A UNIQUE AND UNKNOWN BOOK OF AL-BERUNI

Ghurrah-us-Zijat or Karana Tilaka

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(Continued from the April 1963 issue)

3. SELECTED DATE FOR THE EXAMPLE:--

To give an example for it we take a famous day, i.e., the day of the meeting of Sultan Mahmud with Khan Younus, (may God bestow His mercy on both of them). This meeting took place between the two armies at a valley near Samarqand on Thursday 27 Safar 416 A.H. (in the manuscript 25 Safar 416 A.H.), 29 Naisan 1336 Roman, Ram 21 Urdbihishtmah 294 Yazdjird, and according to the (Amanta System of) Hindus it was 29th tithi of Vaishakha, the second lunar month of 947 Shakakala (in the manuscript 27th tithi of Jeshtha, the third lunar month of 948 Shakakala).

COMMENTARY

(a) Correction of the Manuscript:--

There are two very serious mistakes in the manuscript which appear to be due to some misunderstanding on the part of Beruni. He selects an important date as an example and makes all his calculations on the basis of that date. That date, as he has himself mentioned, is 29 Naisan 1336 Roman, 21 Urdbihishtmah 294 Yazdjird, Thursday. This date actually corresponds to 27 Safar, 416 A.H. (if we reckon the months from the actual visibility of the Crescent), and not to 25 Safar, 416 A.H., as Beruni has mentioned. A method to find out the visibility of the new moon in his Ghurrah-us-Zijat is given which will be fully explained and exemplified when we reach that chapter. According to this method, we can clearly see that the new moon of Safar at Multan (for which place Beruni has made all his calculations in the examples) was sighted on 2 Naisan, 1336 Roman. If we convert this date into the Christian Calendar, we get 2 April, 1025 A.D. which was a Friday. Therefore, on 29 Naisan, 1336 Roman (which corresponds to 29 April, 1025 A.D.) it was 27 Safar, 416 A.H. If we adopt the "Conventional" method of the Muslim Calendar (which was used by the Muslim astronomers and was independent of the actual visibility of the new moon), we get 28 Safar instead of 27 Safar. But I have preferred to accept 27 Safar, because it depends on the actual visibility of the new moon. In any case, the date 25 Safar, as given by Beruni, is incorrect.

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Similarly, the date in question corresponds to 29 Vaishakha 947 Shaka-kala, (according to the Amanta System of reckoning, which will be explained later), and not to 27 Jeshta, 948 Shakkakala as given by Beruni. Even if we use “Purnimanta” system of reckoning, (which will be explained later) we find that the date in question corresponds to 14 Jeshta and not to 27 Jeshta. Perhaps Beruni was confused in understanding the complicated calculations of “Amanta” and “Purnimanta” systems. I have seen that even the Hindu astronomers are often confused in these two systems, especially while making calculations for “adhivasa” or the intercalary month. The mistake of writing 948 Shakkakala instead of 947 Shakkakala, is obviously due to the fact that under this system, unlike all other Calendars, the number of the total years passed is used, instead of the number of the current year. For example, when we write 20 Naisan 1336 Roman, we mean that 1335 complete years of the Roman era have passed and the 1336th year is now passing. But when we write 20 Vaishakha 947 Shakakala, we mean that 947 complete years of Shakakala have passed and the 948th year is now passing. Here Beruni has used the figure 948 in the usual sense that 948th year of Shakakala is passing which should have not been used. Therefore, I have corrected this figure in the text accordingly and have written 947 Shakakala, instead of 948 Shakakala. I wonder how could Beruni make this mistake here, although in his Indica he has clearly stated that the year of the Hijra 426 corresponds to 947 Shakakala (vide al-Beruni’s India-1910-Vol. II. p. 9, l. 19).

(ii) Amanta and Purnimanta Systems: A brief description of these two systems has already been given earlier in this article. Here a more detailed description is given in order to show how complicated calculations are involved in finding out a date. It has already been explained that from the time of conjunction of the Sun and the Moon up to the time of their opposition, the period is known as the “bright half” or “Shukla Paksha” of the lunar month, and from conjunction to opposition it is the “dark half” of Krishna Paksha. The following complete ekadsis, “halves”, or “Pakshas”, are combined in “Amanta” and “Purnimanta” Systems and how an “intercalary” month or “Adhimaas” is calculated. It is also shown in which “Paksha” the transit of the Sun or “Sankranti” has taken place. The names of the twelve signs of Zodiac or “Rasis” through which the Sun passes are:- (1) Aries, (2) Taurus, (3) Gemini, (4) Cancer, (5) Leo, (6) Virgo, (7) Libra, (8) Scorpio, (9) Sagittarius, (10) Capricorn, (11) Aquarius and (12) Pisces. Their Sanskrit names are: (1) Mekha, (2) Brikha, (3) Meithena, (4) Raska, (5) Singha, (6) Kanya, (7) Tula, (8) Vishuklikha, (9) Dhanu, (10) Makara, (11) Kumbha, and (12) Meena.

Purnimanta Shukla Paksha (No Sankranti) Amana
Shukla Paksha (Mekha Sankranti) Chaitra
Krishna Paksha (No Sankranti) Vaishakha
Adhimaasa (Brikha Sankranti) Adhimaasa

Vaishakha Shukla Paksha (No Sankranti) Vaishakha
Krishna Paksha (No Sankranti) Adhimaasa
Shukla Paksha (Mithuna Sankranti) Vaishakha

Jeshta Shukla Paksha (No Sankranti) Vaishakha
Krishna Paksha (No Sankranti) Adhimaasa
Shukla Paksha (Mithuna Sankranti) Vaishakha

It should be carefully seen that, although there are two adjacent Pakshas in which no Sankranti occurs, yet there is no Adhimaasa, because these two Pakshas do not make a complete month of the Amanta System; One Paksha belongs to Vaishakha and the other Paksha belongs to Jeshta. No doubt these two Pakshas make a complete month of Jeshta according to the Purnimanta System, but, for the calculation of Adhimaasa, we always consider the Amanta System.

Now turning to the actual figures of the text, we find that the date in question was 29 Vaishakha, i.e., 14 of Krishna Paksha (15 tithis being reckoned in Shukla Paksha); and we may call this date as Vaishakha Krishna Paksha Chaturdashi (Amanta). The same date according to the Purnimanta system is 14 Jeshta, i.e., 14 of Krishna Paksha; and we may call the same date as Jeshta Krishna Paksha Chaturdashi (Purnimanta). In northern India the Purnimanta System is used in performance of all religious ceremonies, except in determination of Adhimaasa, in which case the Amanta System is used. In astronomical calculations the Amanta system is considered easier and perhaps for this reason Beruni has used this System in his text. But it appears that he had not thoroughly studied these systems, as is evident from his Indica also.

(ii) Hijra Calendar: This Calendar is used by all the Muslims of the world for religious performances. The commencement of the month is taken after the actual visibility of the new moon. The day is reckoned from evening to evening. Each month has either 29 days or 30 days. Generally,
these two types of months occur alternately, but it is also possible that in extreme cases there are three consecutive months of 29 days each, or four consecutive months of 30 days each. There are various astronomical methods to find out whether the new moon will be visible at a particular place on a particular day or not, but these methods are so complicated that it is very difficult to prepare a calendar on the basis of the actual sightability of the new moon. Therefore, the Muslim astronomers had devised a "conventional" calendar independent of the actual sightability of the new moon. This calendar gives a date which is usually one or two days ahead of the actual date determined by the visibility of the new moon. For this conventional method the astronomers have decided to reckon the days of the month in the following way:

1. Moharram 30
2. Safar 29
3. RabI' I 30
4. RabI' II 29
5. Jamadi I 30
6. Jamadi II 29
7. Rajab 30
8. Sh'aban 29
9. Ramadan 30
10. Shawwal 29
11. Dhiq'a'd 30
12. Dhulhijj 29

In this way there are only 354 days in a year; but during a period of 30 years there are eleven leap years, in which the twelfth month has 30 days, instead of 29 days. These leap years are 2nd, 5th, 7th, 10th, 13th, 15th, 18th, 21st, 24th, 26th, and 29th years from the beginning of each period of 30 years. The complete years of the Hijra era may be divided by 30, and for the remainder the above-mentioned order may be considered to find out the leap year. In this way the total number of days which elapsed since the beginning of the Hijra era up to 28 Safar 416 A.H. comes to 147120.

The first day of the Hijra era was a Thursday, therefore 147120th day of this era was also a Thursday (this can be verified by dividing the total number of days by 7 and counting the remainder from Thursday). Apart from this conventional method, we have seen that the actual date of the Hijra era was 27 Safar, which shows that there was a difference of one day between these two systems.

(iii) Roman Calendar: In this calendar one year is supposed to be of 365 days and for this reason three consecutive years are supposed to have 365 days each and the fourth year is supposed to be a leap year of 366 days. There are twelve months in a year and each month has a fixed number of days except the fifth month which has twenty-eight days in ordinary years and twenty-nine days in leap years. The names of the months and the days in each month are given below:

1. Tashrin I 31
2. Tashrin II 30
3. Kanun I 31
4. Kanun II 31
5. Shubat 28
6. Azar 31
7. Naisan 30
8. Ayar 31
9. Haziran 30
10. Tamoz 31
11. Ab 31
12. Elol 30

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It will be seen that the number of days in each month is the same as in the Christian calendar in which February corresponds to Shubat. The difference between the Roman calendar and the Christian calendar is that in the Roman calendar the year begins with the month Tashrin I (which corresponds to October) but in the Christian calendar the year begins with January (which corresponds to Kanun I). Moreover, the Roman era starts 311 years earlier than the Christian era, so that if we deduct 311 years from the Roman era, we get the Christian era. In this way 29 Naisan 1336 Roman corresponds to 29 April, 1025 A.D. The total number of days of the Roman era which elapsed since its beginning up to 29 Naisan 1336 Roman is 487820.

The first day of this era was Monday, therefore 487820th day of this era was Thursday (this can be verified by dividing the number of days by 7 and counting the remainder from Monday). To find out whether a particular year is a leap year or not, we should add 1 to the current year of the era and then if it is divisible by 4, it is a leap year. So the year 1336th was not a leap year but its preceding year was a leap year.

(iv) Yazdird Calendar: In this calendar each year is supposed to be of 365 days without any fraction, so that there is no leap year in this system. There are twelve months in a year and each month has 30 days, each of which has a separate name. The remaining 5 days are added either at the end of the eighth month or at the end of the twelfth month; these five days also have separate names. The names of the months are given below:

Farwardinmah, Urdibihishmah, Khurdamah, Tirmah, Murdadmah, Shahrevarmah, Mehrmah; Abanmah, Azurmah, Dimah, Behnamah, Isfandarmuzmah.

Similarly, the names of days of each month are given below:

1. Hurmuz (2) Behman (3) Urdibihish
2. Shahrevar (5) Isfandarmuz (6) Khurdam
3. Murdah (8) Debazur (9) Azur
4. Ab (11) Khur (12) Mah
5. Tir (14) Josh (15) Debirmehr
6. Mehr (17) Sarosh (18) Rishn
7. Farwardin (20) Behram (21) Ram
8. Bad (23) Debidin (24) Din
9. Erad (26) Ashtad (27) Asman

The names of the remaining five days are different in different books, but the common names are:

1. Ahmud (2) Ashtud (3) Isfandarm
2. Hasht (5) Hashtoosh

The total number of days of this era which elapsed since the beginning up to Ram (i.e., 21st) of Urdibihishmah 394 Yazdird, is 145496. The first
day of this era was Tuesday; therefore 143496th day of this era was Thursday (this can be verified by dividing the total number by 7 and counting the remainder from Tuesday).

(v) Shakaaka: In this calendar very complicated calculations are involved and a lunisolar system is used as already explained in the previous article. Each year consists of either twelve or thirteen synodic lunar months. In 4320000 years there are 1577917828 civil days and 169000000 synodic lunar days. The total number of days which elapse since the beginning of this era up to 29 Vaishaka 947 Shakaaka (Amanta) is 345950. The first day of the era was a Tuesday; therefore the 345950th day of this era was a Thursday (this can be verified by dividing the total number by 7 and counting the remainder from Tuesday).

(c) Elaboration of the principle:
No elaboration of any principle is required.

(d) Explanation of the text:
No explanation of the text is required.

(e) Additional example:
No additional example is required.

4. Example for the selected date:
(Actually this example is given for 27 Jeshtha 947 Shakaaka (Amanta) which corresponds to 26 Rabi-ul-Awwal 416 A.H., 27 Ayar 1336 Roman, Farwadding 19 Khurdaamah 394 Yazdjid, Thursday.)

We took complete years of Shakaaka 947 and subtracted it from 888, getting the remainder 59. We multiplied it by 12 and to the product added the past two months and then placed the sum at two places above and below. We multiplied the lower figure by 900 getting product 639000; to it added 661, getting 639661. We then divided it by 29282 and got the quotient 21 which is the number of Adhamasas, and the remainder was 24739. Then we added these Adhamasas to the figure already written at the upper place getting the sum 731. We multiplied it by 30, getting the product 21930; to it we added the past Tithis of the third month, i.e., 27, getting the sum 21957. We wrote that figure at two places, above and below. Then we multiplied the figure at the lower place by 3300, getting the product 7245800, to it we added 64106, getting the sum 2522606. We divided it by 210902, getting the quotient 12 which may be called the first “fixed number.” The remainder is 182820 which may be called the second “fixed number.” We deducted the first “fixed number” from the figure already written at the upper place, getting the remainder 21614, which is the “Ahargana.”

Although we had said that we would not add anything to this book from our side except the examples, yet we feel the necessity of adding the description as to how to find out the dates used in our country from the Ahargana described by the author of this book, because it is evident that non-Hindus do not know the dates used by the Hindus.

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Commentary
(a) Correction of the Manuscript:
There is no correction required in this article. As explained in the previous article, Beruni has made a mistake in calculating the lunisolar date of the Hindus. He has selected a date to quote as an example and that date is 29 Naisan, 1336 Roman, which actually corresponds to 29 Vaishaka 947 Shakaaka (Amanta) or 14 Jeshtha 947 Shakaaka (Purnimanta). In more technical words these dates may be called as Vaishakh Krishnapaksha Chaturdashi (Amanta) or Jeshtha Krishna Paksha Chaturdashi (Purnimanta). Whatever system, whether Amanta or Purnimanta, is used, we have to reckon the past Tithis from Chaitra Shukla Pratipada which is common to both systems and the same result is obtained. So we see that according to these dates full one month and twenty-nine Tithis had passed since Chaitra Shukla Pratipada. But Beruni has erroneously supposed that it was 27 Jeshtha (Amanta) and according to this he supposed that full two months and 27 Tithis had passed since Chaitra Shukla Pratipada. Therefore, he wrongly calculates the Ahargana for 29 Naisan 1336 Roman as 21614. If we correctly calculate the Ahargana for 29 Naisan 1336 Roman, which corresponds to 29 Vaishaka 947 Shakaaka (Amanta), we get 21586, i.e., 28 days less than the figure calculated by Beruni. Unfortunately, this difference of 28 was divided by 7 and so Beruni found the same Thursday according to his Ahargana and consequently thought his ahargana to be correct, because if the day of the week tallies with the Ahargana, the Ahargana is taken to be correct. If we divide the Ahargana by 7 and count the remainder from Sunday, we get the day of the week. It will be seen that both from 21614 and 21586 we get 5 as remainder after dividing by 7, which gives Thursday.

At first I thought of making correction in the Ahargana and changing the figure 21614 to make it 21586. But afterwards I found that if the ahargana was changed, the whole calculations of the book would have to be changed, because the entire calculations are based on this ahargana. Therefore, I have not changed the ahargana, but have clearly shown that this ahargana is not in accordance with 29 Naisan 1336 Roman, but it actually corresponds to 27 Ayar 1336 Roman, 19 Khurdaamah 394 Yazdjid, 26 Rabi-ul-Awwal, 416 A.H., Jeshtha Krishna Paksha Dawadashi (Amanta) or Ashadha Krishna Paksha Dawadashi (Purnimanta) 947 Shakaaka, Thursday, 27 May 1025 A.D. This fact should also be borne in mind that 26 Rabi-ul-Awwal has been calculated according to the actual sightibility of the new moon. According to the “Conventional” system, as explained in the previous article, it is 27 Rabi-ul-Awwal, i.e., one day more than the actual date. In future we will always use the actual Islamic date according to the visibility of the moon and not according to the “Conventional” system.

(b) Translation of the Technical Terms:
No clarification of any kind is required.

(c) Elaboration of the principle:
No elaboration of any principle is required.
5. To find the date of Yazdjid era from this date:—

When we want to know the date of Yazdjid from this date, we divide the corresponding Ahargana by 365 and add 334 to the quotient to get the complete years of Yazdjid era (and the next year is the current year). From the remainder we go on deducting 30 for each month beginning from Farwardinnah. For Abanmah we deduct 35, instead of 30, and in this way we come to the month whose day cannot be deducted, then that month is the current month and the remaining days are the day, passed (up to the midnight which immediately follows that day).

Example:— We divided the Ahargana already calculated by 365, getting the quotient 59; we added 334 to it, getting the sum 393 which represents the complete years of Yazdjid era (and the next year, i.e., 394th is the current year). After division the remainder was 79; from it we deducted 30 days of Farwardinnah and 30 days of Urdbibishthmah, getting the remainder 19. Therefore, these are the past days of Khuruladmah (up to the midnight which immediately follows that day).

Commentary

(a) Correction of the Manuscript:—

In this article also Beruni had made a mistake by stating that "deduct 29 from the Ahargana and then divide the remainder by 365." I have deleted this phrase from the text, because Beruni had said so due to the wrong Ahargana calculated by him. He had tried to get the correct result from wrong Ahargana and therefore he had made this mistake, otherwise there is no necessity of deducting 29 from the Ahargana. Accidentally the first day of the Ahargana of Karanatilaka exactly corresponds to the first day of the 335th year of Yazdjid era. Therefore we can use the Ahargana of Karanatilaka without subtracting any thing from it. As each year of Yazdjid era consists of 365 days, it is very easy to find out the number of the years passed by dividing the ahargana by 365; and after further adding 334 years already passed at the beginning of the ahargana, we get the complete years of the Yazdjid era.

(b) Translation of the Technical Terms.

No clarification is required.

(c) Elaboration of the principle.

On the first day of Yazdjid era, i.e., on 1 Farwardinnah, 1 Yazdjid, it was Tuesday, 16 June 632 A.D. and the Julian day was 1952063. If we divide the Julian day by 7 and count the remainder from Tuesday we get the day of the week, because the first Julian day was a Tuesday. The Julian day actually is counted from midday to midday at Greenwich but the days of the week are counted from midnight to midnight. Therefore there is always a confusion in the relation of the Julian day and the day of the week. Ordinarily, if we take the Julian day before the noon at Greenwich, the first day of this period corresponds to Tuesday; but if we take the Julian day after the noon at Greenwich, the first day of this period corresponds to Monday. I have adopted such Julian day for all of my references which begin from Tuesday. This Julian date was derived by Joseph Scaliger, and named by him after his father whose name was Julius Scaliger. The cycle of 7980 years as the common multiple of the three cycles used by the Roman, this multiple being computed to date from noon of the first of January 4713 B.C. and to finish by the end of 3267 A.D. If we need more accuracy of time, we can use decimal fractions also to show the exact moment of a happening. For example, the mean noon at Lanka (its longitude being 75° 45' E) when the Ahargana of Karanatilaka was "1," can be represented by 2073972.78958 Julian day, but for ordinary use we only say that it was 2073973 Julian day; and when the Ahargana of Karanatilaka was 0, the Julian day was 2073972. It means that if we convert any date into the Julian day and then subtract from it 2073972, we get the ahargana of Karanatilaka; or if we add 2073972 to the ahargana of Karanatilaka, we get the Julian day.

Actually the Yazdjid calendar is neither a solar calendar nor a lunar calendar. This calendar is mostly used now by the Zoroastrians of Persia for their religious ceremonies. It was started from the date of the coronation of the Persian King Yazdjid, son of Sharyar. In order to make it a pure solar calendar, the Persian King Jalal-ud-Din Malikshah, son of Alparsalan Saljuqi ordered the famous poet and astronomer Umar Khiyam to reform it, and since then the majority of the Persians are using the reformed calendar which is known as the "Maliki" or "Jalali" calendar. The Parsis of India and Pakistan still use the same old Yazdjid calendar for their religious performances, but their calendar is known as "Parsi calendar" and is exactly 30 days behind the actual Yazdjid calendar used in Persia. The reason for this
"Lag" is said to be the unaccounted period of one month lost in the migration of the Parsis from Persia to India.

(d) Explanation of the Text:

The correction made by me in the actual method of the text has already been explained. Due to this correction the figures of the calculation given in the "Example" have also been changed. I am giving here these changed as well as the original figures of the manuscript.

(i) The following phrase has been deleted from the text after the word من هذا التاريخ:

إذا نقص من الأصل عاء اللام التاء

(ii) The following phrase has been deleted from the example in the beginning:

إذا نقص من الأصل عاء اللام التاء

(iii) The figure 50 has been deleted from the example and in its place 79 has been written.

(iv) The following phrase has been deleted from the example:

و لأم النباء من أربعينات مال

and in its place the following phrase has been inserted:

و لأم النباء من أربعينات مال

The phrase ام النباء من خراب مال (in the original text) has been changed to ام النباء من خراب مال (in the translated text).

(c) Additional Example:

No additional example is required.

6. To find the date of Hijra era from this date:

When we need to find the Arabic date from the date of the Hindus given in this book, we add 87 in the aharagna and multiply the sum by 60 (and divide this product by 91704, and deduct the quotient from the same product). Whatever we get, we divide it by 2162 and add 354 to the quotient, getting the complete years of the Hijra era (and the next year is the current year). Then we divide the remainder which represents ghati by 60 and the quotient represents complete days; if the remainder is 30 or more, then we further add "11" to the quotient otherwise we ignore it. Now we start deducting alternately 30 and 29 from the complete days to get complete months beginning from Moharram, till we get such a remainder from which the days of the next month cannot be deducted. This remainder represents the past days of that month (for the coming midnight of the day in question).

Example:- We added 87 to the aharagna getting the sum 21701; we multiplied it by 60 getting the product 1302060 (we divided this product by 91704 and deducted the quotient from that product getting 1302059); we divided it by 2162 getting the quotient 61 which we added to 33 getting the sum 415 which represents the complete years of the Hijra era (and the next i.e., the 416th year is the current year). From the remaining ghati we got 85 days, from these we took 30 days from Moharram, 29 days for and the remaining 26 days belonged to the next month (i.e., to Rab'ul-Awwal) which had passed (up to the coming midnight of the day in question).

Commentary:

(a) Correction of the Manuscript:

Here also Beruni makes a mistake when he says "we add 57 to the aharagna." I have corrected this figure and have written 87 instead of 57. This mistake also is due to the wrong aharagna calculated by Beruni; he had made a mistake in calculating the aharagna and then he had tried to get the correct date of the Hijra era from that wrong aharagna. Moreover, he had supposed that 29 Naisan 1356 Roman corresponded to 25 Safar 416 A.H., but actually it was 27 Safar 416 A.H., so a mistake of 2 days was made in supposing a wrong date. Similarly, he had calculated the aharagna for that date as 21614, but the correct aharagna was 21586; so a mistake of 28 days was made in calculating wrong aharagna. In this way a total mistake of 30 days was made by Beruni in calculating the constant number 57; the correct number should have been 57 + 30 = 87.

Moreover, the method given by Beruni here can hold good only within a span of a few centuries; if we use this method today, i.e., after a thousand years, there may occur a mistake of one or two days in the Arabic date. So in order to make this method useful for a span of millions of years, I have added a phrase in the original text within a bracket, stating "and divide this product by 91704 and deduct the quotient from the same product." This is just an additional phrase and has no effect on the original text given by Beruni. Actually Beruni had no intention to give a method which might be useful for millions and millions of years, because such a long period of time is outside the scope of a "Ziyaj" or "Karana," which normally covers a period of a few centuries and "simply of calculation" is its essence.

(b) Translation of the technical terms:

Ghati:- In Hindu calculations a day (from sunrise to sunrise) is divided into sixty equal parts and each of this part is called a "ghati". This ghati is further subdivided into sixty parts, each part being called a "pala"; each pala is subdivided into sixty parts, each part being called a "vipala." There are further subdivisions of time but usually we calculate up to "vipala" only.

(c) Elaboration of the Principle:

The basic principle of this method is that the number of civil days is converted into the number of synodic lunar days. The civil days are first
converted into ghatis by multiplying them by 60. Then these ghatis are divided by the figure 21262 which represents the total from the same elementary constants which were used in formulating the method for ahargana. It has already been shown that in a Chaturyaga the number of synodic lunar months is 33433346 and the number of civil days is 1577917828. When these civil days are converted into ghatis by multiplying them by 60, we get 94675069680 ghatis. Therefore, the number of ghatis in a synodic lunar year is obtained by dividing these ghatis by the number of synodic lunar years. The synodic lunar years are obtained by dividing the number of months by 12 and getting the quotient 4452778. So the number of ghatis in a lunar year = 94675069680

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\frac{4452778}{21262} = 103844
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So in “1” ghati the difference = 103844

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\frac{4452778}{103844}
\]

The fraction being more than half can be taken as “1” so that we get 911704

Therefore it is clear that for more accurate results we should divide the “total ghatis” by 911704 and the quotient should be deducted from the total ghatis, then the remainder will represent a much more accurate figure of the total ghatis. This is the correction which I have mentioned in my additional phrase given in the text within a bracket.

It can be shown with the help of “back calculation” that, when the ahargana of Karana Tilaka was zero, it was 28th of Rabi'-ul-Awwal, 355 A.H. It reveals that at the beginning of the ahargana of Karana Tilaka 354 complete years and 87 complete days of the Hijra era had already passed. That is the reason why Beruni tells us to add 87 days in the ahargana of Karana Tilaka,

so that we may get the complete days that have elapsed since the beginning of the 35th year of the Hijra era. After converting these civil days into synodic lunar days, months and years, he further tells us to add 354 to the number of the lunar years obtained from the ahargana; this is due to the fact that 354 of the Hijra era had already passed at the beginning of the ahargana of Karana Tilaka.

(d) Explanation of the text:--
As already mentioned, Beruni had made a mistake in the calculation of the ahargana for 29 Naisan 1336 Roman and from that wrong ahargana he had tried to derive correct date of the Hijra calendar. For this reason the method given by him was wrong which has now been corrected. Consequently, the calculations of the example have also gone wrong. The changes made by me in the original text are shown below:

(i) I have deleted the following phrase from the text

زاً على الأصل لا 

and in its place the following phrase has been inserted:

زاً على الأصل لا 

(ii) I have added the following phrase in the text within brackets for greater accuracy:

و قسمنا الحجم على 911704 و ألقينا ما خرج في فقي

(iii) I have added the following phrase in the text within brackets to give better understanding:

وبعثر الالي الذي به الارتفاع الصوبي

(iv) I have added the following phrase in the example within brackets for greater accuracy:

و قسمنا على 911704 و ألقينا ما خرج في فقي

(v) I have deleted the following phrase from the example:

لحرم ل و بقي كى وهى الألزم اللانية

and in its place the following phrase has been inserted:

لحرم ل والصفر كى و بقي كى وهى الألزم اللانية من

(vi) The following further changes have been made in the figures of the example:

I have written 18 instead of 18, 2171 instead of 21671, 130060 instead of 1300606, 12 instead of 4 and 85 instead of 55.

(e) Additional Example:--

No additional example is required.

7. To Find the Date of Roman Era from this Date:--

When we intend to find the date of the Roman era, we add 175 to the ahargana and multiply the sum by 60; to the product we add 30 and then
divide it by 21915; to the quotient we add 1276 getting the complete years of the Roman era (and the next year is the current year). The remainder represents the ghati which are converted into days; then we start subtracting the date of the month beginning from Tashrin I, as we have done in all other dates. If it is a leap year, we take 29 days for Shubat, and if it is not a leap year we take 28 days. The indication for a leap year is that while converting the ghati into days, we get complete days and no remainder is obtained.

Example:- We added 175 to the ahargana getting 21789; we multiplied it by 60 and got 1307340; to it we added 50 and got 1307760; we divided it which represents the complete years of the Roman era (and the next, i.e. the 1335th year of the current year). The remainder was 1485 ghati which, while converted into days, gave 239. As we get some remainder also while converting ghati into days, it is not a leap year. From it we deducted the number of days of seven months beginning from Tashrin I, i.e. 212, and got the remainder 27. This is the number of days of Ayar already passed (up to the coming midnight of the day in question).

Commentary

(a) Correction of the manuscript:-

There are two main corrections made by me in this article. As already explained, Beruni had calculated a wrong ahargana and from this wrong ahargana he had tried to get the correct date of the Roman era. For this purpose he had said, "we add 147 to the ahargana", i.e. 28 days. Due to the mistake of 28 days made by Beruni in ahargana, this figure should have been 147 + written 175 in its place. Due to this correction, most of the figures of the example have also been changed which will be explained later.

The second mistake made by Beruni is that he has not taken into account the 30 ghati already accumulated for the previous two years; without adding these 30 ghati into the total ghati of the ahargana we cannot find out the correct leap years. So I have added a phrase to the text stating, "to the product we add 30" in order to eliminate the mistake made by Beruni. All such petty mistakes clearly show that Beruni wrote this book in a hurry and had never a chance to see it again. These mistakes are never a proof of Beruni's lack of knowledge.

(b) Translation of the technical term:-

We have already described the names of the months of the Roman era and no further clarification is required.

(c) Elaboration of the Principle:-

Beruni has based this method on the fact that every fourth year of the Roman era is a leap year and consists of 366 days, instead of 365 days. Therefore the mean duration of a year in this system is 365.25 days or 21915 ghati. Therefore, if we convert the ahargana into ghati by multiplying it by 60 and then divide the total number of ghati by 21915, we get the complete years of the Roman era. The difference of 15 ghati per year becomes 60 ghati in the fourth year and that year is considered as a leap year, but it is very important to remember that in the Roman era you cannot find out the leap year simply by dividing the current year by 4 as we do in the case of the Christian era. In the Roman era you should add "1" to the current and then divide by 4 to find out the leap year. In the leap year of the Roman calendar the fifth month Shabat has 29 days instead of 28 days.

It can be shown by "back calculation" that when the ahargana of Karanatikara was zero, it was 24th of Azar 1277 Roman. It showeth that before the start of the ahargana of Karanatikara, 175 days of the 1277th year had already passed from Tashrin I to 24 Azar (i.e. 31 + 30 + 31 + 28 + 24 = 175). So if we add 175 to the ahargana of Karanatikara, we get the complete days from the start of the 1277th year, i.e. 1276 complete years had already passed. That is why we add 1276 to the complete years obtained by the ahargana in order to get the complete years of the Roman era. Moreover, the 1275th year was a leap year which means that before the start of that year a difference of 30 ghati per year had already accumulated to 60 ghati, or full one day. Therefore, a difference of 15 ghati was accumulated in the 1275th year, and so a total difference of 30 ghati had already accumulated before the start of the 1277th year. This is why we add 30 ghati to the total ghati of the ahargana to get the correct number of ghati since the beginning of the 1277th year of the Roman era.

The Roman calendar was started 12 years after the death of Alexander. This calendar is seldom used in the modern world, because it is not a pure Solar calendar. Actually the length of a Solar year (i.e., a tropical year, if we use a more technical term) is equal to 365.2422 civil days, and not 365.25 civil days, as is assumed in the Roman calendar. Therefore a difference of 0.0078 day per year accumulates to 3.12 days in four centuries. Therefore, if we decide that the first, second and third centuries will not have a leap year, the fourth century will have a leap year, then the mentioned difference of three days can be eliminated, but a difference of 0.12 days per four hundred years will still remain unaccounted for; it may be ignored for smaller spans of time.

In very early days the Roman calendar was converted into the Christian calendar by changing the "beginning of the year" and counting the year from the death of Christ. So there was a difference of 311 years between the two calendars and when it was the first year of the Christian calendar, it was 374th year of the Roman calendar. The Christian year was started from the beginning of January, instead of Tashrin I, and this month was named as January, keeping the number of days of each month the same as the Roman calendar. This calendar was known as Julian calendar after Julius Caesar who had taken much interest in it. This Julian calendar must not be confused with the "Julian date" or "Julian day" which is absolutely a different thing. The names of the Christian months along with their Roman equivalents and number of days are given below, showing also the comparative years:
now living were born under the old style, i.e., the Julian calendar. The Russian Orthodox Church still uses the Julian calendar; that is why the Russian Easter may differ by one or two weeks from the date of Easter in the rest of the Christian world.

(d) Explanation of the Text:

As already explained Beruni has made two basic mistakes in this article due to which the following changes have been made:

(i) I have deleted the following phrase from the text:

\[ \text{زِدّت فِي الأَلْسُن} \]

and in its place the following phrase has been inserted:

\[ \text{زِدّت فِي الأَلْسُن} \]

(ii) I have added the following phrase to the text:

\[ \text{وَزِدّت فِي الأَلْسُن} \]

(iii) I have added the following phrase to the example:

\[ \text{وَزِدّت فِي الأَلْسُن} \]

(iv) In the example I have written 175 instead of 147, 217 instead of 21761, 1307340 instead of 1305660, 14385 instead of 12675, 239 instead of 211, 212 instead of 182; and the following:

\[ \text{كَرْمَة} \]

instead of

\[ \text{نايت} \]

(e) Additional Example:

In this book methods are given to calculate ahargana from any calendar, but in the modern world the widely used calendar is the Gregorian calendar, which unfortunately was not existing at the time of Beruni. But from the same reasoning we have found a method of calculating the ahargana of Karana Tilaka from the Gregorian calendar. With the help of this method we found out the ahargana for 10 May 1957, as 361097. We have also shown that the difference between the Julian day and the ahargana of Karana Tilaka is 3073972, so the ahargana can also be found by deducting 2073972 from the Julian day if we know it. Therefore the best method of finding out the ahargana in modern days is to find out the Julian day first which can be found out with the help of any modern ephemeris, and then deducting 2073972 from it. For example, the Julian day on 10 May 1957 A.D. was 2453900 and when we deducted 2073972 from it, we got 361097 which is the required ahargana and exactly tallies with the previous ahargana obtained by another method.

To calculate the Roman date from this ahargana, we added 175 to the ahargana getting 369172. multiplied it by 60 getting 21730320, added 30 to it getting 21730330, divided it by 2115 getting the quotient 1001, added 1270 to it getting 2298 which represents the complete years of the Roman era and the next, i.e., 2268th year is the current year. We converted the remainder 19558 ghatiss into complete days by dividing it by 60, getting 294 days and 45 ghatiss, deducted from it the days of the month beginning from Tashrin 1 up
to Ayar, i.e., $31 + 30 + 31 + 31 + 28 + 31 = 182$ days getting the remainder $27$ days which belong to Nisân, which is the next month. We have taken $28$ days for Shubat, because the $2968$th year of the Roman era is not a leap year which is evident from the fact that we got a remainder of $45$ ghatís while converting the total ghatís into complete days; had it been a leap year there would have been no remainder. So we see that the date was $27$ Nisân, $2968$ Roman. We have also shown that there is a difference of $311$ years between the Roman and the Christian calendars, so that if we deduct $311$ from $2968$ we get $1957$ which is the Christian year. Similarly, at present there is a difference of $13$ days between the Roman and Christian months; the difference of $10$ days was created in the year $1582$ A.D. by Pope Gregory XIII and a further difference of $5$ days has occurred in the years $1700$, $1800$, and $1900$ A.D. which were not considered leap years in Gregorian system. Therefore if we add $13$ days to the Roman date, we get $10$ Ayar which corresponds to $10$ May of the Christian calendar. Therefore it has been verified that our calculations are correct, because we get the correct date $10$ May $1957$ A.D.

To calculate the Arabic date from this alhargana, we added $97$ to the alhargana getting $362064$, multiplied by $60$ getting the product $2175940$, divided it by $911704$, getting the quotient $29$, deducted it from the same product getting $2175907$, divided it by $21629$ getting the quotient $1021$ and the remainder $1515$, added $354$ to the quotient getting $1375$ which represent the complete years of Hijra era and the next $1367$th year is the current year. Then we converted the remaining $1515$ ghatís into days by dividing it by $60$, getting the quotient $25$ which represents the complete days of the $1367$th year passed. It is very important to remember that in these calculations, when we say “so many complete days passed up to such and such particular date” that particular date is also included in the total of the complete days passed, because we always count up to the coming midnight of the particular date. Now from $275$ complete days we deducted alternately $30$ and $29$ days for the months beginning from Moharram. So we deducted $266$ days upto Ramadan and the remaining $9$ days belong to Shawwal. Therefore the Arabic date on $10$ May, $1957$ was $9$ Shawwal $1376$ A.H. This date has been verified by me from my personal diary in which it is written that Eid was celebrated all over India and Pakistan on $2$nd May, $1957$ A.D. which was $1$ Shawwal $1376$ A.H.

To calculate the Persian date from this alhargana, we divided the alhargana by $365$ getting the quotient $991$ and the remainder $282$, added $334$ to the quotient getting $1325$ which represents the complete years of the Yazdigird calendar and the next, i.e., $1326$th year is the current year. From the remaining $282$ days we deducted the days of the months beginning from Farwardinmah, i.e., $30 + 30 + 30 + 30 + 30 + 30 + 30 + 30 + 30 + 30 + 30 + 30 = 275$ days getting the remainder $7$ days which belongs to Dīmāh which is the next month. So the Persian date on $10$ May, $1957$ A.D. was Mūrad, $7$ Dinām, $1326$ Yazdîgird. This date has been verified by me from a calendar printed in Persia. The Parsis of India and Pakistan do not include the five additional days in Abanmah as we have done in the above-mentioned calculations; they add these five special days at the end of the year after Nisîndarmuzmah. Moreover, they are exactly $30$ days backward from the old Persian calendar but still they call their calendar “Yazdîgird calendar”, because except the two above-mentioned variations, the Parsi calendar is exactly similar to the Yazdîgird calendar. Therefore, if we want to find out the date of the Parsi calendar from the above-mentioned date, we get Mah, $12$ Azūmār $1326$ Yazdîgird. This date also has been verified by me from a calendar printed in India. The reformed form of this calendar, known as Malikî or Jalalî calendar, is absolutely different from it and neither years nor months nor days tally with each other. The Jalali year starts from the day when the sun crosses the first point of Aries; so sometimes there are $365$ days and sometimes $366$ days in a year which can only be determined by actual calculations. Therefore we can say that the Jalalī calendar is a pure Solar calendar and does not require any modifications or alterations from time to time. This calendar was derived, as has already been stated, by the famous poet and astronomer, Umar Khyyam. Since space does not permit me to give a detailed description of this calendar, I leave it at this stage.

(م) استثمار الخلقيه من التاريخ شكل كله:—

(و) يوم السبع عشر من الشهر القرمي من حرم آتام ثلاث حرمين (نحو 148 شهور)، في الميلاد: 1956.
استخراج تاريخ الإسكندر من هذا التاريخ:

إذا أراد تأريخ الإسكندر زدا على الأصل 100 وضرب ما إلى في ستين وزدا على التمرين، وقنا الناقة على 1111، فخرج زدا عليه 1736.

(1) استخراج تاريخ زبدة:
إذا زدا على الأصل 100، فقل 1736، وزيدا على التمرين، وقنا الناقة على 1111، فخرج زدا عليه 1736.

مثال: إذا زدا على الأصل 100، فقل 1736، وزيدا على التمرين، وقنا الناقة على 1111، فخرج زدا عليه 1736.

(2) استخراج تاريخ الهجرة:
繁荣 

وهو الزمان المفتوح لم يشرك اصبعاً، ولقد في استعمال هذا الرجع.

والم ينقر عكس ما كنا عن، لم يكون اصبعاً، ولقد في استعمال هذا الرجع.

1963

GHURMAT-UZZIJAT OR KARANA TILAKA

وين وان ضاء ان لا تزيد في الكتب غير الألفية إلاأن شهريه من زيادة استخراج
التاريخ المتصلة في بلادنا من هذا التاريخ الذي جعله معيز للزمن، ولا لنقلا العلوم.

(1) له زبدة.
A UNIQUE AND UNKNOWN BOOK OF AL-BERUNI

Ghurrat-uz-Zijut or Karana Tilaka

Sayyid Samad Husain Rizvi*

(Continued from the July, 1963 issue)

8. To find the Ahargana from the date of the Hijra era:

When we know the date of the Hijra era, we always deduct 354 from the complete years, and put the remainder at three places. Then we multiply the "upper" figure by 360, the "middle" figure by 5, and the "lower" figure by 38. (then we divide this "lower" product by 1629 and deduct the quotient from the same product). Then we divide the "lower" figure by 60 and add to it the "middle" figure; if the remainder is 30 or more, we add "1" more to the "middle" figure, and if the remainder is less than 30, we ignore it. After this we always add 87 to the "middle" figure and add the past days (up to the coming midnight of the day in question) of the incomplete year to the "upper" figure. Now we deduct the "middle" figure from the "upper" figure, and the remainder is the Ahargana which represents the number of days up to that date.

Example:— We deducted 354 from the above-mentioned Hijra era getting the remainder 62, and put it at three places; then we multiplied the upper figure by 360 getting the product 21600, the middle figure by 5 getting the product 305 and the lower figure by 38 getting the product 2318 (then we divided this lower product by 1629 getting the quotient "1" and deducted it from the same product getting the remainder 2317). Then we divided it by 60 getting 38; we added it to the middle figure getting the sum 344 after considering the remainder (i.e., 37) equal to "1" (because it is more than 30). We added 87 to it getting the sum 431; to the upper figure we added 85, the past days (up to the coming midnight of the day concerned) of the incomplete year getting 23045. Now we deducted the middle figure from the upper figure getting 21614 which is the Ahargana.

Commentary

(a) Correction of the manuscript:—

In this article corrections are made similar to those in the article No. 6. An additional divisor 1629 has been introduced in the text to obtain more accurate results from this formula even after millions of years. The figure

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* Mr. Sayyid Samad Husain Rizvi, Executive Engineer, Pakistan, Scholar of Sanskrit, Hindi, Urdu, Arabic, Persian, English, Science, Arithmetic and Astronomy.
87 has been written instead of 57, because Beruni had made a mistake in the calculation of the Ahargana, as already explained.

(b) Translation of the Technical Terms:–
No translation of any technical term is required.

(c) Elaboration of the principle:–
As explained in the commentary of the article No. 6, there are 5343336 synodic lunar months or 4452778 synodic lunar years in a chaturyaga which has 157797828 civil days; therefore in one lunar year the number of civil days is $157797828/4452778 = 354.1634416$ civil days = 5 2818362 civil days.

There are 360 lunar days in one lunar year, so that the difference = 360 - 354 = 6 1634416 civil days.

If we convert the "fractional" part of the above-mentioned figure into another fraction after selecting 60 as denominator, then the numerator "x" can be found in the following way:–

\[ x = \frac{2818362}{4452778} \]

\[ = \frac{60 \times 2818362}{4452778} = \frac{166012720}{4452778} = 37 \frac{4348034}{4452778} = 37 \frac{38}{4452778} = 38 \frac{193844}{4452778} \]

The above fraction is less than half, therefore it can be ignored, and we get the difference = 5 + $\frac{38}{60}$ . It means that if we multiply the lunar years by 5 and then by $\frac{38}{60}$ , the sum of these two should be deducted from the corresponding lunar days in order to get the corresponding number of civil days. From the number of these civil days, we deduct 87 days of the 355th year of the Hijra era; to the remainder we add the past days (including the day in question) of the current year. Whatever we get, is the Ahargana or the number of civil days passed since the date of reference of Karana Tilaka.

Again, if we do not ignore the above-mentioned fraction, the number of lunar years must be multiplied by this fraction and this product deducted from the product of "38 and the number of years". Now, instead of using the number of lunar years, if we use the number of "lunar years multiplied by 38", the above fraction becomes $\frac{38 \times 4452778}{103844} = 169205564$. Moreover, instead of multiplying the fraction, if we want some other fraction by which we can divide the number of "lunar years multiplied by 38" to get the same result, that other fraction will obviously be $\frac{169205564}{103844} = 1629.3688$. The fraction being less than half can be ignored, so that we get the figure 1629. This is the figure by which we divide the number of "lunar years multiplied by 38", and deduct the quotient from the same product in order to get much more accurate results.

(d) Explanation of the text:–

The following changes have been made by me in the original text:

(i) The following phrases have been added to the text within brackets:–

(و نسبه ميلادا 1001 و 1002 وما خرج منه)

(بصف الاقبل الذي بعد الظهر البسيط)

(ii) I have deleted the following phrase:–

(6) زدنا على الأوسط نز ابدا)

and instead of this phrase, the following phrase has been inserted:–

(6) زدنا على الأوسط نز ابدا)

(iii) The following phrases have been inserted in the example within brackets,

(و نسبه ميلادا 1001 و 1002 وما خرج منه في 1629)

(بصف الاقبل الذي بعد الظهر البسيط)

(iv) I have written in the example 87 instead of 57, 431 instead of 401, 85 instead of 55, and 22045 instead of 22015.

(e) Additional Example:–

For additional example we take 9 Shawwal 1376 A. H. (corresponding to May 10, 1957 A. D.) which shows 1375 complete years and 275 complete days. We deducted 354 from the complete years of Hijra era getting 1021, put it at three places and multiplied the upper figure by 360 getting the product 367560, multiplied the middle figure by 5 getting the product 5105, multiplied the lower figure by 38 getting the product 38798. Then we divided this lower product by 1629 getting the quotient 23, which we deducted from the same product getting 38775, divided it by 60 getting 646, added it to the middle figure getting 3731, then added 87 getting 3838. Now to the upper figure we added 275 the past days of the current year getting the sum 367835, from it we deducted the middle figure getting the remainder 361997 which is the ahargana. This has been verified in the commentary of article No. 7.

9. TO FIND THE AHARGANA FROM THE DATE OF THE YAZDJIRD ERA:–

If the given date is of the Yazdjird era, we deduct 334 from the complete years and multiply the remainder by 365; to the product we add the past days (including the day in question) of the current year; the sum is the ahargana.

EXAMPLE:– According to the above mentioned date we deducted 334 from the complete years of the Yazdjird era getting the remainder 59.
multiplied it by 365 getting the product 21535, to it added the past days (including the day in question) of the current year getting 21614 which is the ahargana.

**Commentary**

a. **Correction of the manuscript**:

As mentioned in the previous articles, Beruni had calculated a wrong ahargana and from that wrong ahargana he had tried to get the correct Persian date due to which he had said in this article “and we always add 29”. But this phrase is actually wrong, and I have deleted it from the text. A mistake of 28 days was made by Beruni in the calculation of the ahargana, as already explained, and a further mistake of one day has been made by him due to some misunderstanding and oversight in this article; so a total mistake of 29 days had been made which has now been eliminated.

b. **Translation of the technical terms**:

No translation of any technical term is required.

c. **Elaboration of the principle**:

The ahargana of Karana Tilaka started on the first day of the 335th year of the Yazdjird era; therefore, if we deduct 334 years from the complete years of this era, we get the remaining years since the beginning of the required Ahargana. These complete years can be converted into days by multiplying by 365; to the product the past days of the current year are added and thus we get the total number of days since the beginning of the 335th year of this era which is the required Ahargana.

d. **Explanation of the text**:

As already explained, the following changes have been made in the text:

(i) I have deleted the following phrase in the text after the words “من أيام السنة”:

و على الجمع 29 إما

(ii) I have added the following phrase in the text and the example within brackets:

(نص فيت الزملي مم بعد الياز (السوم))

(iii) I have written 21614 instead of 21585.

(iv) I have deleted the following phrase in the example after the words “من أيام السنة”:

زمن عليها 29 فصادر 21614

e. **Additional Example**:

For additional example we may take Murdad 7 Dimah 1326 Yazdjird which corresponds to May 10, 1957 A.D. We deducted 334 from the complete years of the era getting the remainder 991, multiplied it by 365 getting the product 361795; to it we added the past days of the current year, i.e., 30+30+30+30+30+30+30+30+30+7=282, getting the sum 364997 which is the ahargana.

10. **To find the Ahargana from the date of the Roman era**:

If the given date is of the Roman era; we deduct 1276 from the complete years of that era and multiply the remainder by 1461, after adding 1 to it we divide the product by 4 and to the quotient we add the past days of the current year (including the day in question up to midnight), from the sum we deduct 175 and the remainder is the ahargana.

**Example**:

We deducted 1276 from the complete years of the above-mentioned Roman era getting the remainder 59, multiplied it by 1461 getting the product 86299, to it added 1 getting 86300, divided it by 4 getting the quotient 21575, to it added 239 past days (including the day in question up to midnight) of the current year getting the sum 21814, from it deducted 175 getting the remainder 21614 which is the Ahargana.

**Commentary**

(a) **Correction of the manuscript**:

I have made two main corrections in the manuscript. One is due to the mistake of 28 days made by Beruni in the calculation of the Ahargana and the other due to an oversight on the part of Beruni. The first correction is that, instead of the figure 147, I have written 147+28=175. The second correction is that I have added the phrase “after adding 1 to it.” Actually the leap year of the Roman era cannot be found out simply by dividing the current year by 4 as in the case of the Christian calendar, but we must add 1 to the current year of the Roman era before dividing it by 4. This important fact was not taken into account by Beruni, perhaps due to the hurry in which he had written this book.

(b) **Translation of the technical terms**:

No translation of any technical term is required.

c. **Elaboration of the principle**:

As already explained, the Ahargana of Karana Tilaka had started on 25 Azar 1277 Roman; it means that before the beginning of the Ahargana of Karana Tilaka full 1276 years and 175 days (from the first of Tashrin 1 to the 24th of Azar 1277 Roman) had already passed since the beginning of the era. That is why we deduct 1276 from the complete years of the Roman era before calculating the Ahargana from it. According to the Roman calendar, the mean duration of a year is 365 days or \( \frac{1461}{4} \) days. Therefore, in order to convert the complete years into days, we first multiply the years by \( \frac{1461}{4} \) and then divide the product by 4. We, however, add 1 to the
product before dividing it by 4. The reason for this is that at the end of the 1276th year 1/4th of a day was left unaccounted for, and that 1/4th of a day is added to the days of the complete years. So if we denote the number of the complete years by "Y," the number of days will be given by

\[ 1461Y + 1/4 = \frac{1461Y + 1}{4} \]

This 1/4th of a day belongs to the year 1276 which was not a leap year. The year 1275 was a leap year and so at the end of this year no fraction of a day was left, because all the four fractions of the previous years had already been accounted for by adding 1 day to the month of Shubat and counting its days as 29 instead of 28.

(d) *Explanation of the Text:*

The changes have been made in the Arabic manuscript:

(i) I have added the following phrases in the text:

و زيدا علي الليل و احدا

( NSF الليل الذي بد النهار (السروب)

(ii) I have deleted the following phrase from the text:

وقصة من الحلة (18)

and instead of it the following phrase has been inserted

وقصة من الحلة 80

(iii) I have added the following phrase in the example:

و زيدا علي الليل و احدا فصار 890

(iv) I have deleted the following phrase from the example after the word

باد جبر الكسر لزيادة على نصف الفجر

(v) In the example I have written 39 instead of 311, 21789 instead of 21761, and 175 instead of 147.

(vi) I have added the following phrase in the example:

( NSF الليل الذي بد النهار (السروب)

(e) *Additional Example:*

For additional example we may take 27 Nisan 2268 Roman which corresponds to May 10, 1957 A.D. We deducted 1276 from the complete years of this era getting 991, multiplied it by 1461 getting the product 1443852, to it added 1 getting 1443853, divided it by 4 getting the quotient 361963, to it added 290 past days (including the day in question up to midnight) of the current year getting the sum 362273, from it deducted 175 days getting the remainder 361997 which is the Ahargana.

11. To find the date of the Shakkaka from the Ahargana:

This ahargana may be obtained from any date. Now we put it at two places and multiply the "lower" one by 3300 and (after adding 64106 to the product) divide it by 207602 (deduct 1 from the quotient, if remainder is less than 1/8th of the quotient), add this quotient to the "upper" figure and put the sum at two places, multiply the "lower" one by 30 and (after adding 661 to the product) divide the product by 30182, multiply the quotient by 30 and deduct the product from the "upper" figure, divide the remainder by 350, then the quotient represents the complete years of this book. Now we add 888 to it to get the Shakkaka, we divide the remainder by 30, then the quotient represents the complete months of the current year and the remainder represents the past tithis of the incomplete month (up to the midnight of the day in question).

*Example:* We had obtained 21614 ahargana, we put it at two places and multiplied the lower one by 3300 getting the product 7132620 (to it added 64106 getting 7139036), divided it by 207602 getting the quotient 343 (the remainder 182920 being more than 1/8th of the quotient i.e., 43), added it to the "upper" figure getting the sum 21957, put it at two places and multiplied the lower one by 30 getting the product 659710 (to it added 661 getting 659371), divided it by 30182 getting the quotient 21, multiplied it by 30 getting the product 630, deducted from it the "upper" figure getting the remainder 21927, divided it by 360 getting the quotient 59 and the remainder 87, divided it by 30 getting the quotient 2 and the remainder 27 which represents the past tithis of the third (Amanta) month Jeshtha (up to the midnight of the day in question); the complete years of this book were 59, we added 888 to it getting 947 which is the Shakkaka of the date selected by us for the example to understand.

Now we again go back to the continued text of the original book.

**Commentary**

a. *Correction of the manuscript:*

As already explained, the essence of a "Zij" or a "Karana book" is its simplicity of calculation and therefore small figures are used to cover a span of only a few centuries. Keeping this principle in view, Beruni had given a method which could not be used to-day after a thousand years. He had also made some omissions which have now been supplied. In order to make this method useful for a span of a million of years, I have added a few figures in the text within brackets. It should also be remembered that article numbers 1, 3, 4, 5, 6, 7, 8, 9, 10 and 11 have been added by Beruni from his own side; these articles are not included in the Sanskrit manuscript of Karana Tilaka.

b. *Translation of the technical terms:*

**Shakkaka:** As explained before, in this era the number of the complete years passed are written, instead of the number of the current year. Therefore in the above-mentioned example we write 947 Shakkaka, instead of 948 Shaka Kal.
c. Elaboration of the principle:

In the above-mentioned method the ahargana (which actually represents the number of civil days passed since the beginning) is first changed into the number of the synodic lunar days and then the adhimasas passed are calculated; then the number of lunar days of these adhimasas are deducted from the total lunar days obtained and the remaining lunar days are converted into lunar months and years.

In a chaturyuga there are: \(1577917828\) civil days and \(1603000080\) “synodic lunar days” which we may also call “lunar days”, so the number of lunar days in “1” civil day is given by the following expression:

\[
1603000080 \div 1577917828 = 1 + \frac{25082252}{1577917828} \text{ lunar days.}
\]

In order to simplify the fraction, we may arbitrarily select \(3300\) as a suitable numerator and then the corresponding denominator \(X\) can be found out as given below:

\[
\frac{300}{x} = \frac{25082252}{1577917828} \Rightarrow x = 3300 \times \frac{1577917828}{25082252} = 207602 \frac{3152696}{25082252}
\]

The fraction being less than half may be ignored, so that the value of the denominator is 207602, and the expression for the lunar days in “1” civil day becomes \((1 + \frac{3300}{207602})\)

Therefore, we should multiply this expression by the number of civil days (or the ahargana, to get the corresponding number of lunar days. For a more accurate result we should not ignore the fraction \(\frac{3152696}{25082252}\) which is approximately equal to \(1/8\), so we should see that the remainder, while dividing by 207602, should not be less than \(1/8\)th of the quotient obtained, otherwise we should deduct “1” from the quotient. The same correction can also be applied while calculating ahargana from the Shakakala, as explained in article No. 2; in this case also we should deduct “1” from the quotient while dividing by 210092, if the remainder is less than the \(1/8\)th of the quotient, because the ignored fraction \(\frac{2936696}{25082252}\) is also equal to \(1/8\) approximately.

It will not be out of place to mention here that ordinarily the ancient Indian astronomers used to simplify a fraction with the help of the “continued fraction”; but the author of Karana Tilaka, Vijay Nandi, has adopted a different method which gives a more simplified fraction although the error of approximation is increased comparatively. For example, in Article No. 2 we have seen that Vijay Nandi has simplified the fraction \(\frac{3503336}{51840000}\) to a frac-

\[
\begin{align*}
\frac{1}{32 + \frac{1}{1 + \frac{1}{1 + \frac{1}{6 + \frac{1}{1 + \frac{1}{1 + \frac{1}{5 + \frac{1}{1 + \frac{1}{2 + 1}}}}}}}}}
\end{align*}
\]

which is equal to the fraction \(\frac{704}{22905}\)

But Vijay Nandi has not recommended the use of this fraction purposely, because its numerator 704 is not so simple as the numerator 900 of the fraction \(\frac{29282}{22905}\), although the former is more accurate than the latter as shown in the following decimal fractions:

\[
\begin{align*}
900 - 0.03073569 \quad 704 - 0.030735647 \quad 1593336 \quad 0.030735648
\end{align*}
\]

For the sake of comparison, the various forms of the above-mentioned fraction, as given by the authors of various Karana-books are given below and the value of these in the decimal system upto nine places is also given.

Varahamihira, in the year 427 Shakakala or 505 A.D., gave the fraction \(\frac{7}{228}\), whose value was 0.030700754 (vide Panchasiddhantika chapter I, sloka 9); Brahmagupta, in the year 587 Shakakala or 665 A.D., gave the fraction \(\frac{1 - \frac{1}{14945}}{30}\), whose value was 0.030735648 (vide Khandakadyaka, chapter I, Slokas 3, 4 and 5); Bhaskaracharya, in the year 1105 Shakakala or 1183 A.D., gave the fraction \(\frac{2}{65} \quad (1 - \frac{1}{900})\), whose value was 3.030735042 (vide Karanakutuhala chapter I, slokas 2 and 3).

Now, let us see how many lunar days, since the beginning of the Kaliyuga, had passed up to the midnight at Lanka when the Ahargana of Karana Tilaka
was zero. We have seen that on that day the Kalivuga Ahargana was 1485507 
and so the number of lunar days passed up to that day is given by the following 
expression:

\[ \begin{align*}
\text{X} & = 1485507 \times 1603000080 \text{ lunar days} \\
& = 2381207833840560 \text{ lunar days} \\
& = (1509120 + 487249200) \text{ lunar days}.
\end{align*} \]

From the above we see that at the beginning of the Ahargana of Karana Tilaka a partial lunar day equal to 487249200 had already passed in addition to the 1509120 complete lunar days. In order to include this fraction of a lunar day in our previously obtained expression \((1 + \frac{3300}{20760})\), we should select the denominator equal to 207602, then the corresponding numerator \("X"\) can be found out in the following way.

\[ \begin{align*}
X & = 487249200 \quad \text{or} \quad X = 207602 \times 2487249200 \\
& = \frac{10115908415400}{1577917828} = \frac{14860514160}{1577917828}.
\end{align*} \]

The fraction being more than half may be taken as \("1"\), so that the numerator becomes 64106. This is the number which is to be added in the above-mentioned expression and so the final expression to find the lunar days corresponding to any Ahargana, say \("A"\), is given below:

\[ \begin{align*}
\text{X} & = (A + \frac{3300}{20760} \times 64106) \text{ lunar days}.
\end{align*} \]

Similarly, we find an expression for the adhimasas. We know that in 1603000080 lunar days there are 1593336 adhimasas, therefore in one lunar day the fraction of adhimasas is \(\frac{1593336}{160000080}\). If we select the numerator 30, the denominator "X" is given by the following equation:

\[ \begin{align*}
X & = \frac{1593336}{160000080} \quad \text{or} \quad X = 30 \times 1603000080 \\
& = \frac{48000002400}{1593336} = \frac{30181}{1528584} \times 1593336 = 30182. \quad \text{The fraction being more than half is taken as 1.}
\end{align*} \]

Now in 1509120 past lunar days the number of adhimasas is given by the following expression:

\[ \begin{align*}
\text{X} & = \frac{1590120 \times 1593336}{160000080} \text{ adhimasas}
\end{align*} \]
adhimasa-days instead of 2189894018 instead of adhimasa-days, as wrongly calculated by Beruni. So there was a mistake of 38 days due to adopting the wrong method of calculating the adhimasa-months directly by multiplying it by 30. As there was a mistake of 28 days, which number is divisible by 7, Beruni could not detect it, because he got the correct day of the week even from the wrong Ahargana by dividing it by 7 and counting the remainder from the reference day of that Ahargana.

(d) Explanation of the Text:-

There is no need of repeating the phrases added by me in the text and the example, because all these phrases are given within brackets and can be distinguished easily.

(e) Additional Example:-

Let us take the Ahargana 361937 which corresponds to May 10, 1957 A.D. We put it at two places and multiplied the "lower" one by 30 getting the product 1194595000, to it added 64166 getting the sum 1194541666, divided it by 207062 getting the quotient 5754. (the remainder 112658 being more than 1/8th of the quotient, i.e., 719), added it to the "upper" figure getting the sum 367751, put it at two places and multiplied the "lower" one by 30 getting the product 11029538, to it added 650 getting the sum 11032518, divided it by 30182 getting the quotient 365, multiplied it by 30 getting the product 10150, deducted it from the "upper" figure getting the remainder 35801, divided it by 307 getting 991 and the remainder 41, divided it by 30 getting the quotient 1 and the remainder 11, which represents the 11th tithi of the second month (amanta) Vaishakha (up to the midnight of the day in question); then we added 888 to the complete years 1979 getting the sum 1879 which represents the Shaka-kala; if we add 135 to it we get 2014 which represents Vikramasamvat. Therefore, the Ahargana corresponds to Vaishakha Shuklapaksha Ekadashi, 1879 Shaka-kala, 2014 Vikram Samvat. As already explained, the Shuklapaksha of every month is the same in both the Amanta and Purnimanta Systems, therefore we need not write the word "Amanta" or "Purnimanta" after any date of Shuklapaksha; but if the date belongs to a Krishnapaksha, the "Amanta" or "Purnimanta" must be written, because in this case if it is Chaitra in the Amanta System, it is Vaishakha in the Purnimanta System. However, in any system, the past tithis are counted from the Chaitra Shukla Pratipada which is common to both the systems. The above-mentioned date has been verified by me from a standard Panchanga (or Indian calendar) printed at Varanasi, therefore the formula given by Beruni is proved to be correct.

TO FIND THE LORDS OF VARIOUS PERIODS, THE FIRST BEING THE LORD OF THE YEAR:

12. TO FIND THE LORD OF THE YEAR:

Add 854 to the Ahargana and divide by 360; multiply the quotient by 3 and to the product always add 1; divide the sum by 7, the remainder being never more than 7. Count this remainder in the order of the week-days beginning from Sunday, then the day at which you finish represents the lord of the year and the remainder (after dividing it by 360) represents the past days of its rule, after deducting these days from 360, the remaining days of its rule are obtained.

Example:- We added 854 to the Ahargana getting the sum 24568 divided by 360 getting the quotient 62, multiplied it by 3 and added 1 to the product, divided the sum by 7 getting the remainder 5; we counted it from Sunday and got Thursday, therefore the lord of the year is Jupiter; after division the remainder was 48 which represents the past days of its rule and 212 days are yet to pass.

COMMENTARY

(a) Correction of the manuscript:-

No correction is required except a clarifying phrase which has been added within brackets.

(b) Translation of the technical terms:-

Lord of the Year:- This term is actually the translation of the Arabic term (o-l al-sah) which is the translation of the Sanskrit terms Varshadhipa, Varshapati, or Vershsha. This term has no significance in astrology, but in astrology it is considered very important. It is supposed that each day of the week is ruled by a planet in the following order beginning from Sunday:

1. Sun;
2. Moon;
3. Mars;
4. Mercury;
5. Jupiter;
6. Venus;
7. Saturn.

It is further supposed, according to the tradition followed by the author of Karana Tilaka, that the earth and planets, etc., were created on Sunday and from that day onward the planetary movements had started. So, from that day up to the 365th day, one astrological year is reckoned, and the ruler of this whole period is supposed to be the "Sun," because the ruler of the first day of this astrological year is also "Sun." Then from the 366th day up to the 730th day the second year is reckoned whose ruler is Mercury, because the ruler of its first day (which is Wednesday) is also Mercury. It means that a difference of 35 days takes place between the beginnings of two consecutive years; so if we add 2 to the number of the week-day of the first day of any year, we get the week-day of the first day of the next year. The day in Hindu astronomy and astrology is reckoned from sunrise to sunset.

(c) Elaboration of the principle:-

As explained above, the number of the ruler of an astrological year is obtained by adding 3 to the number of the ruler of the previous year, therefore the order of the rulers of 7 consecutive years since the creation of the world is given below:

1. Sun;
2. Mercury;
3. Saturn;
4. Mars;
5. Venus;
6. Moon;
After 7 years or 2520 days the same order of the rulers of the year is repeated; therefore if we divide the Ahargana since creation by 2520, the remainder will show the same order of the rulers as given above.

Now, according to the Surya Siddhanta, on which the calculations of Karana Tilaka are based, the age of Brahma is 100 divine years, each divine year of which is equal to 360 "complete" divine days, each "complete" divine day of which is equal to 7 divine days and one divine night, each divine day or divine night of which is equal to one "Kalpa," each Kalpa is equal to 1000 Chaturyugas, each Chaturyuga is equal to 4320000 solar years or 157791782 civil days, each civil day is equal to 24 hours or 60 ghatis and is reckoned from sunrise to sunrise.

In this way Brahma lives for 100 divine years. When he sleeps during a Kalpa, the whole universe stops functioning and this dormant state is known as "Pralaya"; when he awakes during a Kalpa, the whole universe again starts functioning and this conscious state is known as "Srishti." So during the life of Brahma there occur 36000 such Pralayas and 36000 such Srishtis. After that period when Brahma dies, the whole universe vanishes with him, and this state of annihilation continues for a period of 100 divine years which is known as "Maha Pralaya." At the end of Maha Pralaya a new Brahma comes into being and with him the universe again comes into existence, and after 100 divine years when this Brahma dies, again a Maha Pralaya of 100 divine years takes place and at the end of this Maha Pralaya again another Brahma is born. This goes on happening again and again, because "time" is endless, eternal and infinite. So far as the present Brahma is concerned, half of his age has already passed and the first divine day, or the Kalpa, of the 51st divine year is continuing. A Kalpa is subdivided into "Manvantaras" and "Sandhis"; a Manvantara is a period of 71 Mahayugas, and a Sandhi is a period of 2/5 Mahayuga which always occurs before and after a Manvantara. A Kalpa starts with a Sandhi after which a Manvantara takes place; then again a Sandhi occurs and after it the second Manvantara starts which is again followed by a Sandhi. In this way there occur 15 Sandhis and 14 Manvantaras in a Kalpa; 15 Sandhis are equal to 15 × 2/5 = 6 Mahayugas, and 14 Manvantaras are equal to 14 × 71 = 994 Mahayugas, thus a Kalpa is equal to 6 + 994 = 1000 Mahayugas. Each Mahayuga is subdivided into four smaller Yugas which are called Satya-Yuga, Treta-Yuga, Dwaparayuga, and Kali-Yuga; these Yugas consist of 172800, 129600, 864000 and 432000 solar years, respectively, the total of these four yugas being 432000 solar years. After the above-mentioned four consecutive yugas of one Mahayuga, again the same four yugas of the next Mahayuga start in the same order. Of the current Kalpa, 7 Sandhis with 6 intervening Manvantaras have already passed and the 7th Manvantara is current; of the current Manvantara, 27 Maha-Yugas have already passed and the 28th Maha-Yuga is current; of the current Mahayuga, first three yugas (which are equal to 9/10 Mahayuga) have already passed and the Kali-Yuga is current; of the current Kaliyuga 4067 solar years had already passed at the beginning of the Ahargana of Karana Tilaka, i.e., 888 Shakakala. The first day of the Kaliyuga was Friday, the 19th of February B.C., 3102. If we find the period since the beginning of the current Kaliyuga upto the beginning of the Ahargana of Karana Tilaka in civil days instead of solar years, we get 1485507 civil days which is known as Kaliyuga-Ahargana. Similarly, if we find the period since the beginning of the current Kaliyuga up to the beginning of the current Kaliyuga, we get

\[ \left( \frac{7}{10} \times 3 + \frac{7}{10} \times 6 + \frac{9}{10} \right) = 456 \frac{7}{10} \text{ Mahayugas.} \]

But it is believed that the actual creation of the earth and planets etc., and their motions had started after a long period since the beginning of the Kalpa. This period of "lag" is considered to be equal to the first Sandhi, plus first three Mahayugas of the first Manvantara plus first Yuga (i.e., Satayuga) of the fourth Mahayuga plus 3/4 of the second Yuga (i.e., 3/4 of TretaYuga) of the fourth Mahayuga. This is more clearly shown in the following lines:

\[ \text{Sandhi} + 3 \text{ Mahayugas} + 1 \text{ Satayuga} + \frac{3}{4} \text{ TretaYuga}, \]

\[ = \left( \frac{2}{5} + \frac{3}{5} + \frac{3}{20} \right) = 3 \frac{19}{20} \text{ Mahayugas; so the period elapsed since the} \]

creation upto the beginning of the current Kaliyuga is given below:

\[ \left( 456 \frac{7}{10} - 3 \frac{19}{20} \right) = 452 \frac{3}{4} \text{ Mahayugas} \]

or \[ 452 \frac{3}{4} \times 432000 = 1955880000 \text{ solar years} \]

or \[ 452 \frac{3}{4} \times 157791782 = 71440296627 \text{ civil days} \]

Therefore, the period elapsed since the creation upto the beginning of the Ahargana of Karana Tilaka (i.e., 888 Shakakala) is given below:

\[ (1955880000 + 4064) = 1955884067 \text{ solar years} \]

or \[ 71440296627 + 1485507 = 714403782134 \text{ civil days} \]

The first day on which the creation took place was Sunday; therefore the lord of the first astrological year since the creation was the Sun; then after having the lords of the consecutive 7 years in the order already explained, we again have the same order after 2520 days. If we divide 714403782134 civil days by 2520 we get the quotient 283493564 (which represents the number of groups, each group consisting of 7 astrological years) and the remainder 854. This shows that at the beginning of the Ahargana Karana Tilaka 854 days of the 283493565th group had already passed; therefore, if we add the 854 to Ahargana of Karana Tilaka, we get the total number of days passed since the beginning of the 283493565th group which had started with the Sun as the lord of the year. So if we take 1 = Sunday, 2 = Monday, 3 = Tuesday, and so on, we should divide the number of days since the beginning of any group by 360; the quotient we should multiply by 3, because there is a difference of 3 weeks after every astrological year; to this sum we should further add 1, because we have taken 1 = Sunday, which is the first day of each group. In this way whatever number we get, we should divide it by 7 and the remainder should be counted from Sunday to find out the week-day on the first day of that astrological year which also represents the lord of the year. This is the principle on which the formula of this article is based.
(d) **Explanation of the Text:**

No change in the text was considered necessary.

(e) **Additional Example:**

We take the Ahargana on 10 May, 1957 A.D. which is 361997. We added 854 to it getting 362851; divided it by 360 getting the quotient 1007 and the remainder 351; multiplied the quotient by 3 getting 3022; divided it by 7 getting the remainder 5; counted it from Sunday getting Thursday. Therefore the lord of the year is Jupiter, 331 days of whose rule have already passed and 29 days have yet to pass.

13. **To find the lord of the month:**

Add 854 to the Ahargana and divide the sum by 30; double the quotient and add 1 to it; divide it by 7; the remainder being never more than 7; count it from Sunday and you will find the lord of the month; whatever is the remainder, will show the past days of its rule and whatever is obtained after deducting it from 80, will show the remaining days of its rule.

**Example:** We divided 22468 by 30 getting the quotient 748; to the double of it we added 1 getting 1497; we divided it by 7 getting the remainder 6; we counted it from Sunday getting Friday so we found Venus as the lord of the month. The past days of its rule are those which are obtained as a remainder, after the division, i.e., 28 days are yet to pass.

**Commentary**

(a) **Correction of the manuscript:**

No correction of the manuscript is required.

(b) **Translation of the technical terms:**

**LORD OF THE MONTH:** This is an English translation of the Arabic term (َالله), which is the translation of the Sanskrit terms Masadhipa, Maspati, or Masesha. It is an astrological term and has no significance in astronomy.

(c) **Elaboration of the principle:**

The formula here given is also based on the same principle which has already been explained in Article No. 12. Each astrological year of 360 days consists of twelve astrological months each of 30 days; and the lord of the first day of the month is considered the lord of the whole month also. If we divide 30 days by 7, we get the remainder 2 which shows that there is a difference of 2 week-days in each month; therefore if we divide the total number of days by 30, the quotient should be doubled to get the week-day of the first day of the current month. As we have started with the month whose first day was Sunday which is represented by 1, we should further add 1 to the doubled quotient and then the sum should be divided by 7 to eliminate complete weeks, and the remainder should be counted from Sunday to find the lord of the month.

(d) **Explanation of the text:**

No change in the manuscript is required.

(e) **Additional example:**

We take the Ahargana on 10 May, 1958 A.D. which is 361997. We added to it 854 getting the sum 362851; divided it by 30 getting the quotient 12095 and the remainder 1; doubled the quotient getting 24190 and added 1 to it getting 24191; divided it by 7 getting the remainder 6, counted it from Sunday getting Friday; so we find Venus as the lord of the month, one day of whose rule has passed and 29 days are yet to pass.

14. **To find the lord of the day:**

Divide the Ahargana by 7 and count the remainder from Sunday.

**Example:** We divided the Ahargana by 7 getting the remainder 5; we counted it from Sunday getting Thursday which belongs to Jupiter, therefore it is the lord of the day.

**Commentary**

(a) **Correction of the manuscript:**

No correction of the manuscript is required.

(b) **Translation of the technical terms:**

**LORD OF THE DAY:** This is an English translation of the Arabic term (َالله), which is the translation of the Sanskrit terms Dinadhpa, Dinapati, or Dineshah. This is an astrological term.

(c) **Elaboration of the principle:**

As the Ahargana of Karana Tilaka starts from Sunday, we do not require to add any number to the Ahargana. The name of the week-day is directly found by dividing the Ahargana by 7 and counting the remainder from Sunday.

(d) **Explanation of the text:**

No change has been made in the manuscript.

(e) **Additional example:**

We take the Ahargana on 10 May, 1957 A.D., which is 361997. We divided the Ahargana by 7 getting the remainder 6; counted it from Sunday getting Friday; therefore the lord of the day is Venus.
15. **To find the Lord of the Hora:**

Find out the degrees of the past ascendants since sunrise, in other words, find out the difference in degrees between the ascendant of the required moment and the true place of the Sun; or convert these degrees into minutes. Divide it by 900 and count the quotient from the Lord of that day in the order of the distances of the planets from the earth, from the farthest to the nearest (i.e., in the order Saturn, Jupiter, Mars, Sun, Venus, Mercury, Moon), and when your counting reaches the Moon, start again from Saturn.

**Example:** As we had not taken any particular moment in our above-mentioned example, suppose a moment near the midday. For example, we take that moment when the difference between the Sun and the ascendant is 80 degrees. When we convert it into minutes, we get 4800 minutes; if we divide it by 900, we get the quotient 5 1/3. Its hows that the moment in question falls within the sixth hora; when we count it from Jupiter (which is the lord of that day) downwards, we reach at the Moon, therefore it is the lord of the hora.

**Commentary**

(a) **Correction of the manuscript:**

No correction of the manuscript is required.

(b) **Translation of the technical terms:**

**Lord of the Hora:** This is an English translation of the Arabic term (اللَّه), which is the translation of the Sanskrit term Horadhipa, Horapati, or Horesha.

Ordinarily a hora is 1/24th part of the period from sunrise to sunrise and therefore it is equal to an "hour"; the word "hour" itself has been derived from the Sanskrit word "hora" but more technically, a "hora" is the period during which the ascendant advances by 15 degrees or 900 minutes which is sometimes more and sometimes less than an hour.

(c) **Elaboration of the principle:**

Full description of "ascendant" will be given when we come to that article; at this place only a rough idea is given. At any moment at a particular place the ascendant indicates that point on the ecliptic which touches the eastern horizon. Due to the rotation of the earth, the ecliptic moves through 360 degrees approximately at the eastern horizon from sunrise to sunrise but due to the obliquity of the ecliptic and the latitude of the place, this movement is not strictly uniform. Therefore every portion of 15 degrees of the ecliptic may not take exactly one hour in moving through the eastern horizon, it may be a bit more or a bit less, as the case may be, but the total duration of the movement of all the 24 such portions of the ecliptic would always be equal to 24 hours approximately. In order to find the hora at a particular place and at a particular moment, we should first find out the true place of the Sun, and then we should calculate the correct value of the ascendant (both of these calculations will be described at a later stage); then we should deduct the true place of the Sun from the correct value of the ascendant and the difference should be divided by 15, if the difference is in degrees; if the difference is found in minutes, for more accurate results it should be divided by 900. The quotient will represent the complete horas passed since sunrise and the next hora will be current; the lord of the first hora is always the same as the lord of that day, and the lords of the next horas can be found by counting them in the same order as given in the text within brackets, i.e., Saturn, Jupiter, Mars, Sun, Venus, Mercury, Moon; these are given in the descending order of their distances from the earth.

It will be interesting to note that the order of the week-days also has been derived from the order of the horas of these days. On the day of creation at the sunrise the lord of the first hora was the Sun, and so the lord of that day was also considered to be the Sun and it was called Sunday. Then counting the next horas of that day in the order explained above, we find that the 24th or the last hora of that day was ruled by Mercury; and the 25th or the first hora of the next day was ruled by the Moon and so the lord of that day was also considered to be the Moon and it was called Monday. Then counting the next horas of that day in the same order, we find that the 48th or the last hora of that day was ruled by Jupiter; and the 49th or the first hora of the next day was ruled by Mars and so the lord of that day was also considered to be Mars and it was called Tuesday. In the same way the 73rd or the first hora of the next day was ruled by Mercury and it was called Wednesday; the 97th or the first hora of the next day was ruled by Jupiter and it was called Thursday; the 121st or the first hora of the next day was ruled by Venus and it was called Friday; the 145th or the first hora of the next day was ruled by Saturn and it was called Saturday; the 169th or the first hora of the next day was ruled by the Sun and it was called Sunday. In this way the order of the week days was fixed and the same is repeated again and again; and that is why we see that the lord of the first hora of any day is the same as the lord of that day.

(d) **Explanation of the Text:**

I have added the following phrase within a bracket in the text in order to make it more intelligible.

(e) **Additional Example:**

We take the day of 10 May, 1957 A.D., which is Friday, and find the lord of hora at the moment when the difference between the ascendant and the Sun is 112 degrees, 51 minutes, 45 seconds. We converted it into minutes getting 6772 minutes app.; then we divided it by 900 getting the quotient 7 472, which means that since sunrise 7 horas had passed and the 8th hora was current. We counted it from Venus (which was the lord of that day) in the descending order of the distances of the planets and again found Venus; so the lord of the hora was Venus.
استخراج شكل كن من أحد هذه التواريخ الثلاثة:

(8) استخراج الأصل من تاريخ الهجرة:

إذا كان التمذجي مارحاً تاريخ الهجرة تقضي من السنة التامة 2434 أبداً ووضعًا ما يấp في في الثلث أسماحة ثم شرباً إلى إذ 2434 والأوسط في خمسة والألف في 2434 (وآخذًا على 2434 وناقشه ما خرج منه) وردًا الأصل إلى الأول من السنة وفقًا على 2434 ذاتي ما يفضل على في الثلث اسماء 2434 إلى الألف وحَدًا وانه ما يقر به التحية ثم زاداً على الألف في 2434 أبداً وعلى الألف ما يمضى من أيام السنة الكاسرة (بتبع القيم الذي بعد النكار الهيجاب) وفقًا للألف في 2434، وفقًا للألف في 2434، وفقًا للألف في 2434.

مثال: إذا قضا من سنة الهجرة التامة 2434 في 2434 وفقًا في ثلاثة أسماحة في 2434 وفقًا للألف في 2434، وفقًا للألف في 2434.

(9) استخراج الأصل من تاريخ الرجرد:

وكان النطفي تاريخ الرجرد تقضي من السنة التامة 2434 وفقًا على 2434 ورداً على الألف ما يمضى من أيام السنة (بتبع القيم الذي بعد النكار الهيجاب) في جميع الأصل.

مثال: في اليوم المذكور إنا تقضي مع سنة، تاريخ الرجرد التامة 2434 في 2434، وفقًا على الألف ما يمضى من أيام السنة (بتبع القيم الذي بعد النكار الهيجاب) في جميع الأصل.

(10) استخراج الأصل من تاريخ الإسكندر:

وكان النطفي تاريخ الإسكندر تقضي من سنة، تاريخه التامة 2434 وفقًا على 2434 ورداً على الألف ما يمضى من أيام السنة (بتبع القيم الذي بعد النكار الهيجاب) في جميع الأصل.

مثال: يوم المذكور ذكرنا إنا تقضي مع سنة، تاريخ الإسكندر التامة 2434، في 2434.

(11) استخراج شكل كن من أحد هذه التواريخ:

فافًا تحتم في موضعين ونطقي اسمًا في 2434، وفقًا على الألف في 2434، وفقًا على الألف في 2434، وفقًا للألف في 2434.

مثال: إذا قضا من سنة، الهجرة التامة 2434 في 2434 وفقًا في ثلاثة أسماحة في 2434 وفقًا للألف في 2434، وفقًا للألف في 2434، وفقًا للألف في 2434.
لا يوجد نص يمكن قراءته بشكل طبيعي من الصورة المقدمة.