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ARNOLD LEBEUF

THE ORIGIN OF THE *TZOLKIN* AND THE LONG COUNT: HANS LUDENDORFF WAS RIGHT

The Long Count of the Olmec and Mayan calendars is composed of a series of 5,200 formal "years" of 360 days each called *Tun*. It has always been used as a chronological series of natural days starting from a day zero (0.0.0.0.0), corresponding to the JD 584,284 (August 12, 3114 BC, Gregorian proleptic). Already in the earliest inscriptions this count of days is associated with the corresponding date in the sacred almanac of 260 days called *Tzolkin*. The day zero of the Long Count is associated with the day *4-Ahau* in the *Tzolkin*. These two series have never been reformed and were continued without corrections or changes all through the history of Mesoamerica, regardless of many differences in epochs, cultures, and languages. There is a difference of one day between the Olmec-Mayan convention and the convention of Central Mexico which bases *4-Xochitl* (the Nahuatl equivalent of the Mayan *4-Ahau)* on JD 584,283. This difference has yet to find any satisfactory explanation.

The cycle of 260 days results of the combination of two unequal series, the first of twenty names and the second of 13 numbers, so that every 260 days a specific day name will match again the same number. In 1930 Hans Ludendorff claimed the *Tzolkin* is a small computer for eclipse predictions which has to be reset by one day back in the sacred calendar (*Tzolkin*) every 20 *Tun*, so that it would take 5,200 *Tun* for the system to regress one turn inside the *Tzolkin* (260 x 20 = 5,200). The Long Count, claimed Ludendorff, is the period of correction at long run for the derivation of the node of the lunar orbit in the *Tzolkin* serving as a small eclipse calculator. I myself have proposed that the Venus table in the Dresden Codex was primarily a table for the organization of the New Fire Ceremonies every 104 "years" or rather every true 65 Venus cycles. Venus serving then as the visible indicator of the invisible node of the lunar orbit because of their congruency every 65 true Venus mean cycles (Lebeuf 2003, 214-223). The present study does not propose any other correlation than the one usually accepted, that is 0.0.0.0.0, 4-Ahau 8-Cumhu = JD 584,284 for the Mayan (Caso 1967; 1971, 333-348). It only considers another possible relation between astronomy, the *Tzolkin*, and the Long Count at the time of their creation. The results fully confirm the hypothesis of Hans Ludendorff concerning the origin of these two series. Without disclaiming the use of the Long Count as a chronological series of natural days, I shall propose here to read also, and maybe primarily, the Long Count as a conventional representation of 5,200 "years" or more exactly of 3,250 Venus cycles representing the derivation of the nodes of the lunar orbit inside the *Tzolkin*.

KEY WORDS: Olmecs, Mayan calendar and astronomy, Long Count, Tzolkin, Ludendorff

THE MAYA CALENDAR

The basic Maya calendar counts are:

The *Tzolkin* of 260 days composed of a series of 13 numbers and a series of 20 names (260 x 7,200 = 1,872,000 days; 260 x 7,300 = 1,898,000 days).

The Long Count of 5,200 *Tun* of 360 days each, equal to 1,872,000 days.

The *Haab* of 365 days (5,200 x 365 = 1,898,000 days).

The cycle of Venus of 584 days as it appears in the Dresden Codex (3,250 x 584 = 1,898,000 days).

The *Tzolkin, Haab*, and the formal Venus cycles are congruent every 104 *Haab* because 146 x 260 = 104 x 365 = 65 x 584. But of course all of these numbers are conventional approximations of natural cycles. The solar tropical year has 365.24219879 days; Venus synodic cycle has 583.9213 days, and as the sacred calendar of 260 is concerned, it also represents a natural cycle, the cycle of the nodes of the lunar orbit, (Ludendorff 1930). The ecliptic revolution of the nodes of the lunar orbit counts 6798.3633 days.

The Venus table in the Dresden Codex is a formal conventional representation of series of 50 x 65 true Venus cycles or 3,250 Venus cycles (Lebeuf 2003, 214-223). Venus Morning First (heliacal rise) is indexed on the day 1-Ahau 18 Kayab with which the table starts again every 65 Venus cycles.

Let us consider that the *Tun* and the *Haab* are two different conventions for Venus counts, and that 5,200 *Tun* = 5,200 *Haab* = 3,250 mean true Venus cycles.

Let us then abandon the conventional measures. The Sun, Venus, and the nodes of the lunar orbit are congruent every 65 true Venus cycles, and form a very regular figure exactly and only in the years of the celebrations of the New Fire Ceremonies every 65 true Venus cycles (Lebeuf 2003, 214-223). The Venus inferior conjunction, the Venus superior conjunctions, and the conjunctions of the Sun with the nodes are then organized in a regular symmetrical pattern (32 days between Venus inferior conjunctions and the moment of the sun passage on the nodes of the lunar orbit every 173 days, the superior conjunction forming the central point of symmetry):

Venus inferior conjunction	+ 32 days
Sun on the Node of the lunar orbit	+ 173 days
Sun on the Node of the lunar orbit	+ 86 days
Venus superior conjunction	+ 87 days
Sun on the Node of the lunar orbit	+ 173 days
Sun on the Node of the lunar orbit	+ 32 days
Venus inferior conjunction	

Or:

VIC 32 SN 173 SN 86 VSC 87 SN 173 SN 32 VIC

VIC = Venus inferior conjunction;
VSC = Venus superior conjunction;
SN = Sun on the node of the lunar orbit.

With this very regular congruency lasting for millennia in the well documented years of the celebration of the New Fire Ceremony, and only in those years, the inferior conjunction of Venus can serve as an indicator of the position of the nodes of the lunar orbit (Lebeuf 2003, 214-223). Every 104 years, Venus can serve as the visible indicator of the position of the invisible node.

HANS LUDENDORFF THE ORIGIN OF THE *TZOLKIN* AND THE LONG COUNT. ANOTHER READING OF THE LONG COUNT

The two calendar cycles of the *Tzolkin* and the Long Count are the oldest known in Mesoamerica. They appear together in the first inscriptions and have never been reformed. The origin of the *Tzolkin* remains to this day a subject of discussions. If the 360 days of the *Tun* and the 365 days of the *Haab* are evidently formal approximations of the solar year, and the cycle of 584 days the formal approximation of the synodic cycle of Venus, for some authors the *Tzolkin* corresponds to no natural period. According to Herbert Spinden, "An invention pure and simple" (Spinden 1928, 113)[1]; Dittrich refuses any naturalist explication: "Naturbedingt, wie das Jahr oder die Lunation, ist der Tzolkin nicht. Deshalb ist seine Herkunft dunkel, und es gibt etwa 12 verschiedenen Aufsichten darüber" (Dittrich 1939, 18). Some authors have claimed the length of the *Tzolkin* represents the growth of maize from planting to harvest, and others have said it corresponds to the duration of human gestation (Brotheston 1983; Justeson 1989, 78). Others still believed that those 260 days mark the time between two successive passages of the Sun by the zenith at the latitude of Izapa (Malmström 1973; Coggins 1982, 111-123). All these solutions seem unacceptable. Eduard Seler is more credible when he explains that this cycle is the result of the two basic series of 13 numbers and 20 days for purely numerical reasons and would stem from the accord of the common denominator 73 for the Solar 365 days and the Venusian 584 days cycles (73 x 5 and 73 x 8). Then, 65 x 584 = 104 x 365 = 146 x 260.

Dieser Zeitraum von 260 Tagen ist eben das Tonalamatl, das „Buch der Tage und der durch sie bestimmten Geschicke", das der ganzen Zeitperiodenbildung und Zeitperiodenbenennung der alten Mexikaner und Mittelamerikaner zu Grunde liegt und überhaupt, wie ich im Anfange sagte, das A und das O der mexikanischen und mittelamerikanischen Priesterweisheit darstellt. Wieso die Mexikaner – oder wem sonst die Erfindung dieses Kalenders zuzuschreiben ist – darauf gekommen sind, gerade die Zahl dreizehn mit den zwanzig Zeichen zu kombinieren, ist eine zum Theil noch ungelöste Frage. Ich bin der Meinung, dass eine Kombination des Sonnenjahres, das jene alten Kalendermacher und Astronomen zu 365 (oder 5 X 73) Tagen rechneten, und der Venusperiode, die annähernd genau zu 584: (oder 8 X 73) Tagen angenommen wurde, ihnen eine Periode von 13 x 73 Tagen lieferte, deren Zwanzigfaches wieder eine volle Zahl von Jahren, die bekannte Periode von 52 Jahren, ergab. Diese größere Periode zerlegte sich, in ähnlicher Weise, wie das Sonnenjahr und die Venusperiode, in 20 X 13 X 73 Tage. Und damit war das Tonalamatl als eine Einheit gegeben (Seler 1904, 16).

Such numerological and combinatory methods to establish congruencies certainly fit well with Mesoamerican astronomy, but we could object that the archaeological material shows that the Tzolkin is older than the other two cycles, so that it is difficult to accept that it could have been derived from them. Michael P. Closs declares: *it may also be significant that the earliest Long Counts do not record Vague Year dates but only Sacred Round dates. This suggests that the Vague year and its combinations with the Sacred Round may be later accretions to a simpler pre-existing Sacred Round/long Count calendric structure* (Closs 1977, 21). Though, let us

[1] But immediately after acquainting himself with the hypothesis of Hans Ludendorff, very probably as soon as in September 8th 1928, Spinden will abandon his earlier peremptory position and adopt the solution proposed by Ludendorff, *The Mayas, as Ludendorff has shown, constructed their Tzolkin on the basis of 3 x 173,31 = 2 x 260 .... We must imagine the Maya conception as one in which the double Tzolkin is divided into thirds which represent eclipse seasons* (Spinden 1930, 47), this demonstrate that the function of the *Tzolkin* as an eclipse cycle is the original discovery of Ludendorff and not of John Teeple who is generally credited for it. *On peut sans doute dater la communication de Ludendorff à Spinden entre le 30 Août 1928 date de dépôt du manuscrit de l'article « Venus and the Moon», et le 10 Septembre 1928, date du rajout «Addendum» à cet article. En effet, la datation au onzième siècle que propose alors Spinden pour la table des éclipses ne peut être obtenue qu'à partir de la dérive du Noeud dans le Tzolkin. S'il obtient alors un résultat si remarquable, alors que jusque-là il s'était égaré de 260 Haab plus tôt exactement, c'est sans doute qu'ici il s'était affranchi des références dans le Compte Long et ne considérait plus que des noms de jours dans le Tzolkin. Pour obtenir un tel résultat, il n'a pu travailler qu'à partir de la logique interne au Tzolkin et de la dérive du Noeud dans le cycle de 260 jours, ce qui signifie qu'il connaissait déjà cette théorie. Son addendum du 10 Septembre 1928 est brillant. Et il en était parfaitement conscient puisqu'il l'envoya en toute hâte à l'éditeur avant impression alors que ce rajout n'apporte rien ou presque au contenu de l'article proprement dit. Dans sa note de 1928, Spinden avait à la hâte calculé à partir du 10-Cimi, mais en 1930, il revient plus sagement au 12-Lamat et propose une série de dix éclipses possibles qui pourraient correspondre au premier ou au dernier des 12-Lamat du Dresden, la première est au Jour Julien 2068892, la dernière au 2176532. Au milieu de cette série on trouve 12-Lamat 1 Chen, 2116732, 25 Avril 1083 et 12-Lamat 16 Zotz, 2182692, 23 Janvier 1116.* (Lebeuf 2003, 171, and note 522, full manuscript before cuts for impression).

also consider that we only dispose of inscriptions on stones but cannot ignore the possibility of older oral traditions or inscriptions on perishable supports such as paper, leaves, or sand. For example, it is known that the teachings and traditions of Hindu astronomy were kept secret. They used to make their calculations on the ground using small stones (from the Latin calculus, a small stone, a pebble), or seeds or shells (cowries). This was a kind of abacus which they swept away immediately after their operations. Only the results were registered in small almanacs made of palm leaves (Le Gentil de la Galaisière, 1753, 87; 88; 209; 216; 239). Justeson presents a numerological hypothesis very much akin to that of Seler: *it seems unlikely that the system intentionally approximated any interval. Structurally, the ritual calendar is a permutation of two cycles, one of 20 named days and one of 13 numerals. Such a structure is unlikely to arise in a calendar whose essential rationale was its overall length; subdivision in such instances is usually into sequential units. Rather it parallels the structure of the calendar round: there, two separate, coexisting cycles together formed a 52-year cycle; they come to be cited together since their permutation was useful for fixing dates in historical time, but no one doubts that the constituent cycles were independent. Most likely, the 260-day period was also the effect of combining two pre-existing ritual cycles; one of 20 names days and one of 13 numerals* (Justeson 1989, 78). Eduard Seler attributed to the native people of Mesoamerica a normal degree of intellectual reflection when he proposed a genesis of the calendar in terms of arithmetic and calendric. But John Justeson believes that what was first was the combination of the mini cycles of 7; 9; 13; 20 days which were used only for ritual purposes, and then by pure chance their congruencies would have produced an almost perfect model of celestial mechanics! This astonishing opinion comes from the belief that the indigenous people of Mesoamerica were concerned only by ritual necessities and consequently it is impossible to attribute them with a form of reasoning specific to modern science. Let us rather consider that when we have three basic cycles, they should correspond to the three major luminaries, that is the Sun, Moon, and Venus. Is then the *Tzolkin* related to the Moon? The twenty names of the *Tzolkin* recall the twenty days of the months of the *Haab*, but although the name *Uinal* of those months is etymologically related to the name of the Moon „U" in the Maya language, we do not know any lunar period of this length, even roughly. Fortunately, a positive argument excludes all the preceding hypotheses – namely, the excellent proposal by Hans Ludendorff (Ludendorff 1930). Ludendorff demonstrates that the *Tzolkin* was originally created as a small instrument for the prediction of eclipses. According to Hans Ludendorff the *Tzolkin* of 260 days is a small computer for eclipses because 2 x 260/3 gives 173.333 days, which is the time it takes for the sun to progress from one node of the lunar orbit to the other. But as the real period for the sun to pass from one node of the lunar orbit to the next is only of 173.31, Ludendorff also claims that it takes 20 *Tun* for the sun–node conjunctions to regress by one day in the tzolkin and thus, the complete regression by one turn in the calendar of 260 days takes 5,200 *Tun* (260 x 20 = 5,200). After 260 times the one day derivation of the node of the lunar orbit every *Katun* of twenty *Tun*, the nodes regress to their original position in the *Tzolkin*. So, according to Ludendorff, the Long Count is the module of correction of the small short term computer for eclipses that the *Tzolkin* constitutes. In other words, the *Tzolkin* and the Long Count constitute together an everlasting eclipse clock or computer. The fact is that the measure of the regression of 260 days inside the *Tzolkin* for 5,200 x 360 days is not very precise. In 5,200 *Tun*, the regression is only of 252 days. The measure of the Venus cycle of 584 days is as well only an approximation, the real value being of 583.9213 days. Every 65 true Venus cycles, Venus cycle is congruent with the nodes and for this reason can serve as its indicator, Venus being the visible aspect of the invisible node. This explains well why in Mesoamerica Venus is curiously very strongly associated with the eclipse monster (Closs 1989, 389-415). The Olmec and Mayan Long Count starts on JD 584,284, but the table of Venus in the Dresden Codex starts 2,200 days before the day zero of the Long Count, on JD 582,084. If the Mayas or rather the Olmecs really wanted to associate the Long Count with the Venus cycles, why did they place the starts of these two series 2,200 days apart? This is too near to be indifferent and too far to make sense! If we now take the exact value of Venus inferior conjunction nearest to the start of the Dresden Venus table, that is on JD 582,281, we are still 2,003 days before the start of the Long Count, which we still have difficulties to grasp the reason of. And again, if we calculate the last inferior conjunction of Venus after 50 x 65 true cycles, 50 ceremonies of the New Fire, or according to a conventional count, 50 times 65 natural Venus cycles make 5,200 *Haab* (minus 260 days). The Venus table in the Dresden Codex shows this was the intended length of the whole Venus count (Lebeuf 2003, 214-223). Starting from the first inferior conjunction nearest to the conventional date in the Dresden, we fall 65 years exactly after the end of the Long Count (JD 2,480,025, 22.XII.2077). This does not seem to make much sense, but one thing should attract our attention, This last Inferior Conjunction of Venus falls on the winter solstice exactly as the end day of the Long Count does 65 years earlier, on December 22 XII 2012, a peculiarity which hardly could be casual. Let us now consider that if first, the very length of 5,200 *Tun* of the Long Count is really related to the derivation of the nodes of the lunar orbit as Ludendorff claimed, and second, we know Venus to be congruent with the nodes of the lunar orbit every 65 Venus true cycles, then the logical conclusion would be that the Long Count can be somehow related to Venus as well. We could then try to extend the Long Count to the beginning and end of the 3,250 true Venus cycles forming 50 New Fire Ceremonies. We could pull the Long Count so that its first and last days would coincide with the first and the last inferior conjunctions of Venus 3250 cycles of Venus apart starting from the nearest one to the 1-Ahau 18 Kayab conventional Venus Morning First on 3120.08.03 BC (JD 582,084) in the Dresden codex. I proposed years ago the possibility to extend the conventional astronomical cycles to their exact values in function of (according to) the problems to be solved. For example, the "days" of the *Tun* could represent 1/360 of the solar year of 365.2422 days, or the "days" of the 365 days of the *Haab* could represent 1/365,2422 days of the solar year (Lebeuf 2003, 383). In the same way as in Babylonian astronomy the year of 360 days is in fact a correct tropical year of 360 *sauradinas* (progression of the sun on one degree of the ecliptic, and not a natural day), in the case of the Long Count of 5,200 x 360 units, we shall extend it

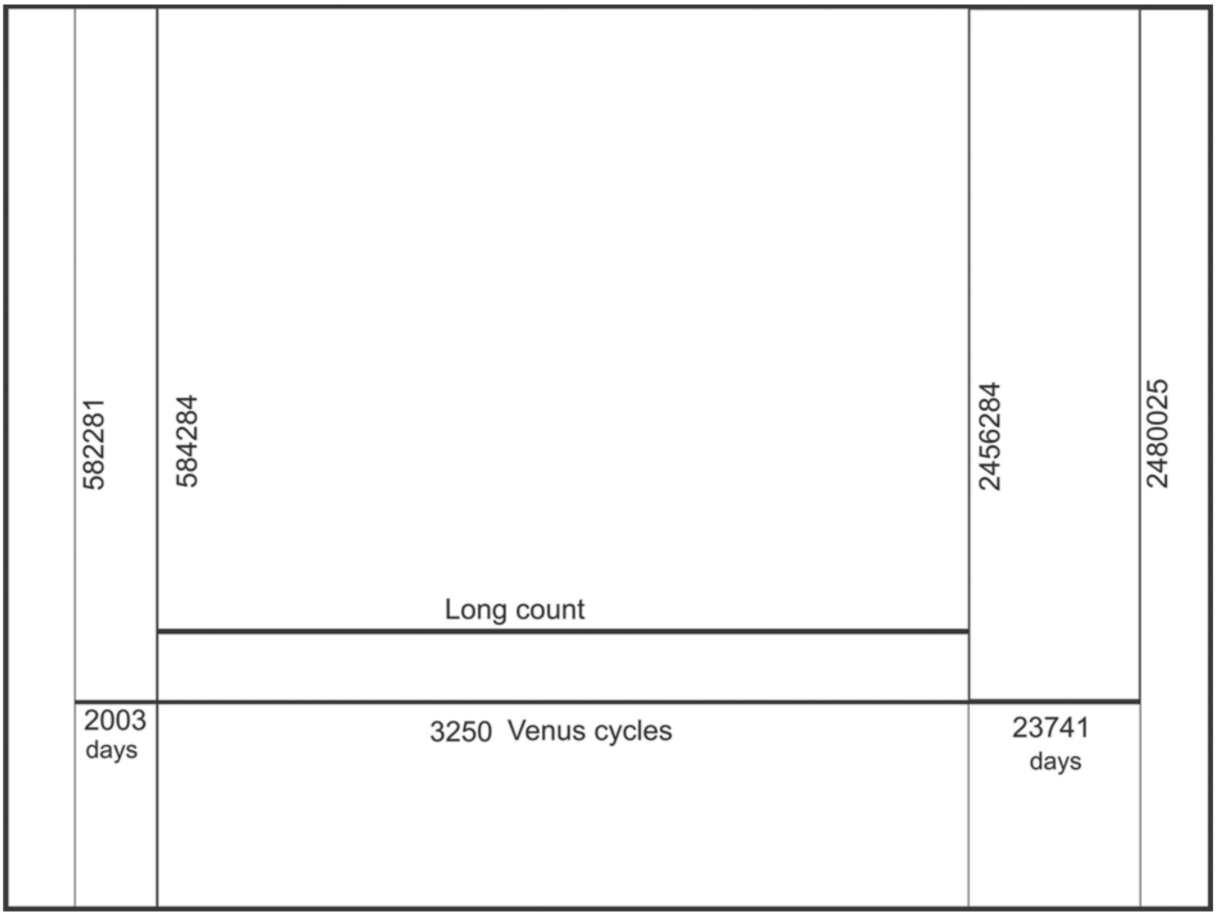

Fig. 1.

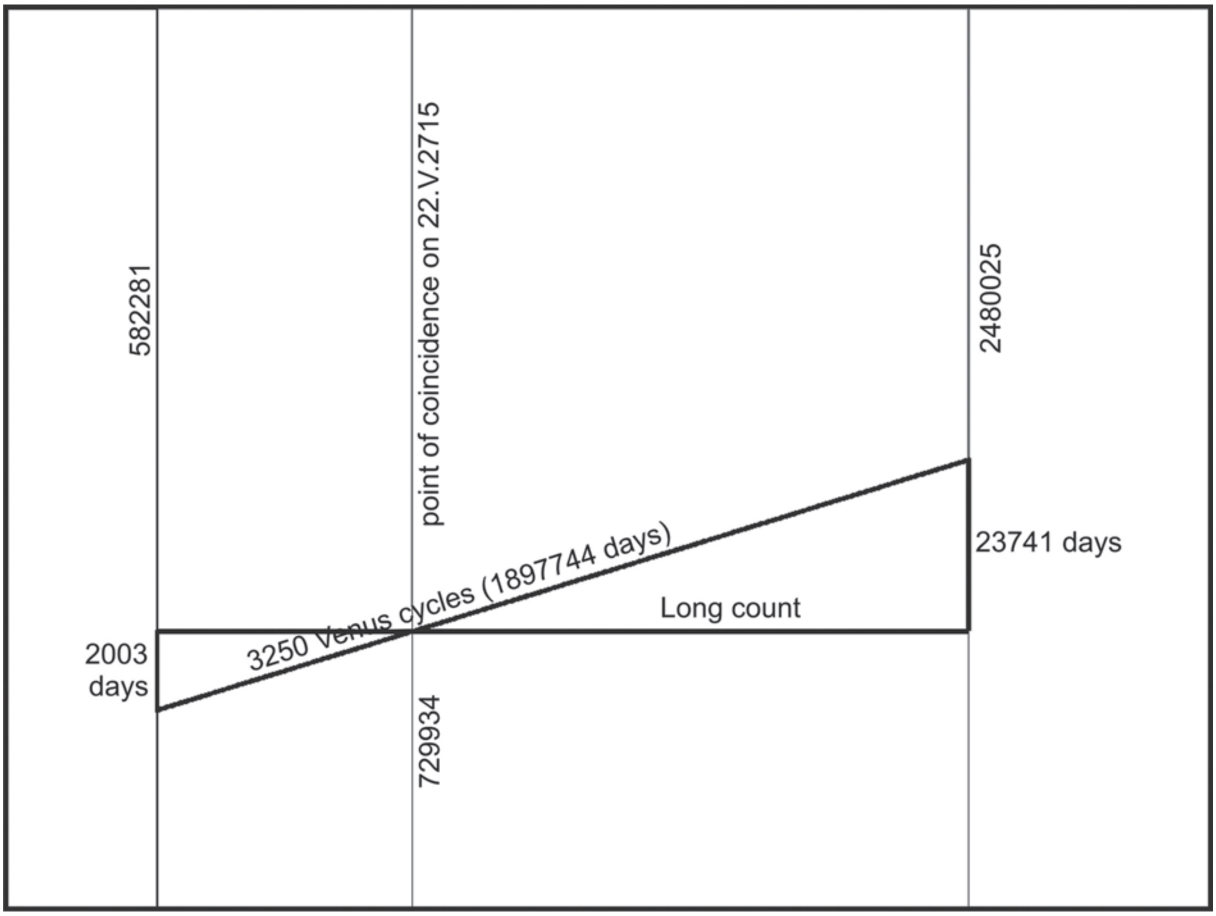

Fig.2.

to fit 3,250 natural cycles of Venus (50 x 65 x 583, 9213).

The inferior conjunction nearest to the start of the Venus table in the Dresden Codex takes place on 3119.02.16 BC., JD 582,281. This means 2,003 days before the start of the Long Count (JD 584,284). The last one will then necessarily be on the 2077.12.22. A.D., JD 2,480,025. Exactly 65 tropical years after the end of the Long Count on 2012.12.22 A.D. (JD 2,456,284) that is 23,741 days later.

We are looking for the point of coincidence of these two series by extending like an elastic the Long Count to 3,250 true cycles of Venus, then only one day of the Long Count will not move from its original place in natural time, this should define the day of the creation of the Long Count, when the two series coincided. We can represent it schematically as in the fig.2.

By calculation, we count 1,897,744 days for the cycle of Venus and 1,872,000 "days" for the Long Count, the difference is 25,744 days. These 25,744 days of difference are divided by 2,003 days at the beginning and 23,741 days at the end. So we can do the following operations:

(1,897,744/25,744) x 2,003 = 147,653.

We add 147,653 to 582,281 to obtain the JD 729,934.

On the other side: (1,897,744/25,744) x 23,741 = 1,750,091.

We subtract 1,750,091 of 2,480,025 to obtain the same JD 729,934.

One way or the other, this is indicating the JD 729,934 that is to say 2715.05.22. BC as the point of departure of both series, the day on which they coincide and from which they run apart towards the future and towards the past. We would be inclined to consider this date as the moment of the creation and installation of the Long Count, but this date seems much too early for such an achievement, as we will see further down the implications of such a time set. Nevertheless we will see that the astronomical conditions shortly preceding this date are so very peculiar and interesting that they could indeed have permitted the ultimate verification of a model previously conceived. In the following table (table 1) we find the relative distances between the sun, Venus and the node of the lunar orbit some four/five years earlier:

Table 1.

JDN	Proleptic Greg. Date	Sun-Node Distance	Venus-Sun Distance
727969	2720.01.3 BC	32	292
728001	2720.02.4 BC	0	-260
728175	2720.07.28 BC	0	-86
728261	2720.10.22 BC	86	0
728348	2719.01.17 BC	0	87
728521	2719.08.9 BC	0	260
728553	2719.08.10 BC	32	292

This perfect concordance between the Sun, Venus, and the nodes is symmetrically centered on an inferior conjunction of Venus (JD 728,261). This is really of great interest if we consider that the whole set appears as the exact inversion, the negative picture of the very regular and specific figure already noticed in the years of New Fire Ceremonies, simply because here the central point is an inferior conjunction instead of a superior conjunction in the figure presented previously:

VIC 32 SN 173 SN 86 VSC 87 SN 173 SN 32 VIC

VSC 32 SN 173 SN 86 VIC 87 SN 173 SN 32 VSC

This is of course worth considering, but as if that was not enough yet, we also notice centralized on the node on the date 2720.07.28. BC, another perfectly symmetrical series, a series of eclipses (table 2).

Table 2.

JD	Proleptic Gregorian date	Moon Age	Sun-Node	Eclipse
727658	2721.02.27 BC	15	3	Total vis.
727820	2721.08.7 BC	30	-8	Partial inv.
727835	2721.08.22 BC	15	7	Total vis.
727997	2720.01.31 BC	29	-4	Total central Inv.
728012	2720.02.15 BC	15	11	Partial penumbral inv.
728160	2720.07.13 BC	15	-15	Partial penumbral vis.
728174	2720.07.27 BC	29	-1	Annular central inv.
728189	2720.08.11 BC	15	14	Partial umbral vis.
728337	2719.01.6 BC	15	-11	Partial penumbral vis.
728352	2719.01.21 BC	30	4	Total central. Inv.
728514	2719.07.2 BC	15	-7	Partial penumbral vis.
728529	2719.07.17 BC	30	8	Anular central vis.
728691	2719.12.26 BC	15	-3	Total vis.

The accord of these two intertwined perfectly symmetrical series is very rare, only five occurrences in 5,000 years (with the limits of Moon age from 29 to 30; the distance Sun-Node, -1 to +1; and Venus -87 to -86). and their observations might well have permitted to establish the Long Count. The dates, found for the meeting point of the Long Count and the Venus series (2715.05.22. BC) preceded by an exact coincidence of Venus–nodes conjunctions and a regular series of symmetrical eclipses (during the years 2721-2719 BC), certainly seems much too early for such a complex knowledge We will see later the evident implications of such an arrangement. And all could seem the result of some coincidence. Already too many coincidences indeed! – but another equivalency comes to confirm fully these first results. We find here near to the central Venus inferior conjunction of that set another very interesting approximation. The day of the inferior conjunction of Venus in the middle of the series is:
JD 728261 2720 X 22 AC LC 0.19.19.16.17
6-Caban N.86 V.0

We are then only at 23 days distance before the start of the second *Baktun* 1.0.0.0.0 of the Long Count, JD 728,284. If the astronomers wanted to set the point of reference of the Long Count on this peculiar inferior conjunction of Venus, why did they fix the departure point 1,673 days later? And what is the meaning of these 23 days of distance between that conjunction of Venus and the start of the second *Baktun*? – again much too near to be indifferent, and much too far to prove any astronomical deed.

But are there really 23 days of difference?

Between the inferior conjunction of Venus on JD 728,261 and the day of separation of the two series on JD 729,934 (22.05.2715) we have 1,673 days.

We will apply to these 1,673 days the same operation according to the proportion in which 5,200 *Tun* equal 3,250 true Venus cycles: [(25744/1897743) x 1673], and the divergence produces 22,69 days, it means 23 days in the Mesoamerican arithmetical system ignoring decimals. And this is exactly the difference we observe between the central Venus

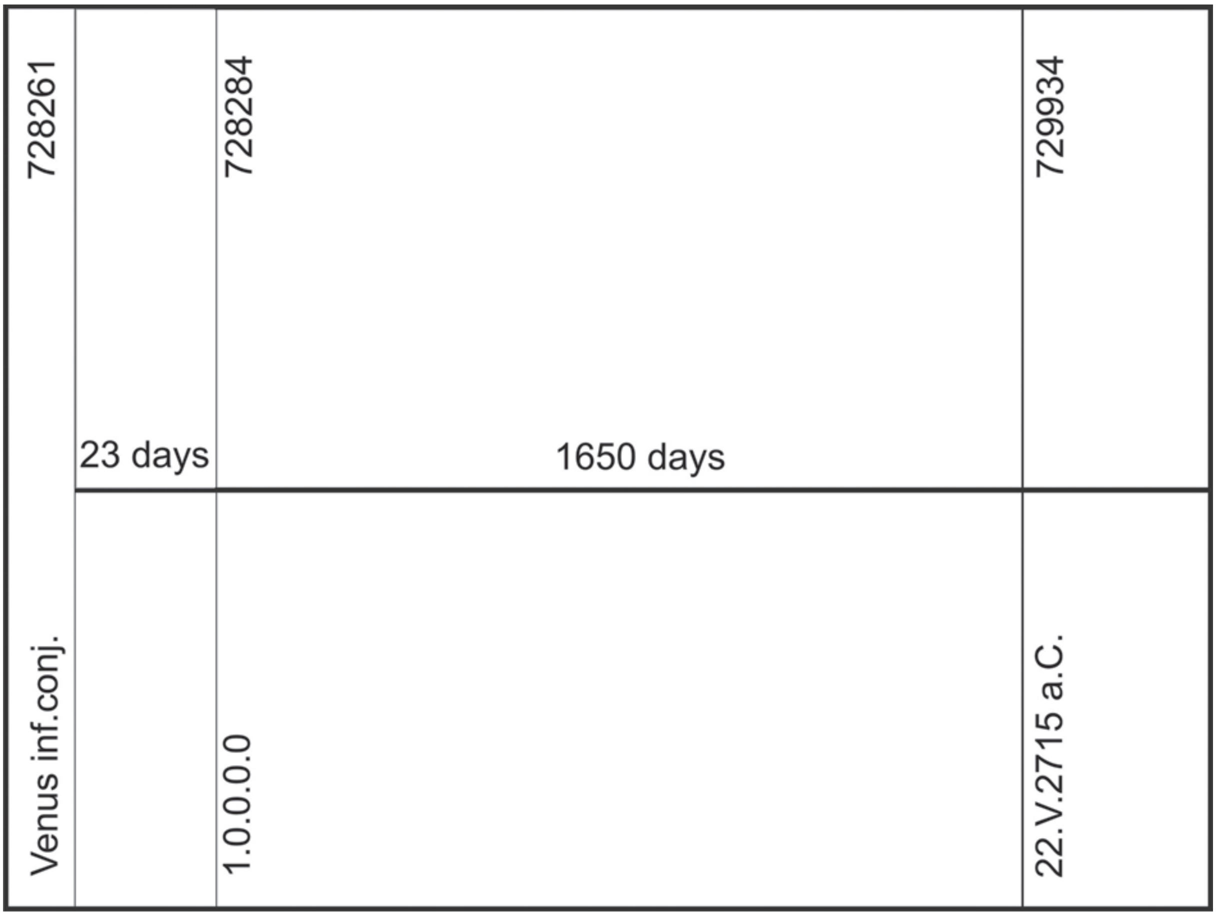

Fig. 3.

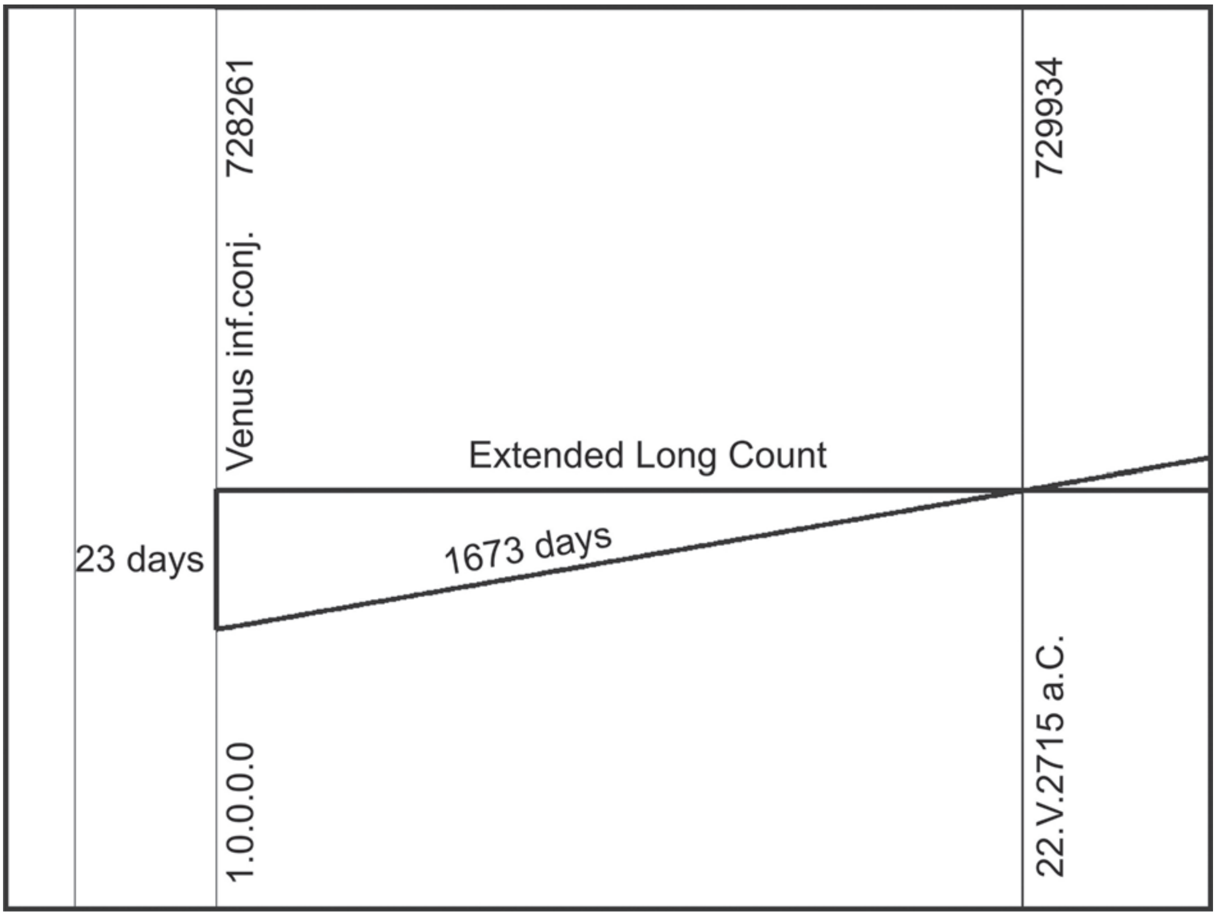

Fig. 4.

inferior conjunction (728,261) and the date 1.0.0.0.0 (728,284), which means that using this same way of extending the Long count to 3,250 true Venus cycles, with an origin on 22.05.2715 BC, the first day of the second *Baktun* coincides very precisely with the central inferior conjunction of Venus in the astronomical series mentioned above.

I consider that this very exact and unexpected coincidence obtained for the inferior conjunction at the start of the second *Baktun*, when treated with the same proportion (5,200 *Tun* equals 3,250 natural cycles of Venus), constitutes a full justification of our starting hypothesis. This could mean that the astronomers of ancient Mesoamerica wanted to index the reference point of the Long Count on that remarkable inferior conjunction. But they certainly could not pretend to be contemporaneous with the start of times, to be themselves the creators of the new world, the creators of time. They would have decided to give themselves one *Baktun* of antiquity. But again, if the ancient astronomers of Mesoamerica wanted to take this specific central Venus inferior conjunction as a key reference to the starting point of the second *Baktun*, why did they set it 1,673 days later? was it not possible to fix simply the reference point on the Venus conjunction itself? How can we then interpret this difference and the chronological root on 2715.05.22 BC? – a date on which nothing particular happened in the skies. And besides, we cannot healthily believe that a congress of astronomers met to establish this sophisticated calendar accord as early as 2715 BC. This all could have been calculated much later. We can consider that for religious and symbolical reasons the ends of epochs were supposed to coincide with the winter solstice. As it is impossible to manipulate the stars, they first looked for an inferior conjunction of Venus on a 21 or 22 of December, 32 days from the node, according to the regular figure presented previously, and that moreover would fall inside the traditional years of the New Fire Ceremony.

Between the second century BC (first known inscriptions of the Long Count) and 2500 AD we find such a situation only twice:

AD. 830.12.21 N.33 V.0

AD. 2077.12.22 N.32 V.0

This date of 21.12.830 AD is not meaningless either, as it is the end of the Xochicalco cosmology (Lebeuf 2003, note 620; Lebeuf 2012). For the accord of the Olmec Maya tradition they chose the 22.12.2077 AD and so that the end of the Long Count would also fall on a 22 of December, they chose the 22 of December 2012, exactly 65 years earlier. They probably did not have any other choice in case they wanted a start of a *Baktun* to fall also on an inferior conjunction of Venus dividing symmetrically the nodal passages of the sun, a condition which required even more complicated calculations. These two series, the conventional Long Count and the true measure of 3,250 Venus cycles necessarily had to meet on 22.05.2715 BC[2]. And the first inferior conjunction 3,250 Venus cycles before the final one in 2077, fell necessarily on JD 582,281[3]. Such a set could have been calculated later, and indeed we find the confirmation of it because of a difference between the eclipse series of the years 2721-2719 BC and the modern calculations. The fact that the calculations of Venus inferior conjunctions at the beginning and the end of the Long Cycle of 3,250, confirmed by the last one falling on the winter solstice and the reference one on JD 728,261 at the start of the second *Baktun*, and their associated nodal positions are exact to the day[4] compared to modern tables shows the abilities of ancient Mesoamerican astronomers to observe and establish perfectly those astronomical cycles. But only a good symmetrical regular series of eclipses centered on the node would permit to verify the exactness of the moment of passage of the sun on the nodes of the lunar orbit. The fact is that we observe a difference of three days between the results of a calculation by regular circular mean positions of the sun and lunar syzygies (in the eclipse series from 2721 BC to 2719 BC) and the modern values[5]. This shows us that this series of eclipses was calculated

[2] It is worth mentioning that the Mexican manuscript of the "Leyenda de los Soles" is also dated 22nd of May in the year 1558, this refers to the year the great New Fire Ceremony should have taken place, had it not been forbidden by the Spaniards. This coincidence might not be casual but referential.

[3] The fact that neither does this date coincide with the beginning of the Venus table in the Dresden Codex is because the Dresden table is also applying conventional numbers, i.e. 584 days instead of 583,92 starting from 1-Ahau 18 Kayab on 1038.10.30, JD 2,100,484. Moreover, the day 1-Ahau 18 Kayab found constantly in the Dresden Codex Venus table is the heliacal rise, not the inferior conjunction.

[4] The Mesoamerican calendar and astronomical traditions only accept the full day as the minimal unit of time and applied certainly mean regular circular motions in their calculations of the stars on their orbits. The results of a uniform calculation coincide with those of modern tables for the days 582,281 and 2,480,025 for the passage of the sun on the node of the lunar orbit at the beginning and the end of the Venus series. We cannot expect any better match than to a day more or less of difference for several reasons:

1) The JD starts at midday on Greenwich meridian;

2) The natural day starts in Mesoamerica about six hours later than in Europe;

3) We do not know at which moment started the day in Mesoamerica. Midday? Midnight? Sunrise? Sunset?

For those reasons it would be vain to look for a correspondence more precise than to the day. The extreme positions of the passage of the sun on the nodes are excellent for the days of first and last conjunctions 5,200 years apart. For the day of the first conjunction (our JD 582,281), the modern calculation by Patrick Rocher gives: 13/03/-3118 (JD 582,280) at 20h 34m 19s UTC: Venus is in inferior conjunction, diam. app.: 57.1", lat. = + 7° 26,4'. TT-UTC = 77533s +/- 9734s; Lis Brack Bernsen gives (JD 582,280), 3119 BC; March 13, 20h UT, at this time sun and Venus had the same longitude of 327° 55'. For the JD 2,480,025, the modern calculation by Patrick Rocher gives: - 22/12/2077 (JD 2480025), at 14h 40m 17s UTC: Venus in inferior conjunction, diam. app.: 63.1", lat. = + 2° 14,4'. TT-UTC = 152s +/- 31s); Lis Brack Bernsen gives (JD 2,480,025), 2077 Dec. 22 at 14H 53, Sun and Venus had the longitude 238° 33'.

[5] For the series of eclipses in the years 2721–2719 BC, we observe differences between the mean circular calculation and modern results. The measures of the first four columns were obtained using regular mean motions for lunar and solar positions according to ancient Mesoamerican standards. These results compared to the modern calculation offered by Patrick Rocher astronomer at the Institut de Mécanique Céleste et de Calcul des Éphémérides (IMCCE) UMR 8028 du CNRS de l'Observatoire de Paris differ up to three days (or degrees) for the distances between the sun and the node at the moments of syzygies. For example, for the JD 728175 which marks for us the moment of the sun-node conjunction, the modern calculation gives:

– the 19/08/-2719 at 07h 38m 26s UTC : New moon (JD 728174).

– the 19/08/-2719 at 17h 03m 14s UTC : the moon passes by the descending node of its orbit, apparent longitude: 128° 9' 30,76" (JD 728,174).

theoretically and not observed directly, and this certainly offers a strong argument for a later dating of this calendar accord, the invention and installation of the Long Count. But it also proves their ability to calculate those astronomical positions thousands of years back or forth. In any case, whichever the moment, the Long Count was installed as a conventional measure for 3,250 natural cycles of Venus and as a corrective system for the derivation of eclipse zones inside the *Tzolkin*, which is the knowledge these calculation implicitly demonstrate?

First, I estimate that to reach such precision they had to keep registrations of observations for at least three to five centuries.

They reached the exact values of:

Solar tropical year.

Venus cycle.

Moon cycles.

Cycle of the nodes of the lunar orbit.

And all of their interactions and congruencies.

The Long Count and the *Tzolkin* have never been altered nor reformed. The earliest known inscriptions date from the first century BC so that this systems was necessarily conceived earlier. All this means that the astronomers of Mesoamerica already possessed a very exact and sophisticated theory of eclipses at the latest by the end of the first millennium BC. Or more probably already as early as by the middle of the first millennium BC[6], and were able to express it in the most simple and synthetic possible manner.

All this demonstrates that from the very beginning of the formation of the Mesoamerican cosmology and calendar systems, the basic structural element was the mastering of the nodes of the lunar orbit and consequently the prevision of eclipses, and this concerns all the variations found in Mesoamerican calendar systems from the times of Olmec culture and all through the successive civilizations that used the 260 days cycle. And because Venus is the visible image of the invisible node of the lunar orbit, it was used as the most central and important object for Mesoamerican knowledge and religious philosophy for social organization. Their way of expressing it shows an impressive sense of abstraction and relativity in general.

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– the 23/08/-2719 at 23h 13m 43s UTC : the sun passes by the longitude, long. = +128° 9' 30,76" TT-UTC = 65492s +/- 7293s, which corresponds to the JD 728,278.

Lis Brack Bernsen gives 24.08.2720 BC (Julien day 728,279) at 00 :05. These two results (those of P. Rocher and L. Brack Bersen, private communications) are coherent with a minor difference and both show a significant difference of three days with my results issued of a mean uniform calculation. This same difference affects all this series of eclipses, and this explains why the theoretical eclipse on JD 728,160 did not occur in fact because at the moment of opposition, the moon was not at 15 degrees from the node, but at 18 degrees, just passed the limit. This difference comes from the variations in the velocity of the Moon on its orbit and the sun on the ecliptic due to their elliptical shapes. These differences can reach up to three days before or after the mean position. (see Christian P. Moesgaard, "The Full Moon Serpent", *Centaurus*, 1980: Vol. 24: 51-96).

6 The Olmec cylinder seal from San Andrés, Tabasco, Mexico. Dated ca. 650 BCE would push back the whole datation by half a millennium. It would mean a full understanding of the eclipse theory already at the beginning of the first millennium BC.

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Author's address:

Arnold Lebeuf
Professor emeritus, Institute for the History of Religions
Jagiellonian University, Kraków
https://orcid.org/0000-0003-1873-139X