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The Mayan Long Count Calendar

Thomas Chanier

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1 Introduction

The Maya had a very elaborate and accurate calendar. First, the Mayan Long Count Calendar (LCC) was used to point historical events from a selected "beginning of time". The Long Count Periods are given on Table 1. It is also characterized by the existence of a religious month Tzolk'in and a civic year Haab'. One Tzolk'in of 260 days (Kin) was composed of 13 months (numrated from 1 to 13) of 20 named days (Imix, Ik, Akbal, Kan, Chicchan, Cimi, Manik, Lamat, Muluc, Oc, Chuen, Eb, Ben, Ix, Men, Cib, Caban, Eznab, Cauac, Ahau). One Haab' of 365 days is composed of 18 named months (Pop, Uo, Zip, Zotz, Tzec, Xul, Yaxkin, Mol, Chen, Yax, Zac, Ceh, Mac, Kankin, Muan, Pax, Kayab, Cumhu) with 20 days (Uinal) plus one month of 5 days called Uayeb. The LCC is supposed to begin on 11 August -3114 BC known as the Goodman-Martinez-Thompson (GMT) correlation to the Gregorian calendar based on historical facts and end on 21 December 2012 corresponding to a period of approximately 5125 years or 13 Baktun. We explain here the origin the Long Count Periods and the 13 Baktun cycle. Mars is proposed to have an importance in Mayan religion along with Venus.

| Days | Long Count Period | Long Count period | Approx. solar year |
|--------|-------------------|-------------------|--------------------|
| 1 | 1 Kin | | - |
| 20 | 20 Kin | = 1 Uinal | 0.0547 |
| 260 | 13 Uinal | = 1 Tzolk'in | 0.7118 |
| 360 | 18 Uinal | = 1 Tun | 0.9856 |
| 7200 | 20 Tun | = 1 Katun | 19.7125 |
| 144000 | 20 Katun | = 1 Baktun | 394.2505 |

Table 1: Table of Long Count Unit.

| Period | N [day] | Prime factorization |
|------------------------|-------------|-----------------------------------|
| Mercury synodic period | 116 | $2^2 \times 29$ |
| Venus synodic period | 584 | $2^3 \times 73$ |
| Mars synodic period | 780 | $2^2 \times 3 \times 5 \times 13$ |
| Jupiter synodic period | 399 | $19 \times 7 \times 3$ |
| Saturn synodic period | 378 | $7 \times 3^3 \times 2$ |
| Tzolk'in | 260 | $2^2 \times 5 \times 13$ |
| Haab' | 365 | 5×73 |
| Tun | 360 | $2^3 \times 3^2 \times 5$ |
| Katun | 7200 | $2^5 \times 3^2 \times 5^2$ |
| Baktun | 144000 | $2^7 \times 3^2 \times 5^3$ |
| Pictun | 2880000 | $2^9 \times 3^2 \times 5^4$ |
| Calabtun | 57600000 | $2^{11} \times 3^2 \times 5^5$ |
| Kinchiltun | 1152000000 | $2^{13} \times 3^2 \times 5^6$ |
| Alautun | 23040000000 | $2^{15} \times 3^2 \times 5^7$ |

Table 2: Prime factorization of the periods.

2 Origin of the Long Count Calendar

Two calendars, the Tzolk'in and the Haab', coexist with the Long Count Calendar. The Tzolk'in and the Haab' coincide every 73 Tzolk'in or 52 Haab' or a sheaf cycle: $73 \times 260 = 52 \times 365 = 18980$ days. There is a coincidence between Venus synodic period[†] and the Tzolk'in: the least common multiple (LCM) of these two numbers is $65 \times 584 = 146 \times 260 = 104 \times 365 = 37960$ days (2 sheaf cycles). There is a coincidence between Mars synodic period, the Haab': the LCM of these two numbers is $73 \times 780 = 219 \times 260 = 156 \times 365 = 56940$ days (3 sheaf cycles).

| LCP | N [day] | $\text{LCM}(N, 365)$ | $\text{LCM}(N, 365)/N$ | $\text{LCM}(N, 365)/365$ |
|------------|-------------|----------------------|------------------------|--------------------------|
| Tun | 360 | 26280 | 73 | 72 |
| Katun | 7200 | 525600 | 73 | 1440 |
| Baktun | 144000 | 10512000 | 73 | 28800 |
| Pictun | 2880000 | 210240000 | 73 | 576000 |
| Calabtun | 57600000 | 4204800000 | 73 | 11520000 |
| Kinchiltun | 1152000000 | 84096000000 | 73 | 230400000 |
| Alautun | 23040000000 | 1681920000000 | 73 | 4608000000 |

Table 3: Coincidence of the civic month Haab' with the Long Count Period (LCP).

When we look at the LCM of the number of days N of a Long Count Period (LCP) and a Haab' (365 days) we obtain $\text{LCM}(N, 365) = 73 \times N$ as

| LCP | N [day] | $\text{LCM}(N, 584)$ | $\text{LCM}(N, 584)/584$ |
|------------|-------------|----------------------|--------------------------|
| Tun | 360 | 26280 | 45 |
| Katun | 7200 | 525600 | 900 |
| Baktun | 144000 | 10512000 | 18000 |
| Pictun | 2880000 | 210240000 | 360000 |
| Calabtun | 57600000 | 4204800000 | 7200000 |
| Kinchiltun | 1152000000 | 84096000000 | 144000000 |
| Alautun | 23040000000 | 1681920000000 | 2880000000 |

Table 4: Coincidence of Venus synodic period with the Long Count Period (LCP).

seen on Table 3. 73 is not present in the prime factorizations of the Tzolk'in and the Long Count Periods (Table 2) which explains the results in Table 3. Table 4 gives the coincidence of Venus synodic period and the LCP. For example, 45 Venus cycles or 72 Haab' corresponds to 73 Tun.

| Planet | P [day] | $\text{LCM}(P, 365)$ | LCC date |
|---------|-----------|----------------------|-------------|
| Mercury | 116 | 42340 | 0.5.17.11.0 |
| Venus | 584 | 2920 | 0.0.8.2.0 |
| Earth | 365 | 365 | 0.0.1.0.5 |
| Moon | 30 | 2190 | 0.0.6.1.10 |
| Mars | 780 | 56940 | 0.7.18.3.0 |
| Jupiter | 399 | 145635 | 1.0.4.9.15 |
| Saturn | 378 | 137970 | 0.19.3.4.10 |

Table 5: Coincidence of the synodic periods and the Haab' and their date in the Long Count Calendar (LCC) from the selected "beginning of time".

The only planets of the solar system visible with a naked eye in the sky are Mercury, Venus, Earth (solar year), Moon, Mars, Jupiter and Saturn. The LCM of the Haab' and the planet synodic periods are given in Table 5. This corresponds to the period between two identical observations of a planet in the sky on a particular day of the Haab'. Jupiter has the greater value: $\text{LCM}(399, 365) = 145635$ days. That explains why the Long Count Calendar stops at the Baktun (144000 days). With the LCC, Mayan astronomers were able to date the coincidence of each planet identical position in the sky with the Haab' calendar.

3 Origin of the 13 Baktun cycle

| LCP | N [day] | $\text{LCM}(N, 260)$ | $\text{LCM}(N, 260)/N$ | $\text{LCM}(N, 260)/260$ |
|------------|-------------|----------------------|------------------------|--------------------------|
| Tun | 360 | 4680 | 13 | 18 |
| Katun | 7200 | 93600 | 13 | 360 |
| Baktun | 144000 | 1872000 | 13 | 7200 |
| Pictun | 2880000 | 37440000 | 13 | 144000 |
| Calabtun | 57600000 | 748800000 | 13 | 2880000 |
| Kinchiltun | 1152000000 | 14976000000 | 13 | 57600000 |
| Alautun | 23040000000 | 299520000000 | 13 | 1152000000 |

Table 6: Coincidence of the religious month Tzolk'in with the Long Count Period (LCP).

When we look at the LCM of the number of days N of a Long Count Period and a Tzolk'in (260 days) we obtain $\text{LCM}(N, 260) = 13 \times N$ as seen on Table 6. 13 is not present in the prime factorizations of the Long Count Periods (Table 2) which explains the results in Table 6. There is for example a Katun cycle of 93600 days and a Baktun cycle of 1872000 days corresponding respectively to 360 and 7200 Tzolk'in. This means that the Baktun cycle coincides with the Tzolk'in cycle every 13 Baktun corresponding approximately to 5125 years. The only synodic period dividable by 260 is Mars synodic period. On Tables 6 and 7, a coincidence can be noted between Mars synodic period ($780 = 3 \times 260 = 3$ Tzolk'in) and the Long Count Periods. For example, 13 Tun corresponds to 18 Tzolk'in or 6 Mars synodic period. Mars seems to have play a role in Mayan religion along with Venus.

| LCP | N [day] | $\text{LCM}(N, 780)$ | $\text{LCM}(N, 780)/780$ |
|------------|-------------|----------------------|--------------------------|
| Tun | 360 | 4680 | 6 |
| Katun | 7200 | 93600 | 120 |
| Baktun | 144000 | 1872000 | 2400 |
| Pictun | 2880000 | 37440000 | 48000 |
| Calabtun | 57600000 | 4204800000 | 960000 |
| Kinchiltun | 1152000000 | 14976000000 | 19200000 |
| Alautun | 23040000000 | 299520000000 | 384000000 |

Table 7: Coincidence of Mars synodic period with the Long Count Period (LCP).

4 Conclusion

We give here the origin of the Long Count Calendar and its connection with the Tzolk'in and Haab' cycles. Based on naked eye observation of the solar system, Mayan astronomers were able to predict when the same astronomical observation would occur on a certain day of the Haab'. The religious month Tzolk'in is based on Mars cycle whereas the civil month Haab' is used to point a day of a solar year. The 13 Baktun cycle corresponds to 2400 Mars cycles or 7200 Tzolk'in whereas a 73 Baktun cycle corresponds to 18000 Venus cycles or 28800 Haab'.

[†] Synodic period : The time required for a planet within the solar system to return to the same or approximately the same position relative to the Sun as seen by an observer on the Earth.