A Study of Ethnoastronomy in Ciptagelar Civilizations, Sukabumi Regency, West Java, Indonesia: Relation of Full Moon Phase with Javanese Calendar and Hijriyah Calendar

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Abstract. Astronomy has been practiced for as long as humans have been looking at the sky. Early civilizations used several celestial objects to do their daily activities, like doing a traditional ceremony. Ciptagelar Village is located at Sukabumi Regency, West Java, Indonesia. It has been established for almost 650 years. Ciptagelar villagers consider that a full Moon phase is a special and sacred thing. They have a welcoming ceremony for it, named Mapag Purnama. We study this activity in the way of Ethnoastronomy. The methods that we used are interviewing the villagers, including the customary leader of Ciptagelar Village, and doing a literature study. Ceremony of Mapag Purnama is held every 13rd to the night of 14th of the Moon Javanese Calendar. We use three references for choosing the date of full Moon phase, namely Fred Espenak, NASA, and Stellarium application. This date is then converted from Solar Calendar to Javanese and Hijriyah. Because Javanese Calendar is adopted from Hijriyah Calendar, both of two will have the same dates. We use 120-years correction for a difference cycle and number of leap years. However, after 2010 CE this correction is no longer valid. We find that the Javanese Calendar is one day slower than the Hijriyah Calendar.

1 Introduction

Indonesia is an archipelago. It has many islands as well as ethnicity and culture. In this modern era, it turns out that there are still a number of ethnic groups whom uphold their customs until now. One of them is the Ciptagelar Civilization which we study in this paper. They are located in Sukabumi Regency, West Java, Indonesia.

We conduct this research because of three motivations. First, we like a science that has a direct relation to the civilizations. We choose to study the ethnoastronomy in this way. "Ethnoastronomy is the study of astronomies of different races, people or ancient cultures which includes folk or indigenous astronomies, calendars, celestial lore, sky mythology and related ritual, cosmological concepts and celestial-related traditions of all people and cultures." [1]. We try to understand how science affects their lives. Second, Indonesia is a

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country that is suitable for doing an ethnoastronomy research. So many islands and differences in each ethnicity we can observe. Indonesia has an abundance of nature and culture.

Civilizations use many signs in nature to assist their daily activities [4, 5, 6, 7, 8, 11]. One of them is related to astronomy, i.e. they have seen the sky and used several celestial objects to help them know about time to work, to farm, etc. Each ethnicity has a unique traditional ceremony related to observing the sky. Why then do we choose to study the Ciptagelar civilization than other civilizations in Indonesia? This question asks whether the third thing that motivates us. That is because Ciptagelar civilization is an unique civilization than others. What makes them unique? As we knew about customary civilizations, they tend to be backward, closed, and rarely want to accept technology, but this is different with Ciptagelar civilizations. Indeed, they are a customary civilization, but they live in an advanced village that is very open to the outside world and technology savvy.

The Ciptagelar villagers have several kinds of ceremonies. A few ceremonies are related to astronomy knowledge. One of them is *Malam Opat Belasan*. This name is taken from the Sundanese language and means a ceremony that held in every 13rd to the night of 14th in Javanese Lunar Calendar. This ceremony is conducted to welcome the full Moon phase. Thus, in Sundanese this ceremony also called *Mapag Purnama*.

2 Method

This research uses some methods to collect the data. First, we conduct a direct interview with the villagers and the customary leader of the Ciptagelar Village. Second, we conduct a literature study. To do the interview, we have to prepare the three steps, i.e. the preparation, the interview, and the post interview [9, 10]. For the preparation, we have to contact the villagers for asking permission related to their willingness to be interviewed. Then, if they are willing, we propose our arrival date to conduct the interview process. Then, we have to prepare the questions that will be asked to them in the interview. We also have to make sure our belongings that will be brought to their village and funds needed during the research.

The next step is about the interview. In this step, we just have to do well the interview process with questions that already prepared before. We also documented it during the interview. The last step is the post interview. In this step, we thanked the interviewees for their willingness to be interviewed. We also ask them about a possibility to conduct a further interview if needed.

3 The Ceremony of *Opat Belasan*

This ceremony is intended to welcome the full Moon phase. This ceremony aims to preserve ancestral traditions and mysteries. In Indonesian, it is referred to as *wangsit* from the ancestors to the customary leader of Ciptagelar Village. This ceremony enlivened by many art performances, such as *Angling Dogdog Lojor*, *Topeng Kolot*, *Wayang Golek Rurukan*, *Jipeng*, and *Degung Gonjringan*. The interesting thing about the art performance of *Wayang Golek Rurukan* is the story of the ancestors [13, 16, 17, 18]. The Ciptagelar Villagers carried out this ceremony in the customary building, i.e. *Imah Gede*. This building is also the house of the customary leader, named Abah Ugi.

4 The Javanese Calendar System

The Javanese Calendar has been used since 1600s CE. The Javanese Calendar is the result of an assimilation of the Indian Calendar, named Saka Calendar and Hijriyah (Islamic) Calendar. In the Javanese Calendar, the year numbering continues the year number of the Saka Calendar, the date and month are derived from the Hijriyah Calendar. Thus, in 1633 CE, the Javanese Calendar has a year number of 1555 Java instead of 1043 Hijriyah (H) [14].

The Javanese Calendar has its own system of cycles. The two longest unit of time in Javanese Calendar are *windu* and *lambang*. Both of them have the same duration, i.e. eight years, but they have a different cycle. The total cycle of *lambang* is 16 years that is divided into two kinds of *lambang*, i.e. *langkir* and *kulawu*. For *windu*, it has a total cycle of 32 years that is divided into four kinds of *windu*, i.e. *adi*, *kuntara*, *sengara*, and *sancaya*.

From *lambang* and *windu*, there are eight kinds of year, i.e. *Alip* (354 days), *Ehe* (355 days), *Jimawal* (354 days), *Je* (354 days), *Dal* (355 days), *Be* (354 days), *Wawu* (354 days), and *Jimakir* (355 days). The Javanese have two kinds of calendar systems, i.e. the *Pranata Mangsa* (Solar Calendar) and the Lunar Calendar. This eight-year cycle is only for the Javanese Lunar Calendar. The 2nd, 5th, and 8th year are categorized as a leap year where a year consists of 355 days [3]. The additional day for the leap year is added to the 12th month. The name and duration for each month on the Moon Javanese Calendar can be seen in the Table 1 below.

Table 1. The Name of Months in the Moon Javanese Calendar and their Duration.

No.	Name of Months	Duration (days)
1.	<i>Sura</i>	30
2.	<i>Sapar</i>	29
3.	<i>Mulud</i>	30
4.	<i>Bakda Mulud</i>	29
5.	<i>Jumadilawal</i>	30
6.	<i>Jumadilakir</i>	29
7.	<i>Rejeb</i>	30
8.	<i>Ruwah</i>	29
9.	<i>Pasa</i>	30
10.	<i>Sawal</i>	29
11.	<i>Sela</i>	30
12.	<i>Besar</i>	29 or 30

In the Javanese Calendar, there are the terms *Pancawara* and *Saptawara*. Both of them are unit of time for the week. *Pancawara* consists of five days, namely *Legi*, *Pahing*, *Pon*, *Wage*, and *Kliwon*, while *Saptawara* consists of seven days, namely *Ahad*, *Senin*, *Selasa*, *Rabu*, *Kamis*, *Jum'at* and *Sabtu*. Both run concurrently and are known as *Pasaran* in Javanese. Besides *Pancawara* and *Saptawara*, there are still six other kinds of *Pasaran*, i.e. *Dwiwara* (2 days), *Triwara* (3 days), *Caturwara* (4 days), *Sadwara* (6 days), *Astawara* (8 days), and *Sangawara* (9 days). Also, in the Javanese Calendar, there is another unit of time that is a combination of *Pancawara* and *Saptawara* namely *Wuku*. Each type of *Wuku* will change every week which consists of seven days.

The first month in the Javanese Calendar is *Sura*, thus first *Sura* is the beginning of the Javanese Calendar year. To decide this beginning of the year, the Javanese Calendar follows the Hijriyah Calendar year. Thus, first *Sura* coincides with first *Muharram* (the first month in Hijriyah Calendar).

5 The Determination of the Date of Occurrence of the Full Moon Phase and Its Relation to the Ceremony of *Malam Opat Belasan*

Ciptagelar villagers have their own perception about full Moon phase. Based on their opinion, a full Moon phase is something sacred. We know that Ciptagelar villagers have a ceremony that relates to the full Moon phase, namely *Malam Opat Belasan*. It is held every the 13rd to the night of 14th every month in the Moon Javanese Calendar.

When we interviewed one of the Ciptagelar villagers named Mr. Yoyo, he told that the ceremony of *Malam Opat Belasan* has two rituals. The first ritual is held at the night of the full Moon phase and the second is held after that full Moon phase. Also, he said that determining the date for the occurrence of the full Moon phase was based on the first experience of their ancestors who saw the full Moon phase in 1368 CE. That year, their ancestors saw the full Moon phase on the 13rd to the night of 14th in the Javanese Lunar Calendar. Accordingly, this date is set as the date of the full Moon phase in the Javanese Calendar. Until now, this date has been used as a celebration for the ceremony of *Malam Opat Belasan*.

To confirm Mr. Yoyo's explanation, we trace back the date and check whether it is true or not. To do so, we convert that date from the Western Calendar (in this case the Julian Calendar) to the Javanese Lunar Calendar. There are two ways to perform the conversion. First, we convert directly from the Gregorian Solar Calendar to the Hijriyah Calendar using the Hisab Urfi Calculation. Then, we use the year number in the Hijriyah calendar to obtain the year number in the Javanese Lunar Calendar. The other method is to convert the date from the Gregorian Solar Calendar to the Hijriyah Calendar then change the year number to the Javanese Lunar Calendar, and then apply the 120-year correction between the Javanese and Hijriyah Calendar.

6 Hisab Urfi Islamic Dating System

There are many types of Islamic Dating System, such as Hisab Hakiki, and Imkan Rukyat, but for this conversion, we will use the Hisab Urfi dating system. This dating system uses the Synodic cycle (based on observations) of Moon on average, i.e. 29 days, 12 hours, 44 minutes, and 2.8 seconds in every month as a reference calculation. This value is a time duration from one conjunction to another. Initially, the dating system began when the *hijrah* (moving from one place to another) event of the *Prophet Muhammad SAW* from Mecca to Medina that occurred on 15th or 16th of July 622 CE.

The determination of the beginning of the month is based on *hilar* (thin crescent Moon) observation that can be seen after the Sunset. Hisab Urfi Islamic dating system is based on calculation. It means that it tends to predict rather than observe in determining something (for example, an astronomical phenomenon). A year consists of 12 months and each month consists of 29 days (for even months) or 30 days (for odd months). The names of the 12 months are *Muharram*, *Safar*, *Rabi'ul Awal*, *Rabi'ul Akhir*, *Jumadil Awal*, *Jumadil Akhir*, *Rajab*, *Shakban*, *Ramadhan*, *Syawal*, *Zulkaidah*, and *Zulhijah* [12].

The Hisab Urfi Islamic dating system has 30-year cycle. It contains of 11 leap years and 19 non-leap years. For leap years, a year consists of 355 days and the additional day is in the 12th month. Leap years are assigned by dividing the year number by 30 and taking the remainder. Years with a remainder of 2, 5, 7, 10, 13, 15 (or 16), 18, 21, 24, 26, or 29 are leap years [2]. In addition, there is a correction approximately every about 2347-solar years between Hisab Urfi Islamic and the Gregorian Calendar because the Hisab Urfi Islamic Calendar is one day faster than the Gregorian Calendar.

7 A 120-Year Correction

Although the Javanese Lunar Calendar has the same first date as the Hisab Urfi Islamic Calendar, the year numbering is different. In addition, they are not always synchronised. For 30 years, Javanese Lunar Calendar consists of 10,631.25 days and Hijriyah Calendar consists of 10,631 days. For 60 years, Javanese Lunar Calendar consists of 21,262.5 days and Hijriyah Calendar consists of 21,262 days. For 120 years, Javanese Lunar Calendar consists of 42,525 days and Hijriyah Calendar consists of 42,524 days. Thus, there is an additional correction every 120 years.

7.1 Date Conversion from the Solar to Javanese Calendar

To convert dates in the Western Calendar (Julian Calendar) to the Javanese Lunar Calendar, we calculate the difference in days between the date we want to convert and a reference date, ΔH. The first date is the start of the Hijriyah Calendar, i.e. Muharram 1st 1 H or July 15th or 16th 622 CE (we choose July 16th). This simplifies the conversion because the Hijriyah Calendar is related to the Javanese Lunar Calendar. The second reference date is July 16th, 1368 CE, being in the year that the ancestors of Ciptagelar civilization first saw the full Moon phase which falls on 14th each month. The date we want to convert can be located between the two reference dates or outside of both. We can choose the date from three references, i.e. Espenak, National Aeronautics and Space Administration (NASA), and Stellarium application. Full Moon dates from Stellarium will be the date where the moon has the brightest apparent magnitude. Details of this conversion are in Diagram 1.

Diagram 1. The Calculation Scheme

7.1.1 Date Conversion with the Hisab Urfi Approach

To conduct the conversion, we have to calculate ΔH at first, then treat it in the framework of Hisab Urfi Islmaic dating system. The details are as follows:

- The date we want to convert: July 1st, 1368 CE
 - Visual apparent magnitude of the Moon: -12.40
- Number of days between July 16th 622 CE and July 1st, 1368 CE in the Solar Calendar, ΔH:

ΔH = (1368 CE-622 CE) - (Δ days between July 1st, 1368 CE and July 16th, 1368 CE)

= 746 years-15 days = (746 x 365.25) days-15 days = 272,461.5 days (1)

Number of days between July 16th, 622 CE and July 1st, 1368 CE in Hijriyah Calendar, A

A = (272,461.5 days) / (10,631 days) = 25 cycles and 6,686.5 days (2)

To calculate number of years in the Hijriyah Calendar B,

B = 25 cycles x 30 years/cycle = 750 H (3)

To calculate the month and date in the Hijriyah Calendar C,

C = 6.686,5:10.631/30 = 18 H and 307.9 days ≈ 18 H and 308 days (4)

308 days = 10 months and 13 days (5)

From B and C, to calculate the year number D,

D = 750 + 18 = 768 H (6)

From C to calculate the month E,

E = 10 + 1 = 11 = Month of *Dzulqo'dah* (7)

To calculate year number in the Javanese Calendar F,

F = D + 512 = 1280 Java (8)

Thus, July 1st, 1368 CE corresponds to *Dzulqo'dah*, 13th, 768 H and *Sela*, 13th, 1280 Java. Then we calculate the conversion for all months in 1368 CE and compare it with the two other references, i.e. Espenak and NASA. The results are in Table 2 below.

Table 2. Date Conversion from Julian Calendar to Hijriyah Calendar and Javanese Calendar for 1368 CE with *Hisab Urfi* Approach

Julian Calendar (1368 CE)				Hijriyah Calendar			Javanese Calendar		
Literature	Month	Date	UTC +07	Year	Month	Date	Year	Month	Date
Espenak	Jan	6	03:26	768	Jumadil Awal	13	1280	Jumadil Awal	13
NASA		-	-	-	-	-	-	-	-

Julian Calendar (1368 CE)				Hijriyah Calendar			Javanese Calendar		
Literature	Month	Date	UTC +07	Year	Month	Date	Year	Month	Date
Stellarium		6	23:00	768	Jumadil Awal	13	1280	Jumadil Awal	13
Espenak	Feb	4	22:39	768	Jumadil Akhir	12	1280	Jumadilakhir	12
NASA		-	-	-	-	-	-	-	-
Stellarium		5	23:00	768	Jumadil Akhir	13	1280	Jumadilakhir	13
Espenak	Mar	5	15:22	768	Rajab	13	1280	Rejeb	13
NASA		-	-	-	-	-	-	-	-
Stellarium		5	23:00	768	Rajab	13	1280	Rejeb	13
Espenak	Apr	4	04:54	768	Syakban	13	1280	Ruwah	13
NASA		-	-	-	-	-	-	-	-
Stellarium		4	23:00	768	Syakban	13	1280	Ruwah	13
Espenak	May	3	15:36	768	Ramadhan	13	1280	Pasa	13
NASA		-	-	-	-	-	-	-	-
Stellarium		3	23:00	768	Ramadhan	13	1280	Pasa	13
Espenak	Jun	2	00:18	768	Syawal	13	1280	Sawal	13
NASA		-	-	-	-	-	-	-	-
Stellarium		2	23:00	768	Syawal	13	1280	Sawal	13
Espenak	Jul (1)	1	07:49	768	Dzulqo'dah	13	1280	Sela	13
NASA		-	-	-	-	-	-	-	-
Stellarium		1	23:00	768	Dzulqo'dah	13	1280	Sela	13
Espenak	Jul (2)	30	15:01	768	Dzulhijah	12	1280	Besar	12
NASA		-	-	-	-	-	-	-	-
Stellarium		31	23:00	768	Dzulhijah	13	1280	Besar	13
Espenak	Agt	28	22:43	769	Muharram	12	1281	Sura	12
NASA		-	-	-	-	-	-	-	-
Stellarium		29	23:00	769	Muharram	13	1281	Sura	13
Espenak	Sep	27	07:54	769	Safar	12	1281	Sapar	12
NASA		-	-	-	-	-	-	-	-
Stellarium		28	23:00	769	Safar	13	1281	Sapar	13
Espenak	Oct	26	19:28	769	Rabi'ul Awal	12	1281	Mulud	12
NASA		-	-	-	-	-	-	-	-

Julian Calendar (1368 CE)				Hijriyah Calendar			Javanese Calendar		
Literature	Month	Date	UTC +07	Year	Month	Date	Year	Month	Date
Stellarium		27	23:00	769	Rabi'ul Awal	13	1281	Mulud	13
Espenak	Nov	25	10:01	769	Rabi'ul Akhir	12	1281	Bakda Mulud	12
NASA		-	-	-	-	-	-	-	-
Stellarium		26	23:00	769	Rabi'ul Akhir	13	1281	Bakda Mulud	13
Espenak	Des	25	03:17	769	Jumadil Awal	13	1281	Jumadil Awal	13
NASA		-	-	-	-	-	-	-	-
Stellarium		25	23:00	769	Jumadil Awal	13	1281	Jumadil Awal	13

Note: *Italic* means there is inequality of date between those two references.

7.1.2 Date Conversion Using A 120-Year Correction between Hijriyah and Javanese Calendar

To conduct this conversion, we use again (1) then treat it in the framework of the Javanese Calendar. The details are as follows:

Number of days between July 16th, 622 CE and July 1st, 1368 CE in Javanese Calendar *G*,

$$G = 272,461.5/2,835 = 96 \text{ cycles and } 301.5 \text{ days} \tag{9}$$

To calculate number of years in the Javanese Calendar that has passed *H*,

$$H = 96 \text{ cycles} \times 8 \text{ years/cycle} = 768 \text{ Java} \tag{10}$$

Using 512 as the difference in the number of years between the Hijriyah and Javanese Calendar, the actual Javanese year number *J*,

$$J = H + 512 = 1280 \text{ Java} \tag{11}$$

To calculate the month and date in Javanese Calendar *K*,

$$K = 301.5 \text{ days} = 10 \text{ months and } 6.5 \text{ days} \approx 10 \text{ months and } 7 \text{ days} \tag{12}$$

From *K*, number of month *L*,

$$L = 10 + 1 = 11 = \textit{Sela} \tag{13}$$

With a 120-year correction *N*, we obtain,

$$N = 7 + 6 = 13 \tag{14}$$

Thus July 1st, 1368 CE corresponds to *Sela* 13th, 1280 Java. Then we calculate the conversion for all months in 1368 CE in the framework of the Javanese Calendar and compare it with the two other references, i.e. Espenak and NASA. The results are shown in the Table 3.

Table 3. Date Conversion from Julian Calendar to Javanese Calendar for 1368 CE with a 120-Year Correction

Julian Calendar (1368 CE)				Javanese Calendar		
Literature	Month	Date	UTC +07	Year	Month	Date
Espenak	Jan	6	3:26	1280	Jumadil Awal	13
NASA		-	-	-	-	-
Stellarium		6	23:00	1280	Jumadil Awal	13
Espenak	Feb	4	22:39	1280	Jumadilakir	12
NASA		-	-	-	-	-
Stellarium		5	23:00	1280	Jumadilakir	13
Espenak	Mar	5	15:22	1280	Rejeb	13
NASA		-	-	-	-	-
Stellarium		5	23:00	1280	Rejeb	13
Espenak	Apr	4	4:54	1280	Ruwah	13
NASA		-	-	-	-	-
Stellarium		4	23:00	1280	Ruwah	13
Espenak	May	3	15:36	1280	Pasa	13
NASA		-	-	-	-	-
Stellarium		3	23:00	1280	Pasa	13
Espenak	Jun	2	0:18	1280	Sawal	13
NASA		-	-	-	-	-
Stellarium		2	23:00	1280	Sawal	13
Espenak	Jul (1)	1	7:49	1280	Sela	13
NASA		-	-	-	-	-
Stellarium		1	23:00	1280	Sela	13
Espenak	Jul (2)	30	15:01	1280	Besar	12
NASA		-	-	-	-	-
Stellarium		31	23:00	1280	Besar	13
Espenak	Agt	28	22:43	1281	Sura	12
NASA		-	-	-	-	-
Stellarium		29	23:00	1281	Sura	13
Espenak	Sep	27	7:54	1281	Sapar	12
NASA		-	-	-	-	-
Stellarium		28	23:00	1281	Sapar	13

Julian Calendar (1368 CE)				Javanese Calendar		
Literature	Month	Date	UTC +07	Year	Month	Date
Espenak	<i>Oct</i>	26	19:28	1281	Mulud	12
NASA		-	-	-	-	-
Stellarium		27	23:00	1281	Mulud	13
Espenak	<i>Nov</i>	25	10:01	1281	Bakda Mulud	12
NASA		-	-	-	-	-
Stellarium		26	23:00	1281	Bakda Mulud	13
Espenak	<i>Des</i>	25	3:17	1281	Jumadilawal	13
NASA		-	-	-	-	-
Stellarium		25	23:00	1281	Jumadilawal	13

Note: *Italic* means there is inequality of date between those two references.

7.1.3 Date Conversion from Solar to Javanese Calendar for 2018 CE

To calculate this conversion, we take into account that the Western Calendar transitioned from the Julian Calendar to the Gregorian Calendar on October 5th, 1582 CE. Using the same conversion as the previous section, we get for the last day of the Julian Calendar,

October 4th, 1582 CE = *Ramadhan* 16th, 990 H = *Pasa* 16th, 1502 Java.

We know that the next day is *Pasa* 17th, 1502 Java, but in the Gregorian Calendar the next day is October 15th, 1582 CE. For this reason, we choose new reference dates for the conversion, indicated in Diagram 2.

Diagram 2. The Calculation Scheme

As we did for the previous conversion, we calculate for all months in 2018 CE in the framework of the Javanese Calendar using a 120-year correction and compare it with the two other references. We can see the result in the Table 4 below.

Table 4. Date Conversion from Gregorian Calendar to Hijriyah Calendar and Javanese Calendar in 2018 CE

Gregorian Calendar (2018 CE)				Hijriyah Calendar			Javanese Calendar		
Literature	Month	Date	UTC +07	Year	Month	Date	Year	Month	Date
Espenak	Jan (1)	2	9:24	1439	Rabi'ul Akhir	13	1951	Bakda Mulud	12

Gregorian Calendar (2018 CE)				Hijriyah Calendar			Javanese Calendar		
Literature	Month	Date	UTC +07	Year	Month	Date	Year	Month	Date
NASA		2	9:24	1439	Rabi'ul Akhir	13	1951	Bakda Mulud	12
Stellarium		2	23:00	1439	Rabi'ul Akhir	13	1951	Bakda Mulud	12
Espenak	Jan (2)	31	20:27	1439	Jumadil Awal	13	1951	Jumadil Awal	12
NASA		31	20:27	1439	Jumadil Awal	13	1951	Jumadil Awal	12
Stellarium		31	23:00	1439	Jumadil Awal	13	1951	Jumadil Awal	12
Espenak	Mar (1)	2	7:51	1439	Jumadil Akhir	14	1951	Jumadilakhir	13
NASA		2	7:51	1439	Jumadil Akhir	14	1951	Jumadilakhir	13
Stellarium		1	23:00	1439	Jumadil Akhir	13	1951	Jumadilakhir	12
Espenak	Mar (2)	31	19:37	1439	Rajab	13	1951	Rejeb	12
NASA		31	19:37	1439	Rajab	13	1951	Rejeb	12
Stellarium		31	23:00	1439	Rajab	13	1951	Rejeb	12
Espenak	Apr	30	7:58	1439	Syakban	13	1951	Ruwah	12
NASA		30	7:58	1439	Syakban	13	1951	Ruwah	12
Stellarium		30	23:00	1439	Syakban	13	1951	Ruwah	12
Espenak	May	29	21:20	1439	Ramadhan	13	1951	Pasa	12
NASA		29	21:20	1439	Ramadhan	13	1951	Pasa	12
Stellarium		29	23:00	1439	Ramadhan	13	1951	Pasa	12
Espenak	Jun	28	11:53	1439	Syawal	13	1951	Sawal	12
NASA		28	11:53	1439	Syawal	13	1951	Sawal	12
Stellarium		28	23:00	1439	Syawal	13	1951	Sawal	12
Espenak	Jul	28	3:21	1439	Dzulqo'dah	14	1951	Sela	13
NASA		28	3:21	1439	Dzulqo'dah	14	1951	Sela	13
Stellarium		27	23:00	1439	Dzulqo'dah	13	1951	Sela	12
Espenak	Agt	26	18:56	1439	Dzulhijah	13	1951	Besar	12
NASA		26	18:56	1439	Dzulhijah	13	1951	Besar	12
Stellarium		26	23:00	1439	Dzulhijah	13	1951	Besar	12
Espenak	Sep	25	9:53	1440	Muharram	13	1952	Sura	12
NASA		25	9:53	1440	Muharram	13	1952	Sura	12
Stellarium		25	23:00	1440	Muharram	13	1952	Sura	12
Espenak	Oct	24	23:45	1440	Safar	12	1952	Sapar	11

Gregorian Calendar (2018 CE)				Hijriyah Calendar			Javanese Calendar		
Literature	Month	Date	UTC +07	Year	Month	Date	Year	Month	Date
NASA		24	23:45	1440	Safar	12	1952	Sapar	11
Stellarium		25	23:00	1440	Safar	13	1952	Sapar	12
Espenak	Nov	23	12:39	1440	Rabi'ul Awal	13	1952	Mulud	12
NASA		23	12:39	1440	Rabi'ul Awal	13	1952	Mulud	12
Stellarium		23	23:00	1440	Rabi'ul Awal	13	1952	Mulud	12
Espenak	Des	23	0:49	1440	Rabi'ul Akhir	13	1952	Bakda Mulud	12
NASA		23	0:49	1440	Rabi'ul Akhir	13	1952	Bakda Mulud	12
Stellarium		23	23:00	1440	Rabi'ul Akhir	13	1952	Bakda Mulud	12

Note: *Italic* means there is inequality of date between those two references.

We find from this table that every date in the Gregorian Calendar that we convert into the Hijriyah and the Javanese Lunar Calendar, there is no same date between the Hijriyah and the Javanese Lunar Calendar even though we have applied the 120-year correction. From Table 4, we find that the Javanese Lunar Calendar is one day slower than the Hijriyah calendar. This invalidity happens since 2010 CE, the cause of which is still unknown.

8 Conclusions

We conclude that the date of the *Malam Opat Belasan* ceremony which is always held on the 13th to the night of 14th in every month is correct if the date of the full Moon phase that we choose in Stellarium follows the definition of full Moon phase in the Hijriyah Calendar. Specifically, the Hijriyah definition of the full moon indicates that the full Moon phase occurs on the 13rd, 14th, and 15th day of each lunar month.

However, we also find that the 120-year correction between the Hijriyah and Javanese Lunar Calendar is invalid since 2010 CE. The Javanese Lunar Calendar is one day slower than Hijriyah calendar. The cause of this is still unknown.

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