Serb. Astron. J. № 204 (2022), 65 - 76 **UDC 523.41–13 (=972.6)**
DOI: https://doi.org/10.2298/SAJ211222002V Original scientific paper

DID OLD MAYA OBSERVE MERCURY?

J. Vondrák[1], V. Böhm[2] and B. Böhm[†]

[1] *Emeritus at Astronomical Institute, Czech Academy of Sciences, Boční II 1041, 141 01 Prague, Czech Republic, ORCiD 0000-0002-4674-0771*
E–mail: *vondrak@ig.cas.cz*

[2] *Retired from The University for Political and Social Sciences, Barborská 52, 287 01 Kutná Hora, Czech Republic*
E–mail: *jarolik@post.cz*

(Received: December 22, 2021; Accepted: January 25, 2022)

SUMMARY: It is well known that the rich culture of old Maya contained, among other, also a very complicated and complex calendar, in which they recorded not only historical events, but also significant astronomical phenomena. Main source of information is the Dresden Codex, roughly covering the interval between 280 and 1325 AD. The problem of the so-called correlation between Mayan and our calendars (expressing the difference between Long Count of Mayan calendar and Julian date) is very old, there exist about fifty different solutions that mutually differ by up to hundreds of years. Out of these, historians mostly accept the so-called Goodman - Martínez - Thompson (GMT) value of 584 283 days, which is based almost entirely on historical events. On the contrary, we stressed very precisely dated astronomical data, demonstrated the contradictions of GMT with them, and derived the so-called Böhm correlation (BB) of 622 261 days, which is in excellent agreement with astronomical phenomena recorded in Dresden Codex. Maya researchers are mostly convinced that Maya did not pay much attention to Mercury. Here we conclude that the truth is opposite; we analyze the data in Dresden Codex and find many records corresponding to visibility of Mercury near its maximum elongations from the Sun, and also to their conjunctions.

Key words. Ephemerides – Planets and satellites: individual: Mercury – History and philosophy of astronomy – Time

1. INTRODUCTION

Mercury can only be observed with naked eye with difficulty near its maximum elongations from the Sun. The old Maya evidently did not have a special glyph for Mercury in their records. There is a hypothesis that the Maya connected Mercury with an owl (or even two or four owls). We looked for the origin of this hypothesis and found it in a short article by Potter (1988). It says that D. Tedlock, who translated a book Popul Vuh (Quiché Mayan book of creation), suggests that the owls correspond to the planet Mercury because the movements of the owls (mentioned there as messengers to and from underworld), described in the book, match the movement of the planet Mercury. This seems to be highly speculative, with no sufficient reasoning. In addition, we

† This paper is devoted to the memory of Bohumil Böhm who contributed to this study from the very beginning, and deceased in 2015.

found no owl glyph accompanying the dates of Mercury observations in Dresden Codex. Also, Popul Vuh is much younger than Dresden Codex, so we are convinced that this hypothesis is not true.

These facts are probably the main reason why many Maya researchers think that the Maya did not pay much attention to Mercury (see, e.g., Thompson (1960)). On the other hand, some of them admit that the Maya might observe Mercury and record their observations – see, e.g., Aveni and Hotaling (1994). The reader can find more details in comprehensive studies like (Powell 1997) or (Bricker and Bricker 2011). In the following, we shall try to prove that the Maya did observe Mercury, based on the analysis of calendar dates recorded in the Dresden Codex.

1.1. Short history of Maya civilization and its astronomy

The following text provides an abridged historical background to our study. More reading about the Maya civilization and astronomy is available at `https://en.wikipedia.org/wiki/Maya_civilization#Astronomy.`

In the territory of today's Mexico, Guatemala, Belize, Northwest Salvador, and West Honduras important indigenous civilizations were formed, during thousands of years. They were practicing agriculture (growing mainly maize) and their sufficient reserves of foodstuffs eliminated their everyday dependence on nature. It also led to the growth of population whose part could practice non-agricultural activities. They specialized in handicrafts, commerce, building, arts, and also spirituality. Their villages started to grow and change to the places of social contacts; local religion cults are formed, connected with corresponding ceremonials. Spacious buildings were constructed, ranging from simple barrows with wooden shrines to stone pyramids, temples and whole cities. These places became centers of religious cults, education and arts, and they were also points of markets and exchange of goods. Step by step, peculiar cultural activities appear in different parts of Mexico and neighbouring areas. Among these new civilizations existed mutual interchange of both material and spiritual values, but sometimes also conflicts.

Out of them excels especially the Mayan civilization (see the map in Fig. 1, taken over from `https://discover.hubpages.com/education/Facts-about-the-Maya-Indian`). Its development proceeded similarly to others, but it differed from them namely in the field of spiritual culture. Here, the Maya reached such a high level that their outstanding intellectual achievements overcame their simple technological possibilities. The Maya developed a hieroglyphic writing system and a complicated calendar, probably coming from the Olmec civilization. Outstanding are also the results of their astronomical observations and calculations. E.g., they determined the length of tropical year, synodic periods of all visible planets, observed the timing of their mutual positions and conjunctions, maximum elongations of Mercury, or solar eclipses.

The origin of Maya civilization is seen at the old agricultural settlements on the Pacific shore of Guatemala (Clark and Pye 2005, Serrano and Schawrz 2005) and Guatemalan highlands (Popenoe de Hatch 1989). The oldest ones are placed to 2200–1900 BC (Estrada-Belli 2011). The settlements quickly spread throughout the entire Mayan territory. Big settlements with temple barrows are built, sometimes covered with stone, topped with wooden shrines. E.g., in archaeological locality Kaminaljuyú at Guatemala Highlands, there are about 200 of such barrows. Some of them have luxuriously equipped tombs. Their origin is put between 300 BC and 200 AD. This development culminated in El Mirador in the north of Guatemala, close to Mexican border. During centuries, a gigantic temple city grew containing tens of pyramids (Pérez 2013). The largest one is La Danta, one of the largest buildings in the world (Suyuc Ley and Hansen 2013). During the second and third century AD, El Mirador collapsed (Sharer and Traxler 2006) due to dry weather. But the cultural boom quickly developed throughout the entire Mayan territory, splendid stone cities were build. One of the most elegant temple cities is Palenque in today's Mexican state Chiapas. Temples are built on step terraces, with large stone panels containing hieroglyphic scripts.

After 800 AD, there comes a disaster. Due to catastrophic draughts and invasion of militant groups from the central Mexico, Mayan cities were abandoned. Cultural activities moved to Yucatán, with the most powerful city of Chichén Itzá. But, even these late cities were abandoned step by step. At the beginning of 16th century, after the Spanish invasion, the Maya lived only in simple villages. The glory of the past had completely disappeared.

1.2. Maya calendar, correlation

The Maya developed a very complicated calendar system (Foster 2002). It consisted of several cycles that can be represented by a simple scheme shown in Fig. 2. Parallel to this, there also exists the so called Long Count (LC) expressing the number of days elapsed since the origin of Mayan chronology. The whole cycle has the value of 1 872 000 days. After its end, a new cycle began. All cycles shown in Fig. 2 and the LC met after 136 656 000 days, i.e., after 374 152 years. The LC is similar to Julian Date (JD) used in astronomy. In the preserved texts in Dresden Codex (DC, see below), the dates expressed in LC are usually accompanied by dates in the 260-day Tzolkin and 365-day Haab'. To express the date in LC the Maya used a modified vigesimal (base-20) positional numeral system of five time intervals and their multiples. These intervals are as follows:

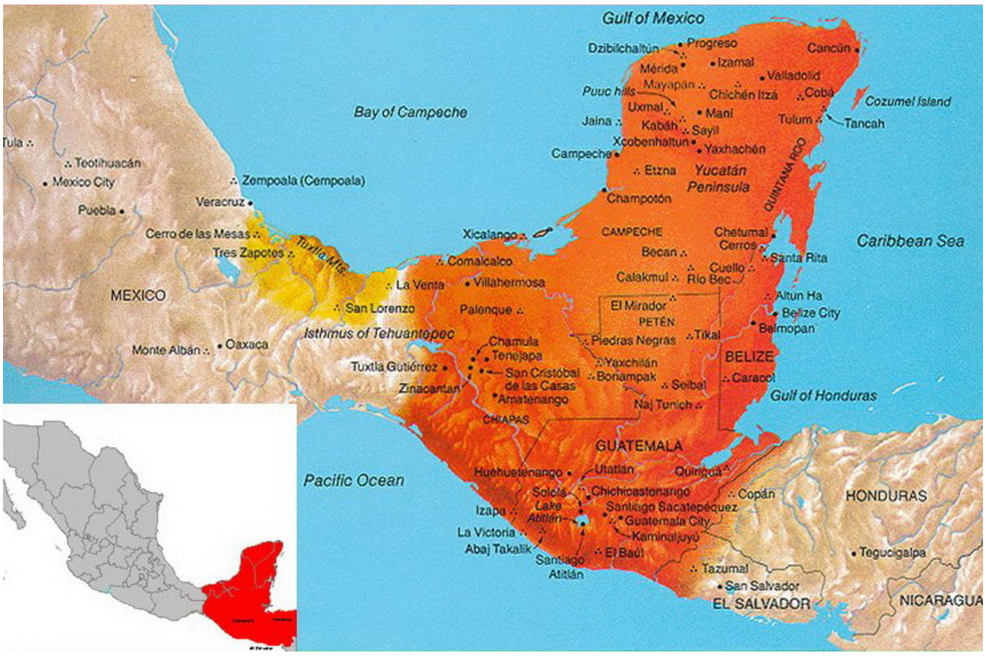

Fig. 1: Region of Maya settlements.

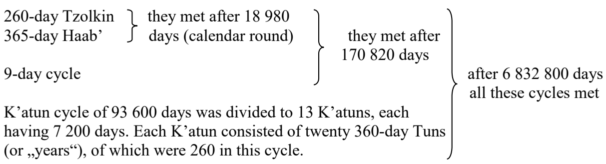

Fig. 2: Maya calendar.

K'in = day

Uinal = 20 K'ins

Tun = 18 Uinals = 360 K'ins

K'atun = 20 Tuns = 7 200 K'ins

B'ak'tun = 20 K'atuns = 144 000 K'ins

The date in LC is therefore written in Maya scripts as five numerals, usually ranged from top to bottom, or from left to right. These numbers lie usually between 0 and 19, with the only exception of Tun that lies between 0 and 17. In order to convert the Maya LC to our JD, historians introduced the so called *correlation* which is simply the difference between the JD and LC expressed in days. Many authors tried to derive this value, with significantly different results. We counted 52 such values which are listed, together with corresponding references, in our earlier papers devoted to the correlation, some in (Klokočník et al. 2008), and all of them in (Böhm et al. 2013). The differences among them are enormous – they range from 394 483 to 774 083 days. Historians (to name at least one of many, Powell (1997)) mostly accept the value 584 283 days (Thompson 1935), which is based dominantly on historical data; this one is denominated as the Goodman - Martínez - Thompson (GMT) correlation.

In contrast to this, we used only astronomical data, that are precisely dated in the JD from the theories of planetary motions (practically *any planetary theory* developed during the past century is capable of predicting these phenomena with accuracy much better than a day; here we use the theory by Bretagnon and Francou (1988)), to derive our own correlation (Böhm and Böhm 1991b, Böhm and Böhm 1996). It was later confirmed by Klokočník et al. (2008) or Böhm et al. (2013). To this end, we used the astronomical data recorded in the DC, namely heliacal risings/settings of planets (i.e., the moments when the planet is first/last seen above horizon before sunrise/sunset); heliacal risings of Venus and Saturn and heliacal settings of Jupiter were used. We also used solar eclipses and conjunctions of Venus with Mars. The obtained value 622 261 days is denoted as the Böhm correlation (BB). Unlike GMT, it fits excellently with all above mentioned astronomical phenomena.

1.3. Dresden Codex

Unfortunately, most of Maya inscriptions were destroyed during the Spanish Inquisition; Dresden

Codex (DC) is one of the four hieroglyphic codices that survived. DC was rediscovered in Dresden (hence its name), and is now deposited in the museum of the Saxon State Library. It is a book represented as a belt of paper which is folded to 39 sheets (78 pages), of size 8.5 × 20.5 cm. Its origin is put on Yucatán Penninsula. It is probably a copy made from three different original sources around 1200 AD, and it covers the interval between 280 and 1325 AD. The DC is written in Mayan glyphs and refers to an original text from three to four hundred years earlier, describing the local history and astronomical tables. The reader can find more details in (Thompson 1972) or https://en.wikipedia.org/wiki/Dresden_Codex. The dates in the DC are not ranged chronologically and quite often they are not marked which phenomenon they refer to. Sometimes they appear in pairs, and the difference between the two dates is also recorded. They are often expressed in LC, but some of them only by a date in the 260-day Tzolkin, or as a difference from the preceding LC date.

2. SELECTION OF POSSIBLE DATA CONCERNING MERCURY

To find the dates in DC that probably refer to some Mercury phenomena we use the method, proposed earlier by brothers Böhm, published in Czech (Böhm and Böhm 1991a), and called it the method of 'non-integer remainders'. It consists in the following:

1. LC dates from DC are divided by length of the synodic period of Mercury (115.88 days);
2. The remainder after division is further divided by the same period, the result is a number between 0 and 1;
3. Groups of dates with similar remainders are detected. These are probable candidates for some Mercury phenomenon;
4. These dates are converted to JD by adding the BB correlation, and further (by standard procedure) to Julian Calendar;
5. Positions of Mercury and the Sun around this date with respect to the horizon of Palenque (17°29′ N, 92°03′ W) are calculated in order to see if Mercury was visible.

An example comes from page D24 of the DC, shown in Fig. 3, where we found two dates in the LC and their difference, most probably referring to Mercury.

There are two LC dates and their difference, shown in frames. Below we show these dates and their conversion into decimal system (in brackets):
9.9.9.16.0 (1 364 360)
9.9.16.0.0 (1 366 560)
the difference 6.2.0 (2 200 days).

They correspond to dates in Julian calendar: January 27, 727 and February 4, 733, respectively, if the BB correlation is applied. It appears that these two dates are only several days different from the maximum elongations of Mercury from the Sun[1] that occurred on January 21, 727 and January 31, 733. The difference of 2 200 days expresses a concourse of the synodic (118.88 days) and sidereal (87.97 days) period of Mercury with the length of tropical year (365.24 days). It contains 19 synodic, 25 sidereal periods and 6 tropical years. After such time interval, Mercury is located in almost identical position with respect to the Sun and stars, and occurs in the same season above the same part of the horizon. These two dates are displayed in the next Subsection 2.1, Table 1, as items No. 12 and 13, respectively.

Several other examples offers page D49, shown in Fig, 4. The dates displayed on the left are represented as the LC (5 numerals) and the differences (3 and 2 numerals below them, respectively) to be subtracted from them to obtain other dates. The dates on the right are all given in LC. Three numbers in brackets are corrections: (9) on the left is to replace a probably erroneous numeral 10, (10) and (9) on the right to add the missing ones, corresponding to B'ak'tuns. The latter two dates overlap in the DC, one in brown numerals, one in black. Thus, we identify 12 different dates that are summarized below, with their positions in Tables 1 and 2 in Subsections 2.1 and 2.2, respectively:

9.13.12.10.0	Table 2, No. 4
-1.12.6	
9.13.10.15.14	Table 1, No. 14
9.19.11.13.0	Table 1, No. 17
-4.10.6	
9.19.7.2.14	Table 2, No. 7
8.6.16.12.0	Table 1, No. 1
-4.6	
8.6.16.7.14	Table 2, No. 1
8.16.19.10.0	Table 2, No, 2
-(9).8	
8.16.19.0.12	Table 1, No. 10
10.17.13.12.12	Table 1, No. 19
10.11.3.18.14	Table 2, No. 8
(9).15.9.15.14	Table 2, No. 6
(10).14.2.16.12	Table 2, No. 9

2.1. Maximum elongations

We inspected the dates in a part of DC and found quite a number of candidates that could refer to Mercury. First group of 19 events, displayed in Table 1, evidently belong to the visibility of Mercury. In the

[1]We consider geocentric elongations throughout the paper. The difference from the topocentric value is quite negligible, due to very small parallaxes (several arcseconds) of Mercury and the Sun.

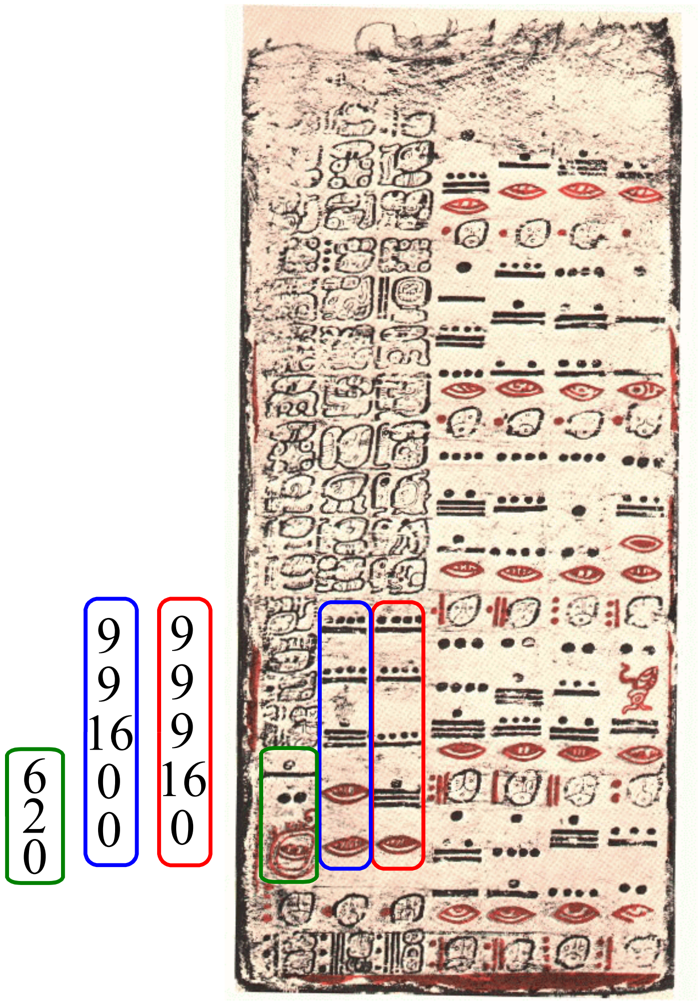

Fig. 3: Page D24 of Dresden Codex containing two dates referring to Mercury.

header, page means the page in the DC where the date was found, LC stands for the Long Count date as recorded there (the number in brackets means that the inscription was partly damaged and we reconstructed this value). LC days is then the LC converted into decimal system, JD is the Julian date calculated from the preceding column by adding the BB correlation. Finally, the last two columns contain the date in the Julian calendar, converted from JD and the one of nearest maximum elongation, calculated from the motion of Mercury and the Sun, respectively. These two dates are rather close – they differ by no more than several days which is quite acceptable considering the fact that the elongation near its maximum changes very slowly (the elongation typically decreases by about $0.^\circ1$, $0.^\circ7$ and $1.^\circ3$ for two, five and seven days apart from the date of its maximum, respectively).

We further analyzed the dates of the table and among them found many cases with important concourse of the three periods mentioned above (including the example shown above):

No. 12 and 13 interval of 2 200 days (19 synodic, 25 sidereal, and 6 tropical);

No. 2 and 12 interval of 130 375 days (1 125 synodic, 1 482 sidereal, and 357 tropical);

No. 3 and 5 interval of 34 303 days (296 synodic, 390 sidereal, and 94 tropical);

No. 5 and 9 interval of 4 3908 days (38 synodic, 50 sidereal, and 12 tropical);

No. 6 and 11 interval of 16 461 days (142 synodic, 187 sidereal, and 45 tropical);

No. 8 and 16 interval of 160 716 days (1 387 synodic, 1 827 sidereal, and 619 tropical);

No. 9 and 18 interval of 226 083 days (1 951 synodic, 2 570 sidereal, and 619 tropical);

No. 10 and 19 interval of 293 280 days (2 531 synodic, 3 354 sidereal, and 803 tropical.

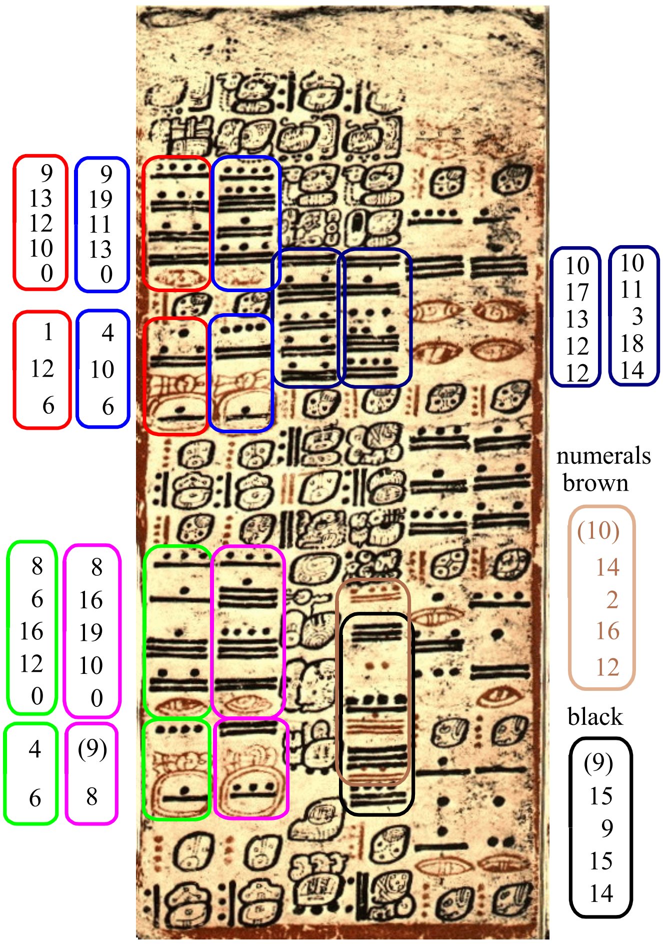

Fig. 4: Page D49 of Dresden Codex containing twelve dates referring to Mercury.

These dates, therefore with no doubt, refer to the positions of Mercury. In groups of dates No. (2, 12, 13), (3, 5, 9,18), (6, 11), (8, 16), and (10, 19) we can expect that the positions of Mercury with respect to the Sun and local horizon were very similar, and they occurred in the same part of the year. For these 19 cases, we calculated more precisely the Mercury positions, with respect to the Sun and local horizon, around these dates. In the range ± 2 to 3 weeks from the dates of Table 1 , we calculated for each day:

- heliocentric positions of Mercury and the Earth, using the semi-analytic planetary theory VSOP 87 (French abbreviation: Variations Séculaires des Orbites Planétaires) by Bretagnon and Francou (1988),
- converted them to the geocentric equatorial system,
- calculated the moments of civil twilight (when the altitude of the Sun is $6°$ below horizon) for the location of Palenque (latitude $17°29'$ N, longitude $92°03'$ W), and
- calculated, for these moments and the same location, the topocentric horizontal coordinates (azimuth, altitude) of Mercury, the astronomical refraction included.

The results are graphically displayed in Figs. 5 to 15. Figs. 5 through 9 are organized according to the groups of dates with similar positions of Mercury, mentioned above. The rest of them show single plots, with no 'partners' with similar behaviour. In each plot, the position of Mercury with respect to the horizon (azimuth A, measured from the south, and altitude h above the horizon, including astronomical refraction) at the moment of civil twilight is shown for each day. Only the dates with altitude exceeding $5°$ are shown. Three different dates are marked with a cross – date recorded in DC, the date of maximum altitude and date of maximum elongation. The magnitude of Mercury m is also displayed, for the dates of beginning, maximum altitude and ending of the graph.

We expect that the Maya observed the date of the maximum altitude above the horizon rather than the elongation from the Sun; they had no instrument to directly measure the angular distance between Mercury and the Sun. These two events occur usually very close to each other but the date recorded in DC differs from them more (usually by up to a week, two weeks in one case).

Fig. 5 shows the positions of Mercury near its maximum west elongations for the dates No. 2, 12 and 13, i.e. the ones that appeared before sunrise above the east horizon. The maximum elongations occurred on February 23, 370, January 21, 727 and January 31, 733, with angular distances 27.7, 26.1 and 26.7 degrees, respectively, from the Sun. As expected, all three plots display similar time behaviour, they occur in the same part of the year, and above the same part of the horizon. Time behaviour of Mercury's magnitude is also almost identical.

Fig. 6 shows the positions of Mercury near its maximum west elongations for the dates No. 3, 5, 9 and 18, i.e. the ones that appeared before sunrise above the east horizon. The maximum elongations occurred on October 13, 370, September 10, 464, September 29, 476 and September 18, 1095, with angular distances 19.0, 17.9, 18.4 and 18.0 degrees, respectively, from the Sun. Again, all four plots look quite similar, they occur in September/October, and approximately at the same azimuth. Also, the magnitude behaves similarly.

Fig. 7 shows the positions of Mercury, near its maximum east elongations for the dates No. 6 and 11, i.e., the ones that appeared after sunset above the west horizon. The maximum elongations occurred on May 10, 475 and May 29, 520, with angular distances 23.6 and 25.2 degrees, respectively, from the Sun. As expected, both events occur in the same month, at almost the same azimuth, and also the time evolution of Mercury's magnitude is similar. However, the date of the second event, recorded in DC, is rather apart from the maximum elongation and altitude.

Fig. 8 shows the positions of Mercury, near its maximum east elongations for the dates No. 8 and 16, i.e. the ones that appeared after sunset above the west horizon. The maximum elongations occurred on September 6, 475 and September 18, 915 with angular distances 25.8 and 25.3 degrees, respectively, from the Sun. Again, the time evolution of Mercury's position in both plots is almost identical and at similar azimuths, the magnitude behaviour is practically the same.

Fig. 9 shows the positions of Mercury near its maximum east elongations for the dates No. 10 and 19, i.e. the ones that appeared after sunset above the west horizon. The maximum elongations occurred on October 22, 479 and October 12, 1282 with angular distances 22.5 and 23.8 degrees, respectively, from the Sun. As expected, both plots are similar again, i.e.

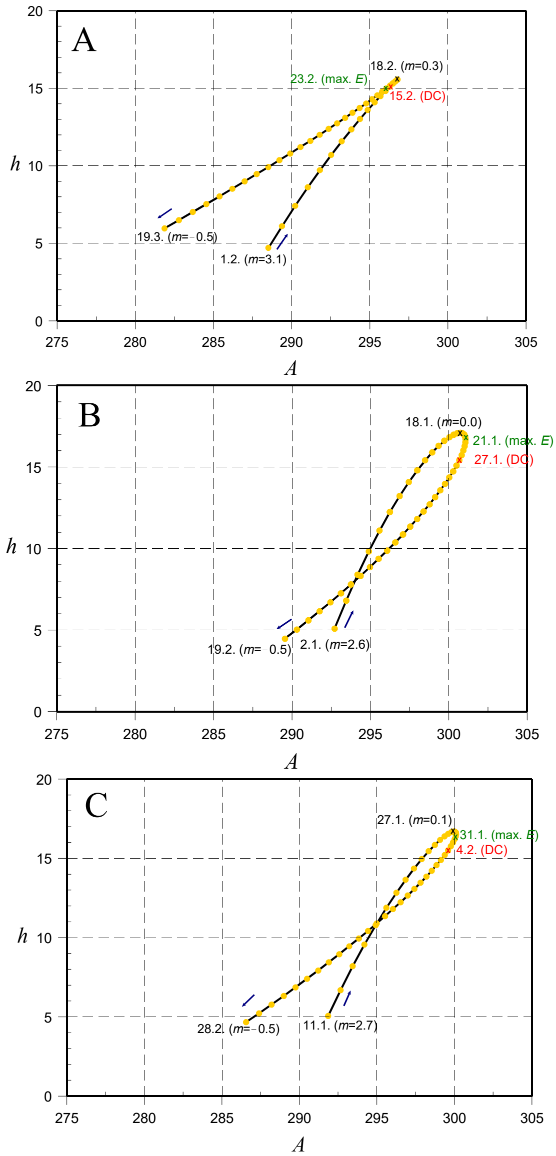

Fig. 5: Positions of Mercury at the moment of civil twilight in January/February 370 (A), 727 (B), 733 (C).

around the same azimuth, as well as the magnitude behaviour. All three crosses, referring to the maximum elongation, maximum altitude, and the date in DC, are close to each other.

Fig. 10 shows the positions of Mercury, near its maximum west elongation for the date No. 1, i.e. the one that appeared before sunrise above the east horizon. The maximum elongation occurred on May 16, 280, with angular distance 23°.5 from the Sun.

Fig. 11 shows the positions of Mercury near its maximum east elongation, for the date No. 4, i.e. the one that appeared after sunset above the west horizon. The maximum elongation occurred on April 16, 450 with angular distance 21°.6 from the Sun.

Fig. 12 shows the positions of Mercury near its maximum west elongation for the date No. 7, i.e.

Table 1: Dates in DC close to maximum elongations of Mercury from the Sun. The number in brackets marks reconstruction of a corrupted inscription, addition of a missing item or correction of misprint.

No.	page	LC	LC days	JD	Jul. calendar	max. elong.
1	D49	8.6.16.12.0	1 201 200	1 823 461	May 13, 280	May 16, 280
2	D42	8.11.7.13.5	1 233 985	1 856 246	Feb 15, 370	Feb 23, 370
3	D42	8.11.8.7.0	1 234 220	1 856 481	Oct 8, 370	Oct 13, 370
4	D40	(8).15.9.1.3	1 263 263	1 885 524	Apr 14, 450	Apr 16, 450
5	D42	8.16.3.12.3	1 268 523	1 890 784	Sep 7, 464	Sep 10,464
6	D41	8.16.14.9.3	1 272 423	1 894 684	May 13, 475	May 10, 475
7	D41	8.16.14.11.5	1 272 465	1 894 726	Jun 24, 475	Jun 28, 475
8	D41	8.16.14.15.4	1 272 544	1 894 805	Sep 11, 475	Sep 6, 475
9	D41	8.16.15.16.1	1 272 921	1 895 182	Sep 22, 476	Sep 29, 476
10	D49	8.16.19.0.12	1 274 052	1 896 313	Oct 28, 479	Oct 22, 479
11	D42	(8).19.0.4.4	1 288 884	1 911 145	Jun 6, 520	May 29, 520
12	D24	9.9.9.16.0	1 364 360	1 986 621	Jan 27, 727	Jan 21, 727
13	D24	9.9.16.0.0	1 366 560	1 988 821	Feb 4, 733	Jan 31, 733
14	D49	9.13.10.15.14	1 393 514	2 015 775	Nov 22, 806	Nov 23, 806
15	D48	9.15.9.9.4	1 407 424	2 029,685	Dec 22, 844	Dec 18, 844
16	D24	9.19.1.5.0	1 433 260	2 055 521	Sep 17, 915	Sep 18, 915
17	D49	9.19.11.13.0	1 437 020	2 059 281	Jan 2, 926	Dec 22, 925
18	D42	10.8.3.16.4	1 499 004	2 121 265	Sep 16, 1095	Sep 18, 1095
19	D49	10.17.13.12.12	1 567 332	2 189 593	Oct 12, 1282	Oct 12, 1282

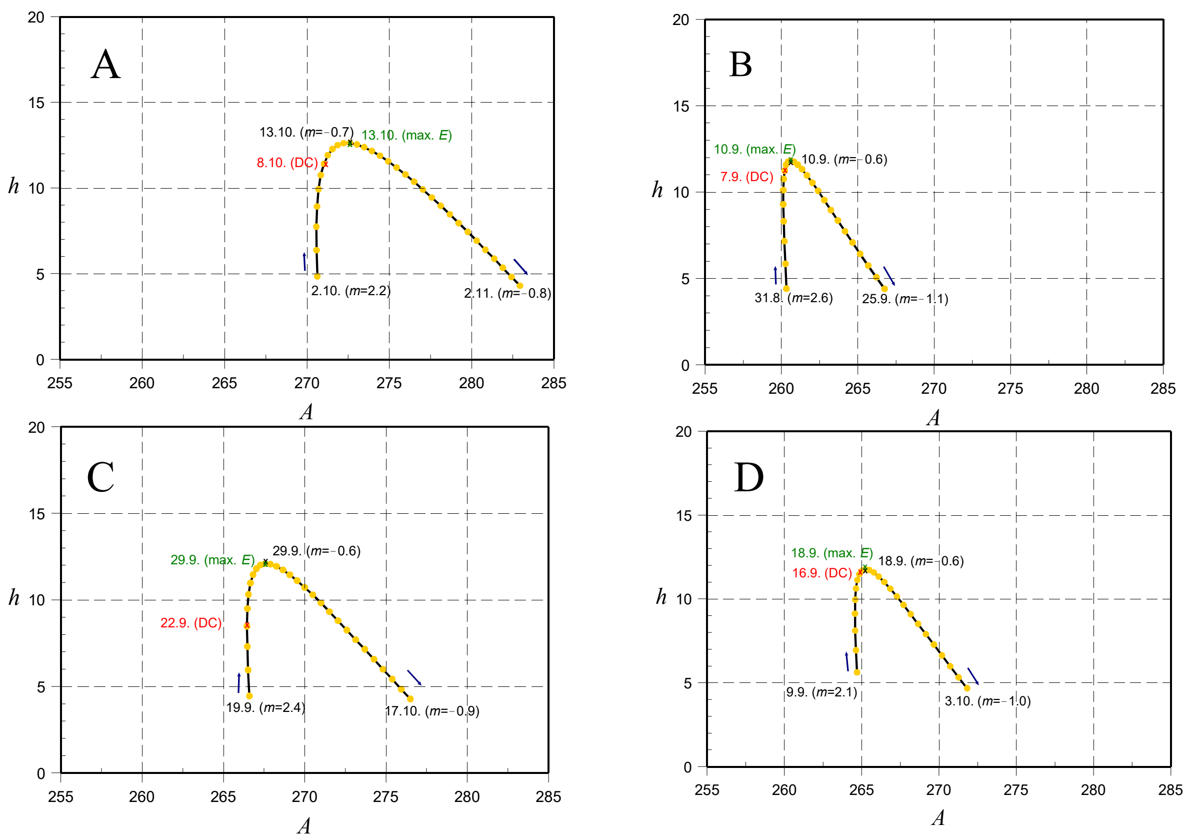

Fig. 6: Positions of Mercury at the moment of civil twilight in September/October 370 (A), 464 (B), 476 (C), 1095 (D).

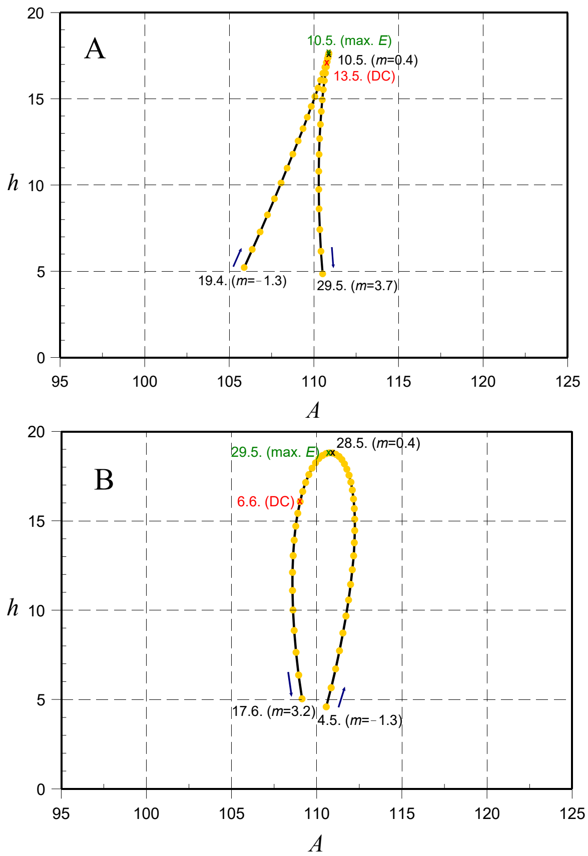

Fig. 7: Positions of Mercury at the moment of civil twilight in May 475 (A) and 520 (B).

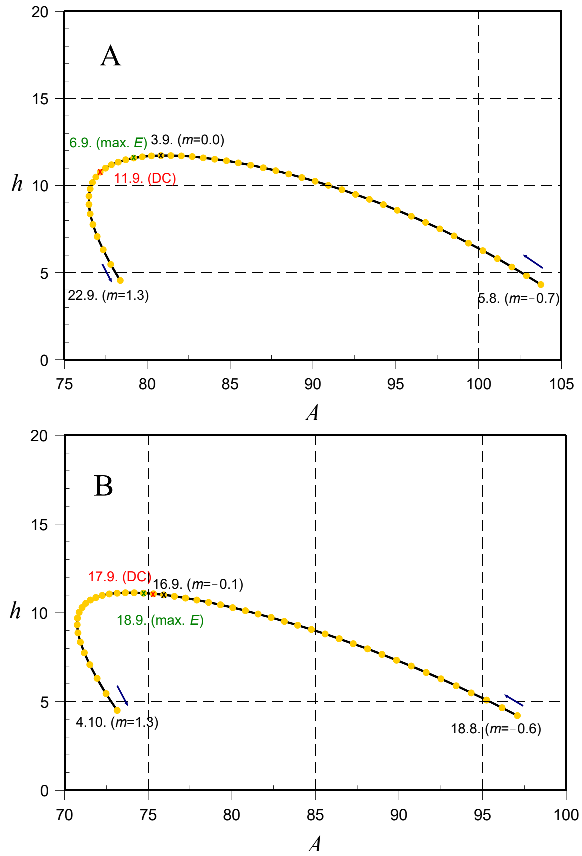

Fig. 8: Positions of Mercury at the moment of civil twilight in September 475 (A) and 915 (B).

the one that appeared before sunrise above the east horizon. The maximum elongation occurred on June 28, 475 with angular distance 20°.1 from the Sun.

Fig. 13 shows the positions of Mercury near its maximum east elongation for the date No. 14, i.e. the one that appeared after sunset above the west horizon. The maximum elongation occurred on November 23, 806 with angular distance 20°.4 from the Sun.

Fig. 14 shows the positions of Mercury near its maximum east elongation for the date No. 15, i.e. the one that appeared after sunset above the west horizon. The maximum elongation occurred on December 18, 844 with angular distance 19°.1 from the Sun.

Fig. 15 displays the positions of Mercury near its maximum west elongation for the date No. 17, i.e. the one that appeared before sunrise above the east horizon. The maximum occurred on December 22, 925 with angular distance 23°.6 from the Sun.

We can deduce, from all these figures, that the Maya evidently observed Mercury during its visibility and recorded these dates. The differences from the highest altitude of up to a week are quite acceptable taking into consideration the flat change of the elongation around its maximum. Differences in altitude do not exceed a couple of degrees, which is explainable by the lack of measuring instruments.

2.2. Conjunctions with the Sun

We also noticed several dates in DC that passed the test of 'non-integer remainders' but do not correspond to maximum elongations. They might, however, correspond to conjunctions of Mercury with the Sun. Of course, the conjunctions could not be directly observable by the Maya, but we expect that the Maya estimated them as the mean from the preceding and following maximum elongations. This is why they are slightly less accurate than the timing of elongations; the differences between Maya records and real conjunctions (the last two columns) can reach up to two weeks. There are 9 of them and they are listed in Table 2. The header is similar to the one of Table 1, conjunction in the last column means the calculated date of the nearest conjunction. This could indicate that these dates of DC really refer to conjunctions.

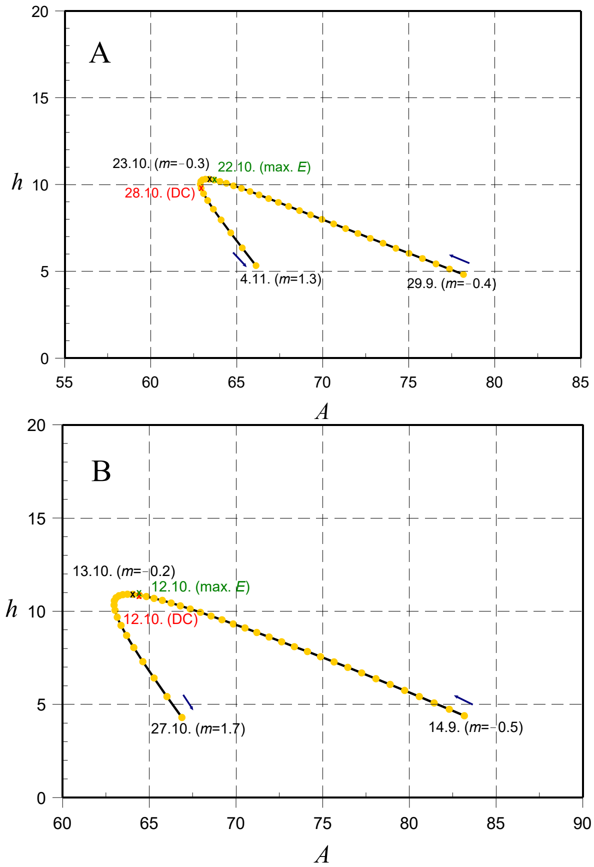

Fig. 9: Positions of Mercury at the moment of civil twilight in October 479 (A) and 1282 (B).

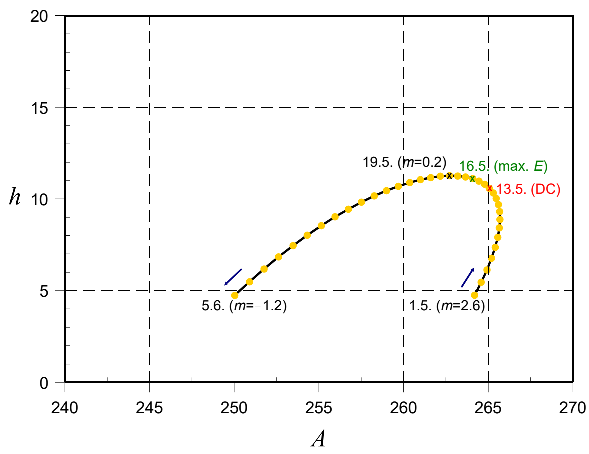

Fig. 10: Positions of Mercury at the moment of civil twilight in May 280.

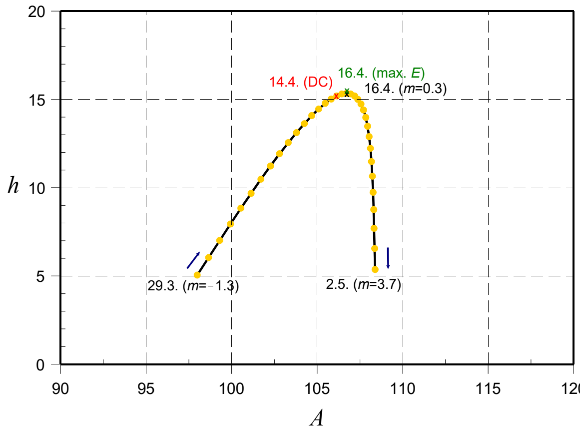

Fig. 11: Positions of Mercury at the moment of civil twilight in April 450.

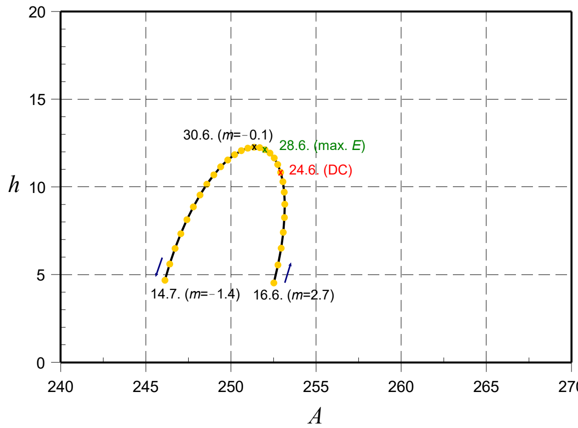

Fig. 12: Positions of Mercury at the moment of civil twilight in June 475.

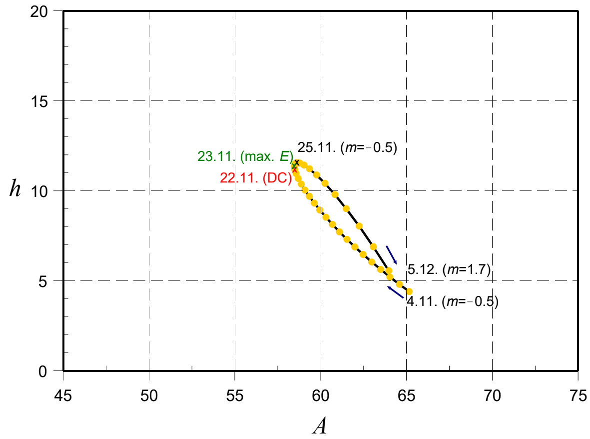

Fig. 13: Positions of Mercury at the moment of civil twilight in November 806.

3. CONCLUSIONS

We suggest that the Maya paid sufficient attention also to the planet Mercury. We demonstrate this by exposing 19 records of its best visibility and 9 records of conjunctions, found in Dresden Codex so far. For the west elongations, the Maya recorded dates in average 2 days *before* the elongation occurred, with average error of 1°.0 in altitude. For the East elongations this is on average 2 days *after* the maximum elongation, with average error of 0°.6 in alti-

Table 2: Dates in DC close to conjunctions of Mercury with the Sun. Numbers in brackets mark reconstruction of a corrupted inscription, addition of a missing item, or correction of misprint.

No.	page	LC	LC days	JD	Jul. cal.	conjunction
1	D49	8.6.16.7.14	1 201 114	1 823 375	Feb 17, 280	Mar 2, 280 superior
2	D49	8.16.19.10.0	1 274 240	1 896 501	May 3, 480	May 4, 480 superior
3	D52	(9).4.16.8.12	1 330 732	1 952 993	Jan 2, 635	Dec 27, 634 inferior
4	D49	9.13.12.10.0	1 394 120	2 016 381	Jul 20, 808	Jul 22, 808 inferior
5	D48	(9).15.9.4.4	1 407 324	2 029 585	Sep 13, 844	Sep 20, 844 superior
6	D49	(9).15.9.15.14	1 407 554	2 029 815	May 1, 845	May 2, 845 inferior
7	D49	9.19.7.2.14	1 435 374	2 057 635	Jul 1, 921	Jun 30, 921 inferior
8	D49	10.11.3.18.14	1 520 654	2 142 915	Dec 25, 1154	Dec 21, 1154 inferior
9	D49	(10).14.2.16.12	1 541 852	2 164 113	Jan 7, 1213	Jan 9, 1213 inferior

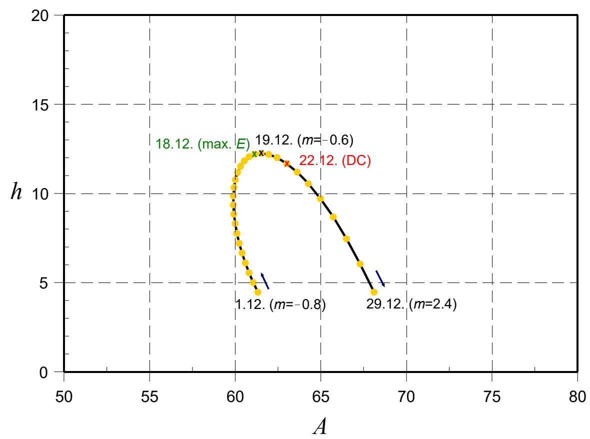

Fig. 14: Positions of Mercury at the moment of civil twilight in December 844.

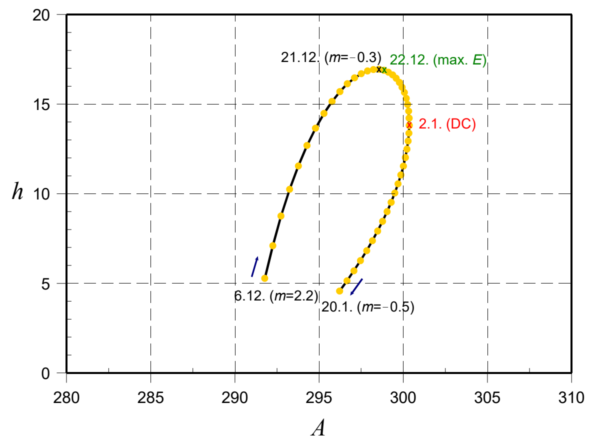

Fig. 15: Positions of Mercury at the moment of civil twilight in December 925 – January 926.

tude. Considering the time of the DC origin, we expect that the Maya records in Dresden Codex refer to real observations roughly before 1000 AD, and to the predictions afterwards. The results document a solid accuracy of observations. It is in agreement with the absence of a more sophisticated observational technique and a limited capability of naked eye observation. This study is also another independent validation of the Böhm correlation. Remarkable is the competence of the Maya to observe with high accuracy different astronomical phenomena, their mathematical skill to discover their regularities (periodic repeating), and to use it for the predictions.

Acknowledgements – This study was carried out thanks to the project RVO:67985815. The authors express their thanks to the reviewer, prof. Miroslav Filipović, for his valuable comments that helped to improve the text substantially.

REFERENCES

Aveni, A. F. and Hotaling, L. D. 1994, Archaeastronomy, 25, 21

Böhm, B. and Böhm, V. 1991a, Vesmír, 70, 98

Böhm, B. and Böhm, V. 1991b, in Actes du XII^e Congrès Internat. Sci. Préhist. et Protohist. Inst. Archéologique de l'Académie Slovaque des Sciences. Bratislava, 123

Böhm, B. and Böhm, V. 1996, in Proc. XIII Interntl. Congress of Prehistoric and Protohistoric Sciences, 544

Böhm, V., Böhm, B., Klokočník, J., Vondrák, J. and Kostelecký, J. 2013, SerAJ, 186, 53

Bretagnon, P., and Francou, G. 1988, A&A, 202, 309

Bricker, H. M. and Bricker, V. R. 2011, Astronomy in the Maya Codices (Philadelphia: American Philos. Soc.), pp. 235–245

Clark, J. E. and Pye, M. E. 2005, in XIX Simposio de Investigaciones Arqueológicas en Guatemala, ed. J. P. Laporte, B. Arroyo and H. Majía (Guatemala: Museo Nacional de Arqueología y Etnología), 10

Estrada-Belli, F. 2011, The First Maya Civilization Ritual and Power Before the Classic Period (Abingdon & New York: Routledge)

Foster, L. 2002, Handbook to Life in the Ancient Maya World (New York: Oxford University Press)

Klokočník, J., Kostelecký, J., Böhm, V., Böhm, B., Vondrák, J. and Vítek, F. 2008, AN, 329, 426

Pérez, E. B. 2013, Reconstrucción virtual de la ciudad maya El Mirador del período preclásico de Petén, Tesario Fac. Arquitectura Univ. San Carlos de Quatemala

Popenoe de Hatch, M. 1989, in New Frontiers in the Archaeology of the Pacific Coast of Southern Mesoamerica, ed. F. Bove and L. Heller (Anthropological Research Papers 39, Arizona State University), 25

Potter, A. 1988, The Mercury Mesenger Issue 2, 2

Powell, Ch. 1997, A New View on Maya Astronomy, Thesis Univ. Texas Austin. Univ. Texas Austin

Serrano, L. I. A. and Schawrz, C. W. 2005, Libro de texto universitario sobre la historia de Guatemala (Universidad de San Carlos de Guatemala)

Sharer, R. J. and Traxler, L. P. 2006, The Ancient Maya, 6th ed. (Stanford: Stanford University Press)

Suyuc Ley, E. and Hansen, R. D. 2013, in Millenary Maya Societies: Past Crises and Resilience, ed. M. Ch. Arnauld and A. Breton, 217 (Electronic document: `https://www.mesoweb.com/publications/MMS/14_Suyuc-Hansen.pdf`)

Thompson, J. E. S. 1935, Contrib. Amer. Archaeology, 14, 51 Carnegie Inst. Washington

Thompson, J. E. S. 1960, in Maya Hieroglyphic Writing: An Introduction. Civilization of the American Indian Series 56, 215

Thompson, J. E. S. 1972, A Commentary on the Dresden Codex: A Maya Hieroglyphic Book. American Philosophical Society.

Thompson, J. E. S. 1974, Phil. Trans. Roy. Soc. London, 276, 83

ДА ЛИ СУ ДРЕВНЕ МАЈЕ ПОСМАТРАЛЕ МЕРКУР?

J. Vondrák[1], **V. Böhm**[2] **and B. Böhm**

[1]*Astronomical Institute, Czech Academy of Sciences, Boční II 1041, 14101 Prague, Czech Republic*

E–mail: *vondrak@ig.cas.cz*

[2]*Retired from The University for Political and Social Sciences, Ovčárecká 312, 28002 Kolín, Czech Republic*

E–mail: *jarolik@post.cz*

УДК 523.41–13 (=972.6)

Оригинални научни рад

Добро је познато да је богата култура старих Маја садржала, између осталог, веома компликован и комплексан календар, у ком су поред историјских догађаја бележили и значајне астрономске феномене. Главни извор информација је Дрезденски кодекс, који угрубо покрива период од 280. до 1325. године н.е. Проблем такозване корелације мајанског и наших календара (изражавање разлике између мајанског Дугог рачуна и Јулијанског датума) је веома стар, стога постоји око педесет различитих решења која се међусобно разликују чак и стотинама година. Од њих историчари најчешће прихватају тзв. Гудман-Мартинез-Томпсон (GMT) вредност од 584283 дана, засновану скоро у потпуности на историјским догађајима. Насупрот томе, ми истичемо веома прецизно датиране астрономске догађаје који су у супротности са GMT, и изводимо тзв. Бемову корелацију (BB) од 622261 дана, која је се одлично слаже са астрономским догађајима забележеним у Дрезденском кодексу. Мајански истраживачи већином верују да Маје нису обраћале пуно пажње на Меркур. Овде долазимо до супротног закључка; анализом Дрезденског кодекса налазимо велики број записа који одговарају видљивости Меркура близу своје максималне елонгације од Сунца, као и њиховој коњукцији.