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Dating the Five Suns of Aztec Cosmology[1]

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Abstract. The present paper shows that the Mesoamerican astronomers were indeed able to calculate the positions and periods of the Nodes of Moon orbit and based their cosmology according to eclipse possibilities and impossibilities during their successive world eras. Here mythology and imperial ideology proves to be firmly constructed on scientific observations and conclusions.

It is broadly accepted that the 'Suns', or eras of Aztec cosmology, began and ended on the days of their respective names in the years 2-Acatl, the years of the great New Fire Ceremonies returning every 52 years. It has also been claimed that eclipses accompanied these repeated cataclysms marking the end of the successive Suns. Although no such statement appear in Aztec sources, different information may lead to the conclusion supported by Susan Milbrath that the Aztecs feared the end of their world would come with a solar eclipse on a day 4-Ollin, the day name of the fifth Sun of Aztec mythology. The proposition is even more acceptable if we consider that such similar beliefs are documented in other Mesoamerican traditions, for example among the Mayas.

If the solution proposed here for the names and order of the five Suns of Aztec cosmology can be accepted, it would prove that the Aztecs based their astronomical and calendrical calculations on the same bases as the other cultures of Ancient Mesoamerica and that the location and periods of the Nodes of Moon orbit were essential to these constructions. It also suggests that an astronomical abstraction was at the centre of their religious ideology. This very schematical presentation of a new hypothesis concerning the names and order of Aztec eras is just tempting, as I am fully aware of the many odd hypotheses previously presented. I hope this new one deserves at least a careful examination, discussion and critics for further development or eventual rejection.

[1] The present paper is the reduced presentation in English of Chapter III.*5,* 'Le Soleil 4-Ollin des Azteques et la Piedra del Sol', in Arnold Lebeuf, *Les eclipses dans l'ancien Mexique* (Krakow: Jagiellonian University Press, 2003).

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For the sake of curiosity, I consulted astronomical tables to look for historical moments when such a phenomenon might have occurred (using the 584283 correlation), and found that no eclipse at all was recorded on a day 4-Ollin between the years 1040 CE and 2080 CE, largely covering the period of Aztec domination. The most striking feature in this result was that the date of the beginning of the period of impossibility for this event (an eclipse on a day 4-Ollin) coincides very closely with the date, accepted on numerous historical accounts and scholarly reconstructions, for the beginning of the present era, the historical one following mythical previous 'Suns', the epoch in which Aztecs gained power over central Mexico, i.e., 1038/1040 CE.[4]

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[2] Susan Milbrath, 'Star gods and astronomy of the Aztecs', in: *La Antropología Americanista en la Actualidad* (Mexico D.F: Editores Mexicanos Unidos, 1980), Vol. I, pp. 289–303 (p. 294); Susan Milbrath, 'Eclipse Imagery in Mexica Sculpture of Central Mexico', *Vistas in Astronomy* 39, no. 4 (1995): pp. 496–99.

[3] Maria Elena Ruiz Gallut, 'The solar eclipses in ancient Mexico', *Research Amateur Astronomy* 33 (1992) ASP Conference Series, Stephen J. Edberg, ed.: p. 216; Michael Closs, 'Cognitive aspects of Ancient Maya Eclipse Theory', in A. Aveni, ed., *World Archaeoastronomy*, Septima mesa redonda de Palenque, Mexico (New York: Cambridge University Press, 1989), p. 393.

[4] Michel Graulich, *Mythes et rituels du Mexique préhispanique* (Bruxelles: Palais des académies, 1982), p. 84, n. 22, pp. 102–03; 'Historia de los Mexicanos', in Joaquin Garcia Icazbalceta, ed., *Nueva colección de documentos para la historia de Mexico*, 5 vols (Mexico: Editorial Salvador Chavez Hayhoe, 1886-1892), Vol. 3, pp. 214–15; Francisco Chimalpahin, 'Tercera Relacion', in *Relaciones originales de Chalco Amaquemecan*, Paleografiadas y traducidas del nahuatl con una introduccion por S. Rendon, Mexico (Buenos Aires: Fondo de Cultura Economica, 1965); Fernando Alva Ixtlixochitl, *Obras históricas*, edición,

Having established that interesting coincidence, the next step was naturally to investigate the situations of the previous Sun's day's names regarding eclipses. The result was very striking. When the fifth Sun (4-Ollin) started its career of 1040 years safe of eclipses in the year 1040 CE, the previous Sun's day (4-Atl) was just entering an eclipse zone after 1040 years safe of eclipses. The Sun 4-Atl had then started in the year zero of the Christian era. The same conditions also ruled the previous three Suns – 4-Ocelotl, 4-Ehecatl, 4-Quiahuitl – each one being successively free of eclipses for 1040 years. Interestingly, a long time period of 1040 years is documented in Mesoamerican materials.[5]

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estudios introductorios y un apéndice documental por E. O'Gorman, 2 vols (Mexico: Instituto de Investigaciones Históricas, Universidad Nacional Autónoma de Mexico, 1975-1977), Vol. 1, pp .415–521 ; R. Tomicki in A. Lebeuf, 'Astronomia en Xochicalco', in J. Wimer, ed., *La Acropolis de Xochicalco,* with Miguel Leon-Portilla, Norberto Gonzales, and Beatriz de la Fuente (Cuernavaca, Mexico: Instituto de Cultura de Morelos, 1995)), pp. 211–87; J. Galindo Trejo, *Arqueoastronomia en la America Antigua* (Mexico: CNCT, 1994), p. 108; G. de Ayala, quoted by Librado Silva Galeana, *Estudios de Cultura Nahuatl* Nr. 27 (Mexico: UNAM, 1997), p. 401. Also see the final date of the Venus table in the Dresden Codex, 416 Xihuitl after 9.9.9.16.0. (1038 CE), in G. Lounsbury Floyd, 'Maya Numeration, Computation, and Calendrical Astronomy', in C.C. Gillispie, ed., *Dictionary of Scientific Biography* 15, suppl. 1 (New York: Charles Scribner's Sons, 1978), pp. 759–818.

[5] Manuel Orrozco y Berra, *Historia Antigua y de la Conquista de Mexico* (1880; Mexico: Biblioteca Porua, 1978), T.II. pp. 50, 57, quoting a manuscript of Fabrega/ This cycle is also mentioned by Cristobal del Castillo, *Fragmentos de la obra general sobre historia de los Mexicanos escrita en lingua nahuatl por Cristobal del Castillo a fines del siglo XVI* (Florencia: Tipografia de Salvador Landi, 1908); Leon y Gamma, 1979); Don Antonio De Leon Y Gama, 'Descripcion Historica y cronologica de las dos piedras que con ocasion del nuevo empedrado que se esta formando en la plaza municipal de Mexico se hallaban en el año 1750', in Eduardo Mato Moctezuma, *Trabajos arqueologicos en el centro de la Ciudad de Mexico* (1832; Mexico: INAH, 1979), pp. 25–54 (p. 53). See also Codex Borgia, fol. 48-63 and Alexander von Humboldt, 1974, *Vistas de las cordilleras y monumentos de los pueblos Indigenas de America*, prologo de Miguel Wionczek, traduccion de Jaime Labastida, secretaria de Hacienda y credito Publico, (1810; Mexico: 1974). T.2, p. 8. For these 20 x 52 years, see A. Chavero, *Mexico a traves de los siglos* (Mexico: Editorial Cumbre, 1981), T.II, also quotes Francisco del Paso y Troncoso, 'Ensayo sobre

It must be recalled here that several sources and archaeological pieces inform us about the division of Aztec cosmology into five consecutive Suns,[6] each one bearing the name of one day in the 260 days Mesoamerican Almanac, and each one was supposed to have started and ended on his day name in the years 2-Acatl.[7] The names and order of the five Suns is almost constant: 4-Ocelotl, the first; 4-Ehecatl, the second; 4-Quiahuitl, the third; 4-Atl, the fourth; 4-Ollin the fifth.[8] So the periods of eclipse impossibility for each day in the 260 days Almanac, corresponding to the five successive Suns, were following each other regularly and in the good order by steps of 1040 years.

3120 BCE – 2080 BCE 4-Ocelotl
2080 BCE – 1040 BCE 4-Ehecatl
1040 BCE – 0 4-Quiahuitl
0 – 1040 CE 4-Atl
1040 CE – 2080 CE 4-Ollin

This group of five regularly ordered periods ending in the year 2080 CE would then have lasted for 5200 years altogether (5 x 1040), and thus had started in the year 3120 BCE. These two measures are again meaningful as the length of 5200 years of one 'World' recalls the 5200 Tuns of the Long Count of the Olmec/Maya system (13 x 20 x 20 x 360 days), and the year 3120 BCE (in fact 3119 BCE, see further down) falls precisely on the well documented start of the Venus table in the Dresden Codex (3119 BCE), a table built on sequences of 104 years commanding the

los simbolos cronologicos de los mexicanos', *Anales del Museo*, época, I, v.2 (1992), pp. 325–402.

[6] The *Leyenda de los Soles*, the *Historia de los Mexicanos por sus Pinturas*, the *Anales de Cuauhtitlan*, and the *Historia Tolteca-Chichimeca* by Motolinia, the *Obras historicas* of Alva Ixtlixochitl and some monuments agree with the Aztec Calendar Stone on the names, number and order of the five Suns.

[7] It must be mentioned that the *Leyenda de los Soles* gives the same names and chronological order as other sources but other days for the start and end of the five Suns, it also presents uneven lengths for their durations, this is a problem which cannot be discussed here.

[8] Only Motolinia differs from other sources ,calling the fifth Sun 4-Acatl instead of 4-Ollin. For this question, see A. Lebeuf, *Les eclipses dans l'ancien Mexique* (Krakow: Jagiellonian University Press, 2003), p 282.

Great Ancient New Fire Ceremonies (Huehuetiliztli).[9] This all suggests that the Aztecs might have used the same basic astronomical code as the Olmecs and Mayas to construct their cosmology. It could be that the Aztec reform of the calendar might just have divided the world era of 5200 years differently, as it is known that the previous systems were built on only four successive Suns to which the Aztecs added a fifth one. The Aztec reform would have been principally aimed at constructing an ideology that insured them an invincible empire of 1040 years, a lapse of time during which their Sun, the Sun 4-Ollin could not be eclipsed.

But what could be the technical reason for such a regular succession of safety and vulnerability epochs of the five Suns of Aztec cosmology? The Potsdam astronomer Hans Ludendorff gave the elements of an answer in 1930. In his article 'About the origin of the Tzolkin period in the Maya calendar', Ludendorff claims that both the 260 days Almanac and the 5200 Tuns Long Count were constructed in order to serve the tracking of the nodes of Moon orbit and the prediction of eclipses.[10] According to him, these two calendar wheels constitute a sort of archaic simple computer for eclipse prediction at short and long run.

1) The 260 days Almanac (Tzolkin) is congruent with eclipses seasons because 2 x 260 =520, and 520 = 3 x 173,333. This last measure (173,3 days) is very close to the period separating the successive passages of the Sun on alternative nodes of Moon orbit. Because of this congruence between the Almanac and the eclipse seasons, the Sun passes on the Nodes regularly on only three equidistant days in the 260 days Almanac. But because the Moon or the Sun can be eclipsed within 17 days distance from the nodes, any New Moon less than 17 days off the Node will eclipse the Sun, and every Full Moon less than 17 days from the Node will be eclipses by the Earth shadow. The three equidistant days in the Almanac mark the central points of three eclipsable

[9] The New Fire Ceremony was celebrated every 52 years at the congruency of the 260 and 365 days cycles. To reach also the congruency with the 584 days Venus cycle, one has to wait for the double period of 104 years, as 65 x 584 = 104 x 365 = 146 x 260.

[10] Hans Ludendorff, 'Über die Entstehung der Tzolkin Period im Kalendar der Maya', in *Preussischen Akad. der Wissenschaft, Phys.-Math. Classe* (Berlin: 1930).

zones, each of 35 days. The nearer to the Nodes (central days of these eclipse windows) and the larger the magnitude of the eclipse. The further from the Nodes, the smaller the eclipse. Further out than 17 days, an eclipse is impossible.

2) Of course, the exact 'geometrical' measure of 173,3333 days, resulting from the division by three of the double Tzolkin, which was accepted for the time distance between the passages of the Sun on opposite Nodes of Moon's orbit is not absolutely exact, and the real measure is slightly inferior. This means that the three eclipse windows are slowly regressing in the Almanac. Ludendorff calculated that the rate of regression of the nodes in the Almanac is of one day for twenty Tuns, and thus it would take 5200 Tuns for the Nodes and eclipse windows to regress by one complete revolution in the Almanac of 260 days (260 x 20).[11]

According to Ludendorff, both the Tzolkin and the Long Count were established in order to represent the eclipse periods. I do not want to enter here into detailed criticism of these numbers; the general thesis of Ludendorff is very appealing. Let us only accept that the Tun of 360 days could represent an arithmetical approximation easier to manipulate than the 365 days year (Haab) and in some cases, one stands for the other and can replace it.[12] In any case, if the regression of eclipse windows in the Almanac is of one day for twenty years, any specific day of the Almanac entering an eclipse window will be potentially a day of eclipse for the next 700 years (35 x 20 = 700). It will then enter into a zone of eclipse security for the next 1040 years before it enters the next eclipse window. The reason for this is that if we subtract 3 x 35 days for the three equidistant eclipse windows from the 260 days of the calendar, we have 155 days left, also divided into three equidistant zones of 52 days (the Mesoamerican mathematics ignore fractions), and it necessarily takes 1040 years for a day of the Almanac to drift through these 52 days zones

[11] The Tun is a measure of 360 days resulting from the multiplication of 20 by 18.

[12] Mesoamerican convention seems to have counted 260 days of regression for 5200 Haab/Xihuitl, but in fact, the regression of the nodes in the Tzolkin is of only 256 days during this period of time, and Ludendorff's solution would have given slightly less even.

of eclipse impossibility at the rate of one day for twenty years. This is precisely the reason why each of the days of the five successive suns of the Aztec cosmology last for 1040 years successively. But the marvel of the organisation is that each one starts its career when the previous one finishes, and also that this mechanism respects the good order of the Aztec cosmology as reported in ancient chronicles and on monuments.

But one could argue that any five days dividing regularly the 260 days Almanac would produce the same effect. Certainly so, but no single set of five Almanac days evenly dividing the Almanac would fall on new fire ceremonies years well documented in archives and start in the same year as the Venus/New Fire Ceremonies of the Dresden Codex. Moreover, the repartition of the five days is not regular in the Almanac. In the event that the names of the five days naming the Suns would be regularly spaced at 52 days distance in the Almanac, we could argue that this eclipse specificity is just a natural result of a calendrical order and was not necessarily intended. We could believe that the builders of Aztec cosmology only wanted to represent the cosmos according to a regular pattern for the sake of good order, aesthetics and mythological balance, and that the coincidence with eclipse seasons is just a necessary result of a regularly divided cosmogram, some sort of geometrical mandala. But this is not the case, and the distances inside the Tzolkin between the five days are 52, 13, 143, 130 and 52 days, respectively.

The reason for this irregularity of the pattern comes from a set of three restrictive conditions imposed on the builders of the calendar.

1. Best possible post-nodal distance position near 17 days off the Node, at the limit out of the eclipse windows.

2. Day names indexed on a number 4, probably for the sake of mythological aesthetic and ritualistic preference for regularity (4-Ocelotl; 4-Ehecatl; 4-Quiahuitl; 4-Atl; 4-Ollin).

3. A day falling in the year 2-Acatl, the only acceptable year date for the Aztec Celebration of the New Fire Ceremony.

When we accept these three limitations for the starts of the five Suns, we obtain the following results: (all dates in retroactive Gregorian calendar).

9 VII 3119 BC 4-Ocelotl A. 2-Acatl Node +16

22 IX 2080 BCE 4-Ehecatl A. 2-Acatl Node +15
21 XI 1041 BCE *4-Itzcuintli* A. 2-Acatl Node +14
7 I 1 CE 4-Atl A. 2-Acatl Node +18
9 III 1040 CE 4-Ollin A. 2-Acatl Node +17

We see here that four of the day's names fitting best the imposed restrictive conditions are precisely those of the Aztec Suns. The only exception is for the name chosen for the third Sun, recorded as 4-Quiahuitl in sources when we find 4-Itzcuintli as the best possible answer to our requests. On the 9th of May 1040 BCE (a year 2-Acatl), the day 4-Quiahuitl was only 10 days off the nodal Sun passage and the second best position after 4-Itzcuintli (node +14). Why then has it been chosen instead of the better solution 4-Itzcuintli? The reason is most probably ritual and symbolic, as it is well known that the day Itzcuintli, meaning *a dog* is associated to death, illnesses and a bad omen, it would certainly not be acceptable for the birth of a New Sun and a re-creation of the world.[13] And for that reason, was replaced by the next best astronomical candidate filling the conditions imposed by the ritual and mythology.

If the solution proposed here for the names and order of the five Suns of Aztec cosmology can be accepted, it would prove that the Aztecs constructed their astronomical and calendrical calculations on the same bases as the other cultures of Ancient Mesoamerica and that the location and periods of the Nodes of Moon orbit were essential to these constructions. It also suggests that an astronomical abstraction was at the centre of their cosmology and religious ideology.

This very schematic presentation of a new hypothesis concerning the names and order of Aztec eras is just tentative, as I am fully aware of the many odd hypothesis previously presented. I hope this new one deserves at least a careful examination, discussion and critics for further development or eventual rejection.

[13] Hermann Beyer , 'El significado simbólico del perro en el Mexico antiguo', in *El Mexico Antiguo*, Tomo X (1965): pp. 440–43; M. de la Garza, 'El Perro como simbolo religioso', in *Estudios de Cultura Nahuatl* Nr. 27 (Mexico: UNAM, 1997), pp. 112–33.

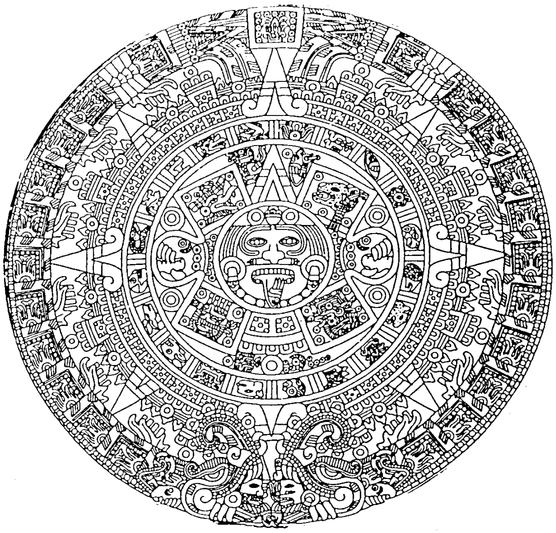

Figure 1. The Aztec calendar stone, Museum of Anthropology and History, Mexico.

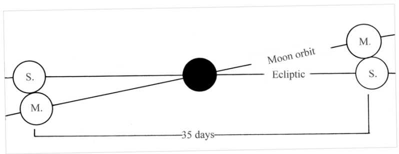

Figure 2. The node of Moon orbit on the ecliptic and the reason why the eclipse zones cover 35 days

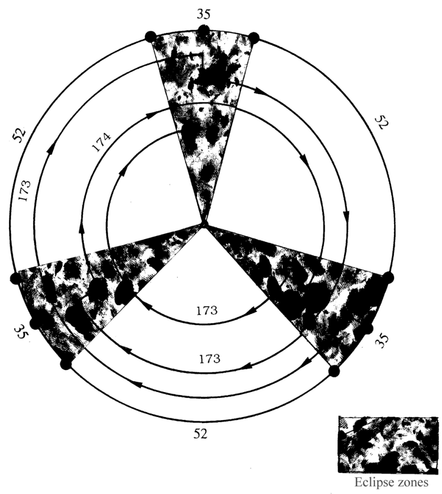

Figure 3. The three eclipse zones of 35 days and three eclipse free zones of 52 days in the 260 days Almanac (Tzolkin/Metzpohualli); successive passages every 173/174 days of the Sun on successive nodes.

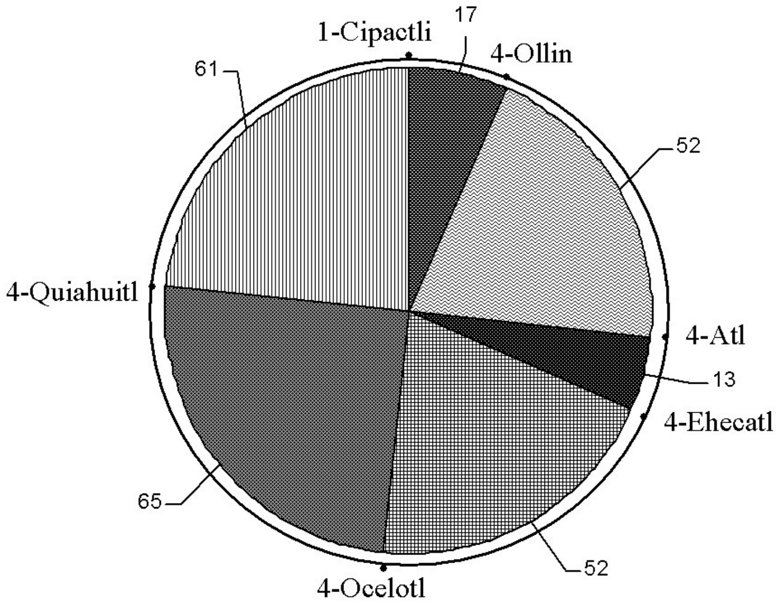

Figure 4. Uneven repartition of the five days in the Almanac. (One Cipactli is here added only to mark the classical start of the Almanac during the last Sun. In 1040 A.D. it was the seat of the node, 17 days off the date 4-Ollin.[14])

[14] Exactly in the same way as the day 1-Tecpatl is the seat of the node of Moon orbit in 3120 BC when the day 4-Ocelotl starts its career 17 days after the node at the start of the first Sun.