

Duke Summer Program

The Mayan Astronomy and Calendar

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Math of Universe

Paper 2

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Introduction

Before 2012, there was a well-known rumor stated that according to the prediction of the Mayan, all the world would come to the end on December 21th, 2012. When talking about it, we can definitely guarantee that this saying was untrue since sun still rose on the morning of December 22th. However, what we can research more deeply is the origin of this rumor. At least, we can obtain many information about "the end of the world" on the internet and books published before 2012. Is it just a coincidence, or a lie fabricated by charlatans and mystics? How did this rumor relate to Mayan? All of the question can be solved by the Mayan calendar.

Maya Civilization

The Maya are an indigenous people of Mexico and Central America who have continuously inhabited the lands comprising modern-day Yucatan, Quintana Roo, Campeche, Tabasco, and Chiapas in Mexico and southward through Guatemala, Belize, El Salvador and Honduras. The designation *Maya* comes from the ancient Yucatan city of Mayapan, the last capital of a Mayan Kingdom in the Post-Classic Period. The Maya people refer to themselves by ethnicity and language bonds such as *Quiche* in the south or *Yucatec* in the north (though there are many others). The 'Mysterious Maya' have intrigued the world since their 'discovery' in the 1840's by John Lloyd Stephens and Frederick Catherwood but, in reality, much of the culture is not that mysterious when understood. Contrary to popular imagination, the Maya did not vanish and the descendants of the people who

built the great cities of Chichen Itza, Bonampak, Uxmal and Altun Ha still exist on the same lands their ancestors did and continue to practice, sometimes in a modified form, the same rituals which would be recognized by a native of the land one thousand years ago.

● Correlative Knowledge in Astronomy

In history of ancient world civilization, Maya is indisputably prosperous. Among the magnificent achievement produced by the Mayan, mathematics and astronomy are especially outstanding. The ancient Mayan know the accurate movement cycle of celestial bodies without heliocentric theory of Nicolaus Copernicus or other precise counting strategies. For example, in ancient Maya astronomy, a year has 365.2420 days, while it has 365.2422 in modern astronomy. Thus, someone may have question: how could Mayan get so rigorous information without modern instruments and theories? The Mayan understand and predict the motion of stars and planets by Maya calendar. Where did Maya calendar come from? How does it reflect celestial movement? To solve these problems, we need to introduce some simple concepts of astronomy.

Celestial spheres

In astronomy, the celestial spheres are imaginary sphere in order to take research on location and movement of celestial bodies. The center of it is Earth, and the radius is infinity. Since the distance observer moves with Earth is much smaller than the distance between observer and celestial body, it seems that

celestial bodies are same far away from us, just like they are on a sphere whose center is observer. Actually, what we see is the projection location of the celestial body on this sphere, and this sphere is celestial sphere. The extension of the Earth's rotation axis to the sky defines the North and South Celestial Poles (the NCP and SCP), while the extension of the Earth's equatorial plane defines the celestial equator. The NCP is in the constellation Ursa Minor (the Smaller Bear) close to the direction of the star Polaris, otherwise called the North Star. The SCP is in the modern constellation Octans, the Octant, in the general direction of the faint southern pole star Sigma Octantis (Polaris Australis).

Apparent Motion of Celestial Bodies

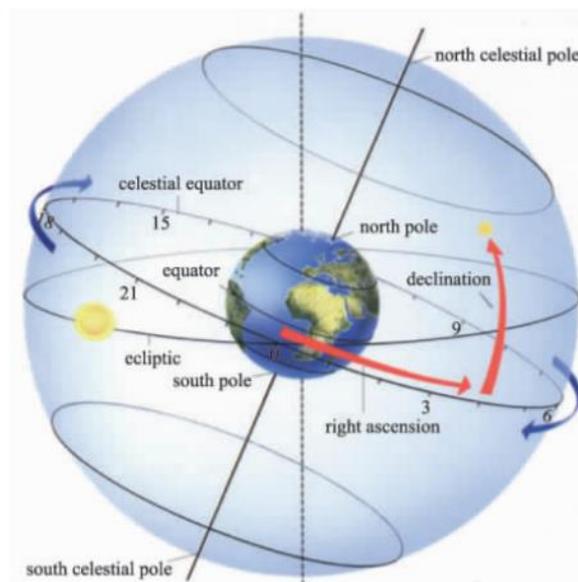


Figure 1

An apparent motion is a motion that a celestial object appears to make across the sky. The “actual motion” may be different. Stars “appear” to rise from the east and set in the west along a pathway known as an arc. Each star’s “apparent” motion in

the sky is at a constant rate -- 15° per hour. Some stars near Polaris (North Star) move in a complete circle.

Apparent Motions of the Sun – The Celestial Sphere

The “apparent motion” of the Sun is the same as that of the stars, planets and Moon. The Sun “appears” to rise from the east and set in the west.

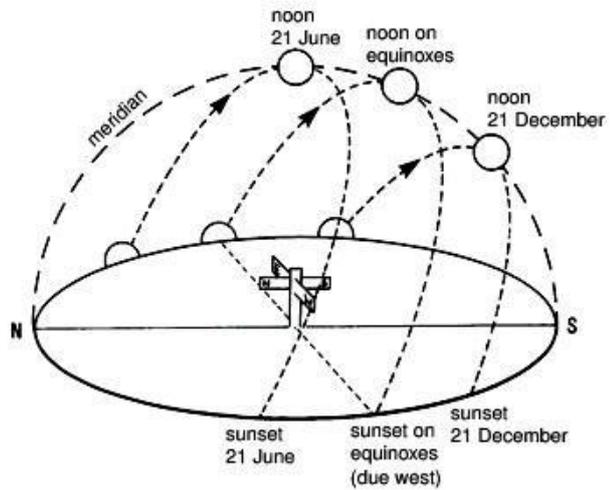


Figure II

A celestial sphere is a model to help illustrate the “apparent motions” of objects in the sky –

such as the Sun. Throughout the year, the “apparent motion” of the Sun in the celestial sphere changes in altitude, origin and length with the seasons.

Maya Astronomy.

Now we can abandon heliocentric theory and the concepts above. Imagine still observer is the center of the space. Then, what will you see? If we just concern rotation of Earth, all the planets and stars will rotate around the observer. Every round is “a day”. Thus, we have had the definition of day. Also, when we watch celestial bodies such as Sun and Venus, they have different locations in different periods. When they locate in the same position for twice continuously, we can say that they have rotated a period. Then we can obtain the concept of time from their movement. This is how to obtain the period of apparent motion of celestial

bodies from watching celestial bodies' movement. Hence, schedule according to astronomical motion appear, and that is calendar.

Maya Ancient Astronomy Observatory

Since 1800s, a lot of researchers investigated and unearthed many significant ruins of Maya.

Palenque is a vital part of Maya civilization. Palenque is located in the Tumbalá mountains, and overlooks the jungle below. The



Figure III

Mayan builders and architects of Palenque balanced landscape

with platforms, temples and palaces, which created an artful harmony at the settlement. The Usumacinta River is part of the settlement and created a means of transportation for Palenque citizens. The river also placed Palenque along a main trade route and fed water through man-made canals into the city. The Otulum, a tributary of the Usumacinta, was channeled into an ingenious 50m long canal that crosses through the city. In 2010, archeologists discovered that this canal was pressurized, the first of its kind in the world.

Palenque is one of the most studied and documented Mayan archeological ruins. The known history about Palenque is more than we can provide here. The ongoing debates focus on the interpretation of the hieroglyphics, the gender and role of the many rulers, and how educators decipher and interpret the secrets and

evolving facts about the Maya. Undoubtedly, many details remain unknown.

Dresden Codex

The *Dresden Codex* is the oldest surviving book from the Americas, dating to the thirteenth or fourteenth century. The codex was rediscovered in the city of Dresden and is how the Maya book received its present name. It is located in the museum of the Saxon State Library in Dresden, Germany.

The book received serious water damage during World War II. The



Figure IV Dresden Codex

pages are 8 inches (20 cm) high and can be folded accordion-style; when unfolded the codex is 12 feet (3.7 m) long. It has Mayan hieroglyphs and refers to an original text of some three or four hundred years earlier, describing local history and astronomical tables.

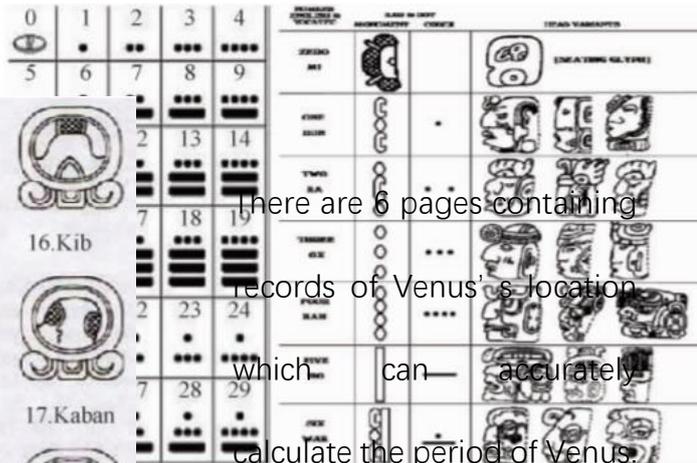
In the end of 1800s, E. W.



Figure VI Name and figure of different days calendar in *Dresden Codex* and found the

In Dresden Codex, there are also names and figures of different days. (20 days altogether)

number Mayan had used.



There are 6 pages containing records of Venus's location which can accurately calculate the period of Venus.

Figure V Maya number

Förstemann deciphered the Maya



Maya Calendar

The Mayan Calendar consists of three separate corresponding calendars, the *Long Count*, the *Tzolkin* (divine calendar) and the *Haab* (civil calendar). Time is cyclical in the calendars and a set number of days must occur before a new cycle can begin.

The three calendars are used simultaneously. The Tzolkin and the Haab identify and name the days, but not the years. The Long Count date comes first, then the Tzolkin date and last the Haab date. A typical Mayan date would read: 13.0.0.0.0 4 Ahau 8 Kumku, where 13.0.0.0.0 is the Long Count date, 4 Ahau is the Tzolkin date and 8 Kumku is the Haab date.

The Haab

The *Haab* is a 365-day solar calendar which is divided into 18 months of 20 days each and one month which is only 5 days long (*Uayeb*). The calendar has an outer ring of Mayan glyphs (pictures) which represent each of the 19 months. Each day is represented by a number in the month followed by the name of the month. Each glyph represents a personality associated with the month.

The Haab is somewhat inaccurate as it is exactly 365 days long. An actual tropical or solar year is 365.2422 days long. In today's Gregorian calendar we adjust for this discrepancy by making almost every fourth year a leap year by adding an extra day – a leap day – on the 29th of February.

Figure VII record of Venus

The Tzolkin

The divine calendar is also known as the Sacred Round or the Tzolkin which means “the distribution of the days”. It is a 260-day calendar, with 20 periods of 13 days used to determine the time of religious and ceremonial events. Each day is numbered from one to thirteen, and then repeated. The day is also given a name (glyph) from a sequence of 20 day names. The calendar repeats itself after each cycle.

The Long Count

The Long Count is an astronomical calendar which was used to track longer periods of time, what the Maya called the “universal cycle”. Each such cycle is calculated to be 2,880,000 days (about 7885 solar years). The Mayans believed that the universe is destroyed and then recreated at the start of each universal cycle. This belief still inspires a myriad of prophecies about the end of the world.

The “creation date” for the current cycle we are in today, is 4 Ahaw, 8 Kumku.

According to the most common conversion, this date is equivalent to August 11, 3114 BCE in the Gregorian calendar or September 6 in the Julian calendar.

How to Set the Date

A date in the Maya calendar is specified by its position in both the Tzolkin and the Haab calendars which aligns the *Sacred Round* with the *Vague Year* creating the joint cycle called the *Calendar Round*, represented by two wheels rotating in different directions. The Calendar round cycle takes approximately 52 years to complete.

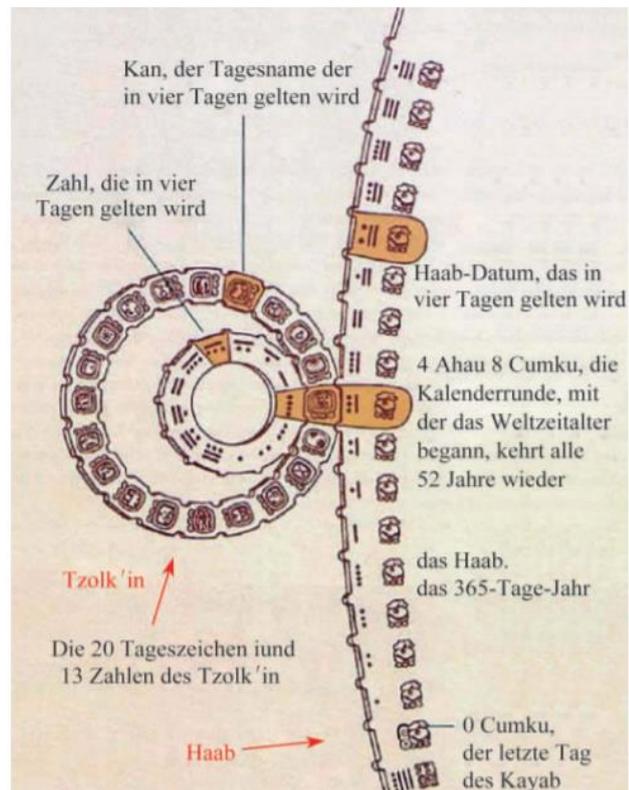


Figure VIII The combination of Tzolkin and Haab

The smallest wheel consists of 260 teeth with each one having the name of the days of the Tzolkin. The larger wheel consists of 365 teeth and has the name of each of the positions of the Haab year. As both wheels rotate, the name of the Tzolkin day corresponds to each Haab position.

The date is identified by counting the number of days from the “creation date”.

A typical long count date has the following format: Baktun. Katun. Tun. Uinal.Kin.

- Kin = 1 Day.
- Uinal = 20 kin = 20 days.

- Tun = 18 uinal = 360 days.
- Katun = 20 tun = 360 uinal = 7,200 days.
- Baktun = 20 katun = 400 tun = 7,200 uinal = 144,000 days.

The kin, tun and katun are numbered from zero to 19; the uinal are numbered from zero to 17; and the baktun are numbered from one to 13. The Long Count has a cycle of 13 baktuns, which will be completed 1.872.000 days (13 baktuns) after 0.0.0.0.0. This period equals 5125.36 years and is referred to as the "Great Cycle" of the Long Count.

End of the World?

The Mayan calendar completes its current "Great Cycle" of the Long Count on the 13th baktun, on 13.0.0.0.0. Using the most common conversion to our modern calendar (the Gregorian calendar) the end of the "Great Cycle" corresponds to 11:11 Universal Time (UTC), December 21, 2012, hence the myriad of doomsday prophecies surrounding this date.

Conclusion

According to the research, "the end of the world" is just an end of a "Great cycle" in Mayan calendar. Even though prediction of Maya said that Earth would have great disaster in every end of a "Great cycle", what we got was just a simple day without difference from others. It is just like Christmas, a signal of a year's end and a new beginning.

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