History of Science in South Asia

Mean and True Positions of Planets as Described in Gaṇitagannaḍi
A Karaṇa Text on Siddhāntic Astronomy in Kannaḍa

B. S. Shylaja and Seetharam Javagal

Volume 9, 2021

URI: https://id.erudit.org/iderudit/1085749ar
DOI: https://doi.org/10.18732/hssa62

See table of contents

Publisher(s)

University of Alberta Library

ISSN

2369-775X (digital)

Explore this journal

Cite this article

Shylaja, B. & Javagal, S. (2021). Mean and True Positions of Planets as Described in Gaṇitagannaḍi: A Karaṇa Text on Siddhāntic Astronomy in Kannaḍa. *History of Science in South Asia*, *9*, 232–272. https://doi.org/10.18732/hssa62

Article abstract

The unpublished seventeenth-century Kannaḍa-language mathematical work Gaṇitagannaḍi is transmitted in a single palm-leaf manuscript. It was composed by Śaṅkaranārāyaṇa Jōisaru of Śṛṅgeri and is a karaṇa text cast as a commentary on the Vārṣikatantrasaṅgraha by Viddaṇācārya. Gaṇitagannaḍi's unique procedures for calculations wer introduced in an earlier paper in volume 8 (2020) of this journal. In the present paper the procedures for calculations of the mean and true positions of planets are described.

History of Science in South Asia

A journal for the history of all forms of scientific thought and action, ancient and modern, in all regions of South Asia

Mean and True Positions of Planets as Described in Gaṇitagannaḍi – A *Karaṇa* Text on *Siddhāntic* Astronomy in *Kannaḍa*

B. S. Shylaja and Seetharam Javagal

Jawaharlal Nehru Planetarium, Bengaluru, and Independent

MLA style citation form: B. S. Shylaja and Seetharam Javagal. "Mean and True Positions of Planets as Described in Gaṇitagannaḍi – A *Karaṇa* Text on *Siddhāntic* Astronomy in *Kannaḍa*." *History of Science in South Asia*, 9 (2021): 232–272. DOI: 10.18732/hssa62.

Online version available at: http://hssa-journal.org

HISTORY OF SCIENCE IN SOUTH ASIA
A journal for the history of all forms of scientific thought and action, ancient and modern, in all regions of South Asia, published online at http://hssa-journal.org

ISSN 2369-775X

Publisher:

History of Science in South Asia

Principal Contact:

Dominik Wujastyk, Editor, University of Alberta
Email: ⟨wujastyk@ualberta.ca⟩

Mailing Address:

History of Science in South Asia,
Department of History, Classics and Religion,
2–81 HM Tory Building,
University of Alberta,
Edmonton, AB, T6G 2H4
Canada

The electronic versions were generated from sources marked up in LaTeX in a computer running GNU/LINUX operating system. PDF was typeset using XeTeX from TeXLive. The base font used for Latin script and oldstyle numerals was TeX Gyre Pagella developed by GUST, the Polish TeX Users Group.

Mean and True Positions of Planets as Described in Gaṇitagannaḍi – A *Karaṇa* Text on *Siddhāntic* Astronomy in *Kannaḍa*

B. S. Shylaja and Seetharam Javagal

Jawaharlal Nehru Planetarium, Bengaluru, and Independent

1 INTRODUCTION

This is the second paper published in this journal concerning an astronomical manual (Sanskrit *karaṇa*) of 1604 CE in Kannaḍa, named *Gaṇitagannaḍi*, that is a commentary on *Vārṣikatantra* of Viddaṇācārya, written by Śaṅkaranārāyaṇa Jōisaru.[1] The earlier paper discussed the first chapter which was on the exact instant when the sun enters the sidereal Aries at the beginning of a given solar year (Sanskrit *meṣasaṅkrānti*) and the mean longitudes of all the planets at that instant. The present paper is on the mean positions of the planets corresponding to a count of civil days from the epoch (*ahargaṇa*) specified by the lunar phase (*tithi*) and lunar month of a given year. This is part of the first chapter itself. We include the second chapter giving the true positions which are obtained after the application of the first equation (*manda*) correction and the second equation (*śīghra*) correction for the five planets which look like stars (*tārāgraha*), i.e., Mercury, Venus, Mars, Jupiter and Saturn.

In the first part of this paper we provide a description of the procedure highlighting the technique used in the text. This will be followed by a diplomatic transcription of the text. The palm leaf manuscript includes both Sanskrit and Kannaḍa languages and is written in the archaic script called Nandināgarī. We provide a translation of the commentary from Kannaḍa. The suggestions on

An unpublished draft of the present paper was included in the book Shylaja and Javagal 2021.

1 The earlier paper was Shylaja and Javagal 2020. For a description and examples of the *karaṇa* genre, see Plofker 2009: §4.4.1.

DOI: 10.18732/HSSA62

possible corrections for scribal errors are also discussed at relevant places. As explained in the earlier paper, the Sanskrit verses are translated in to Kannaḍa by rearranging phrases to follow the grammar of Kannaḍa, where generally sentences commence with adjectives of the subject and end with the verb. It may be seen that words get rearranged to follow the grammar of Kannaḍa. A small phrase may require explanation extending to several long sentences in the commentary. The rearranged phrases with intervening meanings read as complete sentences. This is the same method taught as "meaning according to word-sequence" (*anvayānusārārtha*) even today.

The introduction of classical texts of Sanskrit with commentaries in regional languages was already prevalent in Keraḷa by the seventeenth century, as described by Sarma (1972; 1985), who cites several examples of texts with prose or poem in Malayāḷam interlaced between Sanskrit verses. It would be interesting to study the evolution of such texts of astronomy in Kannaḍa, with the very first example being offered by *Gaṇitagannaḍi*. Among the 466 manuscripts classified as astral sciences (*jyotiṣam*) in the Oriental Research Institute, Mysore (Malladevaru 1983), the majority are devoted to predictive astrology. Five of them have Kannaḍa translations, interlaced with Sanskrit verses, following the "syntactic sequence" (*anvayānusāra*) method. As pointed out by Gurevitch (2020), translations were initiated to bring texts within the reach of local populations. Considering the importance given to the routine astronomical calculations for Sṛṅgeri, which was a seat of knowledge, a text of this kind was perhaps in great demand.

This study presents translation at two levels. The *Gaṇitagannaḍi* itself is based on a translation. This translation of 1604 CE was aimed at providing an elaborate commentary with references to the original phrases as and when required. As the author mentioned in the introduction, it was for the benefit of beginners and students. He stated,

> ಇಲ್ಲಿ ಮುಂದೆಯೂ ಈ ಪ್ರಕಾರದಲ್ಲಿ ಶಬ್ದಶಕ್ತಿಯ ಕಾಣಿಸಿ ಅರ್ಥ ಸಂಬಂಧವ ಮಾಡಿ ಗ್ರಂಥಾರ್ಥವ ಹೇಳ್ವೀನೆಂದರೆ | ಮುಂದೆ ಕೆಲವು ಬಳಿಗಳಲ್ಲಿ ಅನ್ವಯ ಯೋಜನೆಗಳು ಸಂಗತವಾಧಾವು | ಕೆಲವು ಬಳಿಗಳಲ್ಲಿ ಸಂಬಂಧವಾಗವು | ಅದೇಕೆಂದರೆ | ಇದು ಗಣಿತಪ್ರಧಾನವಾದ ಸಂಖ್ಯಾ ಶಾಸ್ತ್ರ ವಾದ ಕಾರಣ | ಹಾಗಾದರೂ ಅದು ಅಲ್ಲದೇ | ಅಶಿಕ್ಷಿತರಾದ ಬಾಲರಿಗೆ ಹೇಳುವಾಗ ಪರಿಭಾಷೆಯೇ ಪ್ರಧಾನವಾಗಿ ಶಿಕ್ಷೆಯ ಮಾಡಬೇಕಾದ ಕಾರಣದಿಂದಲ್ಲೂ | ಹೇಗೆ ಸುಸಂಗತವಾಗಿ ಅರ್ಥಾನುಸಂಧಾನವಹುದು | ಹೇಗೆ ಬಾಲರಿಗೆ ತಿಳಿವುದು ಹಾಗೆ ಅರ್ಥವು ಹೇಳಲ್ಪಡುತಿದ್ಧೀತು | ಇಲ್ಲಿ ದುರನ್ವಯ ದುರ್ಯೋಜನೆ ಲಿಂಗ ವಚನ ವಿಭಕ್ತಿ ವ್ಯತ್ಯಯಗಳಾದವೆಂದು ಬಲ್ಲವರು ತಿಳಿಯಲಾಗದು.
>
> Hereafter, the power of words is used to decipher the inner meaning of the work (*grantha*). Sometimes the interpretations are relevant. At some places they may not appear to be related. This is so because we are dealing with a mathematically oriented subject. When we are

> teaching young students who are not yet competent [with the basics], the method of expression of the meanings of the words becomes very important. Scholars should not mistake that there is a misinterpretation or that the grammatical rules for gender and number (*vacana*) and case (*vibhakti*) are violated.

In this paper we have tried to follow a similar rationale, so that it will be understandable for present-day students and scholars who may not have previously been exposed to the texts and methods of teaching in the medieval period. The mathematical treatment of concepts is given priority. We have provided the original text with the translation so that any doubt on possible deviation from the original can be inspected immediately. We believe that this will be useful for readers who wish to understand the mathematical techniques. As we shall see later, the crisp and short phrases require a lengthy explanation, even to a person conversant with the tools of mathematics. Here is an example: the commentary for verse number 2.3 states,

> The *śīghrahara* 10 [*vyomendavaḥ*] should be added to *koṭiphala*, if *śīghrakendra* is *mrigādi* and subtracted if it is *karkyādi*.

It is implied that a number 10, (called *śīghrahara* for a specific reason) should be added to the result obtained and called *koṭiphala* if the angle (called "centre" or *kendra*) with which we started the entire scheme of correction, is between 0 and 180; it should be subtracted if the angle is between 180 and 360 degrees. Thus, the English rendering requires a higher number of longer sentences. The difficulty posed by the absence of relevant diagrams in the original manuscript transmission is addressed by their introduction in this paper, in order to facilitate the mathematical treatment.

2 THE MEAN POSITIONS

Generally, all the texts (*Siddhānta* or *Karaṇa*) start with the calculation of mean positions starting from the value of the *ahargaṇa* itself. Gaṇitagannaḍi too starts with a modified *ahargaṇa* or *dyugaṇa* which corresponds to the count from the midnight before the *meṣa saṅkrānti* (the date of entry of the sun in to Aries). For the date of calculation which is referred to as desired date (*iṣṭa dina*) and the average lunar day decided by the phase of moon (*tithi*) are known. The calculations are done to fix the *tithi* of the phase of the moon corresponding to the date of entry of sun in to Aries (*saṅkrānti*). Since the year is reckoned on the first day after new moon before the *meṣa saṅkrānti*, given as *caitra śuddha pratipat*, the *meṣa saṅkrānti* need not coincide with this. It is here that the method differs from that of other texts such as *Karaṇakutūhala* (Balachandra Rao and Uma 2008) by Bhāskarācārya, where the *ahargaṇa* count is directly used to get the mean longitudes. In a later text, the *Grahalāghava* by Gaṇeśa Daivajña, the total number of civil days is regrouped in to *cakras* of 11 years and a modified number is used for deriving the mean longitudes of all planets (Balachandra Rao and Uma 2006).

For the Moon, from the described procedure, it is clear that the mean motion is taken to be $12 + \frac{12}{68} + 1$ degrees per day. The procedure requires that the longitude of the moon obtained in units of *rāśi*, degrees, minutes and seconds, be converted in to one unit namely degrees. Since *rāśi* is 30 degrees, its count is multiplied by 30 and added to the degrees count. For example, if the longitude of the moon is 1 *rāśi* and 10 degrees, it is equivalent of 40 degrees. To get the *tithi* we have to divide this number by the motion of the moon $12 + \frac{12}{68} + 1$ per day. The procedure states that division by 12 should suffice and the quotient is not needed. It should be noted that the words *bhāga*, *aṃśa* and *bhāgi* are used interchangeably for degrees. Thus conversion to degrees and division by 12 provides the *saṅkrānti tithi*, which is used for the exact calculation of *dyugaṇa*. This provides the count of the month since the solar month starts from *saṅkrānti tithi*. Days from *caitra śuddha pratipat* to the date of interest are counted including the intercalary month if applicable. The number corresponding to that of *saṅkrānti tithi* is then subtracted. Here the idea of *ṛtu* (can be understood as season, a year has six *ṛtu*s) is introduced to avoid one step of calculation. (Each *ṛtu* means 2 months). Therefore, *dyugaṇa* count from the *meṣa saṅkrānti* is obtained.

Let us take an example. In the year *śaka* 1069 (corresponding to 1147 CE) the *meṣa saṅkrānti* occurred on 5th day after full moon in the month of *Caitra* based on a stone inscription (Shylaja and Geetha, 2016). This corresponds to March 24 as verified by another inscription recording a solar eclipse of the same year. Thus there is a difference of 20 days, which will be the carried on as the difference between *dyugaṇa* and *ahargaṇa* (which starts from *Caitra śu* 1) counts.

After getting the number of *dyugaṇa*, its verification is done by the week day by dividing by 7. The remainder zero corresponds to Thursday, 1 corresponds to Friday and so on. The difference between *dyugaṇa* and *sāvana dhruva* (it is the longitude for the beginning of the year for the planet as explained in the earlier paper) is called *pada* and is expressed in *ghaḷige* and *vighaḷige*. The subtraction is explained step by step. Thus *pada* defines the number of days to the desired date as counted from the *meṣa saṅkrānti*, (defined as the First point of Aries in the current usage of spherical astronomy text books) effectively, the longitude expressed in units of days.

A quantity called *pada* was used in *Vaśiṣṭasiddhānta* as described by Shukla (2016, p502). It was coined as 1/248th part of the motion of the moon, equivalent to 1/9th of a day. Similar definitions existed for Jupiter and Saturn too, to derive the longitude. It referred to unequal divisions of the planets' motion in a sidereal revolution. Here, in *Vārṣiktantra,* the definition itself is different. Lalla also has defined similar divisions in *Śiṣyadhīvṛddhidatantra* (Chatterjee 1981). But that definition also is very different - the word used is pāda, which means a quarter. In the conventional methods (example *Karaṇakutūhala*) the *ahargaṇa* count is converted to the *dhruvaka* (longitude) and added to the *dhruvāṃśa* obtained earlier. Here the same procedure is adopted to get the *dhruvaka* using the quantity *pada*.

Therefore as a first step, *pada* is converted to units of degrees, arc minutes and arc seconds by dividing by 70. All the steps for this are explained - the first division gives degrees. The remainder is multiplied by 60 and then divided by 70 to get *ghaḷige*. The remainder of this is again multiplied by 60 and divided by 70 to get *vighaḷige*. This gives the mean longitude of the sun (stated as Ravi). The rationale for this is explained in the next sentence - the mean *gati* (daily motion) of Ravi 59′ (arcmin) 8″ (arcsec), which is expressed as

$$1\,\text{deg} - 52\,\text{arcsec} = 1 - 52/3600\,\text{deg}$$

Now, 52/3600 is very close to 1/70. Hence the motion of the sun is taken to be (1 − 1/70) degree per day. So, when the *pada* (in days, *ghaḷige* and *vighaḷige*) is divided by 70 and the ratio is subtracted from itself, the result would be the mean longitude of the sun in degrees, arcminutes and arcseconds, as the mean longitude is zero at the *meṣa saṅkrānti*.

For Mars, Mercury, Jupiter, Venus, Saturn, Moon's nodes and the Moon's apogee, the mean daily motions can be inferred to be: $4/229, (4/30 + 1/325), 1/361, 40/749, 1/897, 1/566$ and $3/808$ *rāśis*, respectively. The values in degrees per day are found by multiplying these by 30. The mean longitudes for any *ahargaṇa* would be

$$\textit{dhruvāṃśa} + (\textit{pada} \times \textit{gati})$$

Thus for the remaining part of the verse *gati* is expressed as a ratio with the values of multiplier and divisor defined in the *bhūtasankhya* system for all planets. In case of Mars, the conversion in to units of degree is explained. If the *pada* is $a^d|b^l|c^v$, c is divided by 60 and added to b, the sum is divided by 60 and added to a. Thus the final value of *pada* is expressed in units of days. The mean motion of Mars is 4 *rāśis* or 120 degrees in 229 days here. Hence, numerator is 4 (in units of *rāśis*), expressed as *kṛti*, and denominator is 229 expressed as *nidhi pakṣa netra* here, and (*pada*) multiplied by the ratio is the mean motion of Mars during a *pada*.

For *Budha śīghrocca*, the multiplier is not stated explicitly. Using the idea that a plural has been used for the multiplier, the same number as for the previous one (Mars) is employed. The divisor is 30. Apart from this, to this, one has to add 1 divided by 325. Thus the correction is in 2 steps.

For the Moon, from the described procedure, it is clear that the mean motion is taken to be equal to

$$12 + \frac{12}{68} + 1 = 13.17647$$

degrees per day.

The details of the multipliers and divisors for the planets, beginning with Mars are shown in Table 1. Table 2 compares the mean motions as derived from this text with those from *Sūryasiddhānta*, depicting the accuracy of the procedure.

Name	**mult, div**	**Numerals in *Bhūtasaṅkhyā* system**
Kuja/Mars	4, 229	*Kṛti, nidhi pakṣa netra*
Budha/Mercury	(4), 30 ; 1, 325	(*krti*), *khāgni; Eka, pañcarada - 2 steps Multiplier 4 is not explicitly stated*
Guru/Jupiter	1, 361	*bhū, mahi ṣatkṛti*
Śukra/Venus	40, 749	*khābdi, tāna nāga*
Śani/Saturn	1, 897	*kṣiti, muni randhra nāga*
Rāhu/Node	1, 566	*ku, rasāngaiṣu*
Candrocca/Apogee	3, 808	*thri, vasu vyoma gaja*

Table 1: The multipliers and divisors of the planets beginning with *Kuja* (Mars)

The mean motion	***Sūryasiddhānta***	**GG (this text)**
Candra/Moon	13.17635	13.17647
Budha/Mercury	4.15210	4.0911
Kuja/Mars	0.524019	0.524017
Guru/Jupiter	0.08309	0.08310
Śukra/Venus	1.602146	1.062136
Śani/Saturn	0.033439	0.033444
Rāhu/Node	0.052984	0.052240
Candrocca/Apogee	0.111383	0.111386

Table 2: The mean motions of the planets as derived in this text compared with the values from *Sūryasiddhānta*

Finally another correction for only the sun and the moon is specified. That is to add the result of *pada* divided by 150; the rationale for this is not explained here but is covered in the chapter called *Chāyādhikāra*.

The mean values for all planets are for the midnight of Laṅkā (equator). Here the central meridian is described as passing through Laṅkā, Ujjain (Avanti), Rohtak, Mānasa Sarovar and another place called Svāmimale mountain (which is not mentioned in the original *Vārṣiktantra*). The correction for location of the observer requires the *viṣuvadchāyā*, which is the shadow length of a 12 *aṅgula* (inches) gnomon on the day of equinox. The *lambajyā* (R cosine) of this is multiplied by 5060 and divided by 120 to get the correction called *yojanaphala*.

The rationale is derived from *Sūryasiddhānta* (Bapu Deva Sastri 1861: vv. 1–59). The radius of earth is taken as 800 yojanas. Therefore its circumference is 5060 yojanas. Here the value for the ratio the circumference to the diameter of a circle, π, is taken as square root of 10. This calculation is needed to find the time difference between the observer's place and the standard meridian just defined. The daily motion of each planet is different and therefore the time differences will have to be calculated individually. However, the observer is not on the equator but a certain latitude φ. Therefore the circumference will be along a circle parallel to the equator, which is obtained by multiplying the radius by $\cos\varphi$ as shown in Figure 1. Here we have the value of latitude from the gnomon shadow on equinoctial day. Therefore to get the cosine of that we have to use the sine tables (provided in the next chapter on true values) for an angle $(90 - \varphi)$. This works out to be 116|27. The number 5060 corresponding to the equator, is multiplied by 116|27 and divided by 120 so that we *svadeśabhūparidhi*, (the circumference of the small circle at the latitude of the observer) for the given place.

The *viṣuvad chāyā* is 3 *aṅgula*; the *lambajyā* is 116|27, can be understood as latitude, $\varphi = \tan^{-1}(3/12) = 14^\circ|2'|11''$

$$R\cos\varphi = 116|27$$

From the Figure 1, the circumference of the earth at this latitude is

$$bh\bar{u}paridhi = 5060 \times R\cos\varphi/120$$

Here, 5060, $= 2 \times 800 \times \sqrt{10}$, is taken from the *Sūryasiddhānta*

The R sines are to be obtained from the sine tables provided in the next chapter with the value of R as 120. This latitude of $14^\circ 2' 11''$ refers to a location north of Śṛṅgeri (latitude $13^\circ 25'$). However, since the author mentions the name Śṛṅgeri in the next chapter the *Chāyādhikāra*, this small difference may be attributed to his location in the outskirts of the town.

The next step is to get the mean values for the time of the day. This is achieved by taking the difference from midnight of the same day or the previous day. This is multiplied by the *gati* (or the daily motion) of the individual planets.

Thus we see that the technique offers a different approach as compared to the conventional methods (like those of the *Karaṇakutūhala*) in the determination of the mean positions. The multipliers for deriving the *dhruvakās* (longitudes) of planets have been modified suitably.

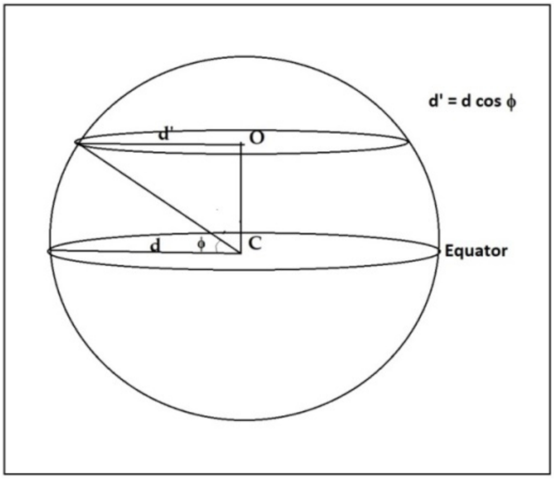

Figure 1: The circle parallel to equator at *O* is the *svadeśabhūparidhi* at latitude φ.

3 TRUE POSITIONS

The procedure is based on the *Sūryasiddhānta* but many details are not explicitly mentioned.

After getting the mean positions as explained in Section 2, the corrections to derive the true positions are performed in two steps. The first correction is called the *manda* correction and the second one is called *śīghra*. The very first verse introduces the reference points needed for the second correction, called *śīghrocca.* The farthest point on the epicycle created for this correction also has the same name.

From the second verse onwards the procedure for the *manda* correction is described.

The positions of the *mandocca* (apogee) for all the planets are given. Then there is an explanation for how these numbers have been arrived at. As per the definitions provided in *Sūryasiddhānta* (1–41 and 42), the number of years since the epoch is multiplied by the number of revolutions in a *mahāyuga* or *kalpa* and is divided by the number of years in that period to get the *mandocca* in revolutions. The fractional part multiplied by 360 corresponds to the position on the ecliptic in degrees for the required date. He further states there can be an error of 1 or 2 *liptis* (arc minutes) from the epoch specified by the Ācārya and therefore he has added 1 degree to account for such small deviations.

The word *kendra* is used to indicate the angle between *mandocca* (or *śighrocca*) and the mean position (or position after *manda* correction). They are referred to by abbreviations *manda* (or *śīghra*). The corrections (as shown in the following discussion) derived using these are called *mandaphala* (or *śīghraphala*). It should be noted that word *mṛgādi* is used here. All along the discussion used the zodiacal signs - here it becomes luni-solar *Mṛga* corresponding to the month *Mārgaśira*.

This correction can be understood with the help of Figure 2. The basic idea of the *manda* correction is to account for the elliptical orbit, which is achieved with another smaller circle moving along the mean circular orbit. (Bapu Deva Sastri 1861).

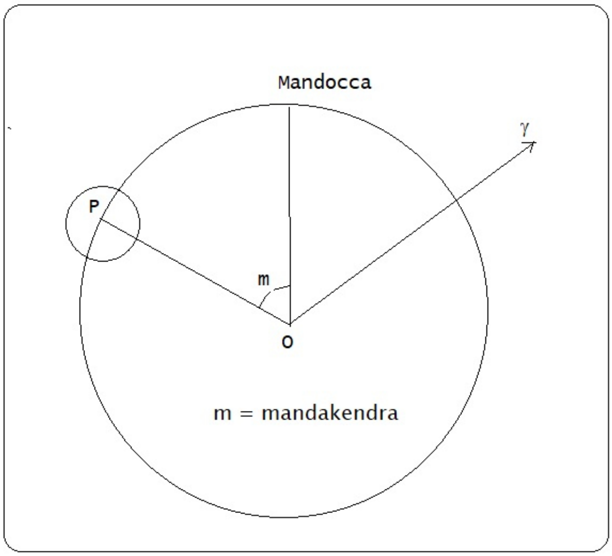

Figure 2: Definition of *Mandakendra*

In Figure 3, at the apogee A, the planet is farthest and at B it is the closest. The planet moves along the small circle so that the distance difference is achieved over half the orbit. There is always a phase difference between the true position (shown in red colour) and the mean position of the planet (shown in black).

Since the projection of the position on the radius vector is needed for the calculation we have to get the sine of the angle called *mandakendra*, shown in Figure 1. The correction is indicated by the dashed line in Figure 3.

The next verses describe how to get the *R* sine values. In all the astronomical texts the trigonometric sine ratio is treated as the arc *R* sine (angle), called as *jyā*. In this text the word *jīva* is also used. Here *R* is taken as 120. The arc itself is expressed in units of degree (*bhāga*) arc minutes (*kalā*) and arc seconds (*vikalā*). A table is provided for the calculation of *R* sine of any angle. Every 10 degrees is termed a *khaṇḍa* (section) and the value of the differences of *R* sine is provided. The value for any intermediate value is obtained by interpolation. The numbers are specified in *bhūtasaṅkhyā*.

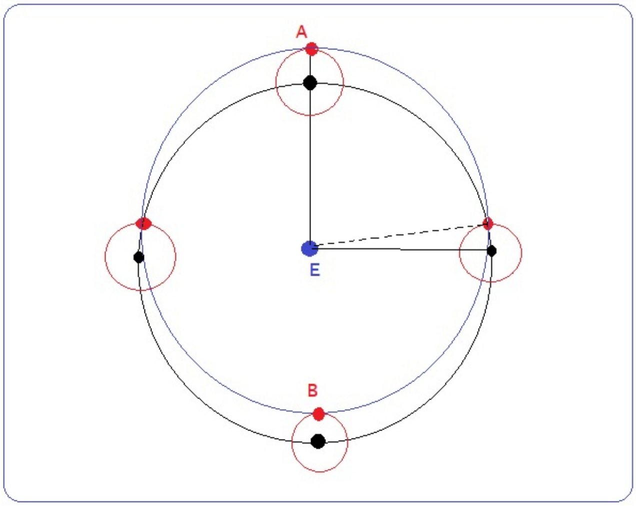

Figure 3: Apogee and epicycles: Black circle is the mean orbit.

khaṇḍa	1	2	3	4	5	6	7	8	9
khaṇḍa jyā	21	20	19	17	15	12	9	5	2

The author proceeds to explain how to get the R sine for any angle. The angle should be divided by 10 to identify the *khaṇḍa*. All values preceding it are added up. The *jyā* difference corresponding to the remainder after dividing by 10 is obtained between the successive *khaṇḍa* and added to the earlier sum. This procedure will be clear with an example. If we want find the R sine for 34 degrees, we look up the value for number 3, since 34/10 has quotient 3 (*khaṇḍa* number) and the remainder is 4. The sum of all *jyā* values preceding 3 is $21 + 20 + 19 = 60$. Now we have to interpolate between *khaṇḍas* 3 and 4 for the remainder 4, as $(\frac{17}{10} \times 4) = 6$ and remainder is 8. This is added to 60 as 66 and remainder 8 is multiplied by 60 to get $48'$. Thus the R sine of 34 is $66^\circ 48'$.

The text also gives the same numbers in the reverse order as

2|5|9|12|15|17|19|20|21|

The sums of all the preceding values of *jyā*, are provided in the next verse in the *bhūtasankhya* system. These are termed *piṇḍīkṛta jīva.*

khaṇḍa	1	2	3	4	5	6	7	8	9
piṇḍīkṛta jīva	21	40	60	77	92	104	113	118	120

Another interesting part introduced by the author is the table of *utkramajyā*. This trigonometric ratio (1 – cos) is not included along with the other three in the text books of today, although it has been named versine.

|2|7|16|28|43|60|79|99|120|

For example if the angle is 60, its *utkramajyā* is R $(1 - \cos 60)$ which is 60. This is the number in the 6^{th} *khaṇḍa*.

The next verse gives the values of divisors for *manda* corrections for the planets. Here the author follows a technique that is different from others, for example, *Karaṇakutūhala*. In most Indian texts on astronomy including *Sūryasiddhānta*, the computation of *mandaphala* is based on an epicycle model (Figure 4).

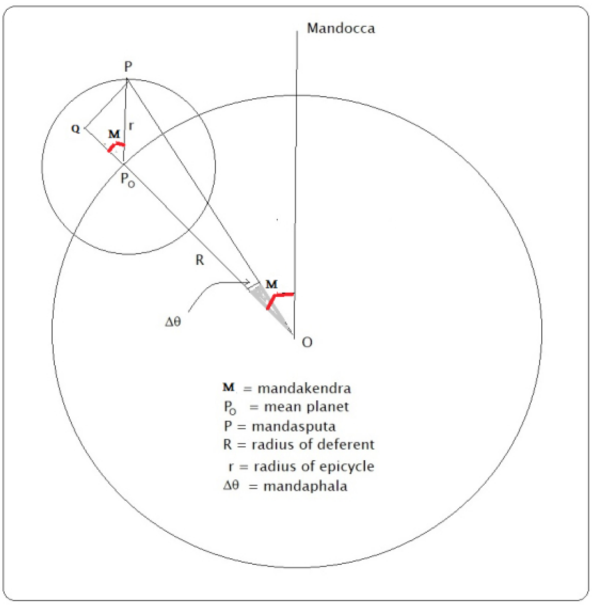

Figure 4: Derivation of the *manda* correction

P_o is the mean position of the planet. P is the position corrected for *manda*, referred to as *mandasphuṭa*. The angle MOP_o is called M, *mandakendra* ; the angle POP_o, $\Delta\theta$, is called *mandaphala*. Writing r as the radius of epicycle and R as the radius of deferent, we get from trianlges OQP and PQP_o,

$$PQ = OP \sin \Delta\theta \text{ and also } PQ = r \sin M \text{ or}$$

$$\Delta\theta = \frac{r \sin M}{R} \text{ (in radians) } = \frac{r \sin M}{R} \times \frac{3438}{60} \text{ (in degrees)}, \tag{1}$$

where r and R are the radii of the epicycle and the deferent, respectively.

From the descriptive procedure we understand that the *mandaphala* is given as

$$\frac{R\sin M \times 60}{x + \frac{R\sin M\times 60}{y}}$$

where M is the *mandakendra*, and the denominator is called the corrected *mandaccheda*. Here x and y are specified for each planet. For instance, for the Sun, $x = 3230$ (*vyomāgnidanta*) and $y = 90$ (*khāṅka*). The first term in the denominator is much larger than the second term.

Therefore,

$$\frac{R\sin M \times 60}{x + \frac{R\sin M\times 60}{y}}$$

is approximated as

$$\frac{R\sin M \times 60}{x + \frac{R\sin M\times 60}{y}} = \frac{R\sin M \times 60}{x}\left[1 - \frac{R\sin M \times 60}{xy}\right]$$

In the *Sūryasiddhānta*, r is of the form

$$x' - y' \sin M x' \left[1 - \frac{y'}{x'} \sin M\right]$$

and $R = 360$. For instance, for the Sun, $x' = 14$ and $y' = \frac{1}{3}$. In Table 3 the values for *mandaphala* from the two texts are compared.

Table 3 shows that the *Ganitagannaḍi* expression for the *mandaphala* would give very nearly the same results as the ones following from *Sūryasiddhānt* rules. For all planets the divisors are derived and provided using the siddhanatic vaues of the peripheries. The values from *Karaṇakutūhala* (Balachandra Rao and Uma 2008) are compared in Table 4.

The correction is explained in the next verse. It is called *tātkālika*, which can be interpreted as "as applicable for that instant." The procedure to apply this correction appears to be have been devised by the author himself. The R sine of the *mandakendra* is converted to *lipti* (arcminutes) by multiplying the value in degrees by 60. Then the *liptis* are added so that the entire value is in *liptis*. These are to be divided by different numbers for each planet specified by the verse beginning with *khāṅkaiḥ*, 90 for the sun and so on. The result is again added to the numbers specified earlier in the verse beginning with *vyomāgnidantaḥ*, to get the divisors. Dividing the R sine of *mandakendra* by this corrected divisor gives the *mandaphala*. The numbers are 90 (*khāṅka*), 490 (*khatāna*), 300, (*viyadabhrarāma*), 70 (*khāsva*) 170 (*kha śailendu*), 21 (*indupakṣa*), 380 (*khāṣṭāgni*). Thus the correction extends to the fraction of a degree.

Planet	X	y	x'	y'	*mandaphala* in *Gaṇitagannaḍi* in degrees	*mandaphala* in *Sūryasiddhānta* in degrees
Ravi/sun	3230	90	14	$\frac{1}{3}$	$2.2291[1 - .02477 \sin M] \sin M$	$2.2283[1 - 0.02380 \sin M] \sin M$
Candra / Moon	1413	49	32	$\frac{1}{3}$	$5.0955[1 - 0.0104 \sin M] \sin M$	$5.0933[1 - 0.0104 \sin M] \sin M$
Kuja/ Mars	603	30	75	3	$11.9402[1 - 0.03998 \sin M] \sin M$	$11.9375[1 - 0.0400 \sin M] \sin M$
Budha / Mercury	1510	70	30	2	$4.7682[1 - 0.0681 \sin M] \sin M$	$4.7750[1 - 0.0667 \sin M] \sin M$
Guru / Jupiter	1371	170	33	1	$5.2516[1 - 0.0309 \sin M] \sin M$	$5.2525[1 - 0.0303 \sin M] \sin M$
Śukra / Venus	3769	21	12	1	$1.9103[1 - 0.0910 \sin M] \sin M$	$1.9100[1 - 0.0833 \sin M] \sin M$
Śani / Saturn	923	380	49	1	$7.8006[1 - 0.0205 \sin M] \sin M$	$7.7992[1 - 0.0204 \sin M] \sin M$

Table 3: Comparison of *mandaphalas* in the *Gaṇitagannaḍi* and the *Sūryasiddhānta*. Kindly provided by the anonymous referee.

Name of planet	*Mandacheda Divisor*	*Phrase bhūtasaṅkhyā*	*circumference of epicycle*	*circumference of epicycle (KK)*
Ravi / Sun	3230	*vyomāgnidanta*	13 | 22	13 | 40
Candra / Moon	1413	*śikhirupaśakra*	30 |34	31 | 36
Kuja/ Mars	603	*purāmbarānga*	70 |38	70
Budha / Mercury	1510	*digartha candra*	28 |36	38
Guru/ Jupiter	1371	*rūpāgaviśva*	31 |30	33
Śukra/ Venus	3769	*amkarasādrirāma*	11 | 28	11
Śani / Saturn	923	*tripakṣarandhra*	46 | 48	50
				Karaṇakutūhala

Table 4: The ratios of circumferences of epicycles of planets used in this text, compared to those in the *Karaṇakutūhala* (*KK*)

The final value after the correction is called *mandasphuṭa* (corrected for *manda*).

The next verse provides similar divisors *śīghracheda* for the second correction. Although the author declares it is on the same lines as done for *manda* correction, the procedure is not very clear as can be seen later. Prior to the discussion on *śīghra* correction, he summarises the procedure for *manda* in a single sentence, whose translation was also difficult. Here is the summary:

- Get the *mandakendra,* difference between *mandocca,* the apogee and the mean
- Get the *R* sine of *mandakendra* and *koṭi* (*R* cosine) also. (*Koṭi* is not needed for *manda* correction)
- Convert the *R* sine in to arc minute by multiply by 60 and adding to the *lipti* component.
- Divide it by the appropriate number as given by the sequence stated in the verse starting with 90.
- Add the result to corresponding numbers provided by the sequence starting with 3230.
- Divide the product of 6 and *R* sine of *mandakendra* by the corrected divisor.

This last step, namely dividing it by 6, was not specified in the procedure earlier. This division is necessary because while, converting it into *lipti* we had multiplied it by 60. Essentially, the procedure can be written in the modern notations as an equation,

$$a = \frac{6R \sin M}{\text{corrected divisor}} \tag{2}$$

where,

$$\text{corrected divisor} = \text{number } 3230 + \frac{R \sin M (\text{in liptis})}{\text{Correction factor } 90} \qquad \text{for the sun.}$$

Similar devisors are derived for other planets.

The *śīghra* correction takes the *manda* corrected position as the reference. Let us first see how the correction is achieved.

The procedure for *śīghraphala*, which has been very aptly clarified and compared with the procedure in *Sūryasiddhānta* by the referee is being reproduced here.[2]

The *śīghrocca* for the planets is the sun itself. In the Figure 2.4, the sun, the planet and the earth are represented by S, E and P. The relevant angles are marked as θ_{ms} *mandasphuṭa*, θ_s *śīghra*, r, radius of *śīghra* epicycle and R, the radius of deferent.

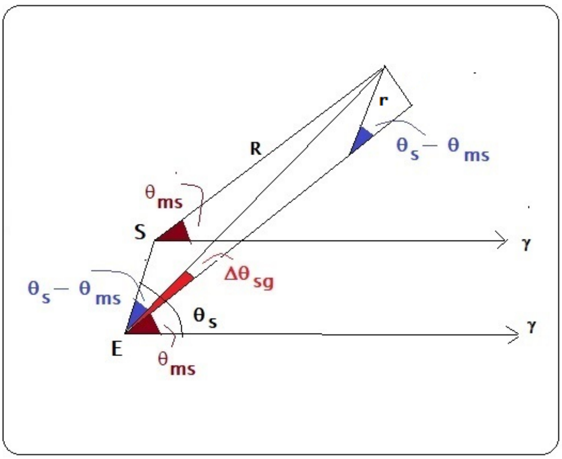

Figure 5: Derivation for *śīghraphala* from *Sūryasiddhānta*

$$\textit{śīghrakendra} = \theta_{ms} - \theta_s = -M_{sk}$$

$$\textit{śīghraphala} = \Delta\theta, \text{ is given by}$$

$$R \sin \Delta\theta = \frac{r \sin(\theta_{ms} - \theta_s)}{\left[\{R + r\cos(\theta_{ms} - \theta_s)\}^2 + r\sin(\theta_{ms} - \theta_s)^2\right]^{1/2}}$$

$$\sin \Delta\theta = \frac{r/R \sin(M_{sk})}{[\{1 + r/R \cos(M_{sk})\}^2 + r/R \sin(M_{sk})^2]^{1/2}} \tag{3}$$

2 The anonymous referee of has kindly provided a critical analysis and comparison of this formula with the one in *Sūryasiddhānta*.

IN THE *GAṆITAGANNAḌI*

Now, let us see the procedure in *Gaṇitagannaḍi*.

The epicycle of the *śīghra* is rather large although Figure 5 represents it as a small circle of radius d. S' is the direction of *śīghroccha*, the conjunction of the planet with the sun. The *manda* corrected position is P_0. By the time the mean position has changed to P_0 from conjunction the projection on the epicycle would have moved from J' to J. The corresponding shift on the orbit takes it to the point P as the true position.

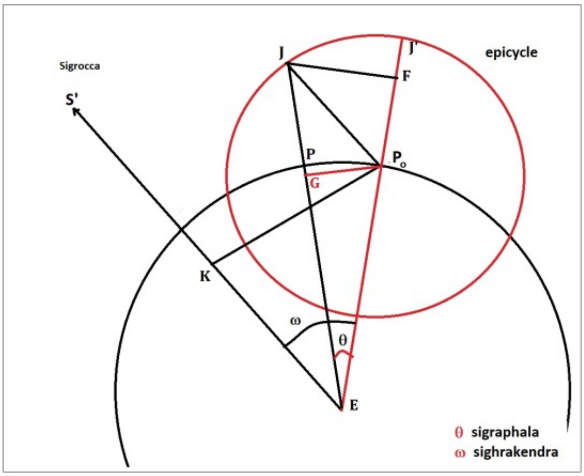

Figure 6: Diagram for explanation of *śīghraphala*

From the Figure 6, we can derive an expression for the angle θ, the *śīghraphala*. The *śīghraphala*, s is expressed as (Somayaji, 1971)

$$R \sin\theta = \frac{d}{k} R \sin m$$

where k is called the *calabāṇa*, EJ, the distance of the planet from earth at the desired instant. (Bapu Deva Sastri 1861). The word *caladbāṇa* also is used.

From the properties of similar triangles we can show that

$$k_2 = \left[\frac{d}{a} R \sin m\right]^2 + \left[d + \frac{d}{a} R \cos m\right]^2 \qquad (4)$$

The procedure requires that $\left[\frac{d}{a} R \sin m\right]$ and $\left[\frac{d}{a} R \sin\cos m\right]$ be determined, these are termed *bhujaphala* and *koṭiphala* respectively. The author has used a different technique to compute k, the *calabāṇa*. The term d in the expression $\left[d + \frac{d}{a} R \cos m\right]$

has been fixed to 10. Accordingly *koṭiphala* is added to 10 and its square is added to the square of *bhujaphala*, essentially getting the value of k_2. Its square root is the divisor for *bhujaphala* again to get *śīghraphala*.

Then the value of a is adjusted as per the ratio d/a. For, example for Mars, the ratio is known to be 1.5 (given as the ratio of radii of peripheries with 360). If d is 10 the value of a will $d/1.5$. However the ratio d/a will not change. It is to be noted that the coefficients of $R \sin m$ and $R \cos m$ are same. By this adjustment the coefficient of numerator in (3) also will be the same. To take care of the *trijyā*, multiplication by 120 also is necessary. Let us call the ratio of d/a as y. Since d is fixed at 10 the value of a is $10/y$. The *śīghracheda* is 720 y which we can write as A.

$$bhujaphala = \frac{yR \sin m60}{śīghracheda} = \frac{120 \sin m60}{A} \quad \frac{10}{10} y = y \sin m \tag{5}$$

Similarly the coefficient of $R \cos m$ also is adjusted by dividing by A. This looks very tricky but we can see that it is devised to get rid of several steps such as division by 60 and 120. Thus the same *Bhujaphala* and *Koṭiphala* (with $R = 120$) are

$$Bhujaphala = BP = \frac{R \sin(M_{sk})}{śighracheda} \times 60$$

$$Koṭiphala = KP = \frac{R \cos(M_{sk})}{śīghracheda} \times 60$$

Here, the divisor, *śīghracheda* is provided for all planets (eg., for Mars it is 1110)

The hypotenuse *calabāṇa* is defined as

$$calabāṇa = [\{10 + KP\}_2 + BP^2]_2$$

$$śīghraphala = \Delta\theta, \quad \text{is given by}$$

$$R \sin \Delta\theta = 120 \times BP \times R/calabāṇa$$

this is same as equation (3) above and is further reduced to

$$\sin \Delta\theta = \frac{720 \sin(M_{sk})}{śīghracheda \left[\left\{ 10 + \left(\frac{120 \cos(M_{sk})}{śīghracheda} \times 60 \right) \right\}^2 + \left\{ \frac{120 \sin(M_{sk})}{śīghracheda} \times 60 \right\}^2 \right]^{1/2}} \tag{6}$$

Thus if we identify r/R of (3) with 720/*śīghracheda* of (4); they are identical. Table 6 lists the numbers and the implied ratios, which is in agreement with the values currently in use. Thus *Gaṇitagannaḍi* (GG) has the same procedure from the *Sūryasiddhānta* (SS) to aid calculations. (*śīghrakendra* as M_{sk}, can have any value from 0 to 90). The agreement to second decimal place implies 6′. The values of the ratios of the radii of the planets are concealed in these numbers (A) provided as *śīghracheda*.

Name of planet	***Śīghracheda Divisor***	**Phrase *bhūtasaṅkhyā***	**implied ratio of orbit radii**
Kuja/ Mars	1110	*Digīśvara*	1.54
Budha/ Mercury	1956	*tarka śarāṅka candra*	0.37
Guru/ Jupiter	3651	*ku arthānga rāma*	5.07
Śukra/ Venus	993	*jvalanāṅka nanda*	0.72
Śani /Saturn	6562	*dvāṅgaiṣu tarka*	9.11

Table 5: The values of *śīghracheda* for five planets and implied ratio of radii

This procedure has a great advantage in computations, since only *bhujaphala* and *koṭiphala* are to be read out from the sine tables and the constants take care of the conversions. It can be summarized as follows:

1. Calculate the *calabāṇa* and *śīghrakendra* for the individual planet
2. Get the *bhujaphala* and *koṭiphala* putting the corresponding *śīghracheda*
3. Calculate *śīghraphala* putting using (6)

Thus if we identify r/R of (4) with 720/*śīghracheda* of (3); they are identical. The comparison of the ratios are in the Table 6 below.

Planet	**sg (GG)**	**720/sg**	**r in (SS)**	r/R for $M = 0$	r/R for $M = 90$
Kuja / Mars	1110	0.6486	$235 - 3\lvert\sin M\rvert$	0.6317	0.6389
Budha / Mercury	1956	0.3681	$133 - \lvert\sin M\rvert$	0.3694	0.3667
Guru / Jupiter	3651	0.1972	$70 + 2\lvert\sin M\rvert$	0.1944	0.1999
Śukra / Venus	993	0.725	$262 - 2\lvert\sin M\rvert$	0.7277	0.7222
Śani / Saturn	6562	0.1097	$39 + \lvert\sin M\rvert$	0.1083	0.1111

Table 6: Ratios compared from *Gaṇitagannaḍi* (GG) and *Sūryasiddhānt* (SS). (*śīghracheda* is abbreviated as sg, *mandakendra* as M).

The next step is to get the sine inverse form the same sine tables which is quite straight forward and explained already.

The next verse describes the procedure for getting the *sphuṭagati*, the true motion of the planet. We will see that the concept of *calabāṇa* has been utilized here also to lessen the steps of calculations. It is assumed that the reader is aware of the procedure and the steps are mentioned very briefly. The average value of the *gati* obtained as an average for one revolution is called the mean. The first step of *mandasphuṭa* correction uses the value of *koṭiphala* arrived above. This procedure is not discussed here.

The correction in the second step requires the *śīghra* corrected value and the *calabāṇa,* earth planet distance, to get the *sphuṭagati* or the true motion. In case of the sun and the moon the second step is not needed. Here only the second step is explained. The planet earth distance which was termed *calabāṇa* is being used again here.

The difference between the *gati* of the *śīghrocca* (U) and that of the planet (V) is multiplied by a quantity which we shall call q, defined as the difference of the *śīghrahara* as per *catuḥpratinyāya*. This phrase is not explained and the meaning is not very clear. But we try to understand the procedure and interpret. After multiplication it is divided by the same *śīghrahara* used for getting *calabāṇa*. This is added to or subtracted from the *gati* obtained after *manda sphuṭa* correction.

The *sphuṭagati* consists of three components - the mean motion of the planet, the mean motion after the *manda* correction and the mean motion after the *śīghra* correction. The last quantity is given by

$$dm = U - (U - V)R\cos\theta/k \quad (7)$$

where θ is the *śīghraphala* and k *caladbāṇa*, is the earth-planet distance. Here U represents the mean motion of *śīghrocca* and V is the mean motion of the planet. In the case of planets *śīghrocca* is the sun itself. Therefore $(U - V)$ is a measure of the difference in speeds of sun and planet. The difference between the two becomes substantial as the planet - earth distance and the sun - planet distances have a larger range as compared to the sun or the moon. The statement above can be expressed as an equation as given in the text as

$$dm = U - \frac{(U - V) \times q}{calab\bar{a}\d{n}a} \quad (8)$$

Thus we can interpret that the quantity q is $R\cos\theta$. The meaning of *catuhpratinyāya* perhaps is discussed elsewhere and assumed to be known to the reader. It implies 10 − (the *śīghrahara* added value) = 10 − (10 + $R\cos\theta$), which is $\cos\theta$, itself. The phrase used is "*caladbāṇa harāntareṇa*." The word *bāṇa* refers to the term $(R + R\cos\theta)$. Then, *śīghrahara* is 10, so the difference will be $R\cos\theta$.

The *calabāṇa* is converted to arc seconds and subtracted from *mandasphuṭagati* if *calabāṇa* is smaller; that gives the *sphuṭagati*.

The equation (8) also shows the effect of the difference of speeds as seen from the earth. The projection of difference of speeds in the line of sight is achieved by the multiplication by $R\cos\theta$. If dm is negative the difference implies the *vakragati* - the apparent reversal in the direction of motion. This idea is used to fix the onset of retrograde motion for these five planets.

The next verse mentions a correction to be done for the sun and the moon. This is described in the *Sūryasiddhānta* as per the verse quoted in the text. (This verse is included in the appendix) This is called the *bhujāntara* correction and is needed because of the non-uniform motion of the sun. As can be guessed this is a direct consequence of the elliptical orbit.

All these computations are for midnight at Ujjain. The time difference will be determined with reference to a uniform motion of 360 degrees a day or 21600 arcminutes per day. The word *cakralipti*, number of *liptis* (arcminutes) in a *cakra* (circle), is used for 21600. This is the only place where *kaṭapayādi* system has been used to denote this as *anantapura*.

The procedure here is as follows:- the *R* sine of the sun is converted to *lipti* and divided by 27; the result in *liptis* is added to the sun and the moon. Addition or subtraction is decided by *bhujaphala* (as positive or negative). That gives *Ravibhujasaṁskṛtacandra* - which means moon corrected for *Ravibhuja*. This correction is to be done for all planets. But for all the others it is quite small and therefore the author states that he specifically applies it for the moon. This correction should be done for all planets. This is as per the verse in *Sūryasiddhānta* (II - 46) - the *gati* of planets should be multiplied by *Ravibhujaphala* in *kala* and divided by 21600; the result is positive or negative as is the case for the Sun. The mean *gati* of the Moon is 791. Dividing 21600 by 791 gives 27. Therefore the author gives the rule as divide by 27.

This completes the second chapter called *Grahasphuṭādhikāra*. The colophon is identical to the one for the first chapter, with identical adjectives.

This chapter for calculation of true positions of planets has used procedures which render computations easy and simplified. The rationale for the procedures has been explained. The ratios of planetary distances and the epicycle radii are compared with those given in *Karaṇakutūhala*. The constants used here have been modified by the author himself and small corrections also have been incorporated.

Finally a note on the colophon: the author has attributes "like a full moon for the ocean of nectar, and, who, to the ignorant astronomers is like Garuḍa (Brahminy kite, the mythological enemy for snakes) to snakes." The corresponding translation can have two interpretations in the absence of the specific case endings:

- *Dēmaṇajyotiṣāgragaṇya-sudhārṇava-pūrṇacandra* – can be a single phrase meaning "like the full moon for the nectar ocean of *Dēmaṇa* who is an expert astronomer."
- *Vāsavguru Dēmaṇa* – can be one phrase comparing *Dēmaṇa* to the guru of the Gods. Now *agragaṇya* gets attributed to the ocean so that the implied meaning is "like the full moon for the nectar ocean of expert astronomers."

Generally the ocean and full moon metaphor is used to signify happiness - akin to the high tides associated with full moon. Here the ambiguity arises with the word *dēmaṇajyotisagragaṇya* leading to the above two possibilities. This is by treating the expression as a descriptive compound (*karmadhāraya*) as suggested by the referee and K. R. Ganesha (personal communication).

There is yet another interpretation as provided by Mahesh and Seetharama Javagal (2020) in the context of edition of *Karaṇābharaṇa* by the same author, Śaṅkaranārāyaṇa Joyisa. The translation of the same phrase reads

> Composed by Śaṅkaranārāyaṇa Joyisa who is "a falcon to the serpents of unaccomplished astronomers,"
> and
> the full moon emerged from the nectar-ocean of the foremost astronomer Dēmaṇa Joyisa, the one who is equivalent to the guru of Indra.

This is based on the mythological story that the moon was churned out of the ocean (*amṛta manthana*). The simile classified as *rupakālankāra* describes the happiness of the father provided by the genius of the son. Here the fact that Dēmaṇa is the father has been utilized although not specified and *Garuḍa* is translated as falcon.

These titles are not found in the earlier works of Śaṅkaranārāyaṇa Joyisa, namely *Tantradarpaṇa* (1601 CE) and *Karaṇābharaṇam* (1603 CE) where it reads

> ...composed by Śaṅkaranārāyaṇa Joyisa, the son of Dēmaṇa Joyisa, the astronomer, who is equivalent to the *guru* of Indra, a resident of Śṛṅgapurī. (Mahesh and Seetharama Javagal 2020)

Perhaps he was bestowed with the titles in 1604 CE. Or, did he crown himself, or, did he become more poetic?

4 *GRAHAMADHYĀDHIKĀRA* TRANSLATION

THIS CHAPTER, a continuation of the verses explained in our earlier paper (Shylaja and Javagal 2020), explains getting the mean positions of all planets. Since there is an ending note stating that *Dhruvādhikāra* is concluded and *Grahamadhyādhikāra* is commencing, we may consider this as a sub-section of the first chapter. For degrees the words *bhāga* and *bhāgi* are used interchangeably. We have retained the usage in English as well.

The text is provided in the next section as is given in the manuscript which has the text in both the languages, Sanskrit and Kannaḍa. As mentioned earlier the script is *Nandināgarī* and here we have put both languages in Kannaḍa script. Translation and the verses from 1 to 10 of *Dhruvādhikāra* have been already provided in the earlier paper. It is to be noted that the translation is provided only for the *ṭīke* or commentary in Kannaḍa not for the *mūla,* the original Sanskrit verses. Very long phrases have been split to shorter sentences.

GRAHAMADHYĀDHIKĀRA

Now the procedure to derive the mean values for the required date will be explained from the number of *dyugaṇas*, whose derivation, based on the parameters like *saṅkrānti* and *tithi* is explained.

VERSE || 11 ||

[This is to get the *tithi* of *saṅkrānti*.] The *dhruvāṃśa*, obtained earlier [for the beginning of the year], of the moon is considered. The *rāśi* part is multiplied by 30 and added to the degrees part so that we have it expressed in degrees. This is divided by 12 to get the quotient as the *saṅkrānti tithi*. The remainder is of no consequence here.

Saṅkrānti tithi is defined as the number of civil days intervening from *caitra śuddha pratipat* to *meṣa saṅkrānti* for the sun [to cover it] with its mean daily motion.

[Now the calculation of *dyugaṇa*] Number of days from *caitra śuddha pratipat* is counted – this should include the intercalary month if needed. The number of *saṅkrānti tithis* is subtracted. Every *ṛtu*, season, has two months. The number of *ṛtu*s elapsed are subtracted to get the *dyurāśi*. The *dyugaṇa* is obtained by removal of *saṅkrānti tithis* and *ṛtu*s; this is the number of *tithis* from the beginning of the solar year [*meṣa saṅkrānti*].

VERSE || 12 ||

As per [the verse starting with] "*nagāpta śiṣta*", the *dyugaṇa* thus obtained is divided by 7. The remainder is added to the *vāra* of *sāvanadhruva*. 7 is subtracted from it if it is more than 7.

As per [the verse starting with] "*vārapatirniśīthe*", the remainder obtained is the week day number starting from Friday. If the number is 1 it is midnight of Friday; 2 implies midnight of Saturday [and so on].

FIRST LINE OF VERSE || 13 ||

This method gives the week day correction of one day more, or one day less which can be applied to the *dyugaṇa*-count (so that the calculated and the actual week-day are the same). The *sāvana dhruva* should be subtracted from the corrected *dyugaṇa* in units of *ghaḷige* and *vighaḷige*. This is how you can do it. Take out one *dyugaṇa* [which is equal to 60 ghaĪige] and [write it] as 59 *ghaḷighe*. Place the *dyugaṇa* and take one from it and bring (it as) 60 (*ghaḷige*). From this, with (1 *ghaḷige* further written as) 59 (*ghaḷige* and 60 *vighaḷige*), the *sāvanadhruva* with *ghaḷige* and *vighaḷige* is subtracted. The result is called a *pada* expressed in units of day, *ghaḷige* and *vghaḷige*. ("*pada*" is the time-interval between the *meṣa saṅkrānti* (beginning of the solar year) and the beginning of the desired day) [This is the number] to be used for all the planets.

Now consider the *pada* twice – as per [the verse starting with] "*khāgamśa hīnena phalam*", divide the second one by 70 to get degrees. The remainder is multiplied by 60 and divided by 70 to get *lipti* and similarly *vilipti*. These values are subtracted from the (first) *pada* to get the mean sun in *bhāga* units. That should be divided by 30 to get *raśi*. The remainder is *bhāga*, thus you get the mean sun for the midnight of the desired day in units of *bhāga, lipti* and *vilipti*.

The rule applied is – for one day the mean *gati* is 59 *lipti* 8 *vilipti*. The mathematical explanation of this is that the value gets lesser by 1 *bhāgi* in 70 days.

SECOND LINE OF VERSE || 13 ||

[The same *pada* is used now for the moon.] It is multiplied by 12 specified as *arkanighnam* (*arka* 12, *nighnam*, multiplication) in the verse. Two copies of the product are kept; the lower copy is divided by 68 to get the product in units of *bhāga*, and added to the upper copy. This is added to one *pada*. Divide it by 30; if the result is more than 12 divide it by 12; discarding the quotient, the remainder is the *rāśi*, and the lower units are *bhāga*, *lipti* and *vilipti*. As per the verse "*dhruveṣu yojya*", this quantity in *rāśi* and other units, is added to the *dhruva* for the beginning of the year (obtained earlier) for the moon to get the mean moon for midnight of the desired day.

VERSES || 14 || AND || 15 ||

To get the mean Kuja (Mars): All the three copies of the *pada* are multiplied by 4 as per (the verse) "*kṛtaghnāt*." The lower two are divided by 60 and (and the square of 60 respectively) and added back. The sum is divided by *nidhi, pakṣa, netra* that is 229, to get *bhāgi*. The reminder is multiplied by 60 and again divided by 229 to get *lipti* and same way to get *vilipti*. The *rāśi* and sub units, obtained this way is added to the *dhruva* of Kuja (obtained earlier) to get mean Kuja.

Here *kṛti* [corresponds to] 4 *rāśi* and *nidhi, pakṣa, netra* [corresponds to] 229 days, arrived at as completion of 4 *rāśi* s by the mean Kuja. Therefore the rule of three used is [as follows] 229 days correspond to 4 *rāśi* – therefore how many *rāśi* for the desired number of days? It is the same procedure for all the planets [hereafter].

Now the (determination of) *śīghroccha*, higher apsis of the epicycle, of Budha (Mercury).

The divisor has been specified as 30, from "*jñaḥ khāgnibhiḥ*", in plural, but not the multiplier. Based on the context we consider the multiplier *guṇaka* is the same as that for Mars namely 4. The *pada* is multiplied by 4 as before and divided by 30 and expressed as *rāśi* which is kept aside. Multiplying the *pada* by one [you get back] the same *pada*. This is divided by 325 (*paṇcaradaiḥ*) to get the *rāśi* units and added to the earlier obtained *rāśi*. This is finally added to *varṣa dhruva* to get Budha *śīghroccha*.

Now the procedure for mean Guru (Jupiter) – the multiplier is 1, specified by *bhu*. This is to be divided by 361 to get Guru. This [converted to units of *rāśi*] is added to *dhruva* for the year to get mean Guru.

Now the *śigrocca* of Śukra (Venus) – *pada* is multiplied by 40 and divided by 749. The result [converted to *rāśi* units] is added to the *dhruva* obtained earlier.

To get the mean Śani (Saturn) – *pada* is mulitpiled by 1, and divided by 897; the product [converted to units of *rāśi*] is added to the *dhruva* to get mean Śani.

The multiplier for, *Rāhu* (Moon's ascending node) is 1. It is divided by 566. This is subtracted from the *Dhruva* as per *tamasaḥ pratipa,* to get mean *Rāhu*. Adding 6 *rāśis* will fetch *Ketu*.

For getting the *candrocca,* (Moon's apogee) pada is multiplied by 3 and divided by 808; the result [converted to *rāśis*] is added to previously obtained *dhruva*.

VERSE || 16 ||

Dyugaṇa is divided by 150; the result expressed in *lipti, vilipti* is subtracted from the mean values for the sun and the moon. Thus all the mean positons of all planets are obtained for the midnight of Laṇka. Laṇka is to be understood as the south of *mahāmeru*.

VERSE || 17 ||

Getting the *lambajyā* of the place of observation (*svadeśa*) is explained later in the chapter *chāyādhyāya*; this is multiplied by 5060 and divided by the *trijyā* 120, which is defined in *sphuṭādhyaya.* This is the *svadeśabhūparidhi*, the circumference of the small circle at the observer's latitude. For a place with an equinoctial shadow of 3 *aṅgula*, the *lambajyā* is 116/27. The derivation of 5060 is explained as per *Sūryasiddhānta* in this verse.

Quotation from Sūryasiddhānta

Multiply the square of the earth's diameter (1600) by 10 and its square root is the circumference in yojanas.

The *bhūmadhyarekhā* stretches from Laṇka to Meru Mountain. Rouhitaka country, Svamimale, Avanti is Ujjaini, Amarādri sāra is Mānasa Sarovara. The north south axis, *sutra*, passes through these and is called *bhūmadhyarekhā*.

VERSE || 18 ||

The distance in *yojana* of the place of observation from the *bhūmadhyarekhā* to the east or west is to be determined. This number is multiplied by the mean *gati* [in *lipti*] of all the planets and divided by the circumference, *svadeśabhūparidhi* obtained earlier. This is subtracted from the mean values of the respective planets, if *svadeśa*, the place of observation, is to the east, or added [if it is] to the west. This is the correction [called] *yojanasanskāra*.

Now the procedure for getting all the mean planets at midnight of the *iśṭakāla* desired date.

VERSE || 19 ||

One has to get the time interval in *ghaḷige vighaḷige*, ahead of or lagging behind, from midnight; this time interval is multiplied by the *madhya gati* (mean rate of motion) in *lipti, vilipti* and divided by 60. If the *iśṭakāla* (time of interest) is before midnight, the values in [*lipti, vilipti*] have to be subtracted; if it ls after midnight [they have] to be added. The mean positions of all planets are now available for the desired time.

This completes the first chapter called *Grahamadhyādhikāra* of the book called *Gaṇitagannaḍi*, a commentary of *Vārṣiktantra* in the language of *Karṇāṭa* written by *Śaṅkaranārāyaṇa Jyōtiṣi*, who, is like *Garuḍa* (mythological enemy of snakes, the Brahminy kite) to snake-like ignorant astronomers, and who, akin to a full moon for the ocean of nectar [and] of *Bṛhaspati* - like *Dēmaṇa*, an eminent astronomer and a resident of Śṛṅgapura.

5 SPHUṬĀDHIKARA – TRANSLATION

SECOND CHAPTER *Grahasphuṭādhikāra*, getting the true position of planets.

VERSE || 1 ||

Ravi, the sun, is the foremost of all planets is reckoned as the *śīghrocca* for *Guru*, *Kuja* and *Śani* [for calculations from their] mean positions [which are known]. For *Budha* and *Śukra* the mean Sun (Ravi) is the mean [position] and the *śīghrocc*a are themselves.

VERSE || 2 ||

The *śīghrocca* was told first; now *mandocca* is being told. For the sun it is 78 (*vasvādri*), for *Maṅgala*, 130 (*khaviśva*), for *Budha*, 221 (*rūpākṛti*), for *Guru*, 172 (*dvadrindavaḥ*), for *Śukra*, 80 (*khāṣṭa*) and for *Śani*, 237 (*agāgnidasrāḥ*). This is obtained from the *mandocca bhagaṇas* [number of revolutions of the apogee, *mandocca*] stated in the *Sūryasiddhānta* in verses (I: 41 and 42) starting with "*prāggate sūryamandasya*" up to "*gognayaḥ śani mandasya*", [these numbers are] multiplied by the number of years up to the desired year, and divided by the number of years in a *kalpa*. The current *mandocca* will be deficient by a few *liptis* from the date provided by Ācārya and one *bhāgi* has been added to account for this as *Dhruva* (constants).

VERSE || 3 ||

Kendra of a planet is obtained in *raśi* [and its subunits] after subtracting the *śīghrocca* or *mandocca* from the mean planet. If the *kendra* is *tulādi* (starting with *tulā*, the angle is between 180 and 360 degrees) the calculated *śīghrabhujaphala or mandabhujaphala* should be added to the mean planet. If the *kendra* is *meśādi* (the angle is between 0 and 180 degrees) it should be subtracted. Later the method of getting the *śīghraphala* will be told [where] the *śīghrahara* 10 [*vyomendavaḥ*] should be added to *koṭiphala*, if *śīghrakendra* is *mrigādi* and subtracted if it is *karkyādi*.

VERSE || 4 ||

Now the procedure to get *bhuja* and *koṭi*.* (In a right angled triangle, *bhuja* is the opposite side of the right-triangle and *koṭi* is the adjacent side of the right-triangle).In the odd quadrant *Bhujā* is determined by the current angle. *Koṭi* is (yet to be) covered. In the even (*yugma*) quadrant it is the opposite of this. That means - the angle to be covered determines the *bāhu* and the angle covered determines the *koṭi*. The *bhuja* and *koṭi* are for three *rāśis* (90 deg). For 12 *rāśis* there are four *padas*; there are two odd (*oja*) quadrants. For *rāśis* 0, 1 and 2 are the same as for raśis 6, 7 and 8. Here *bhuja* is determined by angle covered and *koṭi* by the angle yet to be covered. For *rāśis* 3, 4 and 5 and also for 9, 10, 11 which are even quadrants *koṭi* is determined by angle covered and *bhuja* by angle to be covered. Thus the *bhuja* and *koṭi* (found) for three *raśis* repeat for the others. From *bhuja*, *koṭi* can be determined by subtracting by 3 *rāśis*.

(* We are thankful to the anonymous referee for pointing out the confusion in the original work itself. The corrections as per convention have been incorporated here.)

VERSE || 5 ||

Now to get the *R* sine for *bhuja* and *koṭi:* The *rāśi* number is multiplied by 30 and added to *bhāgi* [*degrees*], divide this total [in degrees] *bhagi* by 10. The quotient is the number of the *khaṅḍajīvā* covered all ready. The corresponding *jīvā* is written down. The value of the next *khaṅḍaj jīvā* is divided by 10 and multiplied by the remainder whose *lipti* and *vilipti* have been converted to *bhāga* and added back to the *bhāga* value. The result (quotient) is added to the earlier obtained *jīvā*. The remainder (in this step) is multiplied by 60 and divided by 10, converted to *lipti, vilipti* and added to the *jīvā*. This is the *jīvā* or *koṭi* derived for the desired angle. It should be noted that this is in [units of] *bhāgādi* (degrees).

VERSE || 6 ||

The nine *khaṅḍas* of the *jīvās*, (expressed in *bhūtasaṅkhya*) in the direct order are stated:

21 | 20 | 19 | 17 | 15 | 12 | 9 | 5 | 2
and
2 | 5 | 9 | 12 | 15 | 17 | 19 | 20 | 21 |

VERSE || 7 ||

The successive *jyākhaṅḍas* are added to get the *piṅḍikṛtajīvā*. They are 21, 41, 60, 77, 92, 104, 113, 118, and 120.

The *utkṛamapiṇḍas* are also provided. They are 2, 7, 16, 28, 43, 60, 79, 99, and 120.

VERSE || 8 ||

The *mandacheda* [divisors to get *mandaphala*] is being told [in words]. (*vyomāgnidanta*) 3230, (*śikhirupaśakra*) 1413, 603, (*purāmbarāṅga*),1510, (*digarthacandra*) 1371, (*rūpāgaviśva*) 3769 (*aṅkarasādrirāma*) and 923 (*tripakṣarandhra*), for the planetary bodies starting from the sun (Ravi). These are the values of the divisors [for getting the *mandaphala*].

VERSE || 9 ||

To get the correction for the instant, *R* sine is multiplied by 60 and added to *lipti*. The sum is divided by the numbers 90 and others for the respective planets as prescribed in the verse starting with *khāṅkaiḥ*. (2.9) The result is added to the numbers mentioned earlier as *vyomāgnidanta* and so on {(490 (*khatāna*), 300 (*viyad abhrarāma*), 70 (*khāśva*), 170 (*khaśailendu*), 21(*indupakṣa*), 380(*khāṣṭāgni*)} to get the corrected divisor *sphuṭamandacheda*.

Now the *śīghra cheda* for the five planets starting from Kuja.

VERSE || 10 ||

1110 (*digīśvara*), 1956 (*tarkaśarāṅkacandra*), 3651 (*kvarthāṅgarāma*), 993 (*jvalanāṅkananda*), 6562 (*dvāṅgaiṣutarka*). These *śīghrachedas* have been devised similar to *mandacheda* as specified in [*Sūrya*]*siddhānta*.

VERSE || 11 ||

To get the *mandaphala* and *śīghraphala*, [one needs] *bhujaphala* and *koṭiphala*. The *bhujā* and *koṭijīvas* are kept in two places; multiply them by 60 and add to the *litpi* in lower place. Then they are divided by the respective *manda cheda* and *śīghra cheda* to get *bhujaphala* and *koṭiphala* in degrees etc. As stated in the verse the *manda* arises because of only *bhujaphala* and therefore there is no need of *koṭiphala* for the *manda* correction. The *jyā* of *bhuja* is multiplied by 60 and added to the *lipti* part and divided by the divisors as specified by *vyomāgni* etc. which are made true by correcting with *khankaih* etc., for the planets beginning with the Sun for the respective planets. The result in *bhāga* units [degrees] is the [first correction] *mandaphala.* This is negative if the *kendra* obtained by subtracting mean from *mandocca* is in *karkyādi*, (starting from karka, between 0 and 180) positive if it is *tulādi* (*between 180 and 360*). This gives the [longitude] after the [first] manda correction, *mandasphuṭa*.

VERSES || 12 ||, || 13 || AND || 14 ||

The mean motion *madhyagati* of the planets are being told *in lipti, vilipti*. For Ravi it is 59|8, for the moon 790|35 for *Kuja* 31|26, for *Budha* 245|32, for *Guru* 5|0, for *Śukra* 96|8, for *Śani* 2|0, for *Rāhu* 3|11, for *candrocca* 6|41. While making the *mandasphuṭa* correction, for getting the *R* sine, the *khaṅḍa* corresponding to the *eṣya* [to be covered part], is multiplied by the *madhyagati* in *lipti*, *vilipti* and multiplied by 6 (*rasaghna*) and divided by the appropriate divisor and added if it is *karkyādi,* subtracted for *makarādi*. This gives *mandasphuṭagati.*

The derivation of the (mean motion) *madhyagati* is done by dividing the *bhagaṇa* (number of revolutions) as specified in *Sūryasiddhānta* by the *bhūsāvanadina* (number of days). It is [done] like this. Number of revolutions of Ravi is 4320000. The number of *sāvana* days are 1577917828. When this is divided [by number of revolutions] we get 0 *rāśi*, 0 *bhāga*, *lipti* 59 and *vilipti* 8. This is done for all planets. The meaning of *madhyagati* is the number of *liptis* covered in a day.

Although the procedure for *mandasphuṭa* is explained, I am summarising it again. It is like this. After obtaining the mean planets, take the difference with respective *mandoccas*, get the *R* sine by using the rule as *bhāgāstayoḥ kenduhṛta*, (verse number 2.5 above) multiply by 60 and add the *lipti*. Consider the numbers specified by the verse *khāṅka* and so on, added to the original divisors specified by *vyomāgni*, and divide the *jyā*, which is already multiplied by 60 by the revised divisor, and take the result in *bhāga*. When the mean planet is corrected with this, by subtraction, if it is *meṣādi*, and by addition, if it is *tulādi*, the *mandasphuṭa* is obtained. Here it should be remembered that the sun and the moon are *sphuṭa* by this correction. The five planets *Kujādi* will be *spaṣṭa* after the two corrections, namely, *manda* and *śīghra*. Thus after completing the explanation for *manda*, I proceed to explain *śīghraphala*.

VERSE || 15 ||

Now, the procedure for *śīghraphala* for the planets starting from *Kuja*. The *śīghraocca* subtracted from the *mandasphuṭa* corrected planet is the *kendra*. Both the *bhuja* (*R* sine) and *koṭi* (*R* cosine) are obtained. As per the verse *do koṭiḥ jīve kharasaiḥ nihatyāt*, (verse 2.11 above) the *bhujājīva* and *koṭijīva* are multiplied by 60, the remainder is added back. These are divided by the appropriate divisors as specified by the verse starting with *digīśvara*. (verse 2.10 above) The result from *bhuja* is *bhujaphala*; the result from *koṭi* is *koṭiphala*. *Vyomendu* 10, is the *śīghrahara*. The *koṭiphala* obtained is added to or subtracted from this *hara* (10) as per *mrigādi* or *karkādi*. The square of this sum or difference is obtained. Next, as stated by *dorjyaphala varga yogāt*, the square of *bhujaphala* is obtained. The two squares are added and the square root is the *phala* called the *calabāṇa*.

VERSE || 16 ||

The *bhujaphala* is multiplied by the trijya 120, divided by *calabāṇa*. The inverse sine, *cāpa*, of this is the *śīghraphala* in *bhāga* (degrees). For Kuja, Budha, Guru, Śukra and Śani this is applied as positive or negative as mentioned earlier. Thus we get all the true planets.

VERSE || 17 ||

The procedure to get the inverse sine, *cāpa* (the arc of the angle). The arc has to be obtained (from the *jyā*). Subtract as many *khaṇḍajīvās* as *possible* from the *jīvā*. Keep aside the number of *khaṇḍajīvās* subtracted. The remainder is multiplied by 10 and divided by the *khaṇḍajīvā* which is the *khaṇḍa* which comes after the subtracted ones. When this is added to 10 times the number (of *khaṇḍajīvās*) kept aside [earlier], that (sum) is the desired arc in (degrees). The result is the inverse sine, *cāpa*.

VERSE || 18 ||

The *gati* of the *mandasphuṭa* is subtracted from the *gati* of the difference of *śīghrocca* and *graha*. What remains is multiplied by the difference between the *śīghrahara* and the *calabāṇa* as per the [rule of] *catuḥpratinyāya*. This is divided by the *calabāṇa* and the result in *liptadi* [sundivisions of arcminutes] is added to the *mandasphuṭa* if the *bāṇa* is greater than the *hara*, and subtracted from it if the *bāṇa* is less than the *hara*. The result is the *sphuṭagati* (true rate of motion). If the (earlier) result is greater than the *mandagati*, the *mandagati* is subtracted from the (earlier) result, and what remains is the *vakragati* (retrograde rate of motion).

VERSE || 19 ||

The $R \sin e$ of the sun (Ravi) is converted to *lipti* as per the verse *uṣṇāṁśu dorjaphalam* and divided by 27. The result in *liptis* is added to or subtracted from the moon, *Candra*, as per the correction to the sun. If the *bhujaphala* is positive it is added to the moon. If it is negative for the sun it should be subtracted from the moon also. That gives *Ravibhujasaṁskṛtacandra* - moon corrected for *Ravibhuja*. This correction is to be done for all planets as stated in the [Sūrya]*siddhānta*. But for all the others it is quite small and therefore I told it specifically for the moon. This correction should be done for all planets.

VERSE || 20 || *SŪRYASIDDHĀNTA* (II - 46)

This is as per the statement in [*Sūrya*]*siddhānta* - the *gati* of planets should be multiplied by *Ravibhujaphala* in *kala* (arc minutes) and divided by *cakralipti*, that is 21600; the result is positive or negative as is the case for the sun. The mean *gati* of the moon is 791 *lipti*. *Adripakṣa*, 27 is the result when 21600 is divided by this. Therefore I made the rule for division by 27.

This completes the second chapter called *Grahasphuṭādhikāra* of the book called *Gaṇitagannaḍi*, a commentary of *Vārṣiktantra* in the language of *Karṇāṭa* written by *Śaṅkaranārāyaṇa Jyōtiṣi*, who, to the ignorant astronomers, is like *Garuḍa* to snakes and who, akin to a full moon for the ocean of nectar [and] of *Bṛhaspati* – like *Dēmaṇa*, an eminent astronomer and a resident of Śṛṅgapura.

6 TEXTS

HERE WE GIVE THE TEXT from the original palm leaf manuscript for the second half of first chapter and the second chapter (covered in this paper) which has the verses in Sanskṛt and commentary in Kannaḍa. As mentioned earlier the script is *Nandināgarī* and here we have put both languages in Kannaḍa script.

CONTINUATION OF CHAPTER 1

ಗ್ರಹ ಮಧ್ಯಾಧಿಕಾರ

ಇಂನು ಮಧ್ಯಗ್ರಹರನೂ ಇಷ್ಟದಿನಕ್ಕೆ ತರಲೋಸ್ಕರ ಅದಕ್ಕೆ ಕಾರಣವಾದ ದ್ಯುಗಣವನರಿಯ-
ಲೋಸ್ಕರ

ತತ್ಸಾಧನ ಭೂತವಾದ ಸಂಕ್ರಾಂತಿ ತಿಥಿಗಳ ತಹ ಉಪಾಯವ ಪೇಳುತಿದ್ದಾನು ||

ಇಂದುಧ್ರುವಾಂಶಾ ರವಿಭಿರ್ವಿಭಕ್ತಾಃ ಸಂಕ್ರಾಂತಿಸಂಜ್ಞಾಸ್ತಿಥಯೋ ಭವಂತಿ |
ತಾಭಿರ್ವಿಶುದ್ಧಾಶ್ಚ ಗತರ್ತುಹೀನಾಶ್ಚೈತ್ರಾದಿಕಾಃ ಸ್ಯಾತ್ತಿಥಯೋ ದ್ಯುರಾಶಿಃ || 11 ||

ಇಂದುಧ್ರುವಾಂಶಾ ಯೆಂದು ಮುಂನ ಬಂದ ಚಂದ್ರನ ವರ್ಷಧ್ರುವವನಿಕ್ಕಿಕೊಂಡು | ಅದಂ ರಾಶಿ ತ್ರಿಂಶದ್ಗುಣಿತಂ ಭಾಗಯುತಂ ಯೆಂಬ ಪರಿಭಾಷೆಯಿಂದ ರಾಶಿಸ್ಥಾನವಂ 30 ರಿಂ ಗುಣಿಸಿ ಕೆಳಗಿದ್ದ ಭಾಗಿಯಂ ಕೂಡಿ ಹೀಗೆ ಭಾಗೀಕರಿಸಿಕೊಂಡು | ರವಿಭಿರ್ವಿಭಕ್ತಾಃ ಯೆಂದು 12 ರಿಂ ಭಾಗಿಸಿ ಬಂದ ಲಬ್ಧವೇ ಸಂಕ್ರಾಂತಿ ತಿಥಿಯೆಂಬ ಸಂಜ್ಞೆಯನುಳ್ಳದಹುದು | ಶೇಷದಿಂದ ಪ್ರಯೋಜನವಿಲ್ಲ | ಸಂಕ್ರಾಂತಿ ತಿಥಿಯೆಂದರೆ ಚೈತ್ರ ಶುದ್ಧ ಪಾಡ್ಯವಾರಭ್ಯ ಸೂರ್ಯನು ಮಧ್ಯಚಾರದಿಂದ ಮೇಷರಾಶಿಗೆ ಪ್ರವೇಶವಹ ಪರ್ಯಂತರ ಮಧ್ಯದಲ್ಲಿ ಉಂಟಾದ ತಿಥಿ ಸಂಖೆಯೆಂದರಿವುದು | ಇಂನು ತಂನ ಇಷ್ಟ ದಿನಕ್ಕೆ ಚೈತ್ರ ಶುದ್ಧ ಪಾಡ್ಯ ಆರಭ್ಯವಾಗಿ ಸಂದ ದಿನವ ಲೆಕ್ಕಿಸಿ ಇರಿಸಿಕೊಂಡು | ಆ ಮಧ್ಯದಲ್ಲಿ ಅಧಿಕಮಾಸವುಂಟಾದರೆ ಅದನೂ ಸಹವಾಗಿ ಕೂಡಿಕೊಂಡು | ಅವರೊಳಗೆ | ತಾಭಿರ್ವಿಶುಧ್ಯಾಃ ಯೆಂದು ಈ ಮೊದಲು ಬಂದ ಸಂಕ್ರಾಂತಿ ತಿಥಿಗಳಂ ಕಳದು | ಅಲ್ಲಿ ಗತರ್ತುಹೀನಾಯೆಂದು ಚೈತ್ರಾದಿ ಯೆರಡೆರಡು ಮಾಸಕ್ಕೆ ವೊಂದೊಂದು ಋತುವೆಂದು ಇಷ್ಟದಿಂದ ಹಿಂದೆ ಸಂದ ಋತು ಸಂಖೆಯಂ ಕಳದುಳಿದದು | ಚೈತ್ರಾದಿಕಾಃ ಸ್ಯಾತ್ ತಿಥಯೋ ದ್ಯುರಾಶಿಃ ಯೆಂದು | ಸಂಕ್ರಾಂತಿಸಂಜ್ಞೆಯ ತಿಥಿಯನೂ ಗತ ಋತುವನೂ ಕಳದುಳಿದಂಥಾ ಚೈತ್ರಾದೀಷ್ಟ ತಿಥಿಗಳೇ ಸೌರವರ್ಷಾದಿಯಾದ ತಂನ್ನ ಇಷ್ಟ ದಿನಕ್ಕೆ ಬಂದ ದ್ಯುಗಣವಹುದು ||

ನಗಾಪ್ತಶಿಷ್ಟೋ ಧ್ರುವವಾರಯುಕ್ತೋ ದ್ಯುಸಂಚಯೋ ವಾರಪತಿರ್ನಿಶೀಥೇ |
ಅಹರ್ಗಣಃ ಸಾವನನಾಡಿಕೋನಃ ಪದಂ ಗ್ರಹಾಸ್ತತ್ರ ಭವಂತಿ ಸೂರ್ಯಾತ್ || 12 ||

ಆ ದ್ಯುಗಣವಂ ನಗಾಪ್ತಶಿಷ್ಟಾ ಯೆಂದು 7 ರಿಂ ಭಾಗಿಸಿ ಮಿಕ್ಕ ಶೇಷಕ್ಕೆ ಧ್ರುವವಾರಯುಕ್ತಾ ಯೆಂದು ಸಾವನಧ್ರುವೆಯ ವಾರವಂ ಕೂಡಿ ಯೇಳರಿಂದಧಿಕವಾದರೆ ಯೇಳಂ ಕಳದುಳಿದದು |

ವಾರಪತಿರ್ನಿಶೀಥೇ ಯೆಂದು ಶುಕ್ರವಾರಾದಿಯಾಗಿ ಇಷ್ಟದಿನಕ್ಕೆ ಬಂದ ವಾರ ಸಂಖೆಯಹುದು | ಇಲ್ಲಿ ವೊಂದು ಉಳಿದರೆ ಶುಕ್ರವಾರ ಮಧ್ಯರಾತ್ರೆಗೆ ಬಂದದು | ಯೆರಡು ಉಳಿದರೆ ಶನಿವಾರ ಮಧ್ಯರಾತ್ರಿಗೆ ಬಂದದು ಯೆಂದರಿವುದು ||

ಇಂತು ವಾರವನರಿತುಕೊಂಡು ತಂನ ಇಷ್ಟದಿನಕ್ಕೆ ಬಂದ ದ್ಯುಗಣದಲ್ಲಿ ವೊಂದು ಹೆಚ್ಚಿದರೂ ವೊಂದು ಕುಂದಾದರೂ ವೊಂದು ಕಳದು ಕೂಡಿ ಸರಿದಂದುಕೊಂಬುದು | ಇಂಥಾ ದ್ಯುಗಣದಲ್ಲಿ | ಅಹರ್ಗಣಾ ಸಾವನನಾಡಿಕೋನಃ ಯೆಂದು ಸಾವನ ಧ್ರುವದ ಘಳಿಗೆ ವಿಘಳಿಗೆಗಳಂ ಕಳವುದು | ಅದೆಂತೆಂದರೆ | ದ್ಯುಗಣವನಿಕ್ಕಿಕೊಂಡು ಅಲ್ಲಿಂದ ವೊಂದ ತೆಗೆದುಕೊಂಡು ಕೆಳಗೆ ಅರುವತ್ತ ಬರದುಕೊಂಡು | ಅಲ್ಲಿಂದ ವೊಂದಂ ತೆಗೆದುಕೊಂಡು ಆ ಕೆಳಗೆ ಅರುವತ್ತನಿಕ್ಕಿಕೊಂಡು | ಅಲ್ಲಿ ಕ್ರಮದಿಂದ ದ್ಯುಗಣದ ಕೆಳಗಿದ್ದ 59 ರಲ್ಲು 60 ರಲ್ಲು ಸಾವನ ಧ್ರುವದ ಘಳಿಗೆ ವಿಘಳಿಗೆಗಳಂ ಕಳದುಳಿದದು | ದಿನ ಘಳಿಗೆ ವಿಘಳಿಗೆ ಯಾದ ಮೂರು ಪ್ರತಿಯನುಳ್ಳದಹುದು | ಅದಕ್ಕೆ ಪದವೆಂಬ ಸಂಜ್ಞೆಯಹುದು | ಆ ಪದದಲ್ಲಿಯೇ ಸೂರ್ಯಾದಿ ಗ್ರಹರೆಲ್ಲಾ ಉತ್ಪಂನರಹರು ||

ಪದಂ ಸ್ವಖಾಗಾಂಶಫಲೇನ ಹೀನಂ ಭಾಗಾದಿಕೋ ಮಧ್ಯದಿವಾಕರಃ ಸ್ಯಾತ್ |

ಪದವಂ ಬೇರೊಂದು ಪ್ರತಿಯನಿರಿಸಿಕೊಂಡು ಖಾಗಾಂಶಫಲೇನ ಹೀನಂ ಯೆಂದು 70 ರಿಂ ಭಾಗಿಸಿ ಬಂದ ಲಬ್ಧ ಭಾಗಿ | ಆ ಶೇಷವಂ 60 ರಿಂ ಗುಣಿಸಿ ಕೆಳಗಣ ಘಳಿಗೆಯಂ ಕೂಡಿ 70

ರಿಂ ಭಾಗಿಸಿ ಬಂದದು ಲಿಪ್ತಿ | ವಿಲಿಪ್ತಿಯಂ ತಹುದು | ಇದಂ ಮುಂನಿನ ಪದದೊಳಗೆ ಕ್ರಮ-ದಿಂದ ಕಳೆಯಲು ಉಳಿದದು ಭಾಗಾದಿಯಾದ ಮಧ್ಯಾದಿತ್ಯನಹನು | ಆ ಭಾಗಿಯ ಸ್ಥಾನಮಂ 30 ರಿಂ ಭಾಗಿಸಿ ಬಂದ ಲಬ್ಧವಂ ಮೇಲೆ ಇರಿಸಲು ಅದೇ ರಾಶಿ | ಶೇಷವೇ ಭಾಗಿ | ಮೊದಲ-ವೇ ಲಿಪ್ತಿ ವಿಲಿಪ್ತಿ | ಇಂತು ರಾಶಿ ಭಾಗಿ ಲಿಪ್ತಿ ವಿಲಿಪ್ತಾತ್ಮಕವಾಗಿ ತಾ ನೋಡುವ ದಿನದ ಮಧ್ಯ ರಾತ್ರೆಗೆ ಬಂದ ಮಧ್ಯ ರವಿಯಹನು ||

ಇಲ್ಲಿ ದಿನ 1ಕ್ಕೆ ಮಧ್ಯಗತಿ ಲಿಪ್ತಿ 59 ವಿಲಿಪ್ತಿ 8 | ಈ ಲೆಕ್ಕದಲ್ಲಿ 70 ದಿನಕ್ಕೆ ವೊಂದು ಭಾಗಿ ಕಡಮೆ ಯಹುದೆಂಬುದೀಗ ಗಣಿತ ವಾಸನೆ ||

ಅಂಶಾದಿಕೇಂದೋಃ ಪದಮರ್ಕನಿಘ್ನಂ ಸ್ವಾಷ್ಟಾಂಗಭಾಗೇನ ಪದೇನ ಯುಕ್ತಂ || 13 ||

ಪದಂ ಪದವನು | ಅರ್ಕನಿಘ್ನಂ ಯೆಂದು 12 ರಿಂ ಗುಣಿಸಿ ಸ್ವಾಷ್ಟಾಂಗಭಾಗೇನ ಯುಕ್ತಂ ಯೆಂದು | ಆ ಹನ್ನೆರಡರಿಂ ಗುಣಿಸಿದ್ದನೆ ಯೆರಡು ಪ್ರತಿ ಇಟ್ಟು ಕೆಳಗಣ ಪ್ರತಿಯಂ 68 ರಿಂ ಭಾಗಿಸಿ ಬಂದ ಭಾಗಾದಿ ಲಬ್ಧವಂ ಮೇಲಣ ಪ್ರತಿಯೊಳು ಕೂಡಿ | ಅಲ್ಲಿ ಪದೇನ ಯುಕ್ತಂ ಯೆಂದು ಪದವಂ ಕೂಡಿದರೆ ಭಾಗಾದಿಯಹುದು | ಅವಂ 30 ರಿಂದೆತ್ತಿ ಬಂದ ಲಬ್ಧವಂ ಮೇಲಿರಿಸಿಕೊಂಡು ಅವು ಹಂನೆರಡರಿಂದಧಿಕವಾಗಿದ್ದರೆ 12 ರಿಂ ಭಾಗಿಸಿ ಬಂದ ಲಬ್ಧವಂ ಬಿಟ್ಟು ನಿಂದ ಶೇಷವೇ ರಾಶಿ | ಕೆಳಗಣವೇ ಭಾಗೆ ಲಿಪ್ತಿ ವಿಲಿಪ್ತಿಗಳು |

ಅಲ್ಲಿ ಧ್ರುವೇಷು ಯೋಜ್ಯಾಃ ಯೆಂದು ಈ ರಾಶ್ಯಾದಿಯಂ ಮುಂನ ಬಂದ ಚಂದ್ರನ ವರ್ಷ ಧ್ರು-ವದೊಳು ಕೂಡಲು ತಾನು ನೋಡುವ ದಿನದ ಮಧ್ಯರಾತ್ರೆಗೆ ಬಂದ ಮಧ್ಯಚಂದ್ರನಹನು ||

ಕುಜಃ ಕೃತಘ್ನಾನ್ನಿಧಿಪಕ್ಷನೇತ್ರೈರ್ಜ್ಞಃ ಖಾಗ್ನಿಭಿಃ ಪಂಚರದೈಸ್ತು ಕುಘ್ನಾತ್ |
ಭೂಘ್ನಾನ್ಮಹೀಷಟ್ಕೃತಿಭಿಃ ಸುರೇಜ್ಯಃ ಖಾಬ್ಧಿಘ್ನತಸ್ತಾನನಗೈಃ ಸಿತಃ ಸ್ಯಾತ್ || 14 ||

ಶನಿಃ ಕ್ಷಿತಿಘ್ನಾನ್ಮುನಿರಂಧ್ರನಾಗೈಃ ಕುಘ್ನಾದ್ರಸಾಂಗೇಷುಭಿರಿಂದುಪಾತಃ |
ತ್ರಿಘ್ನಾದ್ವಸುವ್ಯೋಮಗಜೈರ್ವಿಧೂಚ್ಚೋ ಧ್ರುವೇಷು ಯೋಜ್ಯಾಸ್ತಮಸಃ ಪ್ರತೀಪಂ || 15 ||

ಮಧ್ಯ ಮಂಗಳನಂ ತಹರೆ |

ಪದದ ಮೂರು ಸ್ಥಾನವನೂ | ಕೃತಘ್ನಾತ್ ಯೆಂದು 4 ರಿಂ ಗುಣಿಸಿ ಕೆಳಗಣ ಯೆರಡು ಪ್ರತಿ-ಗಳಂ 60 ರಿಂದೆತ್ತಿ ಬಂದವಂ ಮೇಲೆ ಕೂಡಿಕೊಂಡು ಮೇಲಣ ಪ್ರತಿಯಂ ನಿಧಿಪಕ್ಷನೇತ್ರೈಃ ಯೆಂದು 229 ರಿಂ ಭಾಗಿಸಿ ಬಂದವು ರಾಶಿ | ನಿಂದ ಶೇಷವಂ ಶೇಷಸಹ 30 ರಿಂ ಗುಣಿ-ಸಿ ಕೆಳಗಣವಂ ಯೆತ್ತಿ ಕೂಡಿಕೊಂಡು 229 ರಿಂ ಭಾಗಿಸಿ ಬಂದವು ಭಾಗಿ | ನಿಂದ ಶೇಷವಂ 60 ರಿಂ ಗುಣಿಸಿ 229 ರಿಂ ಭಾಗಿಸಿ ಬಂದವು ಲಿಪ್ತಿ ವಿಲಿಪ್ತಿಯಂ ತಂದುಕೊಂಬುದು | ಇಂತು ಬಂದ ರಾಶ್ಯಾದಿಯಂ ಕುಜನ ವರ್ಷಧ್ರುವದೊಳು ಕೂಡಲು ಮಧ್ಯಕುಜನಹನು ||

ಇಲ್ಲಿ ಕೃತ ಯೆಂಬ 4 ರಾಶಿ | ನಿಧಿಪಕ್ಷನೇತ್ರಾ ಯೆಂಬ 229 ದಿನ || ಈ ಇನ್ನೂರಇಪ್ಪತ್ತೊಂ-ಭತ್ತು ದಿನಕ್ಕೆ ಮಂಗಳನ ಮಧ್ಯ ಗತಿ ವಶದಿಂದ 4 ರಾಶಿ ಬಹುದು | ಅದರಿಂದ ನಿಧಿಪಕ್ಷನೇತ್ರ ಯೆಂಬಷ್ಟು ದಿನಕ್ಕೆ ಕೃತಾ ಯೆಂಬಷ್ಟು ರಾಶಿಯಾದರೆ ಇಷ್ಟ ದಿನಕ್ಕೆ ಯೆಷ್ಟು ರಾಶಿ ಯೆಂಬುದು ತ್ರೈರಾಶಿಕ|

ಇಂನು ಮೇಲಾದ ಗ್ರಹರಿಗೂ ಇದೇ ಪ್ರಕಾರವೆಂದರಿವುದು ||

ಬುಧ ಶೀಘ್ರೋಚ್ಚವಂ ತಹರೆ ||

ಜ್ಞಃ ಖಾಗ್ನಿಭಿಃ ಯೆಂದು ತೃತೀಯಾ ಬಹುವಚನಾಂತವಾದ ಭೇದವನೆ ಹೇಳಿ ಗುಣಕವ ಪೇಳಿ-ದ್ದಿಲ್ಲವಾಗಿ ಪ್ರಕರಣಬಲದಿಂದ ಕುಜಗೆ ಪೇಳಿದ ಕೃತ ಯೆಂಬುದೇ ಗುಣಕವೆಂದು | ಪದವಂ

ಮುಂನಿನಂತೆ 4 ರಿಂ ಗುಣಿಸಿ 30 ರಿಂ ಭಾಗಿಸಿ ಬಂದ ರಾಶ್ಯಾದಿಯಂ ಬೇರಿರಿಸಿ | ಮತ್ತಂ ಪದವನಿಟ್ಟು | ಕುಘ್ನಾತ್ ಯೆಂದು ವೊಂದರಿಂದ ಹೆಚ್ಚ ಗುಣಿಸಿ ವೊಂದರಿಂ ಗುಣಿಸಲು ಏಕೇನ ಗುಣಿತಂ ತದೇವ ಭವತಿ ಯೆಂದು ಇದ್ದದೇ ಇಹುದು | ಅದಂ ಪಂಚರದ್ಯೈಃ ಯೆಂಬ 325 ರಿಂ ಭಾಗಿಸಿ ಬಂದ ರಾಶ್ಯಾದಿಯಂ ಮುಂನ ಬೇರಿದ್ದ ರಾಶ್ಯಾದಿಯನೊಂದಾಗಿ ಕೂಡಿ ವರ್ಷ ಧ್ರುವಮಂ ಕೂಡಲು ಬುಧಶೀಘ್ರೋಚ್ಚ ವಹುದು||

ಮಧ್ಯಗುರುವಿಗೆ ಪದವಂ ಭೂಘ್ನಾತ್ ಯೆಂದು 1 ರಿಂ ಗುಣಿಸಿ ಮಹೀಷಟ್ಕೃತಿಭಿಃ ಯೆಂದು ಮಹೀ ಯೆಂದರೆ 1 ಷಟ್ಕೃತಿಭಿಃ ಯೆಂದರೆ ಆರರ ವರ್ಗ 36 ಅಂತು 361 ಇವರಿಂ ಭಾಗಿಸಿ ಬಂದ ರಾಶ್ಯಾದಿ ಫಲವಂ ವರ್ಷ ಧ್ರುವದೊಳು ಕೂಡಲು ಮಧ್ಯಗುರುವಹನು ||

ಶುಕ್ರ ಶೀಘ್ರೋಚ್ಚಮಂ ತಹರೆ |

ಪದವಂ ಖಾಬ್ಧಿಘ್ನತಃ ಯೆಂದು 40 ರಿಂ ಗುಣಿಸಿ ತಾನನ್ನಗೈಃ ಯೆಂದು ತಾನವೆಂದರೆ 49 ನಗ 7 ಹೀಗೆ 749 ರಿಂ ಭಾಗಿಸಿ ಬಂದ ರಾಶ್ಯಾದಿಯಂ ಪೂರ್ವಧ್ರುವದೊಳು ಕೂಡಲು ಶುಕ್ರ ಶೀಘ್ರೋಚ್ಚ ವಹುದು ||

ಮಧ್ಯ ಶನಿಯಂ ತಹರೆ |

ಪದವಂ ಕ್ಷಿತಿಘ್ನಾತ್ ವೊಂದರಿಂದ ಗುಣಿಸಿ | ಮುನಿರಂಧ್ರನಾಗೈಃ ಯೆಂಬ 897 ಇವರಿಂ ಭಾಗಿಸಿ ಬಂದ ರಾಶ್ಯಾದಿ ಫಲವಂ ಪೂರ್ವಧ್ರುವದೊಳು ಕೂಡಿ ಕಳೆಯೇರಿಸಲು ಮಧ್ಯ ಶನಿ ಅಹನು ||

ರಾಹುವಿಗೆ ಪದವಂ ಕುಘ್ನಾತ್ ಯೆಂದು 1 ರಿಂ ಗುಣಿಸಿ ರಸಾಂಗೇಷುಭಿಃ ಯೆಂದು 566 ರಿಂ ಭಾಗಿಸಿ ಬಂದ ರಾಶ್ಯಾದಿಯಂ ತಮಸಃ ಪ್ರತೀಪಂ ಯೆಂದು ವರ್ಷ ಧ್ರುವದೊಳು ಕಳೆಯಲು ರಾಹುವಹನು|

ಅಲ್ಲಿ 6 ರಾಶಿಯಂ ಕೂಡಲು ಕೇತುವಹನು ||

ಚಂದ್ರೋಚ್ಚಕ್ಕೆ ಪದವನ್ನಿಕ್ಕಿಕೊಂಡು ತ್ರಿಘ್ನಾತ್ ಯೆಂದು 3 ರಿಂ ಗುಣಿಸಿ ವಸುವ್ಯೋಮಗಜೈಃ ಯೆಂದು 808 ರಿಂ ಭಾಗಿಸಿ ಬಂದ ರಾಶ್ಯಾದಿಯಂ ಮುಂನ ಬಂದ ವರ್ಷ ಧ್ರುವದೊಳು ಕೂಡಲು ಚಂದ್ರೋಚ್ಚ ವಹುದು ||

ಅಹ್ನಾಂಗಣಃ ಖೇಷುಮಹೀವಿಭಕ್ತಃ ಕಲಾದಿಹೀನಃ ಶಶಿತಿಗ್ಮರಶ್ಮ್ಯೋಃ |
ನಭಶ್ಚರಾ ಮಧ್ಯಗತಿಪ್ರಚಾರಾ ಭವಂತಿ ಲಂಕಾ ವಿಷಯೇ ऽರ್ಧರಾತ್ರೌ || 16 ||

ದ್ಯುಗಣವಂ 150 ರಿಂ ಭಾಗಿಸಿ ಬಂದ ಲಿಪ್ತಾದಿಯಂ ಮಧ್ಯಾರ್ಕಚಂದ್ರರ ಲಿಪ್ತಾದಿಯಲ್ಲಿ ಕಳವುದು | ಈ ಪ್ರಕಾರದಲ್ಲಿ ಗ್ರಹರೆಲ್ಲಾ ಮಧ್ಯಗತಿ ಚಾರದಿಂದ ಲಂಕಾಪಟ್ಟಣ ವಿಷಯಕ್ಕೆ ಮಧ್ಯರಾತ್ರೆಗೆ ಬಂದವರಹರು | ಲಂಕಾ ವಿಷಯವೆಂದರೆ ಮಹಾಮೇರು ಪರ್ವತನ ದಕ್ಷಿಣ ಭೂಭಾಗವೆಂದರಿವುದು ||

ಲಂಬಜ್ಯಯಾಘ್ನಃ ಖರಸಾಂಬರಾರ್ಥಾಸ್ತ್ರಿಭಜ್ಯಯಾ ಭೂಪರಿಧಿರ್ವಿಭಕ್ತಃ |
ಭೂಮಧ್ಯರೇಖಾಸುರಧಾಮಲಂಕಾ ರೌಹೀತಕಾವಂತ್ಯಮರಾದ್ರಿಸಾರಾಃ || 17 ||

ಖರಸಾಂಬರಾರ್ಥಾ ಯೆಂಬ 5060 ಇವಂ ಲಂಬಜ್ಯಯಾಘ್ನಃ ಯೆಂದು ಮುಂದೆ ಛಾಯಾಧ್ಯಾಯದಲ್ಲಿ ಪೇಳುವ ಸ್ವದೇಶಲಂಬಜ್ಯೆಯಿಂ ಗುಣಿಸಿ | ತ್ರಿಭಜ್ಯಯಾ ವಿಭಕ್ತಃ ಯೆಂದು ಸ್ಫುಟಾಧ್ಯಾಯೋಕ್ತ ತ್ರಿಜ್ಯ 120 ಇವರಿಂ ಭಾಗಿಸಿ ಬಂದದು ಸ್ವದೇಶಭೂಪರಿಧಿಯಹುದು | ವಿಷುವಚ್ಛಾಯೆ ಮೂರಂಗುಲವಾದ ದೇಶಕ್ಕೆ ಲಂಬಜ್ಯೆ 116 | 27 ಖರಸಾಂಬರಾರ್ಥಾ ಯೆಂಬುದರ ಸ್ವರೂಪವೇನೆಂದರೆ | ಸೂರ್ಯಸಿದ್ಧಾಂತದಲ್ಲಿ|

ಯೋಜನಾನಿ ಶತಾನ್ಯಷ್ಟೌ ಭೂಕರ್ಣೋ ದ್ವಿಗುಣಾನಿ ತು |
ತದ್ವರ್ಗತೋ ದಶಗುಣಾತ್ಪದಂ ಭೂಪರಿಧಿರ್ಭವೇತ್ || (I-59)

ಯೆಂಬ ಸೂತ್ರದಲ್ಲಿ ನಿರೂಪಿಸಿದ ಕ್ರಮದಿಂದ ಅರ್ಧೋತ್ತರ ಸಹಿತ ಬಂದದೆಂದರಿವುದು||

ಇಂನು ಭೂಮಧ್ಯರೇಖೆಯೆಂದರೆ ಮೇರುಪರ್ವತಕ್ಕೂ ಲಂಕೆಗೂ ಸೂತ್ರವ ಹಿಡಿಯಲಾಗಿ | ರೌಹೀತಕವೆಂದರೆ ದೇಶ ವಿಶೇಷ, ಸ್ವಾಮಿಮಲೆ, ಅವಂತಿಯೆಂಬುದು ಉಜ್ಜೈನಿ | ಅಮರಾ-ದ್ರಿಸಾರವೇ ಮಾನಸ ಸರೋವರ | ಇವರ ಮೇಲೆ ಆ ದಕ್ಷಿಣೋತ್ತರ ಸೂತ್ರವಿದ್ದದರಿಂದ ಈ ಪ್ರದೇಶಗಳು ಭೂಮಧ್ಯರೇಖೆ ಯೆಂದರಿವುದು ||

ಸ್ವಕೀಯದೇಶಾಂತರಯೋಜನಘ್ನಾ ಗತಿರ್ಧರಿತ್ರೀವಲಯೇನ ಭಕ್ತಾ |
ಫಲಂ ಕುರೇಖಾಪರಪೂರ್ವಸಂಸ್ಥಃ ಕುರ್ಯಾದ್ಧನರ್ಣಂ ನಿಖಿಲಗ್ರಹೇಷು || 18 ||

ಈ ಮುಂನ ಪೇಳಿದ ಭೂಮಧ್ಯರೇಖಾ ಪ್ರದೇಶದಿಂದ ತಾನಿದ್ದ ದೇಶ ಮೂಡಲಾಗಲಿ ಪಡುವ-ಲಾಗಲಿ ಯೆಷ್ಟು ಯೋಜನವೆಂಬುದನರಿತುಕೊಂಡು | ಆ ಯೋಜನ ಸಂಖೆಯಿಂದ ರವ್ಯಾ-ದಿ ಗ್ರಹರ ಮಧ್ಯಗತಿ ಲಿಪ್ತಾದಿಗಳಂ ಗುಣಿಸಿ | ಧರಿತ್ರೀವಲಯೇನ ಭಕ್ತಾ ಯೆಂದು ಮುನ್ನಿನ ಸ್ವದೇಶ ಭೂಪರಿಧಿಯಿಂ ಭಾಗಿಸಿ ಬಂದ ಲಿಪ್ತಾದಿಯಂ ಮಧ್ಯಗ್ರಹರಲ್ಲಿ ತಾನಿದ್ದ ಠಾವು ಮೂ-ಡಲಾದರೆ ಕಳವುದು | ಪಡುವಲಾದರೆ ಕೂಡುವದು || ಇದು ಯೋಜನಸಂಸ್ಕಾರ ಪ್ರಕಾರ ||

ಇಂನು ಈ ಮಧ್ಯರಾತ್ರೆಗೆ ಬಂದ ಮಧ್ಯಗ್ರಹರನೆಲ್ಲಾ ತಂನ ಇಷ್ಟ ಕಾಲಕ್ಕೆ ತಂದುಕೊಂಬ ಉಪಾಯ ಪೇಳುವ ಶ್ಲೋಕ ||

ಅಭೀಷ್ಟನಾಡೀ ಗುಣಿತಾ ಗ್ರಹಾಣಾಂ ಷಷ್ಟ್ಯಾ ವಿಭಕ್ತಾ ಗತಯಃ ಕಲಾದ್ಯಾಃ |
ಶೋಧ್ಯಾಃ ಸಮೇತಾ ಗತಗಮ್ಯಕಾಲೇ ತಾತ್ಕಾಲಿಕಾ ವ್ಯೋಮಚರಾ ಭವಂತಿ || 19 ||

ತನ್ನ ಇಷ್ಟ ಕಾಲವು ಮಧ್ಯರಾತ್ರಿಯಿಂದ ಹಿಂದೆಯಾಗಲಿ | ಮುಂದೆಯಾಗಲಿ | ಇಷ್ಟು ಘಳಿಗೆ-ಗೆ ಯೆಂಬುದ ನೋಡಿಕೊಂಡು | ಆ ಘಳಿಗೆ ಸಂಖೆಯಿಂದೀ ಗ್ರಹರ ಮಧ್ಯಗತಿ ಲಿಪ್ತಿ ವಿಲಿಪ್ತಿ ಗಳಂ ಗುಣಿಸಿ 60 ರಿಂದೆತ್ತಿ ಬಂದ ಲಿಪ್ತಾದಿಯಂ | ತಂನ ಇಷ್ಟ ಕಾಲವು ಮಧ್ಯ ರಾತ್ರೆಯಿಂದ ಹಿಂದಾಗಿದ್ದರೆ ಮಧ್ಯಗ್ರಹದಲ್ಲಿ ಕಳವುದು | ಮುಂದಾದರೆ ಕೂಡುವುದು | ಆಗಲಾ ಗ್ರಹರು ಇಷ್ಟ ಕಾಲ್ಲಿಕರಹರು ||

ಇಂತು ಶೃಂಗಪುರವಾಸ ವಾಸವಗುರುಸಮಾನ ದೇಮಣಜ್ಯೋತಿಷಾಗ್ರಗಣ್ಯಸುಧಾರ್ಣ-ವಪೂರ್ಣಚಂದ್ರನಾದ | ಅವ್ಯುತ್ಪಂನ್ನಗಣಕಪನ್ನಗಸುಪರ್ಣನಾದ ಶಂಕರನಾರಾಯಣ ಜ್ಯೋತಿಷನಿಂದ ವಿರಚಿತಮಪ್ಪ ಗಣಿತಗನ್ನಡಿಯೆನಿಪ ವಾರ್ಷಿಕತಂತ್ರದ ಕರ್ಣಾಟಭಾಷಾ-ವ್ಯಾಖ್ಯಾನದೊಳು ಗ್ರಹಮಧ್ಯಾಧಿಕಾರವೆನಿಪ ಪ್ರಥಮಾಧ್ಯಾಯ ಪರಿಸಮಾಪ್ತವಾಯಿತು ||

SECOND CHAPTER

ಶ್ರೀ ಗುರುಭ್ಯೋ ನಮಃ ದ್ವಿತೀಯಾಧ್ಯಾಯ ಗ್ರಹಸ್ಫುಟಾಧಿಕಾರ

ಆದ್ಯೋ ರವಿಜೀವಕುಜಾರ್ಕಜಾನಾಂ ಶೀಘ್ರೋಚ್ಚಸಂಜ್ಞಃ ಖಚರಾಸ್ತ ಏವ |
ಜ್ಞಶುಕ್ರಯೋರ್ಮಧ್ಯರವಿರ್ಗ್ರಹಃ ಸ್ಯಾತ್ ಶೀಘ್ರೋಚ್ಚಸಂಜ್ಞೌ ಭವತಃ ಸ್ವಯೋಸ್ತೌ || 1 ||

ಆದ್ಯಃ | ಗ್ರಹರಿಗೆಲ್ಲಾ ಮೊದಲಿಗನಾಗಿದ್ದಂಥಾ | ರವಿಃ ಸೂರ್ಯನು | ಜೀವಕುಜಾರ್ಕಜಾನಾಂ ಗುರುಕುಜಶನೈಶ್ಚರರಿಗೆ | ಶೀಘ್ರೋಚ್ಚಸಂಜ್ಞಃ | ಶೀಘ್ರೋಚ್ಚವಹನು | ಖಚರಾಸ್ತ ಏವ | ಆ ಕುಜಗುರುಶನಿಗಳೇ ಮಧ್ಯಗ್ರಹರು | ಜ್ಞಶುಕ್ರಯೋಃ | ಬುಧಶುಕ್ರರಿಗೆ | ಮಧ್ಯರವಿರ್ಗ್ರಹಃ ಸ್ಯಾತ್ | ಮಧ್ಯರವಿಯೇ ಗ್ರಹನು | ತಾವೇ ತಮಗೆ ಶೀಘ್ರೋಚ್ಚವಹರು ||

ವಸ್ವದ್ರಯಸ್ತಿಗ್ಮರುಚಃ ಖವಿಶ್ವೇ ಭೌಮಸ್ಯ ರೂಪಾಕೃತಯೋ ಬುಧಸ್ಯ |
ದ್ವ್ಯದ್ರೀಂದವೋ ವಾಕ್ಪತಿಮಂದಭಾಗಾಃ ಖಾಷ್ಟೌ ಭೃಗೋಃ ಸೌರರಗಾಗ್ನಿದಸ್ರಾಃ || 2 ||

ಮೊದಲು ಶೀಘ್ರೋಚ್ಚಮಂ ಪೇಳಿ ಈಗ ಮಂದೋಚ್ಚಮಂ ಪೇಳುತಿದ್ದಾನು | ಅದೆಂತೆನೆ | ತಿಗ್ಮರುಚಃ ಆದಿತ್ಯಗೆ ಮಂದೋಚ್ಚಭಾಗೇ 78 ವಸ್ವದ್ರಯಃ ಯೆಂಬ ಸಂಖೆ (78) | ಭೌಮಸ್ಯ ಮಂಗಲಗೆ ಖವಿಶ್ವೇ 130 | ರೂಪಾಕೃತಯೋ ಬುಧಸ್ಯ | ಬುಧಂಗೆ 221 | ವಾಕ್ಪತಿ ಮಂದಭಾಗಾಃ | ಗುರುವಿಗೆ ಮಂದೋಚ್ಚಭಾಗೆಗಳು | ದ್ವ್ಯದ್ರೀಂದವಃ 172 | ಭೃಗೋಃ ಶುಕ್ರಗೆ ಖಾಷ್ಟೌ 80 | ಶನೈಶ್ಚರಗೆ ಅಗಾಗ್ನಿದಸ್ರಾಃ 237 || ಇವರ ಸ್ವರೂಪವೆಂತೆಂದರೆ | ಪ್ರಾಗ್ಗತೇಃ ಸೂರ್ಯಮಂದಸ್ಯ ಯೆಂಬುದಾದಿಯಾಗಿ | ಗೋಗ್ನಯಃ ಶನಿಮಂದಸ್ಯ ಯೆಂಬ ಪರ್ಯಂತರ ಶ್ರೀಸೂರ್ಯಸಿದ್ಧಾಂತದಲ್ಲಿ ನಿರೂಪಿಸಿದ ಮಂದೋಚ್ಚ ಭಗಣಗಳಿಂದ ಸೃಷ್ಟ್ಯಾದಿ ಇಷ್ಟ ವರ್ಷಕ್ಕೆ ಸಂದ ವರ್ಷವಂ ಗುಣಿಸಿ ಕಲ್ಪಾಬ್ದಗಳಿಂ ಭಾಗಿಸಿ ಬಂದ ಭಗಣಾದಿ ಲಬ್ಧವೇ ಮಂದೋಚ್ಚ | ಈಗ ಆಚಾರ್ಯನು ಹೇಳಿದ ಮಂದೋಚ್ಚ ಭಾಗಿಗಳಿಂದಲ್ಲೂ ಈ ವರ್ತಮಾನಕಾಲದ ಮಂದೋಚ್ಚಗಳು ವೊಂದಿಷ್ಟು ಲಿಪ್ತಾದಿಗಳಿಂದ ನ್ಯೂನವಾಗಿದ್ದರೂ ಬಹಳ ವರ್ಷಕ್ಕಲ್ಲದೆ ವೊಂದೊಂದು ಭಾಗೆ ಹೆಚ್ಚವಾಗಿ ಧ್ರುವದಂತೆ ಕಟ್ಟುಕವ ಮಾಡಿದನು ||

ಸ್ವೋಚ್ಚೋನಿತೇ ಕೇಂದ್ರಪದಂ ಗ್ರಹೇ ऽಸ್ಮಿನ್ ತುಲಾದಿಕೇ ಬಾಹುಫಲಂ ಗ್ರಹೇ ಸ್ವಂ |
ಋಣಂ ಕ್ರಿಯಾದೌ ಮೃಗಕರ್ಕಿಪೂರ್ವೇ ಕೇಂದ್ರೇ ಧನರ್ಣಂ ಚ ಹರೇ ತು ಕೋಟಿಃ || 3 ||

ತನಗಿಷ್ಟವಾದ ಮಧ್ಯಗ್ರಹದೊಳಗೆ ತಂಮ ತಂಮ ಶೀಘ್ರೋಚ್ಚವಾಗಲೀ ಮಂದೋಚ್ಚವಾಗಲಿ ಕಳದುಳಿದ ರಾಶ್ಯಾದಿ ಶೇಷವಂ ಕೇಂದ್ರವೆಂದು ಬರವುದು | ಆ ಕೇಂದ್ರ ತುಲಾದಿಯಾದರೆ | ಬಾಹುಫಲಂ ಮುಂದೆ ತಹಂಥಾ ಶೀಘ್ರಭುಜಾಫಲವಾಗಲಿ ಮಂದಭುಜಫಲವನಾಗಲಿ | ಗ್ರಹೇ ಆ ಗ್ರಹದಲ್ಲಿ | ಸ್ವಂ ಕೂಡುವದು | ಕ್ರಿಯಾದೌ ಋಣಂ | ಮೇಷಾದಿ ಕೇಂದ್ರವಾದರೆ ಋಣವ ಮಾಡುವದು || ಇಂನು ಮುಂದೆ ಶೀಘ್ರಫಲವ ತಹರೆ ಹೇಳುವಂಥ ವ್ಯೋಮೇಂದವಃ ಯೆಂಬ ಶೀಘ್ರಹರದೊಳಗೆ ಕೋಟಿಫಲವಂ ಆ ಮೊದಲು ಪೇಳಿದ ಶೀಘ್ರಕೇಂದ್ರ ಮೃಗಾದಿಯಾದರೆ ಕೂಡುವದು | ಕರ್ಕ್ಯಾದಿಯಾದರೆ ಋಣವಮಾಡುವದು ||

ಪ್ರವರ್ತತೇ ಬಾಹುರಯುಗ್ಮಪಾದೇ ಕೋಟಿರ್ಗತಾ ಯುಗ್ಮಪದೇ ಪ್ರತೀಪಂ |
ತ್ರಿರಾಶಿಭೋಗೇನ ವಿಹಾಯ ಭೋಗಂ ತಯೋಃ ಸ್ಥಿತೋऽಯಂ ತ್ರಿಭಶೋಧಿತೋ ऽನ್ಯಃ || 4 ||

ಭುಜಕೋಟಿಗಳನರಿವ ಕ್ರಮ | ಅಯುಗ್ಮಪಾದೇ | ಓಜಪದದಲ್ಲಿ | ಬಾಹುಃ ಪ್ರವರ್ತತೇ | ಭುಜೆ ವರ್ತಿಸುತಂ ವಿಹುದು | ಕೋಟಿರ್ಗತಾ | ಕೋಟಿಗತವಾಗಿಹುದು | ಏಷ್ಯಪದದಲ್ಲೂ ಇಹದು | ಯುಗ್ಮಪದೇ | ಯುಗ್ಮಪದದಲ್ಲಿ | ಪ್ರತೀಪಂ | ಇದರ ವಿಪರೀತ | ಅದೆಂತೆನೆ | ಸಮಪದದಲ್ಲಿ ಕೋಟಿ ವರ್ತಿಸುತ್ತಹುದು | ಭುಜೇ ಗತವಾಗಿಹುದು | ತ್ರಿರಾಶಿ ಭೋಗೇನ ವಿಹಾಯ ಭೋಗಂ ಯೆಂದು ಈ ಭುಜಾಕೋಟಿಗಳಿಗೆ ಮೂರು ಮೂರು ರಾಶಿಯ ಭೋಗ | ಅದಕೆ ಭುಜೆ ಮೂರು ಕೋಟಿ ಮೂರು ಭುಜೆ ಮೂರು ಕೋಟಿ ಮೂರು ಯೆಂದು ಹೋದಷ್ಟು ರಾಶಿಯಂ ಮೂರು ಮೂರಾಗಿ ಕಳವುದು | ಇಲ್ಲಿ ಹಂನೆರಡು ರಾಶಿಗೂ ಸಹ ನಾಲ್ಕು ಪದ | ಓಜಯುಗ್ಮ ಓಜಯುಗ್ಮವೆಂದು | ಅದೆಂತೆನೆ | ಕೆಳಗೆ ಕೆಲವು ಭಾಗಾದಿಗಳು ಇದ್ದು

| ರಾಶಿ ಸ್ಥಾನ ಸೊಂನೆ ವೊಂದು ಯೆರಡಾಗಿದ್ದಾಗಲೂ ಹಾಗೆ ರಾಶಿ ಆರು ಯೇಳು ಯೆಂಟಾಗಿದ್ದಾಗಲೂ ಇದೆರಡೂ ಓಜಪದ | ಇಲ್ಲಿ ಭುಜೆ ಇಹುದು | ಕೋಟಿ ಹೋಗಿಹುದು | ಇಂನು ರಾಶಿ ಮೂರು ನಾಲ್ಕು ಐದು ಹಾಗೆ ರಾಶಿ ವೊಂಭತ್ತು ಹತ್ತು ಹಂನೊಂದಾಗಿದ್ದಾಗ ಇದೆರಡೂ ಯುಗ್ಮಪದ | ಇಲ್ಲಿ ಕೋಟಿ ಇಹುದು | ಭುಜೆ ಗತವಾಗಿಹುದು |

ತಯೋಃ ಸ್ಥಿತೋಽಯಂ ತ್ರಿಭ ಶೋಧಿತೋಽನ್ಯಃ ಯೆಂದು ಈ ಭುಜಾಕೋಟಿಗಳೊಳಗೆ ಆವದು ವರ್ತಿಸುತಿದ್ಧೀತು ಅದಂ ಮೂರು ರಾಶಿಯೊಳು ಶೋಧಿಸಲು ಅದೇ ಮತ್ತೊಂದಹುದು | ಭುಜೆ ಇದ್ದರೆ ಕೋಟಿ | ಕೋಟಿಯಿದ್ದರೆ ಮೂರು ರಾಶಿಯೊಳಗೆ ಶೋಧಿಸಿದುದೇ ಭುಜೆಯಹುದೆಂಬುದರ್ಥ ||

ಭಾಗಸ್ತಯೋಃ ಖೇಂದುಹೃತಾ ಗತಾನಾಂ ಜ್ಯಾಖಂಡಕಾನಾಂ ಭವತೀಹ ಸಂಖ್ಯಾ |
ತದಗ್ರಖಂಡೇನ ನಿಹತ್ಯ ಶೇಷಂ ದಶಾಹೃತಂ ಯೋಜ್ಯಮತೀತಖಂಡೇ || 5 ||

ಈ ಮುಂನ ಪೇಳಿದ ಭುಜಾಕೋಟಿಗಳಿಗೆ ಜೀವಗೊಂಬ ಕ್ರಮ | ಭಾಗಾಸ್ತಯೋಃ ಯೆಂದು ಭುಜೆಗಾಗಲಿ ಕೋಟಿಗಾಗಲಿ ತನಗೆ ಆವದಕ್ಕೆ ಜೀವೆಯ ತರಬೇಕಾಯಿತು | ಆಗ ಆ ರಾಶಿಯಂ 30 ರಿಂ ಗುಣಿಸಿ ಭಾಗಿಯಂ ಕೂಡಿ ಭಾಗೀಕರಿಸಿ ಕೊಂಡು | ಆ ಭಾಗಿಗಳಂ | ಖೇಂದುಹೃತಾ ಯೆಂದು 10 ರಿಂ ಭಾಗಿಸಿ ಬಂದ ಲಬ್ಧವು | ಇಹ ಈ ತಂತ್ರದಲ್ಲಿ | ಗತಾನಾಂ ಜ್ಯಾಖಂಡಕಾನಾಂ ಸಂಖ್ಯಾ ಭವತಿ | ಹಿಂದೆ ಸಂದ ಖಂಡಜೀವೆಗಳ ಸಂಖೆಯಹುದು | ತದಗ್ರಖಂಡೇನ ನಿಹತ್ಯ ಶೇಷಂ | ಆ ಮುಂದಣ ಖಂಡಜೀವೆಯಿಂದ ಈ ಹತ್ತರಿಂ ಭಾಗಿಸಿ ಮಿಕ್ಕ ಭಾಗಿ ಶೇಷಮಂ ಲಿಪ್ತಿವಿಲಿಪ್ತಿಗಳಂ ಗುಣಿಸಿ ಕೆಳಗಿಂದ ಯೆತ್ತಿ ಕೂಡಿಕೊಂಡು ಮತ್ತ ಮಾ ಭಾಗಿಸ್ಥಾನಮಂ 10 ರಿಂ ಭಾಗಿಸಿ ಬಂದ ಲಬ್ಧವಂ ಮೊದಲು ಸಂದ ಜೀವೆಗಳೊಳಗೆ ಕೂಡುವದು | ಶೇಷವಂ 60 ರಿಂ ಗುಣಿಸಿ 10 ರಿಂ ಭಾಗಿಸಿ ಬಂದವಂ ಕೆಳಗೆ ಇರಿಸಿಕೊಂಬುದು | ಅದು ಭುಜೆಗಾಗಲಿ ಕೋಟಿಗಾಗಲಿ ತಾನು ತಂದದಕೆ ಬಂದ ಜೀವೆಯಹುದು || ಆ ಜೀವೆಯಂ ಭಾಗಾದಿಯೆಂದರಿವುದು ||

ರೂಪಾಶ್ವಿನೌ ವಿಂಶತಿರರ್ಕಚಂದ್ರಾಃ ಶೈಲೇಂದವಃ ಪಂಚದಶಾಕ್ಷಿಚಂದ್ರಾಃ |
ರಂಧ್ರಾಣಿ ಬಾಣಾನಯನೇನವ್ಯೆವಂ ದೋಃ ಕೋಟಿಕಾಲೇ ಕ್ರಮಖಂಡಜೀವಾಃ || 6 ||

ರೂಪಾಶ್ವಿನೌ 21 ವಿಂಶತಿಃ 20 ಅಂಕಚಂದ್ರಾಃ 19 ಶೈಲೇಂದವಃ 17 ಪಂಚದಶ 15 ಅಕ್ಷಿಚಂದ್ರಾಃ 12 | ರಂಧ್ರಾಣಿ 9 ಬಾಣಾಃ 5 ನಯನೇ 2 | ಈ ವೊಂಭತ್ತು ಕ್ರಮಖಂಡಜೀವೆಗಳು |

ಉತ್ಕ್ರಮಖಂಡಜೀವೆಗಳೆಂತೆಂದರೆ | 2 | 5 | 9 | 12 | 15 | 17 | 19 | 20| 21 |

ಇವೀಗ ||

ಪಿಂಡೀಕೃತಜ್ಯಾಃ ಶಶಿಲೋಚನಾನಿ ಕ್ಷೋಣೀಕೃತಾಃ ಷಷ್ಟಿರಗಾಕ್ಷಿತಿಧ್ರಾಃ |
ದ್ವ್ಯಂಕಾಃ ಕೃತಾಶಾಃ ಪುರಭೂಶಶಾಂಕಾ ಧೃತೀಂದವಃ ಖಾಕ್ಷಿಭುವಃ ಪ್ರದಿಷ್ಟಾಃ || 2.7 ||

ಆ ಹಿಂದೆ ಹೇಳಿದ ಖಂಡ ಜೀವೆಗಳನೇ ಕ್ರಮದಿಂದ ಕೂಡಲಾಗಿ ಪಿಂಡೀಕೃತ ಜೀವೆಗಳು |

ಶಶಿಲೋಚನಾನಿ 21 ಕ್ಷೋಣೀಕೃತಾಃ 41 ಷಷ್ಟಿಃ 60 ಅಗಕ್ಷಿತಿಧ್ರಾಃ 77 ದ್ವ್ಯಂಕಾಃ 92 ಕೃತಾಶಾಃ 104 ಪುರಭೂಶಶಾಂಕಾಃ 113 ಧೃತೀಂದವಃ 118 ಖಾಕ್ಷಿಭುವಃ 120 || ಇವೀಗ ಕ್ರಮಪಿಂಡಜೀವೆಗಳು | ಇಂನು ಹಾಗೇ ಉತ್ಕ್ರಮಪಿಂಡಜೀವೆಗಳು | 2 | 7 | 16 | 28 | 43 | 60 | 79 | 99 | 120 |

ವ್ಯೋಮಾಗ್ನಿದಂತಾಃ ಶಿಖಿರೂಪಶಕ್ರಾಃ ಪುರಾಂಬರಾಂಗಾನಿ ದಿಗರ್ಥಚಂದ್ರಾಃ |
ರೂಪಾಗವಿಶ್ವೇಂ ऽಕರಸಾದ್ರಿರಾಮಾಃ ತ್ರಿಪಕ್ಷರಂಧ್ರಾಣಿ ಮಾಂದಹರಾಃ ಸ್ಯುರರ್ಕಾತ್

|| 2.8 ||

ಇಂನು ರವ್ಯಾದಿ ಗ್ರಹರಿಗೆ ಮಾಂದಭೇದವಂ ಪೇಳುತಿದ್ದಾನು | ಪದ ಕ್ರಮದಿಂದ | ವ್ಯೋ-ಮಾಗ್ನಿದಂತಾಃ 3230 ಶಿಖಿರೂಪಶಕ್ರಾಃ 1413 ಪುರಾಂಬರಾಂಗಾನಿ 603 ದಿಗರ್ಥಚಂದ್ರಾಃ 1510 ರೂಪಾಗವಿಶ್ವೇ 1371 ಅಂಕರಸಾದ್ರಿರಾಮಾಃ 3769 ತ್ರಿಪಕ್ಷರಂಧ್ರಾಣಿ 923 ಇವು ಮಾಂದಹರಂಗಳು ||

ಈ ಮಾಂದಭೇದಂಗಳಿಗೆ ತಾತ್ಕಾಲಿಕ ಸಂಸ್ಕಾರವಂ ಪೇಳುತಿದ್ದಾನು | ಖಾಂಕೈಃ 90 |
ಖಾಂಕೈಃ ಖತಾನೈರ್ವಿಯದಭ್ರರಾಮೈಃ ಖಾಶ್ವೈಃ ಖಶೈಲೇಂದುಭಿರಿಂದುಪಕ್ಷೈಃ |
ಖಾಷ್ಟಾಗ್ನಿಭಿಃ ಷಷ್ಟಿಹತಾ ಭುಜಜ್ಯಾ ವಿಭಾಜಿತಾ ಮಾಂದಹರೇಷು ಯೋಜ್ಯಾಃ || 2.9 ||

ಭುಜಾಜೀವೆಯನಿಕ್ಕಿಕೊಂಡು 60 ರಿಂ ಗುಣಿಸಿ ಕೆಳಗಣ ಲಿಪ್ತಿಯಂ ಕೂಡಿ | ಆದಿತ್ಯ ಮೊದಲಾ-ದವರಿಗೆ ಖಾಂಕ ಮೊದಲಾದ ಯೇಳು ಭೇದಗಳಿಂ ಭಾಗಿಸಿ ಬಂದ ಫಲವಂ ಮುಂನ ಪೇಳಿದ ವ್ಯೋಮಾಗ್ನಿದಂತಾದಿ ಭೇದಗಳೊಳಗೆ ಕೂಡಲು ಅವು ತಂಮ ತಂಮ ಸ್ಫುಟಮಂದಭೇದವ-ಹುದು

ಇಂನು ಕುಜಾದಿ ಪಂಚಗ್ರಹರಿಗೆ ಶೀಘ್ರಭೇದಂಗಳು |

ದಿಗೀಶ್ವರಾಸ್ತರ್ಕಶರಾಂಕಚಂದ್ರಾಃ ಕ್ವರ್ಥಾಂಗರಾಮಾ ಜ್ವಲನಾಂಕನಂದಾಃ |
ದ್ವ್ಯಂಗೇಷು ತರ್ಕಾಃ ಕುಜಪೂರ್ವಕಾಣಾಂ ಭೇದಾ ಅಮೀ ಶೀಘ್ರವಿಧೌ ಪ್ರದಿಷ್ಟಾಃ || 2.10 ||

ದಿಗೀಶ್ವರಾಃ 1110 ತರ್ಕಶರಾಂಕಚಂದ್ರಾಃ 1956 ಕ್ವರ್ಥಾಂಗರಾಮಾಃ 3651 ಜ್ವಲನಾಂಕ-ನಂದಾಃ 993 ದ್ವ್ಯಂಗೇಷು ತರ್ಕಾಃ 6562 ಇವು ಕುಜಾದಿಗಳಿಗೆ ಶೀಘ್ರಭೇದಂಗಳು | ಇವು ತಾವೇ ಸ್ಫುಟಭೇದ ||

ಇವು ಸಿದ್ಧಾಂತೋಕ್ತ ಮಾಂದಶೀಘ್ರಫಲಗಳಿಗೆ ಸರಿವಹಂತೆ ಕಲ್ಪಿಸಿದ ಭೇದಂಗಳು ||
ದೋಃ ಕೋಟಿ ಜೀವೇ ಖರಸೈರ್ನಿಹನ್ಯಾಚ್ಛೇದ್ಯೈಃ ಸ್ವಕೀಯೈರ್ವಿಭಜೇಲ್ಲವಾದಿ |
ಮಾಂದಂ ಫಲಂ ಬಾಹುಜಮತ್ರ ವಿಂದ್ಯಾನ್ಮಂದಕ್ರಿಯಾಯಾಂ ನ ಹಿ ಕೋಟಿಕರ್ಮ || 2.11 ||

ಮಂದಫಲ ಶೀಘ್ರಫಲಗಳಂ ತಹರೆ | ಭುಜಾಫಲ ಕೋಟಿಫಲಗಳಂ ತರಬೇಕಾಗಿ ಆ ಭು-ಜಾಕೋಟಿಜೀವೆಗಳಂ ಬೇರೆ ಬೇರೆ 60 ರಿಂ ಗುಣಿಸಿ ಕೆಳಗಣ ಲಿಪ್ತಿಯಂ ಕೂಡಿ | ಛೇದ್ಯೈಃ ಸ್ವಕೀಯೈಃ ವಿಭಜೇತ್ ಯೆಂದು ಆ ಆ ಗ್ರಹರಿಗೆ ತಂಮ ತಂಮ ಸ್ಫುಟಮಾಂದಭೇದ ಶೀಘ್ರ-ಭೇದಗಳಿಂ ಭಾಗಿಸಿ ಬಂದದು | ಲವಾದಿ ಭಾಗಾದಿಯಹುದು | ಅದು ಭುಜಾಫಲ ಕೋ-ಟಿಫಲವಹುದು | ಇಲ್ಲಿ ಮಂದಕ್ರಿಯಾಯಾಂ ನ ಹಿ ಕೋಟಿಕರ್ಮ ಯೆಂದು ಮಂದಸ್ಫುಟವ ಮಾಡುವರೆ

ಕೋಟಿಕರ್ಮವಿಲ್ಲವಾಗಿ | ಮಾಂದಂ ಫಲಂ ಬಾಹುಜಮತ್ರ ವಿಂದ್ಯಾತ್ ಯೆಂದು ಮಂದಫ-ಲವು ಭುಜೆಯಿಂದಲೇ ಹುಟ್ಟುವುದಾಗಿ ಪ್ರಸ್ತುತವಾದ ಮಂದಫಲವಂ ತಹರೆ | ಭುಜಾ ಜೀ-ವೆಯನಿಕ್ಕಿ 60 ರಿಂ ಗುಣಿಸಿ ಕೆಳಗಣವಂ ಕೂಡಿ ಆದಿತ್ಯಾದಿಗಳಿಗೆ ವ್ಯೋಮಾಗ್ನಿದಂತಾದಿ ಭೇ-ದಗಳಂ ಖಾಂಕೈಃ ಯೆಂಬ ಇವು ಮೊದಲಾದವರಿಂ ಸ್ಫುಟವ ಮಾಡಿಕೊಂಡು ಆ ಭೇದಗಳಿಂ ಭಾಗಿಸಲು ಭಾಗಾದಿ ಮಂದಫಲವಹುದು | ಅದಂ ಮಧ್ಯಗ್ರಹರಲ್ಲಿ ಮಂದೋಚ್ಚವ ಕಳದ ಕೇಂದ್ರ ಮೇಷಾದಿಯಾದರೆ ಋಣ, ತುಲಾದಿಯಾದರೆ ಧನವಂ ಮಾಡಲು ಮಂದಸ್ಫುಟಗ್ರಹ-ವಹದು ||

ಮಧ್ಯಗತಿರ್ಲಿಪ್ತಿವಿಲಿಪ್ತಿಕಾತ್ಮಾ ದಿವಾಕರಸ್ಯಾಂಕಶರಾ ಗಜಾಶ್ಚ |
ಇಂದೋಃ ಖಗೋಶ್ವಾಃ ಶರವಹ್ನಯಶ್ಚ ಕ್ಷೋಣೀಗುಣಾಃ ಷಡ್ಯಮಲೌ ಕುಜಸ್ಯ || 2.12 ||

ಬುಧಸ್ಯ ಬಾಣಾಬ್ಧಿಯಮಾರದಾಶ್ಚ ಬೃಹಸ್ಪತೇಃ ಪಂಚನಭಶ್ಚ ಭುಕ್ತಿಃ |
ಭೃಗೋ ರಸಾಂಕಾವಸವಃ ಶನೇರ್ದ್ವೌ ವಿಯಚ್ಚ ರಾಹೋಸ್ತ್ರಯ ಈಶ್ವರಾಶ್ಚ || 2.13 ||

ಷಟ್ಚಂದ್ರವೇದಾ ವಿಧು ತುಂಗ ಭುಕ್ತಿರ್ಭುಜೈಷ್ಯಖಂಡೇನ ಹತಾ ರಸಘ್ನಾ |
ಛೇದೈರ್ವಿಭಕ್ತಾಃ ಗತಯಃ ಕಲಾದ್ಯಾಃ ಕರ್ಕ್ಯಾದಿ ಯೋಜ್ಯಂ ಮಕರಾದಿ ಹೀನಂ || 2.14 ||

ರವ್ಯಾದಿ ಗ್ರಹರಿಗೆ ಕ್ರಮದಿಂದ ಮಧ್ಯಗತಿ ಲಿಪ್ತಿ ವಿಲಿಪ್ತಿಗಳು | ರವಿಗೆ ಮಧ್ಯಗತಿ ಲಿಪ್ತಿ ಅಂಕಶರಾಃ 59 ವಿಲಿಪ್ತಿ ಗಜಾಃ 8 ಇಂದೋಃ ಚಂದ್ರಗೆ ಖಗೋಶ್ವಾಃ ಶರವಹ್ನಯಶ್ಚ 790 | 35 ಕುಜಗೆ 31 | 26 ಬುಧಗೆ 245 | 32 ಗುರುವಿಗೆ 5 | 0 ಶುಕ್ರಗೆ 96 | 8 ಶನಿಗೆ 2 | 0 ರಾಹುವಿಗೆ 3 | 11 ಚಂದ್ರೋಚ್ಚಕ್ಕೆ 6 | 41

ಮಧ್ಯಗತಿಯಂ ಮಂದಸ್ಫುಟವ ಮಾಡುವರೆ | ತಂಮ ತಂಮ ಮಂದಸ್ಫುಟಕ್ಕೆ ಭುಜಾಜೀವೆಗೊಂಬಾಗ ಬಂದ ಏಷ್ಯ ಖಂಡದಿಂದ ಗ್ರಹನ ಮಧ್ಯಗತಿಲಿಪ್ತಿವಿಲಿಪ್ತಿಗಳಂ ಗುಣಿಸಿ ರಸಘ್ನಾ 6 ರಿಂ ಗುಣಿಸಿ ಛೇದೈರ್ವಿಭಕ್ತಾಃ ಯೆಂದು ತಂಮ ಸ್ಫುಟ ಮಂದ ಹರದಿಂ ಭಾಗಿಸಿ ಬಂದ ಲಿಪ್ತಾದಿ ಫಲವಂ ತಂಮ ಮಧ್ಯಗತಿಲಿಪ್ತಾದಿಯಲ್ಲಿ | ಮಂದಕೇಂದ್ರ ಕರ್ಕ್ಯಾದಿಯಾದರೆ ಕೂಡುವದು | ಮಕರಾದಿಯಾದರೆ ಕಳವುದು | ಅದು ಮಂದಸ್ಫುಟಗತಿಯಹುದು ||

ಈ ಮಧ್ಯಗತಿಯ ಉತ್ಪತ್ತಿಯೆಂತೆಂದರೆ | ಶ್ರೀಸೂರ್ಯಸಿದ್ಧಾಂತದಲ್ಲಿ ನಿರೂಪಿಸಿದ ತಂಮ ತಂಮ ಭಗಣಂಗಳಂ ಭೂಸಾವನದಿನಗಳಿಂ ಭಾಗಿಸಲಾಗಿ ಭಗಣಾದಿ ಫಲವಹುದು | ಅದೇ ಮಧ್ಯಗತಿ |

ಅದೆಂತೆಂದರೆ | ರವಿ ಭಗಣ 4320000 ಇವಂ ಸಾವನದಿನ 1577917828 ಇವರಿಂ ಭಾಗಿಸಿ ಬಂದ ಭಗಣಂ ರಾಶಿ 0, ಭಾಗಿ 0, ಲಿಪ್ತಿ 59 ವಿಲಿಪ್ತಿ 8, ಇಂತು ಯೆಲ್ಲಾ ಗ್ರಹರಿಗೂ ನೋಡಿಕೊಂಬುದು | ಮಧ್ಯಗತಿಯೆಂದರೆ ಮಧ್ಯಚಾರದಿಂದ ವೊಂದು ದಿನಕ್ಕೆ ನಡವಷ್ಟು ಲಿಪ್ತಾದಿಯೆಂದರಿವುದು | |

ಇಂತು ಮಂದಸ್ಫುಟವ ಮಾಡುವ ಕ್ರಮವ ಮೊದಲೇ ಹೇಳಿದ್ದರೂ ಅದನೆಲ್ಲಾ ಸಂಗ್ರಹಿಸಿ ಸ್ಪಷ್ಟವಾಗಿ ಪೇಳುತಿದ್ಧೇನು | ಅದೆಂತೆನೆ | ಮುಂನ ಬಂದ ಮಧ್ಯಗ್ರಹಂಗಳೊಳಗೆ ತಂಮ ತಂಮ ಮಂದೋಚ್ಚವಂ ಕಳೆದು ಕೇಂದ್ರವಿಟ್ಟು ಭುಜೆಯಂ ಪಡದು | ಭಾಗಾಸ್ತಯೋಃ ಖೇಂದುಹೃತಾ ಯೆಂಬ ನ್ಯಾಯದಿಂದ ಜೀವೆಗೊಟ್ಟು | ಆ ಭುಜಾಜೀವೆಯಂ ಖರಸೈರ್ನಿಹನ್ಯಾತ್ ಯೆಂದು 60 ರಿಂ ಗುಣಿಸಿ ಲಿಪ್ತಿಯಂ ಕೂಡಿ ಅದಂ ಮತ್ತೊಂದು ಪ್ರತಿಯನಿಟ್ಟು ಖಾಂಕಾದಿಗಳಿಂ ಭಾಗಿಸಿ ಬಂದವಂ ವ್ಯೋಮಾಗ್ನಿದಂತಾ ಮೊದಲಾದ ಛೇದಗಳಲ್ಲಿ ಕೂಡಿ ಆ ಛೇದದಿಂದಾ ಖರಸಘ್ನ ವಾದ ಭುಜ್ಯೆಯಂ ಭಾಗಿಸಿ ಬಂದ ಭಾಗಾದಿ ಫಲವಂ ಕೇಂದ್ರ ಮೇಷಾದಿ ಋಣ ತುಲಾದಿ ಧನವೆಂದು ಮಧ್ಯಗ್ರಹದಲ್ಲಿ ಸಂಸ್ಕರಿಸಲು ಮಂದಸ್ಫುಟಗ್ರಹರಹರು | ಇಲ್ಲಿ ರವಿಚಂದ್ರರಿಬ್ಬರೂ ಈ ಮಂದ ಕರ್ಮದಿಂದಲೇ ಸ್ಫುಟವಹರೆಂಬರ್ಥವ ಮುಂದೆ ತಾನೇ ಹೇಳುತಿದ್ಧಾನು | ಮೇಲಾದ ಕುಜಾದಿ ಪಂಚಗ್ರಹರಿಗೆ ಮಾಂದಶೀಘ್ರವೆಂಬ ಯೆರಡು ಕರ್ಮದಿಂದ ಸ್ಫುಟವಹರು | ಇಂತು ಮಾಂದವಂ ಪೇಳಿ ಶೀಘ್ರಫಲಾನಯನವಂ ಪೇಳುತಿದ್ಧಾನು ||

ವ್ಯೋಮೇಂದವಃ ಶೀಘ್ರಹರಃ ಪ್ರದಿಷ್ಟಃ ಸಂಸ್ಕೃತ್ಯಶೀಘ್ರಂ ಫಲಮತ್ರ ಕೋಟೇಃ |
ತದ್ವರ್ಗದೋರ್ಜ್ಯಾಫಲವರ್ಗಯೋಗಾನ್ಮೂಲಂ ಚಲದ್ಬಾಣಮುದಾಹರಂತಿ || 2.15 ||

ಕುಜಾದಿಗಳಿಗೆ ಶೀಘ್ರಫಲವಂ ತಹರೆ | ತಂಮ ತಂಮ ಮಂದಸ್ಫುಟ ಗ್ರಹದೊಳಗೆ ತಂಮ ತಂಮ ಶೀಘ್ರೋಚ್ಚಮಂ ಕಳದು ಕೇಂದ್ರವಿಟ್ಟು | ಭುಜಾಕೋಟಿಗಳೆರಡಂ ಪಡದು ಬೇರೆ ಬೇರೆ ಜೀವೆಗೊಟ್ಟು | ದೋಃ ಕೋಟಿಜೀವೇ ಖರಸೈಃ ನಿಹನ್ಯಾತ್ ಯೆಂದು ಭುಜಾಜೀವೆ-ಯಂ ಕೋಟಿಜೀವೆಯಂ 60 ರಿಂ ಗುಣಿಸಿ ಶೇಷವಂ ಕೂಡಿ ದಿಗೀಶ್ವರಾ ಯೆಂಬುದಾದಿಯಾದ ತಂಮ ತಂಮ ಶೀಘ್ರಭೇದದಿಂ ಭಾಗಿಸಲಾಗಿ ಭುಜಾಜೀವೆಯಿಂ ಬಂದದು ಭುಜಾಫಲ | ಕೋಟಿಜೀವೆಯಂ ಭಾಗಿಸಿ ಬಂದ ಕೋಟಿಫಲವಹುದು | ಇಂತು ಭುಜಾಕೋಟಿಫಲಗಳಂ ತಂದುಕೊಂಡು | ವ್ಯೋಮೇಂದವಃ ಯೆಂದರೆ 10 ಈ ಹತ್ತು ಶೀಘ್ರಹರ | ಈ ಹರದಲ್ಲಿ ಮುನ್ನ ಬಂದ ಕೋಟಿಫಲವಂ ಮೃಗಕರ್ಕಿಪೂರ್ವೇ ಕೇಂದ್ರೇ ಧನರ್ಣಂ ಚ ಹರೇ ತು ಕೋ-ಟಿಃ ಯೆಂಬ ನ್ಯಾಯದಿಂದ ಶೀಘ್ರಕೇಂದ್ರ ಮೃಗಾದಿಯಾದರೆ ಹರದೊಳಗೆ ಕೋಟಿಫಲವಂ ಕೂಡುವದು | ಕರ್ಕ್ಯಾದಿಯೆಂದರೆ ಕಳವುದು | ತದ್ವರ್ಗ | ಕೂಡಿದುದಾಗಲಿ ಕಳದುದಾಗಲಿ ಅದಂ ವರ್ಗಂ ಗೊಂಡು ಇರಿಸಿ ದೋರ್ಜ್ಯಾಫಲವರ್ಗಯೋಗಾತ್ ಯೆಂದು ಭುಜಾಫಲವಂ ವರ್ಗಂ ಗೊಂಡು ಇವೆರಡು ವರ್ಗವನು ಕೂಡಿ | ಮೂಲಂ ಗೊಳಲು | ಬಂದ ಫಲವಂ | ಚಲದ್ಬಾಣಮುದಾಹರಂತಿ | ಚಲಬಾಣವೆಂದು ಹೇಳುತಿಹರು ||

ತ್ರಿಜ್ಯಾ ಗುಣಂ ಬಾಹುಫಲಂ ವಿಭಕ್ತಂ ಚಲಾಖ್ಯಬಾಣೇನ ಫಲಸ್ಯ ಚಾಪಂ |
ಅಂಶಾದಿಕಂ ಶೀಘ್ರಫಲಂ ಪ್ರದಿಷ್ಟಂ ಕುಜಜ್ಞಜೀವಾ ಸ್ಫುಜಿದರ್ಕಜಾನಾಂ || 2.16 ||

ಬಾಹುಫಲಂ ಭುಜಾಫಲವನಿಕ್ಕಿಕೊಂಡು ತ್ರಿಜ್ಯಾ ಗುಣಂ ತ್ರಿಜ್ಯೆಯಿಂ 120 ರಿಂ ಗುಣಿಸಿ | ಚಲ-ಬಾಣದಿಂ ಭಾಗಿಸಿ ಬಂದ ಭಾಗಾದಿ ಫಲ | ಅದಕ್ಕೆ ಚಾಪಂ ಗೊಂಡರೆ ಭಾಗಾದಿ ಶೀಘ್ರಫಲ-ವಹುದು | ಕುಜಬುಧಗುರುಭೃಗುಶನಿಗಳಿಗೆ ಮುಂನಿನಂತೆ ಋಣ ಧನವರಿತು ಮಂದಸ್ಫುಟ-ಗ್ರಹದೊಳಗೆ ಸಂಸ್ಕರಿಸುವುದು | ಅವರು ಸ್ಫುಟವಹರು ||

ಚಾಪಂ ಗೊಂಬ ಪರಿಯೆಂತೆಂದರೆ ||

ಜ್ಯಾಖಂಡಕಾನ್ ಪ್ರೋಝ್ಯ ಯಥಾ ವಿಶೋಧ್ಯಂ ಸಂಖ್ಯಾವಶಿಷ್ಟೇ ಗುಣಯೇತ್ ಖಚಂದ್ರೈಃ |
ಆಯಾತಖಂಡೇನ ವಿಭಜ್ಯ ಶೇಷಂ ಸಂಖ್ಯಾಸು ಯೋಜ್ಯಂ ಧನುಷಃ ಫಲಂ ಸ್ಯಾತ್ || 2.17 ||

ಯೆಲ್ಲಿ ಧನುವ ಮಾಡಬೇಕಾಯಿತು ಅಲ್ಲಿ ಜ್ಯಾ ಭಾಗಾದಿಯನಿಕ್ಕಿಕೊಂಡು ಅದರೊಳಗೆ | ಯಥಾ ವಿಶೋಧ್ಯಂ ಜ್ಯಾಖಂಡಕಾನ್ ಪ್ರೋಝ್ಯ ಹೋಹಷ್ಟು ಖಂಡಜೀವೆಗಳಂ ಕಳದು ಹೋದಷ್ಟರ ಸಂಖೆಯಂ ಮೇಲೆ ಬದಿಗಿರಿಸಿ | ಸಂಖ್ಯಾವಶಿಷ್ಟೇ ಗುಣಯೇತ್ಖಚಂದ್ರೈಃ ಯೆಂದು ಶೇಷವಂ ಆ ಸಂಖೆ ಸಹವಾಗಿ 10 ರಿಂ ಗುಣಿಸಿ ಕೆಳಗಣಿಂದೆತ್ತಿ ಕೂಡಿಕೊಂಡು ಕಳದು ಹೋದುದರ ಮುಂದಣ ಖಂಡಜೀವೆ ಯಿಂ ಭಾಗಿಸಿ ಶೇಷ ಸಹ ತಂದು ಮೇಲೆ 10 ರಿಂ ಗುಣಿಸಿದ ಸಂಖ್ಯಾಸ್ಥಾನದಲ್ಲಿ ಕೂಡಲು ಅದು ಧನುಃ ಫಲವಹುದು ||

ಶೀಘ್ರೋಚ್ಚಭುಕ್ತೇರ್ಗ್ರಹಭುಕ್ತಿಹೀನಾ ನಿಘ್ನಾ ಚಲದ್ಬಾಣಹರಾಂತರೇಣ |
ಬಾಣಾಹೃತಾ ಮಾಂದಗತೇರ್ಧನರ್ಣಂ ಬಾಣೇ ಹರಾದುತ್ತರಪೂರ್ವಸಂಸ್ಥೇ || 2.18 ||

ತಮಗೆ ಶೀಘ್ರೋಚ್ಚವಾದ ಗ್ರಹದ ಗತಿಯಲ್ಲಿ ತಂಮ ತಂಮ ಮಂದಸ್ಫುಟಗತಿಯಂ ಕಳದು ಉಳಿದುದಂ | ನಿಘ್ನಾ ಚಲದ್ಬಾಣಹರಾಂತರೇಣ | ಚಲಬಾಣದ ಶೀಘ್ರಹರದ ಅಂತರದಿಂ ಚತುಃಪ್ರತಿಯ ನ್ಯಾಯದಿಂ ಗುಣಿಸಿ | ಬಾಣಹೃತಾ | ಆ ಚಲಬಾಣದಿಂ ಭಾಗಿಸಿ | ಅದೆಂತೆ-ನೆ | ಆ ಗುಣಿಸಿದುದಂ ಚಲಬಾಣವಂ ಸವರ್ಣಿಸಿಕೊಂಡು ಭಾಗಿಸಿ ಬಂದ ಲಿಪ್ತಾದಿ ಫಲವಂ ಮಂದಸ್ಫುಟಗತಿಯಲ್ಲಿ | ಬಾಣವು ಹರದಿಂದ ಅಧಿಕವಾಗಿದ್ದರೆ ಕೂಡುವುದು | ಹರದಿಂದ

ಬಾಣ ಕಿರಿದಾಗಿದ್ದರೆ ಈ ಬಂದ ಫಲವಂ ಮಂದಸ್ಫುಟಗತಿಯಲ್ಲಿ ಕಳವುದು | ಅದು ಸ್ಫುಟಗತಿಯಹುದು || ಯೆತ್ತಲಾನು ಋಣ ಕಾಲದಲ್ಲಿ ಫಲವಧಿಕವಾಗಿ ಮಂದಗತಿಯೊಳಗೆ ಹೋಗದೆ ಇದ್ದರೆ ಆಗ ಆ ಮಂದಸ್ಫುಟಗತಿಯನೆ ಈ ಫಲದೊಳಗೆ ಕಳೆಯಲು ಉಳಿದದು ವಕ್ರಗತಿಯಹುದು ||

ಉಷ್ಣಾಂಶುದೋರ್ಜ್ಯಾ ಫಲಮದ್ರಿಪಕ್ಷೈರ್ಭಕ್ತಂ ವಿಧೇಯಂ ರವಿವಚ್ಛಶಾಂಕೇ |
ಸ್ಫುಟೌ ಭವೇತಾಂ ರವಿಶೀತರಶ್ಮೀ ಮಾಂದೇನ ಶೀಘ್ರೇಣ ಚ ಕರ್ಮಣಾನ್ಯೇ || 2.19 ||

ಉಷ್ಣಾಂಶುದೋರ್ಜ್ಯಾ ಫಲಂ | ಆದಿತ್ಯನ ಭುಜಾಫಲ ಭಾಗಾದಿಯಂ ಲಿಪ್ತೀಕರಿಸಿಕೊಂಡು | ಅದ್ರಿಪಕ್ಷೈರ್ಭಕ್ತಂ 27 ರಿಂ ಭಾಗಿಸಿ ಬಂದ ಲಿಪ್ತಾದಿ ಫಲವಂ | ಶಶಾಂಕೇ ರವಿವತ್ ವಿಧೇಯಂ | ಚಂದ್ರನಲ್ಲಿಯೂ ಆದಿತ್ಯಗೆ ಭುಜಾಫಲ ಧನಕಾಲವಾದರೆ ಧನವ ಮಾಡುವುದು | ಆದಿತ್ಯಗೆ ಋಣವಾದರೆ ಚಂದ್ರಗೂ ಕಳವುದು | ಅದು ರವಿಭುಜಾಸಂಸ್ಕೃತ ಶುದ್ಧಚಂದ್ರನಹುದು | ಈ ರವಿಭುಜಾಸಂಸ್ಕಾರ ಯೆಲ್ಲಾ ಗ್ರಹರಿಗೂ ಉಂಟು | ಹಾಗಾದರೂ ಉಳಿದವರಿಗೆಲ್ಲಾ ಸ್ವಲ್ಪ ಫಲವಹುದಾಗಿ ವಿಶೇಷವಾಗಿ ಚಂದ್ರನಿಗೆ ಹೇಳಿದನು | ಆ ಪ್ರಕಾರದಲ್ಲಿ ಯೆಲ್ಲರಿಗೂ ಮಾಡಬೇಕೆಂಬಲ್ಲಿ ಸಿದ್ದಾಂತ ವಚನ |

ಅರ್ಕಬಾಹುಫಲಾಭ್ಯಸ್ತಾ ಗ್ರಹಭುಕ್ತಿರ್ವಿಭಾಜಿತಾ |

ಭಚಕ್ರಲಿಪ್ತಿಕಾಭಿಃ ಸ್ಯುರ್ಲಿಪ್ತಾಃ ಕಾರ್ಯಾ ಗ್ರಹೇ ಽರ್ಕವತ್ || (ಸೂರ್ಯಸಿದ್ಧಾಂತ 2 - 46)

ಯೆಂದು ರವಿಭುಜಾಫಲ ಕಲೆಗಳಿಂ ಗ್ರಹರ ಗತಿಯ ಗುಣಿಸಿ ಚಕ್ರಲಿಪ್ತಿ 21600 ಅನಂತಪುರವೆಂಬ ಸಂಖೆಯಿಂ ಭಾಗಿಸಿ ಬಂದ ಆದಿತ್ಯನಂತೆ ಋಣಧನವ ಮಾಡಬೇಕು | ಇಲ್ಲಿ ಚಂದ್ರಗೆ ಮಧ್ಯಗತಿಲಿಪ್ತಿ 791 ಇವರಿಂದಾ ಚಕ್ರಲಿಪ್ತಿ 21600 ಇವಂ ಭಾಗಿಸಿ ಬಂದದು 27. ಅದರಿಂದೀ ಅದ್ರಿಪಕ್ಷ ಯೆಂಬವರಿಂದ ಭಾಗಿಸಿದರೆ ಆ ಫಲವೇ ಬಂಧೀತೆಂದು ಕಟ್ಟು ಮಾಡಿದನು ||

ಇಂತು ಶೃಂಗಪುರವಾಸ ವಾಸವಗುರುಸಮಾನ ದೇಮಣಜ್ಯೋತಿಷಾಗ್ರಗಣ್ಯಸುಧಾರ್ಣವಪೂರ್ಣಚಂದ್ರನಾದ | ಅವ್ಯುತ್ಪಂನಗಣಕಪನ್ನಗಸುಪರ್ಣ ಶಂಕರನಾರಾಯಣ ಜ್ಯೋತಿಷನಿಂದ ವಿರಚಿತಮಪ್ಪ ಗಣಿತಗನ್ನಡಿಯೆನಿಪ | ವಾರ್ಷಿಕತಂತ್ರದ ಕರ್ಣಾಟ ಭಾಷಾ ವ್ಯಾಖ್ಯಾನದೊಳು ಗ್ರಹಸ್ಫುಟಾಧಿಕಾರವೆನಿಪ ದ್ವಿತೀಯಾಧ್ಯಾಯ ಸಮಾಪ್ತವಾಯಿತು ||

7 ACKNOWLEDGEMENTS

THE AUTHORS ARE GRATEFUL to the referees for very critical comments which have greatly enhanced the conceptual clarity. One of the authors (SJ) acknowledges the help by INTACH, Bengaluru and Dr Keladi Gunda Jois for a great help with the manuscripts, Sri Śankara Advaita Śodhana Kendra in Śṛngeri, for getting the scans of the manuscripts. Discussions with Prof. M. D. Srinivas, Dr Venketeswara R. Pai, Dr Uma S. K., Dr K. R. Ganesha and Prof. S. Balachandra Rao are gratefully acknowledged. The meters and typographical corrections for the verses were kindly scrutinised by B. S. Shubha and A. Muralidhara.

SECONDARY LITERATURE

Balachandra Rao, S. and Uma, S. K. (2006), *Grahalāghavam of Gaṇeśa Daivajña: An English Exposition with Mathematical Explanation, Derivations, Examples, Tables and Diagrams* (New Delhi: Indian National Science Academy), 1–4, ARK: ark:/13960/t1zd6hz8s.

—— (2008), *Karaṇakutūhalam of Bhāskarācārya II. An English Translation with Mathematical Explanation, Derivations, Examples, Tables and Diagrams* (New Delhi: Indian National Science Academy); Reprinted from *IJHS*, 42.1–2 (2007); 43.1 & 3 (2008).

Bapu Deva Sastri (1861) (ed.), *Translation of the Súrya Siddhánta and of the Siddhánta Śiromani by the late Lancelot Wilkinson* (Calcutta: Baptist Mission Press), ARK: ark:/13960/t77t69d4g.

Chatterjee, B. (1981), *Śiṣyadhīvṛddhida Tantra of Lalla with the Commentary of Mallikārjuna* (New Delhi: Indian National Science Academy), ARK: ark:/13960/t3gz2x556; vol. 2: http://n2t.net/ark:/13960/t17m8w72b.

Gurevitch, E. M. (2020), 'The Uses of Useful Knowledge and the Languages of Vernacular Science: Perspectives from Southwest India', *History of Science*, 59/3: 256–86. DOI: 10.1177/0073275320931976, https://doi.org/10.1177/0073275320931976.

Mahesh, K. and Seetharama Javagal (2020), *Karaṇābharaṇam, a Commentary on Karaṇaprakāśa of Brahmadeva by Śaṅkaranārāyaṇa, the Son of Śṛṅgapurī Dēmaṇa Joyisa,* (Tirupati: Rashtriya Sanskrit Vidyapeetha).

Malladevaru, H. P. (1983), *Descriptive Catalogue of Sanskrit Manuscripts Volume IX Jyautiṣam* (Oriental Research Institute Series, 140; Mysore: University of Mysore), ARK: ark:/13960/t10q19x3z.

Plofker, K. (2009), *Mathematics in India* (Princeton and Oxford: Princeton University Press), ISBN: 9780691120676.

Sarma, K. V. (1972), *A History of the Kerala School of Hindu Astronomy, in Perspective* (Vishveshvaranand Indological series, 55; Hoshiarpur: Vishveshvaranand Institute), ARK: ark:/13960/t3zt16x8d, (on 5 Mar. 2020).

—— (1985), 'A Survey of Source Materials', in S. N. Sen and K. S. Shukla (eds.), *History of Astronomy in India*, xx (New Delhi: Indian National Science Academy), 1–20, https://insa.nic.in/writereaddata/UpLoadedFiles/IJHS/Vol20-1to4_2_KVSarma.pdf, (on 19 Nov. 2021).

Shylaja, B. S. and Javagal, S. (2020), 'Gaṇitagannaḍi - A Text of 1604 CE on Siddhāntic Astronomy in Kannaḍa', *History of Science in South Asia*, 8 (Apr.): 13–35. DOI: 10.18732/hssa.v8i0.46.

Shylaja, B. S. and Javagal, S. (2021), *Gaṇitagannaḍi: Mirror of Mathematics. An Astronomy Text of 1604 CE in Kannada by Ṡankaranārāyaṇa Joisaru of Ṡṛngeri* [sic]. *Translation with Mathematical Analysis* (Bengaluru: Navakarnataka), ISBN: 97881953177-2-1.

Please write to ⟨wujastyk@ualberta.ca⟩ to file bugs/problem reports, feature requests and to get involved.

The History of Science in South Asia • Department of History and Classics, 2–81 HM Tory Building, University of Alberta, Edmonton, AB, T6G 2H4, Canada.