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► **To cite this version:**

| Thomas Chanier. The Mayan Long Count Calendar. 2013. hal-00750006v2

**HAL Id: hal-00750006**

**<https://hal.science/hal-00750006v2>**

Preprint submitted on 27 Aug 2013 (v2), last revised 16 Dec 2015 (v12)

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# The Mayan Long Count Calendar

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August 27, 2013

## 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 of 260 days (Kin) and a civic year Haab' of 365 days. One Tzolk'in of 260 days was composed of 13 months (numerated 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, Muant, 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. We will explain here the origin of this cycle.

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
Venus synodic period	584	$2^3 \times 73$
Mars synodic period	780	$2^2 \times 3 \times 5 \times 13$
Tzolk'in	260	$2^2 \times 5 \times 13$
Haab'	365	$5 \times 73$
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<sup>†</sup> (584 days) and the Tzolk'in: the least common multiple of these two numbers is  $65 \times 584 = 146 \times 260 = 37960$  days. This corresponds to 104 Haab':  $104 \times 365 = 37960$  days (2 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 least common multiple (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 seen on Table 3. Table 4 gives the coincidence of Venus synodic period and the LCP. 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.

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).

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 5. 13 is not present in the prime factorizations of the Long Count Periods (Table 2) which explains the results in Table 5. 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 planets of the solar system visible with a naked eye in the sky are Mercury, Venus, Earth (equinox or solstice), Moon, Mars, Jupiter and Saturn. Their synodic periods are 116, 584, 365, 30, 780, 399, 378 days respectively. The only synodic period dividable by 260 is Mars synodic period. The least common multiple of 584 and 780 is  $113880 = 260 \times 438 = 365 \times 312 = 3$  sheaf cycles which may have defined another cycle based on Venus and Mars. On Tables 5 and 6, 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 may have played a role in Mayan religion along with Venus.

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

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

### 3 Conclusion

We give here a possible explanation of the different Mayan calendars based on naked eye astronomical observation. Venus and Mars are proposed to play a role in Mayan religion. The Venus cycle was marked on the calendar round which made coincide the Haab' and the Tzolk'in every 73 Tzolk'in or 52 Haab'. The Long Count Calendar was used to track the positions of Mars and Venus. The 13 Baktun cycle corresponds to 2400 Mars equivalent positions in the sky or 7200 Tzolk'in whereas a 73 Baktun cycle corresponds to 18000 Venus equivalent positions in the sky or 28800 Haab'.

<sup>†</sup> 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.