614	6.616	6.617	6.619	6.626	6.628	6.629	6.631	6.626	6.628	6.629	6.631	2145.004375
2150	-16.194	-16.190	-16.136	-16.144	-16.227	-16.224	-16.170	-16.178	-16.227	-16.224	-16.170	-16.178	2150.004481
2155	-1.673	-1.672	-1.663	-1.665	-1.678	-1.676	-1.667	-1.669	-1.678	-1.676	-1.667	-1.669	2155.004588
2160	17.606	17.606	17.587	17.593	17.640	17.641	17.622	17.628	17.640	17.641	17.622	17.628	2160.004695
2165	-1.314	-1.310	-1.276	-1.278	-1.317	-1.314	-1.280	-1.282	-1.317	-1.314	-1.280	-1.282	2165.004802
2170	-16.289	-16.286	-16.262	-16.270	-16.322	-16.320	-16.296	-16.304	-16.322	-16.320	-16.296	-16.304	2170.004909
2175	5.961	5.962	5.946	5.947	5.973	5.974	5.958	5.958	5.973	5.974	5.958	5.958	2175.005015
2180	16.228	16.228	16.239	16.245	16.258	16.259	16.270	16.277	16.258	16.259	16.270	16.277	2180.005122
2185	-9.102	-9.098	-9.067	-9.073	-9.120	-9.117	-9.086	-9.093	-9.120	-9.117	-9.086	-9.093	2185.005229
2190	-12.817	-12.814	-12.819	-12.824	-12.843	-12.840	-12.846	-12.851	-12.843	-12.840	-12.846	-12.851	2190.005336
2195	12.903	12.904	12.917	12.920	12.928	12.929	12.942	12.945	12.928	12.929	12.942	12.945	2195.005443
2200	11.176	11.178	11.200	11.204	11.196	11.199	11.221	11.225	11.196	11.199	11.221	11.225	2200.005549
2205	-14.852	-14.848	-14.840	-14.848	-14.882	-14.878	-14.870	-14.878	-14.882	-14.878	-14.870	-14.878	2205.005656
2210	-6.153	-6.151	-6.128	-6.131	-6.166	-6.164	-6.142	-6.145	-6.166	-6.164	-6.142	-6.145	2210.005763
2215	17.186	17.188	17.219	17.224	17.219	17.221	17.252	17.258	17.219	17.221	17.252	17.258	2215.005870
2220	3.430	3.433	3.435	3.436	3.436	3.439	3.441	3.442	3.436	3.439	3.441	3.442	2220.005977
2225	-16.805	-16.799	-16.770	-16.778	-16.839	-16.834	-16.805	-16.813	-16.839	-16.834	-16.805	-16.813	2225.006083
2230	1.837	1.839	1.888	1.887	1.839	1.841	1.890	1.890	1.839	1.841	1.890	1.890	2230.006190
2235	17.577	17.580	17.581	17.587	17.611	17.614	17.615	17.622	17.611	17.614	17.615	17.622	2235.006297
2240	-4.752	-4.746	-4.732	-4.736	-4.761	-4.756	-4.743	-4.746	-4.761	-4.756	-4.743	-4.746	2240.006404
2245	-14.894	-14.891	-14.831	-14.838	-14.925	-14.923	-14.863	-14.870	-14.925	-14.923	-14.863	-14.870	2245.006510
2250	9.132	9.135	9.154	9.156	9.150	9.152	9.172	9.173	9.150	9.152	9.172	9.173	2250.006617
2255	14.341	14.344	14.331	14.336	14.368	14.372	14.358	14.364	14.368	14.372	14.358	14.364	2255.006724
2260	-11.477	-11.471	-11.420	-11.426	-11.500	-11.495	-11.444	-11.451	-11.500	-11.495	-11.444	-11.451	2260.006831
2265	-10.170	-10.167	-10.132	-10.136	-10.191	-10.189	-10.155	-10.159	-10.191	-10.189	-10.155	-10.159	2265.006938
2270	14.673	14.675	14.660	14.664	14.702	14.704	14.690	14.693	14.702	14.704	14.690	14.693	2270.007044
2275	8.341	8.345	8.363	8.366	8.356	8.360	8.378	8.382	8.356	8.360	8.378	8.382	2275.007151
2280	-15.801	-15.797	-15.752	-15.761	-15.833	-15.830	-15.785	-15.794	-15.833	-15.830	-15.785	-15.794	2280.007258
2285	-3.358	-3.355	-3.359	-3.362	-3.365	-3.362	-3.367	-3.370	-3.365	-3.362	-3.367	-3.370	2285.007365
2290	17.648	17.651	17.653	17.658	17.682	17.685	17.687	17.693	17.682	17.685	17.687	17.693	2290.007472
2295	0.412	0.416	0.448	0.447	0.411	0.416	0.447	0.446	0.411	0.416	0.447	0.446	2295.007578

Julian	**Reference Epoch J2000**				**Reference Epoch J1900**				**Reference Epoch B1900**				**Besselian**
Year	**(A)**	**(B)**	**(C)**	**(D)**	**(A)**	**(B)**	**(C)**	**(D)**	**(A)**	**(B)**	**(C)**	**(D)**	**Year**
2300	-16.724	-16.719	-16.710	-16.718	-16.758	-16.754	-16.745	-16.753	-16.758	-16.754	-16.745	-16.753	2300.007685
2305	4.620	4.623	4.631	4.630	4.629	4.631	4.639	4.639	4.629	4.631	4.639	4.639	2305.007792
2310	16.957	16.961	16.981	16.987	16.989	16.993	17.013	17.020	16.989	16.993	17.013	17.020	2310.007899
2315	-7.782	-7.776	-7.766	-7.772	-7.798	-7.792	-7.782	-7.788	-7.798	-7.792	-7.782	-7.788	2315.008006
2320	-13.600	-13.596	-13.578	-13.584	-13.628	-13.625	-13.607	-13.613	-13.628	-13.625	-13.607	-13.613	2320.008112
2325	11.861	11.864	11.898	11.900	11.883	11.887	11.921	11.923	11.883	11.887	11.921	11.923	2325.008219
2330	12.293	12.298	12.296	12.300	12.316	12.321	12.319	12.324	12.316	12.321	12.319	12.324	2330.008326
2335	-13.818	-13.811	-13.793	-13.801	-13.846	-13.840	-13.821	-13.829	-13.846	-13.840	-13.821	-13.829	2335.008433
2340	-7.382	-7.378	-7.329	-7.332	-7.398	-7.395	-7.346	-7.349	-7.398	-7.395	-7.346	-7.349	2340.008540
2345	16.414	16.418	16.428	16.433	16.446	16.450	16.461	16.465	16.446	16.450	16.461	16.465	2345.008646
2350	5.068	5.074	5.067	5.069	5.077	5.084	5.077	5.078	5.077	5.084	5.077	5.078	2350.008753
2355	-16.367	-16.363	-16.305	-16.314	-16.401	-16.397	-16.340	-16.348	-16.401	-16.397	-16.340	-16.348	2355.008860
2360	0.074	0.078	0.112	0.111	0.072	0.077	0.111	0.109	0.072	0.077	0.111	0.109	2360.008967
2365	17.564	17.569	17.548	17.554	17.598	17.604	17.583	17.589	17.598	17.604	17.583	17.589	2365.009074
2370	-2.822	-2.815	-2.780	-2.783	-2.828	-2.822	-2.787	-2.790	-2.828	-2.822	-2.787	-2.790	2370.009180
2375	-15.538	-15.533	-15.479	-15.486	-15.570	-15.566	-15.512	-15.519	-15.570	-15.566	-15.512	-15.519	2375.009287
2380	7.432	7.436	7.428	7.429	7.446	7.450	7.443	7.443	7.446	7.450	7.443	7.443	2380.009394
2385	15.429	15.435	15.437	15.443	15.458	15.464	15.466	15.473	15.458	15.464	15.466	15.473	2385.009501
2390	-10.095	-10.089	-10.034	-10.040	-10.116	-10.110	-10.055	-10.062	-10.116	-10.110	-10.055	-10.062	2390.009608
2395	-11.584	-11.579	-11.567	-11.572	-11.608	-11.604	-11.592	-11.597	-11.608	-11.604	-11.592	-11.597	2395.009714
2400	13.751	13.757	13.754	13.757	13.778	13.784	13.781	13.784	13.778	13.784	13.781	13.784	2400.009821
2405	10.014	10.019	10.050	10.054	10.031	10.037	10.068	10.072	10.031	10.037	10.068	10.072	2405.009928
2410	-15.286	-15.279	-15.251	-15.260	-15.317	-15.311	-15.283	-15.291	-15.317	-15.311	-15.283	-15.291	2410.010035
2415	-4.870	-4.866	-4.859	-4.862	-4.881	-4.877	-4.870	-4.873	-4.881	-4.877	-4.870	-4.873	2415.010142
2420	17.537	17.543	17.567	17.572	17.571	17.577	17.601	17.607	17.571	17.577	17.601	17.607	2420.010248
2425	2.077	2.084	2.101	2.100	2.080	2.087	2.104	2.103	2.080	2.087	2.104	2.103	2425.010355
2430	-16.784	-16.778	-16.759	-16.768	-16.818	-16.813	-16.794	-16.803	-16.818	-16.813	-16.794	-16.803	2430.010462
2435	3.191	3.197	3.231	3.231	3.196	3.202	3.236	3.236	3.196	3.202	3.236	3.236	2435.010569
2440	17.361	17.367	17.374	17.380	17.394	17.401	17.407	17.414	17.394	17.401	17.407	17.414	2440.010675
2445	-6.143	-6.135	-6.126	-6.130	-6.156	-6.148	-6.139	-6.143	-6.156	-6.148	-6.139	-6.143	2445.010782
2450	-14.267	-14.262	-14.215	-14.222	-14.297	-14.292	-14.246	-14.252	-14.297	-14.292	-14.246	-14.252	2450.010889
2455	10.429	10.435	10.457	10.459	10.448	10.455	10.477	10.479	10.448	10.455	10.477	10.479	2455.010996
2460	13.411	13.419	13.401	13.406	13.436	13.445	13.427	13.432	13.436	13.445	13.427	13.432	2460.011103
2465	-12.489	-12.482	-12.438	-12.446	-12.515	-12.508	-12.464	-12.472	-12.515	-12.508	-12.464	-12.472	2465.011209
2470	-8.878	-8.871	-8.828	-8.831	-8.897	-8.891	-8.847	-8.851	-8.897	-8.891	-8.847	-8.851	2470.011316
2475	15.425	15.432	15.413	15.417	15.455	15.463	15.444	15.448	15.455	15.463	15.444	15.448	2475.011423
2480	6.967	6.974	6.985	6.987	6.979	6.987	6.998	7.000	6.979	6.987	6.998	7.000	2480.011530
2485	-16.013	-16.006	-15.945	-15.953	-16.046	-16.039	-15.978	-15.987	-16.046	-16.039	-15.978	-15.987	2485.011637
2490	-1.886	-1.880	-1.880	-1.882	-1.891	-1.885	-1.885	-1.887	-1.891	-1.885	-1.885	-1.887	2490.011743
2495	17.699	17.707	17.695	17.701	17.733	17.742	17.730	17.736	17.733	17.742	17.730	17.736	2495.011850
2500	-0.896	-0.888	-0.839	-0.841	-0.899	-0.892	-0.842	-0.844	-0.899	-0.892	-0.842	-0.844	2500.011957
Max	**17.699**	**17.707**	**17.695**	**17.701**	**17.733**	**17.742**	**17.730**	**17.736**	**17.733**	**17.742**	**17.730**	**17.736**	
Min	**-16.950**	**-16.947**	**-16.938**	**-16.946**	**-16.984**	**-16.982**	**-16.973**	**-16.981**	**-16.984**	**-16.982**	**-16.973**	**-16.981**	

Note:

In the table, Column (A), (B), (C) and (D) are the respective models given in Chapter(7.6.4) 'Calculation for Nutation in Longitude'. From above table, the maximum value considering all models is found 17.74 Seconds. Since the above values are calculated with 5 Years interval, it is possible that in between these interval periods, the maximum value may reach up to 19.3 Seconds as explained above. That is why, I insisted Nutation in longitude should be calculated through Equation only for any moment (date/time) considered and not to be interpolated.

Table 22: The Nutation in longitude (Δψ) (in Seconds) for the Year 1960

Date	Reference Epoch J2000				Reference Epoch J1900				Reference Epoch B1900				IENA	Diff.
dd-mmm	(A)	(B)	(C)	(D)	(A)	(B)	(C)	(D)	(A)	(B)	(C)	(D)	1960	δψ
0Hrs UT	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(6)-(13)
1-Jan	0.263	0.263	0.302	0.301	0.262	0.262	0.302	0.301	0.262	0.262	0.302	0.301	0.260	0.002
2-Jan	0.299	0.299	0.340	0.339	0.298	0.298	0.339	0.339	0.298	0.298	0.339	0.339	0.300	-0.002
3-Jan	0.293	0.292	0.330	0.329	0.292	0.291	0.329	0.328	0.292	0.291	0.329	0.328	0.280	0.011
4-Jan	0.256	0.255	0.287	0.286	0.255	0.254	0.286	0.285	0.255	0.254	0.286	0.285	0.250	0.004
5-Jan	0.205	0.205	0.230	0.229	0.205	0.204	0.229	0.228	0.205	0.204	0.229	0.228	0.200	0.004
6-Jan	0.160	0.160	0.178	0.177	0.159	0.159	0.177	0.176	0.159	0.159	0.177	0.176	0.150	0.009
7-Jan	0.131	0.131	0.146	0.145	0.130	0.130	0.145	0.144	0.130	0.130	0.145	0.144	0.120	0.010
8-Jan	0.125	0.126	0.140	0.139	0.124	0.125	0.139	0.138	0.124	0.125	0.139	0.138	0.110	0.015
9-Jan	0.143	0.144	0.161	0.160	0.142	0.143	0.160	0.159	0.142	0.143	0.160	0.159	0.130	0.013
10-Jan	0.182	0.183	0.204	0.203	0.181	0.182	0.203	0.202	0.181	0.182	0.203	0.202	0.170	0.012
11-Jan	0.237	0.238	0.265	0.264	0.236	0.237	0.264	0.263	0.236	0.237	0.264	0.263	0.240	-0.003
12-Jan	0.301	0.302	0.336	0.335	0.300	0.301	0.335	0.334	0.300	0.301	0.335	0.334	0.310	-0.009
13-Jan	0.368	0.369	0.410	0.409	0.367	0.368	0.408	0.408	0.367	0.368	0.408	0.408	0.380	-0.012
14-Jan	0.429	0.430	0.478	0.477	0.428	0.429	0.476	0.476	0.428	0.429	0.476	0.476	0.450	-0.021
15-Jan	0.475	0.476	0.529	0.529	0.474	0.475	0.528	0.528	0.474	0.475	0.528	0.528	0.490	-0.015
16-Jan	0.497	0.498	0.554	0.554	0.496	0.497	0.553	0.553	0.496	0.497	0.553	0.553	0.510	-0.013
17-Jan	0.488	0.489	0.545	0.545	0.486	0.488	0.544	0.544	0.486	0.488	0.544	0.544	0.500	-0.012
18-Jan	0.448	0.450	0.502	0.501	0.447	0.448	0.500	0.500	0.447	0.448	0.500	0.500	0.460	-0.012
19-Jan	0.385	0.387	0.431	0.431	0.383	0.386	0.430	0.430	0.383	0.386	0.430	0.430	0.400	-0.014
20-Jan	0.314	0.316	0.352	0.352	0.313	0.315	0.351	0.351	0.313	0.315	0.351	0.351	0.340	-0.025
21-Jan	0.256	0.258	0.286	0.286	0.254	0.257	0.285	0.285	0.254	0.257	0.285	0.285	0.280	-0.023
22-Jan	0.229	0.231	0.255	0.255	0.227	0.230	0.254	0.254	0.227	0.230	0.254	0.254	0.250	-0.020
23-Jan	0.246	0.248	0.274	0.273	0.245	0.247	0.272	0.272	0.245	0.247	0.272	0.272	0.260	-0.013
24-Jan	0.309	0.311	0.343	0.343	0.307	0.309	0.341	0.341	0.307	0.309	0.341	0.341	0.310	-0.001
25-Jan	0.406	0.407	0.451	0.451	0.404	0.405	0.449	0.449	0.404	0.405	0.449	0.449	0.400	0.005
26-Jan	0.516	0.517	0.573	0.573	0.514	0.515	0.572	0.572	0.514	0.515	0.572	0.572	0.500	0.015
27-Jan	0.615	0.615	0.684	0.684	0.613	0.614	0.682	0.682	0.613	0.614	0.682	0.682	0.600	0.014
28-Jan	0.681	0.681	0.757	0.757	0.679	0.679	0.755	0.756	0.679	0.679	0.755	0.756	0.680	-0.001
29-Jan	0.701	0.701	0.780	0.780	0.700	0.700	0.778	0.778	0.700	0.700	0.778	0.778	0.700	0.000
30-Jan	0.675	0.675	0.751	0.751	0.674	0.674	0.749	0.749	0.674	0.674	0.749	0.749	0.680	-0.006
31-Jan	0.613	0.613	0.682	0.682	0.611	0.611	0.680	0.680	0.611	0.611	0.680	0.680	0.620	-0.009
1-Feb	0.531	0.531	0.591	0.591	0.529	0.529	0.589	0.590	0.529	0.529	0.589	0.590	0.540	-0.011
2-Feb	0.447	0.448	0.500	0.500	0.446	0.446	0.498	0.498	0.446	0.446	0.498	0.498	0.450	-0.004
3-Feb	0.377	0.377	0.424	0.424	0.375	0.376	0.422	0.422	0.375	0.376	0.422	0.422	0.380	-0.004
4-Feb	0.328	0.329	0.372	0.373	0.326	0.327	0.371	0.371	0.326	0.327	0.371	0.371	0.320	0.007
5-Feb	0.303	0.304	0.348	0.349	0.302	0.303	0.346	0.347	0.302	0.303	0.346	0.347	0.300	0.003
6-Feb	0.301	0.302	0.348	0.348	0.299	0.300	0.346	0.347	0.299	0.300	0.346	0.347	0.290	0.010
7-Feb	0.315	0.316	0.366	0.367	0.313	0.314	0.364	0.365	0.313	0.314	0.364	0.365	0.310	0.004
8-Feb	0.339	0.340	0.396	0.396	0.337	0.338	0.394	0.394	0.337	0.338	0.394	0.394	0.340	-0.002
9-Feb	0.367	0.368	0.429	0.430	0.365	0.366	0.427	0.428	0.365	0.366	0.427	0.428	0.380	-0.014
10-Feb	0.392	0.392	0.459	0.460	0.389	0.390	0.457	0.458	0.389	0.390	0.457	0.458	0.400	-0.010
11-Feb	0.403	0.404	0.475	0.476	0.401	0.402	0.473	0.474	0.401	0.402	0.473	0.474	0.420	-0.018
12-Feb	0.392	0.393	0.466	0.468	0.389	0.391	0.464	0.465	0.389	0.391	0.464	0.465	0.400	-0.009
13-Feb	0.351	0.353	0.426	0.427	0.349	0.350	0.424	0.425	0.349	0.350	0.424	0.425	0.360	-0.010
14-Feb	0.279	0.281	0.349	0.351	0.277	0.278	0.347	0.348	0.277	0.278	0.347	0.348	0.280	-0.002
15-Feb	0.179	0.181	0.242	0.244	0.177	0.179	0.240	0.241	0.177	0.179	0.240	0.241	0.190	-0.011
16-Feb	0.066	0.068	0.119	0.120	0.063	0.066	0.116	0.118	0.063	0.066	0.116	0.118	0.080	-0.014
17-Feb	-0.043	-0.041	0.000	0.001	-0.046	-0.043	-0.003	-0.001	-0.046	-0.043	-0.003	-0.001	-0.020	-0.023

Date	Reference Epoch J2000				Reference Epoch J1900				Reference Epoch B1900				IENA	Diff.
dd-mmm	(A)	(B)	(C)	(D)	(A)	(B)	(C)	(D)	(A)	(B)	(C)	(D)	1960	δψ
0Hrs UT	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(6)-(13)
18-Feb	-0.128	-0.126	-0.092	-0.091	-0.130	-0.128	-0.094	-0.093	-0.130	-0.128	-0.094	-0.093	-0.100	-0.028
19-Feb	-0.172	-0.170	-0.139	-0.137	-0.174	-0.172	-0.141	-0.140	-0.174	-0.172	-0.141	-0.140	-0.150	-0.022
20-Feb	-0.170	-0.168	-0.134	-0.132	-0.172	-0.170	-0.136	-0.135	-0.172	-0.170	-0.136	-0.135	-0.160	-0.010
21-Feb	-0.129	-0.127	-0.085	-0.083	-0.131	-0.130	-0.087	-0.085	-0.131	-0.130	-0.087	-0.085	-0.130	0.000
22-Feb	-0.066	-0.065	-0.011	-0.009	-0.068	-0.067	-0.014	-0.012	-0.068	-0.067	-0.014	-0.012	-0.080	0.013
23-Feb	-0.005	-0.004	0.060	0.062	-0.007	-0.007	0.057	0.059	-0.007	-0.007	0.057	0.059	-0.020	0.013
24-Feb	0.030	0.030	0.102	0.104	0.028	0.028	0.100	0.102	0.028	0.028	0.100	0.102	0.010	0.018
25-Feb	0.023	0.023	0.098	0.100	0.021	0.021	0.095	0.097	0.021	0.021	0.095	0.097	0.010	0.011
26-Feb	-0.031	-0.031	0.041	0.043	-0.033	-0.033	0.038	0.040	-0.033	-0.033	0.038	0.040	-0.040	0.007
27-Feb	-0.125	-0.125	-0.061	-0.059	-0.128	-0.128	-0.064	-0.062	-0.128	-0.128	-0.064	-0.062	-0.120	-0.008
28-Feb	-0.245	-0.245	-0.191	-0.189	-0.247	-0.248	-0.194	-0.191	-0.247	-0.248	-0.194	-0.191	-0.240	-0.008
29-Feb	-0.372	-0.372	-0.327	-0.325	-0.374	-0.374	-0.330	-0.328	-0.374	-0.374	-0.330	-0.328	-0.370	-0.004
1-Mar	-0.488	-0.488	-0.452	-0.450	-0.491	-0.491	-0.455	-0.452	-0.491	-0.491	-0.455	-0.452	-0.490	-0.001
2-Mar	-0.584	-0.583	-0.553	-0.550	-0.587	-0.586	-0.555	-0.553	-0.587	-0.586	-0.555	-0.553	-0.590	0.004
3-Mar	-0.654	-0.653	-0.624	-0.622	-0.656	-0.656	-0.627	-0.625	-0.656	-0.656	-0.627	-0.625	-0.660	0.004
4-Mar	-0.699	-0.698	-0.669	-0.667	-0.702	-0.701	-0.672	-0.669	-0.702	-0.701	-0.672	-0.669	-0.710	0.009
5-Mar	-0.725	-0.724	-0.692	-0.690	-0.727	-0.727	-0.695	-0.693	-0.727	-0.727	-0.695	-0.693	-0.730	0.003
6-Mar	-0.737	-0.736	-0.701	-0.698	-0.740	-0.739	-0.704	-0.701	-0.740	-0.739	-0.704	-0.701	-0.740	0.001
7-Mar	-0.743	-0.742	-0.703	-0.700	-0.745	-0.745	-0.705	-0.703	-0.745	-0.745	-0.705	-0.703	-0.740	-0.005
8-Mar	-0.749	-0.749	-0.705	-0.702	-0.752	-0.752	-0.708	-0.705	-0.752	-0.752	-0.708	-0.705	-0.750	-0.002
9-Mar	-0.765	-0.765	-0.717	-0.714	-0.768	-0.768	-0.720	-0.717	-0.768	-0.768	-0.720	-0.717	-0.760	-0.008
10-Mar	-0.799	-0.798	-0.749	-0.745	-0.802	-0.801	-0.752	-0.748	-0.802	-0.801	-0.752	-0.748	-0.800	-0.001
11-Mar	-0.859	-0.858	-0.809	-0.806	-0.862	-0.861	-0.812	-0.809	-0.862	-0.861	-0.812	-0.809	-0.860	-0.001
12-Mar	-0.949	-0.948	-0.903	-0.900	-0.952	-0.951	-0.907	-0.903	-0.952	-0.951	-0.907	-0.903	-0.960	0.009
13-Mar	-1.068	-1.067	-1.030	-1.026	-1.071	-1.070	-1.033	-1.029	-1.071	-1.070	-1.033	-1.029	-1.070	0.000
14-Mar	-1.205	-1.204	-1.177	-1.174	-1.208	-1.207	-1.180	-1.177	-1.208	-1.207	-1.180	-1.177	-1.210	0.003
15-Mar	-1.344	-1.342	-1.327	-1.323	-1.347	-1.345	-1.330	-1.326	-1.347	-1.345	-1.330	-1.326	-1.340	-0.005
16-Mar	-1.464	-1.462	-1.456	-1.453	-1.467	-1.465	-1.459	-1.456	-1.467	-1.465	-1.459	-1.456	-1.450	-0.015
17-Mar	-1.547	-1.546	-1.545	-1.542	-1.550	-1.549	-1.548	-1.545	-1.550	-1.549	-1.548	-1.545	-1.540	-0.009
18-Mar	-1.585	-1.584	-1.583	-1.579	-1.588	-1.587	-1.586	-1.582	-1.588	-1.587	-1.586	-1.582	-1.570	-0.017
19-Mar	-1.578	-1.578	-1.571	-1.567	-1.582	-1.581	-1.574	-1.570	-1.582	-1.581	-1.574	-1.570	-1.570	-0.011
20-Mar	-1.542	-1.542	-1.525	-1.522	-1.545	-1.545	-1.529	-1.525	-1.545	-1.545	-1.529	-1.525	-1.550	0.005
21-Mar	-1.498	-1.498	-1.472	-1.468	-1.501	-1.501	-1.475	-1.471	-1.501	-1.501	-1.475	-1.471	-1.510	0.009
22-Mar	-1.471	-1.471	-1.437	-1.432	-1.474	-1.475	-1.440	-1.436	-1.474	-1.475	-1.440	-1.436	-1.490	0.015
23-Mar	-1.480	-1.481	-1.442	-1.438	-1.483	-1.484	-1.446	-1.441	-1.483	-1.484	-1.446	-1.441	-1.500	0.016
24-Mar	-1.535	-1.536	-1.499	-1.495	-1.538	-1.539	-1.503	-1.498	-1.538	-1.539	-1.503	-1.498	-1.560	0.021
25-Mar	-1.633	-1.634	-1.604	-1.599	-1.636	-1.637	-1.607	-1.603	-1.636	-1.637	-1.607	-1.603	-1.650	0.013
26-Mar	-1.761	-1.762	-1.742	-1.738	-1.764	-1.765	-1.745	-1.741	-1.764	-1.765	-1.745	-1.741	-1.770	0.005
27-Mar	-1.901	-1.902	-1.893	-1.888	-1.904	-1.905	-1.896	-1.892	-1.904	-1.905	-1.896	-1.892	-1.900	-0.005
28-Mar	-2.035	-2.035	-2.036	-2.032	-2.038	-2.039	-2.039	-2.035	-2.038	-2.039	-2.039	-2.035	-2.040	0.001
29-Mar	-2.148	-2.149	-2.156	-2.152	-2.152	-2.152	-2.160	-2.155	-2.152	-2.152	-2.160	-2.155	-2.150	-0.002
30-Mar	-2.235	-2.235	-2.246	-2.242	-2.239	-2.239	-2.250	-2.245	-2.239	-2.239	-2.250	-2.245	-2.240	0.001
31-Mar	-2.294	-2.294	-2.306	-2.301	-2.298	-2.298	-2.309	-2.305	-2.298	-2.298	-2.309	-2.305	-2.310	0.012
1-Apr	-2.330	-2.330	-2.340	-2.335	-2.333	-2.334	-2.343	-2.339	-2.333	-2.334	-2.343	-2.339	-2.340	0.006
2-Apr	-2.348	-2.348	-2.355	-2.350	-2.352	-2.352	-2.359	-2.354	-2.352	-2.352	-2.359	-2.354	-2.360	0.008
3-Apr	-2.357	-2.357	-2.360	-2.355	-2.360	-2.361	-2.363	-2.358	-2.360	-2.361	-2.363	-2.358	-2.360	-0.001
4-Apr	-2.362	-2.363	-2.361	-2.356	-2.366	-2.366	-2.365	-2.360	-2.366	-2.366	-2.365	-2.360	-2.360	-0.006
5-Apr	-2.373	-2.373	-2.368	-2.363	-2.377	-2.377	-2.371	-2.366	-2.377	-2.377	-2.371	-2.366	-2.370	-0.007
6-Apr	-2.397	-2.397	-2.389	-2.384	-2.401	-2.401	-2.393	-2.388	-2.401	-2.401	-2.393	-2.388	-2.400	-0.001

Date	Reference Epoch J2000				Reference Epoch J1900				Reference Epoch B1900				IENA	Diff.
dd-mmm	(A)	(B)	(C)	(D)	(A)	(B)	(C)	(D)	(A)	(B)	(C)	(D)	1960	δψ
0Hrs UT	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(6)-(13)
7-Apr	-2.443	-2.443	-2.434	-2.429	-2.447	-2.447	-2.438	-2.433	-2.447	-2.447	-2.438	-2.433	-2.450	0.003
8-Apr	-2.516	-2.516	-2.510	-2.505	-2.520	-2.520	-2.514	-2.509	-2.520	-2.520	-2.514	-2.509	-2.520	0.000
9-Apr	-2.617	-2.617	-2.617	-2.612	-2.621	-2.621	-2.621	-2.616	-2.621	-2.621	-2.621	-2.616	-2.630	0.009
10-Apr	-2.739	-2.738	-2.748	-2.743	-2.743	-2.742	-2.752	-2.747	-2.743	-2.742	-2.752	-2.747	-2.750	0.008
11-Apr	-2.867	-2.867	-2.887	-2.882	-2.871	-2.871	-2.891	-2.886	-2.871	-2.871	-2.891	-2.886	-2.880	0.009
12-Apr	-2.982	-2.982	-3.012	-3.007	-2.986	-2.986	-3.016	-3.011	-2.986	-2.986	-3.016	-3.011	-2.990	0.004
13-Apr	-3.066	-3.065	-3.102	-3.097	-3.070	-3.069	-3.106	-3.101	-3.070	-3.069	-3.106	-3.101	-3.070	0.001
14-Apr	-3.104	-3.104	-3.142	-3.137	-3.108	-3.108	-3.146	-3.141	-3.108	-3.108	-3.146	-3.141	-3.100	-0.008
15-Apr	-3.095	-3.095	-3.129	-3.124	-3.099	-3.100	-3.133	-3.128	-3.099	-3.100	-3.133	-3.128	-3.090	-0.010
16-Apr	-3.049	-3.050	-3.074	-3.069	-3.053	-3.054	-3.079	-3.074	-3.053	-3.054	-3.079	-3.074	-3.050	-0.004
17-Apr	-2.986	-2.987	-3.001	-2.996	-2.991	-2.992	-3.005	-3.000	-2.991	-2.992	-3.005	-3.000	-2.990	-0.002
18-Apr	-2.931	-2.932	-2.936	-2.930	-2.935	-2.936	-2.940	-2.935	-2.935	-2.936	-2.940	-2.935	-2.940	0.004
19-Apr	-2.905	-2.907	-2.904	-2.899	-2.909	-2.911	-2.908	-2.903	-2.909	-2.911	-2.908	-2.903	-2.930	0.019
20-Apr	-2.922	-2.924	-2.920	-2.915	-2.926	-2.928	-2.925	-2.919	-2.926	-2.928	-2.925	-2.919	-2.950	0.022
21-Apr	-2.984	-2.986	-2.987	-2.982	-2.988	-2.990	-2.991	-2.986	-2.988	-2.990	-2.991	-2.986	-3.010	0.020
22-Apr	-3.081	-3.083	-3.093	-3.088	-3.086	-3.088	-3.097	-3.092	-3.086	-3.088	-3.097	-3.092	-3.100	0.012
23-Apr	-3.197	-3.199	-3.218	-3.213	-3.201	-3.203	-3.222	-3.217	-3.201	-3.203	-3.222	-3.217	-3.210	0.007
24-Apr	-3.311	-3.313	-3.342	-3.337	-3.315	-3.317	-3.346	-3.341	-3.315	-3.317	-3.346	-3.341	-3.320	0.003
25-Apr	-3.408	-3.410	-3.446	-3.441	-3.413	-3.414	-3.450	-3.445	-3.413	-3.414	-3.450	-3.445	-3.420	0.006
26-Apr	-3.479	-3.480	-3.520	-3.515	-3.483	-3.484	-3.524	-3.519	-3.483	-3.484	-3.524	-3.519	-3.490	0.006
27-Apr	-3.520	-3.521	-3.562	-3.557	-3.524	-3.525	-3.566	-3.561	-3.524	-3.525	-3.566	-3.561	-3.540	0.015
28-Apr	-3.535	-3.536	-3.575	-3.570	-3.539	-3.540	-3.579	-3.574	-3.539	-3.540	-3.579	-3.574	-3.550	0.010
29-Apr	-3.530	-3.531	-3.566	-3.561	-3.534	-3.535	-3.570	-3.565	-3.534	-3.535	-3.570	-3.565	-3.550	0.015
30-Apr	-3.512	-3.513	-3.543	-3.538	-3.516	-3.517	-3.547	-3.542	-3.516	-3.517	-3.547	-3.542	-3.520	0.003
1-May	-3.488	-3.489	-3.514	-3.509	-3.493	-3.494	-3.519	-3.514	-3.493	-3.494	-3.519	-3.514	-3.490	-0.004
2-May	-3.466	-3.467	-3.487	-3.482	-3.471	-3.472	-3.492	-3.487	-3.471	-3.472	-3.492	-3.487	-3.470	-0.002
3-May	-3.455	-3.456	-3.471	-3.466	-3.459	-3.460	-3.476	-3.471	-3.459	-3.460	-3.476	-3.471	-3.450	-0.010
4-May	-3.461	-3.462	-3.475	-3.470	-3.466	-3.466	-3.480	-3.475	-3.466	-3.466	-3.480	-3.475	-3.460	-0.006
5-May	-3.492	-3.492	-3.507	-3.502	-3.497	-3.497	-3.511	-3.506	-3.497	-3.497	-3.511	-3.506	-3.500	0.003
6-May	-3.550	-3.550	-3.568	-3.563	-3.554	-3.555	-3.573	-3.568	-3.554	-3.555	-3.573	-3.568	-3.560	0.005
7-May	-3.630	-3.630	-3.656	-3.651	-3.635	-3.635	-3.660	-3.656	-3.635	-3.635	-3.660	-3.656	-3.640	0.005
8-May	-3.722	-3.722	-3.756	-3.751	-3.727	-3.726	-3.761	-3.756	-3.727	-3.726	-3.761	-3.756	-3.730	0.004
9-May	-3.806	-3.806	-3.850	-3.845	-3.811	-3.811	-3.855	-3.850	-3.811	-3.811	-3.855	-3.850	-3.810	-0.001
10-May	-3.865	-3.865	-3.915	-3.910	-3.870	-3.869	-3.920	-3.915	-3.870	-3.869	-3.920	-3.915	-3.870	0.001
11-May	-3.881	-3.881	-3.933	-3.929	-3.886	-3.886	-3.938	-3.934	-3.886	-3.886	-3.938	-3.934	-3.890	0.004
12-May	-3.849	-3.850	-3.898	-3.894	-3.854	-3.855	-3.903	-3.899	-3.854	-3.855	-3.903	-3.899	-3.860	0.005
13-May	-3.775	-3.776	-3.815	-3.811	-3.780	-3.781	-3.820	-3.816	-3.780	-3.781	-3.820	-3.816	-3.780	-0.001
14-May	-3.676	-3.677	-3.704	-3.700	-3.681	-3.682	-3.709	-3.705	-3.681	-3.682	-3.709	-3.705	-3.680	-0.002
15-May	-3.575	-3.576	-3.591	-3.587	-3.580	-3.581	-3.596	-3.592	-3.580	-3.581	-3.596	-3.592	-3.580	-0.001
16-May	-3.496	-3.498	-3.503	-3.499	-3.501	-3.503	-3.509	-3.505	-3.501	-3.503	-3.509	-3.505	-3.510	0.007
17-May	-3.457	-3.459	-3.460	-3.456	-3.462	-3.464	-3.466	-3.462	-3.462	-3.464	-3.466	-3.462	-3.480	0.016
18-May	-3.464	-3.466	-3.469	-3.465	-3.469	-3.471	-3.474	-3.470	-3.469	-3.471	-3.474	-3.470	-3.490	0.019
19-May	-3.512	-3.514	-3.522	-3.519	-3.517	-3.519	-3.528	-3.524	-3.517	-3.519	-3.528	-3.524	-3.540	0.021
20-May	-3.584	-3.586	-3.604	-3.600	-3.589	-3.591	-3.609	-3.606	-3.589	-3.591	-3.609	-3.606	-3.610	0.019
21-May	-3.663	-3.665	-3.691	-3.688	-3.668	-3.670	-3.696	-3.693	-3.668	-3.670	-3.696	-3.693	-3.680	0.010
22-May	-3.730	-3.732	-3.765	-3.762	-3.735	-3.737	-3.770	-3.767	-3.735	-3.737	-3.770	-3.767	-3.750	0.013
23-May	-3.773	-3.774	-3.811	-3.808	-3.779	-3.780	-3.817	-3.814	-3.779	-3.780	-3.817	-3.814	-3.800	0.020
24-May	-3.788	-3.788	-3.826	-3.823	-3.793	-3.794	-3.831	-3.828	-3.793	-3.794	-3.831	-3.828	-3.810	0.016
25-May	-3.774	-3.775	-3.810	-3.807	-3.780	-3.780	-3.815	-3.812	-3.780	-3.780	-3.815	-3.812	-3.800	0.020

Date	Reference Epoch J2000				Reference Epoch J1900				Reference Epoch B1900				IENA	Diff.
dd-mmm	(A)	(B)	(C)	(D)	(A)	(B)	(C)	(D)	(A)	(B)	(C)	(D)	1960	δψ
0Hrs UT	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(6)-(13)
26-May	-3.739	-3.740	-3.770	-3.767	-3.745	-3.745	-3.776	-3.773	-3.745	-3.745	-3.776	-3.773	-3.760	0.015
27-May	-3.690	-3.690	-3.715	-3.712	-3.695	-3.696	-3.721	-3.718	-3.695	-3.696	-3.721	-3.718	-3.700	0.004
28-May	-3.634	-3.634	-3.653	-3.650	-3.639	-3.640	-3.659	-3.656	-3.639	-3.640	-3.659	-3.656	-3.640	0.000
29-May	-3.579	-3.579	-3.592	-3.589	-3.584	-3.585	-3.597	-3.594	-3.584	-3.585	-3.597	-3.594	-3.580	-0.005
30-May	-3.531	-3.532	-3.539	-3.536	-3.537	-3.537	-3.545	-3.542	-3.537	-3.537	-3.545	-3.542	-3.530	-0.007
31-May	-3.500	-3.500	-3.504	-3.501	-3.506	-3.506	-3.509	-3.507	-3.506	-3.506	-3.509	-3.507	-3.500	-0.006
1-Jun	-3.492	-3.492	-3.494	-3.491	-3.498	-3.498	-3.500	-3.497	-3.498	-3.498	-3.500	-3.497	-3.490	-0.008
2-Jun	-3.511	-3.510	-3.514	-3.511	-3.516	-3.516	-3.520	-3.517	-3.516	-3.516	-3.520	-3.517	-3.510	-0.006
3-Jun	-3.554	-3.553	-3.562	-3.560	-3.560	-3.559	-3.568	-3.565	-3.560	-3.559	-3.568	-3.565	-3.550	-0.009
4-Jun	-3.613	-3.612	-3.628	-3.626	-3.619	-3.617	-3.634	-3.632	-3.619	-3.617	-3.634	-3.632	-3.610	-0.007
5-Jun	-3.672	-3.670	-3.695	-3.693	-3.677	-3.676	-3.701	-3.699	-3.677	-3.676	-3.701	-3.699	-3.670	-0.006
6-Jun	-3.711	-3.710	-3.741	-3.740	-3.717	-3.716	-3.747	-3.746	-3.717	-3.716	-3.747	-3.746	-3.710	-0.006
7-Jun	-3.714	-3.713	-3.747	-3.745	-3.719	-3.718	-3.753	-3.751	-3.719	-3.718	-3.753	-3.751	-3.720	0.002
8-Jun	-3.669	-3.668	-3.700	-3.699	-3.675	-3.674	-3.706	-3.705	-3.675	-3.674	-3.706	-3.705	-3.680	0.006
9-Jun	-3.580	-3.579	-3.602	-3.601	-3.585	-3.585	-3.608	-3.607	-3.585	-3.585	-3.608	-3.607	-3.590	0.005
10-Jun	-3.458	-3.457	-3.468	-3.467	-3.463	-3.463	-3.474	-3.473	-3.463	-3.463	-3.474	-3.473	-3.460	-0.003
11-Jun	-3.326	-3.326	-3.323	-3.322	-3.331	-3.331	-3.329	-3.328	-3.331	-3.331	-3.329	-3.328	-3.330	-0.001
12-Jun	-3.208	-3.209	-3.194	-3.194	-3.214	-3.215	-3.200	-3.200	-3.214	-3.215	-3.200	-3.200	-3.210	-0.005
13-Jun	-3.126	-3.127	-3.106	-3.105	-3.132	-3.133	-3.112	-3.111	-3.132	-3.133	-3.112	-3.111	-3.130	-0.003
14-Jun	-3.091	-3.091	-3.069	-3.068	-3.097	-3.098	-3.075	-3.074	-3.097	-3.098	-3.075	-3.074	-3.110	0.012
15-Jun	-3.100	-3.101	-3.081	-3.081	-3.106	-3.107	-3.088	-3.087	-3.106	-3.107	-3.088	-3.087	-3.120	0.013
16-Jun	-3.142	-3.142	-3.130	-3.130	-3.148	-3.148	-3.136	-3.136	-3.148	-3.148	-3.136	-3.136	-3.160	0.012
17-Jun	-3.198	-3.198	-3.194	-3.194	-3.204	-3.204	-3.200	-3.201	-3.204	-3.204	-3.200	-3.201	-3.220	0.016
18-Jun	-3.249	-3.249	-3.252	-3.252	-3.255	-3.255	-3.258	-3.259	-3.255	-3.255	-3.258	-3.259	-3.270	0.015
19-Jun	-3.280	-3.280	-3.288	-3.288	-3.286	-3.286	-3.294	-3.294	-3.286	-3.286	-3.294	-3.294	-3.300	0.014
20-Jun	-3.285	-3.284	-3.293	-3.293	-3.291	-3.290	-3.299	-3.299	-3.291	-3.290	-3.299	-3.299	-3.300	0.010
21-Jun	-3.262	-3.261	-3.267	-3.268	-3.268	-3.267	-3.273	-3.274	-3.268	-3.267	-3.273	-3.274	-3.280	0.013
22-Jun	-3.217	-3.216	-3.217	-3.218	-3.223	-3.222	-3.223	-3.224	-3.223	-3.222	-3.223	-3.224	-3.240	0.018
23-Jun	-3.156	-3.155	-3.151	-3.152	-3.163	-3.161	-3.157	-3.158	-3.163	-3.161	-3.157	-3.158	-3.170	0.009
24-Jun	-3.089	-3.088	-3.077	-3.078	-3.095	-3.094	-3.083	-3.084	-3.095	-3.094	-3.083	-3.084	-3.100	0.006
25-Jun	-3.022	-3.021	-3.003	-3.004	-3.028	-3.027	-3.010	-3.011	-3.028	-3.027	-3.010	-3.011	-3.020	-0.007
26-Jun	-2.963	-2.962	-2.938	-2.940	-2.969	-2.968	-2.945	-2.946	-2.969	-2.968	-2.945	-2.946	-2.950	-0.018
27-Jun	-2.919	-2.918	-2.890	-2.891	-2.926	-2.924	-2.896	-2.898	-2.926	-2.924	-2.896	-2.898	-2.910	-0.014
28-Jun	-2.898	-2.896	-2.866	-2.867	-2.904	-2.902	-2.872	-2.874	-2.904	-2.902	-2.872	-2.874	-2.880	-0.022
29-Jun	-2.903	-2.901	-2.872	-2.873	-2.910	-2.908	-2.878	-2.880	-2.910	-2.908	-2.878	-2.880	-2.890	-0.018
30-Jun	-2.936	-2.933	-2.908	-2.909	-2.942	-2.940	-2.914	-2.916	-2.942	-2.940	-2.914	-2.916	-2.920	-0.020
1-Jul	-2.989	-2.986	-2.967	-2.969	-2.995	-2.992	-2.974	-2.976	-2.995	-2.992	-2.974	-2.976	-2.970	-0.022
2-Jul	-3.048	-3.045	-3.035	-3.037	-3.055	-3.052	-3.042	-3.044	-3.055	-3.052	-3.042	-3.044	-3.030	-0.022
3-Jul	-3.096	-3.093	-3.091	-3.093	-3.103	-3.100	-3.098	-3.100	-3.103	-3.100	-3.098	-3.100	-3.080	-0.020
4-Jul	-3.114	-3.111	-3.113	-3.116	-3.121	-3.118	-3.120	-3.122	-3.121	-3.118	-3.120	-3.122	-3.100	-0.018
5-Jul	-3.088	-3.086	-3.087	-3.090	-3.095	-3.092	-3.094	-3.096	-3.095	-3.092	-3.094	-3.096	-3.080	-0.012
6-Jul	-3.016	-3.014	-3.009	-3.011	-3.023	-3.020	-3.015	-3.018	-3.023	-3.020	-3.015	-3.018	-3.020	0.000
7-Jul	-2.906	-2.904	-2.888	-2.891	-2.913	-2.911	-2.895	-2.898	-2.913	-2.911	-2.895	-2.898	-2.910	-0.001
8-Jul	-2.778	-2.776	-2.747	-2.750	-2.785	-2.783	-2.754	-2.757	-2.785	-2.783	-2.754	-2.757	-2.780	-0.003
9-Jul	-2.657	-2.655	-2.614	-2.617	-2.664	-2.662	-2.620	-2.624	-2.664	-2.662	-2.620	-2.624	-2.660	-0.002
10-Jul	-2.565	-2.564	-2.513	-2.517	-2.572	-2.571	-2.520	-2.523	-2.572	-2.571	-2.520	-2.523	-2.560	-0.011
11-Jul	-2.518	-2.517	-2.463	-2.466	-2.525	-2.524	-2.470	-2.473	-2.525	-2.524	-2.470	-2.473	-2.520	-0.004
12-Jul	-2.518	-2.517	-2.465	-2.469	-2.525	-2.524	-2.472	-2.476	-2.525	-2.524	-2.472	-2.476	-2.520	-0.004
13-Jul	-2.558	-2.556	-2.511	-2.515	-2.564	-2.563	-2.518	-2.522	-2.564	-2.563	-2.518	-2.522	-2.560	-0.003

Date	Reference Epoch J2000				Reference Epoch J1900				Reference Epoch B1900				IENA	Diff.
dd-mmm	(A)	(B)	(C)	(D)	(A)	(B)	(C)	(D)	(A)	(B)	(C)	(D)	1960	δψ
0Hrs UT	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(6)-(13)
14-Jul	-2.619	-2.617	-2.581	-2.585	-2.626	-2.624	-2.588	-2.592	-2.626	-2.624	-2.588	-2.592	-2.620	-0.004
15-Jul	-2.682	-2.681	-2.652	-2.656	-2.689	-2.688	-2.659	-2.663	-2.689	-2.688	-2.659	-2.663	-2.690	0.002
16-Jul	-2.731	-2.730	-2.706	-2.711	-2.738	-2.737	-2.714	-2.718	-2.738	-2.737	-2.714	-2.718	-2.740	0.003
17-Jul	-2.756	-2.754	-2.733	-2.738	-2.763	-2.761	-2.740	-2.745	-2.763	-2.761	-2.740	-2.745	-2.760	-0.001
18-Jul	-2.753	-2.751	-2.729	-2.734	-2.760	-2.758	-2.736	-2.741	-2.760	-2.758	-2.736	-2.741	-2.760	0.002
19-Jul	-2.727	-2.725	-2.699	-2.704	-2.734	-2.732	-2.706	-2.711	-2.734	-2.732	-2.706	-2.711	-2.740	0.008
20-Jul	-2.685	-2.682	-2.652	-2.656	-2.692	-2.689	-2.659	-2.664	-2.692	-2.689	-2.659	-2.664	-2.700	0.011
21-Jul	-2.635	-2.632	-2.596	-2.600	-2.642	-2.639	-2.603	-2.608	-2.642	-2.639	-2.603	-2.608	-2.640	0.001
22-Jul	-2.585	-2.582	-2.540	-2.545	-2.592	-2.589	-2.547	-2.552	-2.592	-2.589	-2.547	-2.552	-2.580	-0.009
23-Jul	-2.542	-2.540	-2.492	-2.497	-2.549	-2.547	-2.499	-2.504	-2.549	-2.547	-2.499	-2.504	-2.530	-0.017
24-Jul	-2.515	-2.512	-2.460	-2.465	-2.522	-2.520	-2.468	-2.473	-2.522	-2.520	-2.468	-2.473	-2.500	-0.020
25-Jul	-2.509	-2.506	-2.452	-2.457	-2.516	-2.514	-2.459	-2.465	-2.516	-2.514	-2.459	-2.465	-2.490	-0.024
26-Jul	-2.530	-2.527	-2.474	-2.479	-2.538	-2.535	-2.481	-2.486	-2.538	-2.535	-2.481	-2.486	-2.520	-0.015
27-Jul	-2.580	-2.577	-2.527	-2.532	-2.587	-2.584	-2.534	-2.540	-2.587	-2.584	-2.534	-2.540	-2.560	-0.024
28-Jul	-2.654	-2.651	-2.608	-2.613	-2.662	-2.658	-2.615	-2.621	-2.662	-2.658	-2.615	-2.621	-2.640	-0.018
29-Jul	-2.742	-2.738	-2.704	-2.709	-2.749	-2.745	-2.711	-2.717	-2.749	-2.745	-2.711	-2.717	-2.720	-0.025
30-Jul	-2.825	-2.821	-2.796	-2.802	-2.832	-2.828	-2.804	-2.810	-2.832	-2.828	-2.804	-2.810	-2.800	-0.028
31-Jul	-2.885	-2.881	-2.864	-2.869	-2.893	-2.889	-2.871	-2.877	-2.893	-2.889	-2.871	-2.877	-2.860	-0.029
1-Aug	-2.907	-2.903	-2.888	-2.894	-2.914	-2.910	-2.895	-2.901	-2.914	-2.910	-2.895	-2.901	-2.880	-0.030
2-Aug	-2.882	-2.879	-2.860	-2.866	-2.889	-2.886	-2.868	-2.874	-2.889	-2.886	-2.868	-2.874	-2.870	-0.016
3-Aug	-2.816	-2.813	-2.786	-2.792	-2.823	-2.820	-2.793	-2.800	-2.823	-2.820	-2.793	-2.800	-2.820	0.000
4-Aug	-2.724	-2.721	-2.683	-2.689	-2.731	-2.729	-2.690	-2.697	-2.731	-2.729	-2.690	-2.697	-2.730	0.001
5-Aug	-2.630	-2.627	-2.577	-2.583	-2.637	-2.635	-2.585	-2.591	-2.637	-2.635	-2.585	-2.591	-2.640	0.005
6-Aug	-2.558	-2.556	-2.496	-2.503	-2.565	-2.564	-2.504	-2.510	-2.565	-2.564	-2.504	-2.510	-2.560	-0.004
7-Aug	-2.527	-2.525	-2.461	-2.468	-2.534	-2.533	-2.469	-2.475	-2.534	-2.533	-2.469	-2.475	-2.520	-0.013
8-Aug	-2.544	-2.542	-2.480	-2.486	-2.551	-2.550	-2.487	-2.494	-2.551	-2.550	-2.487	-2.494	-2.540	-0.010
9-Aug	-2.604	-2.602	-2.546	-2.553	-2.612	-2.610	-2.554	-2.561	-2.612	-2.610	-2.554	-2.561	-2.600	-0.010
10-Aug	-2.693	-2.691	-2.644	-2.651	-2.700	-2.699	-2.652	-2.659	-2.700	-2.699	-2.652	-2.659	-2.690	-0.009
11-Aug	-2.791	-2.789	-2.752	-2.759	-2.798	-2.797	-2.760	-2.767	-2.798	-2.797	-2.760	-2.767	-2.790	-0.007
12-Aug	-2.879	-2.877	-2.848	-2.855	-2.887	-2.885	-2.856	-2.863	-2.887	-2.885	-2.856	-2.863	-2.880	-0.005
13-Aug	-2.945	-2.943	-2.918	-2.926	-2.953	-2.951	-2.926	-2.934	-2.953	-2.951	-2.926	-2.934	-2.940	-0.011
14-Aug	-2.984	-2.982	-2.958	-2.965	-2.992	-2.990	-2.966	-2.973	-2.992	-2.990	-2.966	-2.973	-2.990	0.000
15-Aug	-2.997	-2.995	-2.969	-2.976	-3.005	-3.002	-2.977	-2.984	-3.005	-3.002	-2.977	-2.984	-3.010	0.008
16-Aug	-2.991	-2.989	-2.959	-2.966	-2.999	-2.997	-2.967	-2.975	-2.999	-2.997	-2.967	-2.975	-3.000	0.003
17-Aug	-2.975	-2.973	-2.938	-2.946	-2.983	-2.981	-2.947	-2.954	-2.983	-2.981	-2.947	-2.954	-2.980	-0.001
18-Aug	-2.958	-2.956	-2.916	-2.924	-2.966	-2.964	-2.924	-2.932	-2.966	-2.964	-2.924	-2.932	-2.960	-0.004
19-Aug	-2.947	-2.945	-2.901	-2.908	-2.955	-2.953	-2.909	-2.916	-2.955	-2.953	-2.909	-2.916	-2.940	-0.013
20-Aug	-2.949	-2.947	-2.900	-2.907	-2.957	-2.955	-2.908	-2.915	-2.957	-2.955	-2.908	-2.915	-2.940	-0.015
21-Aug	-2.972	-2.970	-2.921	-2.928	-2.980	-2.978	-2.929	-2.936	-2.980	-2.978	-2.929	-2.936	-2.960	-0.018
22-Aug	-3.020	-3.018	-2.970	-2.977	-3.028	-3.026	-2.978	-2.985	-3.028	-3.026	-2.978	-2.985	-3.010	-0.016
23-Aug	-3.097	-3.095	-3.051	-3.058	-3.105	-3.103	-3.059	-3.066	-3.105	-3.103	-3.059	-3.066	-3.090	-0.013
24-Aug	-3.201	-3.198	-3.161	-3.169	-3.209	-3.206	-3.170	-3.177	-3.209	-3.206	-3.170	-3.177	-3.200	-0.006
25-Aug	-3.323	-3.320	-3.292	-3.300	-3.331	-3.328	-3.301	-3.308	-3.331	-3.328	-3.301	-3.308	-3.310	-0.018
26-Aug	-3.447	-3.444	-3.427	-3.435	-3.455	-3.452	-3.436	-3.443	-3.455	-3.452	-3.436	-3.443	-3.430	-0.022
27-Aug	-3.555	-3.552	-3.545	-3.552	-3.563	-3.560	-3.553	-3.561	-3.563	-3.560	-3.553	-3.561	-3.530	-0.030
28-Aug	-3.629	-3.627	-3.625	-3.633	-3.638	-3.635	-3.633	-3.641	-3.638	-3.635	-3.633	-3.641	-3.600	-0.035
29-Aug	-3.659	-3.657	-3.655	-3.663	-3.667	-3.665	-3.664	-3.671	-3.667	-3.665	-3.664	-3.671	-3.640	-0.025
30-Aug	-3.645	-3.642	-3.636	-3.643	-3.653	-3.651	-3.644	-3.652	-3.653	-3.651	-3.644	-3.652	-3.640	-0.011
31-Aug	-3.597	-3.596	-3.580	-3.587	-3.606	-3.604	-3.588	-3.596	-3.606	-3.604	-3.588	-3.596	-3.600	-0.004

Date	Reference Epoch J2000				Reference Epoch J1900				Reference Epoch B1900				IENA	Diff.
dd-mmm	(A)	(B)	(C)	(D)	(A)	(B)	(C)	(D)	(A)	(B)	(C)	(D)	1960	δψ
0Hrs UT	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(6)-(13)
1-Sep	-3.539	-3.537	-3.511	-3.518	-3.547	-3.546	-3.519	-3.527	-3.547	-3.546	-3.519	-3.527	-3.550	0.004
2-Sep	-3.493	-3.492	-3.456	-3.464	-3.502	-3.501	-3.465	-3.473	-3.502	-3.501	-3.465	-3.473	-3.510	0.009
3-Sep	-3.483	-3.482	-3.441	-3.449	-3.491	-3.491	-3.450	-3.457	-3.491	-3.491	-3.450	-3.457	-3.490	-0.001
4-Sep	-3.518	-3.518	-3.477	-3.485	-3.527	-3.526	-3.486	-3.494	-3.527	-3.526	-3.486	-3.494	-3.520	-0.006
5-Sep	-3.600	-3.599	-3.565	-3.572	-3.608	-3.608	-3.573	-3.581	-3.608	-3.608	-3.573	-3.581	-3.600	-0.008
6-Sep	-3.715	-3.714	-3.690	-3.697	-3.723	-3.723	-3.698	-3.706	-3.723	-3.723	-3.698	-3.706	-3.710	-0.013
7-Sep	-3.845	-3.845	-3.831	-3.839	-3.854	-3.853	-3.840	-3.847	-3.854	-3.853	-3.840	-3.847	-3.840	-0.013
8-Sep	-3.971	-3.970	-3.966	-3.974	-3.979	-3.979	-3.975	-3.983	-3.979	-3.979	-3.975	-3.983	-3.970	-0.009
9-Sep	-4.076	-4.075	-4.078	-4.086	-4.085	-4.084	-4.087	-4.095	-4.085	-4.084	-4.087	-4.095	-4.080	-0.004
10-Sep	-4.153	-4.152	-4.158	-4.166	-4.161	-4.161	-4.167	-4.175	-4.161	-4.161	-4.167	-4.175	-4.160	-0.001
11-Sep	-4.201	-4.200	-4.206	-4.214	-4.210	-4.209	-4.215	-4.223	-4.210	-4.209	-4.215	-4.223	-4.210	0.001
12-Sep	-4.227	-4.226	-4.229	-4.237	-4.235	-4.234	-4.238	-4.246	-4.235	-4.234	-4.238	-4.246	-4.240	0.006
13-Sep	-4.238	-4.237	-4.236	-4.244	-4.247	-4.246	-4.245	-4.253	-4.247	-4.246	-4.245	-4.253	-4.250	0.004
14-Sep	-4.244	-4.243	-4.239	-4.246	-4.253	-4.252	-4.248	-4.255	-4.253	-4.252	-4.248	-4.255	-4.250	-0.002
15-Sep	-4.254	-4.253	-4.245	-4.252	-4.263	-4.262	-4.253	-4.261	-4.263	-4.262	-4.253	-4.261	-4.260	-0.002
16-Sep	-4.274	-4.274	-4.262	-4.270	-4.283	-4.283	-4.271	-4.279	-4.283	-4.283	-4.271	-4.279	-4.280	-0.003
17-Sep	-4.312	-4.312	-4.298	-4.306	-4.321	-4.321	-4.307	-4.315	-4.321	-4.321	-4.307	-4.315	-4.310	-0.011
18-Sep	-4.373	-4.372	-4.360	-4.367	-4.382	-4.382	-4.369	-4.376	-4.382	-4.382	-4.369	-4.376	-4.380	-0.002
19-Sep	-4.461	-4.460	-4.451	-4.459	-4.470	-4.469	-4.460	-4.468	-4.470	-4.469	-4.460	-4.468	-4.470	0.001
20-Sep	-4.576	-4.575	-4.572	-4.580	-4.585	-4.584	-4.582	-4.589	-4.585	-4.584	-4.582	-4.589	-4.580	-0.004
21-Sep	-4.711	-4.710	-4.717	-4.724	-4.720	-4.719	-4.726	-4.734	-4.720	-4.719	-4.726	-4.734	-4.720	0.001
22-Sep	-4.854	-4.853	-4.871	-4.878	-4.863	-4.862	-4.880	-4.887	-4.863	-4.862	-4.880	-4.887	-4.850	-0.012
23-Sep	-4.987	-4.985	-5.014	-5.021	-4.996	-4.994	-5.023	-5.030	-4.996	-4.994	-5.023	-5.030	-4.980	-0.014
24-Sep	-5.091	-5.089	-5.125	-5.133	-5.100	-5.099	-5.135	-5.142	-5.100	-5.099	-5.135	-5.142	-5.080	-0.019
25-Sep	-5.152	-5.151	-5.190	-5.197	-5.161	-5.160	-5.199	-5.207	-5.161	-5.160	-5.199	-5.207	-5.140	-0.020
26-Sep	-5.167	-5.167	-5.202	-5.210	-5.176	-5.176	-5.212	-5.219	-5.176	-5.176	-5.212	-5.219	-5.150	-0.026
27-Sep	-5.143	-5.143	-5.171	-5.179	-5.153	-5.152	-5.181	-5.188	-5.153	-5.152	-5.181	-5.188	-5.140	-0.012
28-Sep	-5.099	-5.099	-5.117	-5.124	-5.108	-5.109	-5.127	-5.134	-5.108	-5.109	-5.127	-5.134	-5.100	-0.009
29-Sep	-5.058	-5.059	-5.067	-5.074	-5.068	-5.068	-5.076	-5.084	-5.068	-5.068	-5.076	-5.084	-5.070	0.002
30-Sep	-5.045	-5.045	-5.047	-5.054	-5.054	-5.055	-5.056	-5.063	-5.054	-5.055	-5.056	-5.063	-5.060	0.005
1-Oct	-5.073	-5.074	-5.075	-5.082	-5.082	-5.083	-5.084	-5.091	-5.082	-5.083	-5.084	-5.091	-5.090	0.007
2-Oct	-5.148	-5.149	-5.154	-5.161	-5.157	-5.158	-5.164	-5.171	-5.157	-5.158	-5.164	-5.171	-5.160	0.002
3-Oct	-5.261	-5.262	-5.276	-5.283	-5.270	-5.271	-5.286	-5.292	-5.270	-5.271	-5.286	-5.292	-5.270	-0.001
4-Oct	-5.395	-5.396	-5.421	-5.428	-5.404	-5.405	-5.430	-5.437	-5.404	-5.405	-5.430	-5.437	-5.400	-0.005
5-Oct	-5.529	-5.530	-5.566	-5.573	-5.538	-5.539	-5.575	-5.582	-5.538	-5.539	-5.575	-5.582	-5.530	-0.009
6-Oct	-5.646	-5.646	-5.690	-5.697	-5.655	-5.656	-5.700	-5.707	-5.655	-5.656	-5.700	-5.707	-5.650	-0.006
7-Oct	-5.734	-5.734	-5.783	-5.790	-5.743	-5.744	-5.792	-5.799	-5.743	-5.744	-5.792	-5.799	-5.740	-0.004
8-Oct	-5.790	-5.791	-5.840	-5.847	-5.800	-5.800	-5.850	-5.856	-5.800	-5.800	-5.850	-5.856	-5.800	0.000
9-Oct	-5.820	-5.820	-5.867	-5.874	-5.829	-5.829	-5.877	-5.883	-5.829	-5.829	-5.877	-5.883	-5.840	0.011
10-Oct	-5.830	-5.830	-5.873	-5.880	-5.839	-5.839	-5.883	-5.889	-5.839	-5.839	-5.883	-5.889	-5.850	0.011
11-Oct	-5.830	-5.831	-5.869	-5.876	-5.840	-5.840	-5.879	-5.886	-5.840	-5.840	-5.879	-5.886	-5.840	0.000
12-Oct	-5.831	-5.831	-5.865	-5.871	-5.840	-5.841	-5.875	-5.881	-5.840	-5.841	-5.875	-5.881	-5.840	-0.001
13-Oct	-5.838	-5.838	-5.869	-5.875	-5.848	-5.848	-5.879	-5.885	-5.848	-5.848	-5.879	-5.885	-5.840	-0.008
14-Oct	-5.860	-5.860	-5.888	-5.894	-5.869	-5.870	-5.898	-5.904	-5.869	-5.870	-5.898	-5.904	-5.860	-0.010
15-Oct	-5.901	-5.901	-5.928	-5.935	-5.911	-5.911	-5.938	-5.945	-5.911	-5.911	-5.938	-5.945	-5.900	-0.011
16-Oct	-5.967	-5.967	-5.996	-6.002	-5.976	-5.976	-6.006	-6.012	-5.976	-5.976	-6.006	-6.012	-5.970	-0.006
17-Oct	-6.058	-6.057	-6.092	-6.098	-6.068	-6.067	-6.102	-6.108	-6.068	-6.067	-6.102	-6.108	-6.070	0.003
18-Oct	-6.170	-6.170	-6.212	-6.218	-6.180	-6.180	-6.222	-6.228	-6.180	-6.180	-6.222	-6.228	-6.180	0.000
19-Oct	-6.294	-6.293	-6.345	-6.351	-6.304	-6.303	-6.355	-6.361	-6.304	-6.303	-6.355	-6.361	-6.300	-0.003

Date	Reference Epoch J2000				Reference Epoch J1900				Reference Epoch B1900				IENA	Diff.
dd-mmm	(A)	(B)	(C)	(D)	(A)	(B)	(C)	(D)	(A)	(B)	(C)	(D)	1960	δψ
0Hrs UT	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(6)-(13)
20-Oct	-6.412	-6.411	-6.473	-6.479	-6.422	-6.421	-6.483	-6.489	-6.422	-6.421	-6.483	-6.489	-6.420	-0.001
21-Oct	-6.507	-6.506	-6.576	-6.582	-6.517	-6.516	-6.586	-6.592	-6.517	-6.516	-6.586	-6.592	-6.510	-0.006
22-Oct	-6.562	-6.562	-6.635	-6.641	-6.572	-6.572	-6.645	-6.652	-6.572	-6.572	-6.645	-6.652	-6.560	-0.012
23-Oct	-6.570	-6.570	-6.642	-6.648	-6.580	-6.580	-6.652	-6.658	-6.580	-6.580	-6.652	-6.658	-6.560	-0.020
24-Oct	-6.535	-6.535	-6.599	-6.606	-6.545	-6.545	-6.610	-6.616	-6.545	-6.545	-6.610	-6.616	-6.520	-0.025
25-Oct	-6.470	-6.471	-6.525	-6.531	-6.480	-6.481	-6.535	-6.541	-6.480	-6.481	-6.535	-6.541	-6.470	-0.011
26-Oct	-6.400	-6.401	-6.443	-6.449	-6.410	-6.411	-6.453	-6.459	-6.410	-6.411	-6.453	-6.459	-6.400	-0.011
27-Oct	-6.348	-6.349	-6.382	-6.388	-6.358	-6.359	-6.393	-6.398	-6.358	-6.359	-6.393	-6.398	-6.360	0.001
28-Oct	-6.333	-6.334	-6.363	-6.369	-6.343	-6.344	-6.374	-6.379	-6.343	-6.344	-6.374	-6.379	-6.360	0.016
29-Oct	-6.364	-6.365	-6.396	-6.402	-6.374	-6.375	-6.406	-6.412	-6.374	-6.375	-6.406	-6.412	-6.390	0.015
30-Oct	-6.437	-6.438	-6.475	-6.481	-6.447	-6.448	-6.486	-6.491	-6.447	-6.448	-6.486	-6.491	-6.460	0.012
31-Oct	-6.537	-6.538	-6.585	-6.590	-6.547	-6.548	-6.595	-6.601	-6.547	-6.548	-6.595	-6.601	-6.560	0.012
1-Nov	-6.643	-6.644	-6.701	-6.707	-6.654	-6.655	-6.712	-6.717	-6.654	-6.655	-6.712	-6.717	-6.660	0.005
2-Nov	-6.737	-6.738	-6.803	-6.809	-6.748	-6.748	-6.814	-6.819	-6.748	-6.748	-6.814	-6.819	-6.750	0.002
3-Nov	-6.804	-6.805	-6.875	-6.880	-6.815	-6.815	-6.885	-6.891	-6.815	-6.815	-6.885	-6.891	-6.820	0.005
4-Nov	-6.839	-6.839	-6.909	-6.915	-6.849	-6.849	-6.920	-6.925	-6.849	-6.849	-6.920	-6.925	-6.860	0.011
5-Nov	-6.842	-6.842	-6.910	-6.916	-6.853	-6.853	-6.921	-6.926	-6.853	-6.853	-6.921	-6.926	-6.870	0.017
6-Nov	-6.823	-6.822	-6.885	-6.891	-6.833	-6.833	-6.896	-6.901	-6.833	-6.833	-6.896	-6.901	-6.850	0.017
7-Nov	-6.789	-6.789	-6.846	-6.852	-6.800	-6.800	-6.857	-6.862	-6.800	-6.800	-6.857	-6.862	-6.810	0.010
8-Nov	-6.753	-6.753	-6.804	-6.809	-6.763	-6.763	-6.814	-6.819	-6.763	-6.763	-6.814	-6.819	-6.770	0.007
9-Nov	-6.720	-6.720	-6.766	-6.771	-6.731	-6.731	-6.777	-6.782	-6.731	-6.731	-6.777	-6.782	-6.730	-0.001
10-Nov	-6.699	-6.699	-6.741	-6.746	-6.710	-6.710	-6.751	-6.756	-6.710	-6.710	-6.751	-6.756	-6.700	-0.010
11-Nov	-6.696	-6.696	-6.734	-6.739	-6.706	-6.706	-6.745	-6.750	-6.706	-6.706	-6.745	-6.750	-6.700	-0.006
12-Nov	-6.714	-6.714	-6.752	-6.757	-6.725	-6.725	-6.763	-6.768	-6.725	-6.725	-6.763	-6.768	-6.720	-0.005
13-Nov	-6.757	-6.757	-6.797	-6.802	-6.768	-6.767	-6.808	-6.813	-6.768	-6.767	-6.808	-6.813	-6.770	0.003
14-Nov	-6.822	-6.821	-6.867	-6.872	-6.833	-6.832	-6.878	-6.883	-6.833	-6.832	-6.878	-6.883	-6.830	-0.002
15-Nov	-6.901	-6.900	-6.954	-6.958	-6.912	-6.911	-6.964	-6.969	-6.912	-6.911	-6.964	-6.969	-6.910	-0.001
16-Nov	-6.980	-6.979	-7.041	-7.046	-6.991	-6.989	-7.052	-7.057	-6.991	-6.989	-7.052	-7.057	-6.990	0.001
17-Nov	-7.041	-7.040	-7.109	-7.114	-7.052	-7.050	-7.120	-7.125	-7.052	-7.050	-7.120	-7.125	-7.050	0.000
18-Nov	-7.067	-7.066	-7.139	-7.144	-7.078	-7.077	-7.150	-7.155	-7.078	-7.077	-7.150	-7.155	-7.070	-0.007
19-Nov	-7.047	-7.046	-7.118	-7.123	-7.058	-7.057	-7.129	-7.134	-7.058	-7.057	-7.129	-7.134	-7.050	-0.007
20-Nov	-6.981	-6.981	-7.045	-7.050	-6.992	-6.992	-7.056	-7.061	-6.992	-6.992	-7.056	-7.061	-6.980	-0.012
21-Nov	-6.880	-6.879	-6.932	-6.937	-6.890	-6.890	-6.943	-6.948	-6.890	-6.890	-6.943	-6.948	-6.880	-0.010
22-Nov	-6.763	-6.763	-6.803	-6.808	-6.774	-6.774	-6.814	-6.819	-6.774	-6.774	-6.814	-6.819	-6.760	-0.014
23-Nov	-6.657	-6.657	-6.685	-6.690	-6.668	-6.668	-6.696	-6.701	-6.668	-6.668	-6.696	-6.701	-6.660	-0.008
24-Nov	-6.582	-6.583	-6.603	-6.607	-6.593	-6.594	-6.614	-6.618	-6.593	-6.594	-6.614	-6.618	-6.600	0.006
25-Nov	-6.553	-6.553	-6.571	-6.575	-6.563	-6.564	-6.582	-6.586	-6.563	-6.564	-6.582	-6.586	-6.570	0.006
26-Nov	-6.568	-6.569	-6.589	-6.594	-6.579	-6.580	-6.600	-6.605	-6.579	-6.580	-6.600	-6.605	-6.600	0.020
27-Nov	-6.618	-6.618	-6.646	-6.651	-6.629	-6.629	-6.657	-6.662	-6.629	-6.629	-6.657	-6.662	-6.640	0.011
28-Nov	-6.682	-6.682	-6.719	-6.724	-6.693	-6.693	-6.730	-6.735	-6.693	-6.693	-6.730	-6.735	-6.710	0.017
29-Nov	-6.741	-6.741	-6.785	-6.790	-6.752	-6.752	-6.796	-6.801	-6.752	-6.752	-6.796	-6.801	-6.760	0.008
30-Nov	-6.777	-6.777	-6.826	-6.830	-6.788	-6.788	-6.837	-6.842	-6.788	-6.788	-6.837	-6.842	-6.800	0.012
1-Dec	-6.782	-6.782	-6.831	-6.836	-6.794	-6.793	-6.842	-6.847	-6.794	-6.793	-6.842	-6.847	-6.810	0.017
2-Dec	-6.756	-6.755	-6.801	-6.806	-6.767	-6.766	-6.812	-6.817	-6.767	-6.766	-6.812	-6.817	-6.790	0.024
3-Dec	-6.703	-6.702	-6.743	-6.747	-6.714	-6.714	-6.754	-6.759	-6.714	-6.714	-6.754	-6.759	-6.740	0.026
4-Dec	-6.635	-6.634	-6.667	-6.672	-6.646	-6.645	-6.678	-6.683	-6.646	-6.645	-6.678	-6.683	-6.660	0.015
5-Dec	-6.561	-6.560	-6.586	-6.590	-6.572	-6.572	-6.597	-6.602	-6.572	-6.572	-6.597	-6.602	-6.580	0.008
6-Dec	-6.491	-6.490	-6.508	-6.513	-6.502	-6.501	-6.520	-6.524	-6.502	-6.501	-6.520	-6.524	-6.500	-0.001
7-Dec	-6.431	-6.430	-6.443	-6.447	-6.442	-6.442	-6.454	-6.458	-6.442	-6.442	-6.454	-6.458	-6.440	-0.002

Date	Reference Epoch J2000				Reference Epoch J1900				Reference Epoch B1900				IENA	Diff.
dd-mmm	(A)	(B)	(C)	(D)	(A)	(B)	(C)	(D)	(A)	(B)	(C)	(D)	1960	δψ
0Hrs UT	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(6)-(13)
8-Dec	-6.388	-6.387	-6.395	-6.399	-6.399	-6.399	-6.407	-6.411	-6.399	-6.399	-6.407	-6.411	-6.390	-0.009
9-Dec	-6.366	-6.365	-6.371	-6.375	-6.378	-6.377	-6.383	-6.387	-6.378	-6.377	-6.383	-6.387	-6.360	-0.017
10-Dec	-6.369	-6.368	-6.374	-6.378	-6.381	-6.379	-6.385	-6.389	-6.381	-6.379	-6.385	-6.389	-6.370	-0.009
11-Dec	-6.395	-6.394	-6.403	-6.407	-6.407	-6.405	-6.415	-6.419	-6.407	-6.405	-6.415	-6.419	-6.400	-0.005
12-Dec	-6.439	-6.437	-6.452	-6.456	-6.451	-6.449	-6.464	-6.468	-6.451	-6.449	-6.464	-6.468	-6.440	-0.009
13-Dec	-6.489	-6.487	-6.509	-6.513	-6.500	-6.498	-6.521	-6.525	-6.500	-6.498	-6.521	-6.525	-6.490	-0.008
14-Dec	-6.528	-6.525	-6.554	-6.558	-6.539	-6.537	-6.566	-6.570	-6.539	-6.537	-6.566	-6.570	-6.530	-0.007
15-Dec	-6.537	-6.535	-6.568	-6.572	-6.549	-6.547	-6.580	-6.584	-6.549	-6.547	-6.580	-6.584	-6.540	-0.007
16-Dec	-6.505	-6.503	-6.535	-6.540	-6.517	-6.515	-6.547	-6.551	-6.517	-6.515	-6.547	-6.551	-6.510	-0.005
17-Dec	-6.426	-6.424	-6.450	-6.455	-6.438	-6.436	-6.462	-6.466	-6.438	-6.436	-6.462	-6.466	-6.430	-0.006
18-Dec	-6.307	-6.306	-6.320	-6.325	-6.319	-6.318	-6.332	-6.337	-6.319	-6.318	-6.332	-6.337	-6.310	-0.008
19-Dec	-6.166	-6.165	-6.166	-6.170	-6.178	-6.177	-6.178	-6.182	-6.178	-6.177	-6.178	-6.182	-6.170	-0.007
20-Dec	-6.028	-6.027	-6.014	-6.018	-6.039	-6.039	-6.026	-6.030	-6.039	-6.039	-6.026	-6.030	-6.030	-0.009
21-Dec	-5.915	-5.914	-5.890	-5.895	-5.926	-5.926	-5.902	-5.906	-5.926	-5.926	-5.902	-5.906	-5.920	-0.006
22-Dec	-5.844	-5.844	-5.815	-5.819	-5.856	-5.856	-5.827	-5.831	-5.856	-5.856	-5.827	-5.831	-5.850	-0.006
23-Dec	-5.822	-5.822	-5.793	-5.797	-5.834	-5.834	-5.805	-5.810	-5.834	-5.834	-5.805	-5.810	-5.840	0.006
24-Dec	-5.841	-5.840	-5.817	-5.821	-5.853	-5.852	-5.829	-5.833	-5.853	-5.852	-5.829	-5.833	-5.860	0.008
25-Dec	-5.883	-5.883	-5.867	-5.871	-5.895	-5.895	-5.879	-5.884	-5.895	-5.895	-5.879	-5.884	-5.900	0.005
26-Dec	-5.929	-5.928	-5.920	-5.924	-5.941	-5.940	-5.932	-5.937	-5.941	-5.940	-5.932	-5.937	-5.950	0.010
27-Dec	-5.959	-5.958	-5.955	-5.959	-5.971	-5.970	-5.967	-5.971	-5.971	-5.970	-5.967	-5.971	-5.980	0.010
28-Dec	-5.961	-5.959	-5.958	-5.962	-5.973	-5.972	-5.970	-5.974	-5.973	-5.972	-5.970	-5.974	-5.980	0.008
29-Dec	-5.932	-5.930	-5.926	-5.930	-5.943	-5.942	-5.938	-5.942	-5.943	-5.942	-5.938	-5.942	-5.960	0.018
30-Dec	-5.876	-5.874	-5.864	-5.869	-5.888	-5.886	-5.877	-5.881	-5.888	-5.886	-5.877	-5.881	-5.830	-0.056
31-Dec	-5.802	-5.801	-5.784	-5.788	-5.814	-5.813	-5.796	-5.800	-5.814	-5.813	-5.796	-5.800	-5.740	-0.073
Max	**0.701**	**0.701**	**0.780**	**0.780**	**0.700**	**0.700**	**0.778**	**0.778**	**0.700**	**0.700**	**0.778**	**0.778**	**0.700**	**0.026**
Min	**-7.067**	**-7.066**	**-7.139**	**-7.144**	**-7.078**	**-7.077**	**-7.150**	**-7.155**	**-7.078**	**-7.077**	**-7.150**	**-7.155**	**-7.070**	**-0.073**

Note:

In the table, Column (A), (B), (C) and (D) are the respective models given in Chapter(7.6.4) ‘Calculation for Nutation in Longitude’. From above table, the maximum value considering all models is found to be 7.15 Seconds from 1 Jan to 31 Dec 1960. Thus the Nutation in Longitude varies dynamically within a Month/Year and it can’t be linearly interpolated. (From any given, Yearly or even Monthly interval data).

Further the values calculated from IAU1964 Nutation Model with J1900 Reference Epoch (See Column (6) highlighted in above Table 22) are compared with the Values given in IENA1960 (See Column (13) highlighted). The Difference in Values [Column (6) -Column (13)] are given as ‘δψ’ and found to be Maximum -0.073 Seconds, very small and negligible. Even though both are derived from same Nutation Model (Woolard 1953) this small difference could be due to difference in number of terms considered, loss of significant digits used in the fundamental Arguments, rounding off error etc.,

To show the dynamic behavior of the Nutation in Longitude, the values calculated above from 1 Jan to 31 Dec 1960 @ 00:00Hrs UT on each day, are plotted in below graph (Chart 11) , representing from Series (1) to (13) of the respective Column Number given in Table 22.

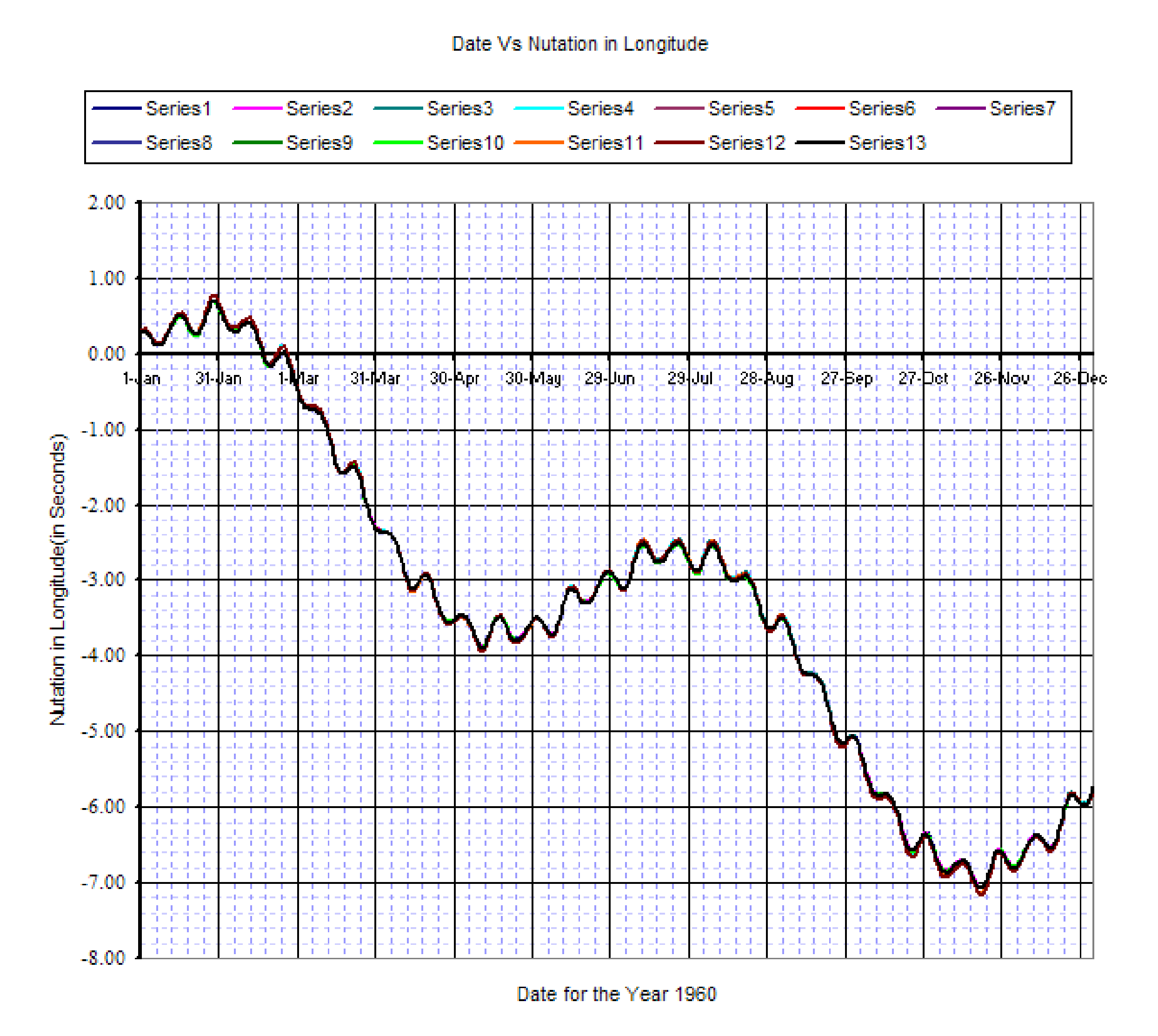

Chart 11: Nutation in Longitude for the Year 1960 Calculated using different Nutation Models & IENA1960 Values

From Chart11: The Nutation in longitude (Δψ) (in Seconds) for the Year 1960

We can see from the above graphs that the fluctuation in values of Nutation in Longitude within a month itself found dynamic and the values are not linear in nature. (Hence it cannot to be interpolated).

It may be noted from above graph, all the 13 graph lines (representing Series (1) to (12) Nutation model's Values, Series 13 of IENA1960 Nutation Values), are running very very close to each other and there is no significant difference is noticed. The Nutation in Longitude changes its sign from +Ve to –Ve values at around mid of Feb 1960. Also the Zero intersection points for some of the models are found more than one location along the date axis. Which means that it is possible for the Nutation in Longitude can reach Zero for more than once within a Year.

From the above, the Maximum positive value in Nutation in Longitude is found to be 0.8 Seconds and negative value to be 7.2 Seconds. This range of values is applicable only for the year 1960, the year taken for our example. However, this range can reach maximum of ±19.3 Seconds, depending on the Epoch considered.(when the Sine function given in Eqn.(73,74) yields ±1.000 for the respective angles).

7.6.6 Calculation for Nutation in Obliquity (Δε)

For the purpose of calculation of Nutation in Obliquity (Δε), the same Models given in the Chapter(7.6.4) 'Calculation for Nutation in Longitude(Δψ)' are considered.

(A) Simon NewComb's Nutation Model (1895)
(B) IAU1964 Nutation Model [E.W.Woolard 1953]
(C) IAU1980 Nutation Model [Seidelmann(1982); Wahr(1981)]
(D) IAU2000A Nutation Model [Mathews et al., 2002]

In all the above, the numbers of pre-selected significant Terms of having same fundamental arguments of respective models given in Table 17 is selected and shown in below Table 23 in the same order. Any of the following two equations can be used for calculation of Nutation in Obliquity (Δε).

(1) Nutation in Obliquity $(\Delta\varepsilon) = \sum_{i=1}^{n} C'_i \text{ Cos}\,\phi_i$ -----------Eqn.[e1]

(2) Nutation in Obliquity $(\Delta\varepsilon) = \sum_{i=1}^{n} C'_i \text{ Cos}\,\theta_i$ -----------Eqn.[e2]

Where,
C'_i = Coefficients given in below table (in Seconds)
n , ϕ and θ are same as defined in Chapter(7.6.4). Also the angle 'ϕ' and 'θ' calculated shall theoretically give the same values as explained in Chapter(7.6.4).

Table 23: Coefficients (C'_i) Values for different Nutation Models

Term No.	Fundamental Arguments	Fundamental Arguments	Coefficients C'_i (in Seconds)				Remarks
			NewComb	IAU1964	IAU1980	IAU2000A	
i	ϕ_i	θ_i	(A)	(B)	(C)	(D)	
1	☊	☊	9.210	9.2100	9.2025	9.2052331	
2	2(F- D + ☊)	2L	0.551	0.5522	0.5736	0.5730336	
3	2(F + ☊)	**2☽**	0.089	0.0884	0.0977	0.0978459	
4	**2☊**	**2☊**	-0.090	-0.0904	-0.0895	-0.0897492	
5	l'	L - π'	0.000	0.0000	0.0054	0.0073871	
6	l	☽ - π	0.000	0.0000	-0.0007	-0.000675	
7	l'+2(F- D + ☊)	3L - π'	0.022	0.0216	0.0224	0.0224386	
8	2F + ☊	**2☽** - ☊	0.018	0.0183	0.0200	0.0200728	
9	l+2(F + ☊)	**3☽** - π	0.011	0.0113	0.0129	0.0129025	
10	-l'+2(F- D + ☊)	L + π'	-0.009	-0.0093	-0.0095	-0.0095929	
11	2D - l	☽ + π - 2L	0.000	0.0000	-0.0001	-0.0001235	
12	2(F- D) + ☊	2L - ☊	-0.007	-0.0066	-0.0070	-0.0068982	
13	-l+2(F + ☊)	☽ + π	-0.005	-0.0050	-0.0053	-0.0053311	
14	☊	☊	0.0009*T	0.00091*T	0.00089*T	0.0009086*T	

As per the definitions given in above Nutation Theories, NewComb's and IAU1964 models are provided with J1900 reference Epoch and the remaining (IAU1980, IAU2000A) are provided with J2000 reference Epoch. The angles calculated using the any of the Eqn.(72,73,74) of respective reference Epoch, should yield the same values for the Epoch in question (can be seen from above charts 2 to 10 results) as they are derived (shifted) from the given reference Epoch to required reference Epoch mathematically to yield same results.

However, the Term No.14 Coefficient (C'_{14}) given in above Table 23 has a function of the Julian Centuries 'T' measured with respect to reference Epoch (J1900 or J2000) of respective models. Hence while calculating the Nutation in Obliquity with other than the basic reference Epoch of the Model, it should be adjusted, to account for the shift from the actual reference Epoch of the models to reference Epoch considered. Using Eqn.(77,79,81) the Coefficients Term 14 given in Table 23, can be adjusted similar to the calculation shown in Table 18. However, the contribution of 14th Term is very small and negligible. Hence up to 13 terms contribution is adequate for astrological calculation. The footnote (1) given below the Table 18 shall be noted here also. When considering all 13th terms the Nutation in Obliquity may go up to ±10.0 Seconds. Similar to Nutation in longitude ($\Delta\psi$) mentioned earlier, Nutation in Obliquity($\Delta\varepsilon$) can vary dynamically within a Month/Year and hence it can't be linearly interpolated. (From any given, Yearly or even Monthly interval data).

For readers convenience, the mean Obliquity(ε_m) given in respective Precession Models are taken and mathematically derived from the given reference Epoch to required reference Epoch and tabulated below. We get mean Obliquity(ε_m) for any time 'T' in a polynomial equation form, having terms up to 4th order of 'T' and with reference Epoch as given below.

$f_4(T) = E_0 + E_1 * T + E_2 * T^2 + E_3 * T^3 + E_4 * T^4$ See Table- Unit of 'T'& Ref.Epoch -----Eqn.[e3]

Table 24: Coefficients (E_i) Values for Precession Models

Sr.	Coefficients E_i (in Seconds)					T in	Reference	Model
No.	E_0	E_1	E_2	E_3	E_4	Unit	Epoch	Name
1	84428.2600	-46.845000	-0.0059000	0.0018100	0.0000	TC	B1900	Newcomb
2	84428.2600	-46.870000	-0.0060000	0.0018400	0.0000	TC	B1900	IAU1964
3	84428.2602	-46.807381	-0.0060290	0.0018130	0.0000	TC	B1900	IAU1976
4	84428.2402	-46.829390	-0.0061960	0.0020060	-5.76×10^{-7}	TC	B1900	IAU2006
5	84428.2604	-46.846000	-0.0059000	0.0018100	0.0000	JC	J1900	Newcomb
6	84428.2604	-46.871001	-0.0060003	0.0018401	0.0000	JC	J1900	IAU1964
7	84428.2606	-46.808381	-0.0060290	0.0018130	0.0000	JC	J1900	IAU1976
8	84428.2406	-46.830390	-0.0061970	0.0020060	-5.76×10^{-7}	JC	J1900	IAU2006
9	84381.4113	-46.852371	-0.0004701	0.0018101	0.0000	JC	J2000	Newcomb
10	84381.3862	-46.877481	-0.0004801	0.0018401	0.0000	JC	J2000	IAU1964
11	84381.4480	-46.815000	-0.0005900	0.0018130	0.0000	JC	J2000	IAU1976
12	84381.4060	-46.836769	-0.0001831	0.0020034	-5.76×10^{-7}	JC	J2000	IAU2006

Note:

1. All the above equation gives Angle for respective Terms in Seconds.
2. Unit for 'T', TC, JC indicates Tropical(Besselian) Centuries & Julian Centuries respectively.
3. For Example, Mean Obliquity angle (ε_m) from J2000 (IAU2006 Precession Model) is given by
   $\varepsilon_m = 84381.4060 - 46.836769 * T - 0.0001831 * T^2 + 0.0020034 * T^3 - 5.76\times10^{-7} * T^4$

We can see from above table that for IAU2006 model, the difference in mean Obliquity(ε_m) from J1900 to J2000 works out to -46.8346 Seconds (84381.4060-84428.2406) (Please see example case given in Chapter(8.4)). I am not sure whether this point has taken care of by software developers. To get the True (correct) Obliquity, correction for Nutation in Obliquity ($\Delta\varepsilon$) shall be added with mean Obliquity(ε_m). Thus using this True Obliquity, we can calculate the accurate sayana (Tropical) longitude of all the cuspal positions for the horoscopes.

7.7 Comparison of True Ayanamsa given in Various Literature/Articles and Discussion

7.7.1 About Ayanamsa Values given in UTOH Book

As discussed above under 'Lahiri's Ayanamsa', In UTOH Book Ref.[57] the Authors adopted a value of 80890.1535 seconds for 15 April 1900. Also the Author states that values given in UTOH only differs by few "seconds" from the Ayanamsa values recommended by IENA (Which is used in the Rashtriya Panchang). However, If we calculate IENA's Mean Ayanamsa for the date 15 April 1900 @ 00:00 Hrs UT, using the above Eqn.(67), we get a value of 80872.0165 Seconds. Which differs by 18.1370 (80890.1535- 80872.0165) Seconds with UTOH.

The Nutation in Longitude for the same date, using IAU1964 Model Eqn.(75) With reference to J1900 Epoch, works out to 15.6361Seconds. Hence, True Ayanamsa for the same date works out to 80887.6526 Seconds (80872.0165 + 15.6361). It is obviously seen, the Ayanamsa value mentioned in UTOH book for the date referred to, does not agree with either Mean Ayanamsa or True Ayanamsa.

In this connection, I request readers to refer my comments in Chapter(7.4) 'Discussion on Lahiri's Ayanamsa'. Now my contention is proved correct through the explanation given above. So the values given in ***Table X of UTOH Book, is completely wrong and unreliable***.

7.7.2 TinWin's Article

In above article Ref.[39] under 'Lahiri Ayanamsa (LAHIRI)' the below statement is provided.
================================Quote==================================
Shri Kuppu Ganapathi has explained about 3 sec. Difference between True and Mean values of the Lahiri Ayanamsa, eg. for 1 Jan 1990 Lahiri Ayanamsa: True value (after taking into account of the Nirayana Longitude of Rahu) is 22d:27m:59s and Mean value is 22d:27m:56s). ***Such a small difference may not affect any calculation even up to Sub Sub Sub level***.
===============================UnQuote=================================

Lahiri's Mean Ayanamsa Calculated for 1 Jan 1990 @00:00Hrs UT, using above Eqn.(50) works out to 23d:43m:02.80s and the Nutation in Longitude for the same date using IAU1964 Model Eqn.(75) works out to 11.8198 Seconds. Both the values are not agreeing with the values given in above statement. The Sub Sub Sub interval for the SUN, KET(Moon's Descending Node) & MARS is equal to 6, 9.53 and 9.53 Seconds respectively. The Nutation in Longitude may reach up to around ±19.3 Seconds. Hence the True Ayanamsa can definitely affect Sub Sub Sub level. It is pertinent to note here that Nayar also emphasized in his article that Ayanamsa (he means True Ayanamsa) for the Epoch correct to the Seconds, will be of use in critical research on Sub Sub Subs and Sookshmas.

7.7.3 About Ref.Ayanamsa Value given by Lahiri & IENA

Referring to chapter(7.5) 'Discussion on Indian Ephemeris Nautical Almanac's / Rashtriya Panchang's Ayanamsa', it was stated that the difference in Mean Ayanamsa calculated as per Equation and the value given by lahiri, IENA was 0°0'16.23" and 0°0'16.65" respectively. The Nutation in Longitude for the same date (21 March 1956@0Hrs) using IAU1964 Model Eqn.(75), works out to 16.7922 Seconds, which closely agrees (small difference may be due the difference in number of terms considered, rounding off error etc.,) with values mentioned above. Hence it may be concluded that the values given by lahiri, IENA is True Ayanamsa only.

The Lahiri's Ayanamsa Values provided in his Ephemeris for some of the selected Years Ref.[21-32] are compared with Lahiri's Mean Ayanamsa Values Calculated as per Eqn.(50) and Nutation in Longitude based on IEA1964 Model as shown below.

Table 25: Comparison of Lahiri's Ayanamsa Calculated Vs Ephemeris Values.

Year	Calculated Values			Lahiri's Ephemeris Values			Difference		
1st Jan	(1)Mean	(2)True	(3)$\Delta\psi$	(4)Mean	(5)True	(6)$\Delta\psi$	(1)-(4)	(2)-(5)	(3)-(6)
1970	23:26:17.29	23:26:21.82	4.53	23:26:16.20	23:26:21.00	4.80	1.09	0.82	-0.27
1971	23:27:07.53	23:27:17.63	10.10	23:27:06.50	23:27:17.00	10.50	1.03	0.63	-0.40
1972	23:27:57.77	23:28:11.99	14.22	23:27:56.70	23:28:11.00	14.30	1.07	0.99	-0.08
1973	23:28:48.15	23:29:04.81	16.66	23:28:47.10	23:29:04.00	16.90	1.05	0.81	-0.24
1974	23:29:38.39	23:29:55.93	17.55	23:29:37.30	23:29:55.00	17.70	1.09	0.93	-0.15
1975	23:30:28.63	23:30:45.46	16.83	23:30:27.60	23:30:44.00	16.40	1.03	1.46	0.43
1976	23:31:18.86	23:31:32.66	13.79	23:31:17.80	23:31:32.00	14.20	1.06	0.66	-0.41
1977	23:32:09.24	23:32:18.33	9.09	23:32:08.20	23:32:17.00	8.80	1.04	1.33	0.29
1978	23:32:59.48	23:33:03.12	3.64	23:32:58.40	23:33:02.00	3.60	1.08	1.12	0.04
1987	23:40:31.93	23:40:27.77	-4.16	23:40:30.80	23:40:28.00	-2.80	1.13	-0.23	-1.36
1988	23:41:22.17	23:41:23.31	1.14	23:41:22.10	23:41:23.00	0.90	0.07	0.31	0.24
1989	23:42:12.55	23:42:19.20	6.65	23:42:12.30	23:42:19.00	6.70	0.25	0.20	-0.05
2003	23:53:56.39	23:53:41.02	-15.37	23:53:56.33	23:53:40.97	-15.36	0.06	0.05	-0.01
2004	23:54:46.63	23:54:34.43	-12.20	23:54:46.62	23:54:34.45	-12.17	0.01	-0.02	-0.03
2005	23:55:37.02	23:55:29.56	-7.46	23:55:36.91	23:55:29.50	-7.41	0.11	0.06	-0.05
2015	24:03:59.77	24:04:04.66	4.89	24:04:00.13	24:04:05.00	4.87	-0.36	-0.34	0.02
2016	24:04:50.02	24:04:49.15	-0.87	24:04:50.00	24:04:49.00	-0.84	0.02	0.15	-0.03
2017	24:05:40.40	24:05:33.89	-6.52	24:05:40.00	24:05:34.00	-6.45	0.40	-0.11	-0.07

From the above, the difference in Mean/True Ayanamsa is found to be around 1 Second from 1970 to 1978, 1987 and afterwards very less. This is due to the correction adopted in Lahiri's Ayanamsa from Year 1985 onwards as discussed above. The difference in Nutation in Longitude is very close to Zero (small difference may be due the difference in number of terms considered, rounding off error etc.,).

7.7.4 About Ayanamsa Value given in Indian Rashtriya Panchang

As discussed in chapter() under 'IENA's Ayanamsa', The Nutation in Longitude for the date 22 March 2018 @ 00:00Hrs UT and 22 March 2019 @ 00:00 Hrs UT using IAU1964 Model Eqn.(75) With reference to J1900 Epoch works out to -13.06 Seconds and -15.94 Seconds respectively. These values are closely agrees (a small difference may be due the difference in number of terms considered, rounding off error etc.,) with above mentioned difference of Ayanamsa by 0°0'11.58" and 0°0'14.83" for the respective reference dates. Thus the Ayanamsa given in Rashtriya Panchang for the above Ref.Dates are True Ayanamsa only.

The Lahiri's Ayanamsa Values provided in his Ephemeris for some of the selected Years Ref.[21-32] are compared with Calculated Values of IENA's Mean Ayanamsa as per Eqn.(50) and Nutation in Longitude based on IEA1964 Model With Reference to J1900 as shown below.

Table 26: Comparison of IENA's Ayanamsa Calculated Vs Lahiri's Ephemeris Values.

Year	IENA's Calculated Values			Lahiri's Ephemeris Values			Difference		
1st Jan	(1)Mean	(2)True	(3)$\Delta\psi$	(4)Mean	(5)True	(6)$\Delta\psi$	(1)-(4)	(2)-(5)	(3)-(6)
1970	23:26:16.21	23:26:20.73	4.53	23:26:16.20	23:26:21.00	4.80	0.01	-0.27	-0.27
1971	23:27:06.45	23:27:16.55	10.10	23:27:06.50	23:27:17.00	10.50	-0.05	-0.45	-0.40
1972	23:27:56.68	23:28:10.90	14.22	23:27:56.70	23:28:11.00	14.30	-0.02	-0.10	-0.08
1973	23:28:47.06	23:29:03.72	16.66	23:28:47.10	23:29:04.00	16.90	-0.04	-0.28	-0.24
1974	23:29:37.30	23:29:54.85	17.55	23:29:37.30	23:29:55.00	17.70	0.00	-0.15	-0.15
1975	23:30:27.54	23:30:44.37	16.83	23:30:27.60	23:30:44.00	16.40	-0.06	0.37	0.43
1976	23:31:17.78	23:31:31.57	13.79	23:31:17.80	23:31:32.00	14.20	-0.02	-0.43	-0.41
1977	23:32:08.16	23:32:17.25	9.09	23:32:08.20	23:32:17.00	8.80	-0.04	0.25	0.29
1978	23:32:58.40	23:33:02.04	3.64	23:32:58.40	23:33:02.00	3.60	0.00	0.04	0.04
1987	23:40:30.85	23:40:26.69	-4.16	23:40:30.80	23:40:28.00	-2.80	0.05	-1.31	-1.36
1988	23:41:21.09	23:41:22.23	1.14	23:41:22.10	23:41:23.00	0.90	-1.01	-0.77	0.24
1989	23:42:11.47	23:42:18.12	6.65	23:42:12.30	23:42:19.00	6.70	-0.83	-0.88	-0.05
2003	23:53:55.30	23:53:39.93	-15.37	23:53:56.33	23:53:40.97	-15.36	-1.03	-1.04	-0.01
2004	23:54:45.55	23:54:33.35	-12.20	23:54:46.62	23:54:34.45	-12.17	-1.07	-1.10	-0.03
2005	23:55:35.93	23:55:28.48	-7.46	23:55:36.91	23:55:29.50	-7.41	-0.98	-1.02	-0.05
2015	24:03:58.68	24:04:03.57	4.89	24:04:00.13	24:04:05.00	4.87	-1.45	-1.43	0.02
2016	24:04:48.93	24:04:48.06	-0.87	24:04:50.00	24:04:49.00	-0.84	-1.07	-0.94	-0.03
2017	24:05:39.32	24:05:32.80	-6.52	24:05:40.00	24:05:34.00	-6.45	-0.68	-1.20	-0.07

From the above, before 1987 both Lahiri's and IENA's Mean Ayanamsa values are found to be same as Lahiri's Mean Ayanamsa. After 1987 onwards the difference in Mean/True Ayanamsa found around 1 second even after a correction was adopted in Lahiri's Ayanamsa from Year 1985 onwards. The difference in Nutation in Longitude is very close to Zero (small difference may be due the difference in number of terms considered, rounding off error etc.,).

It is stated in Lahiri's Ephemeris 1988 Ref.[30] that the initial point of the Nirayana or Sidereal zodiac was the same as the equinoctial point (i.e., The First Point of Aries) of the Vernal Equinox on Sunday March 22, 21:27Hrs IST (15:57Hrs UT) at 285 A.D. At that time both the Sayana and the Nirayana longitude of the Star Citra (Spica) was 180°00'03" degrees and the longitude of the Mean Moon was 351.67° and of Mean Sun 360°00'00". It was thus a New-Moon day also. It is noticed that this date comes before the theoretically worked out Date of 4 May 285@17:13:54 UT earlier above(See Chapter(7.5)). Using Eqn.(67) the Ayanamsa calculated for 22 March 285 @ 15:57Hrs UT(21:27Hrs IST) works out to -00°00'05.88" degrees. This difference agrees with the value given in the statement mentioned in above Lahiri's Ephemeris that due to the adoption of Ayanamsa recommended by the Calendar Reform Committee in IENA, which is less by 5.8" than the value for actual date above. As stated in Lahiri's Ephemeris, this revised value has been adopted from the Year 1960 for the sake of uniformity with IENA. So it may be noted that lahiri has implemented two corrections in his Ephemeris one in Year 1960 (to match with IENA) and another in the 1985(See Chapter(7.5)).

7.8 Comparison/Discussion of Lahiri, KSK and Rajan Ayanamsa

In the Table 27 given below, the following are enumerated for the date 15th April of Each Year. Column (1)-Lahiri's Ayanamsa as per Eqn.(50), Column(2)-KSK's Ayanamsa as per Eqn.(56), Column(3)-Rajan's Ayanamsa as per Eqn.(59),Column(4)-Rajan's Ayanamsa as per his arithmetic Eqn.(32),Column(5)-Rajan's Ayanamsa given in his book Ref.[12],Column(6)- KSK's Ayanamsa given in his Reader1.The difference between Lahiri's, KSK's and Rajan's Ayanamsa are already discussed in Chapter(7.4.1,7.4.2),hence only the significant difference in values between one calculated and published in their books of KSK, Rajan, considered for comparison.

Table 27: Lahiri's, KSK's & Rajan's Ayanamsa & Difference in Ayanamsa

Epoch	Ayanamsa (As on 15th April)						Difference in Ayanamsa (in Seconds)				
Year	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
yy	dd:mm:ss	dd:mm:ss	dd:mm:ss	dd:mm:ss	dd:mm:ss	dd:mm:ss	(3)-(4)	(3)-(5)	(6)-(5)	(2)-(6)	(6+8-2)
500	02:58:52	02:53:58	02:50:42	02:43:10			452.0				
600	04:22:08	04:17:13	04:13:58	04:07:27			391.0				
700	05:45:26	05:40:31	05:37:16	05:31:42			334.5				
800	07:08:46	07:03:52	07:00:36	06:55:54			282.4				
900	08:32:08	08:27:14	08:23:59	08:20:04			234.7				
1000	09:55:33	09:50:39	09:47:23	09:44:12			191.6				
1100	11:19:00	11:14:06	11:10:50	11:08:17			152.8				
1200	12:42:29	12:37:35	12:34:19	12:32:21			118.5				
1300	14:06:00	14:01:06	13:57:51	13:56:22			88.7				
1400	15:29:34	15:24:40	15:21:24	15:20:21			63.3				
1500	16:53:10	16:48:15	16:45:00	16:44:18			42.3				
1600	18:16:46	18:11:52	18:08:37	18:08:12			24.4				
1700	19:40:26	19:35:32	19:32:17	19:32:05			12.2				
1800	21:04:09	20:59:14	20:55:59	20:55:55			4.4				
1810	21:12:31	21:07:37	21:04:21	21:04:17			3.8				
1820	21:20:53	21:15:59	21:12:44	21:12:40			3.4				
1830	21:29:16	21:24:21	21:21:06	21:21:03			2.9				
1840	21:37:38	21:32:44	21:29:29	21:29:26	21:29:00	21:31:00	2.6	28.6	120.0	154.1	-75.28925
1841	21:38:28	21:33:34	21:30:19	21:30:16	21:30:00	21:32:00	2.5	18.8	120.0	144.3	-75.28925
1842	21:39:19	21:34:24	21:31:09	21:31:07	21:31:00	21:33:00	2.5	9.0	120.0	134.5	-75.28925
1843	21:40:09	21:35:14	21:31:59	21:31:57	21:32:00	21:34:00	2.4	-0.8	120.0	124.8	-75.28925
1844	21:40:59	21:36:05	21:32:50	21:32:47	21:33:00	21:35:00	2.5	-10.5	120.0	115.0	-75.28925
1845	21:41:49	21:36:55	21:33:40	21:33:37	21:34:00	21:36:00	2.4	-20.2	120.0	105.3	-75.28925
1846	21:42:40	21:37:45	21:34:30	21:34:28	21:35:00	21:37:00	2.3	-30.0	120.0	95.5	-75.28925
1847	21:43:30	21:38:35	21:35:20	21:35:18	21:35:00	21:37:00	2.3	20.2	120.0	145.8	-75.28925
1848	21:44:20	21:39:26	21:36:11	21:36:08	21:36:00	21:38:00	2.3	10.5	120.0	136.0	-75.28925
1849	21:45:10	21:40:16	21:37:01	21:36:58	21:37:00	21:39:00	2.3	0.7	120.0	126.2	-75.28925
1850	21:46:01	21:41:06	21:37:51	21:37:49	21:38:00	21:40:00	2.2	-9.0	120.0	116.5	-75.28925
1851	21:46:51	21:41:56	21:38:41	21:38:39	21:39:00	21:41:00	2.1	-18.8	120.0	106.8	-75.28925
1852	21:47:41	21:42:47	21:39:32	21:39:29	21:40:00	21:42:00	2.2	-28.5	120.0	97.0	-75.28925
1853	21:48:31	21:43:37	21:40:22	21:40:20	21:40:00	21:42:00	2.1	21.7	120.0	147.2	-75.28925
1854	21:49:22	21:44:27	21:41:12	21:41:10	21:41:00	21:43:00	2.1	11.9	120.0	137.4	-75.28925
1855	21:50:12	21:45:17	21:42:02	21:42:00	21:42:00	21:44:00	2.0	2.2	120.0	127.8	-75.28925
1856	21:51:02	21:46:08	21:42:53	21:42:50	21:43:00	21:45:00	2.1	-7.5	120.0	118.0	-75.28925
1857	21:51:52	21:46:58	21:43:43	21:43:41	21:44:00	21:46:00	2.0	-17.3	120.0	108.2	-75.28925
1858	21:52:43	21:47:48	21:44:33	21:44:31	21:45:00	21:47:00	2.0	-27.1	120.0	98.4	-75.28925
1859	21:53:33	21:48:38	21:45:23	21:45:21	21:45:00	21:47:00	1.9	23.1	120.0	148.8	-75.28925
1860	21:54:23	21:49:29	21:46:13	21:46:12	21:46:00	21:48:00	2.0	13.5	120.0	139.0	-75.28925
1861	21:55:13	21:50:19	21:47:04	21:47:02	21:47:00	21:49:00	1.9	3.7	120.0	129.2	-75.28925
1862	21:56:04	21:51:09	21:47:54	21:47:52	21:48:00	21:50:00	1.8	-6.1	120.0	119.4	-75.28925
1863	21:56:54	21:51:59	21:48:44	21:48:42	21:49:00	21:51:00	1.8	-15.9	120.0	109.8	-75.28925
1864	21:57:44	21:52:50	21:49:34	21:49:33	21:50:00	21:52:00	1.9	-25.5	120.0	100.0	-75.28925
1865	21:58:34	21:53:40	21:50:25	21:50:23	21:50:00	21:52:00	1.8	24.7	120.0	150.2	-75.28925

Epoch	Ayanamsa (As on 15th April)						Difference in Ayanamsa (in Seconds)				
Year	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**
yy	**dd:mm:ss**	**dd:mm:ss**	**dd:mm:ss**	**dd:mm:ss**	**dd:mm:ss**	**dd:mm:ss**	**(3)-(4)**	**(3)-(5)**	**(6)-(5)**	**(2)-(6)**	**(6+8-2)**
1866	21:59:25	21:54:30	21:51:15	21:51:13	21:51:00	21:53:00	1.7	14.9	120.0	140.4	-75.28925
1867	22:00:15	21:55:20	21:52:05	21:52:03	21:52:00	21:54:00	1.7	5.1	120.0	130.8	-75.28925
1868	22:01:05	21:56:11	21:52:55	21:52:54	21:53:00	21:55:00	1.8	-4.5	120.0	121.0	-75.28925
1869	22:01:55	21:57:01	21:53:46	21:53:44	21:54:00	21:56:00	1.7	-14.3	120.0	111.2	-75.28925
1870	22:02:46	21:57:51	21:54:36	21:54:34	21:55:00	21:57:00	1.7	-24.1	120.0	101.4	-75.28925
1871	22:03:36	21:58:41	21:55:26	21:55:25	21:55:00	21:57:00	1.6	26.1	120.0	151.8	-75.28925
1872	22:04:26	21:59:32	21:56:16	21:56:15	21:56:00	21:58:00	1.7	16.5	120.0	142.0	-75.28925
1873	22:05:16	22:00:22	21:57:07	21:57:05	21:57:00	21:59:00	1.6	6.7	120.0	132.2	-75.28925
1874	22:06:07	22:01:12	21:57:57	21:57:55	21:58:00	22:00:00	1.6	-3.1	120.0	122.4	-75.28925
1875	22:06:57	22:02:02	21:58:47	21:58:46	21:59:00	22:01:00	1.5	-12.9	120.0	112.8	-75.28925
1876	22:07:47	22:02:53	21:59:38	21:59:36	22:00:00	22:02:00	1.6	-22.5	120.0	103.0	-75.28925
1877	22:08:37	22:03:43	22:00:28	22:00:26	22:00:00	22:02:00	1.5	27.7	120.0	153.2	-75.28925
1878	22:09:28	22:04:33	22:01:18	22:01:16	22:01:00	22:03:00	1.5	17.9	120.0	143.4	-75.28925
1879	22:10:18	22:05:23	22:02:08	22:02:07	22:02:00	22:04:00	1.4	8.2	120.0	133.8	-75.28925
1880	22:11:08	22:06:14	22:02:59	22:02:57	22:03:00	22:05:00	1.5	-1.5	120.0	124.0	-75.28925
1881	22:11:58	22:07:04	22:03:49	22:03:47	22:04:00	22:06:00	1.5	-11.3	120.0	114.2	-75.28925
1882	22:12:49	22:07:54	22:04:39	22:04:38	22:05:00	22:07:00	1.4	-21.0	120.0	104.5	-75.28925
1883	22:13:39	22:08:44	22:05:29	22:05:28	22:06:00	22:08:00	1.4	-30.8	120.0	94.8	-75.28925
1884	22:14:29	22:09:35	22:06:20	22:06:18	22:06:00	22:08:00	1.4	19.5	120.0	145.0	-75.28925
1885	22:15:19	22:10:25	22:07:10	22:07:08	22:07:00	22:09:00	1.4	9.7	120.0	135.3	-75.28925
1886	22:16:10	22:11:15	22:08:00	22:07:59	22:08:00	22:10:00	1.3	0.0	120.0	125.5	-75.28925
1887	22:17:00	22:12:05	22:08:50	22:08:49	22:09:00	22:11:00	1.3	-9.8	120.0	115.8	-75.28925
1888	22:17:50	22:12:56	22:09:41	22:09:39	22:10:00	22:12:00	1.4	-19.5	120.0	106.1	-75.28925
1889	22:18:40	22:13:46	22:10:31	22:10:29	22:11:00	22:13:00	1.3	-29.2	120.0	96.3	-75.28925
1890	22:19:31	22:14:36	22:11:21	22:11:20	22:11:00	22:13:00	1.3	21.0	120.0	146.5	-75.28925
1891	22:20:21	22:15:26	22:12:11	22:12:10	22:12:00	22:14:00	1.2	11.2	120.0	136.9	-75.28925
1892	22:21:11	22:16:17	22:13:02	22:13:00	22:13:00	22:15:00	1.3	1.6	120.0	127.1	-75.28925
1893	22:22:01	22:17:07	22:13:52	22:13:51	22:14:00	22:16:00	1.3	-8.2	120.0	117.3	-75.28925
1894	22:22:52	22:17:57	22:14:42	22:14:41	22:15:00	22:17:00	1.2	-18.0	120.0	107.5	-75.28925
1895	22:23:42	22:18:48	22:15:32	22:15:31	22:16:00	22:18:00	1.2	-27.8	120.0	97.9	-75.28925
1896	22:24:32	22:19:38	22:16:23	22:16:21	22:16:00	22:18:00	1.3	22.6	120.0	148.1	-75.28925
1897	22:25:22	22:20:28	22:17:13	22:17:12	22:17:00	22:19:00	1.2	12.8	120.0	138.3	-75.28925
1898	22:26:13	22:21:18	22:18:03	22:18:02	22:18:00	22:20:00	1.2	3.0	120.0	128.5	-75.28925
1899	22:27:03	22:22:09	22:18:53	22:18:52	22:19:00	22:21:00	1.1	-6.7	120.0	118.8	-75.28925
1900	22:27:53	22:22:59	22:19:43	22:19:42	22:20:00	22:22:00	1.1	-16.5	120.0	109.0	-75.28925
1901	22:28:43	22:23:49	22:20:34	22:20:33	22:21:00	22:23:00	1.0	-26.3	120.0	99.2	-75.28925
1902	22:29:34	22:24:39	22:21:24	22:21:23	22:21:00	22:23:00	1.0	23.9	120.0	149.4	-75.28925
1903	22:30:24	22:25:29	22:22:14	22:22:13	22:22:00	22:24:00	1.0	14.2	120.0	139.8	-75.28925
1904	22:31:14	22:26:20	22:23:05	22:23:03	22:23:00	22:25:00	1.1	4.5	120.0	130.0	-75.28925
1905	22:32:04	22:27:10	22:23:55	22:23:54	22:24:00	22:26:00	1.0	-5.3	120.0	120.3	-75.28925
1906	22:32:55	22:28:00	22:24:45	22:24:44	22:25:00	22:27:00	1.0	-15.0	120.0	110.5	-75.28925
1907	22:33:45	22:28:50	22:25:35	22:25:34	22:26:00	22:28:00	0.9	-24.8	120.0	100.8	-75.28925
1908	22:34:35	22:29:41	22:26:26	22:26:25	22:26:00	22:29:00	1.0	25.6	**180.0**	91.1	-15.28925

Epoch	Ayanamsa (As on 15th April)						Difference in Ayanamsa (in Seconds)				
Year	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
yy	dd:mm:ss	dd:mm:ss	dd:mm:ss	dd:mm:ss	dd:mm:ss	dd:mm:ss	(3)-(4)	(3)-(5)	(6)-(5)	(2)-(6)	(6+8-2)
1909	22:35:25	22:30:31	22:27:16	22:27:15	22:27:00	22:30:00	1.0	15.8	**180.0**	81.3	-15.28925
1910	22:36:16	22:31:21	22:28:06	22:28:05	22:28:00	22:31:00	1.0	6.0	**180.0**	71.5	-15.28925
1911	22:37:06	22:32:12	22:28:56	22:28:55	22:29:00	22:32:00	0.9	-3.8	**180.0**	61.9	-15.28925
1912	22:37:56	22:33:02	22:29:47	22:29:46	22:30:00	22:33:00	1.0	-13.4	**180.0**	52.1	-15.28925
1913	22:38:46	22:33:52	22:30:37	22:30:36	22:31:00	22:33:00	1.0	-23.2	120.0	102.3	-75.28925
1914	22:39:37	22:34:42	22:31:27	22:31:26	22:31:00	22:34:00	0.9	27.0	**180.0**	92.6	-15.28925
1915	22:40:27	22:35:33	22:32:17	22:32:16	22:32:00	22:35:00	0.9	17.3	**180.0**	82.9	-15.28925
1916	22:41:17	22:36:23	22:33:08	22:33:07	22:33:00	22:36:00	1.0	7.6	**180.0**	73.1	-15.28925
1917	22:42:07	22:37:13	22:33:58	22:33:57	22:34:00	22:37:00	1.0	-2.1	**180.0**	63.4	-15.28925
1918	22:42:58	22:38:03	22:34:48	22:34:47	22:35:00	22:38:00	0.9	-11.9	**180.0**	53.6	-15.28925
1919	22:43:48	22:38:54	22:35:38	22:35:37	22:36:00	22:38:00	0.9	-21.7	120.0	104.0	-75.28925
1920	22:44:38	22:39:44	22:36:29	22:36:28	22:37:00	22:39:00	1.0	-31.3	120.0	94.2	-75.28925
1921	22:45:29	22:40:34	22:37:19	22:37:18	22:37:00	22:39:00	1.0	18.9	120.0	144.4	-75.28925
1922	22:46:19	22:41:24	22:38:09	22:38:08	22:38:00	22:40:00	0.9	9.1	120.0	134.7	-75.28925
1923	22:47:09	22:42:15	22:38:59	22:38:58	22:39:00	22:41:00	0.9	-0.6	120.0	125.0	-75.28925
1924	22:47:59	22:43:05	22:39:50	22:39:49	22:40:00	22:42:00	1.0	-10.3	120.0	115.2	-75.28925
1925	22:48:50	22:43:55	22:40:40	22:40:39	22:41:00	22:43:00	1.0	-20.0	120.0	105.5	-75.28925
1926	22:49:40	22:44:45	22:41:30	22:41:29	22:42:00	22:44:00	0.9	-29.8	120.0	95.7	-75.28925
1927	22:50:30	22:45:36	22:42:20	22:42:20	22:42:00	22:44:00	0.9	20.4	120.0	146.1	-75.28925
1928	22:51:20	22:46:26	22:43:11	22:43:10	22:43:00	22:45:00	1.0	10.8	120.0	136.3	-75.28925
1929	22:52:11	22:47:16	22:44:01	22:44:00	22:44:00	22:46:00	1.0	1.0	120.0	126.5	-75.28925
1930	22:53:01	22:48:07	22:44:51	22:44:50	22:45:00	22:47:00	0.9	-8.8	120.0	116.8	-75.28925
1931	22:53:51	22:48:57	22:45:41	22:45:41	22:46:00	22:48:00	0.9	-18.5	120.0	107.1	-75.28925
1932	22:54:41	22:49:47	22:46:32	22:46:31	22:47:00	22:49:00	1.0	-28.2	120.0	97.4	-75.28925
1933	22:55:32	22:50:37	22:47:22	22:47:21	22:47:00	22:49:00	1.0	22.1	120.0	147.6	-75.28925
1934	22:56:22	22:51:28	22:48:12	22:48:11	22:48:00	22:50:00	0.9	12.3	120.0	137.8	-75.28925
1935	22:57:12	22:52:18	22:49:03	22:49:02	22:49:00	22:51:00	0.9	2.5	120.0	128.2	-75.28925
1936	22:58:03	22:53:08	22:49:53	22:49:52	22:50:00	22:52:00	1.0	-7.1	120.0	118.4	-75.28925
1937	22:58:53	22:53:58	22:50:43	22:50:42	22:51:00	22:53:00	1.0	-16.9	120.0	108.7	-75.28925
1938	22:59:43	22:54:49	22:51:33	22:51:32	22:52:00	22:54:00	0.9	-26.6	120.0	98.9	-75.28925
1939	23:00:33	22:55:39	22:52:24	22:52:23	22:52:00	22:54:00	0.9	23.6	120.0	149.3	-75.28925
1940	23:01:24	22:56:29	22:53:14	22:53:13	22:53:00	22:55:00	1.0	14.0	120.0	139.5	-75.28925
1941	23:02:14	22:57:19	22:54:04	22:54:03	22:54:00	22:56:00	1.0	4.2	120.0	129.7	-75.28925
1942	23:03:04	22:58:10	22:54:54	22:54:53	22:55:00	22:57:00	0.9	-5.6	120.0	119.9	-75.28925
1943	23:03:54	22:59:00	22:55:45	22:55:44	22:56:00	22:58:00	0.9	-15.3	120.0	110.3	-75.28925
1944	23:04:45	22:59:50	22:56:35	22:56:34	22:57:00	22:59:00	1.0	-25.0	120.0	100.6	-75.28925
1945	23:05:35	23:00:41	22:57:25	22:57:24	22:57:00	22:59:00	1.0	25.3	120.0	150.8	-75.28925
1946	23:06:25	23:01:31	22:58:15	22:58:15	22:58:00	23:00:00	0.9	15.5	120.0	141.0	-75.28925
1947	23:07:15	23:02:21	22:59:06	22:59:05	22:59:00	23:01:00	0.9	5.7	120.0	131.4	-75.28925
1948	23:08:06	23:03:11	22:59:56	22:59:55	23:00:00	23:02:00	1.0	-3.9	120.0	121.6	-75.28925
1949	23:08:56	23:04:02	23:00:46	23:00:45	23:01:00	23:03:00	1.0	-13.7	120.0	111.9	-75.28925
1950	23:09:46	23:04:52	23:01:37	23:01:36	23:02:00	23:04:00	0.9	-23.4	120.0	102.1	-75.28925
1951	23:10:36	23:05:42	23:02:27	23:02:26	23:02:00	23:04:00	0.9	26.8	120.0	152.5	-75.28925

Epoch	Ayanamsa (As on 15th April)						Difference in Ayanamsa (in Seconds)				
Year	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
yy	dd:mm:ss	dd:mm:ss	dd:mm:ss	dd:mm:ss	dd:mm:ss	dd:mm:ss	(3)-(4)	(3)-(5)	(6)-(5)	(2)-(6)	(6+8-2)
1952	23:11:27	23:06:32	23:03:17	23:03:16	23:03:00	23:05:00	1.0	17.2	120.0	142.7	-75.28925
1953	23:12:17	23:07:23	23:04:07	23:04:06	23:04:00	23:06:00	1.0	7.4	120.0	132.9	-75.28925
1954	23:13:07	23:08:13	23:04:58	23:04:57	23:05:00	23:07:00	1.0	-2.4	120.0	123.2	-75.28925
1955	23:13:58	23:09:03	23:05:48	23:05:47	23:06:00	23:08:00	0.9	-12.1	120.0	113.5	-75.28925
1956	23:14:48	23:09:54	23:06:38	23:06:37	23:07:00	23:09:00	1.0	-21.7	120.0	103.8	-75.28925
1957	23:15:38	23:10:44	23:07:28	23:07:28	23:08:00	23:10:00	1.0	-31.5	120.0	94.0	-75.28925
1958	23:16:28	23:11:34	23:08:19	23:08:18	23:08:00	23:10:00	1.0	18.7	120.0	144.3	-75.28925
1959	23:17:19	23:12:24	23:09:09	23:09:08	23:09:00	23:11:00	0.9	9.0	120.0	134.6	-75.28925
1960	23:18:09	23:13:15	23:09:59	23:09:58	23:10:00	23:12:00	1.0	-0.7	120.0	124.9	-75.28925
1961	23:18:59	23:14:05	23:10:50	23:10:49	23:11:00	23:13:00	1.0	-10.4	120.0	115.1	-75.28925
1962	23:19:49	23:14:55	23:11:40	23:11:39	23:12:00	23:14:00	1.0	-20.2	120.0	105.3	-75.28925
1963	23:20:40	23:15:45	23:12:30	23:12:29	23:13:00	23:15:00	0.9	-30.0	120.0	95.7	-75.28925
1964	23:21:30	23:16:36	23:13:20	23:13:19	23:13:00	23:15:00	1.0	20.4	120.0	145.9	-75.28925
1965	23:22:20	23:17:26	23:14:11	23:14:10	23:14:00	23:16:00	1.0	10.7	120.0	136.2	-75.28925
1966	23:23:11	23:18:16	23:15:01	23:15:00	23:15:00	23:17:00	1.0	0.9	120.0	126.4	-75.28925
1967	23:24:01	23:19:06	23:15:51	23:15:50	23:16:00	23:18:00	0.9	-8.9	120.0	116.8	-75.28925
1968	23:24:51	23:19:57	23:16:42	23:16:40	23:17:00	23:19:00	1.0	-18.5	120.0	107.0	-75.28925
1969	23:25:41	23:20:47	23:17:32	23:17:31	23:18:00	23:20:00	1.0	-28.3	120.0	97.3	-75.28925
1970	23:26:32	23:21:37	23:18:22	23:18:21	23:18:00	23:20:00	1.0	22.0	120.0	147.5	-75.28925
1971	23:27:22	23:22:28	23:19:12	23:19:11	23:19:00	23:21:00	0.9	12.2	120.0	137.9	-75.28925
1972	23:28:12	23:23:18	23:20:03	23:20:02	23:20:00	23:22:00	1.0	2.6	120.0	128.1	-75.28925
1973	23:29:02	23:24:08	23:20:53	23:20:52	23:21:00	23:23:00	1.0	-7.2	120.0	118.4	-75.28925
1974	23:29:53	23:24:58	23:21:43	23:21:42	23:22:00	23:24:00	1.0	-16.9	120.0	108.6	-75.28925
1975	23:30:43	23:25:49	23:22:33	23:22:32	23:23:00	23:25:00	0.9	-26.7	120.0	99.0	-75.28925
1976	23:31:33	23:26:39	23:23:24	23:23:23	23:23:00	23:25:00	1.0	23.7	120.0	149.2	-75.28925
1977	23:32:24	23:27:29	23:24:14	23:24:13	23:24:00	23:26:00	1.0	13.9	120.0	139.5	-75.28925
1978	23:33:14	23:28:19	23:25:04	23:25:03	23:25:00	23:27:00	1.0	4.2	120.0	129.7	-75.28925
1979	23:34:04	23:29:10	23:25:54	23:25:53	23:26:00	23:28:00	0.9	-5.6	120.0	120.1	-75.28925
1980	23:34:54	23:30:00	23:26:45	23:26:44	23:27:00	23:29:00	1.0	-15.2	120.0	110.3	-75.28925
1981	23:35:45	23:30:50	23:27:35	23:27:34	23:28:00	23:30:00	1.0	-25.0	120.0	100.6	-75.28925
1982	23:36:35	23:31:41	23:28:25	23:28:24	23:28:00	23:30:00	1.0	25.3	120.0	150.8	-75.28925
1983	23:37:25	23:32:31	23:29:16	23:29:15	23:29:00	23:31:00	0.9	15.5	120.0	141.2	-75.28925
1984	23:38:16	23:33:21	23:30:06	23:30:05	23:30:00	23:32:00	1.1	5.9	120.0	131.4	-75.28925
1985	23:39:06	23:34:11	23:30:56	23:30:55	23:31:00	23:33:00	1.0	-3.9	120.0	121.7	-75.28925
1986	23:39:56	23:35:02	23:31:46	23:31:45	23:32:00	23:34:00	1.0	-13.6	120.0	111.9	-75.28925
1987	23:40:46	23:35:52	23:32:37	23:32:36	23:33:00	23:35:00	1.0	-23.4	120.0	102.3	-75.28925
1988	23:41:37	23:36:42	23:33:27	23:33:26	23:33:00	23:35:00	1.1	27.0	120.0	152.5	-75.28925
1989	23:42:27	23:37:33	23:34:17	23:34:16	23:34:00	23:36:00	1.0	17.3	120.0	142.8	-75.28925
1990	23:43:17	23:38:23	23:35:07	23:35:07	23:35:00	23:37:00	1.0	7.5	120.0	133.0	-75.28925
1991	23:44:07	23:39:13	23:35:58	23:35:57	23:36:00	23:38:00	1.0	-2.3	120.0	123.4	-75.28925
1992	23:44:58	23:40:03	23:36:48	23:36:47	23:37:00	23:39:00	1.1	-11.9	120.0	113.7	-75.28925
1993	23:45:48	23:40:54	23:37:38	23:37:37	23:38:00	23:40:00	1.0	-21.6	120.0	103.9	-75.28925
1994	23:46:38	23:41:44	23:38:29	23:38:28	23:39:00	23:41:00	1.0	-31.4	120.0	94.1	-75.28925

Epoch	Ayanamsa (As on 15th April)						Difference in Ayanamsa (in Seconds)				
Year	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**
yy	**dd:mm:ss**	**dd:mm:ss**	**dd:mm:ss**	**dd:mm:ss**	**dd:mm:ss**	**dd:mm:ss**	**(3)-(4)**	**(3)-(5)**	**(6)-(5)**	**(2)-(6)**	**(6+8-2)**
1995	23:47:28	23:42:34	23:39:19	23:39:18	23:39:00	23:41:00	1.0	18.8	120.0	144.5	-75.28925
1996	23:48:19	23:43:25	23:40:09	23:40:08	23:40:00	23:42:00	1.1	9.2	120.0	134.8	-75.28925
1997	23:49:09	23:44:15	23:40:59	23:40:58	23:41:00	23:43:00	1.0	-0.5	120.0	125.0	-75.28925
1998	23:49:59	23:45:05	23:41:50	23:41:49	23:42:00	23:44:00	1.0	-10.3	120.0	115.3	-75.28925
1999	23:50:50	23:45:55	23:42:40	23:42:39	23:43:00	23:45:00	1.0	-20.0	120.0	105.6	-75.28925
2000	23:51:40	23:46:46	23:43:30	23:43:29	23:44:00	23:46:00	1.1	-29.7	120.0	95.9	-75.28925
2001	23:52:30	23:47:36	23:44:21	23:44:20			1.0				
2002	23:53:20	23:48:26	23:45:11	23:45:10			1.0				
2003	23:54:11	23:49:16	23:46:01	23:46:00			1.0				
2004	23:55:01	23:50:07	23:46:51	23:46:50			1.1				
2005	23:55:51	23:50:57	23:47:42	23:47:41			1.0				
2006	23:56:42	23:51:47	23:48:32	23:48:31			1.0				
2007	23:57:32	23:52:37	23:49:22	23:49:21			1.0				
2008	23:58:22	23:53:28	23:50:13	23:50:12			1.1				
2009	23:59:12	23:54:18	23:51:03	23:51:02			1.0				
2010	24:00:03	23:55:08	23:51:53	23:51:52			1.0				
2011	24:00:53	23:55:59	23:52:43	23:52:42			1.0				
2012	24:01:43	23:56:49	23:53:34	23:53:33			1.1				
2013	24:02:34	23:57:39	23:54:24	23:54:23			1.0				
2014	24:03:24	23:58:30	23:55:14	23:55:13			1.0				
2015	24:04:14	23:59:20	23:56:04	23:56:03			1.0				
2016	24:05:04	24:00:10	23:56:55	23:56:54			1.1				
2017	24:05:55	24:01:00	23:57:45	23:57:44			1.1				
2018	24:06:45	24:01:51	23:58:35	23:58:34			1.0				
2019	24:07:35	24:02:41	23:59:26	23:59:25			1.0				
2020	24:08:26	24:03:31	24:00:16	24:00:15			1.1				
2021	24:09:16	24:04:22	24:01:06	24:01:05			1.1				
2022	24:10:06	24:05:12	24:01:56	24:01:55			1.0				
2023	24:10:56	24:06:02	24:02:47	24:02:46			1.0				
2024	24:11:47	24:06:52	24:03:37	24:03:36			1.1				
2025	24:12:37	24:07:43	24:04:27	24:04:26			1.1				
2026	24:13:27	24:08:33	24:05:18	24:05:17			1.0				
2027	24:14:17	24:09:23	24:06:08	24:06:07			1.0				
2028	24:15:08	24:10:14	24:06:58	24:06:57			1.1				
2029	24:15:58	24:11:04	24:07:49	24:07:47			1.1				
2030	24:16:48	24:11:54	24:08:39	24:08:38			1.0				
2031	24:17:39	24:12:44	24:09:29	24:09:28			1.0				
2032	24:18:29	24:13:35	24:10:19	24:10:18			1.1				
2033	24:19:19	24:14:25	24:11:10	24:11:09			1.1				
2034	24:20:10	24:15:15	24:12:00	24:11:59			1.0				
2035	24:21:00	24:16:05	24:12:50	24:12:49			1.0				
2036	24:21:50	24:16:56	24:13:41	24:13:39			1.1				
2037	24:22:40	24:17:46	24:14:31	24:14:30			1.1				

Epoch	Ayanamsa (As on 15th April)						Difference in Ayanamsa (in Seconds)				
Year	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**
yy	**dd:mm:ss**	**dd:mm:ss**	**dd:mm:ss**	**dd:mm:ss**	**dd:mm:ss**	**dd:mm:ss**	**(3)-(4)**	**(3)-(5)**	**(6)-(5)**	**(2)-(6)**	**(6+8-2)**
2038	24:23:31	24:18:36	24:15:21	24:15:20			1.0				
2039	24:24:21	24:19:27	24:16:11	24:16:10			1.0				
2040	24:25:11	24:20:17	24:17:02	24:17:01			1.1				
2041	24:26:02	24:21:07	24:17:52	24:17:51			1.1				
2042	24:26:52	24:21:58	24:18:42	24:18:41			1.0				
2043	24:27:42	24:22:48	24:19:32	24:19:31			1.0				
2044	24:28:32	24:23:38	24:20:23	24:20:22			1.1				
2045	24:29:23	24:24:28	24:21:13	24:21:12			1.1				
2046	24:30:13	24:25:19	24:22:03	24:22:02			1.0				
2047	24:31:03	24:26:09	24:22:54	24:22:53			1.0				
2048	24:31:54	24:26:59	24:23:44	24:23:43			1.1				
2049	24:32:44	24:27:50	24:24:34	24:24:33			1.1				
2050	24:33:34	24:28:40	24:25:25	24:25:23			1.0				
2055	24:37:46	24:32:51	24:29:36	24:29:35			1.0				
2060	24:41:57	24:37:03	24:33:48	24:33:46			1.1				
2065	24:46:09	24:41:14	24:37:59	24:37:58			1.1				
2070	24:50:20	24:45:26	24:42:10	24:42:09			1.1				
2075	24:54:31	24:49:37	24:46:22	24:46:21			1.0				
2080	24:58:43	24:53:49	24:50:33	24:50:32			1.1				
2085	25:02:55	24:58:00	24:54:45	24:54:44			1.1				
2090	25:07:06	25:02:12	24:58:56	24:58:55			1.1				
2095	25:11:17	25:06:23	25:03:08	25:03:07			1.1				
2100	25:15:29	25:10:35	25:07:19	25:07:18			1.0				
2105	25:19:40	25:14:46	25:11:31	25:11:30			1.0				
2110	25:23:52	25:18:58	25:15:42	25:15:41			1.0				
2115	25:28:03	25:23:09	25:19:54	25:19:53			0.9				
2120	25:32:15	25:27:21	25:24:05	25:24:04			1.0				
2125	25:36:27	25:31:32	25:28:17	25:28:16			1.0				
2130	25:40:38	25:35:44	25:32:28	25:32:27			1.0				
2135	25:44:50	25:39:55	25:36:40	25:36:39			1.0				
2140	25:49:01	25:44:07	25:40:52	25:40:50			1.1				
2145	25:53:13	25:48:18	25:45:03	25:45:02			1.0				
2150	25:57:24	25:52:30	25:49:15	25:49:14			1.0				
2155	26:01:36	25:56:41	25:53:26	25:53:25			1.0				
2160	26:05:47	26:00:53	25:57:38	25:57:37			1.1				
2165	26:09:59	26:05:05	26:01:49	26:01:48			1.1				
2170	26:14:11	26:09:16	26:06:01	26:06:00			1.0				
2175	26:18:22	26:13:28	26:10:12	26:10:11			1.0				
2180	26:22:34	26:17:39	26:14:24	26:14:23			1.1				
2185	26:26:45	26:21:51	26:18:36	26:18:35			1.1				
2190	26:30:57	26:26:03	26:22:47	26:22:46			1.0				
2195	26:35:09	26:30:14	26:26:59	26:26:58			1.0				
2200	26:39:20	26:34:26	26:31:10	26:31:09			1.0				

In the above Table 27, Ayanamsa calculated [Column(1) to (4)] are rounded up to seconds and values published in the text books are given as it is in Column (5) & (6). However, the difference in Ayanamsa (in Seconds) shown, are calculated directly from the respective formulae.

When Rajan's Ayanamsa calculated using Eqn.(59) [Column (3)] rounded up to minutes, it completely matches with values given in his text book Ref.[12] except for the Year 1883, 1920, 1957 and 1994. For these four Years the difference is 1 or 2 Seconds (highlighted), which is negligible and can be ignored.

It is noticed that the difference in Rajan's Ayanamsa values [Column(7)] between calculated using Eqn.(59) [Column(3)] and Eqn.(32) [Column(4)] is appreciable. It gradually reduces from 452 Seconds at the beginning of Year 500 to 4.4 Seconds in Year 1800 and gradually reduces to around 1 Second between year 1800 and 1900.

It may be noted that in Nayar's Ayanamsa calculation (See Chart 1), also had similar discrepancy between Year 500 to 1600 but not as high as compared to Rajan's Values, may be due to slightly different/modified concept adopted by Nayar in his calculation.

The loss of significant digits due to rounding off values up to minutes as published in Rajan's text book Ref.[12][Column(5)] with respect to actual Ayanamsa values calculated using Eqn.(59) [Column (3)] are given in Column(8). These values vary in the range of –31.5 to 28.6 Seconds and the error is not cumulative, gradually distributed and adjusted with in every 6 to 7 consecutive year blocks, due to obvious reasons given above.

It is also noticed that Ayanamsa table's pattern given in KP Reader1 is most similar to C.G.Rajan's Ayanamsa table given in Ref.[12] except small difference in values which may be due to adoption of different year of coincidence. KSK also acknowledged in his Reader1 that the difference between what he follow, Lahiri & C.G.Rajan follow is negligible. However, his contention cannot be substantiated in the case of twins, triplets etc., as for the Cusp's/Planet's Sub-sub, Sub-sub-subs even 1 second counts.

The table given in both the books, exactly covers from the year 1840 to 2000 and the difference is found 2 minutes or 120 Seconds [Column(9)] uniformly (except from the Year 1908-1912 and 1914-1918 which is 3 minutes or 180 Seconds, might be typographical error or due to calculation method adopted and rounding off error etc.).

Even though the difference in Published Ayanamsa values (up to minutes) between Rajan and KSK is uniform, the difference in Rajan's values (Column(8), due to loss of significant digits.i.e, rounding off error) between one calculated and published does not agree with the difference in KSK's values (Column(10), varies from 52.1 to 154.1 Seconds) between one calculated and published in his Reader1 book.

The amount contributing this discrepancy is calculated by assuming that the difference in Rajan's values[Column(8)] is same for KSK's values published in his book[Column(6)], accordingly values in Column(8) is added with Column(6) (to get KSK's published values up to seconds) and subtracted with actual calculated values[Column(2)], the discrepancy amount found to be around -75.28925 Seconds for most Years (Column(11), except for years 1908 to 1912 and 1914 to 1918 -15.28925 Seconds for the same reasons above). This amount is further investigated in the following Chapter.

7.9 Error Analysis of Rajan's, KSK's Ayanamsa, Comparison and Discussion

Rajan's and KSK's rounding off Ayanamsa values (assuming 120 Seconds difference between them for all the years) are studied for error analysis by using the method of least square curve fitting concept. A second order (quadratic) polynomial equation is derived, from the set of datas (X,Y), where X is in Julian Years (calculated from the Julian Days of date 15th April on Each Year) and Y is the Ayanamsa Value for the respective Julian Years as shown below. For both equations R^2 works out 0.99995. Considering X=T (measured in Julian Years from J0000 Epoch reference date) and Y=P (PG- Rajan Ayanamsa, PK-KSK Rajan Ayanamsa). Readers may refer any mathematics textbooks or online resources under the heading 'least square curve fitting method'. Applications programs like Microsoft Excel may be used to add trend lines to fit a curve (using the method of least square curve fitting concept) for any plotted XY Graph.

$$\mathrm{PG} = -14671.957637 + 49.7670 * \mathrm{T} + 0.000134433 * \mathrm{T}^2 (\textit{Seconds})$$ -----------Eqn.[82]

$$\mathrm{PK} = -14551.957637 + 49.7670 * \mathrm{T} + 0.000134433 * \mathrm{T}^2 (\textit{Seconds})$$ -----------Eqn.[83]

Solving the above Eqn.(82) for 'T' we get, for Rajan
T = 294.578576299939 Julian Years
= 18 July 294 @ 07:47:59 Hrs UT (JD = 1828639.82499355 days) as Zero Ayanamsa Date
This differs from actual adopted date 17 Feb 295@14:19:47UT, JD=1828854.09707486 days)

Similarly, Solving the above Eqn.(83) for 'T' we get, for KSK
T = 292.171155595424 Julian Years
= 20 Feb 292 @ 00:21:00 Hrs UT(JD =1827760.51458123 Days) as Zero Ayanamsa Date
This differs from actual adopted date 21 Mar 291 @ 04:09 hrs UT, JD =1827424.67291667 days)

By mathematically shifting the Origin from J0000 to J1900 for the above Eqn.(82,83) we get,

$$\mathrm{PG} = 80370.6455 + 50.2778454 * \mathrm{T} + 0.000134433 * \mathrm{T}^2 (\textit{Seconds})$$ -----------Eqn.[84]

$$\mathrm{PK} = 80490.6457 + 50.2778454 * \mathrm{T} + 0.000134433 * \mathrm{T}^2 (\textit{Seconds})$$ -----------Eqn.[85]

The concept of translation adopted can be referred in Chapter(7.6.4) 'Calculation for Nutation in longitude ($\Delta\psi$)' given above. For more details, readers may refer any mathematics textbooks or online resources under the heading 'Translation and rotation of geometry' or 'Coordinate Transformation and Rotation'. By differentiating the above equations, we get rate of Precession with reference to J1900 Julian Epoch for both the Equations as

$$p = 50.2778454 + 0.0002688866 * \mathrm{T}(\textit{Seconds})$$ -----------Eqn. [86]

we can write the above Eqn.(86) in general form as

$$p_T = p_0 + m * \mathrm{T}(\textit{Seconds})$$ -----------Eqn. [87]

Where
p_T = Precession Rate for the required Time 'T' (in Seconds)
p_0 = Precession Rate for the reference Epoch (Julian/Besselian Epoch) (in Seconds)
m = Rate of change of Precession Rate (or) Acceleration
T = Time measured from the reference Epoch (in Julian/Besselian Years)

The above Eqn.(87) represents a straight line Equation of form $y = m * x + c$. Where 'm' is the slope of the line equal to $\tan\theta$ and 'θ' angle with respect to x-axis (can be taken as angular acceleration in circular motion as discussed in Eqn.(20)) and 'c' is the y-axis intercept (can be taken as Precession Rate at Origin/Reference Epoch or Initial angular velocity in circular motion). The values given in Eqn.(86) are compared with actual values given in Eqn.(g') and the Error in Precession Rate and Angular acceleration (Slope) for the date J1900 Epoch works out to –0.0203454 (50.2575-50.2778454) Seconds [It indicates the straight line's vertical downward Shift in y-axis], –0.000046866(0.000222-0.000268866) radians [It indicates the straight line's clockwise rotation with respect to Origin at y-axis intercept point] respectively. When the 'θ' angle in radians is very small, $\tan\theta \approx \theta$ can be taken mathematically. By equating and solving above Eqn.(86,g') we get 'T' at point of intersection,

T = -434.118550761746 Julian Year
JY = 1900 - 434.118550761746
= 1465.88144923825 Julian Years (JD = 2256458.19933427 Days)
= 5 November 1465 @:16:4702 Hrs UT(Date at which both lines will intersect to each other)

This is because of error in the above Eqn.(86) due to the loss of significant digits while rounding off values up to minutes in the Ayanamsa Values. It can be represented graphically the above discussed points as shown below.

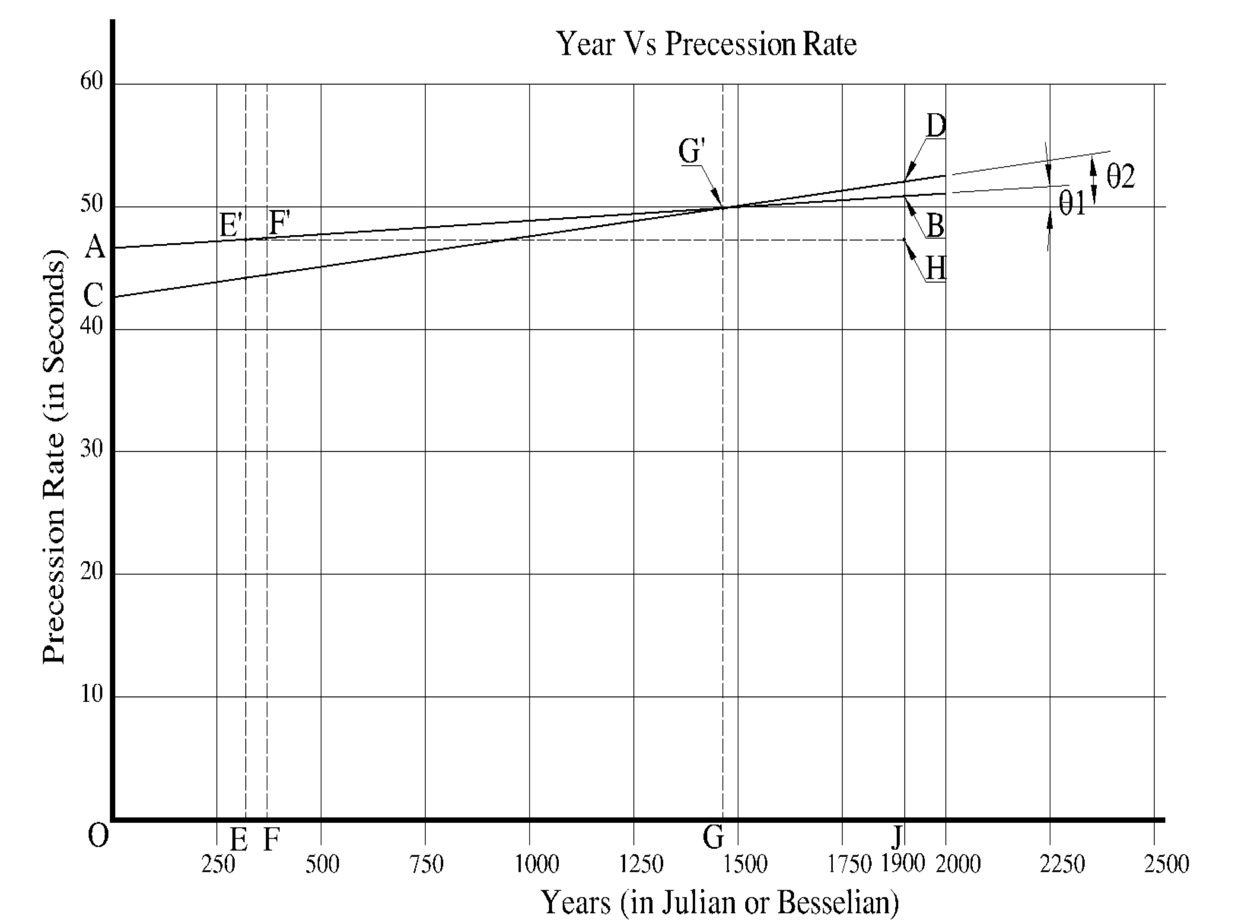

Chart 12: Graphical Representation of Precession Rate and Ayanamsa

For the above Chart 12, let horizontal x-axis represents time in Years (in Julian or Besselian), Vertical y-axis represents the Precession Rate (in Seconds) and both axis intersecting at 'O'.

AB = Line represents the Precession Rate Eqn.(g').
JB = p_T Precession Rate @ J1900 Epoch
m_1 = $\text{Tan}\theta_1$ = Slope of the line AB (in radians)
OE = Period of Zero Ayanamsa Year
E'H = Line parallel to x-axis from E' intersecting line JB at H
EE' = p_0 Precession Rate @ Zero Ayanamsa Date
EJ = 'T' Time Duration measured in Julian Years from Zero Ayanamsa Date

Precession Rate for the Epoch 1900 (JB) calculated from Zero Ayanamsa Reference Date can be represented by the following Equation

$$\text{JB} = \text{JH} + \text{HB}$$
$$= \text{EE}' + \text{Tan}\theta_1 * \text{EJ}(\because \text{JH} = \text{EE}', \text{E}'\text{H} = \text{EJ} \,\&\, \text{HB} = \text{E}'\text{H} * \text{Tan}\theta_1)$$
$$p_T = p_o + m_1 * \text{T}(\because \text{EE}' = p_o, \text{EJ} = \text{T} \,\&\, \text{Tan}\theta_1 = m_1) \quad \text{-----------Eqn.[88]}$$

The above Eqn.(88) is same as Eqn.(87) discussed above except notations. The same Eqn.(88) can be used With Ref. Epoch as J1900 except replacing $p_0 = p_1$ Precession Rate @ J1900 Date p_1 and 'T' Time Duration measured in Julian Years from J1900 Ref. Epoch Date.

Precession Rate for the Epoch $p_T = p_1 + m_1 * \text{T}$ (Ref. J1900 Epoch) -----------Eqn.[89]

Ayanamsa for the Epoch J1900 calculated from Zero Ayanamsa Reference Date can be represented by the Area of Trapezoidal EJBE'.

Ayanamsa for the Epoch = Area of Trapezoidal EJBE'
Area of Trapezoidal EJBE'= Area of rectangle EJHE'+ Area of Triangle E'HB -----------Eqn.[90]
Area of rectangle EJHE' $= \text{EE}' * \text{EJ}$
Area of rectangle EJHE' $= p_o * \text{T}$ -----------Eqn.[91]

Area of Triangle E'HB $= \frac{1}{2} * \text{E}'\text{H} * \text{HB}$

$$= \frac{1}{2} * \text{EJ} * \text{EJ} * \text{Tan}\theta_1 (\because \text{E}'\text{H} = \text{EJ} \,\&\, \text{HB} = \text{E}'\text{H} * \text{Tan}\theta_1)$$

$$= \frac{1}{2} * \text{T} * \text{T} * \text{m}_1 (\because \text{EJ} = \text{T} \,\&\, \text{Tan}\theta_1 = m_1)$$

Area of Triangle E'HB $= \frac{1}{2} * \text{m}_1 * \text{T}^2$ -----------Eqn.[92]

Substituting Eqn.(91,92) in Eqn.(90) we get,

Area of Trapezoidal EJBE'= $p_o * \text{T} + \frac{1}{2} * \text{m}_1 * \text{T}^2$

Ayanamsa for the Epoch $= p_o * \text{T} + \frac{1}{2} * \text{m}_1 * \text{T}^2$ -----------Eqn.[93]

The above Eqn.(93) is similar to Eqn.(21) except notations. The same Eqn.(93) can be modified when Ref. Epoch as J1900 used except replacing $p_0 = p_1$ Precession Rate @ J1900 Date p_1, 'T' Time Duration measured in Julian Years with Reference to J1900 Epoch Date and introduction of Constant Term 'C' representing the Ayanamsa for the reference date which is the Area of Trapezoidal EJBE' as

Ayanamsa for the Epoch $P = C + p_1 * \text{T} + \frac{1}{2} * \text{m}_1 * \text{T}^2$ (Ref. J1900 Epoch) -----------Eqn.[94]

Similarly, Eqn.(86) can be represented graphically,

CD = Line represents the Precession Rate Eqn.(86).
JD = p_2 Precession Rate @ J1900 Epoch
m_2 = Tanθ_2 = Slope of the line CD (in radians)
T = Time Duration measured in Julian Years from With Reference to J1900 Epoch Date

Precession Rate $p_T = p_2 + m_2 * T$ (Ref. J1900 Epoch) -----------Eqn.[95]

Ayanamsa for the Epoch $P = C + p_2 * T + \frac{1}{2} * m_2 * T^2$ (Ref. J1900 Epoch) -----------Eqn.[96]

Now at J1900 Epoch date, the error in Precession Rate and Rate of change of Precession Rate (Acceleration) can be represented as,

Error in Precession Rate BD=JD-JB [indicates straight line's vertical downward Shift in y-axis]
Error in Precession Rate $\delta p = p_2 - p_1$ (Ref. J1900 Epoch) -----------Eqn.[97]

Error in Slope(rotation angle) $Tan\delta\theta = \left(\frac{m_1 - m_2}{1 + m_1 * m_2} \right)$ (Ref. J1900 Epoch) -----------Eqn.[98]

When 'θ' angle in radians is very small, we can write
$m_1 = Tan\theta_1 \approx \theta_1$
$m_2 = Tan\theta_2 \approx \theta_2$
$m_1 * m_2 \approx 0$
$\tan\delta\theta \approx \delta\theta$

Thus the above Eqn.(98) simplified as
Error in Slope(rotation angle) $\delta\theta = \theta_1 - \theta_2$ in radians(Ref. J1900 Epoch) -----------Eqn.[99]
[It indicates the straight line's clockwise rotation with respect to Origin at y-axis intercept point]

Readers may refer above mentioned books or on-line resources under the caption like 'Coordinate Transformation and Rotation of lines' for sign convention used while rotating the line in Clockwise or Anti-Clockwise directions etc.

The shift and rotation values are already discussed above. Also both the lines AB & CD intersects at point G' marked in above Chart 12 can be solved using Eqn.(88,95) by substituting appropriate values and the results are given above.

Similarly the other Precession Models IAU1976, IAU2006 can be represented as line (not shown in above Chart 12) and the intersection points between IAU1976, IAU2006 and NewComb Models can be found by solving Eqn.(12,16,g") and the values are given in below Table.

Table 28: Details of Intersection Points Between Various Precession Models

	Model-A (Line-A)			**Model-B (Line-B)**			**Line-A &B Intersection Point Details**			
Sr. No.	Precession p_1	Slope m_1	Model Name	Precession p_2	Slope m_2	Model Name	'T' in Julian Years	Julian Year (JY)	Julian Days (JD)	DateTime (in UT)
1	50.28796195	0.022108696	IAU2000	50.290966	0.0222226	IAU1976	-26.37352507	1973.6265	2441912.069967	17Aug1973 @13:40:45
2	50.28796195	0.022108696	IAU2000	50.2797	0.000222	NewComb	-0.37748731	1999.6225	2451407.122760	16Aug1999 @14:56:46
3	50.290966	0.0222226	IAU1976	50.2797	0.000222	NewComb	-0.512076943	1999.4879	2451357.963896	28Jun1999 @11:08:01

It is noticed from the above table that Slope for the IAU1976 & IAU2006 Models are found approximately 100 times greater than the NewComb's Model Slope. Readers should note that at this intersection Point of the respective Models, will have the same Precession Rate.

From the Chart 12, Suppose Point E, F represents the Zero Ayanamsa Date for Lahiri and KSK respectively then difference in Ayanamsa between the two is nothing but Area of the Trapezoidal EFE'F' and Ayanamsa component for any time 'T' beyond point F is same for both the case as the area subtended from F to time T remains same (while calculating with same precession Model). With this brief graphical representation, readers can understand what the Precession Rate and Ayanamsa means in the Graph.

We have already found from Table 27 that Rajan's Ayanamsa values up to minutes given in his book exactly matches with values calculated using Eqn.(59) rounded up to minutes. Hence the shift and rotation values explained above are, only due to the loss of significant digits while adopting rounding off values up to minutes in Ayanamsa Values.

Since the Eqn.(86) is same for Rajan and KSK, we can conclude that both Rajan's and KSK's Ayanamsa values published in their text book agrees with NewComb's theory except the difference in KSK's Ayanamsa -75.28925 Seconds [See Column No.(11) values shown in above Table 27 is due to shift in Zero Ayanamsa date from actually adopted date value 21 Mar 291 @ 04:09 hrs UT,JD=1827424.67291667 days) as calculated and shown below.

In Eqn.(56), by adjusting & substituting constant as 80489.10398(80564.39323-75.28925) Seconds we get Ayanamsa Equation as,

$$PK = 80489.10398 + 50.2575 * T + 0.000111 * T^2 (Seconds) \qquad \text{-----------Eqn.[100]}$$

Zero Ayanamsa date can be found by solving above quadratic Eqn.(100) for PK=0 and we get,
T= =-1607.23954201743 Julian Years.
Adding this with above reference Year, we get Julian epoch for Zero Ayanamsa date as,
JY=1900-1607.23954201743
= 292.76045798257 Julian Years
Substituting JY in Eqn.(j2) With J1900 as Reference, we get Julian days (JD) as,

$$292.76045798257 = 1900 + \frac{JD - 2415020}{365.25}$$

$$JD = 1827975.75727813 \text{ Julian Days}$$

From above JD, the corresponding Date works out to 22 September 292 @ 06:10:29 hrs UT). This differs from actual adopted date 21 Mar 291 @ 04:09 hrs UT, JD=1827424.67291667 days.

For the purpose of comparison, I give below Table 29 different Ayanamsa values. In the table Column(1) Rajan's Ayanamsa values calculated using Eqn.(59), Column(2) KSK's Ayanamsa using Eqn.(58),Column(3) KSK's Ayanamsa using Eqn.(100),Column(4) Ayanamsa Values published in Eashwar Manu's Book Ref.[10], Column(5) showing rounded up values of Column(3) in minutes(For rounding off purpose, 30 Seconds and above is taken as 1 minute), Column(6) shows Values published in KSK's Reader1 book. All the Ayanamsa values calculated in the table are for the date 15th April @ 0Hrs UT of each year from 1840A.D to 2000 A.D.

Here I have taken Eashwar Manu for comparison because KSK has approved the Ayanamsa Values worked out by him.

Table 29: Comparison of KSK's Ayanamsa Calculated Vs Published Values

Epoch	Ayanamsa (As on 15th April)						Difference in Ayanamsa(Seconds)			
Year	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
yy	dd:mm:ss	dd:mm:ss	dd:mm:ss	dd:mm:ss	dd:mm	dd:mm	(5)-(6)	(3)-(1)	(3)-(4)	(2)-(4)
1840	21:29:29	21:32:44	21:31:29	21:32:04	21:31	21:31	0	120	-35.4	39.9
1841	21:30:19	21:33:34	21:32:19	21:32:54	21:32	21:32	0	120	-35.2	40.1
1842	21:31:09	21:34:24	21:33:09	21:33:44	21:33	21:33	0	120	-35.0	40.3
1843	21:31:59	21:35:14	21:33:59	21:34:34	21:34	21:34	0	120	-34.8	40.5
1844	21:32:50	21:36:05	21:34:50	21:35:24	21:35	21:35	0	120	-34.5	40.8
1845	21:33:40	21:36:55	21:35:40	21:36:14	21:36	21:36	0	120	-34.2	41.0
1846	21:34:30	21:37:45	21:37:00	21:37:04	21:36	21:37	0	120	-34.0	41.3
1847	21:35:20	21:38:35	21:37:20	21:37:54	21:37	21:37	0	120	-33.8	41.5
1848	21:36:11	21:39:26	21:38:11	21:38:44	21:38	21:38	0	120	-33.5	41.8
1849	21:37:01	21:40:16	21:39:01	21:39:34	21:39	21:39	0	120	-33.3	42.0
1850	21:37:51	21:41:06	21:39:51	21:40:24	21:40	21:40	0	120	-33.0	42.2
1851	21:38:41	21:41:56	21:40:41	21:41:14	21:41	21:41	0	120	-32.8	42.5
1852	21:39:32	21:42:47	21:41:32	21:42:04	21:42	21:42	0	120	-32.5	42.8
1853	21:40:22	21:43:37	21:42:22	21:42:54	21:42	21:42	0	120	-32.3	43.0
1854	21:41:12	21:44:27	21:43:12	21:43:44	21:43	21:43	0	120	-32.1	43.2
1855	21:42:02	21:45:17	21:44:02	21:44:34	21:44	21:44	0	120	-31.8	43.4
1856	21:42:53	21:46:08	21:44:53	21:45:24	21:45	21:45	0	120	-31.5	43.8
1857	21:43:43	21:46:58	21:45:43	21:46:14	21:46	21:46	0	120	-31.3	44.0
1858	21:44:33	21:47:48	21:46:33	21:47:04	21:47	21:47	0	120	-31.1	44.2
1859	21:45:23	21:48:38	21:47:23	21:47:54	21:47	21:47	0	120	-30.9	44.4
1860	21:46:13	21:49:29	21:48:13	21:48:44	21:48	21:48	0	120	-30.5	44.8
1861	21:47:04	21:50:19	21:49:04	21:49:34	21:49	21:49	0	120	-30.3	45.0
1862	21:47:54	21:51:09	21:49:54	21:50:24	21:50	21:50	0	120	-30.1	45.2
1863	21:48:44	21:51:59	21:50:44	21:51:14	21:51	21:51	0	120	-29.9	45.4
1864	21:49:34	21:52:50	21:51:34	21:52:04	21:52	21:52	0	120	-29.5	45.8
1865	21:50:25	21:53:40	21:52:25	21:52:54	21:52	21:52	0	120	-29.3	46.0
1866	21:51:15	21:54:30	21:53:15	21:53:44	21:53	21:53	0	120	-29.1	46.2
1867	21:52:05	21:55:20	21:54:05	21:54:34	21:54	21:54	0	120	-28.9	46.4
1868	21:52:55	21:56:11	21:54:55	21:55:24	21:55	21:55	0	120	-28.5	46.8
1869	21:53:46	21:57:01	21:55:46	21:56:14	21:56	21:56	0	120	-28.3	47.0
1870	21:54:36	21:57:51	21:56:36	21:57:04	21:57	21:57	0	120	-28.1	47.2
1871	21:55:26	21:58:41	21:57:26	21:57:54	21:57	21:57	0	120	-27.9	47.4
1872	21:56:16	21:59:32	21:58:16	21:58:44	21:58	21:58	0	120	-27.5	47.8
1873	21:57:07	22:00:22	21:59:07	21:59:34	21:59	21:59	0	120	-27.3	48.0
1874	21:57:57	22:01:12	21:59:57	22:00:24	22:00	22:00	0	120	-27.1	48.2
1875	21:58:47	22:02:02	22:00:47	22:01:14	22:01	22:01	0	120	-26.9	48.4
1876	21:59:38	22:02:53	22:01:38	22:02:04	22:02	22:02	0	120	-26.5	48.8
1877	22:00:28	22:03:43	22:02:28	22:02:54	22:02	22:02	0	120	-26.3	49.0
1878	22:01:18	22:04:33	22:03:18	22:03:44	22:03	22:03	0	120	-26.1	49.2
1879	22:02:08	22:05:23	22:04:08	22:04:34	22:04	22:04	0	120	-25.8	49.4
1880	22:02:59	22:06:14	22:04:59	22:05:24	22:05	22:05	0	120	-25.5	49.8
1881	22:03:49	22:07:04	22:05:49	22:06:14	22:06	22:06	0	120	-25.3	50.0

Epoch	Ayanamsa (As on 15th April)						Difference in Ayanamsa(Seconds)			
Year	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
yy	dd:mm:ss	dd:mm:ss	dd:mm:ss	dd:mm:ss	dd:mm	dd:mm	(5)-(6)	(3)-(1)	(3)-(4)	(2)-(4)
1882	22:04:39	22:07:54	22:06:39	22:07:04	22:07	22:07	0	120	-25.0	50.2
1883	22:05:29	22:08:44	22:07:29	22:07:54	22:07	22:08	-60	120	-24.8	50.5
1884	22:06:20	22:09:35	22:08:20	22:08:44	22:08	22:08	0	120	-24.5	50.8
1885	22:07:10	22:10:25	22:09:10	22:09:34	22:09	22:09	0	120	-24.3	51.0
1886	22:08:00	22:11:15	22:10:00	22:10:24	22:10	22:10	0	120	-24.0	51.3
1887	22:08:50	22:12:05	22:10:50	22:11:14	22:11	22:11	0	120	-23.8	51.5
1888	22:09:41	22:12:56	22:11:41	22:12:04	22:12	22:12	0	120	-23.5	51.8
1889	22:10:31	22:13:46	22:12:31	22:12:54	22:13	22:13	0	120	-23.2	52.1
1890	22:11:21	22:14:36	22:13:21	22:13:44	22:13	22:13	0	120	-23.0	52.3
1891	22:12:11	22:15:26	22:14:11	22:14:34	22:14	22:14	0	120	-22.8	52.5
1892	22:13:02	22:16:17	22:15:02	22:15:24	22:15	22:15	0	120	-22.4	52.9
1893	22:13:52	22:17:07	22:15:52	22:16:14	22:16	22:16	0	120	-22.2	53.1
1894	22:14:42	22:17:57	22:16:42	22:17:04	22:17	22:17	0	120	-22.0	53.3
1895	22:15:32	22:18:48	22:17:32	22:17:54	22:18	22:18	0	120	-21.8	53.5
1896	22:16:23	22:19:38	22:18:23	22:18:44	22:18	22:18	0	120	-21.4	53.9
1897	22:17:13	22:20:28	22:19:13	22:19:34	22:19	22:19	0	120	-21.2	54.1
1898	22:18:03	22:21:18	22:20:03	22:20:24	22:20	22:20	0	120	-21.0	54.3
1899	22:18:53	22:22:09	22:20:53	22:21:14	22:21	22:21	0	120	-20.7	54.5
1900	22:19:43	22:22:59	22:21:43	22:22:04	22:22	22:22	0	120	-20.5	54.8
1901	22:20:34	22:23:49	22:22:34	22:22:54	22:23	22:23	0	120	-20.3	55.0
1902	22:21:24	22:24:39	22:23:24	22:23:44	22:23	22:23	0	120	-20.1	55.2
1903	22:22:14	22:25:29	22:24:14	22:24:34	22:24	22:24	0	120	-19.8	55.4
1904	22:23:05	22:26:20	22:25:05	22:25:24	22:25	22:25	0	120	-19.5	55.8
1905	22:23:55	22:27:10	22:25:55	22:26:14	22:26	22:26	0	120	-19.3	56.0
1906	22:24:45	22:28:00	22:26:45	22:27:04	22:27	22:27	0	120	-19.0	56.3
1907	22:25:35	22:28:50	22:27:35	22:27:54	22:28	22:28	0	120	-18.8	56.5
1908	22:26:26	22:29:41	22:28:26	22:28:44	22:28	22:29	**-60**	120	-18.4	56.8
1909	22:27:16	22:30:31	22:29:16	22:29:34	22:29	22:30	**-60**	120	-18.2	57.1
1910	22:28:06	22:31:21	22:30:06	22:30:24	22:30	22:31	**-60**	120	-18.0	57.3
1911	22:28:56	22:32:12	22:30:56	22:31:14	22:31	22:32	**-60**	120	-17.8	57.5
1912	22:29:47	22:33:02	22:31:47	22:32:04	22:32	22:33	**-60**	120	-17.4	57.9
1913	22:30:37	22:33:52	22:32:37	22:32:54	22:33	22:33	0	120	-17.2	58.1
1914	22:31:27	22:34:42	22:33:27	22:33:44	22:33	22:34	**-60**	120	-17.0	58.3
1915	22:32:17	22:35:33	22:34:17	22:34:34	22:34	22:35	**-60**	120	-16.7	58.6
1916	22:33:08	22:36:23	22:35:08	22:35:24	22:35	22:36	**-60**	120	-16.4	58.9
1917	22:33:58	22:37:13	22:35:58	22:36:14	22:36	22:37	**-60**	120	-16.1	59.1
1918	22:34:48	22:38:03	22:36:48	22:37:04	22:37	22:38	**-60**	120	-15.9	59.4
1919	22:35:38	22:38:54	22:37:38	22:37:54	22:38	22:38	0	120	-15.7	59.6
1920	22:36:29	22:39:44	22:38:29	22:38:44	22:38	22:39	-60	120	-15.3	60.0
1921	22:37:19	22:40:34	22:39:19	22:39:34	22:39	22:39	0	120	-15.1	60.2
1922	22:38:09	22:41:24	22:40:09	22:40:24	22:40	22:40	0	120	-14.9	60.4
1923	22:38:59	22:42:15	22:40:59	22:41:14	22:41	22:41	0	120	-14.6	60.7
1924	22:39:50	22:43:05	22:41:50	22:42:04	22:42	22:42	0	120	-14.3	61.0

Epoch	Ayanamsa (As on 15th April)						Difference in Ayanamsa(Seconds)			
Year	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
yy	dd:mm:ss	dd:mm:ss	dd:mm:ss	dd:mm:ss	dd:mm	dd:mm	(5)-(6)	(3)-(1)	(3)-(4)	(2)-(4)
1925	22:40:40	22:43:55	22:42:40	22:42:54	22:43	22:43	0	120	-14.0	61.2
1926	22:41:30	22:44:45	22:43:30	22:43:44	22:44	22:44	0	120	-13.8	61.5
1927	22:42:20	22:45:36	22:44:20	22:44:34	22:44	22:44	0	120	-13.6	61.7
1928	22:43:11	22:46:26	22:45:11	22:45:24	22:45	22:45	0	120	-13.2	62.1
1929	22:44:01	22:47:16	22:46:01	22:46:14	22:46	22:46	0	120	-13.0	62.3
1930	22:44:51	22:48:07	22:46:51	22:47:04	22:47	22:47	0	120	-12.8	62.5
1931	22:45:41	22:48:57	22:47:41	22:47:54	22:48	22:48	0	120	-12.5	62.8
1932	22:46:32	22:49:47	22:48:32	22:48:44	22:49	22:49	0	120	-12.2	63.1
1933	22:47:22	22:50:37	22:49:22	22:49:34	22:49	22:49	0	120	-11.9	63.4
1934	22:48:12	22:51:28	22:50:12	22:50:24	22:50	22:50	0	120	-11.7	63.6
1935	22:49:03	22:52:18	22:51:03	22:51:14	22:51	22:51	0	120	-11.5	63.8
1936	22:49:53	22:53:08	22:51:53	22:52:04	22:52	22:52	0	120	-11.1	64.2
1937	22:50:43	22:53:58	22:52:43	22:52:54	22:53	22:53	0	120	-10.9	64.4
1938	22:51:33	22:54:49	22:53:33	22:53:44	22:54	22:54	0	120	-10.6	64.7
1939	22:52:24	22:55:39	22:54:24	22:54:34	22:54	22:54	0	120	-10.4	64.9
1940	22:53:14	22:56:29	22:55:14	22:55:24	22:55	22:55	0	120	-10.0	65.3
1941	22:54:04	22:57:19	22:56:04	22:56:14	22:56	22:56	0	120	-9.8	65.5
1942	22:54:54	22:58:10	22:56:54	22:57:04	22:57	22:57	0	120	-9.6	65.7
1943	22:55:45	22:59:00	22:57:45	22:57:54	22:58	22:58	0	120	-9.3	65.9
1944	22:56:35	22:59:50	22:58:35	22:58:44	22:59	22:59	0	120	-9.0	66.3
1945	22:57:25	23:00:41	22:59:25	22:59:34	22:59	22:59	0	120	-8.7	66.6
1946	22:58:15	23:01:31	23:00:15	23:00:24	23:00	23:00	0	120	-8.5	66.8
1947	22:59:06	23:02:21	23:01:06	23:01:14	23:01	23:01	0	120	-8.3	67.0
1948	22:59:56	23:03:11	23:01:56	23:02:04	23:02	23:02	0	120	-7.9	67.4
1949	23:00:46	23:04:02	23:02:46	23:02:54	23:03	23:03	0	120	-7.7	67.6
1950	23:01:37	23:04:52	23:03:37	23:03:44	23:04	23:04	0	120	-7.4	67.9
1951	23:02:27	23:05:42	23:04:27	23:04:34	23:04	23:04	0	120	-7.2	68.1
1952	23:03:17	23:06:32	23:05:17	23:05:24	23:05	23:05	0	120	-6.8	68.5
1953	23:04:07	23:07:23	23:06:07	23:06:14	23:06	23:06	0	120	-6.6	68.7
1954	23:04:58	23:08:13	23:06:58	23:07:04	23:07	23:07	0	120	-6.4	68.9
1955	23:05:48	23:09:03	23:07:48	23:07:54	23:08	23:08	0	120	-6.1	69.2
1956	23:06:38	23:09:54	23:08:38	23:08:44	23:09	23:09	0	120	-5.7	69.5
1957	23:07:28	23:10:44	23:09:28	23:09:34	23:09	23:10	-60	120	-5.5	69.8
1958	23:08:19	23:11:34	23:10:19	23:10:24	23:10	23:10	0	120	-5.3	70.0
1959	23:09:09	23:12:24	23:11:09	23:11:14	23:11	23:11	0	120	-5.0	70.3
1960	23:09:59	23:13:15	23:11:59	23:12:04	23:12	23:12	0	120	-4.7	70.6
1961	23:10:50	23:14:05	23:12:50	23:12:54	23:13	23:13	0	120	-4.4	70.9
1962	23:11:40	23:14:55	23:13:40	23:13:44	23:14	23:14	0	120	-4.2	71.1
1963	23:12:30	23:15:45	23:14:30	23:14:34	23:15	23:15	0	120	-4.0	71.3
1964	23:13:20	23:16:36	23:15:20	23:15:24	23:15	23:15	0	120	-3.6	71.7
1965	23:14:11	23:17:26	23:16:11	23:16:14	23:16	23:16	0	120	-3.3	71.9
1966	23:15:01	23:18:16	23:17:01	23:17:04	23:17	23:17	0	120	-3.1	72.2
1967	23:15:51	23:19:06	23:17:51	23:17:54	23:18	23:18	0	120	-2.9	72.4

Epoch	**Ayanamsa (As on 15th April)**						**Difference in Ayanamsa(Seconds)**			
Year	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**
yy	dd:mm:ss	dd:mm:ss	dd:mm:ss	dd:mm:ss	dd:mm	dd:mm	**(5)-(6)**	**(3)-(1)**	**(3)-(4)**	**(2)-(4)**
1968	23:16:42	23:19:57	23:18:42	23:18:44	23:19	23:19	0	120	-2.5	72.8
1969	23:17:32	23:20:47	23:19:32	23:19:34	23:20	23:20	0	120	-2.3	73.0
1970	23:18:22	23:21:37	23:20:22	23:20:24	23:20	23:20	0	120	-2.0	73.3
1971	23:19:12	23:22:28	23:21:12	23:21:14	23:21	23:21	0	120	-1.8	73.5
1972	23:20:03	23:23:18	23:22:03	23:22:04	23:22	23:22	0	120	-1.4	73.9
1973	23:20:53	23:24:08	23:22:53	23:22:54	23:23	23:23	0	120	-1.2	74.1
1974	23:21:43	23:24:58	23:23:43	23:23:44	23:24	23:24	0	120	-0.9	74.4
1975	23:22:33	23:25:49	23:24:33	23:24:34	23:25	23:25	0	120	-0.7	74.6
1976	23:23:24	23:26:39	23:25:24	23:25:24	23:25	23:25	0	120	-0.3	75.0
1977	23:24:14	23:27:29	23:26:14	23:26:14	23:26	23:26	0	120	-0.1	75.2
1978	23:25:04	23:28:19	23:27:04	23:27:04	23:27	23:27	0	120	0.2	75.5
1979	23:25:54	23:29:10	23:27:54	23:27:54	23:28	23:28	0	120	0.4	75.7
1980	23:26:45	23:30:00	23:28:45	23:28:44	23:29	23:29	0	120	0.8	76.1
1981	23:27:35	23:30:50	23:29:35	23:29:34	23:30	23:30	0	120	1.0	76.3
1982	23:28:25	23:31:41	23:30:25	23:30:24	23:30	23:30	0	120	1.3	76.6
1983	23:29:16	23:32:31	23:31:16	23:31:14	23:31	23:31	0	120	1.5	76.8
1984	23:30:06	23:33:21	23:32:06	23:32:04	23:32	23:32	0	120	1.9	77.2
1985	23:30:56	23:34:11	23:32:56	23:32:54	23:33	23:33	0	120	2.1	77.4
1986	23:31:46	23:35:02	23:33:46	23:33:44	23:34	23:34	0	120	2.4	77.7
1987	23:32:37	23:35:52	23:34:37	23:34:34	23:35	23:35	0	120	2.6	77.9
1988	23:33:27	23:36:42	23:35:27	23:35:24	23:35	23:35	0	120	3.0	78.3
1989	23:34:17	23:37:33	23:36:17	23:36:14	23:36	23:36	0	120	3.3	78.5
1990	23:35:07	23:38:23	23:37:07	23:37:04	23:37	23:37	0	120	3.5	78.8
1991	23:35:58	23:39:13	23:37:58	23:37:54	23:38	23:38	0	120	3.7	79.0
1992	23:36:48	23:40:03	23:38:48	23:38:44	23:39	23:39	0	120	4.1	79.4
1993	23:37:38	23:40:54	23:39:38	23:39:34	23:40	23:40	0	120	4.4	79.7
1994	23:38:29	23:41:44	23:40:29	23:40:24	23:40	23:41	-60	120	4.6	79.9
1995	23:39:19	23:42:34	23:41:19	23:41:14	23:41	23:41	0	120	4.8	80.1
1996	23:40:09	23:43:25	23:42:09	23:42:04	23:42	23:42	0	120	5.2	80.5
1997	23:40:59	23:44:15	23:42:59	23:42:54	23:43	23:43	0	120	5.5	80.8
1998	23:41:50	23:45:05	23:43:50	23:43:44	23:44	23:44	0	120	5.7	81.0
1999	23:42:40	23:45:55	23:44:40	23:44:34	23:45	23:45	0	120	6.0	81.3
2000	23:43:30	23:46:46	23:45:30	23:45:24	23:46	23:46	0	120	6.3	81.6

When KSK's Ayanamsa calculated using Eqn.(100) rounded up to minutes Column(5), completely matches with Column(6) values (given in Reader1 book Ref.[18]) except for the Year 1883, 1920, 1957 and 1994 which is highlighted. However, it may be noted as explained earlier, for the Year 1908 to 1912 and 1914 to 1918, the quantity shown against Column(7) as –60 Seconds is not due to rounding off process but for different reason. Please note that the difference values shown in Column(9,10) are directly calculated from the formulae of respective Ayanamsa.

The difference between KSK's Calculated Values (Column(3)) and Values Published in Eshwar Manu's book (Column(4)) varies gradually from –35.4 Seconds to 6.3 Seconds from year 1840 to 2000, converging nearly to zero at Year 1977 (Column (9)).When the difference between selected Year and 1977 goes higher, the error will start accumulating gradually with +Ve value for any year after 1977 and with –Ve value for any Year before 1977 and hence can give erroneous results accordingly.

Similarly, the difference between KSK's Calculated Values (Column(2)) and Values Published in Eshwar Manu's book (Column(4)) gradually increases from 39.9 Seconds to 81.6 Seconds between year 1840 and 2000 (will increase further beyond 2000). This difference will further reduce when we go before Year 1840 obviously reach Zero at a particular year and become –Ve thereafter accordingly can give erroneous results.

Thus Krishnamuti Ayanamsa Values published in Eashwar Manu's Book Ref.[10] agrees neither with KSK's Calculated Values Using Eqn.(100) nor Using Eqn.(58). It is obvious that the NewComb's actual Precession Rate for B1900 is 50.2564 Seconds also varies due to acceleration and whereas Eashwar Manu has considered Constant Precession rate of 50 Seconds ignoring the fraction part and change due to acceleration caused such difference.

Readers should note that the same Pattern of difference in Ayanamsa is noticed for the Rajan's Ayanamsa calculated using Eqn.(59) as explained above for Table 27 results. The difference between KSK's and Rajan's calculated Ayanamsa values (up to Seconds) is found exactly 120 Seconds or 2 minutes (Column (8)) as per adopted base difference.

It is very clear that KSK has not taken individual effort to calculate Ayanamsa value using NewComb's actual formula but simply added 2 minute for every year of what Rajan has given in his book Ref.[12]. So it is interesting to note that the values given in Reader1 by KSK fall in line with Newcomb's precession theory just because of Rajan's table work only.

Rajan in his book Ref.[12] on Page 10 below Table7 states that to calculate the Ayanamsa for the Years after 2000A.D refer to the method given in his '*Raja Jyothida Ganitham'* book. Whereas KSK has given in his Reader-1 book to use Precession Rate 50.2388475 Seconds (actually it is the Precession Rate for the Year B1821) to add each year beyond 2000 is also found wrong. Hence the basis for KP Reader-1 Ayanamsa values is Rajan's work only.

It is surprise to note that though the above book was available during KSK's period well known to him, why he failed to take the mathematics part from it to derive his own values is unknown. Also instead of taking values up to Seconds published in above book, KSK has used the values up to Minutes published in Rajan's another book Ref.[12]. This may be to minimize the labour work and might have thought up to minutes approximation is good enough for his calculations but failed to modify correctly to suit his own recommended values particularly Zero Ayanamsa Year 291AD.It seems he never disclosed to anyone how he arrived his own recommended values.

8. Summary & Conclusion

So in this book, the basics of the Precession rate and formulation of equations for calculating Ayanama with proper equations/formulae, are presented to give mathematical awareness to the astrologers. The summary of equations so far derived along with three basic model's equations having latest Reference Epoch J2000, for the calculation of Ayanamsa are given below for Reader's ready reference.

8.1 Summary of Precession Rate Equations

we can write the Precession Rate in general form as

$p_T = p_0 + m * \text{T(Seconds)}$ -----------Eqn.[s1]

Where

p_T = Precession Rate (Precession Per unit Time 'T') for required Epoch (in Seconds)
p_0 = Precession Rate (Precession Per unit Time 'T') for reference Epoch (Julian/Besselian) (in Seconds)
m = Rate of change of Precession Rate (or) Acceleration
T = Time measured from Reference to required Epoch (in Julian/Besselian Years/Centuries)
= (Required Epoch - Reference Epoch)

The parameters used for Eqn.(s1) is given in below table

Table 30: Parameters of the Precession Rate

Sr. No	p_0	m	T in	Ref. Epoch	Julian Days (JD in Days)	Date&Time (in UT)	Model	Remark
1	50.2388475	0.0002225	BY	B1821	2386166.1798163	31 Dec 1820 @16:18:56hr	Newcomb	Eqn.(i)
2	50.2453	0.0002225	BY	B1850	2396758.2035810	31 Dec 1849 @16:53:09hr	Newcomb	Eqn.(h)
3	50.2564	0.0002225	BY	B1900	2415020.3135200	31 Dec 1899 @19:31:28hr	Newcomb	Eqn.(e)
4	50.2564	0.0002220	BY	B1900	2415020.3135200	31 Dec 1899 @19:31:28hr	Newcomb	Eqn.(f)
5	50.26196	0.0002225	BY	B1925	2424151.3684895	31 Dec 1924 @20:50:37hr	Newcomb	Eqn.(26)
6	50.23992	0.0002225	JY	J1821	2386165.2500000	30 Dec 1820 @18:00:00hr	Newcomb	Eqn.(j)
7	50.25747324	0.0002225	JY	J1900	2415020.0000000	31 Dec 1899 @12:00:00hr	Newcomb	Eqn.(g)
8	50.2575	0.0002220	JY	J1900	2415020.0000000	31 Dec 1899 @12:00:00hr	Newcomb	Eqn.(g')
9	50.2686	0.000222	JY	1950	2433282.5000000	01 Jan 1950 @00:00:00hr	Newcomb	Eqn.(64)
10	50.27972324	0.0002225	JY	J2000	2451545.0000000	01 Jan 2000 @12:00:00hr	Newcomb	Eqn.(39)
11	50.2797	0.0002220	JY	J2000	2451545.0000000	01 Jan 2000 @12:00:00hr	Newcomb	Eqn.(g")
12	5029.096600	2.2222600	JC	J2000	2451545.0000000	01 Jan 2000 @12:00:00hr	IAU1976	Eqn.(12)
13	5028.796195	2.2108696	JC	J2000	2451545.0000000	01 Jan 2000 @12:00:00hr	IAU2006	Eqn.(16)

Where
JY = Julian Year
BY= Besselian Year (Tropical Year)
JC = Julian Century
BC= Besselian Century (Tropical Century)

Even though there are many reference dates used for deriving the Precession Rate of respective model to calculate Ayanamsa, only selected cases are presented in above table, some of them are found adopted in IENA, AENA(American ephemeris and Nautical Almanac, Astronomical Almanac). Also the readers should note that a set of equations (Sr.No. {4, 8, 11}) shown for Newcomb's Precession Model covering the reference Epoch B1900, J1900 and J2000 shall give same results for any selected Epoch because the basic equations used for calculating Precession Rate remains same and the different reference Epochs represents just shift in Origin of the same straight line as shown/discussed in Chapter(7.8) under Chart 12. Hence readers may take a note of three basic model's equations (Sr.No. 11, 12 & 13 - highlighted), having reference Epoch J2000 in all three, which is followed in recent precession theories.

8.2 Summary of Ayanamsa(Precession) Equations

we can write the Ayanamsa in general form as

$$P_T = A_0 + p_0 * T + q * T^2 \text{(Seconds)}$$ -----------Eqn.[s2]

Where

P_T = Ayanamsa(Precession) for required Epoch (in Seconds)

A_0 = Ayanamsa(Precession) for reference Epoch (Julian/Besselian) (in Seconds)

p_0 = Precession Rate (Precession Per unit Time 'T') for reference Epoch (Julian/Besselian) (in Seconds)

$q = \left(\frac{m}{2}\right)$ Constant (Half of [Rate of change of Precession Rate (or) Acceleration])

m = Rate of change of Precession Rate (or) Acceleration

T = Time measured from Reference to required Epoch (in Julian/Besselian Years/Centuries)
= (Required Epoch - Reference Epoch)

The parameters used for Eqn.(s2) is given in below table

Table 31: Parameters of the Precession/Ayanamsa

Sr. No	A_0	p_0	q	T in	Ref. Epoch	Julian Days (JD_0 in Days)	Date&Time (T_0 in UT)	Longitude (D_0)	Model XX_Z	Eqn. No.
1	80564.38104	50.2564	0.000111	BY	B1900	1827424.6729167	21 Mar 291 @04:09:00	♈ 00:00:00	M1_K	(57)
2	80564.39323	50.2575	0.000111	JY	J1900	1827424.6729167	21 Mar 291 @04:09:00	♈ 00:00:00	M1_K	(56)
3	85591.25323	50.2797	0.000111	JY	J2000	1827424.6729167	21 Mar 291 @04:09:00	♈ 00:00:00	M1_K	(58)
4	85610.17405	5029.096600	1.1111300	JC	J2000	1827424.6729167	21 Mar 291 @04:09:00	♈ 00:00:00	M2_K	(14)
5	85606.70378	5028.796195	1.1054348	JC	J2000	1827424.6729167	21 Mar 291 @04:09:00	♈ 00:00:00	M3_K	(18)
6	80369.09196	50.2564	0.000111	BY	B1900	1828854.0970749	17 Feb 295 @14:19:47	♒ 28:54:39	M1_G	(60)
7	80369.10398	50.2575	0.000111	JY	J1900	1828854.0970749	17 Feb 295 @14:19:47	♒ 28:54:39	M1_G	(59)
8	85395.96398	50.2797	0.000111	JY	J2000	1828854.0970749	17 Feb 295 @14:19:47	♒ 28:54:39	M1_G	(61)
9	85414.84222	5029.096600	1.1111300	JC	J2000	1828854.0970749	17 Feb 295 @14:19:47	♒ 28:54:39	M2_G	(44)
10	85411.37610	5028.796195	1.1054348	JC	J2000	1828854.0970749	17 Feb 295 @14:19:47	♒ 28:54:39	M3_G	(45)
11	80858.71016	50.2564	0.000111	BY	B1900	1825270.2753712	26 Apr 285 @18:36:32	♉ 05:50:16	M1_H	(52)
12	80858.72259	50.2575	0.000111	JY	J1900	1825270.2753712	26 Apr 285 @18:36:32	♉ 05:50:16	M1_H	(12)
13	85885.58259	50.2797	0.000111	JY	J2000	1825270.2753712	26 Apr 285 @18:36:32	♉ 05:50:16	M1_H	(55)
14	85904.56758	5029.096600	1.1111300	JC	J2000	1825270.2753712	26 Apr 285 @18:36:32	♉ 05:50:16	M2_H	(62)
15	85901.09109	5028.796195	1.1054348	JC	J2000	1825270.2753712	26 Apr 285 @18:36:32	♉ 05:50:16	M3_H	(63)
16	80857.62510	50.2564	0.000111	BY	B1900	1825278.2179861	04 May 285 @17:13:54	♉ 13:26:42	M1_I	(68)
17	80857.63750	50.2575	0.000111	JY	J1900	1825278.2179861	04 May 285 @17:13:54	♉ 13:26:42	M1_I	(67)
18	85884.49750	50.2797	0.000111	JY	J2000	1825278.2179861	04 May 285 @17:13:54	♉ 13:26:42	M1_I	(69)
19	85903.48225	5029.096600	1.1111300	JC	J2000	1825278.2179861	04 May 285 @17:13:54	♉ 13:26:42	M2_I	(70)
20	85900.00579	5028.796195	1.1054348	JC	J2000	1825278.2179861	04 May 285 @17:13:54	♉ 13:26:42	M3_I	(71)

Where

JY = Julian Year

BY= Besselian Year (Tropical Year)

JC = Julian Century

BC= Besselian Century (Tropical Century)

JD_0= Julian Days for the Zero Ayanamsa Date
T_0 = Zero Ayanamsa Date &Time in UT(dd mmm YYYY @ hh:mm:ss Hrs.)
D_0 = Sayana (Tropical) Longitude of Sun on Zero Ayanamsa Date in [Sign] Deg: Min: Sec
♈ = Aries Sign (Hindu Vedic Name-Mesha Rasi)
♒ = Aquarius Sign (Hindu Vedic Name-Kumba Rasi)
♉ = Taurus Sign (Hindu Vedic Name-Rishaba Rasi)
Legend:
XX_Z = Prefix to '_' indicates Model Name 'XX' and Suffix to '_' indicates Ayanamsa by 'Z'
XX = M1 (Newcomb's Precession Model)
= M2 (IAU1976 Precession Model)
= M3 (IAU2006 Precession Model)
Z = K (KSK's Ayanamsa [Precession])
= G (Rajan's Ayanamsa [Precession])
= H (Lahiri's Ayanamsa [Precession])
= I (IENA's Ayanamsa [Precession])
M1_K = KSK's Ayanamsa using Newcomb's Precession Model
M2_K = KSK's Ayanamsa using IAU1976 Precession Model
M3_K = KSK's Ayanamsa using IAU2006 Precession Model
M1_G = Rajan's Ayanamsa using Newcomb's Precession Model
M2_G = Rajan's Ayanamsa using IAU1976 Precession Model
M3_G = Rajan's Ayanamsa using IAU2006 Precession Model
M1_H = Lahiri's Ayanamsa using Newcomb's Precession Model
M2_H = Lahiri's Ayanamsa using IAU1976 Precession Model
M3_H = Lahiri's Ayanamsa using IAU2006 Precession Model
M1_I = IENA's Ayanamsa using Newcomb's Precession Model
M2_I = IENA's Ayanamsa using IAU1976 Precession Model
M3_I = IENA's Ayanamsa using IAU2006 Precession Model

Even though there are many reference dates used for calculating Ayanamsa (Precession) of respective model, only selected cases are presented in above table for the reasons given below.

The readers should note that a set of equations (Sr.No.{1, 2, 3},{6,7,8},{11,12,13},{16,17,18}) shown for Newcomb's Precession Model(M1) covering the reference Epoch B1900, J1900 and J2000 for respective Ayanamsa case shall give same results for any selected Epoch because the basic equations used for calculating the Ayanamsa remains same and the different reference Epochs represents just shift in Origin of the same straight line as shown, discussed in Chapter(7.8) under Chart 12. Hence the readers may take a note of various Ayanamsa equations related with three basic models (Sr.No. 3,4,5,8,9,10,13,14,15,18,19 & 20- highlighted) having reference Epoch J2000 in all, which is followed in recent precession theories.

It may also be noted that Zero Ayanamsa date calculated for Rajan's, Lahiri's and IENA's may be fictitious and the actual date for IENA's/Lahiri's Ayanamsa is based on the date and time when both the Sayana and the Nirayana longitude of the Star Citra (Spica) were the same as 180°00'03" degrees. A correction amount of 0.658 Seconds was adopted from 1985 (as mentioned on Page(5) of Lahiri's Indian ephemeris 2004). Since the calculated Zero Ayanamsa date has shifted from the previously considered values, approximately 1 Second difference is noticed between the IENA's and Lahiri's Ayanamsa Values. However, the values published before 1985 in Lahiri's Indian Ephemeris are exactly same as the values adopted in IENA, because both followed the same Precession Theory and Zero Ayanamsa date as base.

8.3 True Ayanamsa Calculation

Readers should note that all the Ayanamsa Equations shown above, in various chapters of this book including Eqn.(s2), Chapter(8.1) ‘Summary of Ayanamsa Equations’ are for the calculation of Mean Ayanamsa only. To get the True Ayanamsa, correction for Nutation in longitude ($\Delta\psi$) shall be added with Mean Ayanamsa. Even though there are many reference dates used for calculating the Nutation in longitude of respective Nutation model, only selected case is recommended for the reasons given below.

We have seen in chapter(7.6.4) that Nutation in longitude calculated using various Nutation Models with different Reference Epoch, yields almost same values with insignificant difference that can be neglected. Hence readers are recommended to use the latest Nutation Model IAU2000A with reference Epoch J2000 (For Fundamental Arguments- Refer Table 2 Highlighted items, ignoring 4th Order Term, with First 10 (Ten) Terms contributing for Nutation in Longitude ($\Delta\psi$)- Refer Table 18, Highlighted items in Column(D)) compatible with above recommended Ayanamsa (Precession) Equations so that time ‘T’ calculated for selected Epoch can be commonly used for both Mean Ayanamsa and Nutation in longitude ($\Delta\psi$) calculations.

For readers convenience, Eqn.(72) of respective Fundamental Arguments of IAU2000A Nutation Model (given in Table 2) is substituted in each term’s angle formula given in Table 18, We get Angle (ϕ_i or θ_i) for any Julian century ‘T’ in a polynomial equation form, similar to Eqn.(72), having terms up to 4th order of ‘T’ and with reference Epoch as given below.

$f_5(T) = D_0 + D_1 * T + D_2 * T^2 + D_3 * T^3 + D_4 * T^4$ Julian century ‘T’& Ref. J2000 ----------Eqn.[s3]

Table 32: Coefficients (D_i) Values for IAU2000A Nutation Model

Term	Angle		Coefficients D_i (in Seconds)				
i	ϕ_i	θ_i	D_0	D_1	D_2	D_3	D_4
1	☊	☊	450160.398036	-6962890.5431	7.4722	0.007702	-0.00005939
2	2(F- D + ☊)	2L	723358.441156	259205542.1914	2.1832	0.000144	-0.00004706
3	2(F + ☊)	2☽	275879.848536	3465128744.6094	-10.5580	0.013330	-0.00011044
4	2☊	2☊	900320.796072	-13925781.0862	14.9444	0.015404	-0.00011878
5	*l'*	L - π'	1287104.793050	129596581.0481	-0.5532	0.000136	-0.00001149
6	*l*	☽ - π	485868.249036	1717915923.2178	31.8792	0.051635	-0.00024470
7	*l'*+2(F- D + ☊)	3L - π'	714463.234206	388802123.2395	1.6300	0.000280	-0.00005855
8	2F + ☊	2☽ - ☊	1121719.450500	3472091635.1525	-18.0302	0.005628	-0.00005105
9	*l*+2(F + ☊)	3☽ - π	761748.097572	5183044667.8272	21.3212	0.064965	-0.00035514
10	-*l'*+2(F- D + ☊)	L + π'	732253.648106	129608961.1433	2.7364	0.000008	-0.00003557
11	2D - *l*	☽ + π - 2L	362653.158344	1488007279.2002	-44.6204	-0.038449	0.00018132
12	2(F- D) + ☊	2L - ☊	273198.043120	266168432.7345	-5.2890	-0.007558	0.00001233
13	-*l*+2(F + ☊)	☽ + π	1086011.599500	1747212821.3916	-42.4372	-0.038305	0.00013426

Note:

1. All the above equation gives Angle for respective Terms in Seconds.
2. For Example, Angle for Term1 (ϕ_1 or θ_1) from J2000 (IAU 2000A Nutation Model) is given by

$$\phi_1 = 450160.398036 - 6962890.5431 * T + 7.4722 * T^2 + 0.007702 * T^3 - 0.00005939 * T^4$$

Table 33: IAU2000A Model-Each Term's Nutation in Longitude(Δψ)(in Sec) for ϕ or θ (in Deg)

ϕ or θ	1	2	3	4	5	6	7	8	9	10	11	12	13
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	-0.3003	-0.0230	-0.0040	0.0036	0.0026	0.0012	-0.0009	-0.0007	-0.0005	0.0004	0.0003	0.0002	0.0002
2	-0.6005	-0.0460	-0.0079	0.0072	0.0052	0.0025	-0.0018	-0.0014	-0.0011	0.0008	0.0005	0.0004	0.0004
3	-0.9005	-0.0689	-0.0119	0.0109	0.0077	0.0037	-0.0027	-0.0020	-0.0016	0.0011	0.0008	0.0007	0.0006
4	-1.2003	-0.0919	-0.0159	0.0145	0.0103	0.0050	-0.0036	-0.0027	-0.0021	0.0015	0.0011	0.0009	0.0009
5	-1.4996	-0.1148	-0.0198	0.0181	0.0129	0.0062	-0.0045	-0.0034	-0.0026	0.0019	0.0014	0.0011	0.0011
6	-1.7986	-0.1377	-0.0238	0.0217	0.0154	0.0074	-0.0054	-0.0040	-0.0032	0.0023	0.0016	0.0013	0.0013
7	-2.0969	-0.1605	-0.0277	0.0253	0.0180	0.0087	-0.0063	-0.0047	-0.0037	0.0026	0.0019	0.0016	0.0015
8	-2.3947	-0.1833	-0.0317	0.0289	0.0205	0.0099	-0.0072	-0.0054	-0.0042	0.0030	0.0022	0.0018	0.0017
9	-2.6917	-0.2060	-0.0356	0.0325	0.0231	0.0111	-0.0081	-0.0061	-0.0047	0.0034	0.0025	0.0020	0.0019
10	-2.9879	-0.2287	-0.0395	0.0360	0.0256	0.0123	-0.0090	-0.0067	-0.0052	0.0037	0.0027	0.0022	0.0021
11	-3.2831	-0.2513	-0.0434	0.0396	0.0282	0.0136	-0.0099	-0.0074	-0.0058	0.0041	0.0030	0.0024	0.0024
12	-3.5774	-0.2738	-0.0473	0.0431	0.0307	0.0148	-0.0107	-0.0081	-0.0063	0.0045	0.0033	0.0027	0.0026
13	-3.8706	-0.2963	-0.0512	0.0467	0.0332	0.0160	-0.0116	-0.0087	-0.0068	0.0049	0.0035	0.0029	0.0028
14	-4.1626	-0.3186	-0.0551	0.0502	0.0357	0.0172	-0.0125	-0.0094	-0.0073	0.0052	0.0038	0.0031	0.0030
15	-4.4533	-0.3409	-0.0589	0.0537	0.0382	0.0184	-0.0134	-0.0100	-0.0078	0.0056	0.0041	0.0033	0.0032
16	-4.7427	-0.3630	-0.0627	0.0572	0.0407	0.0196	-0.0142	-0.0107	-0.0083	0.0059	0.0043	0.0035	0.0034
17	-5.0307	-0.3851	-0.0666	0.0607	0.0432	0.0208	-0.0151	-0.0113	-0.0088	0.0063	0.0046	0.0037	0.0036
18	-5.3171	-0.4070	-0.0703	0.0641	0.0456	0.0220	-0.0160	-0.0120	-0.0093	0.0067	0.0049	0.0040	0.0038
19	-5.6019	-0.4288	-0.0741	0.0675	0.0480	0.0232	-0.0168	-0.0126	-0.0098	0.0070	0.0051	0.0042	0.0040
20	-5.8849	-0.4505	-0.0779	0.0710	0.0505	0.0243	-0.0177	-0.0132	-0.0103	0.0074	0.0054	0.0044	0.0042
21	-6.1662	-0.4720	-0.0816	0.0743	0.0529	0.0255	-0.0185	-0.0139	-0.0108	0.0077	0.0056	0.0046	0.0044
22	-6.4456	-0.4934	-0.0853	0.0777	0.0553	0.0266	-0.0194	-0.0145	-0.0113	0.0081	0.0059	0.0048	0.0046
23	-6.7231	-0.5146	-0.0889	0.0811	0.0577	0.0278	-0.0202	-0.0151	-0.0118	0.0084	0.0061	0.0050	0.0048
24	-6.9985	-0.5357	-0.0926	0.0844	0.0600	0.0289	-0.0210	-0.0158	-0.0123	0.0088	0.0064	0.0052	0.0050
25	-7.2717	-0.5566	-0.0962	0.0877	0.0624	0.0301	-0.0218	-0.0164	-0.0127	0.0091	0.0066	0.0054	0.0052
26	-7.5428	-0.5774	-0.0998	0.0909	0.0647	0.0312	-0.0227	-0.0170	-0.0132	0.0095	0.0069	0.0056	0.0054
27	-7.8115	-0.5979	-0.1033	0.0942	0.0670	0.0323	-0.0235	-0.0176	-0.0137	0.0098	0.0071	0.0058	0.0056
28	-8.0779	-0.6183	-0.1069	0.0974	0.0693	0.0334	-0.0243	-0.0182	-0.0142	0.0101	0.0074	0.0060	0.0058
29	-8.3418	-0.6385	-0.1104	0.1006	0.0716	0.0345	-0.0251	-0.0188	-0.0146	0.0105	0.0076	0.0062	0.0060
30	-8.6032	-0.6585	-0.1138	0.1037	0.0738	0.0356	-0.0258	-0.0194	-0.0151	0.0108	0.0078	0.0064	0.0062
31	-8.8620	-0.6784	-0.1172	0.1068	0.0760	0.0366	-0.0266	-0.0199	-0.0155	0.0111	0.0081	0.0066	0.0064
32	-9.1180	-0.6980	-0.1206	0.1099	0.0782	0.0377	-0.0274	-0.0205	-0.0160	0.0114	0.0083	0.0068	0.0065
33	-9.3713	-0.7173	-0.1240	0.1130	0.0804	0.0387	-0.0281	-0.0211	-0.0164	0.0118	0.0086	0.0070	0.0067
34	-9.6217	-0.7365	-0.1273	0.1160	0.0825	0.0398	-0.0289	-0.0217	-0.0169	0.0121	0.0088	0.0072	0.0069
35	-9.8692	-0.7555	-0.1306	0.1190	0.0847	0.0408	-0.0296	-0.0222	-0.0173	0.0124	0.0090	0.0074	0.0071
36	-10.1137	-0.7742	-0.1338	0.1219	0.0867	0.0418	-0.0304	-0.0228	-0.0177	0.0127	0.0092	0.0075	0.0073
37	-10.3551	-0.7926	-0.1370	0.1248	0.0888	0.0428	-0.0311	-0.0233	-0.0181	0.0130	0.0094	0.0077	0.0074
38	-10.5933	-0.8109	-0.1401	0.1277	0.0909	0.0438	-0.0318	-0.0238	-0.0186	0.0133	0.0097	0.0079	0.0076
39	-10.8283	-0.8289	-0.1433	0.1306	0.0929	0.0448	-0.0325	-0.0244	-0.0190	0.0136	0.0099	0.0081	0.0078
40	-11.0601	-0.8466	-0.1463	0.1333	0.0949	0.0457	-0.0332	-0.0249	-0.0194	0.0139	0.0101	0.0082	0.0079
41	-11.2884	-0.8641	-0.1493	0.1361	0.0968	0.0467	-0.0339	-0.0254	-0.0198	0.0142	0.0103	0.0084	0.0081
42	-11.5133	-0.8813	-0.1523	0.1388	0.0988	0.0476	-0.0346	-0.0259	-0.0202	0.0144	0.0105	0.0086	0.0083
43	-11.7347	-0.8983	-0.1553	0.1415	0.1007	0.0485	-0.0352	-0.0264	-0.0206	0.0147	0.0107	0.0087	0.0084
44	-11.9526	-0.9149	-0.1581	0.1441	0.1025	0.0494	-0.0359	-0.0269	-0.0209	0.0150	0.0109	0.0089	0.0086

ϕ or θ	1	2	3	4	5	6	7	8	9	10	11	12	13
45	-12.1668	-0.9313	-0.1610	0.1467	0.1044	0.0503	-0.0365	-0.0274	-0.0213	0.0153	0.0111	0.0091	0.0087
46	-12.3773	-0.9474	-0.1638	0.1492	0.1062	0.0512	-0.0372	-0.0279	-0.0217	0.0155	0.0113	0.0092	0.0089
47	-12.5840	-0.9633	-0.1665	0.1517	0.1079	0.0520	-0.0378	-0.0283	-0.0220	0.0158	0.0115	0.0094	0.0090
48	-12.7869	-0.9788	-0.1692	0.1542	0.1097	0.0528	-0.0384	-0.0288	-0.0224	0.0160	0.0117	0.0095	0.0092
49	-12.9858	-0.9940	-0.1718	0.1566	0.1114	0.0537	-0.0390	-0.0292	-0.0228	0.0163	0.0118	0.0097	0.0093
50	-13.1809	-1.0089	-0.1744	0.1589	0.1131	0.0545	-0.0396	-0.0297	-0.0231	0.0165	0.0120	0.0098	0.0095
51	-13.3719	-1.0236	-0.1769	0.1612	0.1147	0.0553	-0.0402	-0.0301	-0.0234	0.0168	0.0122	0.0100	0.0096
52	-13.5588	-1.0379	-0.1794	0.1635	0.1163	0.0560	-0.0407	-0.0305	-0.0238	0.0170	0.0124	0.0101	0.0097
53	-13.7417	-1.0519	-0.1818	0.1657	0.1179	0.0568	-0.0413	-0.0309	-0.0241	0.0172	0.0125	0.0102	0.0099
54	-13.9203	-1.0655	-0.1842	0.1678	0.1194	0.0575	-0.0418	-0.0313	-0.0244	0.0175	0.0127	0.0104	0.0100
55	-14.0947	-1.0789	-0.1865	0.1699	0.1209	0.0583	-0.0423	-0.0317	-0.0247	0.0177	0.0129	0.0105	0.0101
56	-14.2648	-1.0919	-0.1887	0.1720	0.1224	0.0590	-0.0428	-0.0321	-0.0250	0.0179	0.0130	0.0106	0.0102
57	-14.4305	-1.1046	-0.1909	0.1740	0.1238	0.0596	-0.0433	-0.0325	-0.0253	0.0181	0.0132	0.0108	0.0104
58	-14.5919	-1.1170	-0.1931	0.1759	0.1252	0.0603	-0.0438	-0.0328	-0.0256	0.0183	0.0133	0.0109	0.0105
59	-14.7488	-1.1290	-0.1951	0.1778	0.1265	0.0610	-0.0443	-0.0332	-0.0258	0.0185	0.0135	0.0110	0.0106
60	-14.9012	-1.1406	-0.1971	0.1797	0.1278	0.0616	-0.0448	-0.0335	-0.0261	0.0187	0.0136	0.0111	0.0107
61	-15.0491	-1.1520	-0.1991	0.1814	0.1291	0.0622	-0.0452	-0.0339	-0.0264	0.0189	0.0137	0.0112	0.0108
62	-15.1924	-1.1629	-0.2010	0.1832	0.1303	0.0628	-0.0456	-0.0342	-0.0266	0.0191	0.0139	0.0113	0.0109
63	-15.3310	-1.1735	-0.2028	0.1848	0.1315	0.0634	-0.0460	-0.0345	-0.0269	0.0192	0.0140	0.0114	0.0110
64	-15.4650	-1.1838	-0.2046	0.1865	0.1327	0.0639	-0.0465	-0.0348	-0.0271	0.0194	0.0141	0.0115	0.0111
65	-15.5943	-1.1937	-0.2063	0.1880	0.1338	0.0645	-0.0468	-0.0351	-0.0273	0.0196	0.0142	0.0116	0.0112
66	-15.7188	-1.2032	-0.2080	0.1895	0.1348	0.0650	-0.0472	-0.0354	-0.0275	0.0197	0.0143	0.0117	0.0113
67	-15.8386	-1.2124	-0.2095	0.1910	0.1359	0.0655	-0.0476	-0.0357	-0.0277	0.0199	0.0145	0.0118	0.0114
68	-15.9535	-1.2212	-0.2111	0.1923	0.1368	0.0659	-0.0479	-0.0359	-0.0280	0.0200	0.0146	0.0119	0.0114
69	-16.0636	-1.2296	-0.2125	0.1937	0.1378	0.0664	-0.0482	-0.0362	-0.0281	0.0201	0.0147	0.0120	0.0115
70	-16.1687	-1.2377	-0.2139	0.1949	0.1387	0.0668	-0.0486	-0.0364	-0.0283	0.0203	0.0148	0.0120	0.0116
71	-16.2690	-1.2453	-0.2152	0.1962	0.1395	0.0672	-0.0489	-0.0366	-0.0285	0.0204	0.0148	0.0121	0.0117
72	-16.3643	-1.2526	-0.2165	0.1973	0.1404	0.0676	-0.0492	-0.0368	-0.0287	0.0205	0.0149	0.0122	0.0117
73	-16.4546	-1.2595	-0.2177	0.1984	0.1411	0.0680	-0.0494	-0.0370	-0.0288	0.0206	0.0150	0.0123	0.0118
74	-16.5399	-1.2661	-0.2188	0.1994	0.1419	0.0684	-0.0497	-0.0372	-0.0290	0.0207	0.0151	0.0123	0.0119
75	-16.6201	-1.2722	-0.2199	0.2004	0.1426	0.0687	-0.0499	-0.0374	-0.0291	0.0208	0.0152	0.0124	0.0119
76	-16.6953	-1.2780	-0.2209	0.2013	0.1432	0.0690	-0.0501	-0.0376	-0.0293	0.0209	0.0152	0.0124	0.0120
77	-16.7654	-1.2833	-0.2218	0.2021	0.1438	0.0693	-0.0504	-0.0377	-0.0294	0.0210	0.0153	0.0125	0.0120
78	-16.8304	-1.2883	-0.2227	0.2029	0.1444	0.0696	-0.0506	-0.0379	-0.0295	0.0211	0.0154	0.0125	0.0121
79	-16.8903	-1.2929	-0.2235	0.2036	0.1449	0.0698	-0.0507	-0.0380	-0.0296	0.0212	0.0154	0.0126	0.0121
80	-16.9450	-1.2971	-0.2242	0.2043	0.1453	0.0700	-0.0509	-0.0381	-0.0297	0.0213	0.0155	0.0126	0.0122
81	-16.9946	-1.3009	-0.2248	0.2049	0.1458	0.0702	-0.0510	-0.0383	-0.0298	0.0213	0.0155	0.0127	0.0122
82	-17.0390	-1.3043	-0.2254	0.2054	0.1462	0.0704	-0.0512	-0.0384	-0.0299	0.0214	0.0155	0.0127	0.0122
83	-17.0782	-1.3073	-0.2259	0.2059	0.1465	0.0706	-0.0513	-0.0384	-0.0299	0.0214	0.0156	0.0127	0.0123
84	-17.1122	-1.3099	-0.2264	0.2063	0.1468	0.0707	-0.0514	-0.0385	-0.0300	0.0215	0.0156	0.0128	0.0123
85	-17.1409	-1.3121	-0.2268	0.2067	0.1470	0.0708	-0.0515	-0.0386	-0.0300	0.0215	0.0156	0.0128	0.0123
86	-17.1645	-1.3139	-0.2271	0.2070	0.1472	0.0709	-0.0516	-0.0386	-0.0301	0.0215	0.0157	0.0128	0.0123
87	-17.1828	-1.3153	-0.2273	0.2072	0.1474	0.0710	-0.0516	-0.0387	-0.0301	0.0216	0.0157	0.0128	0.0123
88	-17.1959	-1.3163	-0.2275	0.2073	0.1475	0.0711	-0.0517	-0.0387	-0.0301	0.0216	0.0157	0.0128	0.0123
89	-17.2038	-1.3169	-0.2276	0.2074	0.1476	0.0711	-0.0517	-0.0387	-0.0301	0.0216	0.0157	0.0128	0.0123
90	-17.2064	-1.3171	-0.2276	0.2075	0.1476	0.0711	-0.0517	-0.0387	-0.0301	0.0216	0.0157	0.0128	0.0123

ϕ or θ	1	2	3	4	5	6	7	8	9	10	11	12	13
91	-17.2038	-1.3169	-0.2276	0.2074	0.1476	0.0711	-0.0517	-0.0387	-0.0301	0.0216	0.0157	0.0128	0.0123
92	-17.1959	-1.3163	-0.2275	0.2073	0.1475	0.0711	-0.0517	-0.0387	-0.0301	0.0216	0.0157	0.0128	0.0123
93	-17.1828	-1.3153	-0.2273	0.2072	0.1474	0.0710	-0.0516	-0.0387	-0.0301	0.0216	0.0157	0.0128	0.0123
94	-17.1645	-1.3139	-0.2271	0.2070	0.1472	0.0709	-0.0516	-0.0386	-0.0301	0.0215	0.0157	0.0128	0.0123
95	-17.1409	-1.3121	-0.2268	0.2067	0.1470	0.0708	-0.0515	-0.0386	-0.0300	0.0215	0.0156	0.0128	0.0123
96	-17.1122	-1.3099	-0.2264	0.2063	0.1468	0.0707	-0.0514	-0.0385	-0.0300	0.0215	0.0156	0.0128	0.0123
97	-17.0782	-1.3073	-0.2259	0.2059	0.1465	0.0706	-0.0513	-0.0384	-0.0299	0.0214	0.0156	0.0127	0.0123
98	-17.0390	-1.3043	-0.2254	0.2054	0.1462	0.0704	-0.0512	-0.0384	-0.0299	0.0214	0.0155	0.0127	0.0122
99	-16.9946	-1.3009	-0.2248	0.2049	0.1458	0.0702	-0.0510	-0.0383	-0.0298	0.0213	0.0155	0.0127	0.0122
100	-16.9450	-1.2971	-0.2242	0.2043	0.1453	0.0700	-0.0509	-0.0381	-0.0297	0.0213	0.0155	0.0126	0.0122
101	-16.8903	-1.2929	-0.2235	0.2036	0.1449	0.0698	-0.0507	-0.0380	-0.0296	0.0212	0.0154	0.0126	0.0121
102	-16.8304	-1.2883	-0.2227	0.2029	0.1444	0.0696	-0.0506	-0.0379	-0.0295	0.0211	0.0154	0.0125	0.0121
103	-16.7654	-1.2833	-0.2218	0.2021	0.1438	0.0693	-0.0504	-0.0377	-0.0294	0.0210	0.0153	0.0125	0.0120
104	-16.6953	-1.2780	-0.2209	0.2013	0.1432	0.0690	-0.0501	-0.0376	-0.0293	0.0209	0.0152	0.0124	0.0120
105	-16.6201	-1.2722	-0.2199	0.2004	0.1426	0.0687	-0.0499	-0.0374	-0.0291	0.0208	0.0152	0.0124	0.0119
106	-16.5399	-1.2661	-0.2188	0.1994	0.1419	0.0684	-0.0497	-0.0372	-0.0290	0.0207	0.0151	0.0123	0.0119
107	-16.4546	-1.2595	-0.2177	0.1984	0.1411	0.0680	-0.0494	-0.0370	-0.0288	0.0206	0.0150	0.0123	0.0118
108	-16.3643	-1.2526	-0.2165	0.1973	0.1404	0.0676	-0.0492	-0.0368	-0.0287	0.0205	0.0149	0.0122	0.0117
109	-16.2690	-1.2453	-0.2152	0.1962	0.1395	0.0672	-0.0489	-0.0366	-0.0285	0.0204	0.0148	0.0121	0.0117
110	-16.1687	-1.2377	-0.2139	0.1949	0.1387	0.0668	-0.0486	-0.0364	-0.0283	0.0203	0.0148	0.0120	0.0116
111	-16.0636	-1.2296	-0.2125	0.1937	0.1378	0.0664	-0.0482	-0.0362	-0.0281	0.0201	0.0147	0.0120	0.0115
112	-15.9535	-1.2212	-0.2111	0.1923	0.1368	0.0659	-0.0479	-0.0359	-0.0280	0.0200	0.0146	0.0119	0.0114
113	-15.8386	-1.2124	-0.2095	0.1910	0.1359	0.0655	-0.0476	-0.0357	-0.0277	0.0199	0.0145	0.0118	0.0114
114	-15.7188	-1.2032	-0.2080	0.1895	0.1348	0.0650	-0.0472	-0.0354	-0.0275	0.0197	0.0143	0.0117	0.0113
115	-15.5943	-1.1937	-0.2063	0.1880	0.1338	0.0645	-0.0468	-0.0351	-0.0273	0.0196	0.0142	0.0116	0.0112
116	-15.4650	-1.1838	-0.2046	0.1865	0.1327	0.0639	-0.0465	-0.0348	-0.0271	0.0194	0.0141	0.0115	0.0111
117	-15.3310	-1.1735	-0.2028	0.1848	0.1315	0.0634	-0.0460	-0.0345	-0.0269	0.0192	0.0140	0.0114	0.0110
118	-15.1924	-1.1629	-0.2010	0.1832	0.1303	0.0628	-0.0456	-0.0342	-0.0266	0.0191	0.0139	0.0113	0.0109
119	-15.0491	-1.1520	-0.1991	0.1814	0.1291	0.0622	-0.0452	-0.0339	-0.0264	0.0189	0.0137	0.0112	0.0108
120	-14.9012	-1.1406	-0.1971	0.1797	0.1278	0.0616	-0.0448	-0.0335	-0.0261	0.0187	0.0136	0.0111	0.0107
121	-14.7488	-1.1290	-0.1951	0.1778	0.1265	0.0610	-0.0443	-0.0332	-0.0258	0.0185	0.0135	0.0110	0.0106
122	-14.5919	-1.1170	-0.1931	0.1759	0.1252	0.0603	-0.0438	-0.0328	-0.0256	0.0183	0.0133	0.0109	0.0105
123	-14.4305	-1.1046	-0.1909	0.1740	0.1238	0.0596	-0.0433	-0.0325	-0.0253	0.0181	0.0132	0.0108	0.0104
124	-14.2648	-1.0919	-0.1887	0.1720	0.1224	0.0590	-0.0428	-0.0321	-0.0250	0.0179	0.0130	0.0106	0.0102
125	-14.0947	-1.0789	-0.1865	0.1699	0.1209	0.0583	-0.0423	-0.0317	-0.0247	0.0177	0.0129	0.0105	0.0101
126	-13.9203	-1.0655	-0.1842	0.1678	0.1194	0.0575	-0.0418	-0.0313	-0.0244	0.0175	0.0127	0.0104	0.0100
127	-13.7417	-1.0519	-0.1818	0.1657	0.1179	0.0568	-0.0413	-0.0309	-0.0241	0.0172	0.0125	0.0102	0.0099
128	-13.5588	-1.0379	-0.1794	0.1635	0.1163	0.0560	-0.0407	-0.0305	-0.0238	0.0170	0.0124	0.0101	0.0097
129	-13.3719	-1.0236	-0.1769	0.1612	0.1147	0.0553	-0.0402	-0.0301	-0.0234	0.0168	0.0122	0.0100	0.0096
130	-13.1809	-1.0089	-0.1744	0.1589	0.1131	0.0545	-0.0396	-0.0297	-0.0231	0.0165	0.0120	0.0098	0.0095
131	-12.9858	-0.9940	-0.1718	0.1566	0.1114	0.0537	-0.0390	-0.0292	-0.0228	0.0163	0.0118	0.0097	0.0093
132	-12.7869	-0.9788	-0.1692	0.1542	0.1097	0.0528	-0.0384	-0.0288	-0.0224	0.0160	0.0117	0.0095	0.0092
133	-12.5840	-0.9633	-0.1665	0.1517	0.1079	0.0520	-0.0378	-0.0283	-0.0220	0.0158	0.0115	0.0094	0.0090
134	-12.3773	-0.9474	-0.1638	0.1492	0.1062	0.0512	-0.0372	-0.0279	-0.0217	0.0155	0.0113	0.0092	0.0089
135	-12.1668	-0.9313	-0.1610	0.1467	0.1044	0.0503	-0.0365	-0.0274	-0.0213	0.0153	0.0111	0.0091	0.0087
136	-11.9526	-0.9149	-0.1581	0.1441	0.1025	0.0494	-0.0359	-0.0269	-0.0209	0.0150	0.0109	0.0089	0.0086

ϕ or θ	1	2	3	4	5	6	7	8	9	10	11	12	13
137	-11.7347	-0.8983	-0.1553	0.1415	0.1007	0.0485	-0.0352	-0.0264	-0.0206	0.0147	0.0107	0.0087	0.0084
138	-11.5133	-0.8813	-0.1523	0.1388	0.0988	0.0476	-0.0346	-0.0259	-0.0202	0.0144	0.0105	0.0086	0.0083
139	-11.2884	-0.8641	-0.1493	0.1361	0.0968	0.0467	-0.0339	-0.0254	-0.0198	0.0142	0.0103	0.0084	0.0081
140	-11.0601	-0.8466	-0.1463	0.1333	0.0949	0.0457	-0.0332	-0.0249	-0.0194	0.0139	0.0101	0.0082	0.0079
141	-10.8283	-0.8289	-0.1433	0.1306	0.0929	0.0448	-0.0325	-0.0244	-0.0190	0.0136	0.0099	0.0081	0.0078
142	-10.5933	-0.8109	-0.1401	0.1277	0.0909	0.0438	-0.0318	-0.0238	-0.0186	0.0133	0.0097	0.0079	0.0076
143	-10.3551	-0.7926	-0.1370	0.1248	0.0888	0.0428	-0.0311	-0.0233	-0.0181	0.0130	0.0094	0.0077	0.0074
144	-10.1137	-0.7742	-0.1338	0.1219	0.0867	0.0418	-0.0304	-0.0228	-0.0177	0.0127	0.0092	0.0075	0.0073
145	-9.8692	-0.7555	-0.1306	0.1190	0.0847	0.0408	-0.0296	-0.0222	-0.0173	0.0124	0.0090	0.0074	0.0071
146	-9.6217	-0.7365	-0.1273	0.1160	0.0825	0.0398	-0.0289	-0.0217	-0.0169	0.0121	0.0088	0.0072	0.0069
147	-9.3713	-0.7173	-0.1240	0.1130	0.0804	0.0387	-0.0281	-0.0211	-0.0164	0.0118	0.0086	0.0070	0.0067
148	-9.1180	-0.6980	-0.1206	0.1099	0.0782	0.0377	-0.0274	-0.0205	-0.0160	0.0114	0.0083	0.0068	0.0065
149	-8.8620	-0.6784	-0.1172	0.1068	0.0760	0.0366	-0.0266	-0.0199	-0.0155	0.0111	0.0081	0.0066	0.0064
150	-8.6032	-0.6585	-0.1138	0.1037	0.0738	0.0356	-0.0258	-0.0194	-0.0151	0.0108	0.0078	0.0064	0.0062
151	-8.3418	-0.6385	-0.1104	0.1006	0.0716	0.0345	-0.0251	-0.0188	-0.0146	0.0105	0.0076	0.0062	0.0060
152	-8.0779	-0.6183	-0.1069	0.0974	0.0693	0.0334	-0.0243	-0.0182	-0.0142	0.0101	0.0074	0.0060	0.0058
153	-7.8115	-0.5979	-0.1033	0.0942	0.0670	0.0323	-0.0235	-0.0176	-0.0137	0.0098	0.0071	0.0058	0.0056
154	-7.5428	-0.5774	-0.0998	0.0909	0.0647	0.0312	-0.0227	-0.0170	-0.0132	0.0095	0.0069	0.0056	0.0054
155	-7.2717	-0.5566	-0.0962	0.0877	0.0624	0.0301	-0.0218	-0.0164	-0.0127	0.0091	0.0066	0.0054	0.0052
156	-6.9985	-0.5357	-0.0926	0.0844	0.0600	0.0289	-0.0210	-0.0158	-0.0123	0.0088	0.0064	0.0052	0.0050
157	-6.7231	-0.5146	-0.0889	0.0811	0.0577	0.0278	-0.0202	-0.0151	-0.0118	0.0084	0.0061	0.0050	0.0048
158	-6.4456	-0.4934	-0.0853	0.0777	0.0553	0.0266	-0.0194	-0.0145	-0.0113	0.0081	0.0059	0.0048	0.0046
159	-6.1662	-0.4720	-0.0816	0.0743	0.0529	0.0255	-0.0185	-0.0139	-0.0108	0.0077	0.0056	0.0046	0.0044
160	-5.8849	-0.4505	-0.0779	0.0710	0.0505	0.0243	-0.0177	-0.0132	-0.0103	0.0074	0.0054	0.0044	0.0042
161	-5.6019	-0.4288	-0.0741	0.0675	0.0480	0.0232	-0.0168	-0.0126	-0.0098	0.0070	0.0051	0.0042	0.0040
162	-5.3171	-0.4070	-0.0703	0.0641	0.0456	0.0220	-0.0160	-0.0120	-0.0093	0.0067	0.0049	0.0040	0.0038
163	-5.0307	-0.3851	-0.0666	0.0607	0.0432	0.0208	-0.0151	-0.0113	-0.0088	0.0063	0.0046	0.0037	0.0036
164	-4.7427	-0.3630	-0.0627	0.0572	0.0407	0.0196	-0.0142	-0.0107	-0.0083	0.0059	0.0043	0.0035	0.0034
165	-4.4533	-0.3409	-0.0589	0.0537	0.0382	0.0184	-0.0134	-0.0100	-0.0078	0.0056	0.0041	0.0033	0.0032
166	-4.1626	-0.3186	-0.0551	0.0502	0.0357	0.0172	-0.0125	-0.0094	-0.0073	0.0052	0.0038	0.0031	0.0030
167	-3.8706	-0.2963	-0.0512	0.0467	0.0332	0.0160	-0.0116	-0.0087	-0.0068	0.0049	0.0035	0.0029	0.0028
168	-3.5774	-0.2738	-0.0473	0.0431	0.0307	0.0148	-0.0107	-0.0081	-0.0063	0.0045	0.0033	0.0027	0.0026
169	-3.2831	-0.2513	-0.0434	0.0396	0.0282	0.0136	-0.0099	-0.0074	-0.0058	0.0041	0.0030	0.0024	0.0024
170	-2.9879	-0.2287	-0.0395	0.0360	0.0256	0.0123	-0.0090	-0.0067	-0.0052	0.0037	0.0027	0.0022	0.0021
171	-2.6917	-0.2060	-0.0356	0.0325	0.0231	0.0111	-0.0081	-0.0061	-0.0047	0.0034	0.0025	0.0020	0.0019
172	-2.3947	-0.1833	-0.0317	0.0289	0.0205	0.0099	-0.0072	-0.0054	-0.0042	0.0030	0.0022	0.0018	0.0017
173	-2.0969	-0.1605	-0.0277	0.0253	0.0180	0.0087	-0.0063	-0.0047	-0.0037	0.0026	0.0019	0.0016	0.0015
174	-1.7986	-0.1377	-0.0238	0.0217	0.0154	0.0074	-0.0054	-0.0040	-0.0032	0.0023	0.0016	0.0013	0.0013
175	-1.4996	-0.1148	-0.0198	0.0181	0.0129	0.0062	-0.0045	-0.0034	-0.0026	0.0019	0.0014	0.0011	0.0011
176	-1.2003	-0.0919	-0.0159	0.0145	0.0103	0.0050	-0.0036	-0.0027	-0.0021	0.0015	0.0011	0.0009	0.0009
177	-0.9005	-0.0689	-0.0119	0.0109	0.0077	0.0037	-0.0027	-0.0020	-0.0016	0.0011	0.0008	0.0007	0.0006
178	-0.6005	-0.0460	-0.0079	0.0072	0.0052	0.0025	-0.0018	-0.0014	-0.0011	0.0008	0.0005	0.0004	0.0004
179	-0.3003	-0.0230	-0.0040	0.0036	0.0026	0.0012	-0.0009	-0.0007	-0.0005	0.0004	0.0003	0.0002	0.0002
180	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
181	0.3003	0.0230	0.0040	-0.0036	-0.0026	-0.0012	0.0009	0.0007	0.0005	-0.0004	-0.0003	-0.0002	-0.0002
182	0.6005	0.0460	0.0079	-0.0072	-0.0052	-0.0025	0.0018	0.0014	0.0011	-0.0008	-0.0005	-0.0004	-0.0004

ϕ or θ	1	2	3	4	5	6	7	8	9	10	11	12	13
183	0.9005	0.0689	0.0119	-0.0109	-0.0077	-0.0037	0.0027	0.0020	0.0016	-0.0011	-0.0008	-0.0007	-0.0006
184	1.2003	0.0919	0.0159	-0.0145	-0.0103	-0.0050	0.0036	0.0027	0.0021	-0.0015	-0.0011	-0.0009	-0.0009
185	1.4996	0.1148	0.0198	-0.0181	-0.0129	-0.0062	0.0045	0.0034	0.0026	-0.0019	-0.0014	-0.0011	-0.0011
186	1.7986	0.1377	0.0238	-0.0217	-0.0154	-0.0074	0.0054	0.0040	0.0032	-0.0023	-0.0016	-0.0013	-0.0013
187	2.0969	0.1605	0.0277	-0.0253	-0.0180	-0.0087	0.0063	0.0047	0.0037	-0.0026	-0.0019	-0.0016	-0.0015
188	2.3947	0.1833	0.0317	-0.0289	-0.0205	-0.0099	0.0072	0.0054	0.0042	-0.0030	-0.0022	-0.0018	-0.0017
189	2.6917	0.2060	0.0356	-0.0325	-0.0231	-0.0111	0.0081	0.0061	0.0047	-0.0034	-0.0025	-0.0020	-0.0019
190	2.9879	0.2287	0.0395	-0.0360	-0.0256	-0.0123	0.0090	0.0067	0.0052	-0.0037	-0.0027	-0.0022	-0.0021
191	3.2831	0.2513	0.0434	-0.0396	-0.0282	-0.0136	0.0099	0.0074	0.0058	-0.0041	-0.0030	-0.0024	-0.0024
192	3.5774	0.2738	0.0473	-0.0431	-0.0307	-0.0148	0.0107	0.0081	0.0063	-0.0045	-0.0033	-0.0027	-0.0026
193	3.8706	0.2963	0.0512	-0.0467	-0.0332	-0.0160	0.0116	0.0087	0.0068	-0.0049	-0.0035	-0.0029	-0.0028
194	4.1626	0.3186	0.0551	-0.0502	-0.0357	-0.0172	0.0125	0.0094	0.0073	-0.0052	-0.0038	-0.0031	-0.0030
195	4.4533	0.3409	0.0589	-0.0537	-0.0382	-0.0184	0.0134	0.0100	0.0078	-0.0056	-0.0041	-0.0033	-0.0032
196	4.7427	0.3630	0.0627	-0.0572	-0.0407	-0.0196	0.0142	0.0107	0.0083	-0.0059	-0.0043	-0.0035	-0.0034
197	5.0307	0.3851	0.0666	-0.0607	-0.0432	-0.0208	0.0151	0.0113	0.0088	-0.0063	-0.0046	-0.0037	-0.0036
198	5.3171	0.4070	0.0703	-0.0641	-0.0456	-0.0220	0.0160	0.0120	0.0093	-0.0067	-0.0049	-0.0040	-0.0038
199	5.6019	0.4288	0.0741	-0.0675	-0.0480	-0.0232	0.0168	0.0126	0.0098	-0.0070	-0.0051	-0.0042	-0.0040
200	5.8849	0.4505	0.0779	-0.0710	-0.0505	-0.0243	0.0177	0.0132	0.0103	-0.0074	-0.0054	-0.0044	-0.0042
201	6.1662	0.4720	0.0816	-0.0743	-0.0529	-0.0255	0.0185	0.0139	0.0108	-0.0077	-0.0056	-0.0046	-0.0044
202	6.4456	0.4934	0.0853	-0.0777	-0.0553	-0.0266	0.0194	0.0145	0.0113	-0.0081	-0.0059	-0.0048	-0.0046
203	6.7231	0.5146	0.0889	-0.0811	-0.0577	-0.0278	0.0202	0.0151	0.0118	-0.0084	-0.0061	-0.0050	-0.0048
204	6.9985	0.5357	0.0926	-0.0844	-0.0600	-0.0289	0.0210	0.0158	0.0123	-0.0088	-0.0064	-0.0052	-0.0050
205	7.2717	0.5566	0.0962	-0.0877	-0.0624	-0.0301	0.0218	0.0164	0.0127	-0.0091	-0.0066	-0.0054	-0.0052
206	7.5428	0.5774	0.0998	-0.0909	-0.0647	-0.0312	0.0227	0.0170	0.0132	-0.0095	-0.0069	-0.0056	-0.0054
207	7.8115	0.5979	0.1033	-0.0942	-0.0670	-0.0323	0.0235	0.0176	0.0137	-0.0098	-0.0071	-0.0058	-0.0056
208	8.0779	0.6183	0.1069	-0.0974	-0.0693	-0.0334	0.0243	0.0182	0.0142	-0.0101	-0.0074	-0.0060	-0.0058
209	8.3418	0.6385	0.1104	-0.1006	-0.0716	-0.0345	0.0251	0.0188	0.0146	-0.0105	-0.0076	-0.0062	-0.0060
210	8.6032	0.6585	0.1138	-0.1037	-0.0738	-0.0356	0.0258	0.0194	0.0151	-0.0108	-0.0078	-0.0064	-0.0062
211	8.8620	0.6784	0.1172	-0.1068	-0.0760	-0.0366	0.0266	0.0199	0.0155	-0.0111	-0.0081	-0.0066	-0.0064
212	9.1180	0.6980	0.1206	-0.1099	-0.0782	-0.0377	0.0274	0.0205	0.0160	-0.0114	-0.0083	-0.0068	-0.0065
213	9.3713	0.7173	0.1240	-0.1130	-0.0804	-0.0387	0.0281	0.0211	0.0164	-0.0118	-0.0086	-0.0070	-0.0067
214	9.6217	0.7365	0.1273	-0.1160	-0.0825	-0.0398	0.0289	0.0217	0.0169	-0.0121	-0.0088	-0.0072	-0.0069
215	9.8692	0.7555	0.1306	-0.1190	-0.0847	-0.0408	0.0296	0.0222	0.0173	-0.0124	-0.0090	-0.0074	-0.0071
216	10.1137	0.7742	0.1338	-0.1219	-0.0867	-0.0418	0.0304	0.0228	0.0177	-0.0127	-0.0092	-0.0075	-0.0073
217	10.3551	0.7926	0.1370	-0.1248	-0.0888	-0.0428	0.0311	0.0233	0.0181	-0.0130	-0.0094	-0.0077	-0.0074
218	10.5933	0.8109	0.1401	-0.1277	-0.0909	-0.0438	0.0318	0.0238	0.0186	-0.0133	-0.0097	-0.0079	-0.0076
219	10.8283	0.8289	0.1433	-0.1306	-0.0929	-0.0448	0.0325	0.0244	0.0190	-0.0136	-0.0099	-0.0081	-0.0078
220	11.0601	0.8466	0.1463	-0.1333	-0.0949	-0.0457	0.0332	0.0249	0.0194	-0.0139	-0.0101	-0.0082	-0.0079
221	11.2884	0.8641	0.1493	-0.1361	-0.0968	-0.0467	0.0339	0.0254	0.0198	-0.0142	-0.0103	-0.0084	-0.0081
222	11.5133	0.8813	0.1523	-0.1388	-0.0988	-0.0476	0.0346	0.0259	0.0202	-0.0144	-0.0105	-0.0086	-0.0083
223	11.7347	0.8983	0.1553	-0.1415	-0.1007	-0.0485	0.0352	0.0264	0.0206	-0.0147	-0.0107	-0.0087	-0.0084
224	11.9526	0.9149	0.1581	-0.1441	-0.1025	-0.0494	0.0359	0.0269	0.0209	-0.0150	-0.0109	-0.0089	-0.0086
225	12.1668	0.9313	0.1610	-0.1467	-0.1044	-0.0503	0.0365	0.0274	0.0213	-0.0153	-0.0111	-0.0091	-0.0087
226	12.3773	0.9474	0.1638	-0.1492	-0.1062	-0.0512	0.0372	0.0279	0.0217	-0.0155	-0.0113	-0.0092	-0.0089
227	12.5840	0.9633	0.1665	-0.1517	-0.1079	-0.0520	0.0378	0.0283	0.0220	-0.0158	-0.0115	-0.0094	-0.0090
228	12.7869	0.9788	0.1692	-0.1542	-0.1097	-0.0528	0.0384	0.0288	0.0224	-0.0160	-0.0117	-0.0095	-0.0092

ϕ or θ	1	2	3	4	5	6	7	8	9	10	11	12	13
229	12.9858	0.9940	0.1718	-0.1566	-0.1114	-0.0537	0.0390	0.0292	0.0228	-0.0163	-0.0118	-0.0097	-0.0093
230	13.1809	1.0089	0.1744	-0.1589	-0.1131	-0.0545	0.0396	0.0297	0.0231	-0.0165	-0.0120	-0.0098	-0.0095
231	13.3719	1.0236	0.1769	-0.1612	-0.1147	-0.0553	0.0402	0.0301	0.0234	-0.0168	-0.0122	-0.0100	-0.0096
232	13.5588	1.0379	0.1794	-0.1635	-0.1163	-0.0560	0.0407	0.0305	0.0238	-0.0170	-0.0124	-0.0101	-0.0097
233	13.7417	1.0519	0.1818	-0.1657	-0.1179	-0.0568	0.0413	0.0309	0.0241	-0.0172	-0.0125	-0.0102	-0.0099
234	13.9203	1.0655	0.1842	-0.1678	-0.1194	-0.0575	0.0418	0.0313	0.0244	-0.0175	-0.0127	-0.0104	-0.0100
235	14.0947	1.0789	0.1865	-0.1699	-0.1209	-0.0583	0.0423	0.0317	0.0247	-0.0177	-0.0129	-0.0105	-0.0101
236	14.2648	1.0919	0.1887	-0.1720	-0.1224	-0.0590	0.0428	0.0321	0.0250	-0.0179	-0.0130	-0.0106	-0.0102
237	14.4305	1.1046	0.1909	-0.1740	-0.1238	-0.0596	0.0433	0.0325	0.0253	-0.0181	-0.0132	-0.0108	-0.0104
238	14.5919	1.1170	0.1931	-0.1759	-0.1252	-0.0603	0.0438	0.0328	0.0256	-0.0183	-0.0133	-0.0109	-0.0105
239	14.7488	1.1290	0.1951	-0.1778	-0.1265	-0.0610	0.0443	0.0332	0.0258	-0.0185	-0.0135	-0.0110	-0.0106
240	14.9012	1.1406	0.1971	-0.1797	-0.1278	-0.0616	0.0448	0.0335	0.0261	-0.0187	-0.0136	-0.0111	-0.0107
241	15.0491	1.1520	0.1991	-0.1814	-0.1291	-0.0622	0.0452	0.0339	0.0264	-0.0189	-0.0137	-0.0112	-0.0108
242	15.1924	1.1629	0.2010	-0.1832	-0.1303	-0.0628	0.0456	0.0342	0.0266	-0.0191	-0.0139	-0.0113	-0.0109
243	15.3310	1.1735	0.2028	-0.1848	-0.1315	-0.0634	0.0460	0.0345	0.0269	-0.0192	-0.0140	-0.0114	-0.0110
244	15.4650	1.1838	0.2046	-0.1865	-0.1327	-0.0639	0.0465	0.0348	0.0271	-0.0194	-0.0141	-0.0115	-0.0111
245	15.5943	1.1937	0.2063	-0.1880	-0.1338	-0.0645	0.0468	0.0351	0.0273	-0.0196	-0.0142	-0.0116	-0.0112
246	15.7188	1.2032	0.2080	-0.1895	-0.1348	-0.0650	0.0472	0.0354	0.0275	-0.0197	-0.0143	-0.0117	-0.0113
247	15.8386	1.2124	0.2095	-0.1910	-0.1359	-0.0655	0.0476	0.0357	0.0277	-0.0199	-0.0145	-0.0118	-0.0114
248	15.9535	1.2212	0.2111	-0.1923	-0.1368	-0.0659	0.0479	0.0359	0.0280	-0.0200	-0.0146	-0.0119	-0.0114
249	16.0636	1.2296	0.2125	-0.1937	-0.1378	-0.0664	0.0482	0.0362	0.0281	-0.0201	-0.0147	-0.0120	-0.0115
250	16.1687	1.2377	0.2139	-0.1949	-0.1387	-0.0668	0.0486	0.0364	0.0283	-0.0203	-0.0148	-0.0120	-0.0116
251	16.2690	1.2453	0.2152	-0.1962	-0.1395	-0.0672	0.0489	0.0366	0.0285	-0.0204	-0.0148	-0.0121	-0.0117
252	16.3643	1.2526	0.2165	-0.1973	-0.1404	-0.0676	0.0492	0.0368	0.0287	-0.0205	-0.0149	-0.0122	-0.0117
253	16.4546	1.2595	0.2177	-0.1984	-0.1411	-0.0680	0.0494	0.0370	0.0288	-0.0206	-0.0150	-0.0123	-0.0118
254	16.5399	1.2661	0.2188	-0.1994	-0.1419	-0.0684	0.0497	0.0372	0.0290	-0.0207	-0.0151	-0.0123	-0.0119
255	16.6201	1.2722	0.2199	-0.2004	-0.1426	-0.0687	0.0499	0.0374	0.0291	-0.0208	-0.0152	-0.0124	-0.0119
256	16.6953	1.2780	0.2209	-0.2013	-0.1432	-0.0690	0.0501	0.0376	0.0293	-0.0209	-0.0152	-0.0124	-0.0120
257	16.7654	1.2833	0.2218	-0.2021	-0.1438	-0.0693	0.0504	0.0377	0.0294	-0.0210	-0.0153	-0.0125	-0.0120
258	16.8304	1.2883	0.2227	-0.2029	-0.1444	-0.0696	0.0506	0.0379	0.0295	-0.0211	-0.0154	-0.0125	-0.0121
259	16.8903	1.2929	0.2235	-0.2036	-0.1449	-0.0698	0.0507	0.0380	0.0296	-0.0212	-0.0154	-0.0126	-0.0121
260	16.9450	1.2971	0.2242	-0.2043	-0.1453	-0.0700	0.0509	0.0381	0.0297	-0.0213	-0.0155	-0.0126	-0.0122
261	16.9946	1.3009	0.2248	-0.2049	-0.1458	-0.0702	0.0510	0.0383	0.0298	-0.0213	-0.0155	-0.0127	-0.0122
262	17.0390	1.3043	0.2254	-0.2054	-0.1462	-0.0704	0.0512	0.0384	0.0299	-0.0214	-0.0155	-0.0127	-0.0122
263	17.0782	1.3073	0.2259	-0.2059	-0.1465	-0.0706	0.0513	0.0384	0.0299	-0.0214	-0.0156	-0.0127	-0.0123
264	17.1122	1.3099	0.2264	-0.2063	-0.1468	-0.0707	0.0514	0.0385	0.0300	-0.0215	-0.0156	-0.0128	-0.0123
265	17.1409	1.3121	0.2268	-0.2067	-0.1470	-0.0708	0.0515	0.0386	0.0300	-0.0215	-0.0156	-0.0128	-0.0123
266	17.1645	1.3139	0.2271	-0.2070	-0.1472	-0.0709	0.0516	0.0386	0.0301	-0.0215	-0.0157	-0.0128	-0.0123
267	17.1828	1.3153	0.2273	-0.2072	-0.1474	-0.0710	0.0516	0.0387	0.0301	-0.0216	-0.0157	-0.0128	-0.0123
268	17.1959	1.3163	0.2275	-0.2073	-0.1475	-0.0711	0.0517	0.0387	0.0301	-0.0216	-0.0157	-0.0128	-0.0123
269	17.2038	1.3169	0.2276	-0.2074	-0.1476	-0.0711	0.0517	0.0387	0.0301	-0.0216	-0.0157	-0.0128	-0.0123
270	17.2064	1.3171	0.2276	-0.2075	-0.1476	-0.0711	0.0517	0.0387	0.0301	-0.0216	-0.0157	-0.0128	-0.0123
271	17.2038	1.3169	0.2276	-0.2074	-0.1476	-0.0711	0.0517	0.0387	0.0301	-0.0216	-0.0157	-0.0128	-0.0123
272	17.1959	1.3163	0.2275	-0.2073	-0.1475	-0.0711	0.0517	0.0387	0.0301	-0.0216	-0.0157	-0.0128	-0.0123
273	17.1828	1.3153	0.2273	-0.2072	-0.1474	-0.0710	0.0516	0.0387	0.0301	-0.0216	-0.0157	-0.0128	-0.0123
274	17.1645	1.3139	0.2271	-0.2070	-0.1472	-0.0709	0.0516	0.0386	0.0301	-0.0215	-0.0157	-0.0128	-0.0123

ϕ or θ	1	2	3	4	5	6	7	8	9	10	11	12	13
275	17.1409	1.3121	0.2268	-0.2067	-0.1470	-0.0708	0.0515	0.0386	0.0300	-0.0215	-0.0156	-0.0128	-0.0123
276	17.1122	1.3099	0.2264	-0.2063	-0.1468	-0.0707	0.0514	0.0385	0.0300	-0.0215	-0.0156	-0.0128	-0.0123
277	17.0782	1.3073	0.2259	-0.2059	-0.1465	-0.0706	0.0513	0.0384	0.0299	-0.0214	-0.0156	-0.0127	-0.0123
278	17.0390	1.3043	0.2254	-0.2054	-0.1462	-0.0704	0.0512	0.0384	0.0299	-0.0214	-0.0155	-0.0127	-0.0122
279	16.9946	1.3009	0.2248	-0.2049	-0.1458	-0.0702	0.0510	0.0383	0.0298	-0.0213	-0.0155	-0.0127	-0.0122
280	16.9450	1.2971	0.2242	-0.2043	-0.1453	-0.0700	0.0509	0.0381	0.0297	-0.0213	-0.0155	-0.0126	-0.0122
281	16.8903	1.2929	0.2235	-0.2036	-0.1449	-0.0698	0.0507	0.0380	0.0296	-0.0212	-0.0154	-0.0126	-0.0121
282	16.8304	1.2883	0.2227	-0.2029	-0.1444	-0.0696	0.0506	0.0379	0.0295	-0.0211	-0.0154	-0.0125	-0.0121
283	16.7654	1.2833	0.2218	-0.2021	-0.1438	-0.0693	0.0504	0.0377	0.0294	-0.0210	-0.0153	-0.0125	-0.0120
284	16.6953	1.2780	0.2209	-0.2013	-0.1432	-0.0690	0.0501	0.0376	0.0293	-0.0209	-0.0152	-0.0124	-0.0120
285	16.6201	1.2722	0.2199	-0.2004	-0.1426	-0.0687	0.0499	0.0374	0.0291	-0.0208	-0.0152	-0.0124	-0.0119
286	16.5399	1.2661	0.2188	-0.1994	-0.1419	-0.0684	0.0497	0.0372	0.0290	-0.0207	-0.0151	-0.0123	-0.0119
287	16.4546	1.2595	0.2177	-0.1984	-0.1411	-0.0680	0.0494	0.0370	0.0288	-0.0206	-0.0150	-0.0123	-0.0118
288	16.3643	1.2526	0.2165	-0.1973	-0.1404	-0.0676	0.0492	0.0368	0.0287	-0.0205	-0.0149	-0.0122	-0.0117
289	16.2690	1.2453	0.2152	-0.1962	-0.1395	-0.0672	0.0489	0.0366	0.0285	-0.0204	-0.0148	-0.0121	-0.0117
290	16.1687	1.2377	0.2139	-0.1949	-0.1387	-0.0668	0.0486	0.0364	0.0283	-0.0203	-0.0148	-0.0120	-0.0116
291	16.0636	1.2296	0.2125	-0.1937	-0.1378	-0.0664	0.0482	0.0362	0.0281	-0.0201	-0.0147	-0.0120	-0.0115
292	15.9535	1.2212	0.2111	-0.1923	-0.1368	-0.0659	0.0479	0.0359	0.0280	-0.0200	-0.0146	-0.0119	-0.0114
293	15.8386	1.2124	0.2095	-0.1910	-0.1359	-0.0655	0.0476	0.0357	0.0277	-0.0199	-0.0145	-0.0118	-0.0114
294	15.7188	1.2032	0.2080	-0.1895	-0.1348	-0.0650	0.0472	0.0354	0.0275	-0.0197	-0.0143	-0.0117	-0.0113
295	15.5943	1.1937	0.2063	-0.1880	-0.1338	-0.0645	0.0468	0.0351	0.0273	-0.0196	-0.0142	-0.0116	-0.0112
296	15.4650	1.1838	0.2046	-0.1865	-0.1327	-0.0639	0.0465	0.0348	0.0271	-0.0194	-0.0141	-0.0115	-0.0111
297	15.3310	1.1735	0.2028	-0.1848	-0.1315	-0.0634	0.0460	0.0345	0.0269	-0.0192	-0.0140	-0.0114	-0.0110
298	15.1924	1.1629	0.2010	-0.1832	-0.1303	-0.0628	0.0456	0.0342	0.0266	-0.0191	-0.0139	-0.0113	-0.0109
299	15.0491	1.1520	0.1991	-0.1814	-0.1291	-0.0622	0.0452	0.0339	0.0264	-0.0189	-0.0137	-0.0112	-0.0108
300	14.9012	1.1406	0.1971	-0.1797	-0.1278	-0.0616	0.0448	0.0335	0.0261	-0.0187	-0.0136	-0.0111	-0.0107
301	14.7488	1.1290	0.1951	-0.1778	-0.1265	-0.0610	0.0443	0.0332	0.0258	-0.0185	-0.0135	-0.0110	-0.0106
302	14.5919	1.1170	0.1931	-0.1759	-0.1252	-0.0603	0.0438	0.0328	0.0256	-0.0183	-0.0133	-0.0109	-0.0105
303	14.4305	1.1046	0.1909	-0.1740	-0.1238	-0.0596	0.0433	0.0325	0.0253	-0.0181	-0.0132	-0.0108	-0.0104
304	14.2648	1.0919	0.1887	-0.1720	-0.1224	-0.0590	0.0428	0.0321	0.0250	-0.0179	-0.0130	-0.0106	-0.0102
305	14.0947	1.0789	0.1865	-0.1699	-0.1209	-0.0583	0.0423	0.0317	0.0247	-0.0177	-0.0129	-0.0105	-0.0101
306	13.9203	1.0655	0.1842	-0.1678	-0.1194	-0.0575	0.0418	0.0313	0.0244	-0.0175	-0.0127	-0.0104	-0.0100
307	13.7417	1.0519	0.1818	-0.1657	-0.1179	-0.0568	0.0413	0.0309	0.0241	-0.0172	-0.0125	-0.0102	-0.0099
308	13.5588	1.0379	0.1794	-0.1635	-0.1163	-0.0560	0.0407	0.0305	0.0238	-0.0170	-0.0124	-0.0101	-0.0097
309	13.3719	1.0236	0.1769	-0.1612	-0.1147	-0.0553	0.0402	0.0301	0.0234	-0.0168	-0.0122	-0.0100	-0.0096
310	13.1809	1.0089	0.1744	-0.1589	-0.1131	-0.0545	0.0396	0.0297	0.0231	-0.0165	-0.0120	-0.0098	-0.0095
311	12.9858	0.9940	0.1718	-0.1566	-0.1114	-0.0537	0.0390	0.0292	0.0228	-0.0163	-0.0118	-0.0097	-0.0093
312	12.7869	0.9788	0.1692	-0.1542	-0.1097	-0.0528	0.0384	0.0288	0.0224	-0.0160	-0.0117	-0.0095	-0.0092
313	12.5840	0.9633	0.1665	-0.1517	-0.1079	-0.0520	0.0378	0.0283	0.0220	-0.0158	-0.0115	-0.0094	-0.0090
314	12.3773	0.9474	0.1638	-0.1492	-0.1062	-0.0512	0.0372	0.0279	0.0217	-0.0155	-0.0113	-0.0092	-0.0089
315	12.1668	0.9313	0.1610	-0.1467	-0.1044	-0.0503	0.0365	0.0274	0.0213	-0.0153	-0.0111	-0.0091	-0.0087
316	11.9526	0.9149	0.1581	-0.1441	-0.1025	-0.0494	0.0359	0.0269	0.0209	-0.0150	-0.0109	-0.0089	-0.0086
317	11.7347	0.8983	0.1553	-0.1415	-0.1007	-0.0485	0.0352	0.0264	0.0206	-0.0147	-0.0107	-0.0087	-0.0084
318	11.5133	0.8813	0.1523	-0.1388	-0.0988	-0.0476	0.0346	0.0259	0.0202	-0.0144	-0.0105	-0.0086	-0.0083
319	11.2884	0.8641	0.1493	-0.1361	-0.0968	-0.0467	0.0339	0.0254	0.0198	-0.0142	-0.0103	-0.0084	-0.0081
320	11.0601	0.8466	0.1463	-0.1333	-0.0949	-0.0457	0.0332	0.0249	0.0194	-0.0139	-0.0101	-0.0082	-0.0079

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321	10.8283	0.8289	0.1433	-0.1306	-0.0929	-0.0448	0.0325	0.0244	0.0190	-0.0136	-0.0099	-0.0081	-0.0078
322	10.5933	0.8109	0.1401	-0.1277	-0.0909	-0.0438	0.0318	0.0238	0.0186	-0.0133	-0.0097	-0.0079	-0.0076
323	10.3551	0.7926	0.1370	-0.1248	-0.0888	-0.0428	0.0311	0.0233	0.0181	-0.0130	-0.0094	-0.0077	-0.0074
324	10.1137	0.7742	0.1338	-0.1219	-0.0867	-0.0418	0.0304	0.0228	0.0177	-0.0127	-0.0092	-0.0075	-0.0073
325	9.8692	0.7555	0.1306	-0.1190	-0.0847	-0.0408	0.0296	0.0222	0.0173	-0.0124	-0.0090	-0.0074	-0.0071
326	9.6217	0.7365	0.1273	-0.1160	-0.0825	-0.0398	0.0289	0.0217	0.0169	-0.0121	-0.0088	-0.0072	-0.0069
327	9.3713	0.7173	0.1240	-0.1130	-0.0804	-0.0387	0.0281	0.0211	0.0164	-0.0118	-0.0086	-0.0070	-0.0067
328	9.1180	0.6980	0.1206	-0.1099	-0.0782	-0.0377	0.0274	0.0205	0.0160	-0.0114	-0.0083	-0.0068	-0.0065
329	8.8620	0.6784	0.1172	-0.1068	-0.0760	-0.0366	0.0266	0.0199	0.0155	-0.0111	-0.0081	-0.0066	-0.0064
330	8.6032	0.6585	0.1138	-0.1037	-0.0738	-0.0356	0.0258	0.0194	0.0151	-0.0108	-0.0078	-0.0064	-0.0062
331	8.3418	0.6385	0.1104	-0.1006	-0.0716	-0.0345	0.0251	0.0188	0.0146	-0.0105	-0.0076	-0.0062	-0.0060
332	8.0779	0.6183	0.1069	-0.0974	-0.0693	-0.0334	0.0243	0.0182	0.0142	-0.0101	-0.0074	-0.0060	-0.0058
333	7.8115	0.5979	0.1033	-0.0942	-0.0670	-0.0323	0.0235	0.0176	0.0137	-0.0098	-0.0071	-0.0058	-0.0056
334	7.5428	0.5774	0.0998	-0.0909	-0.0647	-0.0312	0.0227	0.0170	0.0132	-0.0095	-0.0069	-0.0056	-0.0054
335	7.2717	0.5566	0.0962	-0.0877	-0.0624	-0.0301	0.0218	0.0164	0.0127	-0.0091	-0.0066	-0.0054	-0.0052
336	6.9985	0.5357	0.0926	-0.0844	-0.0600	-0.0289	0.0210	0.0158	0.0123	-0.0088	-0.0064	-0.0052	-0.0050
337	6.7231	0.5146	0.0889	-0.0811	-0.0577	-0.0278	0.0202	0.0151	0.0118	-0.0084	-0.0061	-0.0050	-0.0048
338	6.4456	0.4934	0.0853	-0.0777	-0.0553	-0.0266	0.0194	0.0145	0.0113	-0.0081	-0.0059	-0.0048	-0.0046
339	6.1662	0.4720	0.0816	-0.0743	-0.0529	-0.0255	0.0185	0.0139	0.0108	-0.0077	-0.0056	-0.0046	-0.0044
340	5.8849	0.4505	0.0779	-0.0710	-0.0505	-0.0243	0.0177	0.0132	0.0103	-0.0074	-0.0054	-0.0044	-0.0042
341	5.6019	0.4288	0.0741	-0.0675	-0.0480	-0.0232	0.0168	0.0126	0.0098	-0.0070	-0.0051	-0.0042	-0.0040
342	5.3171	0.4070	0.0703	-0.0641	-0.0456	-0.0220	0.0160	0.0120	0.0093	-0.0067	-0.0049	-0.0040	-0.0038
343	5.0307	0.3851	0.0666	-0.0607	-0.0432	-0.0208	0.0151	0.0113	0.0088	-0.0063	-0.0046	-0.0037	-0.0036
344	4.7427	0.3630	0.0627	-0.0572	-0.0407	-0.0196	0.0142	0.0107	0.0083	-0.0059	-0.0043	-0.0035	-0.0034
345	4.4533	0.3409	0.0589	-0.0537	-0.0382	-0.0184	0.0134	0.0100	0.0078	-0.0056	-0.0041	-0.0033	-0.0032
346	4.1626	0.3186	0.0551	-0.0502	-0.0357	-0.0172	0.0125	0.0094	0.0073	-0.0052	-0.0038	-0.0031	-0.0030
347	3.8706	0.2963	0.0512	-0.0467	-0.0332	-0.0160	0.0116	0.0087	0.0068	-0.0049	-0.0035	-0.0029	-0.0028
348	3.5774	0.2738	0.0473	-0.0431	-0.0307	-0.0148	0.0107	0.0081	0.0063	-0.0045	-0.0033	-0.0027	-0.0026
349	3.2831	0.2513	0.0434	-0.0396	-0.0282	-0.0136	0.0099	0.0074	0.0058	-0.0041	-0.0030	-0.0024	-0.0024
350	2.9879	0.2287	0.0395	-0.0360	-0.0256	-0.0123	0.0090	0.0067	0.0052	-0.0037	-0.0027	-0.0022	-0.0021
351	2.6917	0.2060	0.0356	-0.0325	-0.0231	-0.0111	0.0081	0.0061	0.0047	-0.0034	-0.0025	-0.0020	-0.0019
352	2.3947	0.1833	0.0317	-0.0289	-0.0205	-0.0099	0.0072	0.0054	0.0042	-0.0030	-0.0022	-0.0018	-0.0017
353	2.0969	0.1605	0.0277	-0.0253	-0.0180	-0.0087	0.0063	0.0047	0.0037	-0.0026	-0.0019	-0.0016	-0.0015
354	1.7986	0.1377	0.0238	-0.0217	-0.0154	-0.0074	0.0054	0.0040	0.0032	-0.0023	-0.0016	-0.0013	-0.0013
355	1.4996	0.1148	0.0198	-0.0181	-0.0129	-0.0062	0.0045	0.0034	0.0026	-0.0019	-0.0014	-0.0011	-0.0011
356	1.2003	0.0919	0.0159	-0.0145	-0.0103	-0.0050	0.0036	0.0027	0.0021	-0.0015	-0.0011	-0.0009	-0.0009
357	0.9005	0.0689	0.0119	-0.0109	-0.0077	-0.0037	0.0027	0.0020	0.0016	-0.0011	-0.0008	-0.0007	-0.0006
358	0.6005	0.0460	0.0079	-0.0072	-0.0052	-0.0025	0.0018	0.0014	0.0011	-0.0008	-0.0005	-0.0004	-0.0004
359	0.3003	0.0230	0.0040	-0.0036	-0.0026	-0.0012	0.0009	0.0007	0.0005	-0.0004	-0.0003	-0.0002	-0.0002
360	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Note:

1. Column No. 1 to 13 above, gives respective Term's Nutation in Longitude ($\Delta\psi$) (in Seconds) for the calculated Angle ϕ or θ (in Degrees) using Eqn.(s3)for the respective Terms.
2. For Example, Angle for Term1 (ϕ_1 or θ_1) for the date J2000 (1 Jan 2000 @ 12:00Hrs UT) is given by $\phi_1 = 450160.398036(\text{Seconds}) = 125°2'40.398036'(\approx 125°)(\textit{Degrees})$ (From Eqn.(s3),for T=0) Thus $\Delta\psi_1 = -14.0947(\text{Seconds})\ \text{for}\ \phi_1 \approx 125°$ (Value from Column 1 above, for ϕ_1=125)

8.4 True Obliquity Calculation

Readers should note that all the obliquity Eqn.(e3) shown in Table 24,Chapter(7.6.6) 'Calculation for Nutation in Obliquity' are for the calculation of Mean Obliquity only. To get the True Obliquity, correction for Nutation in Obliquity (Δε) shall be added with Mean Obliquity. Even though there are many reference dates used for calculating the Nutation in obliquity of respective Nutation model, only selected case is recommended for the reasons given below.

We can see from the Coefficient values of Eqn.(e3) shown in Table 24 of various Nutation Models with respective Reference Epoch, shows almost same values with insignificant difference. However, readers are recommended to use the latest Precession Model (IAU2006- Refer Sr.No.12, Table 24, Highlighted item) & Nutation Model(IAU2000A) with reference Epoch J2000 (For Fundamental Arguments- Refer Table 2 Highlighted items, ignoring 4th Order Term, with First 10 (Ten) Terms contributing for Nutation in Obliquity (Δε)- Refer Table 23, Highlighted items in Column(D)) compatible with above recommended Mean Obliquity Equation so that time 'T' calculated for selected Epoch can be commonly used for both Mean Obliquity and Nutation in Obliquity (Δε) calculations.The same angle (ϕ_i or θ_i) given in Eqn.(s3) of Chapter(8.3) 'True Ayanamsa Calculation' shall be used for calculating Nutation in Obliquity (Δε) of the respective terms also.

The effect of change in True Obliquity on Sayana longitude of the cuspal positions are studied with example case below. For the calculation purpose, the reference epoch J1900 and J2000 are considered with IAU2006 Precession model and Sidereal time, geocentric latitude are assumed as 21:31:50 Hrs & 13°N respectively. The Nutation in Obliquity (Δε) for the respective reference epoch assumed for demonstration purpose as 00°00'00" & -00°00'10" (the actual values shall be calculated similar to the sample calculation shown in Chapter(10) 'Further Studies'), by adding this with mean Obliquity(ε_m) (see Table 24), we get True (correct) Obliquity(ε_T) as 84428.2406 (84428.2406 + 0.00) & 84371.4060 (84381.4060-10.00) Seconds respectively.

Example: Sayana longitude of Cusps for IAU2006 Nutation Model

Cusp	Sayana Longitude (dd:mm:ss)		Co-rulers (Sign:Star:Sub1:Sub2:Sub3)		Diff.(Sec.)
(A)	**(B) J1900**	**(C) J2000**	**(D) J1900**	**(E) J2000**	**(F)=(C)-(D)**
1	060:00:17	059:59:53	MER:MAR:MER:MER:MER	**VEN**:MAR:**SAT**:**JUP**:**RAH**	-24.11
2	087:02:58	087:02:47	MER:JUP:VEN:MOO:MOO	MER:JUP:VEN:MOO:MOO	-10.88
3	112:52:34	112:52:38	MOO:MER:MOO:MER:MER	MOO:MER:MOO:MER:MER	4.42
4	140:33:27	140:33:39	SUN:VEN:JUP:SAT:RAH	SUN:VEN:JUP:SAT:RAH	12.09
5	172:04:04	172:04:09	MER:MOO:VEN:SAT:SUN	MER:MOO:VEN:SAT:SUN	4.11
6	206:28:03	206:27:48	VEN:JUP:KET:MER:KET	VEN:JUP:KET:MER:KET	-14.69
7	240:00:17	239:59:53	JUP:KET:KET:KET:VEN	**MAR**:**MER**:**SAT**:**JUP**:**RAH**	-24.11
8	267:02:58	267:02:47	JUP:SUN:SUN:SAT:MOO	JUP:SUN:SUN:SAT:MOO	-10.88
9	292:52:34	292:52:38	SAT:MOO:SUN:RAH:SUN	SAT:MOO:SUN:RAH:SUN	4.42
10	320:33:27	320:33:39	SAT:JUP:JUP:MER:KET	SAT:JUP:JUP:MER:KET	12.09
11	352:04:04	352:04:09	JUP:MER:SUN:MER:SAT	JUP:MER:SUN:MER:SAT	4.11
12	026:28:03	026:27:48	MAR:VEN:KET:SAT:MER	MAR:VEN:KET:SAT:MER	-14.69

The sayana longitude of cuspal positions shown above are calculated using the placidus house division formulae given in my article '*Trigonometry behind the House Cusps*'(Ref.[55]) available on-line for free. It is noticed from above table that for 56.8346 (84428.2406 - 84371.4060) Seconds difference in True Obliquity gives the difference in Sayana longitude of respective Cusps about 4 to -24 Seconds. Also Co-rulers of 1st and 7th cusps are found changed even without calculating Nirayana longitude by applying True Ayanamsa, which possibly can change further.

Table 34: IAU2000A Model-Each Term's Nutation in Obliquity(Δε)(in Sec) for ϕ or θ (in Deg)

ϕ or θ	1	2	3	4	5	6	7	8	9	10	11	12	13
0	9.2052	0.5730	0.0978	-0.0897	0.0074	-0.0007	0.0224	0.0201	0.0129	-0.0096	-0.0001	-0.0069	-0.0053
1	9.2038	0.5729	0.0978	-0.0897	0.0074	-0.0007	0.0224	0.0201	0.0129	-0.0096	-0.0001	-0.0069	-0.0053
2	9.1996	0.5727	0.0978	-0.0897	0.0074	-0.0007	0.0224	0.0201	0.0129	-0.0096	-0.0001	-0.0069	-0.0053
3	9.1926	0.5722	0.0977	-0.0896	0.0074	-0.0007	0.0224	0.0200	0.0129	-0.0096	-0.0001	-0.0069	-0.0053
4	9.1828	0.5716	0.0976	-0.0895	0.0074	-0.0007	0.0224	0.0200	0.0129	-0.0096	-0.0001	-0.0069	-0.0053
5	9.1702	0.5709	0.0975	-0.0894	0.0074	-0.0007	0.0224	0.0200	0.0129	-0.0096	-0.0001	-0.0069	-0.0053
6	9.1548	0.5699	0.0973	-0.0893	0.0073	-0.0007	0.0223	0.0200	0.0128	-0.0095	-0.0001	-0.0069	-0.0053
7	9.1366	0.5688	0.0971	-0.0891	0.0073	-0.0007	0.0223	0.0199	0.0128	-0.0095	-0.0001	-0.0068	-0.0053
8	9.1156	0.5675	0.0969	-0.0889	0.0073	-0.0007	0.0222	0.0199	0.0128	-0.0095	-0.0001	-0.0068	-0.0053
9	9.0919	0.5660	0.0966	-0.0886	0.0073	-0.0007	0.0222	0.0198	0.0127	-0.0095	-0.0001	-0.0068	-0.0053
10	9.0654	0.5643	0.0964	-0.0884	0.0073	-0.0007	0.0221	0.0198	0.0127	-0.0094	-0.0001	-0.0068	-0.0053
11	9.0361	0.5625	0.0960	-0.0881	0.0073	-0.0007	0.0220	0.0197	0.0127	-0.0094	-0.0001	-0.0068	-0.0052
12	9.0041	0.5605	0.0957	-0.0878	0.0072	-0.0007	0.0219	0.0196	0.0126	-0.0094	-0.0001	-0.0067	-0.0052
13	8.9693	0.5583	0.0953	-0.0874	0.0072	-0.0007	0.0219	0.0196	0.0126	-0.0093	-0.0001	-0.0067	-0.0052
14	8.9318	0.5560	0.0949	-0.0871	0.0072	-0.0007	0.0218	0.0195	0.0125	-0.0093	-0.0001	-0.0067	-0.0052
15	8.8916	0.5535	0.0945	-0.0867	0.0071	-0.0007	0.0217	0.0194	0.0125	-0.0093	-0.0001	-0.0067	-0.0051
16	8.8486	0.5508	0.0941	-0.0863	0.0071	-0.0006	0.0216	0.0193	0.0124	-0.0092	-0.0001	-0.0066	-0.0051
17	8.8030	0.5480	0.0936	-0.0858	0.0071	-0.0006	0.0215	0.0192	0.0123	-0.0092	-0.0001	-0.0066	-0.0051
18	8.7547	0.5450	0.0931	-0.0854	0.0070	-0.0006	0.0213	0.0191	0.0123	-0.0091	-0.0001	-0.0066	-0.0051
19	8.7037	0.5418	0.0925	-0.0849	0.0070	-0.0006	0.0212	0.0190	0.0122	-0.0091	-0.0001	-0.0065	-0.0050
20	8.6501	0.5385	0.0919	-0.0843	0.0069	-0.0006	0.0211	0.0189	0.0121	-0.0090	-0.0001	-0.0065	-0.0050
21	8.5938	0.5350	0.0913	-0.0838	0.0069	-0.0006	0.0209	0.0187	0.0120	-0.0090	-0.0001	-0.0064	-0.0050
22	8.5349	0.5313	0.0907	-0.0832	0.0068	-0.0006	0.0208	0.0186	0.0120	-0.0089	-0.0001	-0.0064	-0.0049
23	8.4735	0.5275	0.0901	-0.0826	0.0068	-0.0006	0.0207	0.0185	0.0119	-0.0088	-0.0001	-0.0063	-0.0049
24	8.4094	0.5235	0.0894	-0.0820	0.0067	-0.0006	0.0205	0.0183	0.0118	-0.0088	-0.0001	-0.0063	-0.0049
25	8.3428	0.5193	0.0887	-0.0813	0.0067	-0.0006	0.0203	0.0182	0.0117	-0.0087	-0.0001	-0.0063	-0.0048
26	8.2736	0.5150	0.0879	-0.0807	0.0066	-0.0006	0.0202	0.0180	0.0116	-0.0086	-0.0001	-0.0062	-0.0048
27	8.2019	0.5106	0.0872	-0.0800	0.0066	-0.0006	0.0200	0.0179	0.0115	-0.0085	-0.0001	-0.0061	-0.0048
28	8.1277	0.5060	0.0864	-0.0792	0.0065	-0.0006	0.0198	0.0177	0.0114	-0.0085	-0.0001	-0.0061	-0.0047
29	8.0511	0.5012	0.0856	-0.0785	0.0065	-0.0006	0.0196	0.0176	0.0113	-0.0084	-0.0001	-0.0060	-0.0047
30	7.9720	0.4963	0.0847	-0.0777	0.0064	-0.0006	0.0194	0.0174	0.0112	-0.0083	-0.0001	-0.0060	-0.0046
31	7.8904	0.4912	0.0839	-0.0769	0.0063	-0.0006	0.0192	0.0172	0.0111	-0.0082	-0.0001	-0.0059	-0.0046
32	7.8065	0.4860	0.0830	-0.0761	0.0063	-0.0006	0.0190	0.0170	0.0109	-0.0081	-0.0001	-0.0059	-0.0045
33	7.7202	0.4806	0.0821	-0.0753	0.0062	-0.0006	0.0188	0.0168	0.0108	-0.0080	-0.0001	-0.0058	-0.0045
34	7.6315	0.4751	0.0811	-0.0744	0.0061	-0.0006	0.0186	0.0166	0.0107	-0.0080	-0.0001	-0.0057	-0.0044
35	7.5405	0.4694	0.0802	-0.0735	0.0061	-0.0006	0.0184	0.0164	0.0106	-0.0079	-0.0001	-0.0057	-0.0044
36	7.4472	0.4636	0.0792	-0.0726	0.0060	-0.0005	0.0182	0.0162	0.0104	-0.0078	-0.0001	-0.0056	-0.0043
37	7.3516	0.4576	0.0781	-0.0717	0.0059	-0.0005	0.0179	0.0160	0.0103	-0.0077	-0.0001	-0.0055	-0.0043
38	7.2538	0.4516	0.0771	-0.0707	0.0058	-0.0005	0.0177	0.0158	0.0102	-0.0076	-0.0001	-0.0054	-0.0042
39	7.1538	0.4453	0.0760	-0.0697	0.0057	-0.0005	0.0174	0.0156	0.0100	-0.0075	-0.0001	-0.0054	-0.0041
40	7.0516	0.4390	0.0750	-0.0688	0.0057	-0.0005	0.0172	0.0154	0.0099	-0.0073	-0.0001	-0.0053	-0.0041
41	6.9473	0.4325	0.0738	-0.0677	0.0056	-0.0005	0.0169	0.0151	0.0097	-0.0072	-0.0001	-0.0052	-0.0040
42	6.8408	0.4258	0.0727	-0.0667	0.0055	-0.0005	0.0167	0.0149	0.0096	-0.0071	-0.0001	-0.0051	-0.0040
43	6.7323	0.4191	0.0716	-0.0656	0.0054	-0.0005	0.0164	0.0147	0.0094	-0.0070	-0.0001	-0.0050	-0.0039
44	6.6217	0.4122	0.0704	-0.0646	0.0053	-0.0005	0.0161	0.0144	0.0093	-0.0069	-0.0001	-0.0050	-0.0038

ϕ or θ	1	2	3	4	5	6	7	8	9	10	11	12	13
45	6.5091	0.4052	0.0692	-0.0635	0.0052	-0.0005	0.0159	0.0142	0.0091	-0.0068	-0.0001	-0.0049	-0.0038
46	6.3945	0.3981	0.0680	-0.0623	0.0051	-0.0005	0.0156	0.0139	0.0090	-0.0067	-0.0001	-0.0048	-0.0037
47	6.2780	0.3908	0.0667	-0.0612	0.0050	-0.0005	0.0153	0.0137	0.0088	-0.0065	-0.0001	-0.0047	-0.0036
48	6.1595	0.3834	0.0655	-0.0601	0.0049	-0.0005	0.0150	0.0134	0.0086	-0.0064	-0.0001	-0.0046	-0.0036
49	6.0392	0.3759	0.0642	-0.0589	0.0048	-0.0004	0.0147	0.0132	0.0085	-0.0063	-0.0001	-0.0045	-0.0035
50	5.9170	0.3683	0.0629	-0.0577	0.0047	-0.0004	0.0144	0.0129	0.0083	-0.0062	-0.0001	-0.0044	-0.0034
51	5.7930	0.3606	0.0616	-0.0565	0.0046	-0.0004	0.0141	0.0126	0.0081	-0.0060	-0.0001	-0.0043	-0.0034
52	5.6673	0.3528	0.0602	-0.0553	0.0045	-0.0004	0.0138	0.0124	0.0079	-0.0059	-0.0001	-0.0042	-0.0033
53	5.5398	0.3449	0.0589	-0.0540	0.0044	-0.0004	0.0135	0.0121	0.0078	-0.0058	-0.0001	-0.0042	-0.0032
54	5.4107	0.3368	0.0575	-0.0528	0.0043	-0.0004	0.0132	0.0118	0.0076	-0.0056	-0.0001	-0.0041	-0.0031
55	5.2799	0.3287	0.0561	-0.0515	0.0042	-0.0004	0.0129	0.0115	0.0074	-0.0055	-0.0001	-0.0040	-0.0031
56	5.1475	0.3204	0.0547	-0.0502	0.0041	-0.0004	0.0125	0.0112	0.0072	-0.0054	-0.0001	-0.0039	-0.0030
57	5.0135	0.3121	0.0533	-0.0489	0.0040	-0.0004	0.0122	0.0109	0.0070	-0.0052	-0.0001	-0.0038	-0.0029
58	4.8780	0.3037	0.0519	-0.0476	0.0039	-0.0004	0.0119	0.0106	0.0068	-0.0051	-0.0001	-0.0037	-0.0028
59	4.7410	0.2951	0.0504	-0.0462	0.0038	-0.0003	0.0116	0.0103	0.0066	-0.0049	-0.0001	-0.0036	-0.0027
60	4.6026	0.2865	0.0489	-0.0449	0.0037	-0.0003	0.0112	0.0100	0.0065	-0.0048	-0.0001	-0.0034	-0.0027
61	4.4628	0.2778	0.0474	-0.0435	0.0036	-0.0003	0.0109	0.0097	0.0063	-0.0047	-0.0001	-0.0033	-0.0026
62	4.3216	0.2690	0.0459	-0.0421	0.0035	-0.0003	0.0105	0.0094	0.0061	-0.0045	-0.0001	-0.0032	-0.0025
63	4.1791	0.2602	0.0444	-0.0407	0.0034	-0.0003	0.0102	0.0091	0.0059	-0.0044	-0.0001	-0.0031	-0.0024
64	4.0353	0.2512	0.0429	-0.0393	0.0032	-0.0003	0.0098	0.0088	0.0057	-0.0042	-0.0001	-0.0030	-0.0023
65	3.8903	0.2422	0.0414	-0.0379	0.0031	-0.0003	0.0095	0.0085	0.0055	-0.0041	-0.0001	-0.0029	-0.0023
66	3.7441	0.2331	0.0398	-0.0365	0.0030	-0.0003	0.0091	0.0082	0.0052	-0.0039	-0.0001	-0.0028	-0.0022
67	3.5968	0.2239	0.0382	-0.0351	0.0029	-0.0003	0.0088	0.0078	0.0050	-0.0037	0.0000	-0.0027	-0.0021
68	3.4483	0.2147	0.0367	-0.0336	0.0028	-0.0003	0.0084	0.0075	0.0048	-0.0036	0.0000	-0.0026	-0.0020
69	3.2989	0.2054	0.0351	-0.0322	0.0026	-0.0002	0.0080	0.0072	0.0046	-0.0034	0.0000	-0.0025	-0.0019
70	3.1484	0.1960	0.0335	-0.0307	0.0025	-0.0002	0.0077	0.0069	0.0044	-0.0033	0.0000	-0.0024	-0.0018
71	2.9969	0.1866	0.0319	-0.0292	0.0024	-0.0002	0.0073	0.0065	0.0042	-0.0031	0.0000	-0.0022	-0.0017
72	2.8446	0.1771	0.0302	-0.0277	0.0023	-0.0002	0.0069	0.0062	0.0040	-0.0030	0.0000	-0.0021	-0.0016
73	2.6913	0.1675	0.0286	-0.0262	0.0022	-0.0002	0.0066	0.0059	0.0038	-0.0028	0.0000	-0.0020	-0.0016
74	2.5373	0.1579	0.0270	-0.0247	0.0020	-0.0002	0.0062	0.0055	0.0036	-0.0026	0.0000	-0.0019	-0.0015
75	2.3825	0.1483	0.0253	-0.0232	0.0019	-0.0002	0.0058	0.0052	0.0033	-0.0025	0.0000	-0.0018	-0.0014
76	2.2269	0.1386	0.0237	-0.0217	0.0018	-0.0002	0.0054	0.0049	0.0031	-0.0023	0.0000	-0.0017	-0.0013
77	2.0707	0.1289	0.0220	-0.0202	0.0017	-0.0002	0.0050	0.0045	0.0029	-0.0022	0.0000	-0.0016	-0.0012
78	1.9139	0.1191	0.0203	-0.0187	0.0015	-0.0001	0.0047	0.0042	0.0027	-0.0020	0.0000	-0.0014	-0.0011
79	1.7564	0.1093	0.0187	-0.0171	0.0014	-0.0001	0.0043	0.0038	0.0025	-0.0018	0.0000	-0.0013	-0.0010
80	1.5985	0.0995	0.0170	-0.0156	0.0013	-0.0001	0.0039	0.0035	0.0022	-0.0017	0.0000	-0.0012	-0.0009
81	1.4400	0.0896	0.0153	-0.0140	0.0012	-0.0001	0.0035	0.0031	0.0020	-0.0015	0.0000	-0.0011	-0.0008
82	1.2811	0.0798	0.0136	-0.0125	0.0010	-0.0001	0.0031	0.0028	0.0018	-0.0013	0.0000	-0.0010	-0.0007
83	1.1218	0.0698	0.0119	-0.0109	0.0009	-0.0001	0.0027	0.0024	0.0016	-0.0012	0.0000	-0.0008	-0.0006
84	0.9622	0.0599	0.0102	-0.0094	0.0008	-0.0001	0.0023	0.0021	0.0013	-0.0010	0.0000	-0.0007	-0.0006
85	0.8023	0.0499	0.0085	-0.0078	0.0006	-0.0001	0.0020	0.0017	0.0011	-0.0008	0.0000	-0.0006	-0.0005
86	0.6421	0.0400	0.0068	-0.0063	0.0005	0.0000	0.0016	0.0014	0.0009	-0.0007	0.0000	-0.0005	-0.0004
87	0.4818	0.0300	0.0051	-0.0047	0.0004	0.0000	0.0012	0.0011	0.0007	-0.0005	0.0000	-0.0004	-0.0003
88	0.3213	0.0200	0.0034	-0.0031	0.0003	0.0000	0.0008	0.0007	0.0005	-0.0003	0.0000	-0.0002	-0.0002
89	0.1607	0.0100	0.0017	-0.0016	0.0001	0.0000	0.0004	0.0004	0.0002	-0.0002	0.0000	-0.0001	-0.0001
90	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

ϕ or θ	1	2	3	4	5	6	7	8	9	10	11	12	13
91	-0.1607	-0.0100	-0.0017	0.0016	-0.0001	0.0000	-0.0004	-0.0004	-0.0002	0.0002	0.0000	0.0001	0.0001
92	-0.3213	-0.0200	-0.0034	0.0031	-0.0003	0.0000	-0.0008	-0.0007	-0.0005	0.0003	0.0000	0.0002	0.0002
93	-0.4818	-0.0300	-0.0051	0.0047	-0.0004	0.0000	-0.0012	-0.0011	-0.0007	0.0005	0.0000	0.0004	0.0003
94	-0.6421	-0.0400	-0.0068	0.0063	-0.0005	0.0000	-0.0016	-0.0014	-0.0009	0.0007	0.0000	0.0005	0.0004
95	-0.8023	-0.0499	-0.0085	0.0078	-0.0006	0.0001	-0.0020	-0.0017	-0.0011	0.0008	0.0000	0.0006	0.0005
96	-0.9622	-0.0599	-0.0102	0.0094	-0.0008	0.0001	-0.0023	-0.0021	-0.0013	0.0010	0.0000	0.0007	0.0006
97	-1.1218	-0.0698	-0.0119	0.0109	-0.0009	0.0001	-0.0027	-0.0024	-0.0016	0.0012	0.0000	0.0008	0.0006
98	-1.2811	-0.0798	-0.0136	0.0125	-0.0010	0.0001	-0.0031	-0.0028	-0.0018	0.0013	0.0000	0.0010	0.0007
99	-1.4400	-0.0896	-0.0153	0.0140	-0.0012	0.0001	-0.0035	-0.0031	-0.0020	0.0015	0.0000	0.0011	0.0008
100	-1.5985	-0.0995	-0.0170	0.0156	-0.0013	0.0001	-0.0039	-0.0035	-0.0022	0.0017	0.0000	0.0012	0.0009
101	-1.7564	-0.1093	-0.0187	0.0171	-0.0014	0.0001	-0.0043	-0.0038	-0.0025	0.0018	0.0000	0.0013	0.0010
102	-1.9139	-0.1191	-0.0203	0.0187	-0.0015	0.0001	-0.0047	-0.0042	-0.0027	0.0020	0.0000	0.0014	0.0011
103	-2.0707	-0.1289	-0.0220	0.0202	-0.0017	0.0002	-0.0050	-0.0045	-0.0029	0.0022	0.0000	0.0016	0.0012
104	-2.2269	-0.1386	-0.0237	0.0217	-0.0018	0.0002	-0.0054	-0.0049	-0.0031	0.0023	0.0000	0.0017	0.0013
105	-2.3825	-0.1483	-0.0253	0.0232	-0.0019	0.0002	-0.0058	-0.0052	-0.0033	0.0025	0.0000	0.0018	0.0014
106	-2.5373	-0.1579	-0.0270	0.0247	-0.0020	0.0002	-0.0062	-0.0055	-0.0036	0.0026	0.0000	0.0019	0.0015
107	-2.6913	-0.1675	-0.0286	0.0262	-0.0022	0.0002	-0.0066	-0.0059	-0.0038	0.0028	0.0000	0.0020	0.0016
108	-2.8446	-0.1771	-0.0302	0.0277	-0.0023	0.0002	-0.0069	-0.0062	-0.0040	0.0030	0.0000	0.0021	0.0016
109	-2.9969	-0.1866	-0.0319	0.0292	-0.0024	0.0002	-0.0073	-0.0065	-0.0042	0.0031	0.0000	0.0022	0.0017
110	-3.1484	-0.1960	-0.0335	0.0307	-0.0025	0.0002	-0.0077	-0.0069	-0.0044	0.0033	0.0000	0.0024	0.0018
111	-3.2989	-0.2054	-0.0351	0.0322	-0.0026	0.0002	-0.0080	-0.0072	-0.0046	0.0034	0.0000	0.0025	0.0019
112	-3.4483	-0.2147	-0.0367	0.0336	-0.0028	0.0003	-0.0084	-0.0075	-0.0048	0.0036	0.0000	0.0026	0.0020
113	-3.5968	-0.2239	-0.0382	0.0351	-0.0029	0.0003	-0.0088	-0.0078	-0.0050	0.0037	0.0000	0.0027	0.0021
114	-3.7441	-0.2331	-0.0398	0.0365	-0.0030	0.0003	-0.0091	-0.0082	-0.0052	0.0039	0.0001	0.0028	0.0022
115	-3.8903	-0.2422	-0.0414	0.0379	-0.0031	0.0003	-0.0095	-0.0085	-0.0055	0.0041	0.0001	0.0029	0.0023
116	-4.0353	-0.2512	-0.0429	0.0393	-0.0032	0.0003	-0.0098	-0.0088	-0.0057	0.0042	0.0001	0.0030	0.0023
117	-4.1791	-0.2602	-0.0444	0.0407	-0.0034	0.0003	-0.0102	-0.0091	-0.0059	0.0044	0.0001	0.0031	0.0024
118	-4.3216	-0.2690	-0.0459	0.0421	-0.0035	0.0003	-0.0105	-0.0094	-0.0061	0.0045	0.0001	0.0032	0.0025
119	-4.4628	-0.2778	-0.0474	0.0435	-0.0036	0.0003	-0.0109	-0.0097	-0.0063	0.0047	0.0001	0.0033	0.0026
120	-4.6026	-0.2865	-0.0489	0.0449	-0.0037	0.0003	-0.0112	-0.0100	-0.0065	0.0048	0.0001	0.0034	0.0027
121	-4.7410	-0.2951	-0.0504	0.0462	-0.0038	0.0003	-0.0116	-0.0103	-0.0066	0.0049	0.0001	0.0036	0.0027
122	-4.8780	-0.3037	-0.0519	0.0476	-0.0039	0.0004	-0.0119	-0.0106	-0.0068	0.0051	0.0001	0.0037	0.0028
123	-5.0135	-0.3121	-0.0533	0.0489	-0.0040	0.0004	-0.0122	-0.0109	-0.0070	0.0052	0.0001	0.0038	0.0029
124	-5.1475	-0.3204	-0.0547	0.0502	-0.0041	0.0004	-0.0125	-0.0112	-0.0072	0.0054	0.0001	0.0039	0.0030
125	-5.2799	-0.3287	-0.0561	0.0515	-0.0042	0.0004	-0.0129	-0.0115	-0.0074	0.0055	0.0001	0.0040	0.0031
126	-5.4107	-0.3368	-0.0575	0.0528	-0.0043	0.0004	-0.0132	-0.0118	-0.0076	0.0056	0.0001	0.0041	0.0031
127	-5.5398	-0.3449	-0.0589	0.0540	-0.0044	0.0004	-0.0135	-0.0121	-0.0078	0.0058	0.0001	0.0042	0.0032
128	-5.6673	-0.3528	-0.0602	0.0553	-0.0045	0.0004	-0.0138	-0.0124	-0.0079	0.0059	0.0001	0.0042	0.0033
129	-5.7930	-0.3606	-0.0616	0.0565	-0.0046	0.0004	-0.0141	-0.0126	-0.0081	0.0060	0.0001	0.0043	0.0034
130	-5.9170	-0.3683	-0.0629	0.0577	-0.0047	0.0004	-0.0144	-0.0129	-0.0083	0.0062	0.0001	0.0044	0.0034
131	-6.0392	-0.3759	-0.0642	0.0589	-0.0048	0.0004	-0.0147	-0.0132	-0.0085	0.0063	0.0001	0.0045	0.0035
132	-6.1595	-0.3834	-0.0655	0.0601	-0.0049	0.0005	-0.0150	-0.0134	-0.0086	0.0064	0.0001	0.0046	0.0036
133	-6.2780	-0.3908	-0.0667	0.0612	-0.0050	0.0005	-0.0153	-0.0137	-0.0088	0.0065	0.0001	0.0047	0.0036
134	-6.3945	-0.3981	-0.0680	0.0623	-0.0051	0.0005	-0.0156	-0.0139	-0.0090	0.0067	0.0001	0.0048	0.0037
135	-6.5091	-0.4052	-0.0692	0.0635	-0.0052	0.0005	-0.0159	-0.0142	-0.0091	0.0068	0.0001	0.0049	0.0038
136	-6.6217	-0.4122	-0.0704	0.0646	-0.0053	0.0005	-0.0161	-0.0144	-0.0093	0.0069	0.0001	0.0050	0.0038

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137	-6.7323	-0.4191	-0.0716	0.0656	-0.0054	0.0005	-0.0164	-0.0147	-0.0094	0.0070	0.0001	0.0050	0.0039
138	-6.8408	-0.4258	-0.0727	0.0667	-0.0055	0.0005	-0.0167	-0.0149	-0.0096	0.0071	0.0001	0.0051	0.0040
139	-6.9473	-0.4325	-0.0738	0.0677	-0.0056	0.0005	-0.0169	-0.0151	-0.0097	0.0072	0.0001	0.0052	0.0040
140	-7.0516	-0.4390	-0.0750	0.0688	-0.0057	0.0005	-0.0172	-0.0154	-0.0099	0.0073	0.0001	0.0053	0.0041
141	-7.1538	-0.4453	-0.0760	0.0697	-0.0057	0.0005	-0.0174	-0.0156	-0.0100	0.0075	0.0001	0.0054	0.0041
142	-7.2538	-0.4516	-0.0771	0.0707	-0.0058	0.0005	-0.0177	-0.0158	-0.0102	0.0076	0.0001	0.0054	0.0042
143	-7.3516	-0.4576	-0.0781	0.0717	-0.0059	0.0005	-0.0179	-0.0160	-0.0103	0.0077	0.0001	0.0055	0.0043
144	-7.4472	-0.4636	-0.0792	0.0726	-0.0060	0.0005	-0.0182	-0.0162	-0.0104	0.0078	0.0001	0.0056	0.0043
145	-7.5405	-0.4694	-0.0802	0.0735	-0.0061	0.0006	-0.0184	-0.0164	-0.0106	0.0079	0.0001	0.0057	0.0044
146	-7.6315	-0.4751	-0.0811	0.0744	-0.0061	0.0006	-0.0186	-0.0166	-0.0107	0.0080	0.0001	0.0057	0.0044
147	-7.7202	-0.4806	-0.0821	0.0753	-0.0062	0.0006	-0.0188	-0.0168	-0.0108	0.0080	0.0001	0.0058	0.0045
148	-7.8065	-0.4860	-0.0830	0.0761	-0.0063	0.0006	-0.0190	-0.0170	-0.0109	0.0081	0.0001	0.0059	0.0045
149	-7.8904	-0.4912	-0.0839	0.0769	-0.0063	0.0006	-0.0192	-0.0172	-0.0111	0.0082	0.0001	0.0059	0.0046
150	-7.9720	-0.4963	-0.0847	0.0777	-0.0064	0.0006	-0.0194	-0.0174	-0.0112	0.0083	0.0001	0.0060	0.0046
151	-8.0511	-0.5012	-0.0856	0.0785	-0.0065	0.0006	-0.0196	-0.0176	-0.0113	0.0084	0.0001	0.0060	0.0047
152	-8.1277	-0.5060	-0.0864	0.0792	-0.0065	0.0006	-0.0198	-0.0177	-0.0114	0.0085	0.0001	0.0061	0.0047
153	-8.2019	-0.5106	-0.0872	0.0800	-0.0066	0.0006	-0.0200	-0.0179	-0.0115	0.0085	0.0001	0.0061	0.0048
154	-8.2736	-0.5150	-0.0879	0.0807	-0.0066	0.0006	-0.0202	-0.0180	-0.0116	0.0086	0.0001	0.0062	0.0048
155	-8.3428	-0.5193	-0.0887	0.0813	-0.0067	0.0006	-0.0203	-0.0182	-0.0117	0.0087	0.0001	0.0063	0.0048
156	-8.4094	-0.5235	-0.0894	0.0820	-0.0067	0.0006	-0.0205	-0.0183	-0.0118	0.0088	0.0001	0.0063	0.0049
157	-8.4735	-0.5275	-0.0901	0.0826	-0.0068	0.0006	-0.0207	-0.0185	-0.0119	0.0088	0.0001	0.0063	0.0049
158	-8.5349	-0.5313	-0.0907	0.0832	-0.0068	0.0006	-0.0208	-0.0186	-0.0120	0.0089	0.0001	0.0064	0.0049
159	-8.5938	-0.5350	-0.0913	0.0838	-0.0069	0.0006	-0.0209	-0.0187	-0.0120	0.0090	0.0001	0.0064	0.0050
160	-8.6501	-0.5385	-0.0919	0.0843	-0.0069	0.0006	-0.0211	-0.0189	-0.0121	0.0090	0.0001	0.0065	0.0050
161	-8.7037	-0.5418	-0.0925	0.0849	-0.0070	0.0006	-0.0212	-0.0190	-0.0122	0.0091	0.0001	0.0065	0.0050
162	-8.7547	-0.5450	-0.0931	0.0854	-0.0070	0.0006	-0.0213	-0.0191	-0.0123	0.0091	0.0001	0.0066	0.0051
163	-8.8030	-0.5480	-0.0936	0.0858	-0.0071	0.0006	-0.0215	-0.0192	-0.0123	0.0092	0.0001	0.0066	0.0051
164	-8.8486	-0.5508	-0.0941	0.0863	-0.0071	0.0006	-0.0216	-0.0193	-0.0124	0.0092	0.0001	0.0066	0.0051
165	-8.8916	-0.5535	-0.0945	0.0867	-0.0071	0.0007	-0.0217	-0.0194	-0.0125	0.0093	0.0001	0.0067	0.0051
166	-8.9318	-0.5560	-0.0949	0.0871	-0.0072	0.0007	-0.0218	-0.0195	-0.0125	0.0093	0.0001	0.0067	0.0052
167	-8.9693	-0.5583	-0.0953	0.0874	-0.0072	0.0007	-0.0219	-0.0196	-0.0126	0.0093	0.0001	0.0067	0.0052
168	-9.0041	-0.5605	-0.0957	0.0878	-0.0072	0.0007	-0.0219	-0.0196	-0.0126	0.0094	0.0001	0.0067	0.0052
169	-9.0361	-0.5625	-0.0960	0.0881	-0.0073	0.0007	-0.0220	-0.0197	-0.0127	0.0094	0.0001	0.0068	0.0052
170	-9.0654	-0.5643	-0.0964	0.0884	-0.0073	0.0007	-0.0221	-0.0198	-0.0127	0.0094	0.0001	0.0068	0.0053
171	-9.0919	-0.5660	-0.0966	0.0886	-0.0073	0.0007	-0.0222	-0.0198	-0.0127	0.0095	0.0001	0.0068	0.0053
172	-9.1156	-0.5675	-0.0969	0.0889	-0.0073	0.0007	-0.0222	-0.0199	-0.0128	0.0095	0.0001	0.0068	0.0053
173	-9.1366	-0.5688	-0.0971	0.0891	-0.0073	0.0007	-0.0223	-0.0199	-0.0128	0.0095	0.0001	0.0068	0.0053
174	-9.1548	-0.5699	-0.0973	0.0893	-0.0073	0.0007	-0.0223	-0.0200	-0.0128	0.0095	0.0001	0.0069	0.0053
175	-9.1702	-0.5709	-0.0975	0.0894	-0.0074	0.0007	-0.0224	-0.0200	-0.0129	0.0096	0.0001	0.0069	0.0053
176	-9.1828	-0.5716	-0.0976	0.0895	-0.0074	0.0007	-0.0224	-0.0200	-0.0129	0.0096	0.0001	0.0069	0.0053
177	-9.1926	-0.5722	-0.0977	0.0896	-0.0074	0.0007	-0.0224	-0.0200	-0.0129	0.0096	0.0001	0.0069	0.0053
178	-9.1996	-0.5727	-0.0978	0.0897	-0.0074	0.0007	-0.0224	-0.0201	-0.0129	0.0096	0.0001	0.0069	0.0053
179	-9.2038	-0.5729	-0.0978	0.0897	-0.0074	0.0007	-0.0224	-0.0201	-0.0129	0.0096	0.0001	0.0069	0.0053
180	-9.2052	-0.5730	-0.0978	0.0897	-0.0074	0.0007	-0.0224	-0.0201	-0.0129	0.0096	0.0001	0.0069	0.0053
181	-9.2038	-0.5729	-0.0978	0.0897	-0.0074	0.0007	-0.0224	-0.0201	-0.0129	0.0096	0.0001	0.0069	0.0053
182	-9.1996	-0.5727	-0.0978	0.0897	-0.0074	0.0007	-0.0224	-0.0201	-0.0129	0.0096	0.0001	0.0069	0.0053

ϕ or θ	1	2	3	4	5	6	7	8	9	10	11	12	13
183	-9.1926	-0.5722	-0.0977	0.0896	-0.0074	0.0007	-0.0224	-0.0200	-0.0129	0.0096	0.0001	0.0069	0.0053
184	-9.1828	-0.5716	-0.0976	0.0895	-0.0074	0.0007	-0.0224	-0.0200	-0.0129	0.0096	0.0001	0.0069	0.0053
185	-9.1702	-0.5709	-0.0975	0.0894	-0.0074	0.0007	-0.0224	-0.0200	-0.0129	0.0096	0.0001	0.0069	0.0053
186	-9.1548	-0.5699	-0.0973	0.0893	-0.0073	0.0007	-0.0223	-0.0200	-0.0128	0.0095	0.0001	0.0069	0.0053
187	-9.1366	-0.5688	-0.0971	0.0891	-0.0073	0.0007	-0.0223	-0.0199	-0.0128	0.0095	0.0001	0.0068	0.0053
188	-9.1156	-0.5675	-0.0969	0.0889	-0.0073	0.0007	-0.0222	-0.0199	-0.0128	0.0095	0.0001	0.0068	0.0053
189	-9.0919	-0.5660	-0.0966	0.0886	-0.0073	0.0007	-0.0222	-0.0198	-0.0127	0.0095	0.0001	0.0068	0.0053
190	-9.0654	-0.5643	-0.0964	0.0884	-0.0073	0.0007	-0.0221	-0.0198	-0.0127	0.0094	0.0001	0.0068	0.0053
191	-9.0361	-0.5625	-0.0960	0.0881	-0.0073	0.0007	-0.0220	-0.0197	-0.0127	0.0094	0.0001	0.0068	0.0052
192	-9.0041	-0.5605	-0.0957	0.0878	-0.0072	0.0007	-0.0219	-0.0196	-0.0126	0.0094	0.0001	0.0067	0.0052
193	-8.9693	-0.5583	-0.0953	0.0874	-0.0072	0.0007	-0.0219	-0.0196	-0.0126	0.0093	0.0001	0.0067	0.0052
194	-8.9318	-0.5560	-0.0949	0.0871	-0.0072	0.0007	-0.0218	-0.0195	-0.0125	0.0093	0.0001	0.0067	0.0052
195	-8.8916	-0.5535	-0.0945	0.0867	-0.0071	0.0007	-0.0217	-0.0194	-0.0125	0.0093	0.0001	0.0067	0.0051
196	-8.8486	-0.5508	-0.0941	0.0863	-0.0071	0.0006	-0.0216	-0.0193	-0.0124	0.0092	0.0001	0.0066	0.0051
197	-8.8030	-0.5480	-0.0936	0.0858	-0.0071	0.0006	-0.0215	-0.0192	-0.0123	0.0092	0.0001	0.0066	0.0051
198	-8.7547	-0.5450	-0.0931	0.0854	-0.0070	0.0006	-0.0213	-0.0191	-0.0123	0.0091	0.0001	0.0066	0.0051
199	-8.7037	-0.5418	-0.0925	0.0849	-0.0070	0.0006	-0.0212	-0.0190	-0.0122	0.0091	0.0001	0.0065	0.0050
200	-8.6501	-0.5385	-0.0919	0.0843	-0.0069	0.0006	-0.0211	-0.0189	-0.0121	0.0090	0.0001	0.0065	0.0050
201	-8.5938	-0.5350	-0.0913	0.0838	-0.0069	0.0006	-0.0209	-0.0187	-0.0120	0.0090	0.0001	0.0064	0.0050
202	-8.5349	-0.5313	-0.0907	0.0832	-0.0068	0.0006	-0.0208	-0.0186	-0.0120	0.0089	0.0001	0.0064	0.0049
203	-8.4735	-0.5275	-0.0901	0.0826	-0.0068	0.0006	-0.0207	-0.0185	-0.0119	0.0088	0.0001	0.0063	0.0049
204	-8.4094	-0.5235	-0.0894	0.0820	-0.0067	0.0006	-0.0205	-0.0183	-0.0118	0.0088	0.0001	0.0063	0.0049
205	-8.3428	-0.5193	-0.0887	0.0813	-0.0067	0.0006	-0.0203	-0.0182	-0.0117	0.0087	0.0001	0.0063	0.0048
206	-8.2736	-0.5150	-0.0879	0.0807	-0.0066	0.0006	-0.0202	-0.0180	-0.0116	0.0086	0.0001	0.0062	0.0048
207	-8.2019	-0.5106	-0.0872	0.0800	-0.0066	0.0006	-0.0200	-0.0179	-0.0115	0.0085	0.0001	0.0061	0.0048
208	-8.1277	-0.5060	-0.0864	0.0792	-0.0065	0.0006	-0.0198	-0.0177	-0.0114	0.0085	0.0001	0.0061	0.0047
209	-8.0511	-0.5012	-0.0856	0.0785	-0.0065	0.0006	-0.0196	-0.0176	-0.0113	0.0084	0.0001	0.0060	0.0047
210	-7.9720	-0.4963	-0.0847	0.0777	-0.0064	0.0006	-0.0194	-0.0174	-0.0112	0.0083	0.0001	0.0060	0.0046
211	-7.8904	-0.4912	-0.0839	0.0769	-0.0063	0.0006	-0.0192	-0.0172	-0.0111	0.0082	0.0001	0.0059	0.0046
212	-7.8065	-0.4860	-0.0830	0.0761	-0.0063	0.0006	-0.0190	-0.0170	-0.0109	0.0081	0.0001	0.0059	0.0045
213	-7.7202	-0.4806	-0.0821	0.0753	-0.0062	0.0006	-0.0188	-0.0168	-0.0108	0.0080	0.0001	0.0058	0.0045
214	-7.6315	-0.4751	-0.0811	0.0744	-0.0061	0.0006	-0.0186	-0.0166	-0.0107	0.0080	0.0001	0.0057	0.0044
215	-7.5405	-0.4694	-0.0802	0.0735	-0.0061	0.0006	-0.0184	-0.0164	-0.0106	0.0079	0.0001	0.0057	0.0044
216	-7.4472	-0.4636	-0.0792	0.0726	-0.0060	0.0005	-0.0182	-0.0162	-0.0104	0.0078	0.0001	0.0056	0.0043
217	-7.3516	-0.4576	-0.0781	0.0717	-0.0059	0.0005	-0.0179	-0.0160	-0.0103	0.0077	0.0001	0.0055	0.0043
218	-7.2538	-0.4516	-0.0771	0.0707	-0.0058	0.0005	-0.0177	-0.0158	-0.0102	0.0076	0.0001	0.0054	0.0042
219	-7.1538	-0.4453	-0.0760	0.0697	-0.0057	0.0005	-0.0174	-0.0156	-0.0100	0.0075	0.0001	0.0054	0.0041
220	-7.0516	-0.4390	-0.0750	0.0688	-0.0057	0.0005	-0.0172	-0.0154	-0.0099	0.0073	0.0001	0.0053	0.0041
221	-6.9473	-0.4325	-0.0738	0.0677	-0.0056	0.0005	-0.0169	-0.0151	-0.0097	0.0072	0.0001	0.0052	0.0040
222	-6.8408	-0.4258	-0.0727	0.0667	-0.0055	0.0005	-0.0167	-0.0149	-0.0096	0.0071	0.0001	0.0051	0.0040
223	-6.7323	-0.4191	-0.0716	0.0656	-0.0054	0.0005	-0.0164	-0.0147	-0.0094	0.0070	0.0001	0.0050	0.0039
224	-6.6217	-0.4122	-0.0704	0.0646	-0.0053	0.0005	-0.0161	-0.0144	-0.0093	0.0069	0.0001	0.0050	0.0038
225	-6.5091	-0.4052	-0.0692	0.0635	-0.0052	0.0005	-0.0159	-0.0142	-0.0091	0.0068	0.0001	0.0049	0.0038
226	-6.3945	-0.3981	-0.0680	0.0623	-0.0051	0.0005	-0.0156	-0.0139	-0.0090	0.0067	0.0001	0.0048	0.0037
227	-6.2780	-0.3908	-0.0667	0.0612	-0.0050	0.0005	-0.0153	-0.0137	-0.0088	0.0065	0.0001	0.0047	0.0036
228	-6.1595	-0.3834	-0.0655	0.0601	-0.0049	0.0005	-0.0150	-0.0134	-0.0086	0.0064	0.0001	0.0046	0.0036

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229	-6.0392	-0.3759	-0.0642	0.0589	-0.0048	0.0004	-0.0147	-0.0132	-0.0085	0.0063	0.0001	0.0045	0.0035
230	-5.9170	-0.3683	-0.0629	0.0577	-0.0047	0.0004	-0.0144	-0.0129	-0.0083	0.0062	0.0001	0.0044	0.0034
231	-5.7930	-0.3606	-0.0616	0.0565	-0.0046	0.0004	-0.0141	-0.0126	-0.0081	0.0060	0.0001	0.0043	0.0034
232	-5.6673	-0.3528	-0.0602	0.0553	-0.0045	0.0004	-0.0138	-0.0124	-0.0079	0.0059	0.0001	0.0042	0.0033
233	-5.5398	-0.3449	-0.0589	0.0540	-0.0044	0.0004	-0.0135	-0.0121	-0.0078	0.0058	0.0001	0.0042	0.0032
234	-5.4107	-0.3368	-0.0575	0.0528	-0.0043	0.0004	-0.0132	-0.0118	-0.0076	0.0056	0.0001	0.0041	0.0031
235	-5.2799	-0.3287	-0.0561	0.0515	-0.0042	0.0004	-0.0129	-0.0115	-0.0074	0.0055	0.0001	0.0040	0.0031
236	-5.1475	-0.3204	-0.0547	0.0502	-0.0041	0.0004	-0.0125	-0.0112	-0.0072	0.0054	0.0001	0.0039	0.0030
237	-5.0135	-0.3121	-0.0533	0.0489	-0.0040	0.0004	-0.0122	-0.0109	-0.0070	0.0052	0.0001	0.0038	0.0029
238	-4.8780	-0.3037	-0.0519	0.0476	-0.0039	0.0004	-0.0119	-0.0106	-0.0068	0.0051	0.0001	0.0037	0.0028
239	-4.7410	-0.2951	-0.0504	0.0462	-0.0038	0.0003	-0.0116	-0.0103	-0.0066	0.0049	0.0001	0.0036	0.0027
240	-4.6026	-0.2865	-0.0489	0.0449	-0.0037	0.0003	-0.0112	-0.0100	-0.0065	0.0048	0.0001	0.0034	0.0027
241	-4.4628	-0.2778	-0.0474	0.0435	-0.0036	0.0003	-0.0109	-0.0097	-0.0063	0.0047	0.0001	0.0033	0.0026
242	-4.3216	-0.2690	-0.0459	0.0421	-0.0035	0.0003	-0.0105	-0.0094	-0.0061	0.0045	0.0001	0.0032	0.0025
243	-4.1791	-0.2602	-0.0444	0.0407	-0.0034	0.0003	-0.0102	-0.0091	-0.0059	0.0044	0.0001	0.0031	0.0024
244	-4.0353	-0.2512	-0.0429	0.0393	-0.0032	0.0003	-0.0098	-0.0088	-0.0057	0.0042	0.0001	0.0030	0.0023
245	-3.8903	-0.2422	-0.0414	0.0379	-0.0031	0.0003	-0.0095	-0.0085	-0.0055	0.0041	0.0001	0.0029	0.0023
246	-3.7441	-0.2331	-0.0398	0.0365	-0.0030	0.0003	-0.0091	-0.0082	-0.0052	0.0039	0.0001	0.0028	0.0022
247	-3.5968	-0.2239	-0.0382	0.0351	-0.0029	0.0003	-0.0088	-0.0078	-0.0050	0.0037	0.0000	0.0027	0.0021
248	-3.4483	-0.2147	-0.0367	0.0336	-0.0028	0.0003	-0.0084	-0.0075	-0.0048	0.0036	0.0000	0.0026	0.0020
249	-3.2989	-0.2054	-0.0351	0.0322	-0.0026	0.0002	-0.0080	-0.0072	-0.0046	0.0034	0.0000	0.0025	0.0019
250	-3.1484	-0.1960	-0.0335	0.0307	-0.0025	0.0002	-0.0077	-0.0069	-0.0044	0.0033	0.0000	0.0024	0.0018
251	-2.9969	-0.1866	-0.0319	0.0292	-0.0024	0.0002	-0.0073	-0.0065	-0.0042	0.0031	0.0000	0.0022	0.0017
252	-2.8446	-0.1771	-0.0302	0.0277	-0.0023	0.0002	-0.0069	-0.0062	-0.0040	0.0030	0.0000	0.0021	0.0016
253	-2.6913	-0.1675	-0.0286	0.0262	-0.0022	0.0002	-0.0066	-0.0059	-0.0038	0.0028	0.0000	0.0020	0.0016
254	-2.5373	-0.1579	-0.0270	0.0247	-0.0020	0.0002	-0.0062	-0.0055	-0.0036	0.0026	0.0000	0.0019	0.0015
255	-2.3825	-0.1483	-0.0253	0.0232	-0.0019	0.0002	-0.0058	-0.0052	-0.0033	0.0025	0.0000	0.0018	0.0014
256	-2.2269	-0.1386	-0.0237	0.0217	-0.0018	0.0002	-0.0054	-0.0049	-0.0031	0.0023	0.0000	0.0017	0.0013
257	-2.0707	-0.1289	-0.0220	0.0202	-0.0017	0.0002	-0.0050	-0.0045	-0.0029	0.0022	0.0000	0.0016	0.0012
258	-1.9139	-0.1191	-0.0203	0.0187	-0.0015	0.0001	-0.0047	-0.0042	-0.0027	0.0020	0.0000	0.0014	0.0011
259	-1.7564	-0.1093	-0.0187	0.0171	-0.0014	0.0001	-0.0043	-0.0038	-0.0025	0.0018	0.0000	0.0013	0.0010
260	-1.5985	-0.0995	-0.0170	0.0156	-0.0013	0.0001	-0.0039	-0.0035	-0.0022	0.0017	0.0000	0.0012	0.0009
261	-1.4400	-0.0896	-0.0153	0.0140	-0.0012	0.0001	-0.0035	-0.0031	-0.0020	0.0015	0.0000	0.0011	0.0008
262	-1.2811	-0.0798	-0.0136	0.0125	-0.0010	0.0001	-0.0031	-0.0028	-0.0018	0.0013	0.0000	0.0010	0.0007
263	-1.1218	-0.0698	-0.0119	0.0109	-0.0009	0.0001	-0.0027	-0.0024	-0.0016	0.0012	0.0000	0.0008	0.0006
264	-0.9622	-0.0599	-0.0102	0.0094	-0.0008	0.0001	-0.0023	-0.0021	-0.0013	0.0010	0.0000	0.0007	0.0006
265	-0.8023	-0.0499	-0.0085	0.0078	-0.0006	0.0001	-0.0020	-0.0017	-0.0011	0.0008	0.0000	0.0006	0.0005
266	-0.6421	-0.0400	-0.0068	0.0063	-0.0005	0.0000	-0.0016	-0.0014	-0.0009	0.0007	0.0000	0.0005	0.0004
267	-0.4818	-0.0300	-0.0051	0.0047	-0.0004	0.0000	-0.0012	-0.0011	-0.0007	0.0005	0.0000	0.0004	0.0003
268	-0.3213	-0.0200	-0.0034	0.0031	-0.0003	0.0000	-0.0008	-0.0007	-0.0005	0.0003	0.0000	0.0002	0.0002
269	-0.1607	-0.0100	-0.0017	0.0016	-0.0001	0.0000	-0.0004	-0.0004	-0.0002	0.0002	0.0000	0.0001	0.0001
270	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
271	0.1607	0.0100	0.0017	-0.0016	0.0001	0.0000	0.0004	0.0004	0.0002	-0.0002	0.0000	-0.0001	-0.0001
272	0.3213	0.0200	0.0034	-0.0031	0.0003	0.0000	0.0008	0.0007	0.0005	-0.0003	0.0000	-0.0002	-0.0002
273	0.4818	0.0300	0.0051	-0.0047	0.0004	0.0000	0.0012	0.0011	0.0007	-0.0005	0.0000	-0.0004	-0.0003
274	0.6421	0.0400	0.0068	-0.0063	0.0005	0.0000	0.0016	0.0014	0.0009	-0.0007	0.0000	-0.0005	-0.0004

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275	0.8023	0.0499	0.0085	-0.0078	0.0006	-0.0001	0.0020	0.0017	0.0011	-0.0008	0.0000	-0.0006	-0.0005
276	0.9622	0.0599	0.0102	-0.0094	0.0008	-0.0001	0.0023	0.0021	0.0013	-0.0010	0.0000	-0.0007	-0.0006
277	1.1218	0.0698	0.0119	-0.0109	0.0009	-0.0001	0.0027	0.0024	0.0016	-0.0012	0.0000	-0.0008	-0.0006
278	1.2811	0.0798	0.0136	-0.0125	0.0010	-0.0001	0.0031	0.0028	0.0018	-0.0013	0.0000	-0.0010	-0.0007
279	1.4400	0.0896	0.0153	-0.0140	0.0012	-0.0001	0.0035	0.0031	0.0020	-0.0015	0.0000	-0.0011	-0.0008
280	1.5985	0.0995	0.0170	-0.0156	0.0013	-0.0001	0.0039	0.0035	0.0022	-0.0017	0.0000	-0.0012	-0.0009
281	1.7564	0.1093	0.0187	-0.0171	0.0014	-0.0001	0.0043	0.0038	0.0025	-0.0018	0.0000	-0.0013	-0.0010
282	1.9139	0.1191	0.0203	-0.0187	0.0015	-0.0001	0.0047	0.0042	0.0027	-0.0020	0.0000	-0.0014	-0.0011
283	2.0707	0.1289	0.0220	-0.0202	0.0017	-0.0002	0.0050	0.0045	0.0029	-0.0022	0.0000	-0.0016	-0.0012
284	2.2269	0.1386	0.0237	-0.0217	0.0018	-0.0002	0.0054	0.0049	0.0031	-0.0023	0.0000	-0.0017	-0.0013
285	2.3825	0.1483	0.0253	-0.0232	0.0019	-0.0002	0.0058	0.0052	0.0033	-0.0025	0.0000	-0.0018	-0.0014
286	2.5373	0.1579	0.0270	-0.0247	0.0020	-0.0002	0.0062	0.0055	0.0036	-0.0026	0.0000	-0.0019	-0.0015
287	2.6913	0.1675	0.0286	-0.0262	0.0022	-0.0002	0.0066	0.0059	0.0038	-0.0028	0.0000	-0.0020	-0.0016
288	2.8446	0.1771	0.0302	-0.0277	0.0023	-0.0002	0.0069	0.0062	0.0040	-0.0030	0.0000	-0.0021	-0.0016
289	2.9969	0.1866	0.0319	-0.0292	0.0024	-0.0002	0.0073	0.0065	0.0042	-0.0031	0.0000	-0.0022	-0.0017
290	3.1484	0.1960	0.0335	-0.0307	0.0025	-0.0002	0.0077	0.0069	0.0044	-0.0033	0.0000	-0.0024	-0.0018
291	3.2989	0.2054	0.0351	-0.0322	0.0026	-0.0002	0.0080	0.0072	0.0046	-0.0034	0.0000	-0.0025	-0.0019
292	3.4483	0.2147	0.0367	-0.0336	0.0028	-0.0003	0.0084	0.0075	0.0048	-0.0036	0.0000	-0.0026	-0.0020
293	3.5968	0.2239	0.0382	-0.0351	0.0029	-0.0003	0.0088	0.0078	0.0050	-0.0037	0.0000	-0.0027	-0.0021
294	3.7441	0.2331	0.0398	-0.0365	0.0030	-0.0003	0.0091	0.0082	0.0052	-0.0039	-0.0001	-0.0028	-0.0022
295	3.8903	0.2422	0.0414	-0.0379	0.0031	-0.0003	0.0095	0.0085	0.0055	-0.0041	-0.0001	-0.0029	-0.0023
296	4.0353	0.2512	0.0429	-0.0393	0.0032	-0.0003	0.0098	0.0088	0.0057	-0.0042	-0.0001	-0.0030	-0.0023
297	4.1791	0.2602	0.0444	-0.0407	0.0034	-0.0003	0.0102	0.0091	0.0059	-0.0044	-0.0001	-0.0031	-0.0024
298	4.3216	0.2690	0.0459	-0.0421	0.0035	-0.0003	0.0105	0.0094	0.0061	-0.0045	-0.0001	-0.0032	-0.0025
299	4.4628	0.2778	0.0474	-0.0435	0.0036	-0.0003	0.0109	0.0097	0.0063	-0.0047	-0.0001	-0.0033	-0.0026
300	4.6026	0.2865	0.0489	-0.0449	0.0037	-0.0003	0.0112	0.0100	0.0065	-0.0048	-0.0001	-0.0034	-0.0027
301	4.7410	0.2951	0.0504	-0.0462	0.0038	-0.0003	0.0116	0.0103	0.0066	-0.0049	-0.0001	-0.0036	-0.0027
302	4.8780	0.3037	0.0519	-0.0476	0.0039	-0.0004	0.0119	0.0106	0.0068	-0.0051	-0.0001	-0.0037	-0.0028
303	5.0135	0.3121	0.0533	-0.0489	0.0040	-0.0004	0.0122	0.0109	0.0070	-0.0052	-0.0001	-0.0038	-0.0029
304	5.1475	0.3204	0.0547	-0.0502	0.0041	-0.0004	0.0125	0.0112	0.0072	-0.0054	-0.0001	-0.0039	-0.0030
305	5.2799	0.3287	0.0561	-0.0515	0.0042	-0.0004	0.0129	0.0115	0.0074	-0.0055	-0.0001	-0.0040	-0.0031
306	5.4107	0.3368	0.0575	-0.0528	0.0043	-0.0004	0.0132	0.0118	0.0076	-0.0056	-0.0001	-0.0041	-0.0031
307	5.5398	0.3449	0.0589	-0.0540	0.0044	-0.0004	0.0135	0.0121	0.0078	-0.0058	-0.0001	-0.0042	-0.0032
308	5.6673	0.3528	0.0602	-0.0553	0.0045	-0.0004	0.0138	0.0124	0.0079	-0.0059	-0.0001	-0.0042	-0.0033
309	5.7930	0.3606	0.0616	-0.0565	0.0046	-0.0004	0.0141	0.0126	0.0081	-0.0060	-0.0001	-0.0043	-0.0034
310	5.9170	0.3683	0.0629	-0.0577	0.0047	-0.0004	0.0144	0.0129	0.0083	-0.0062	-0.0001	-0.0044	-0.0034
311	6.0392	0.3759	0.0642	-0.0589	0.0048	-0.0004	0.0147	0.0132	0.0085	-0.0063	-0.0001	-0.0045	-0.0035
312	6.1595	0.3834	0.0655	-0.0601	0.0049	-0.0005	0.0150	0.0134	0.0086	-0.0064	-0.0001	-0.0046	-0.0036
313	6.2780	0.3908	0.0667	-0.0612	0.0050	-0.0005	0.0153	0.0137	0.0088	-0.0065	-0.0001	-0.0047	-0.0036
314	6.3945	0.3981	0.0680	-0.0623	0.0051	-0.0005	0.0156	0.0139	0.0090	-0.0067	-0.0001	-0.0048	-0.0037
315	6.5091	0.4052	0.0692	-0.0635	0.0052	-0.0005	0.0159	0.0142	0.0091	-0.0068	-0.0001	-0.0049	-0.0038
316	6.6217	0.4122	0.0704	-0.0646	0.0053	-0.0005	0.0161	0.0144	0.0093	-0.0069	-0.0001	-0.0050	-0.0038
317	6.7323	0.4191	0.0716	-0.0656	0.0054	-0.0005	0.0164	0.0147	0.0094	-0.0070	-0.0001	-0.0050	-0.0039
318	6.8408	0.4258	0.0727	-0.0667	0.0055	-0.0005	0.0167	0.0149	0.0096	-0.0071	-0.0001	-0.0051	-0.0040
319	6.9473	0.4325	0.0738	-0.0677	0.0056	-0.0005	0.0169	0.0151	0.0097	-0.0072	-0.0001	-0.0052	-0.0040
320	7.0516	0.4390	0.0750	-0.0688	0.0057	-0.0005	0.0172	0.0154	0.0099	-0.0073	-0.0001	-0.0053	-0.0041

ϕ or θ	1	2	3	4	5	6	7	8	9	10	11	12	13
321	7.1538	0.4453	0.0760	-0.0697	0.0057	-0.0005	0.0174	0.0156	0.0100	-0.0075	-0.0001	-0.0054	-0.0041
322	7.2538	0.4516	0.0771	-0.0707	0.0058	-0.0005	0.0177	0.0158	0.0102	-0.0076	-0.0001	-0.0054	-0.0042
323	7.3516	0.4576	0.0781	-0.0717	0.0059	-0.0005	0.0179	0.0160	0.0103	-0.0077	-0.0001	-0.0055	-0.0043
324	7.4472	0.4636	0.0792	-0.0726	0.0060	-0.0005	0.0182	0.0162	0.0104	-0.0078	-0.0001	-0.0056	-0.0043
325	7.5405	0.4694	0.0802	-0.0735	0.0061	-0.0006	0.0184	0.0164	0.0106	-0.0079	-0.0001	-0.0057	-0.0044
326	7.6315	0.4751	0.0811	-0.0744	0.0061	-0.0006	0.0186	0.0166	0.0107	-0.0080	-0.0001	-0.0057	-0.0044
327	7.7202	0.4806	0.0821	-0.0753	0.0062	-0.0006	0.0188	0.0168	0.0108	-0.0080	-0.0001	-0.0058	-0.0045
328	7.8065	0.4860	0.0830	-0.0761	0.0063	-0.0006	0.0190	0.0170	0.0109	-0.0081	-0.0001	-0.0059	-0.0045
329	7.8904	0.4912	0.0839	-0.0769	0.0063	-0.0006	0.0192	0.0172	0.0111	-0.0082	-0.0001	-0.0059	-0.0046
330	7.9720	0.4963	0.0847	-0.0777	0.0064	-0.0006	0.0194	0.0174	0.0112	-0.0083	-0.0001	-0.0060	-0.0046
331	8.0511	0.5012	0.0856	-0.0785	0.0065	-0.0006	0.0196	0.0176	0.0113	-0.0084	-0.0001	-0.0060	-0.0047
332	8.1277	0.5060	0.0864	-0.0792	0.0065	-0.0006	0.0198	0.0177	0.0114	-0.0085	-0.0001	-0.0061	-0.0047
333	8.2019	0.5106	0.0872	-0.0800	0.0066	-0.0006	0.0200	0.0179	0.0115	-0.0085	-0.0001	-0.0061	-0.0048
334	8.2736	0.5150	0.0879	-0.0807	0.0066	-0.0006	0.0202	0.0180	0.0116	-0.0086	-0.0001	-0.0062	-0.0048
335	8.3428	0.5193	0.0887	-0.0813	0.0067	-0.0006	0.0203	0.0182	0.0117	-0.0087	-0.0001	-0.0063	-0.0048
336	8.4094	0.5235	0.0894	-0.0820	0.0067	-0.0006	0.0205	0.0183	0.0118	-0.0088	-0.0001	-0.0063	-0.0049
337	8.4735	0.5275	0.0901	-0.0826	0.0068	-0.0006	0.0207	0.0185	0.0119	-0.0088	-0.0001	-0.0063	-0.0049
338	8.5349	0.5313	0.0907	-0.0832	0.0068	-0.0006	0.0208	0.0186	0.0120	-0.0089	-0.0001	-0.0064	-0.0049
339	8.5938	0.5350	0.0913	-0.0838	0.0069	-0.0006	0.0209	0.0187	0.0120	-0.0090	-0.0001	-0.0064	-0.0050
340	8.6501	0.5385	0.0919	-0.0843	0.0069	-0.0006	0.0211	0.0189	0.0121	-0.0090	-0.0001	-0.0065	-0.0050
341	8.7037	0.5418	0.0925	-0.0849	0.0070	-0.0006	0.0212	0.0190	0.0122	-0.0091	-0.0001	-0.0065	-0.0050
342	8.7547	0.5450	0.0931	-0.0854	0.0070	-0.0006	0.0213	0.0191	0.0123	-0.0091	-0.0001	-0.0066	-0.0051
343	8.8030	0.5480	0.0936	-0.0858	0.0071	-0.0006	0.0215	0.0192	0.0123	-0.0092	-0.0001	-0.0066	-0.0051
344	8.8486	0.5508	0.0941	-0.0863	0.0071	-0.0006	0.0216	0.0193	0.0124	-0.0092	-0.0001	-0.0066	-0.0051
345	8.8916	0.5535	0.0945	-0.0867	0.0071	-0.0007	0.0217	0.0194	0.0125	-0.0093	-0.0001	-0.0067	-0.0051
346	8.9318	0.5560	0.0949	-0.0871	0.0072	-0.0007	0.0218	0.0195	0.0125	-0.0093	-0.0001	-0.0067	-0.0052
347	8.9693	0.5583	0.0953	-0.0874	0.0072	-0.0007	0.0219	0.0196	0.0126	-0.0093	-0.0001	-0.0067	-0.0052
348	9.0041	0.5605	0.0957	-0.0878	0.0072	-0.0007	0.0219	0.0196	0.0126	-0.0094	-0.0001	-0.0067	-0.0052
349	9.0361	0.5625	0.0960	-0.0881	0.0073	-0.0007	0.0220	0.0197	0.0127	-0.0094	-0.0001	-0.0068	-0.0052
350	9.0654	0.5643	0.0964	-0.0884	0.0073	-0.0007	0.0221	0.0198	0.0127	-0.0094	-0.0001	-0.0068	-0.0053
351	9.0919	0.5660	0.0966	-0.0886	0.0073	-0.0007	0.0222	0.0198	0.0127	-0.0095	-0.0001	-0.0068	-0.0053
352	9.1156	0.5675	0.0969	-0.0889	0.0073	-0.0007	0.0222	0.0199	0.0128	-0.0095	-0.0001	-0.0068	-0.0053
353	9.1366	0.5688	0.0971	-0.0891	0.0073	-0.0007	0.0223	0.0199	0.0128	-0.0095	-0.0001	-0.0068	-0.0053
354	9.1548	0.5699	0.0973	-0.0893	0.0073	-0.0007	0.0223	0.0200	0.0128	-0.0095	-0.0001	-0.0069	-0.0053
355	9.1702	0.5709	0.0975	-0.0894	0.0074	-0.0007	0.0224	0.0200	0.0129	-0.0096	-0.0001	-0.0069	-0.0053
356	9.1828	0.5716	0.0976	-0.0895	0.0074	-0.0007	0.0224	0.0200	0.0129	-0.0096	-0.0001	-0.0069	-0.0053
357	9.1926	0.5722	0.0977	-0.0896	0.0074	-0.0007	0.0224	0.0200	0.0129	-0.0096	-0.0001	-0.0069	-0.0053
358	9.1996	0.5727	0.0978	-0.0897	0.0074	-0.0007	0.0224	0.0201	0.0129	-0.0096	-0.0001	-0.0069	-0.0053
359	9.2038	0.5729	0.0978	-0.0897	0.0074	-0.0007	0.0224	0.0201	0.0129	-0.0096	-0.0001	-0.0069	-0.0053
360	9.2052	0.5730	0.0978	-0.0897	0.0074	-0.0007	0.0224	0.0201	0.0129	-0.0096	-0.0001	-0.0069	-0.0053

Note:

1. Column No. 1 to 13 above, gives respective Term's Nutation in Obliquity ($\Delta\varepsilon$) (in Seconds) for the calculated Angle ϕ or θ (in Degrees) using Eqn.(s3)for the respective Terms.
2. For Example, Angle for Term1 (ϕ_1 or θ_1) for the date J2000 (1 Jan 2000 @ 12:00Hrs UT) is given by $\phi_1 = 450160.398036(\text{Seconds}) = 125°2'40.398036' (\approx 125°)(\textit{Degrees})$ (From Eqn.(s3),for T=0)
   Thus $\Delta\varepsilon_1 = -5.2799(\text{Seconds})$ for $\phi_1 \approx 125°$ (Value from Column 1 above, for ϕ_1=125)

8.5 Results of Ayanamsa studies

It is to be note that the studies, findings and conclusions drawn in various chapters of this book are compiled and presented/reiterated in this chapter for reader's ready reference.

8.5.1 Rajan's Calculation

From the results of Ayanamsa presented in Table 27 for Rajan's Ayanamsa, it is found that the Ayanamsa calculated using the arithmetic series summation formulae has given erroneous results particularly in the range of years from 500AD to 1800AD. Due to this, we have to discard the arithmetic series summation concept though his values for the recent years found quit close to my calculated values. It is to be noted that the original Newcomb theory is based on Besselian (Tropical) Year not to be used in arithmetic series based on calendar Year.

8.5.2 Nayar's Calculation

From the results of Ayanamsa presented in Chart 1 for Nayar's Calculation, it is found that the Ayanamsa calculated using the arithmetic series summation formulae, has given erroneous results particularly in the range of years from 500AD to 1800AD. This is because he has followed similar to Rajan's arithmetic concept of course with slight modification. Due to this, we have to discard the arithmetic series summation concept though his values for the recent years found quit close to my calculated values. It is to be noted that the original Newcomb theory is based on Besselian (Tropical) Year not to be used in arithmetic series based on calendar Year.

8.5.3 K.Balachandran's Calculation

As the following points from K.Balachandran's article '*In defence of KP Ayanamsa*' Ref.[17] are found to have been made with incorrect values and wrong assumptions, they are ***completely wrong and shall be rejected***.

i) The Precession Rate 50.2388475" considered for Year 1900A.D is incorrect. This value pertains to the Besselian (Tropical) Year B1821 only. The correct value for B1900 is 50.2564".

ii) The concept adopted i.e., Arithmetic series summation formula and calendar Year is same as Nayar's concept, which is incorrect as explained in previous paragraph.

iii) Balachandran cleverly manipulated Nayar's article by substituting the value of 50.2388475 in place of 50.2564 in the equation with the sole intention of defending KSK.

iv) Further he has not made any attempt to compare his results with that of Reader1 table to justify his caption (See values given in Column (5) Table 29) in fact it varies from –27 to 76 Seconds.

From Tinwin's Article 'Reference Corner: KP Ayanamsas' (Ref.[39]), we can understand that the learned KP Scholar A.R.Raichur (Co-Author of UTOH book) certified that the KP Ayanamsa fixed by K.Balachandran in his article published in KP&Astrology Year book 2003 (Ref.[17]) is the correct one. But unfortunately it is not as per the proof given in this book Chapter(3) 'Newcomb's Precession and scope'.

Unfortunately, most KP Community and software developer were attracted just because he used the figures suggested by KSK i.e., 291 A.D as Zero Ayanamsa Year and the Precession Rate as 50.2388475". Whereas Nayar didn't get much appreciation from KP Community though he adopted in his article (Published around 23 Years before Balachandran's Article) the basic parameters value i.e., 291 A.D as Zero Ayanamsa Year and the Precession Rate as 50.2564" found correct as per Newcomb's Theory except approximation of Arithmetic summation concept similar to Rajan's Concept. This requires in-depth knowledge in Astronomical Science and Mathematics to understand it.

Except few research scholars in astrology community, most astrologers are more focused on prediction part, not ready to spend time on searching scientific information's, due to Professional time constraint, limited interest / knowledge in Astronomical Science & Mathematics and not ready to take the pain for searching of information when the author (including KSK) of a work did not disclose or failed to provide references (previous Author's work) based on which his work(s) was developed.

8.5.4 Notable Persons and Krishnamurti Padhdhati & Universal tables of Houses-Books

It is found from the above studies Ref. Chapter(7.4) that Ayanamsa equation provided in the textbook '*Notable Persons and Krishnamurti Padhdhati*' by K.Hariharan Ref.[33] and the values Published in Table-X, '*Universal tables of Houses*' by S.Balasundaram & A.R.Raichur Ref.[57] are ***completely wrong and shall be Rejected*** due to following reasons

i) The Precession Rate 50.256289" considered for 15 April 1900 @ 00:00 UT is incorrect

ii) The Ayanamsa value 80890.1535" adopted for the date 15 April 1900 @ 00:00 UT doesn't agree with either IENA's Mean Ayanamsa or True Ayanamsa

iii) The concept adopted i.e., Arithmetic series summation formula and calendar Year is same as C.G.Rajan's Concept and we found that it gives erroneous results as mentioned in the Chapter(8.5.1) above because the original Newcomb theory is based on Besselian (Tropical) Year not to be used in arithmetic series based on calendar Year.

iv) The Author of Ref.[33] himself acknowledged that he followed the values given in UTOH (Universal tables of Houses) only differs by few "seconds" from the Ayanamsa values recommended by IENA (Which is used in the Rashtriya Panchang). This declaration, in my view is nothing but the author's consolation statement to cover up the inadvertent error caused by use of incorrect fundamental parameter values, principles/concepts.

8.5.5 Astrological Tables for All & KP Tables of Houses -Books

It is found from the above studies Ref. Table 29, Chapter(7.8) that Ayanamsa values provided in the textbook '*Astrological Tables for All*' by R.Eshwar Manu and values Published in Table-II, '*KP Tables of Houses*' by K.Subramaniam Ref.[19] are ***completely wrong and shall be Rejected*** due to following reasons

i) The Precession Rate of 50" adopted constantly for all the years is incorrect. Because as per Newcomb theory it varies at the rate of 0.000222 Seconds per Tropical/Besselian Year. (The reference Precession Rate is 50.2564" as on B1900).

ii) It is to be noted that the original Newcomb theory is based on Besselian (Tropical) Year not to be used in arithmetic series based on calendar Year.

8.5.6 KSK's Reader1 Book

It is found from the above studies Ref. Table 29, Chapter(7.8) that Ayanamsa values provided in KSK's Reader1 book are ***completely wrong and shall be Rejected*** due to following reasons

i. The Zero Ayanamsa Date, based on the values published in KP Reader1 book works out to 22 September 292 @ 06:10:29 hrs UT (based on Newcomb's theory) and not 291 AD as claimed by him.

ii. Due to Zero Ayanamsa date difference, noticed error amounts to 75.28925 Seconds which is quite significant and cannot be ignored.

iii. The Precession Rate 50.2388475" recommended to consider after Year 2001A.D is incorrect. This value pertains to the Besselian (Tropical) Year B1821 only. The correct value for B1900 is 50.2564".

He would not have made this mistake, if he calculated the difference in Number of years between Rajan's and his Year of coincidence correctly. Because by using this year difference, the actual difference in Precession (Correction amount) can be obtained and applying this correction amount with Rajan's Ayanamsa values his values would have been deduced correctly. Unfortunately, it seems that he might have used some other way or shortcut method(s) probably arrived at erroneous results.

Also KSK stated that he would prove the correctness of his Ayanamsa values at a later date. But unfortunately he never fulfilled his promise till the end. It is to be noted that the basic parameters 291 AD year of coincidence and Precession Rate 50.2388475" are purely related to astronomical science. However, his proof was with "Stellar system" by means of using Natal horoscopes but not with astronomical science basis. I have made possible search in his KP Readers & Magazines but unable to find any scientific/ Astronomical proof given by KSK to substantiate his statement.

Hence, in the absence of any scientific/astronomical evidence from KSK's published research works to support for his Zero Ayanamsa year as 291AD before the publication of D.V.Ketkar's Article Ref.[53] May 1963, it gives an impression that it was sourced from Ref.[53] or some other work (either way, without being referred) and thus implies that the Zero Ayanamsa Year 291 A.D was not invented but recommended by KSK. Readers those who have evidence in this regard are requested to send the details to the author for understanding.

8.5.7 Discussion on prevailing KP Ayanamsas

Most KP followers are aware that after KSK's demise, there were three Ayanamsas emerged by year 2003. Referring to Tinwin's Article(Ref.[39]), let me discuss about three Ayanamsas namely Original or Old KP Ayanamsa(OKPA), KP Straight Line Ayanamsa(KPSTLA) and New KP Ayanamsa(NKPA). These KP Ayanamsas don't follow Newcomb's Theory and its parameters properly as explained below. Hence there is no detailed comparison made, with any of the other KP Ayanamsas explained elsewhere in this book. The demerits of the above said Ayanamsas are discussed below.

a) Original or Old KP Ayanamsa (OKPA)

In KP Reader1, KSK has given the Ayanamsa values for the year 1840 to 2001 in degree and minutes only. There are no evidences found in KP Materials (Readers/Astrology & Athrishta

Magazine) on how the values in the table were derived using the Year 291 and the Precession Rate 50.2388475”. Also he has not explained the background calculations.

It seems that some attempts were made in the past to formulate an equation to have a ‘proper fit’ with the values given in KP Reader1 and to use it in the astrology software applications. According to Tinwin’s Article, one such formula was given by Mr.Neville Lang (developer of Astracadabra) as given below.

$$\text{OKPA} = B + p * T + A * T^2 \text{ (in Seconds)} \qquad \text{-----------Eqn.[k1]}$$

Where,
B = 80520 Seconds (22°22’00” Degrees), Base Value for 1 Jan 1900, @00:00 Hrs UT)
T = Y-1900, Y= Calendar year for which Ayanamsa is required
p = Annual precession rate of Newcomb’s 50.2388475” per year
A = Annual precession rate adjustment of 0.000111” ***per year***

The unit for term ‘A’ given above is wrongly represented. It is actually the rate of change of Precession Rate (or) Acceleration and thus the unit for the same shall be ***Arc Second Per Year²***.

Also we can find the Zero Ayanamsa date by solving above quadratic Eqn.(k1) for OKPA=0 and we get,
T = -1608.45992555591 Calendar Year.
Adding this with above reference Year, we get Zero Ayanamsa date as,
Y=1900 - 1608.45992555591
= 291.54007444409 (Calendar Year)

i) From above Calendar Year, corresponding Date works out to 16 July 291@03:03:08 Hrs UT. This date doesn’t agree with the date 21 March corresponding to the Sayana sun at first point of Aries ‘♈’ Zero degree as per the astronomical data (as discussed earlier in Chapter(2) ‘History and details’).

ii) It is to be noted that the original Newcomb theory is based on Besselian (Tropical) Year not to be used in arithmetic series based on calendar Year.

iii) As mentioned earlier in Chapter(3) ‘Newcomb’s Precession and Scope’, It can be shown that the Precession value proposed by KSK(50.2388475”) exactly matches with Besselian (Tropical) Year B1821 using Newcomb’s Eqn.(h), as detailed below.

$$p = 50.2453 + 0.0002225 * (1821 - 1850)$$
$$p = 50.2453 - 0.0064525$$
$$p = 50.2388475 \text{ (Seconds)}$$

Therefore, in the above Equation reference year used is 1900 instead of B1821.

For the above three reasons OKPA is to be ***Rejected.***

From the online details, it is noted that Mr.Neville Lang released the Astrology software ‘Astracadabra’ in the year 2004 after the publication of Dr.Balachandran’s Article (Ref.[17]) in Year 2003. Thus it is possible that he might have taken the formula-B given in Dr.Balachandran’s Article and replaced the base value as 22°22’00” Degrees for 1 Jan 1900 @ 00:00 Hrs UT given by KSK in Reader1 instead of 22°22’15.96” Degrees arrived at by Dr.Balachandran. Thus OKPA is always less than Balachandran’s value (See c) New KP Ayanamsa[NKPA]) by constant value of around 16” only. So Neville Lang did not attempt to find the formula to 'fit' KP Reader1 values mathematically except base value correction. I have already mentioned in Chapter(8.5.3) that Balachandran's Ayanamsa values varies from Reader1 values by –27 to 76 Seconds. So obviously the OKPA values will differ from Reader1 values by –43 to 60 Seconds. Hence neither it qualifies for 'Proper fit' nor it matches with Reader1 values. Since KSK didn't give any formula to generate the values given in Reader1 table, it is possible that individuals/Software developers might have used formula based on their own understanding and thus it may differ among the KP community and softwares.

It may please be noted that I have derived the 'best fit' formula for the values given in KP Reader1 as per Newcomb's theory, which is given in Chapter(7.9), Eqn.(100). Unfortunately, it gives year of coincidence as September 22, 292 instead of March 21, 291.

b) KP Straight Line Ayanamsa (KPSTLA)

M.C.Khare vide his article in A&A October 1978 (Ref.[11]), studied this Ayanamsa extensively and pointed out that the values arrived using 'Straight line' approach fluctuates nearly 6 minutes with KP Reader1. The dasa balance calculated for these 6 minutes fluctuation shows the range of 16 to 24 days difference for Sun and Venus respectively. The same 'Straight line' approach was studied by MGG.Nayar also, in his article (Ref.[20]) and concluded that the approach has to be dropped due to the high difference in values between the calculated one and KP Reader1.

In spite of the above findings/conclusions made by the KP scholars to discard the straight-line approach, according to Mr.V.Subramanian's Article(Ref.[7]), K.M.Subramaniam(KMS), an eminent and senior KP Astrologer of yesteryear and his followers were using the above straight line Ayanamsa. Subsequently the straight-line simple formula was implemented in the software developed in the year 1998-99 and other software developers followed suit but of course in different names. From Tinwin's Article, the formula for the same is given below.

$$\text{KPSTLA} = p * T \text{ (in Seconds)} \qquad \text{-----------Eqn.[k2]}$$

Where
T = Y- 291 (Year of zero Ayanamsa)
Y= Calendar year for which Ayanamsa is required
p = 50.2388475 sec per year (Newcomb's annual precession rate)

i) It is to be noted that the original Newcomb theory is based on Besselian (Tropical) Year not to be used based on calendar Year.
ii) The Precession Rate is not constant but varies every Besselian (Tropical) Year.
iii) The Precession Rate given by KSK in his reader1 is for year B1821 as per Newcomb's theory and hence not to be taken from year 291.

For the above three reasons KPSTLA is also to be ***Rejected.***

c) New KP Ayanamsa (NKPA)

This Ayanamsa was introduced after K.Balachandran's Article (Ref[17]) Published in KP & Astrology magazine 2003. According to Tinwin's Article, the formula for the same is given below

$$\text{NKPA} = B + p * T + A * T^2 \text{ (in Seconds)} \qquad \text{-----------Eqn.[k3]}$$

Where term ‘p’, ‘T’ & ‘A’ are same as defined in OKPA, except for ‘B’ which is equal to 80550 Seconds (22°22’30” Degrees), Base Value for 15 Apr 1900, @00:00 Hrs UT

For the reasons mentioned in Chapter(8.5.3) ‘K.Balachandran’s Calculation’, This NKPA Ayanamsa has to be ***Rejected***.

It is quite possible that the softwares providing KP Ayanamsa options might have chosen different names for the above three discussed Ayanamsa and differ in values also in the respective Ayanamsas between them. Please be noted that any KP Ayanamsa value (Newcomb based) obtained from the software doesn’t agree with values given by me in Table 27,Column(2) has to be considered as ***incorrect***.

9. Recommendations

‘I am comfortable in predictions with my current Ayanamsa value, why should I change?’

Normally, we encounter such a reply from a KP Astrologer whose mind is bent upon not to accept so easily any change in the system of his practice.

It is a general theory and assumption of many that the slight changes in Ayanamsa value would not affect the sub-lord of planets or cusps. It may have an impact only in sub-sub lord level or even deep inside. So the victims are only the borderline cases.

But the reality is different. When a reasonable number of horoscopes are taken for comparison, a considerable percentage of them could fail even at sub-lord level. If there is change in sub-lords, as a KP Astrologer, you are well aware of the chaos it brings into the predictions.

KP Astrology, the most popular system known for its accuracy, should never give any room for even a slightest form of error.

So to get accurate values of Precession Rate and Ayanamsa (Precession), we shall find the basic parameter ‘T’ (Time duration, from the reference Epoch to the required Epoch) in either Julian or Besselian Year/Century. So that ‘T’ can be used in the selected Precession, Nutation Model based on which they were developed/derived.

Even though in Chapter(8.2) ‘Summary of Ayanamsa Equations’, all the Precession Models M1 (Newcomb), M2 (IAU1976) and M3 (IAU2006) with J2000 Reference Epoch are highlighted, the readers should note from Table 1(Chapter(5)), Chart 1 (Chapter(6)) that the difference in Ayanamsa value among case (A/B/C) and modern Precession theory IAU2006 Case(E), is found to be around 16 seconds for the present years and it gradually increases for the following years. **However, the Precession Model M3(IAU2006) is the latest Model used in astronomical calculation accepted by IAU superseding previous Precession Models M2 and M1**.

In Chapter (7.6) ‘Discussion on Nutation’, though Nutation Models N1 (Newcomb), N2 (IAU1964), N3 (IAU1980) and N4 (IAU2000A) are discussed with J2000 Reference Epoch, the readers should note from Table 20, Table 22 and Chart 11 (Chapter(7.6.5)) that the difference in Nutation in Longitude value among the Models with respect to modern Nutation theory IAU2000A, is found to be less than 100 milliseconds for the present years, which is insignificant.

Similarly, from Table 24(Mean Obliquity) and Table 23(Nutation in Obliquity) (Chapter(7.6.6)), it can be noticed that the difference in respective coefficient values among the Models, with respect to modern Precession(IAU2006) / Nutation (IAU2000A) theory is found to be insignificant. A detailed comparative study for Mean Obliquity and Nutation in Obliquity is not considered for the same reason. **It may be noted that Nutation Model N4(IAU2000A) is the latest one used in astronomical calculation accepted by IAU superseding previous Nutation Models N3, N2 and N1**.

In order to keep the unique name of Ayanamsa advocated by KSK the Table 31:Sr.No(3) M1_K with J2000 Reference Epoch can be named as "KP Ayanamsa" or "KP" other remaining Ayanamsa namely Table 31:Sr.No(4)M2_K, Table 31:Sr.No(5)M3_K with J2000 Reference Epoch may be called as "KP_IAU1976" and "KP_IAU2006" respectively. Similarly, for Lahiri, Rajan, IENA(Rashtriya panchang) names can be given. Also Nutation Models given in Table 18: Namely NewComb, IAU1964, IAU1980 and IAU2000A may be called as "N1_NewComb", "N2_IAU1964", "N3_IAU1980" and "N4_IAU2000A" respectively.

Hence for our astrological calculation it is recommended to adopt ***IAU2006 Precession Model*** along with latest ***Nutation Model IAU2000A*** to obtain True Ayanamsa and True Obliquity, so that more accurate Nirayana position of Cusps, Planets can be obtained (Both for KP System and Hindu Vedic Astrology). Using IAU2006 Model (291AD as year of coincidence), Krishnamurti Mean Ayanamsa as on 15 April @00:00 UT(05:30Hrs IST) of Each Year from 1800A.D to 2399A.D is presented in Table 35 for reader's ready reference.

Similarly, based on IAU2006 Model Mean Ayanamsa as on 15 April @00:00 UT of Each Year from 1800A.D to 2399A.D is presented for Rajan, Lahiri and IENA in Table 36, Table 37 and Table 38 respectively.

"The Only Thing That Is Constant Is Change"
— Heraclitus

Here I would like to bring to the attention of the readers, the words of KSK from his Article "**Which Panchanga to use?**" published in December 1963(Ref.[58]).

"Our ancient astronomers had clearly mentioned in their treatises that the astronomers in future have to revise the calculation from time to time, if and when found necessary. They have expressed that the results arrived at should agree with the scientific and ocular verification. They are of the opinion that if the position of planets is arrived at by using a calculation inconsistent with observational precision then the result is only approximate and rough."

The above words are from the authority and self-explanatory. Hence KP Astrologers are recommended to use the True Ayanamsa and True Obliquity, calculated based on latest Precession/Nutation Model for calculating accurate Nirayana longitude for the Planets and Cusps.

Table 35: Krishnamurti Mean Ayanamsa as on 15 April @00:00Hrs UT(Model:KP_IAU2006)

Year	dd:mm:ss	Year	dd:mm:ss	Year	dd:mm:ss	Year	dd:mm:ss	Year	dd:mm:ss	Year	dd:mm:ss
1800	20:59:28.05	1850	21:41:20.44	1900	22:23:13.39	1950	23:05:06.90	2000	23:47:01.09	2050	24:28:55.70
1801	21:00:18.26	1851	21:42:10.66	1901	22:24:03.63	1951	23:05:57.14	2001	23:47:51.35	2051	24:29:45.96
1802	21:01:08.46	1852	21:43:01.02	1902	22:24:53.86	1952	23:06:47.52	2002	23:48:41.60	2052	24:30:36.37
1803	21:01:58.67	1853	21:43:51.24	1903	22:25:44.09	1953	23:07:37.76	2003	23:49:31.85	2053	24:31:26.63
1804	21:02:49.02	1854	21:44:41.46	1904	22:26:34.46	1954	23:08:28.01	2004	23:50:22.25	2054	24:32:16.90
1805	21:03:39.23	1855	21:45:31.69	1905	22:27:24.69	1955	23:09:18.25	2005	23:51:12.50	2055	24:33:07.16
1806	21:04:29.44	1856	21:46:22.05	1906	22:28:14.93	1956	23:10:08.63	2006	23:52:02.75	2056	24:33:57.57
1807	21:05:19.65	1857	21:47:12.27	1907	22:29:05.16	1957	23:10:58.88	2007	23:52:53.01	2057	24:34:47.83
1808	21:06:10.00	1858	21:48:02.49	1908	22:29:55.53	1958	23:11:49.12	2008	23:53:43.40	2058	24:35:38.10
1809	21:07:00.21	1859	21:48:52.71	1909	22:30:45.76	1959	23:12:39.36	2009	23:54:33.66	2059	24:36:28.37
1810	21:07:50.43	1860	21:49:43.07	1910	22:31:36.00	1960	23:13:29.75	2010	23:55:23.91	2060	24:37:18.77
1811	21:08:40.64	1861	21:50:33.29	1911	22:32:26.23	1961	23:14:19.99	2011	23:56:14.17	2061	24:38:09.04
1812	21:09:30.99	1862	21:51:23.52	1912	22:33:16.60	1962	23:15:10.24	2012	23:57:04.56	2062	24:38:59.31
1813	21:10:21.20	1863	21:52:13.74	1913	22:34:06.84	1963	23:16:00.48	2013	23:57:54.82	2063	24:39:49.57
1814	21:11:11.41	1864	21:53:04.10	1914	22:34:57.07	1964	23:16:50.87	2014	23:58:45.08	2064	24:40:39.98
1815	21:12:01.62	1865	21:53:54.33	1915	22:35:47.30	1965	23:17:41.11	2015	23:59:35.33	2065	24:41:30.25
1816	21:12:51.97	1866	21:54:44.55	1916	22:36:37.68	1966	23:18:31.36	2016	24:00:25.73	2066	24:42:20.51
1817	21:13:42.19	1867	21:55:34.77	1917	22:37:27.91	1967	23:19:21.60	2017	24:01:15.99	2067	24:43:10.78
1818	21:14:32.40	1868	21:56:25.14	1918	22:38:18.15	1968	23:20:11.99	2018	24:02:06.24	2068	24:44:01.19
1819	21:15:22.61	1869	21:57:15.36	1919	22:39:08.38	1969	23:21:02.23	2019	24:02:56.50	2069	24:44:51.46
1820	21:16:12.97	1870	21:58:05.59	1920	22:39:58.76	1970	23:21:52.48	2020	24:03:46.90	2070	24:45:41.73
1821	21:17:03.18	1871	21:58:55.81	1921	22:40:48.99	1971	23:22:42.73	2021	24:04:37.15	2071	24:46:32.00
1822	21:17:53.39	1872	21:59:46.17	1922	22:41:39.23	1972	23:23:33.11	2022	24:05:27.41	2072	24:47:22.40
1823	21:18:43.61	1873	22:00:36.40	1923	22:42:29.47	1973	23:24:23.36	2023	24:06:17.67	2073	24:48:12.67
1824	21:19:33.96	1874	22:01:26.62	1924	22:43:19.84	1974	23:25:13.61	2024	24:07:08.07	2074	24:49:02.94
1825	21:20:24.18	1875	22:02:16.85	1925	22:44:10.08	1975	23:26:03.86	2025	24:07:58.33	2075	24:49:53.21
1826	21:21:14.39	1876	22:03:07.21	1926	22:45:00.31	1976	23:26:54.24	2026	24:08:48.59	2076	24:50:43.62
1827	21:22:04.61	1877	22:03:57.44	1927	22:45:50.55	1977	23:27:44.49	2027	24:09:38.85	2077	24:51:33.89
1828	21:22:54.96	1878	22:04:47.67	1928	22:46:40.93	1978	23:28:34.74	2028	24:10:29.24	2078	24:52:24.16
1829	21:23:45.17	1879	22:05:37.89	1929	22:47:31.16	1979	23:29:24.99	2029	24:11:19.50	2079	24:53:14.43
1830	21:24:35.39	1880	22:06:28.26	1930	22:48:21.40	1980	23:30:15.38	2030	24:12:09.76	2080	24:54:04.84
1831	21:25:25.61	1881	22:07:18.49	1931	22:49:11.64	1981	23:31:05.62	2031	24:13:00.02	2081	24:54:55.11
1832	21:26:15.96	1882	22:08:08.71	1932	22:50:02.02	1982	23:31:55.87	2032	24:13:50.42	2082	24:55:45.38
1833	21:27:06.18	1883	22:08:58.94	1933	22:50:52.26	1983	23:32:46.12	2033	24:14:40.68	2083	24:56:35.66
1834	21:27:56.39	1884	22:09:49.31	1934	22:51:42.49	1984	23:33:36.51	2034	24:15:30.94	2084	24:57:26.07
1835	21:28:46.61	1885	22:10:39.53	1935	22:52:32.73	1985	23:34:26.76	2035	24:16:21.20	2085	24:58:16.34
1836	21:29:36.97	1886	22:11:29.76	1936	22:53:23.11	1986	23:35:17.01	2036	24:17:11.60	2086	24:59:06.61
1837	21:30:27.18	1887	22:12:19.99	1937	22:54:13.35	1987	23:36:07.26	2037	24:18:01.87	2087	24:59:56.88
1838	21:31:17.40	1888	22:13:10.36	1938	22:55:03.59	1988	23:36:57.65	2038	24:18:52.13	2088	25:00:47.29
1839	21:32:07.62	1889	22:14:00.59	1939	22:55:53.83	1989	23:37:47.90	2039	24:19:42.39	2089	25:01:37.57
1840	21:32:57.97	1890	22:14:50.82	1940	22:56:44.21	1990	23:38:38.15	2040	24:20:32.79	2090	25:02:27.84
1841	21:33:48.19	1891	22:15:41.04	1941	22:57:34.45	1991	23:39:28.40	2041	24:21:23.05	2091	25:03:18.11
1842	21:34:38.41	1892	22:16:31.41	1942	22:58:24.69	1992	23:40:18.79	2042	24:22:13.31	2092	25:04:08.53
1843	21:35:28.63	1893	22:17:21.64	1943	22:59:14.93	1993	23:41:09.05	2043	24:23:03.58	2093	25:04:58.80
1844	21:36:18.99	1894	22:18:11.87	1944	23:00:05.31	1994	23:41:59.30	2044	24:23:53.98	2094	25:05:49.07
1845	21:37:09.21	1895	22:19:02.10	1945	23:00:55.55	1995	23:42:49.55	2045	24:24:44.24	2095	25:06:39.35
1846	21:37:59.43	1896	22:19:52.47	1946	23:01:45.79	1996	23:43:39.94	2046	24:25:34.51	2096	25:07:29.76
1847	21:38:49.65	1897	22:20:42.70	1947	23:02:36.03	1997	23:44:30.19	2047	24:26:24.77	2097	25:08:20.04
1848	21:39:40.00	1898	22:21:32.93	1948	23:03:26.41	1998	23:45:20.45	2048	24:27:15.17	2098	25:09:10.31
1849	21:40:30.22	1899	22:22:23.16	1949	23:04:16.66	1999	23:46:10.70	2049	24:28:05.44	2099	25:10:00.59

Year	dd:mm:ss	Year	dd:mm:ss	Year	dd:mm:ss	Year	dd:mm:ss	Year	dd:mm:ss	Year	dd:mm:ss
2100	25:10:50.86	2150	25:52:46.58	2200	26:34:42.84	2250	27:16:39.66	2300	27:58:37.03	2350	28:40:34.96
2101	25:11:41.14	2151	25:53:36.86	2201	26:35:33.14	2251	27:17:29.97	2301	27:59:27.35	2351	28:41:25.29
2102	25:12:31.41	2152	25:54:27.29	2202	26:36:23.44	2252	27:18:20.42	2302	28:00:17.67	2352	28:42:15.76
2103	25:13:21.69	2153	25:55:17.57	2203	26:37:13.74	2253	27:19:10.73	2303	28:01:07.99	2353	28:43:06.09
2104	25:14:12.10	2154	25:56:07.86	2204	26:38:04.17	2254	27:20:01.04	2304	28:01:58.45	2354	28:43:56.42
2105	25:15:02.38	2155	25:56:58.15	2205	26:38:54.47	2255	27:20:51.35	2305	28:02:48.77	2355	28:44:46.75
2106	25:15:52.66	2156	25:57:48.58	2206	26:39:44.77	2256	27:21:41.79	2306	28:03:39.10	2356	28:45:37.22
2107	25:16:42.93	2157	25:58:38.86	2207	26:40:35.07	2257	27:22:32.11	2307	28:04:29.42	2357	28:46:27.56
2108	25:17:33.35	2158	25:59:29.15	2208	26:41:25.51	2258	27:23:22.42	2308	28:05:19.88	2358	28:47:17.89
2109	25:18:23.63	2159	26:00:19.44	2209	26:42:15.81	2259	27:24:12.73	2309	28:06:10.20	2359	28:48:08.22
2110	25:19:13.91	2160	26:01:09.87	2210	26:43:06.11	2260	27:25:03.18	2310	28:07:00.52	2360	28:48:58.69
2111	25:20:04.18	2161	26:02:00.16	2211	26:43:56.41	2261	27:25:53.49	2311	28:07:50.84	2361	28:49:49.03
2112	25:20:54.60	2162	26:02:50.45	2212	26:44:46.85	2262	27:26:43.80	2312	28:08:41.30	2362	28:50:39.36
2113	25:21:44.88	2163	26:03:40.74	2213	26:45:37.15	2263	27:27:34.11	2313	28:09:31.63	2363	28:51:29.69
2114	25:22:35.16	2164	26:04:31.16	2214	26:46:27.45	2264	27:28:24.56	2314	28:10:21.95	2364	28:52:20.17
2115	25:23:25.44	2165	26:05:21.45	2215	26:47:17.75	2265	27:29:14.87	2315	28:11:12.27	2365	28:53:10.50
2116	25:24:15.85	2166	26:06:11.74	2216	26:48:08.19	2266	27:30:05.18	2316	28:12:02.73	2366	28:54:00.83
2117	25:25:06.13	2167	26:07:02.03	2217	26:48:58.49	2267	27:30:55.50	2317	28:12:53.06	2367	28:54:51.17
2118	25:25:56.41	2168	26:07:52.46	2218	26:49:48.79	2268	27:31:45.95	2318	28:13:43.38	2368	28:55:41.64
2119	25:26:46.69	2169	26:08:42.75	2219	26:50:39.09	2269	27:32:36.26	2319	28:14:33.70	2369	28:56:31.98
2120	25:27:37.11	2170	26:09:33.04	2220	26:51:29.53	2270	27:33:26.57	2320	28:15:24.17	2370	28:57:22.31
2121	25:28:27.39	2171	26:10:23.34	2221	26:52:19.83	2271	27:34:16.89	2321	28:16:14.49	2371	28:58:12.65
2122	25:29:17.67	2172	26:11:13.76	2222	26:53:10.14	2272	27:35:07.34	2322	28:17:04.81	2372	28:59:03.12
2123	25:30:07.95	2173	26:12:04.06	2223	26:54:00.44	2273	27:35:57.65	2323	28:17:55.14	2373	28:59:53.46
2124	25:30:58.37	2174	26:12:54.35	2224	26:54:50.88	2274	27:36:47.96	2324	28:18:45.60	2374	29:00:43.79
2125	25:31:48.65	2175	26:13:44.64	2225	26:55:41.18	2275	27:37:38.28	2325	28:19:35.93	2375	29:01:34.13
2126	25:32:38.93	2176	26:14:35.07	2226	26:56:31.49	2276	27:38:28.73	2326	28:20:26.25	2376	29:02:24.60
2127	25:33:29.21	2177	26:15:25.36	2227	26:57:21.79	2277	27:39:19.05	2327	28:21:16.58	2377	29:03:14.94
2128	25:34:19.63	2178	26:16:15.66	2228	26:58:12.23	2278	27:40:09.36	2328	28:22:07.04	2378	29:04:05.28
2129	25:35:09.91	2179	26:17:05.95	2229	26:59:02.54	2279	27:40:59.68	2329	28:22:57.37	2379	29:04:55.61
2130	25:36:00.20	2180	26:17:56.38	2230	26:59:52.84	2280	27:41:50.13	2330	28:23:47.70	2380	29:05:46.09
2131	25:36:50.48	2181	26:18:46.67	2231	27:00:43.14	2281	27:42:40.44	2331	28:24:38.02	2381	29:06:36.43
2132	25:37:40.90	2182	26:19:36.97	2232	27:01:33.59	2282	27:43:30.76	2332	28:25:28.49	2382	29:07:26.77
2133	25:38:31.18	2183	26:20:27.26	2233	27:02:23.89	2283	27:44:21.08	2333	28:26:18.81	2383	29:08:17.10
2134	25:39:21.47	2184	26:21:17.69	2234	27:03:14.20	2284	27:45:11.53	2334	28:27:09.14	2384	29:09:07.58
2135	25:40:11.75	2185	26:22:07.99	2235	27:04:04.50	2285	27:46:01.85	2335	28:27:59.47	2385	29:09:57.92
2136	25:41:02.17	2186	26:22:58.28	2236	27:04:54.95	2286	27:46:52.16	2336	28:28:49.93	2386	29:10:48.26
2137	25:41:52.45	2187	26:23:48.58	2237	27:05:45.25	2287	27:47:42.48	2337	28:29:40.26	2387	29:11:38.60
2138	25:42:42.74	2188	26:24:39.01	2238	27:06:35.56	2288	27:48:32.94	2338	28:30:30.59	2388	29:12:29.07
2139	25:43:33.02	2189	26:25:29.30	2239	27:07:25.86	2289	27:49:23.25	2339	28:31:20.92	2389	29:13:19.41
2140	25:44:23.44	2190	26:26:19.60	2240	27:08:16.31	2290	27:50:13.57	2340	28:32:11.39	2390	29:14:09.75
2141	25:45:13.73	2191	26:27:09.90	2241	27:09:06.62	2291	27:51:03.89	2341	28:33:01.71	2391	29:15:00.09
2142	25:46:04.01	2192	26:28:00.33	2242	27:09:56.92	2292	27:51:54.34	2342	28:33:52.04	2392	29:15:50.57
2143	25:46:54.30	2193	26:28:50.63	2243	27:10:47.23	2293	27:52:44.66	2343	28:34:42.37	2393	29:16:40.91
2144	25:47:44.72	2194	26:29:40.92	2244	27:11:37.68	2294	27:53:34.98	2344	28:35:32.84	2394	29:17:31.25
2145	25:48:35.01	2195	26:30:31.22	2245	27:12:27.98	2295	27:54:25.30	2345	28:36:23.17	2395	29:18:21.59
2146	25:49:25.29	2196	26:31:21.65	2246	27:13:18.29	2296	27:55:15.76	2346	28:37:13.50	2396	29:19:12.07
2147	25:50:15.58	2197	26:32:11.95	2247	27:14:08.60	2297	27:56:06.08	2347	28:38:03.83	2397	29:20:02.41
2148	25:51:06.00	2198	26:33:02.25	2248	27:14:59.04	2298	27:56:56.40	2348	28:38:54.30	2398	29:20:52.75
2149	25:51:56.29	2199	26:33:52.54	2249	27:15:49.35	2299	27:57:46.71	2349	28:39:44.63	2399	29:21:43.09

Table 36: Rajan Mean Ayanamsa as on 15 April @00:00Hrs UT(Model:Rajan_IAU2006)

Year	dd:mm:ss	Year	dd:mm:ss	Year	dd:mm:ss	Year	dd:mm:ss	Year	dd:mm:ss	Year	dd:mm:ss
1800	20:56:12.72	1850	21:38:05.12	1900	22:19:58.07	1950	23:01:51.57	2000	23:43:45.76	2050	24:25:40.37
1801	20:57:02.93	1851	21:38:55.34	1901	22:20:48.30	1951	23:02:41.81	2001	23:44:36.02	2051	24:26:30.64
1802	20:57:53.14	1852	21:39:45.69	1902	22:21:38.53	1952	23:03:32.19	2002	23:45:26.27	2052	24:27:21.04
1803	20:58:43.35	1853	21:40:35.92	1903	22:22:28.76	1953	23:04:22.44	2003	23:46:16.53	2053	24:28:11.31
1804	20:59:33.70	1854	21:41:26.14	1904	22:23:19.13	1954	23:05:12.68	2004	23:47:06.92	2054	24:29:01.57
1805	21:00:23.91	1855	21:42:16.36	1905	22:24:09.36	1955	23:06:02.92	2005	23:47:57.17	2055	24:29:51.84
1806	21:01:14.12	1856	21:43:06.72	1906	22:24:59.60	1956	23:06:53.30	2006	23:48:47.43	2056	24:30:42.24
1807	21:02:04.33	1857	21:43:56.94	1907	22:25:49.83	1957	23:07:43.55	2007	23:49:37.68	2057	24:31:32.51
1808	21:02:54.68	1858	21:44:47.16	1908	22:26:40.20	1958	23:08:33.79	2008	23:50:28.08	2058	24:32:22.77
1809	21:03:44.89	1859	21:45:37.38	1909	22:27:30.43	1959	23:09:24.04	2009	23:51:18.33	2059	24:33:13.04
1810	21:04:35.10	1860	21:46:27.74	1910	22:28:20.67	1960	23:10:14.42	2010	23:52:08.59	2060	24:34:03.44
1811	21:05:25.31	1861	21:47:17.97	1911	22:29:10.90	1961	23:11:04.66	2011	23:52:58.84	2061	24:34:53.71
1812	21:06:15.66	1862	21:48:08.19	1912	22:30:01.27	1962	23:11:54.91	2012	23:53:49.24	2062	24:35:43.98
1813	21:07:05.87	1863	21:48:58.41	1913	22:30:51.51	1963	23:12:45.15	2013	23:54:39.49	2063	24:36:34.24
1814	21:07:56.08	1864	21:49:48.77	1914	22:31:41.74	1964	23:13:35.54	2014	23:55:29.75	2064	24:37:24.65
1815	21:08:46.30	1865	21:50:39.00	1915	22:32:31.98	1965	23:14:25.78	2015	23:56:20.01	2065	24:38:14.92
1816	21:09:36.65	1866	21:51:29.22	1916	22:33:22.35	1966	23:15:16.03	2016	23:57:10.40	2066	24:39:05.19
1817	21:10:26.86	1867	21:52:19.45	1917	22:34:12.58	1967	23:16:06.28	2017	23:58:00.66	2067	24:39:55.45
1818	21:11:17.07	1868	21:53:09.81	1918	22:35:02.82	1968	23:16:56.66	2018	23:58:50.92	2068	24:40:45.86
1819	21:12:07.29	1869	21:54:00.03	1919	22:35:53.06	1969	23:17:46.91	2019	23:59:41.17	2069	24:41:36.13
1820	21:12:57.64	1870	21:54:50.26	1920	22:36:43.43	1970	23:18:37.15	2020	24:00:31.57	2070	24:42:26.40
1821	21:13:47.85	1871	21:55:40.48	1921	22:37:33.67	1971	23:19:27.40	2021	24:01:21.83	2071	24:43:16.67
1822	21:14:38.07	1872	21:56:30.85	1922	22:38:23.90	1972	23:20:17.79	2022	24:02:12.08	2072	24:44:07.07
1823	21:15:28.28	1873	21:57:21.07	1923	22:39:14.14	1973	23:21:08.03	2023	24:03:02.34	2073	24:44:57.34
1824	21:16:18.63	1874	21:58:11.30	1924	22:40:04.51	1974	23:21:58.28	2024	24:03:52.74	2074	24:45:47.61
1825	21:17:08.85	1875	21:59:01.52	1925	22:40:54.75	1975	23:22:48.53	2025	24:04:43.00	2075	24:46:37.88
1826	21:17:59.06	1876	21:59:51.89	1926	22:41:44.99	1976	23:23:38.91	2026	24:05:33.26	2076	24:47:28.29
1827	21:18:49.28	1877	22:00:42.11	1927	22:42:35.22	1977	23:24:29.16	2027	24:06:23.52	2077	24:48:18.56
1828	21:19:39.63	1878	22:01:32.34	1928	22:43:25.60	1978	23:25:19.41	2028	24:07:13.92	2078	24:49:08.83
1829	21:20:29.85	1879	22:02:22.57	1929	22:44:15.84	1979	23:26:09.66	2029	24:08:04.18	2079	24:49:59.10
1830	21:21:20.06	1880	22:03:12.93	1930	22:45:06.07	1980	23:27:00.05	2030	24:08:54.44	2080	24:50:49.51
1831	21:22:10.28	1881	22:04:03.16	1931	22:45:56.31	1981	23:27:50.30	2031	24:09:44.70	2081	24:51:39.78
1832	21:23:00.63	1882	22:04:53.38	1932	22:46:46.69	1982	23:28:40.55	2032	24:10:35.09	2082	24:52:30.06
1833	21:23:50.85	1883	22:05:43.61	1933	22:47:36.93	1983	23:29:30.80	2033	24:11:25.35	2083	24:53:20.33
1834	21:24:41.07	1884	22:06:33.98	1934	22:48:27.17	1984	23:30:21.18	2034	24:12:15.62	2084	24:54:10.74
1835	21:25:31.28	1885	22:07:24.21	1935	22:49:17.41	1985	23:31:11.43	2035	24:13:05.88	2085	24:55:01.01
1836	21:26:21.64	1886	22:08:14.43	1936	22:50:07.78	1986	23:32:01.68	2036	24:13:56.28	2086	24:55:51.28
1837	21:27:11.86	1887	22:09:04.66	1937	22:50:58.02	1987	23:32:51.93	2037	24:14:46.54	2087	24:56:41.56
1838	21:28:02.07	1888	22:09:55.03	1938	22:51:48.26	1988	23:33:42.32	2038	24:15:36.80	2088	24:57:31.97
1839	21:28:52.29	1889	22:10:45.26	1939	22:52:38.50	1989	23:34:32.57	2039	24:16:27.06	2089	24:58:22.24
1840	21:29:42.65	1890	22:11:35.49	1940	22:53:28.88	1990	23:35:22.83	2040	24:17:17.46	2090	24:59:12.51
1841	21:30:32.87	1891	22:12:25.72	1941	22:54:19.12	1991	23:36:13.08	2041	24:18:07.72	2091	25:00:02.79
1842	21:31:23.08	1892	22:13:16.08	1942	22:55:09.36	1992	23:37:03.47	2042	24:18:57.99	2092	25:00:53.20
1843	21:32:13.30	1893	22:14:06.31	1943	22:55:59.60	1993	23:37:53.72	2043	24:19:48.25	2093	25:01:43.47
1844	21:33:03.66	1894	22:14:56.54	1944	22:56:49.98	1994	23:38:43.97	2044	24:20:38.65	2094	25:02:33.75
1845	21:33:53.88	1895	22:15:46.77	1945	22:57:40.22	1995	23:39:34.22	2045	24:21:28.91	2095	25:03:24.02
1846	21:34:44.10	1896	22:16:37.14	1946	22:58:30.46	1996	23:40:24.61	2046	24:22:19.18	2096	25:04:14.43
1847	21:35:34.32	1897	22:17:27.37	1947	22:59:20.71	1997	23:41:14.87	2047	24:23:09.44	2097	25:05:04.71
1848	21:36:24.68	1898	22:18:17.60	1948	23:00:11.09	1998	23:42:05.12	2048	24:23:59.84	2098	25:05:54.98
1849	21:37:14.90	1899	22:19:07.84	1949	23:01:01.33	1999	23:42:55.37	2049	24:24:50.11	2099	25:06:45.26

Year	dd:mm:ss	Year	dd:mm:ss	Year	dd:mm:ss	Year	dd:mm:ss	Year	dd:mm:ss	Year	dd:mm:ss
2100	25:07:35.53	2150	25:49:31.25	2200	26:31:27.51	2250	27:13:24.33	2300	27:55:21.71	2350	28:37:19.63
2101	25:08:25.81	2151	25:50:21.53	2201	26:32:17.81	2251	27:14:14.64	2301	27:56:12.03	2351	28:38:09.96
2102	25:09:16.09	2152	25:51:11.96	2202	26:33:08.11	2252	27:15:05.09	2302	27:57:02.35	2352	28:39:00.43
2103	25:10:06.36	2153	25:52:02.25	2203	26:33:58.41	2253	27:15:55.40	2303	27:57:52.67	2353	28:39:50.76
2104	25:10:56.78	2154	25:52:52.53	2204	26:34:48.85	2254	27:16:45.71	2304	27:58:43.13	2354	28:40:41.09
2105	25:11:47.05	2155	25:53:42.82	2205	26:35:39.14	2255	27:17:36.02	2305	27:59:33.45	2355	28:41:31.43
2106	25:12:37.33	2156	25:54:33.25	2206	26:36:29.44	2256	27:18:26.47	2306	28:00:23.77	2356	28:42:21.90
2107	25:13:27.61	2157	25:55:23.54	2207	26:37:19.74	2257	27:19:16.78	2307	28:01:14.09	2357	28:43:12.23
2108	25:14:18.02	2158	25:56:13.82	2208	26:38:10.18	2258	27:20:07.09	2308	28:02:04.55	2358	28:44:02.56
2109	25:15:08.30	2159	25:57:04.11	2209	26:39:00.48	2259	27:20:57.40	2309	28:02:54.87	2359	28:44:52.89
2110	25:15:58.58	2160	25:57:54.54	2210	26:39:50.78	2260	27:21:47.85	2310	28:03:45.19	2360	28:45:43.37
2111	25:16:48.86	2161	25:58:44.83	2211	26:40:41.08	2261	27:22:38.16	2311	28:04:35.51	2361	28:46:33.70
2112	25:17:39.27	2162	25:59:35.12	2212	26:41:31.52	2262	27:23:28.47	2312	28:05:25.97	2362	28:47:24.03
2113	25:18:29.55	2163	26:00:25.41	2213	26:42:21.82	2263	27:24:18.78	2313	28:06:16.30	2363	28:48:14.37
2114	25:19:19.83	2164	26:01:15.84	2214	26:43:12.12	2264	27:25:09.23	2314	28:07:06.62	2364	28:49:04.84
2115	25:20:10.11	2165	26:02:06.13	2215	26:44:02.42	2265	27:25:59.54	2315	28:07:56.94	2365	28:49:55.17
2116	25:21:00.52	2166	26:02:56.42	2216	26:44:52.86	2266	27:26:49.86	2316	28:08:47.40	2366	28:50:45.51
2117	25:21:50.80	2167	26:03:46.71	2217	26:45:43.16	2267	27:27:40.17	2317	28:09:37.73	2367	28:51:35.84
2118	25:22:41.08	2168	26:04:37.13	2218	26:46:33.46	2268	27:28:30.62	2318	28:10:28.05	2368	28:52:26.31
2119	25:23:31.36	2169	26:05:27.43	2219	26:47:23.76	2269	27:29:20.93	2319	28:11:18.38	2369	28:53:16.65
2120	25:24:21.78	2170	26:06:17.72	2220	26:48:14.20	2270	27:30:11.24	2320	28:12:08.84	2370	28:54:06.98
2121	25:25:12.06	2171	26:07:08.01	2221	26:49:04.51	2271	27:31:01.56	2321	28:12:59.16	2371	28:54:57.32
2122	25:26:02.34	2172	26:07:58.44	2222	26:49:54.81	2272	27:31:52.01	2322	28:13:49.49	2372	28:55:47.79
2123	25:26:52.62	2173	26:08:48.73	2223	26:50:45.11	2273	27:32:42.32	2323	28:14:39.81	2373	28:56:38.13
2124	25:27:43.04	2174	26:09:39.02	2224	26:51:35.55	2274	27:33:32.64	2324	28:15:30.27	2374	28:57:28.46
2125	25:28:33.32	2175	26:10:29.31	2225	26:52:25.86	2275	27:34:22.95	2325	28:16:20.60	2375	28:58:18.80
2126	25:29:23.60	2176	26:11:19.74	2226	26:53:16.16	2276	27:35:13.40	2326	28:17:10.93	2376	28:59:09.28
2127	25:30:13.88	2177	26:12:10.04	2227	26:54:06.46	2277	27:36:03.72	2327	28:18:01.25	2377	28:59:59.61
2128	25:31:04.30	2178	26:13:00.33	2228	26:54:56.90	2278	27:36:54.03	2328	28:18:51.72	2378	29:00:49.95
2129	25:31:54.59	2179	26:13:50.62	2229	26:55:47.21	2279	27:37:44.35	2329	28:19:42.04	2379	29:01:40.29
2130	25:32:44.87	2180	26:14:41.05	2230	26:56:37.51	2280	27:38:34.80	2330	28:20:32.37	2380	29:02:30.76
2131	25:33:35.15	2181	26:15:31.35	2231	26:57:27.82	2281	27:39:25.12	2331	28:21:22.69	2381	29:03:21.10
2132	25:34:25.57	2182	26:16:21.64	2232	26:58:18.26	2282	27:40:15.43	2332	28:22:13.16	2382	29:04:11.44
2133	25:35:15.85	2183	26:17:11.93	2233	26:59:08.56	2283	27:41:05.75	2333	28:23:03.49	2383	29:05:01.78
2134	25:36:06.14	2184	26:18:02.37	2234	26:59:58.87	2284	27:41:56.20	2334	28:23:53.81	2384	29:05:52.25
2135	25:36:56.42	2185	26:18:52.66	2235	27:00:49.18	2285	27:42:46.52	2335	28:24:44.14	2385	29:06:42.59
2136	25:37:46.84	2186	26:19:42.95	2236	27:01:39.62	2286	27:43:36.84	2336	28:25:34.61	2386	29:07:32.93
2137	25:38:37.13	2187	26:20:33.25	2237	27:02:29.92	2287	27:44:27.15	2337	28:26:24.93	2387	29:08:23.27
2138	25:39:27.41	2188	26:21:23.68	2238	27:03:20.23	2288	27:45:17.61	2338	28:27:15.26	2388	29:09:13.75
2139	25:40:17.69	2189	26:22:13.98	2239	27:04:10.54	2289	27:46:07.93	2339	28:28:05.59	2389	29:10:04.08
2140	25:41:08.12	2190	26:23:04.27	2240	27:05:00.98	2290	27:46:58.24	2340	28:28:56.06	2390	29:10:54.42
2141	25:41:58.40	2191	26:23:54.57	2241	27:05:51.29	2291	27:47:48.56	2341	28:29:46.39	2391	29:11:44.76
2142	25:42:48.69	2192	26:24:45.00	2242	27:06:41.60	2292	27:48:39.02	2342	28:30:36.72	2392	29:12:35.24
2143	25:43:38.97	2193	26:25:35.30	2243	27:07:31.90	2293	27:49:29.34	2343	28:31:27.04	2393	29:13:25.58
2144	25:44:29.39	2194	26:26:25.59	2244	27:08:22.35	2294	27:50:19.65	2344	28:32:17.51	2394	29:14:15.92
2145	25:45:19.68	2195	26:27:15.89	2245	27:09:12.66	2295	27:51:09.97	2345	28:33:07.84	2395	29:15:06.26
2146	25:46:09.97	2196	26:28:06.33	2246	27:10:02.96	2296	27:52:00.43	2346	28:33:58.17	2396	29:15:56.74
2147	25:47:00.25	2197	26:28:56.62	2247	27:10:53.27	2297	27:52:50.75	2347	28:34:48.50	2397	29:16:47.08
2148	25:47:50.68	2198	26:29:46.92	2248	27:11:43.72	2298	27:53:41.07	2348	28:35:38.97	2398	29:17:37.43
2149	25:48:40.96	2199	26:30:37.22	2249	27:12:34.03	2299	27:54:31.39	2349	28:36:29.30	2399	29:18:27.77

Table 37: Lahiri Mean Ayanamsa as on 15 April @00:00Hrs UT(Model:Lahiri_IAU2006)

Year	dd:mm:ss	Year	dd:mm:ss	Year	dd:mm:ss	Year	dd:mm:ss	Year	dd:mm:ss	Year	dd:mm:ss
1800	21:04:22.43	1850	21:46:14.83	1900	22:28:07.78	1950	23:10:01.29	2000	23:51:55.48	2050	24:33:50.09
1801	21:05:12.64	1851	21:47:05.05	1901	22:28:58.01	1951	23:10:51.53	2001	23:52:45.73	2051	24:34:40.35
1802	21:06:02.85	1852	21:47:55.41	1902	22:29:48.25	1952	23:11:41.91	2002	23:53:35.99	2052	24:35:30.75
1803	21:06:53.06	1853	21:48:45.63	1903	22:30:38.48	1953	23:12:32.15	2003	23:54:26.24	2053	24:36:21.02
1804	21:07:43.41	1854	21:49:35.85	1904	22:31:28.85	1954	23:13:22.39	2004	23:55:16.63	2054	24:37:11.29
1805	21:08:33.62	1855	21:50:26.07	1905	22:32:19.08	1955	23:14:12.64	2005	23:56:06.89	2055	24:38:01.55
1806	21:09:23.83	1856	21:51:16.43	1906	22:33:09.31	1956	23:15:03.02	2006	23:56:57.14	2056	24:38:51.95
1807	21:10:14.04	1857	21:52:06.65	1907	22:33:59.55	1957	23:15:53.26	2007	23:57:47.40	2057	24:39:42.22
1808	21:11:04.39	1858	21:52:56.88	1908	22:34:49.92	1958	23:16:43.51	2008	23:58:37.79	2058	24:40:32.49
1809	21:11:54.60	1859	21:53:47.10	1909	22:35:40.15	1959	23:17:33.75	2009	23:59:28.05	2059	24:41:22.75
1810	21:12:44.81	1860	21:54:37.46	1910	22:36:30.38	1960	23:18:24.13	2010	24:00:18.30	2060	24:42:13.16
1811	21:13:35.03	1861	21:55:27.68	1911	22:37:20.62	1961	23:19:14.38	2011	24:01:08.56	2061	24:43:03.43
1812	21:14:25.37	1862	21:56:17.91	1912	22:38:10.99	1962	23:20:04.62	2012	24:01:58.95	2062	24:43:53.69
1813	21:15:15.59	1863	21:57:08.13	1913	22:39:01.22	1963	23:20:54.87	2013	24:02:49.21	2063	24:44:43.96
1814	21:16:05.80	1864	21:57:58.49	1914	22:39:51.46	1964	23:21:45.25	2014	24:03:39.46	2064	24:45:34.37
1815	21:16:56.01	1865	21:58:48.71	1915	22:40:41.69	1965	23:22:35.50	2015	24:04:29.72	2065	24:46:24.63
1816	21:17:46.36	1866	21:59:38.94	1916	22:41:32.06	1966	23:23:25.74	2016	24:05:20.12	2066	24:47:14.90
1817	21:18:36.58	1867	22:00:29.16	1917	22:42:22.30	1967	23:24:15.99	2017	24:06:10.37	2067	24:48:05.17
1818	21:19:26.79	1868	22:01:19.52	1918	22:43:12.54	1968	23:25:06.38	2018	24:07:00.63	2068	24:48:55.58
1819	21:20:17.00	1869	22:02:09.75	1919	22:44:02.77	1969	23:25:56.62	2019	24:07:50.89	2069	24:49:45.84
1820	21:21:07.35	1870	22:02:59.97	1920	22:44:53.14	1970	23:26:46.87	2020	24:08:41.28	2070	24:50:36.11
1821	21:21:57.57	1871	22:03:50.20	1921	22:45:43.38	1971	23:27:37.12	2021	24:09:31.54	2071	24:51:26.38
1822	21:22:47.78	1872	22:04:40.56	1922	22:46:33.62	1972	23:28:27.50	2022	24:10:21.80	2072	24:52:16.79
1823	21:23:38.00	1873	22:05:30.79	1923	22:47:23.85	1973	23:29:17.75	2023	24:11:12.06	2073	24:53:07.06
1824	21:24:28.35	1874	22:06:21.01	1924	22:48:14.23	1974	23:30:08.00	2024	24:12:02.46	2074	24:53:57.33
1825	21:25:18.56	1875	22:07:11.24	1925	22:49:04.46	1975	23:30:58.24	2025	24:12:52.71	2075	24:54:47.60
1826	21:26:08.78	1876	22:08:01.60	1926	22:49:54.70	1976	23:31:48.63	2026	24:13:42.97	2076	24:55:38.01
1827	21:26:58.99	1877	22:08:51.83	1927	22:50:44.94	1977	23:32:38.88	2027	24:14:33.23	2077	24:56:28.28
1828	21:27:49.35	1878	22:09:42.05	1928	22:51:35.31	1978	23:33:29.13	2028	24:15:23.63	2078	24:57:18.55
1829	21:28:39.56	1879	22:10:32.28	1929	22:52:25.55	1979	23:34:19.38	2029	24:16:13.89	2079	24:58:08.82
1830	21:29:29.78	1880	22:11:22.65	1930	22:53:15.79	1980	23:35:09.76	2030	24:17:04.15	2080	24:58:59.23
1831	21:30:19.99	1881	22:12:12.87	1931	22:54:06.03	1981	23:36:00.01	2031	24:17:54.41	2081	24:59:49.50
1832	21:31:10.35	1882	22:13:03.10	1932	22:54:56.40	1982	23:36:50.26	2032	24:18:44.81	2082	25:00:39.77
1833	21:32:00.56	1883	22:13:53.33	1933	22:55:46.64	1983	23:37:40.51	2033	24:19:35.07	2083	25:01:30.04
1834	21:32:50.78	1884	22:14:43.69	1934	22:56:36.88	1984	23:38:30.90	2034	24:20:25.33	2084	25:02:20.45
1835	21:33:41.00	1885	22:15:33.92	1935	22:57:27.12	1985	23:39:21.15	2035	24:21:15.59	2085	25:03:10.73
1836	21:34:31.35	1886	22:16:24.15	1936	22:58:17.50	1986	23:40:11.40	2036	24:22:05.99	2086	25:04:01.00
1837	21:35:21.57	1887	22:17:14.38	1937	22:59:07.74	1987	23:41:01.65	2037	24:22:56.25	2087	25:04:51.27
1838	21:36:11.79	1888	22:18:04.74	1938	22:59:57.98	1988	23:41:52.04	2038	24:23:46.51	2088	25:05:41.68
1839	21:37:02.01	1889	22:18:54.97	1939	23:00:48.22	1989	23:42:42.29	2039	24:24:36.78	2089	25:06:31.95
1840	21:37:52.36	1890	22:19:45.20	1940	23:01:38.60	1990	23:43:32.54	2040	24:25:27.18	2090	25:07:22.23
1841	21:38:42.58	1891	22:20:35.43	1941	23:02:28.84	1991	23:44:22.79	2041	24:26:17.44	2091	25:08:12.50
1842	21:39:32.80	1892	22:21:25.80	1942	23:03:19.08	1992	23:45:13.18	2042	24:27:07.70	2092	25:09:02.91
1843	21:40:23.02	1893	22:22:16.03	1943	23:04:09.32	1993	23:46:03.43	2043	24:27:57.96	2093	25:09:53.19
1844	21:41:13.37	1894	22:23:06.26	1944	23:04:59.70	1994	23:46:53.69	2044	24:28:48.37	2094	25:10:43.46
1845	21:42:03.59	1895	22:23:56.49	1945	23:05:49.94	1995	23:47:43.94	2045	24:29:38.63	2095	25:11:33.74
1846	21:42:53.81	1896	22:24:46.86	1946	23:06:40.18	1996	23:48:34.33	2046	24:30:28.89	2096	25:12:24.15
1847	21:43:44.03	1897	22:25:37.09	1947	23:07:30.42	1997	23:49:24.58	2047	24:31:19.16	2097	25:13:14.42
1848	21:44:34.39	1898	22:26:27.32	1948	23:08:20.80	1998	23:50:14.83	2048	24:32:09.56	2098	25:14:04.70
1849	21:45:24.61	1899	22:27:17.55	1949	23:09:11.04	1999	23:51:05.09	2049	24:32:59.82	2099	25:14:54.97

Year	dd:mm:ss	Year	dd:mm:ss	Year	dd:mm:ss	Year	dd:mm:ss	Year	dd:mm:ss	Year	dd:mm:ss
2100	25:15:45.25	2150	25:57:40.96	2200	26:39:37.23	2250	27:21:34.05	2300	28:03:31.42	2350	28:45:29.35
2101	25:16:35.52	2151	25:58:31.25	2201	26:40:27.53	2251	27:22:24.36	2301	28:04:21.74	2351	28:46:19.68
2102	25:17:25.80	2152	25:59:21.67	2202	26:41:17.83	2252	27:23:14.81	2302	28:05:12.06	2352	28:47:10.15
2103	25:18:16.08	2153	26:00:11.96	2203	26:42:08.12	2253	27:24:05.11	2303	28:06:02.38	2353	28:48:00.48
2104	25:19:06.49	2154	26:01:02.25	2204	26:42:58.56	2254	27:24:55.42	2304	28:06:52.84	2354	28:48:50.81
2105	25:19:56.77	2155	26:01:52.54	2205	26:43:48.86	2255	27:25:45.73	2305	28:07:43.16	2355	28:49:41.14
2106	25:20:47.04	2156	26:02:42.96	2206	26:44:39.16	2256	27:26:36.18	2306	28:08:33.48	2356	28:50:31.61
2107	25:21:37.32	2157	26:03:33.25	2207	26:45:29.46	2257	27:27:26.49	2307	28:09:23.80	2357	28:51:21.94
2108	25:22:27.74	2158	26:04:23.54	2208	26:46:19.89	2258	27:28:16.80	2308	28:10:14.26	2358	28:52:12.28
2109	25:23:18.01	2159	26:05:13.83	2209	26:47:10.19	2259	27:29:07.11	2309	28:11:04.59	2359	28:53:02.61
2110	25:24:08.29	2160	26:06:04.25	2210	26:48:00.49	2260	27:29:57.56	2310	28:11:54.91	2360	28:53:53.08
2111	25:24:58.57	2161	26:06:54.54	2211	26:48:50.79	2261	27:30:47.87	2311	28:12:45.23	2361	28:54:43.41
2112	25:25:48.99	2162	26:07:44.83	2212	26:49:41.23	2262	27:31:38.18	2312	28:13:35.69	2362	28:55:33.75
2113	25:26:39.26	2163	26:08:35.12	2213	26:50:31.53	2263	27:32:28.50	2313	28:14:26.01	2363	28:56:24.08
2114	25:27:29.54	2164	26:09:25.55	2214	26:51:21.83	2264	27:33:18.95	2314	28:15:16.34	2364	28:57:14.55
2115	25:28:19.82	2165	26:10:15.84	2215	26:52:12.14	2265	27:34:09.26	2315	28:16:06.66	2365	28:58:04.89
2116	25:29:10.24	2166	26:11:06.13	2216	26:53:02.57	2266	27:34:59.57	2316	28:16:57.12	2366	28:58:55.22
2117	25:30:00.52	2167	26:11:56.42	2217	26:53:52.88	2267	27:35:49.88	2317	28:17:47.44	2367	28:59:45.56
2118	25:30:50.80	2168	26:12:46.85	2218	26:54:43.18	2268	27:36:40.33	2318	28:18:37.77	2368	29:00:36.03
2119	25:31:41.08	2169	26:13:37.14	2219	26:55:33.48	2269	27:37:30.65	2319	28:19:28.09	2369	29:01:26.36
2120	25:32:31.50	2170	26:14:27.43	2220	26:56:23.92	2270	27:38:20.96	2320	28:20:18.55	2370	29:02:16.70
2121	25:33:21.78	2171	26:15:17.72	2221	26:57:14.22	2271	27:39:11.27	2321	28:21:08.88	2371	29:03:07.03
2122	25:34:12.06	2172	26:16:08.15	2222	26:58:04.52	2272	27:40:01.72	2322	28:21:59.20	2372	29:03:57.51
2123	25:35:02.34	2173	26:16:58.44	2223	26:58:54.83	2273	27:40:52.04	2323	28:22:49.53	2373	29:04:47.84
2124	25:35:52.76	2174	26:17:48.74	2224	26:59:45.27	2274	27:41:42.35	2324	28:23:39.99	2374	29:05:38.18
2125	25:36:43.04	2175	26:18:39.03	2225	27:00:35.57	2275	27:42:32.67	2325	28:24:30.32	2375	29:06:28.52
2126	25:37:33.32	2176	26:19:29.46	2226	27:01:25.87	2276	27:43:23.12	2326	28:25:20.64	2376	29:07:18.99
2127	25:38:23.60	2177	26:20:19.75	2227	27:02:16.18	2277	27:44:13.43	2327	28:26:10.97	2377	29:08:09.33
2128	25:39:14.02	2178	26:21:10.04	2228	27:03:06.62	2278	27:45:03.75	2328	28:27:01.43	2378	29:08:59.66
2129	25:40:04.30	2179	26:22:00.34	2229	27:03:56.92	2279	27:45:54.06	2329	28:27:51.76	2379	29:09:50.00
2130	25:40:54.58	2180	26:22:50.77	2230	27:04:47.23	2280	27:46:44.52	2330	28:28:42.08	2380	29:10:40.48
2131	25:41:44.87	2181	26:23:41.06	2231	27:05:37.53	2281	27:47:34.83	2331	28:29:32.41	2381	29:11:30.81
2132	25:42:35.29	2182	26:24:31.35	2232	27:06:27.97	2282	27:48:25.15	2332	28:30:22.87	2382	29:12:21.15
2133	25:43:25.57	2183	26:25:21.65	2233	27:07:18.28	2283	27:49:15.46	2333	28:31:13.20	2383	29:13:11.49
2134	25:44:15.85	2184	26:26:12.08	2234	27:08:08.59	2284	27:50:05.92	2334	28:32:03.53	2384	29:14:01.97
2135	25:45:06.14	2185	26:27:02.37	2235	27:08:58.89	2285	27:50:56.23	2335	28:32:53.86	2385	29:14:52.31
2136	25:45:56.56	2186	26:27:52.67	2236	27:09:49.33	2286	27:51:46.55	2336	28:33:44.32	2386	29:15:42.64
2137	25:46:46.84	2187	26:28:42.96	2237	27:10:39.64	2287	27:52:36.87	2337	28:34:34.65	2387	29:16:32.98
2138	25:47:37.12	2188	26:29:33.40	2238	27:11:29.95	2288	27:53:27.32	2338	28:35:24.98	2388	29:17:23.46
2139	25:48:27.41	2189	26:30:23.69	2239	27:12:20.25	2289	27:54:17.64	2339	28:36:15.31	2389	29:18:13.80
2140	25:49:17.83	2190	26:31:13.99	2240	27:13:10.70	2290	27:55:07.96	2340	28:37:05.77	2390	29:19:04.14
2141	25:50:08.12	2191	26:32:04.28	2241	27:14:01.00	2291	27:55:58.28	2341	28:37:56.10	2391	29:19:54.48
2142	25:50:58.40	2192	26:32:54.72	2242	27:14:51.31	2292	27:56:48.73	2342	28:38:46.43	2392	29:20:44.96
2143	25:51:48.69	2193	26:33:45.01	2243	27:15:41.62	2293	27:57:39.05	2343	28:39:36.76	2393	29:21:35.30
2144	25:52:39.11	2194	26:34:35.31	2244	27:16:32.06	2294	27:58:29.37	2344	28:40:27.23	2394	29:22:25.64
2145	25:53:29.39	2195	26:35:25.61	2245	27:17:22.37	2295	27:59:19.69	2345	28:41:17.56	2395	29:23:15.98
2146	25:54:19.68	2196	26:36:16.04	2246	27:18:12.68	2296	28:00:10.14	2346	28:42:07.89	2396	29:24:06.46
2147	25:55:09.97	2197	26:37:06.34	2247	27:19:02.99	2297	28:01:00.46	2347	28:42:58.22	2397	29:24:56.80
2148	25:56:00.39	2198	26:37:56.63	2248	27:19:53.43	2298	28:01:50.78	2348	28:43:48.69	2398	29:25:47.14
2149	25:56:50.68	2199	26:38:46.93	2249	27:20:43.74	2299	28:02:41.10	2349	28:44:39.02	2399	29:26:37.48

Table 38: IENA Mean Ayanamsa as on 15 April @00:00Hrs UT(Model:IENA_IAU2006)

Year	dd:mm:ss	Year	dd:mm:ss	Year	dd:mm:ss	Year	dd:mm:ss	Year	dd:mm:ss	Year	dd:mm:ss
1800	21:04:21.35	1850	21:46:13.75	1900	22:28:06.70	1950	23:10:00.20	2000	23:51:54.39	2050	24:33:49.00
1801	21:05:11.56	1851	21:47:03.97	1901	22:28:56.93	1951	23:10:50.44	2001	23:52:44.65	2051	24:34:39.27
1802	21:06:01.77	1852	21:47:54.32	1902	22:29:47.16	1952	23:11:40.82	2002	23:53:34.90	2052	24:35:29.67
1803	21:06:51.98	1853	21:48:44.55	1903	22:30:37.39	1953	23:12:31.07	2003	23:54:25.16	2053	24:36:19.93
1804	21:07:42.32	1854	21:49:34.77	1904	22:31:27.76	1954	23:13:21.31	2004	23:55:15.55	2054	24:37:10.20
1805	21:08:32.54	1855	21:50:24.99	1905	22:32:17.99	1955	23:14:11.55	2005	23:56:05.80	2055	24:38:00.47
1806	21:09:22.75	1856	21:51:15.35	1906	22:33:08.23	1956	23:15:01.93	2006	23:56:56.06	2056	24:38:50.87
1807	21:10:12.96	1857	21:52:05.57	1907	22:33:58.46	1957	23:15:52.18	2007	23:57:46.31	2057	24:39:41.14
1808	21:11:03.31	1858	21:52:55.79	1908	22:34:48.83	1958	23:16:42.42	2008	23:58:36.70	2058	24:40:31.40
1809	21:11:53.52	1859	21:53:46.01	1909	22:35:39.06	1959	23:17:32.67	2009	23:59:26.96	2059	24:41:21.67
1810	21:12:43.73	1860	21:54:36.37	1910	22:36:29.30	1960	23:18:23.05	2010	24:00:17.22	2060	24:42:12.07
1811	21:13:33.94	1861	21:55:26.60	1911	22:37:19.53	1961	23:19:13.29	2011	24:01:07.47	2061	24:43:02.34
1812	21:14:24.29	1862	21:56:16.82	1912	22:38:09.90	1962	23:20:03.54	2012	24:01:57.87	2062	24:43:52.61
1813	21:15:14.50	1863	21:57:07.04	1913	22:39:00.14	1963	23:20:53.78	2013	24:02:48.12	2063	24:44:42.87
1814	21:16:04.71	1864	21:57:57.40	1914	22:39:50.37	1964	23:21:44.17	2014	24:03:38.38	2064	24:45:33.28
1815	21:16:54.93	1865	21:58:47.63	1915	22:40:40.61	1965	23:22:34.41	2015	24:04:28.64	2065	24:46:23.55
1816	21:17:45.28	1866	21:59:37.85	1916	22:41:30.98	1966	23:23:24.66	2016	24:05:19.03	2066	24:47:13.82
1817	21:18:35.49	1867	22:00:28.08	1917	22:42:21.21	1967	23:24:14.91	2017	24:06:09.29	2067	24:48:04.08
1818	21:19:25.70	1868	22:01:18.44	1918	22:43:11.45	1968	23:25:05.29	2018	24:06:59.54	2068	24:48:54.49
1819	21:20:15.92	1869	22:02:08.66	1919	22:44:01.69	1969	23:25:55.54	2019	24:07:49.80	2069	24:49:44.76
1820	21:21:06.27	1870	22:02:58.89	1920	22:44:52.06	1970	23:26:45.78	2020	24:08:40.20	2070	24:50:35.03
1821	21:21:56.48	1871	22:03:49.11	1921	22:45:42.29	1971	23:27:36.03	2021	24:09:30.46	2071	24:51:25.30
1822	21:22:46.70	1872	22:04:39.47	1922	22:46:32.53	1972	23:28:26.42	2022	24:10:20.71	2072	24:52:15.70
1823	21:23:36.91	1873	22:05:29.70	1923	22:47:22.77	1973	23:29:16.66	2023	24:11:10.97	2073	24:53:05.97
1824	21:24:27.26	1874	22:06:19.93	1924	22:48:13.14	1974	23:30:06.91	2024	24:12:01.37	2074	24:53:56.24
1825	21:25:17.48	1875	22:07:10.15	1925	22:49:03.38	1975	23:30:57.16	2025	24:12:51.63	2075	24:54:46.51
1826	21:26:07.69	1876	22:08:00.52	1926	22:49:53.62	1976	23:31:47.54	2026	24:13:41.89	2076	24:55:36.92
1827	21:26:57.91	1877	22:08:50.74	1927	22:50:43.85	1977	23:32:37.79	2027	24:14:32.15	2077	24:56:27.19
1828	21:27:48.26	1878	22:09:40.97	1928	22:51:34.23	1978	23:33:28.04	2028	24:15:22.54	2078	24:57:17.46
1829	21:28:38.48	1879	22:10:31.20	1929	22:52:24.47	1979	23:34:18.29	2029	24:16:12.80	2079	24:58:07.73
1830	21:29:28.69	1880	22:11:21.56	1930	22:53:14.70	1980	23:35:08.68	2030	24:17:03.06	2080	24:58:58.14
1831	21:30:18.91	1881	22:12:11.79	1931	22:54:04.94	1981	23:35:58.93	2031	24:17:53.33	2081	24:59:48.41
1832	21:31:09.26	1882	22:13:02.01	1932	22:54:55.32	1982	23:36:49.18	2032	24:18:43.72	2082	25:00:38.69
1833	21:31:59.48	1883	22:13:52.24	1933	22:55:45.56	1983	23:37:39.43	2033	24:19:33.98	2083	25:01:28.96
1834	21:32:49.70	1884	22:14:42.61	1934	22:56:35.80	1984	23:38:29.81	2034	24:20:24.25	2084	25:02:19.37
1835	21:33:39.91	1885	22:15:32.84	1935	22:57:26.04	1985	23:39:20.06	2035	24:21:14.51	2085	25:03:09.64
1836	21:34:30.27	1886	22:16:23.06	1936	22:58:16.41	1986	23:40:10.31	2036	24:22:04.91	2086	25:03:59.91
1837	21:35:20.49	1887	22:17:13.29	1937	22:59:06.65	1987	23:41:00.56	2037	24:22:55.17	2087	25:04:50.19
1838	21:36:10.70	1888	22:18:03.66	1938	22:59:56.89	1988	23:41:50.95	2038	24:23:45.43	2088	25:05:40.60
1839	21:37:00.92	1889	22:18:53.89	1939	23:00:47.13	1989	23:42:41.20	2039	24:24:35.69	2089	25:06:30.87
1840	21:37:51.28	1890	22:19:44.12	1940	23:01:37.51	1990	23:43:31.46	2040	24:25:26.09	2090	25:07:21.14
1841	21:38:41.50	1891	22:20:34.35	1941	23:02:27.75	1991	23:44:21.71	2041	24:26:16.35	2091	25:08:11.42
1842	21:39:31.71	1892	22:21:24.71	1942	23:03:17.99	1992	23:45:12.10	2042	24:27:06.62	2092	25:09:01.83
1843	21:40:21.93	1893	22:22:14.94	1943	23:04:08.23	1993	23:46:02.35	2043	24:27:56.88	2093	25:09:52.10
1844	21:41:12.29	1894	22:23:05.17	1944	23:04:58.61	1994	23:46:52.60	2044	24:28:47.28	2094	25:10:42.38
1845	21:42:02.51	1895	22:23:55.40	1945	23:05:48.85	1995	23:47:42.85	2045	24:29:37.54	2095	25:11:32.65
1846	21:42:52.73	1896	22:24:45.77	1946	23:06:39.09	1996	23:48:33.24	2046	24:30:27.81	2096	25:12:23.06
1847	21:43:42.95	1897	22:25:36.00	1947	23:07:29.34	1997	23:49:23.50	2047	24:31:18.07	2097	25:13:13.34
1848	21:44:33.31	1898	22:26:26.23	1948	23:08:19.72	1998	23:50:13.75	2048	24:32:08.47	2098	25:14:03.61
1849	21:45:23.53	1899	22:27:16.46	1949	23:09:09.96	1999	23:51:04.00	2049	24:32:58.74	2099	25:14:53.89

Year	dd:mm:ss	Year	dd:mm:ss	Year	dd:mm:ss	Year	dd:mm:ss	Year	dd:mm:ss	Year	dd:mm:ss
2100	25:15:44.16	2150	25:57:39.88	2200	26:39:36.14	2250	27:21:32.96	2300	28:03:30.34	2350	28:45:28.26
2101	25:16:34.44	2151	25:58:30.16	2201	26:40:26.44	2251	27:22:23.27	2301	28:04:20.66	2351	28:46:18.59
2102	25:17:24.72	2152	25:59:20.59	2202	26:41:16.74	2252	27:23:13.72	2302	28:05:10.98	2352	28:47:09.06
2103	25:18:14.99	2153	26:00:10.88	2203	26:42:07.04	2253	27:24:04.03	2303	28:06:01.30	2353	28:47:59.39
2104	25:19:05.41	2154	26:01:01.16	2204	26:42:57.48	2254	27:24:54.34	2304	28:06:51.76	2354	28:48:49.72
2105	25:19:55.68	2155	26:01:51.45	2205	26:43:47.77	2255	27:25:44.65	2305	28:07:42.08	2355	28:49:40.06
2106	25:20:45.96	2156	26:02:41.88	2206	26:44:38.07	2256	27:26:35.10	2306	28:08:32.40	2356	28:50:30.53
2107	25:21:36.24	2157	26:03:32.17	2207	26:45:28.37	2257	27:27:25.41	2307	28:09:22.72	2357	28:51:20.86
2108	25:22:26.65	2158	26:04:22.45	2208	26:46:18.81	2258	27:28:15.72	2308	28:10:13.18	2358	28:52:11.19
2109	25:23:16.93	2159	26:05:12.74	2209	26:47:09.11	2259	27:29:06.03	2309	28:11:03.50	2359	28:53:01.52
2110	25:24:07.21	2160	26:06:03.17	2210	26:47:59.41	2260	27:29:56.48	2310	28:11:53.82	2360	28:53:52.00
2111	25:24:57.49	2161	26:06:53.46	2211	26:48:49.71	2261	27:30:46.79	2311	28:12:44.14	2361	28:54:42.33
2112	25:25:47.90	2162	26:07:43.75	2212	26:49:40.15	2262	27:31:37.10	2312	28:13:34.60	2362	28:55:32.66
2113	25:26:38.18	2163	26:08:34.04	2213	26:50:30.45	2263	27:32:27.41	2313	28:14:24.93	2363	28:56:23.00
2114	25:27:28.46	2164	26:09:24.46	2214	26:51:20.75	2264	27:33:17.86	2314	28:15:15.25	2364	28:57:13.47
2115	25:28:18.74	2165	26:10:14.75	2215	26:52:11.05	2265	27:34:08.17	2315	28:16:05.57	2365	28:58:03.80
2116	25:29:09.15	2166	26:11:05.05	2216	26:53:01.49	2266	27:34:58.49	2316	28:16:56.03	2366	28:58:54.14
2117	25:29:59.43	2167	26:11:55.34	2217	26:53:51.79	2267	27:35:48.80	2317	28:17:46.36	2367	28:59:44.47
2118	25:30:49.71	2168	26:12:45.76	2218	26:54:42.09	2268	27:36:39.25	2318	28:18:36.68	2368	29:00:34.94
2119	25:31:39.99	2169	26:13:36.05	2219	26:55:32.39	2269	27:37:29.56	2319	28:19:27.01	2369	29:01:25.28
2120	25:32:30.41	2170	26:14:26.35	2220	26:56:22.83	2270	27:38:19.87	2320	28:20:17.47	2370	29:02:15.61
2121	25:33:20.69	2171	26:15:16.64	2221	26:57:13.14	2271	27:39:10.19	2321	28:21:07.79	2371	29:03:05.95
2122	25:34:10.97	2172	26:16:07.07	2222	26:58:03.44	2272	27:40:00.64	2322	28:21:58.12	2372	29:03:56.42
2123	25:35:01.25	2173	26:16:57.36	2223	26:58:53.74	2273	27:40:50.95	2323	28:22:48.44	2373	29:04:46.76
2124	25:35:51.67	2174	26:17:47.65	2224	26:59:44.18	2274	27:41:41.27	2324	28:23:38.90	2374	29:05:37.09
2125	25:36:41.95	2175	26:18:37.94	2225	27:00:34.49	2275	27:42:31.58	2325	28:24:29.23	2375	29:06:27.43
2126	25:37:32.23	2176	26:19:28.37	2226	27:01:24.79	2276	27:43:22.03	2326	28:25:19.56	2376	29:07:17.91
2127	25:38:22.51	2177	26:20:18.66	2227	27:02:15.09	2277	27:44:12.35	2327	28:26:09.88	2377	29:08:08.24
2128	25:39:12.93	2178	26:21:08.96	2228	27:03:05.53	2278	27:45:02.66	2328	28:27:00.34	2378	29:08:58.58
2129	25:40:03.22	2179	26:21:59.25	2229	27:03:55.84	2279	27:45:52.98	2329	28:27:50.67	2379	29:09:48.92
2130	25:40:53.50	2180	26:22:49.68	2230	27:04:46.14	2280	27:46:43.43	2330	28:28:41.00	2380	29:10:39.39
2131	25:41:43.78	2181	26:23:39.98	2231	27:05:36.45	2281	27:47:33.75	2331	28:29:31.32	2381	29:11:29.73
2132	25:42:34.20	2182	26:24:30.27	2232	27:06:26.89	2282	27:48:24.06	2332	28:30:21.79	2382	29:12:20.07
2133	25:43:24.48	2183	26:25:20.56	2233	27:07:17.19	2283	27:49:14.38	2333	28:31:12.12	2383	29:13:10.41
2134	25:44:14.77	2184	26:26:10.99	2234	27:08:07.50	2284	27:50:04.83	2334	28:32:02.44	2384	29:14:00.88
2135	25:45:05.05	2185	26:27:01.29	2235	27:08:57.81	2285	27:50:55.15	2335	28:32:52.77	2385	29:14:51.22
2136	25:45:55.47	2186	26:27:51.58	2236	27:09:48.25	2286	27:51:45.47	2336	28:33:43.24	2386	29:15:41.56
2137	25:46:45.76	2187	26:28:41.88	2237	27:10:38.55	2287	27:52:35.78	2337	28:34:33.56	2387	29:16:31.90
2138	25:47:36.04	2188	26:29:32.31	2238	27:11:28.86	2288	27:53:26.24	2338	28:35:23.89	2388	29:17:22.38
2139	25:48:26.32	2189	26:30:22.61	2239	27:12:19.17	2289	27:54:16.56	2339	28:36:14.22	2389	29:18:12.71
2140	25:49:16.75	2190	26:31:12.90	2240	27:13:09.61	2290	27:55:06.87	2340	28:37:04.69	2390	29:19:03.05
2141	25:50:07.03	2191	26:32:03.20	2241	27:13:59.92	2291	27:55:57.19	2341	28:37:55.02	2391	29:19:53.39
2142	25:50:57.32	2192	26:32:53.63	2242	27:14:50.22	2292	27:56:47.65	2342	28:38:45.35	2392	29:20:43.87
2143	25:51:47.60	2193	26:33:43.93	2243	27:15:40.53	2293	27:57:37.96	2343	28:39:35.67	2393	29:21:34.21
2144	25:52:38.02	2194	26:34:34.22	2244	27:16:30.98	2294	27:58:28.28	2344	28:40:26.14	2394	29:22:24.55
2145	25:53:28.31	2195	26:35:24.52	2245	27:17:21.28	2295	27:59:18.60	2345	28:41:16.47	2395	29:23:14.89
2146	25:54:18.59	2196	26:36:14.96	2246	27:18:11.59	2296	28:00:09.06	2346	28:42:06.80	2396	29:24:05.37
2147	25:55:08.88	2197	26:37:05.25	2247	27:19:01.90	2297	28:00:59.38	2347	28:42:57.13	2397	29:24:55.71
2148	25:55:59.30	2198	26:37:55.55	2248	27:19:52.35	2298	28:01:49.70	2348	28:43:47.60	2398	29:25:46.06
2149	25:56:49.59	2199	26:38:45.85	2249	27:20:42.66	2299	28:02:40.02	2349	28:44:37.93	2399	29:26:36.40

10. Further Studies

i) Study of horoscope with Nutation effects and results

a) Effect of Nutation in Longitude and True Ayanamsa

Readers may note that Mean Ayanamsa values as per current Precession Model is provided in this book. The True Ayanamsa could be obtained by adding corresponding Nutation in Longitude with Mean Ayanamsa. This has to be studied with set of horoscopes for the changes in cuspal and planetary Nirayana positions impact of its co-rulers up to Sub Sub Subs and Sookshmas will be required for critical studies. KSK developed Krishnamurti paddhati that covers horoscopes of the twins born within few minute time interval, distinctively. However due to modern medical science development more than twin birth that is triplet, quadruplet etc., takes place. For such cases calculation of cuspal and planetary positions up to Sub-Sub-Subs levels and Sookshmas is a must for critical studies.

b) Effect of Nutation in Obliquity and True Obliquity

Nutation in Obliquity is calculated similar to Nutation in Longitude by adding significant Terms explained in respective Nutation Model. Readers may note that Mean and True Obliquity can change Cuspal sayana positions and application of true Ayanamsa can further change cuspal Nirayana positions and impact of its co-rulers up to Sub Sub Subs will be required for critical studies. This has to be studied with set of horoscopes. To study mathematically the impact on Cuspal Position, the readers can refer my article '*Trigonometry behind the House Cusps*' Ref.[55] available on-line for free, which gives the mathematical formulae associated with calculation of the house cusps using placidus house division.

Whatsoever can be the type of birth (Single, Twin etc.,), the actual position of the earth axis at the time of Event (selected Epoch) always represents its true position and hence it is imperative to use True Ayanamsa/Obliquity which is scientifically /astronomically correct.

ii) Study of Lahiri's Ayanamsa

It is mentioned on Page(5) of Lahiri's Indian ephemeris 2004 that from 1985 issue a minor correction value of 0.658" has been made in Indian Astronomical Ephemeris which was duly incorporated by Lahiri in his ephemeris. The explanation for the correction is as follows. The Nirayana longitude of the star Spica has been shown as 179° 59' 03" degrees on 1 Jan 2004. Due to proper motion, the nirayana longitude of star Spica (Chitra) has however diminished by 60 Seconds during the period of 1719 years from Year 285 A.D. Readers should note that Lahiri's Ayanamsa equations for the selected Precession Model mentioned in this book earlier, was derived by me through fundamental equations for the Reference Epoch (based on the Constant amount of Ayanamsa given for the Reference Epoch Year 2003 by Lahiri and not considering 285 A.D as Zero Ayanamsa Year to start with). However, it is Author's opinion that if the fixed Star (Reference Point) itself found moving then the correction should have been applied in Precession Rate to adjust this effect rather than with Constant part in the Ayanamsa Equations. Since the scope of this book is limited to Study of KP Ayanamsa, the interested readers may study further the Star Catalogue, Astronomical details of the Celestial Star Spica to understand and verify accordingly.

iii) Rashtriya Panchang's Ayanamsa

As discussed in Chapter(7.5,7.7.3) the Ayanamsa given in recent Indian Rashtriya Panchang, is True Ayanamsa only though it is mentioned as Mean Ayanamsa, in 2018-2019, 2019-2020 ePanchangs, available in their website www.packolkata.gov.in (FREE Download). In this regard, self contacted the concerned officials and they confirmed that the values published are True Ayanamsa only.

I am unable to source / verify the minor correction value of 0.658” mentioned by Lahiri with the actual reference of Indian Astronomical Ephemeris while writing this book. Hence the recommended values given in Table 38 are based on Zero Ayanamsa date derived from the data furnished prior to correction only. We have seen earlier that both Lahiri’s and IENA (Rashtriya Panchang, Indian Astronomical Ephemeris) Ayanamsa are same. Also the recommended Lahiri’s Mean Ayanamsa given in Table 37 is already implemented with this change. Hence the same can be used for IENA’s latest values but the readers may note the concern about movement of fixed Star (Reference Point) mentioned above.

Interested readers may study further and contact Indian Positional Astronomy Centre, Kolkata, INDIA for any further verification/clarification.

iv) Monitoring New Theories

Since research is never ending process in any field, it is possible that another new modern Precession-Nutation theory will emerge in the following years, one should keep an eye on this and adopt when it is found constructive to our astrological analysis. Readers should make a note that there is an exclusive work Groups in IAU (International Astronomical Union) earmarked for Precession and Nutation exclusively. They are continuously working, monitoring, issuing reports, updates and publish resolution for corrections, new theories based on the latest findings in subject area.

v) Other Studies

In this book Ayanamsa calculation is shown taking Universal Time (UT) for the required Epoch/Date using Besselian/Julian Year/Century only. However in Lahiri’s Indian Ephemeris and Indian Ephemeris & Nautical Almanac the actual planetary positions are provided based on the Ephemeris Time (E.T), adopting correction ‘ΔT’ as discussed in Chapter(7.4). It should be noted that modern astronomy uses dynamic time scales like Terrestrial Time (TT), Terrestrial Dynamical Time (TDT), Barycentric Dynamical Time (TDB) etc. Further dynamic time scales are also used in Modern Precession Theories. Interested readers can study further to get more details and its significance, for our Astrological calculation and decide accordingly.

vi) Tips for the Software Application

It is clear from Quadratic Eqn.(s2) given under ‘Summary of Ayanamsa(Precession) Equations’ that to calculate Ayanamsa for any Precession model, there are basic parameters required. On similar basis, option for User defined Precession Model also can be provided for which user can provide inputs for seven basic parameters (See items 1 to 7 below) which can be used to calculate the Duration of Time ‘T’ (Sr.No 8) followed by Mean Ayanamsa (Sr.No.9) as explained below.

we can write the Precession (Mean Ayanamsa) in general form as

$$\mathrm{P_M} = \mathrm{A_0} + p_0 * \mathrm{T} + q * \mathrm{T}^2 \text{(Seconds)} \qquad \text{-----------Eqn.[r1]}$$

Where

1) A_0 = Precession for reference Epoch (in Seconds)
2) p_0 = Precession Rate (Precession Per unit Time ‘T’) for reference Epoch (in Seconds)
3) q = Constant (Half of [Rate of change of Precession Rate (or) Acceleration])
4) D_0 = Reference Epoch Date in dd mm yyyy@hh:mm:ss UT

5) U_T = Time Measurement Unit in JC(or) BC (or) JY (or) BY
6) U_N = User Defined Unique Name of Precession Model
7) D_T = Required Epoch Date in dd mm yyyy@hh:mm:ss UT
8) T = Duration of Time from Reference Epoch (See Eqn.(r2))
9) P_M = Precession for required Epoch (in Seconds)

Steps to be followed for calculation of Mean and True Ayanamsa

1. Calculate the Julian Days(say 'JD_0') for the Reference Epoch date 'D_0' given by User.
2. Calculate the Julian Days(say 'JD_T') for the Required Epoch date 'D_T' given by User.
3. Calculate Duration of time 'T' as per the Unit given by user using Eqn.(r2) given below

$$T = \left(\frac{JD_T - JD_0}{DE} \right) \qquad \text{-----------Eqn.[r2]}$$

DE = No of Days Per Unit Epoch
= 365.25 Days Per Julian Year (JY)
= 365.242198781 Days Per Besselian (Tropical) Year (BY)
= 36525 Days Per Julian Century (JC)
= 36524.2198781 Days Per Besselian (Tropical) Century (BC)

4. Substitute calculated 'T' & other parameters in above Eqn.(r1) to find 'P_M' which is Mean Ayanamsa for the required Epoch.

Note:

a) Time Measurement Unit 'U_T' used for 'p_0' Precession Per unit Time 'T' and Duration of Time 'T' shall be same. Any mismatch in Time Measurement Unit or Reference Epoch Date shall be modified to suit the astronomical definition of the parameters to be used in the respective Precession-Nutation Model. Readers can refer the Chapter(3) 'Newcomb's Precession and scope' how the Precession Rate Per Besselian (Tropical) Year (BY) given for Reference Epoch B1900 See Eqn.(e) is converted into Precession Rate Per Julian Year (JY) for another Reference Epoch J1900 See Eqn.(g).

b) The Required Epoch date 'D_T' mentioned in above Step-2 is nothing but the Date &Time for which the Ephemeris or horoscope needs to be generated.

c) User can provide set of data (Sr.No. 1 to 6 above) for any number of Precession Model having Unique name of the Ayanamsa 'U_N' accordingly it is can be selected and used in the software Application.

d) To find True Ayanamsa the correction for Nutation in longitude ($\Delta\psi$) shall be added see Chapter(7.6).

e) For Ayanamsa computation, Julian Days (JD) are used as one of the auxiliary parameter and for the definition, procedure, mathematical formulae associated for calculating JD for the given Calendar Date & Time and Converting Julian Days to Calendar Date &Time is not considered under this book's scope. Readers are advised to refer any Astronomy textbooks or online resources to know more details about it.

Let me show an example to find Mean & True Ayanamsa for date 15 Apr 2019@12:00Hrs UT (17:30 Hrs IST) using KP_IAU2006 Precession Model and N4_IAU2000A Nutation Model.

A) To find mean Ayanamsa the following Steps are used.

1. As per Eqn.(j3), Julian Days(‘JD_0’) for the Reference Epoch J2000.0 (date ‘D_0’=1 Jan 2000@12:00 Hrs UT) is given as 2451545.0 days
2. Julian Days(‘JD_T’) for the date 15 Apr 2019@12:00 Hrs UT calculated as 2458589.0 days.
3. Duration of time ‘T’ in Julian Centuries using Eqn.(r2) (taking DE=36525) is calculated as shown below.

$$T = \left(\frac{2458589.0 - 2451545.0}{36525} \right)$$

$$T = \left(\frac{7044.0}{36525} \right)$$

$$T = 0.192854209445585 \text{(Julian Centuries)}$$

Alternatively, the Difference in days between date 15 Apr 2019 @ 12:00 UT and 1 Jan 2000 @ 12:00 Hrs UT can be calculated in the following ways

i) Using Microsoft Excel DATE, TIME & VALUE function, we get Date values as below

VALUE(DATE(2019,4,15)+TIME(12,0,0))	= 43570.5
VALUE(DATE(2000, 1, 1)+TIME(12,0,0))	= 36526.5
Difference in Days (43570.5 - 36526.5)	= 7044.0 Days

(Readers may note that EXCEL has limitation for handling date before 1 Jan 1900 and need to look for alternative, which is not considered this book’s scope)

ii) From Calendar/Panchang/Almanac

Leap Years in the block of Years from 2000 to 2019 are 2000,2004,2008,2012 & 2016. (Readers may refer respective Year Calendar/Panchang/Almanac or suitable method to check for any given Year is Leap Year or not, which is not considered this book’s scope)

Total number of Days from 1 Jan 2000 to 31 Dec 2018	
	= 19*365 + 5(Leap Years)
	= 6940 Days
Total number of Days from 1 Jan 2019 to 14 Apr 2019	
	=31(Jan) + 28(Feb)+31(Mar)+14(in Apr)
	= 104 Days
Days adjustment for 12 Noon(in 1 Jan 2000)	= - 0.5 Days
Days adjustment for 12 Noon(in 15 Apr 2019)	= +0.5 Days
Difference in Days (6940+104-0.5+0.5)	= 7044.0 Days

Readers may note that the difference in days for above example is found +Ve, because the date in question (15 Apr 2019 @ 12:00 UT) comes after 1 Jan 2000@12:00 Hrs UT (Date corresponding to the Reference Epoch J2000.0). But for any date before this reference date, will yield –Ve (Negative) value and thus –Ve(Negative) T value shall be substituted in respective Equations of Mean Ayanamsa and Nutation in Longitude calculations shown below. The formula used in Step3, will give the value with appropriate sign automatically except the calculation shown in above alternative ii) needs manual correction.

4. Substitute calculated 'T' in Eqn.(s2) and find 'P_M'(Mean Ayanamsa) for the required Epoch given as (using Parameters given for KP_IAU2006 Model, Sr.No.5 of Table 31)

$$P_M = 85606.70378 + 5028.796195 * 0.19285421 + 1.1054348 * 0.19285421^2$$

$$P_M = 85606.70378 + 969.82452 + 0.04111$$

$$P_M = 86576.56941 \text{(Seconds)}$$

$$P_M = 24°02'56.56941'' \text{Degrees}$$

B) <u>True Ayanamsa can be calculated as per following Steps/Details</u>

To find True Ayanamsa, the Nutation in longitude ($\Delta\psi$) shall be calculated and added with Mean Ayanamsa. The steps to calculate Nutation in longitude ($\Delta\psi$) and True Ayanamsa are given below.

1. The angle (ϕ or θ) for the each Term in Nutation Model N4_IAU2000A to be calculated using the Eqn.(s3) (up to 3rd order Term is adequate) by substituting 'T' value found for calculating Mean Ayanamsa above.
2. Calculate Sin(angle) value of respective term's angle and multiply with coefficients (Ci) given in the Table 18, we get Nutation in longitude ($\Delta\psi$) of that Term (or) directly take the respective term's value from Table 33 by linear interpolation for the calculated angle.
3. By adding cumulatively, each term's Nutation in longitude ($\Delta\psi$) value up to the required number of terms level/contribution, we will get the total Nutation in longitude ($\Delta\psi$).
4. By adding total Nutation in longitude ($\Delta\psi$) calculated in above Step(3) with Mean Ayanamsa calculated, we get True Ayanamsa as required.

Based on the first three steps given above, the following table has been generated showing total Nutation in longitude ($\Delta\psi$). Since the number of columns in the table is more, it is split in to three parts accommodating set of columns in sequence, keeping the first Column(a) common for all the tables to correlate the values between the tables easily. The details of each column are explained below for Reader's understanding.

Column(a): Term Number in the same order as given in Table 32

Column(b): Showing substitution of values for 'T', Coefficients (Di) of respective Terms(up to 3rd order Term) from Table 32 in Eqn.(s3) to get Angle (ϕ or θ) (in Seconds)

Column(c): Contribution of each Term's value in Eqn.(s3) (up to 3rd order Term) (in Seconds)

Column(d): Sum of each Term's value in Column(c) gives Angle (ϕ or θ) (in Seconds)

Column(e): Value in Column(d) divided by 3600 gives Angle (ϕ or θ) (in Degrees)

Column(f): Value in Column(e) divided by 360°(=1 Cycle) gives Angle (ϕ' or θ') (in Cycles)

Column(g): Fraction part of Angle (ϕ" or θ") in Column(f) (in Cycle) (added 1 if -Ve)

Column(h): Value in Column(g) multiplied with 360° to get Angle (ϕ or θ) (in Degrees)

Column(i): Respective Term's Coefficient (Ci) from Column(D) of Table 18 (in Seconds)

Column(j): Sin(Angle)Column(h) multiplied by Coeff.(Ci)Column(i) gives ($\Delta\psi$) (in Seconds)

Column(k): ($\Delta\psi$) value (in Seconds), Interpolated from Table 33 for the Angle in Column(h)

Column(l): ($\Sigma\ \Delta\psi$)in Seconds, Cumulative of Column(j) values ($\Delta\psi$) from Term1 to ith Term

Column(m):($\Sigma\ \Delta\psi$)in Seconds, Cumulative of Column(k) values ($\Delta\psi$)from Term1 to ith Term

Term No.	**Angle (ϕ or θ) for each Term(in Seconds)**
(a)	(b)
1	450160.398036-6962890.5431*0.19285421+7.4722*0.19285421^2+0.007702*0.19285421^3
2	723358.441156+259205542.1914*0.19285421+2.1832*0.19285421^2+0.000144*0.19285421^3
3	275879.848536+3465128744.6094*0.19285421-10.558*0.19285421^2+0.01333*0.19285421^3
4	900320.796072-13925781.0862*0.19285421+14.9444*0.19285421^2+0.015404*0.19285421^3
5	1287104.79305+129596581.0481*0.19285421-0.5532*0.19285421^2+0.000136*0.19285421^3
6	485868.249036+1717915923.2178*0.19285421+31.8792*0.19285421^2+0.051635*0.19285421^3
7	714463.234206+388802123.2395*0.19285421+1.63*0.19285421^2+0.00028*0.19285421^3
8	1121719.4505+3472091635.1525*0.19285421-18.0302*0.19285421^2+0.005628*0.19285421^3
9	761748.097572+5183044667.8272*0.19285421+21.3212*0.19285421^2+0.064965*0.19285421^3
10	732253.648106+129608961.1433*0.19285421+2.7364*0.19285421^2+0.000008*0.19285421^3
11	362653.158344+1488007279.2002*0.19285421-44.6204*0.19285421^2-0.038449*0.19285421^3
12	273198.04312+266168432.7345*0.19285421-5.289*0.19285421^2-0.007558*0.19285421^3
13	1086011.5995+1747212821.3916*0.19285421-42.4372*0.19285421^2-0.038305*0.19285421^3

Term No.	**Angle (ϕ or θ) for each Term (in Seconds)**	**(ϕ or θ) (in Seconds)**	**(ϕ or θ) (in Deg.)**	**(ϕ' or θ') (in Cycle.)**
(a)	(c)	(d)	(e)	(f)
1	450160.3980-1342822.7550+0.2779+0.0001	-892662.0790	-247.961689	-0.6887824684
2	723358.4412+49988880.0669+0.0812+0.0000	50712238.5893	14086.732941	39.1298137263
3	275879.8485+668264666.5899-0.3927+0.0001	668540546.0458	185705.707235	515.8491867637
4	900320.7961-2685645.5100+0.5558+0.0001	-1785324.1580	-495.923377	-1.3775649367
5	1287104.7931+24993246.2567-0.0206+0.0000	26280351.0292	7300.097508	20.2780486336
6	485868.2490+331307318.2186+1.1857+0.0004	331793187.6537	92164.774348	256.0132620785
7	714463.2342+74982126.3237+0.0606+0.0000	75696589.6185	21026.830450	58.4078623600
8	1121719.4505+669607489.3449-0.6706+0.0000	670729208.1248	186313.668924	517.5379692321
9	761748.0976+999571984.8085+0.7930+0.0005	1000333733.6996	277870.481583	771.8624488423
10	732253.6481+24995633.8102+0.1018+0.0000	25727887.5601	7146.635433	19.8517650927
11	362653.1583+286968468.3044-1.6596-0.0003	287331119.8028	79814.199945	221.7061109590
12	273198.0431+51331702.8220-0.1967-0.0001	51604900.6683	14334.694630	39.8185961947
13	1086011.5995+336957348.3713-1.5784-0.0003	338043358.3921	93900.932887	260.8359246853

Term No.	**(ϕ" or θ") (in Cycle.)**	**(ϕ or θ) (in Deg.)**	**Coeff. (C_i)**	**(Δψ) (in Sec.)**	**(Δψ) (in Sec.)**	**(Σ Δψ) (in Sec.)**	**(Σ Δψ) (in Sec.)**
(a)	(g)	(h)	(i)	(j)	(k)	(l)	(m)
1	0.3112175316	112.0383114	-17.2064161	-15.9492	-15.9491	-15.9492	-15.9491
2	0.1298137263	46.73294147	-1.3170906	-0.9591	-0.9591	-16.9083	-16.9082
3	0.8491867637	305.7072349	-0.2276413	0.1848	0.1849	-16.7234	-16.7233
4	0.6224350633	224.0766228	0.2074554	-0.1443	-0.1443	-16.8677	-16.8676
5	0.2780486336	100.0975081	0.1475877	0.1453	0.1453	-16.7224	-16.7223
6	0.0132620785	4.77434825	0.0711159	0.0059	0.0059	-16.7165	-16.7164
7	0.4078623600	146.8304496	-0.0516821	-0.0283	-0.0282	-16.7448	-16.7446
8	0.5379692321	193.6689236	-0.0387298	0.0092	0.0092	-16.7356	-16.7355
9	0.8624488423	310.4815832	-0.0301461	0.0229	0.0230	-16.7127	-16.7125
10	0.8517650927	306.6354334	0.0215829	-0.0173	-0.0173	-16.7300	-16.7298
11	0.7061109590	254.1999452	0.0156994	-0.0151	-0.0151	-16.7451	-16.7449
12	0.8185961947	294.6946301	0.0128227	-0.0117	-0.0116	-16.7568	-16.7566
13	0.8359246853	300.9328867	0.0123457	-0.0106	-0.0106	-16.7674	-16.7672

In above table, Column(b) to (e) shows calculation of each Term's Angle (in Seconds) and converted in to Degrees. The Angle values in Column(e) are adjusted to show within 0-360 Range in Column(h) by following three steps.

Step1: Angle value in Column(e) is converted in to No of Cycles by dividing it with 360 (Taking, 1 Cycle = 360) [Column(f)].

Step2: Fraction part of Angle in Column(f) (in Cycle) is taken ignoring integer part. If the fraction is –Ve, it is added with 1 to get +Ve value [Column(g)].

Step3: Fraction part of Angle in Column(g) (in Cycle) is converted back to Degree by multiplying it with 360 [Column(h)].

In case of Software Programming, If the Angle values in Column(e) are not within 0-360 Range, They can be adjusted by either adding 360 (if Angle < 0) consecutively until it reaches the required range or subtracting 360 (if, Angle ≥ 360) consecutively until it reaches the required range. Alternatively, suitable MATH functions supported in respective Software programming languages can be used to achieve the same. The Trigonometric SIN function used in most programming languages can handle any value beyond ±360(in Degrees) or ±2π(in Radians) and thus the Angle values in Column(e) can be substituted (after converting Degrees in to Radians as required by the programming language) directly in SIN(angle) function to get the values. Hence in such case, the above steps 1 to 3 need not be carried out.

Once the Angle (ϕ or θ) is found (in Degrees), by multiplying Sin(Angle) [Column(h)] with Coefficient(Ci) [Column(i)], we get Nutation in longitude(Δψ) (in Seconds) for the respective Term [Column(j)]

Alternatively, Nutation in longitude (Δψ) (in Seconds) can be calculated by interpolating the values given in Table 33 for the required Angle [Column(h)]. For example, let us calculate Nutation in longitude (Δψ) for Term1. We have Angle(ϕ or θ) for Term1= 112.0383114 Degrees [Column(h)]. From Column1 of Table 33, We have (Δψ) equal to -15.9535, -15.8386 for 112 and 113 Degree respectively. By linearly interpolating, we can get (Δψ) for the required Angle(ϕ or θ) as shown below.

$$\Delta\psi = -15.9535 + \left(\frac{-15.8386 - (-15.9535)}{113 - 112}\right) * (112.0383114 - 112)$$

$$\Delta\psi = -15.9535 + 4.402x10^{-3}$$

$$\Delta\psi = -15.9491(\text{Seconds})\ [\text{Column(k)}]$$

By cumulatively adding values (Δψ)[Column(j)] of individual Term's from Term1 to i^{th} Term (Where i = required level), we get Total Nutation in longitude (Δψ) (in Seconds) [Column(l)]. Similarly, Total Nutation in longitude (Δψ) (in Seconds) [Column(m)] can be calculated by cumulatively adding values (Δψ)[Column(k)] of individual Term's from Term1 to i^{th} Term.

In the above table, though I have shown Nutation in Longitude calculation for all the 13 terms, but up to first 10 terms contribution for total Nutation in Longitude values (Δψ) are considered for this example problem. Hence from above table we get,

$\Delta\psi = -16.7300$(Seconds) (Above Table, Value in Column(l) at Term 10 level, Highlighted)

Therefore, True Ayanamsa 'P_T' can be calculated by adding Total Nutation in longitude (Δψ) with Mean Ayanamsa 'P_M' we get,

$$P_T = P_M + \Delta\psi$$
$$P_T = 24°02'56.56941" - 00°00'16.7300" (\text{Degrees})$$
$$P_T = 24°02'39.83941" (\text{Degrees})$$

Recommended to use minimum 10 terms (may be up to 13 terms for more precise) to find Total Nutation in longitude ($\Delta\psi$).

Steps to be followed for calculation of Mean and True Obliquity

It is clear from Eqn.(e3) given under Chapter(7.6.6) 'Calculation for Nutation in Obliquity' that to calculate Mean Obliquity(ε_m) for any Precession model, there are basic parameters required. On similar basis, option for User defined Precession Model for Mean Obliquity calculation also can be provided for which user can provide inputs for basic parameters (See items 1 to 9 below) which can be used to calculate the Duration of Time 'T' (Sr.No. 10) followed by Mean Obliquity (Sr.No. 11) as explained below.

we can write the Mean Obliquity(ε_m) in general polynomial Equation form as

$$\varepsilon_M = E_0 + E_1 * T + E_2 * T^2 + E_3 * T^3 + E_4 * T^4 \quad \text{-----------Eqn.[r3]}$$

Where

1) E_0 = Constant Term. i.e., Mean Obliquity for reference Epoch (in Seconds)
2) E_1 = Coefficient of term 'T' (in Seconds Per Unit Time)
3) E_2 = Coefficient of term 'T^2' (in Seconds Per Unit Time^2)
4) E_3 = Coefficient of term 'T^3' (in Seconds Per Unit Time^3)
5) E_4 = Coefficient of term 'T^4' (in Seconds Per Unit Time^4)
6) D_0 = Reference Epoch Date in dd mm yyyy@hh:mm:ss UT
7) U_T = Time Measurement Unit in JC(or) BC (or) JY (or) BY
8) U_N = User Defined Unique Name of Precession Model
9) D_T = Required Epoch Date in dd mm yyyy@hh:mm:ss UT
10) T = Duration of Time from Reference Epoch (See Eqn.(r2))
11) ε_M = Mean Obliquity for required Epoch (in Seconds)

The following steps to be used for calculating Mean and True Obliquity

1. Same as Step1 given above for Calculation of Mean and True Ayanamsa.
2. Same as Step2 given above for Calculation of Mean and True Ayanamsa.
3. Same as Step3 given above for Calculation of Mean and True Ayanamsa.
4. Substitute calculated 'T' & other parameters in above Eqn.(r3) to find 'ε_M' which is Mean Obliquity for the required Epoch.

Note:

a) Time Measurement Unit 'U_T' used for the Coefficient Terms 'E_i' Seconds Per unit Time(T^i) where i=1 to 4 and Duration of Time 'T' shall be same. Any mismatch in Time Measurement Unit or Reference Epoch Date shall be modified to suit the astronomical definition of the parameters to be used in the respective Precession-Nutation Model. For concepts, Readers can refer the Chapter(3) 'Newcomb's Precession and scope' how the Precession Rate Per Besselian (Tropical) Year (BY) given for Reference Epoch B1900 See

Eqn.(e) is converted into Precession Rate Per Julian Year (JY) for another Reference Epoch J1900 See Eqn.(g).

b) The Required Epoch date 'DT' mentioned in above Step-2 is nothing but the Date &Time for which the Ephemeris or horoscope needs to be generated.

c) User can provide set of data (Sr.No. 1 to 8 above) for any number of Precession Model having Unique name of the Precession Model 'U_N' accordingly it is can be selected and used in the software Application.

d) To find True Obliquity the correction for Nutation in Obliquity ($\Delta\varepsilon$) shall be added see Chapter(7.6.6).

The same example given above is used for calculating the Mean & True Obliquity using M3_IAU2006 Precession Model and N4_IAU2000A Nutation Model as shown below.

C) <u>To find mean Obliquity the following Steps are used.</u>

1. This Step is same as Step1 shown under A) mean Ayanamsa calculation.
2. This Step is same as Step2 shown under A) mean Ayanamsa calculation.
3. This Step is same as Step3 shown under A) mean Ayanamsa calculation.
4. Substitute calculated 'T' in Eqn.(e3) and find 'ε_M'(Mean Obliquity) for the required Epoch given as (using Parameters given for IAU2006 Model, Sr.No.12 of Table 24)

$$\varepsilon_M = 84381.406 - 46.836769 * 0.19285421 - 0.0001831 * 0.19285421^2 + 0.0020034 * 0.19285421^3$$

$$\varepsilon_M = 84381.406 - 9.032668 - 0.000007 + 0.000014$$

$$\varepsilon_M = 84372.37334 (\text{Seconds})$$

$$\varepsilon_M = 23°26'12.37334'' \text{Degrees}$$

D) <u>True Obliquity can be calculated as per following Steps/Details</u>

To find True Obliquity, the Nutation in Obliquity ($\Delta\varepsilon$) shall be calculated and added with Mean Obliquity. The steps to calculate Nutation in Obliquity ($\Delta\varepsilon$) and True Obliquity are given below.

1. The angle (ϕ or θ) for the each Term in Nutation Model N4_IAU2000A to be calculated using the Eqn.(s3) (up to 3rd order Term is adequate) by substituting 'T' value found for calculating Mean Obliquity above.(It is same as the value used for Mean Ayanamsa)
2. Calculate Cos(angle) value of respective term's angle and multiply with coefficients (C_i') given in the Table 23, we get Nutation in Obliquity ($\Delta\varepsilon$) of that Term (or) directly take the respective term's value from Table 34 by linear interpolation for the calculated angle.
3. By adding cumulatively, each term's Nutation in Obliquity ($\Delta\varepsilon$) value up to the required number of terms level/contribution, we will get the total Nutation in Obliquity ($\Delta\varepsilon$).
4. By adding total Nutation in Obliquity ($\Delta\varepsilon$) calculated in above Step(3) with Mean Obliquity calculated, we get True Obliquity as required.

Since the above example is used, the first step was carried out for True Ayanamsa calculation and necessary table has been generated already. Hence the same table is utilized except introduction of additional columns in new extended table for executing the remaining Steps 2 and 3 except 4. The additional columns are arranged in sequence, keeping the first Column(a) common for all the tables to correlate the values between the tables easily. The details of additional columns are explained below for Reader's understanding.

Column(n): Respective Term's Coefficient (C_i') from Column(D) of Table 23 (in Seconds)

Column(o): Cos(Angle)Column(h) multiplied by Coeff.(C_i')Column(n) gives (Δε)(in Seconds)

Column(p): (Δε) value (in Seconds), Interpolated from Table 34 for the Angle in Column(h)

Column(q): (Σ Δε)in Seconds, Cumulative of Column(o) values (Δε) from Term1 to i^{th} Term

Column(r): (Σ Δε)in Seconds, Cumulative of Column(p) values (Δε) from Term1 to i^{th} Term

Term No.	**Coeff. (C_i')**	**(Δε) (in Sec.)**	**(Δε) (in Sec.)**	**(Σ Δε) (in Sec.)**	**(Σ Δε) (in Sec.)**	
(a)	(n)	(o)	(p)	(q)	(r)	
1	9.2052331	-3.4540	-3.4540	-3.4540	-3.4540	
2	0.5730336	0.3928	0.3927	-3.0613	-3.0612	
3	0.0978459	0.0571	0.0571	-3.0042	-3.0041	
4	-0.0897492	0.0645	0.0645	-2.9397	-2.9396	
5	0.0073871	-0.0013	-0.0013	-2.9410	-2.9409	
6	-0.000675	-0.0007	-0.0007	-2.9417	-2.9416	
7	0.0224386	-0.0188	-0.0188	-2.9605	-2.9604	
8	0.0200728	-0.0195	-0.0195	-2.9800	-2.9799	
9	0.0129025	0.0084	0.0084	-2.9716	-2.9715	
10	-0.0095929	-0.0057	-0.0057	-2.9773	-2.9773	
11	-0.0001235	0.0000	0.0000	-2.9773	-2.9773	
12	-0.0068982	-0.0029	-0.0029	-2.9802	-2.9801	
13	-0.0053311	-0.0027	-0.0027	-2.9829	-2.9828	

Once the Angle (ϕ or θ) is found (in Degrees), by multiplying Cos(Angle) [Column(h)] with Coefficient(C_i') [Column(n)], we get Nutation in Obliquity(Δε) (in Seconds) for the respective Term [Column(o)]

Alternatively, Nutation in Obliquity (Δε) (in Seconds) can be calculated by interpolating the values given in Table 34 for the required Angle [Column(h)]. For example, let us calculate Nutation in Obliquity (Δε) for Term1. We have Angle(ϕ or θ) for Term1= 112.0383114 Degrees [Column(h)]. From Column1 of Table 34, We have (Δε) equal to -3.4483, -3.5968 for 112 and 113 Degree respectively. By linearly interpolating, we can get (Δε) for the required Angle(ϕ or θ) as shown below.

$$\Delta\varepsilon = -3.4483 + \left(\frac{-3.5968 - (-3.4483)}{113 - 112}\right) * (112.0383114 - 112)$$

$$\Delta\varepsilon = -3.4483 - 5.6892 x 10^{-3}$$

$$\Delta\varepsilon = -3.4540 \text{(Seconds) [Column(p)]}$$

By cumulatively adding values (Δε)[Column(o)] of individual Term's from Term1 to i^{th} Term (Where i = required level), we get Total Nutation in obliquity (Δε) (in Seconds) [Column(q)]. Similarly, Total Nutation in obliquity (Δε) (in Seconds) [Column(r)] can be calculated by cumulatively adding values (Δε)[Column(p)] of individual Term's from Term1 to i^{th} Term.

In the above table, though I have shown Nutation in Obliquity calculation for all the 13 terms, but up to first 10 terms contribution for total Nutation in Obliquity values ($\Delta\varepsilon$) are considered for this example problem. Hence from above table we get,

$\Delta\varepsilon = -2.9773$(Seconds) (Above Table, Value in Column(q) at Term 10 level, Highlighted)

Therefore, True Obliquity 'ε_T' can be calculated by adding Total Nutation in Obliquity ($\Delta\varepsilon$) with Mean Obliquity 'ε_M' we get,

$$\varepsilon_T = \varepsilon_M + \Delta\varepsilon$$
$$\varepsilon_T = 23°26'12.37334" - 00°00'2.9773" \text{(Degrees)}$$
$$\varepsilon_T = 23°26'09.39604" \text{(Degrees)}$$

Recommended to use minimum 10 terms (may be up to 13 terms for more precise) to find Total Nutation in Obliquity ($\Delta\varepsilon$).

Readers may note that the number of Cycles Column(f) for most terms except Term1 is found more than one. Which means that Angle (ϕ or θ) has completed 360° cycle many times as represented by the integer part of it(from 1 Jan 2000 @12:00UT to 15 Apr 2019 @12:00UT).

This is further investigated by solving Eqn.(s3) for 'T', using respective Term's Coefficients (Di) values from Table 32, We get approximate number of days required to complete one cycle for Term1 to Term13 as 6798.3780, 182.6211, 13.6608, 3399.1910, 365.2596, 27.5545, 121.7493, 13.6334, 9.1329, 365.2248, 31.8119, 177.8438 and 27.0925 respectively. The Term 3,6,8,9,13 completes one cycle less than 28 days(least 9.1329 days) and Term1 completes in 6798.3780 days. Thus as mentioned earlier that the Nutation in longitude ($\Delta\psi$) and Nutation in Obliquity ($\Delta\varepsilon$) can vary dynamically within a Month/Year and hence it can't be linearly interpolated. (From any given, Yearly or even Monthly interval data).

E) Sample Horoscope calculations

A sample horoscope details are calculated for the date 01 Jan 2013@11:28:42Hrs UT (16:58:42 Hrs IST) assuming Place Chennai, INDIA (Geocentric latitude 13°N [13°04'00" N Geographic], Geographic longitude 80°17'00" E, Time Zone GMT + 5:30 Hrs) and Sidereal Time 23:34:56 Hrs.

For the above parameters KP Mean and True Ayanamsa, Obliquity has been worked out using IAU2006 Precession Model / IAU2000A Nutation model and values are given below.

==

1.	KP Mean Ayanamsa :	23°57'40.5663"	Mean Obliquity:	23°26'15.3163"
2.	Nutation in Longitude :(+)00°00'14.6435"		Nutation in Obliquity:(-)00°00'05.9227"	
3.	KP True Ayanamsa(1+2):	23°57'55.2098"	True Obliquity(1+2):	23°26'09.3936"

==

Cuspal and planetary longitudes are given in the following table with Case(a) using KP Mean Ayanamsa and Mean Obliquity and Case(b) using KP True Ayanamsa and True Obliquity.

Cusps and Planets Details

Cusp/ Planet	Nirayana Longitude (dd:mm:ss)		Co-rulers (Sign:Star:Sub1:Sub2:Sub3)		Difference (Seconds)
(1)	**(2) Case(a)**	**(3) Case(b)**	**(4) Case(a)**	**(5) Case(b)**	**(6)(3-2)**
Cusp1	065:33:28	065:33:12	MER:MAR:MOO:MOO:MOO	MER:MAR:**SUN**:**VEN**:**KET**	-16.1642
Cusp2	091:13:33	091:13:18	MOO:JUP:MAR:VEN:KET	MOO:JUP:MAR:VEN:**MER**	-14.5454
Cusp3	118:31:05	118:30:51	MOO:MER:SAT:MER:SAT	MOO:MER:SAT:MER:SAT	-13.7152
Cusp4	149:12:44	149:12:30	SUN:SUN:MAR:MOO:VEN	SUN:SUN:MAR:MOO:VEN	-14.3405
Cusp5	182:28:48	182:28:32	VEN:MAR:KET:SAT:VEN	VEN:MAR:KET:SAT:**KET**	-15.9121
Cusp6	215:11:36	215:11:19	MAR:SAT:SAT:JUP:JUP	MAR:SAT:SAT:JUP:JUP	-16.6839
Cusp7	245:33:28	245:33:12	JUP:KET:RAH:RAH:RAH	JUP:KET:**MAR**:**MOO**:**SUN**	-16.1642
Cusp8	271:13:33	271:13:18	SAT:SUN:JUP:JUP:JUP	SAT:SUN:**RAH**:**MAR**:**MOO**	-14.5454
Cusp9	298:31:05	298:30:51	SAT:MAR:SAT:MER:SAT	SAT:MAR:SAT:MER:SAT	-13.7152
Cusp10	329:12:44	329:12:30	SAT:JUP:SUN:MER:MER	SAT:JUP:SUN:MER:MER	-14.3405
Cusp11	002:28:48	002:28:32	MAR:KET:VEN:SAT:RAH	MAR:KET:VEN:SAT:RAH	-15.9121
Cusp12	035:11:36	035:11:19	VEN:SUN:MER:MER:VEN	VEN:SUN:MER:MER:VEN	-16.6839
SUN	257:16:12	257:15:57	JUP:VEN:MOO:VEN:KET	JUP:VEN:MOO:VEN:**MER**	-14.6435
MOO	122:59:43	122:59:28	SUN:KET:VEN:KET:MER	SUN:KET:VEN:KET:MER	-14.6435
MAR	281:06:18	281:06:04	SAT:MOO:MOO:SUN:VEN	SAT:MOO:MOO:SUN:**KET**	-14.6435
MER	247:26:17	247:26:02	JUP:KET:RAH:MOO:SUN	JUP:KET:RAH:MOO:SUN	-14.6435
JUP	043:45:57	043:45:42	VEN:MOO:RAH:MOO:SUN	VEN:MOO:RAH:MOO:VEN	-14.6435
VEN	236:25:00	236:24:45	MAR:MER:JUP:SAT:MER	MAR:MER:JUP:SAT:MER	-14.6435
SAT	195:37:16	195:37:01	VEN:RAH:VEN:SUN:RAH	VEN:RAH:VEN:SUN:RAH	-14.6435
RAH	209:36:37	209:36:23	VEN:JUP:MOO:RAH:RAH	VEN:JUP:MOO:RAH:RAH	-14.6435
KET	029:36:37	029:36:23	MAR:SUN:RAH:JUP:MER	MAR:SUN:RAH:JUP:MER	-14.6435

Note: Sign:Signlord, Star: Starlord, Sub1:Sublord, Sub2:Sub-Sub lord, Sub3:Sub-Sub-Sub lord

The Nirayana longitude of cuspal positions are calculated, using the placidus house division formulae given in my article (Ref.[55]) and planetary positions are calculated from Swiss Ephemeris available on-line for free. It is noticed from above table that the Nutation in Obliquity –05.9227 Seconds and Nutation in longitude +14.6435 Seconds gives the difference in Nirayana longitude of respective Cusps about –14 to -17 Seconds and for planets –14.6435 Seconds, which alters the Co-rulers of 1,2,5,7,8 cusps and planets Sun and Mars. Readers can very well understand the impact of result by actual case studies.

GOOD LUCK!!

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