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Reconstruction of Moon Phases and Period in The Book of Enoch on Islamic Astronomy Perspective

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Abstract: The Book of Enoch presents an explanation of Moon in a different way when compared to many ancient manuscripts. The periods of the Moon associated with the Moon phases are illustrated in a unique way that, in first glance, requires a deep understanding. This explanation is different with what science has explained nowadays. To begin with, the previous research of this subject on the Book of Enoch is out to dated. Therefore, this research conducts a new approach to examine the Book of Enoch using Islamic perspective where this study is rare to conduct. This study utilizes qualitative research with content analysis to gain the answer in depth. This research also uses triangulation method to investigate the data and obtain the validity of the results. Overall, the Moon phase in the Book of Enoch has the same understanding as the modern science. The Book of Enoch describes implicitly the appearance of Moon in the northern hemisphere. The explanation of Enoch lunar-day in each month is followed by the Urfi Islamic calendar. Then the statement about "once the month is 28-day" is based on the using of Callippic cycle in Charles opinion while in the author's opinion that the Book of Enoch shows the sidereal month cycle. In addition, the theory which has been adopted by Islamic astronomy has a strong relationship with this manuscript since it is believed that this manuscript is attributed to Prophet Enoch or Idris.

Keywords: book of enoch; islamic astronomy; moon phases; moon period.

1. Introduction

It is crucial to bring the studies of Moon Phases and Moon period in the Book of Enoch to the surface. Human needs learning Moon phases to determine days, predict tidal pattern, provide insight into cultural practices, rituals and beliefs. In addition, people learn Moon period deeply to gain some regards. They are navigation, time keeping, and used in various culture for religious observance, agriculture and traditional practices. Even though technology has advanced, human still keep some traditional practices to keep in touch with custom and heritage. This enduring relationship with the Moon reflects a deep-seated respect for natural cycle and their influence on human existence.

Many religions around the world rely on the Moon to determine their feast, ceremonies and prayer times. This particularly evident in Indonesia, where the government officially recognizes

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six religions: Islam, Hinduism, Buddhism, Confucianism, Christianity and Catholicism. Each of them incorporates lunar observations into their practices. For instance, Hindus observe the new moon to mark significant events and utilize a lunisolar calendar known as the "Caka calendar" and "Pengalantaka" for their rituals.[2] Buddhists also depend on the lunar calendar for their ceremonies,[3] while Confucian practices are similarly aligned with lunar cycles. Additionally, Christians and Catholics often hold special prayers during the full moon.[4] In Islam, the lunar cycle is essential for determining the Hijri calendar and observing the sighting of the hilal (new crescent moon), which marks important religious occasions. This interconnectedness illustrates how deeply the Moon influences spiritual life across diverse cultures. In reality, Indonesia is very sticky to Moon's observation.

This article will delve into the Moon's significance as described in the Book of Enoch; an ancient manuscript attributed to the biblical figure Prophet Enoch. The Book of Enoch is considered a critical text in the study of early religious thought and cosmology, and its insights into celestial phenomena warrant thorough exploration. Given its historical and theological importance, this study aims to shed light on how the Moon is portrayed within this intriguing work, which has captivated scholars and theologians alike for centuries.

The Book of Enoch is traditionally divided into three main volumes: 1 Enoch, 2 Enoch, and 3 Enoch. The first volume, commonly referred to simply as the Book of Enoch, is regarded as a revelation from Prophet Enoch (Idris), who is noted as the great-grandfather of Prophet Noah (Nuh). This text is particularly well-known for its detailed descriptions of heavenly visions and cosmic order. The second volume, known as the Book of the Secrets of Enoch, offers additional insights into Enoch's experiences and teachings. The third volume, referred to as the Hebrew Book of Enoch, presents further elaborations on themes found in the earlier texts. Each volume contains a distinct number of sections and chapters; however, this article will focus primarily on 1 Enoch. Within this book, there are five sections, with the third section—often called the Heavenly Luminaries section—specifically addressing topics related to astronomy, celestial bodies, and calendars. This section spans chapters 72 to 82 and provides a comprehensive examination of the Moon's role within the broader context of celestial phenomena. With the presence of the Book of Enoch which is classified into ancient manuscript and believed to be attributed to Prophet Enoch, this study needs to be conducted.

The Book of Enoch has some explanation about Moon in the Heavenly Luminaries section. It provides it on chapter 72 until 79 whilst it explained the Moon in unique way. Thus, some descriptions from this book seems have a slight difference with the modern theory. However, the studies about those concepts have lack of understanding because of the limitation of previous

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[2] Ni Putu Audita Placida Emas, Alif Husnul Fikri, and Rendy Darma, "The Pengalantaka Eka Sungsang Ka Paing System and a Diagram for Determining Purnama and Tilem in the Balinese Calendar," 2021, https://doi.org/10.1007/978-3-030-62777-5_20.

[3] Jeffrey Kotyk, "The Chinese Buddhist Approach to Science: The Case of Astronomy and Calendars," *Journal of Dharma Studies* 3, no. 2 (2020): 273–89, https://doi.org/10.1007/s42240-020-00082-y.

[4] Riscky A P Manafe, "Ibadah Bulan Purnama (Study Sosio-Teologis Ibadah Bulan Purnama Di Jemaat GMIM Nafiri Telap)" (Universitas Kristen Satya Wacana Salatiga, 2015).

studies. Many Enochian and Moon studies can be classified into three categories. First, many previous studies from 2020 to 2023 tend to discuss the relation between Moon phases and animal behaviours.[5] Second, studies of the Moon period in ancient manuscripts have rarely been conducted.[6] Third, the studies about the Book of Enoch which contributes to astronomy is out dated.[7] The study of the Moon is essential for advancing knowledge across multiple disciplines, particularly in Islamic astronomy, or ilmu falak.

The significance of lunar studies is enduring, as observations of the Moon have been a fundamental aspect of astronomical research for centuries. While modern astronomers continue to explore deep sky phenomena, there has been a noticeable shift away from lunar observation since the era of space exploration, particularly following the historic missions to the Moon. During that period, nations strove to show off their scientific might and superiority in space exploration. However, when interest in lunar studies dwindled, emphasis went to more distant celestial planets, which many astronomers today see as more difficult and fascinating.

Despite this shift, the Moon remains an important subject of study, with many ambiguities that require additional examination. The complex nature of lunar observations, as well as their significance for calendars and religious activities, underline the need of comprehending all three celestial bodies: the Moon, the Sun, and the Earth. This is especially true in Indonesia, where hilal

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[5] Stanislava Peeva et al., "European Badger's Mating Activities Associated with Moon Phase," *Journal of Ethology* 41, no. 1 (2023), https://doi.org/10.1007/s10164-022-00762-1; Cristian Pérez-Granados, Karl L. Schuchmann, and Marinez I. Marques, "Addicted to the Moon: Vocal Output and Diel Pattern of Vocal Activity in Two Neotropical Nightjars Is Related to Moon Phase," *Ethology Ecology and Evolution* 34, no. 1 (2022), https://doi.org/10.1080/03949370.2021.1886182; G. D. Linley et al., "Moon Phase and Nocturnal Activity of Native Australian Mammals," *Australian Mammalogy* 43, no. 2 (2021), https://doi.org/10.1071/AM19070; Cristian Pérez-Granados, Karl L. Schuchmann, and Marinez I. Marques, "Vocal Activity of the Ferruginous Pygmy-Owl (Glaucidium Brasilianum) Is Strongly Correlated with Moon Phase and Nocturnal Temperature," *Ethology Ecology and Evolution* 33, no. 1 (2021), https://doi.org/10.1080/03949370.2020.1820582; Lindsay A. French et al., "Shark Side of the Moon: Are Shark Attacks Related to Lunar Phase?," *Frontiers in Marine Science*, no. 8 (2021), https://doi.org/10.3389/fmars.2021.745221; Juan Carlos Bautista-Covarrubias et al., "Immune Response and Oxidative Stress of Shrimp Litopenaeus Vannamei at Different Moon Phases," *Fish and Shellfish Immunology* 106 (2020), https://doi.org/10.1016/j.fsi.2020.08.040.

[6] Fumika Yamashina et al., "Darkness at Night during the New Moon Period Alters the Expression Levels of the Clock Genes in the Brain of a Moon-Related Spawner, the Malabar Grouper Epinephelus Malabaricus," *Biological Rhythm Research*, 2023, https://doi.org/10.1080/09291016.2023.2247801; Anuradha Reddy, "Islamic Geometry-Based Moon-Period Calendar and Interaction Design," *Interactions* 30, no. 3 (2023), https://doi.org/10.1145/3592461; M. Yu Barkin and P. M. Shkapov, "On The Motion Period Of The Rotation Axis Pole In The Case Of An Elastic Moon," *Herald of the Bauman Moscow State Technical University, Series Natural Sciences*, no. 5 (2022), https://doi.org/10.18698/1812-3368-2022-5-4-15; J. Karuwal and B. Budiman, "The Influence of Moon Period Day to Paperek Fish (Leiognathus Spp) Cathed and It's Connection with Physical Waters of Boat Live Nets at Dodinga Bay, West Halmahera Districs," in *IOP Conference Series: Earth and Environmental Science*, 2021, https://doi.org/10.1088/1755-1315/797/1/012003.

[7] Helen R. Jacobus, "Reconstructing the Calendar of 4Q208-4Q209 (and a Response to Eshbal Ratzon)," *Revue de Qumran*, 2019, https://doi.org/10.2143/RQ.31.2.3287242; Eshbal Ratzon, "The First Jewish Astronomers: Lunar Theory and Reconstruction of a Dead Sea Scroll," in *Science in Context*, 2017, https://doi.org/10.1017/S0269889717000114; Annette Yoshiko Reed, "Writing Jewish Astronomy in the Early Hellenistic Age: The Enochic Astronomical Book as Aramaic Wisdom & Archival Impulse," *Dead Sea Discoveries*, 2017, https://doi.org/10.1163/15685179-12341412; Helen R. Jacobus, "The Babylonian Lunar Three and the Qumran Calendars of the Priestly Courses: A Response," *Revue de Qumran*, 2013; Henryk Drawnel, "Moon Computation in the Aramaic Astronomical Book," *Revue de Qumran* 89, no. 1 (2007): 3–42.

(the sighting of the new moon) and lunar calendars are deeply ingrained in cultural and religious practices. A detailed examination of these celestial entities can provide useful insights into their connectivity and relevance in both scientific research and traditional activities, reinforcing the value of moon studies in modern astronomy. Therefore, this study conducts the Moon period and phases in the Book of Enoch based on Islamic perspective.

As the aim of this study is to address the limitation of the previous study about the Moon phases in Enoch Book. By doing so, this study intends to fill in the gaps of Moon and Enochian studies. Thus, this research raises question of how the Moon phases and its period in the Book of Enoch in Islamic perspective does. As long as this belief is still be practiced by some religions in Africa, this issue is still place in significant way.

2. Methods

There are various unique ways from the Book of Enoch to explain something happen in the world. The Book of Enoch uses different style to depict the movement of celestial bodies in the heaven. Therefore, this study will examine this manuscript using content analysis. Furthermore, this study utilizes qualitative research in understanding the meaning of this phenomenon. To gain the data, this research uses triangulation method to investigate the data and obtain the validity of the results. Data triangulation itself is by combining and sorting data from various sources, methods or theories. Basically, there are three types of data triangulation, namely theory, data source and time-order.

First, this research uses data triangulation of data sources. These data sources are the Book of Enoch in Amharic; the translation of Book of Enoch by Charles, D. Litt., D.D. Woth an Introduction by W.O.E. Oesterly, D.D. in English; the translation of Book of Enoch by Michael A Knibb in English; the translation of Book of Enoch by Tessa Sitorini with her footnotes in Indonesia; interview with one of the community of Enoch calendar adherents whose name cannot be mentioned; and articles by Helen R Jacobus, Eshbal Ratzon and Henryk Drawnel as Enochian scholars. The triangulation of data sources is used in order to obtain the authenticity of the content because the translation results of each person will produce different oral language so there is a possibility of distortion of meaning. Therefore, data sources must be triangulated in order to obtain valid results in accordance with what is stated in the Book of Enoch in Amharic.

Second, this research uses data triangulation of theory. Based on Imam Shafi'i, "My opinion is right and can be wrong, and the other's opinion is wrong and can be right". We can conclude that there is no absolute truth. so that every existing theory has advantages and disadvantages. this is what is then sorted out and put together in order to compile a hollow puzzle. this triangulation is used when you want to get the hidden meaning that exists in the BOE. for example, in finding the meaning of the direction explanation, the researcher compares the theory put forward by Charles, Knib and compares it with the language habits or dialects of the local community. in addition, the results of interviews are also taken to find out the meaning of the explanation of the portion of the day believed by the community.

In order to get the data in depth, this study will explain the Moon terms in the Book of Enoch to differentiate between "Moon" and "Month". Then, it will examine where is the location where the Moon is explained. After knowing in which hemisphere the Moon is described, this study will examine the Moon position towards the Sun which is known as the Moon phases. Finally, the Moon's period will be examined in the last discussion. All of the theory then will be combined with the Islamic astronomy's theory to conclude all the data. This will see how far the theory put forward in the Book of Enoch aligns with Islamic astronomy and modern astronomy.

3. Results and Discussion

3.1. Moon Term in the Heavenly Luminary's Book

Every country or places has their own name for the Moon. In Amharic language – where the Book of Enoch use this language in its scroll – the Moon is translated into ጨረቃ (č̣äräqa). While in the Heavenly Luminaries Book, the word about Moon is not mentioned as ጨረቃ (č̣äräqa) but as ወርኅ (wärəḫə) which means 'the month'. The using of this word is repeated in chapter 8:2; 41:5; 41:7; 41:8; 53:1; 60:1; 60:12; 69:20; 72:3; 72:6; 72:7; 72:37; 73:1; 73:3; 73:4; 73:7; 74:5; 74:11; 74:12; 74:14; 74:15; 75:3; 75:6; 78:2; 78:4; 78:6; 78:7; 78:9; 78:10; 78:11; 78:13; 78:14; 79:2; 79:3; 80:1; 80:4; 83:11; 100:10. But not all of the chapter above using ወርኅ as 'the Moon' because it also used as 'month' in chapter 72:6; 72:7; 73:3; 74:5; 78:9.

On the other hand, the translate of 'the month' in Amharic is ወርኅ (wärəḫə). The Heavenly Book use this word with different form አውራኂሆሙ (ʾäwəraḫihomu) which means 'month'. This word is repeating in chapter 33:3; 72;1; 74:2; 74:9; 82:9; 82:10. Then, the term of 'certain month' using እሙራት (ʾəmuratə) in chapter 74:4; 78:9.

The various name of the Moon sometimes also is given because of its appearance or the shape of the Moon that facing the Earth. This different appearance is called the Moon shape. In the third book of 1 Enoch, the term of New Moon is mentioned while the other kind of Moon phase is not including there. It just the number of Moon's illumination and not the name of Moon phase. The term of New Moon is stated in chapter 78:12 as ሠርቀ (śärəḳ̣ä) which is mean to steal. In this term, it means the light has been stolen so there is no light could be seen in the heaven. However, if the 'New Moon' is translated into Amharic would be turned into አዲስ ጨረቃ (ʾadisə č̣äräqa). While the Full Moon is only stated as the light is full or something and not leaning the word full against the Moon to make a phrase 'Full Moon'.

Besides, the third section of 1 Enoch also stated that the Moon has four names. Those names are stated in chapter 78:2 as አሶንያ (ʾäsonəya), እብላ (ʾəbəla), ብናሴ (bənase), ኤራዕ (ʾeraʿə). Those names are commonly used transliteration of obscure names. Like the names of the Sun in previous chapter, 78:1, these terms are not obvious in Hebrew, Aramaic, Syriac or Canaanite terms. Some scholars transliterate Asonja as Asenja and Ebla as Abla. There have been several theories proposed to explain the names. One theory is that the four names represent the four

phases of the Moon. However, the names cannot be matched to any known terms in Semitic languages or ancient Egyptian.[8]

አሶንያ (ʾäsonəya) in Hebrew (according to Charles) יהאישון derived from אִישׁ (Man) and יה. This is the name of the Moon in connection with its likeness to the human face.[9] Ghana person said that the name Asonja is of Akan origin and means "it has lighted its light". እብላ (ʾəbəla) means eat if translated from Amharic into English. While in Hebrew, it corrupted from לְבָנָה which mean the pale star. In this case, he thought that the meaning of pale star is related with the waning period of the Moon.

ብናሴ (bənase) in Hebrew derived from בֶּן־בֶּסֶה which from כסה means to cover. In this case, he thought that this name is appropriate name when the Moon on conjunction period then the Moon is invisible. But in Prov. 7:20 and Ps 81:4, כֶּסֶה means the Full Moon as opposite to החרש (New Moon). ኤራዕ (ʾeraʿə). יָרֵחַ from ירה which means to cast, dart or same as ארח which means to journey or go. In this case, he thought this term is suitable as a designation of the waxing or Full Moon.[10]

Therefore, four names in chapter 78:2 refer to Moon's phases, namely new Moon, full Moon, waning and waxing moon. It was different in Islamic astronomy case. Islamic astronomy known three types of Moon's term. First is *hilal* or known as little crescent after the new Moon. Second is *badar* or known as full moon. While the last one is *qamar* or term for Moon referred to any phases. It is a common translation for Moon in Arabic or Islamic astronomy.[11] While in modern astronomy, people know Moon's phases as New Moon, Waxing crescent, First quarter, Waxing gibbous, Full Moon, Waning gibbous, Last (third) quarter and Waning crescent. The modern astronomy put in detail to each waxing and waning phases.

Similarly, Book of Enoch term for mentioning new moon, full moon, waxing and waning phases has similarity on *Pengalantaka* system. The Balinese calendar system, *Pengalantaka*, use the term "tilem" for new moon, "penanggal" for phases from new moon to full moon or the waxing phases, "purname" for full moon and "panglong" for phases from full moon to new moon or the waning phases.[12]

It can be seen that the incompleteness of the moon phase terms in the BOE, Islamic astronomy and the *pengalantaka* system compared to modern astronomy is due to the lack of need for it. Overall, the most important thing for them is the new moon and full moon phases.

3.2. Moon's Location in Which Hemisphere

In the description of the third book, the Heavenly Luminary, there is no specific explanation about the Moon appearance in current hemisphere. In the southern hemisphere, the people see

[8] Scriptural Research Institute, *3rd Enoch: Astronomical Book* (United Kingdom: Digital Ink Production, 2020).

[9] R H Charles, *The Book of Enoch Translated by R. H. Charles, D.Litt., D.D. With an Introduction by W. O. E. Oesterley, D.D.* (London: Society for Promoting Christian Knowledge, 1917).

[10] Charles.

[11] Susiknan Azhari, *Ensiklopedi Hisab Rukyat*, 3rd ed. (Yogyakarta: Pustaka Pelajar, 2012), 76-77..

[12] Emas, Fikri, and Darma, "The Pengalantaka Eka Sungsang Ka Paing System and a Diagram for Determining Purnama and Tilem in the Balinese Calendar."

the Moon 'upside down', so the side which is shining or sunlit seems the opposite from the Northern Hemisphere. In the previous author's article, the movement of Sun through its daylight duration is on the Northern Hemisphere.[13] If that said so, then the Moon's position and its appearance is different between the north and south hemisphere. For the place, it located at various location such as River Euphrates, Turkey, Alborz mountains, Syria, Israel and Iran.

In the northern hemisphere, the Moon phase runs clockwise and it is seen in the south. The Sun and Moon rises in the east which is the left side and sets on the right side or in the west. In the northern hemisphere, the apparent movement of Sun and Moon are from left to right throughout the hours if they are facing the south and north in the back.

However, the location of the Sun and Moon movement also could be identified implicitly by understanding chapter 72:3 and 75:7 which stated that there are many windows to the left and to the right. Where, the position of windows in in the left and right side of east and south. In Hebrew tradition, the left side is known as north while the south is known as the right side. This concept is used when the human is facing east where the celestial body is rising from the edge of the heaven. In Charles translation from Amharic, he used left and right while Michael A Knibb uses north and south. In Amharic language, 'north' is translate into ሰሜን (sämenə) while left is ግራ (gəra). Then, 'south' is translated into ደቡብ (däbubə) and right is ቀኝ (qänyə). But in chapter 72:3 and 75:7, the right side is እምየማኑ (ʾəməyämanu) and ወእምፀጋሙ (wäʾəməṣägamu) is the left side. In chapter 72:3, the first mention is the right and the second is left. While in chapter 75:7, the first one is left and the second is right.

Basically, cardinal direction is fixed and absolute while left and right is depending on what the subject facing. If facing the north, then the right is east and west is the left side. If facing the south, the left side is east and right is the west. Besides, if the subject is lying on the left side on the ground, then left is down and right is up. Based on the explanation, the Moon's position is on the Northern Hemisphere.

3.3. Moon's Position Towards the Sun

The Moon position is always changing in every phases. Allah states in the Quran about the Moon phases in surah Ya sin [36]: 39. "*And the moon - We have determined for it phases, until it returns [appearing] like the old date stalk.*".[14]

If the Moon's face puzzled our forefathers, they were also fascinated by how the Moon appeared to change shape.[15] The Moon's appearance is greatly influenced by its direction in relation to the Sun.[16] The lunar cycle is one of the most visible occurrences in the sky, and it has served as

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[13] Youla Afifah Azkarrula and Ahmad Izzuddin, "An Analytical Study of the Duration of Daylight in the Book of Enoch," ed. Gudrun Wolfschmidt and Susanne M Hoffman, *Astronomy in Culture–Cultures of Astronomy. Astronomie in Der Kultur–Kulturen Der Astronomie.: Featuring the Proceedings of the Splinter Meeting at the Annual Conference of the Astronomische Gesellschaft 57* (2021).

[14] Talal A Itani, *The Quran Translated to English* (Beirut: ClearQuran, 2012).

[15] Christopher DePree and Alan Axelrod, *The Complete Idiots Guide to Astronomy*, 2nd ed. (United Stated of America: Pearson Education, Inc, 2001).

[16] Stan Gibilisco, *Astronomy Demistified* (United Stated of America: McGraw-Hill, 2003).

a natural timekeeper since before the start of human civilization.[17] From the ancestors' experiences, human nowadays could differentiate all of the phases starts from new Moon to waning crescent.

Sometimes the Moon chases the Sun and sometimes goes away from the Sun. The Moon position towards the Sun makes the changing of the Moon shape. In the first phase, the New Moon occurs on the first day of lunar time (chapter 78:12). But in chapter 73:4, the Moon is in the first phase when the Moon rises on the thirtieth morning. Then the reason why it is called the New Moon because on that day, the light rises on it surface (chapter 78:12). When the Moon is on its full phase, in that day the Sun set in the west so the Moon rise in the East (chapter 78:13) at night. in this phase, the Moon shines through the whole night until the Sun rises in the following day. Chapter 78:13 describes the Moon is seen opposite the Sun. so based on the aperture, this phase is on the greatest elongation, is 180°.

There is a different time for Moon to rise and set during its waxing and waning phase. When in waning phase, the moonrise occurs during night and moonset as occurring during the day. This condition concords with actual facts about the Moon movement around the Earth and represent the opposite situation to the waxing phase. In waxing phase is mentioned that the moonrise as occurring during the day and set during the night.

The lunar phase is determined by the distance between the Sun and the Moon so during a Full Moon, the Moon will rise in the East as the sun sets in the west. But during a waxing crescent the Moon will appear just over the horizon in the West just after sunset. The Moon is said to be waxing as it separates from the Sun becoming steadily fuller and waning as it moves closer to the Sun and diminishing until it disappears. This is when the moon is not visible for 1-2 days during a lunar cycle. The moon is often visible in the daytime sky and able to see when it is changing phases as it draws closer or moves further from the Sun. The Moon often appears to be chasing the Sun but the Sun is actually moving through the lunar orbit creating this illusion and changing the lunar phases.[18]

In waning phase from the Full Moon, the Moon is closer to the Sun and it will continue to travel closer to the Sun until it's half a moon. It will go down to a quarter moon and then it will turn into a crescent moon and then it will disappear into the rays of the Sun. Then, human will not be able to see the Moon for one to two days then as sunset the moon will suddenly appear as a two percent crescent moon. Because the moon is next to the sun and the sun just set. But the two percent crescent moon could be seen just over the horizon in the west and that is the reason why the determination of the beginning of the Hijri month is looking for the *hilal* after sunset.

In fact, human may not able to see the moon's crescent (*hilal*) for an additional two or three days depending on how high it is rising in the horizon. It comes just above the horizon and then it just drops back down again and disappears because it is travelling with the Sun. Because

[17] Michael A Seed and Dana E Backman, *Astronomy The Solar System and Beyond*, 6th ed. (United Stated of America: Brooks/Cole, 2010).

[18] Asherit, "Interview with Asherit," 2021.

of this, there are many aspects that influence the appearance of *hilal.* After the New Moon then the appearance of *hilal*, the moon will begin to move away from the sun and it will begin to grow into a quarter moon and then a half-moon and then a quarter moon and then finally it will become a full moon again. Then it will rise in the night just as the sun is setting.

3.4. Moon's Period

The Moon movement and the changing of Moon phase make human use the Moon as time's reference. It has been explained in the Quran by surah Jonah [10]: 5.

> "It is He who made the sun a shining light and the moon a derived light and determined for it phases - that you may know the number of years and account [of time]. Allah has not created this except in truth. He details the signs for a people who know". [19]

In addition, Moon and Sun movement creates revolution where Allah have established the number of months in Quran surah at-Taubah [9]: 36

> "Indeed, the number of months with Allah is twelve [lunar] months in the register of Allah [from] the day He created the heavens and the earth; of these, four are sacred. That is the correct religion, so do not wrong yourselves during them. And fight against the disbelievers collectively as they fight against you collectively. And know that Allah is with the righteous [who fear Him]." [20]

This time reference is known as lunar period. The lunar period has its own day, week and year calculation. The lunar day is same as the solar day which is stated in chapter 73:3. It implies that the lunar day also has 24 hours in a day. As in Islamic astronomy and Fiqh, the beginning of the day in lunar system is start from the sunset. This condition differs from the beginning day in solar system. For Julian and Gregorian time, the beginning of the day is start from midnight. While in the 1 Enoch, the beginning of the day is started from the rising Sun (chapter 72:2).

In 1 Enoch chapter 74: 10-16, the solar year is longer than the lunar and star day. From all description, the lunar year falls behind the solar year ten days each year. The solar year consists of 364 days (72:32). Then the lunar year will have only 354 days by subtracting ten days from 364 days.[21] It is the meaning of the lunar day is ten days behind the solar days. Then, in the four following chapter, 78:15, 1 Enoch describes that for three months (as its proper time), the Moon achieves 30 days, then, for three months, the Moon in each month achieves 29 days. Those days are achieved when the Moon accomplished its waning in the first period. If all the days are added up it will produce 117 days.

Then the following verse (78:16), the number day in each month is 30 days in the time of its rising for three months. Then for three months, the Moon appears in each month for 29 days. Both verse, 78:15 and 78:16 declare that in each period is 177 days. Even if both period is added up it will produce 354 days where 10 days behind the solar year. The chapter 79:4 also repeats

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[19] Itani, *The Quran Translated to English*.

[20] Itani.

[21] Youla Afifah Azkarrula, Susanne M Hoffmann, and Ahmad Izzuddin, "Examining the Impact of the Book of Enoch , Sefer Yetzirah , and Greek Civilization on the Jewish Calendar System : An Islamic Astronomical Law Perspective," *JIL: Journal of Islamic Law* 4, no. 1 (2023): 1–27, https://doi.org/10.24260/jil.v4i1.1153.

the number of one period is 177 days. Then in that verse, 177 days is equal to 25 weeks and 2 days. It concludes that one week in lunar system also consist of seven days as the solar time system. As in one period is 177 days that equal 25 weeks and 2 days. Then, the number of one week is (117-2)/25 that equal to 7. This also strengthen as chapter 73:3 explained.

As it seen in chapter 78:15-16, there are two period of lunar cycle. The waning cycle and the waxing cycle or the rising time. Waning cycle is mentioned twice in chapter 78:15 and 79:4. While the waxing cycle is mentioned in chapter 78:16. According to Knibb, the meaning of 'the waning' could be translated into 'its light comes ton and end and after that it is the beginning of the month'. But he thinks that it seems unlikely in view of the meaning of ትፈጸም.

The explanation about waning and waxing also mentioned in chapter 78:11 and 78:14. The explanation is about the waxing phase of the Moon from New Moon to Full Moon and the waning phase from Full Moon to the New Moon. While the condition in chapter 78:15-16 did not link to those conditions (chapter 78:11 and 78:14). Even if both chapters linked to chapter 78:15-16, the number of days in each period or cycle are different not 177 days (each). Because of the period of waning phase is always same in 30- and 29-day month, the total day in each waning phase is 15 days. If this number gets calculate by multiplying with 12 months (a year), it will produce 180 days not 117 days. So, the waxing phase period in one year is 174 days with six months of 29 day and other six month of 30 day.

In author opinion, the waning and waxing period or cycle of the Moon are related with the Sun movement. In waning cycle, the Moon starts its first period of time (or the first half period of lunar year) on the first gate. If it linked to the whole explanation in chapter 72, the first portal is linked to the winter solstice. Thus, when the Moon is moving from the winter solstice to the summer solstice, the Moonlight is decreasing because its light is not as bright as in the winter solstice. Its light is defeat by the sunlight. Because of this condition, the Moon is on its waning period and vice versa.

When the Moon starts the second period of time (or the second half period of lunar year), the Moon goes forth from summer solstice to winter solstice. Thus, the moonlight starts waxing because going to winter solstice make the Moon shines brighter. The reason why because there is no other brighter light as well as the Sun to cover and defeat the moonlight. Because of this condition, the Moon is on its waxing period. Then based on the explanation, the waning and waxing period of Moon is related with the gate or portal and the Sun movement.

The Moon period (in 1 Enoch) in one year which consist of 354 days is same as the lunar period in common year based on chapter 74:14.[22] The lunar and solar year have two kinds of year; leap year and common year (*basīṭah*). The common lunar year is 354 days while the leap year is 355 days. In 1 Enoch, especially in the third section, there is no explanation about the common or the leap year. 1 Enoch only states the number of each time period that consist of 177 days with three months of 30 days and three months of 29 days. In Hijri Urfi calendar, there are six months of 29 days and six months of 30 days in common year (354 days). While in leap year (355 days), there are five months of 29 days and seven months of 30 days.

[22] Azkarrula, Hoffmann, and Izzuddin, 8-9.

In one cycle, there is 30 years which consist of 11 leap years and 19 common years. The leap year falls on the order of year: 2, 5, 7, 10, 13, 18, 21, 24, 26 and 29. While the number of days in each month is in order as follows:

Table 1. The order of Hijri month in Urfi

Name of the Month	Days
Muharram	30
Safar	29
Rabi I	30
Rabi II	29
Jumada I	30
Jumada II	29
Rajab	30
Sha'ban	29
Ramadan	30
Shawwal	29
Dhu al-Qaeda	30
Dhu al-Hijja	29 (common) / 30 (leap)

Source: Slamet Hambali, Almanak Sepanjang Masa

So, the example of Hijri leap year and common year based on Indonesia Government are as follows:

Table 2. Comparation of leap and common year of Hijri month based on Gregorian month.

Hijri month	Leap year (1442 H)	Days	Common year (1443 H)	Days
1 Muharram	20 August 2020	30	10 August 2021	29
1 Safar	19 September 2020	29	8 September 2021	30
1 Rabi I	18 October 2020	30	8 October 2021	29
1 Rabi II	17 November 2020	29	6 November 2021	30
1 Jumada I	16 December 2020	29	6 December 2021	29
1 Jumada II	14 January 2021	30	4 January 2022	29
1 Rajab	13 February 2021	30	2 February 2022	30
1 Sha'ban	15 March 2021	29	4 March 2022	30
1 Ramadan	13 April 2021	30	3 April 2022	29
1 Shawwal	13 May 2021	30	2 May 2022	30
1 Dhu al-Qaeda	12 June 2021	29	1 June 2022	30
1 Dhu al-Hijja	11 July 2021	30	1 July 2022	29
	Total	355		354

Source: Digital Falak App and the Government Decision (Itsbat)

As the description in table 2, it can be seen that the number of common and leap year in are exactly 354 and 355 days. While the order of the number of each month is not always arranged alternately. The order could be random as long as the year is on leap or common year. And in 1 Enoch, there is no explanation that the number of days in each month should be arranged in order.

While if 1 Enoch also compared to Jewish calendar that consumed lunisolar system, it only could be compared with the simple year. Jewish calendar has six kinds of year; regular simple year (354 days), long simple year (355 days), long leap year (385 days), short simple year (353

days), regular leap year (384 days) and short leap year (383 days). The current Jewish calendar also uses intercalation just like 1 Enoch in chapter 75:1-2 however the current Jewish calendar uses one month of 30 days to insert.

Table 3. Comparation of regular simple and long simple year of Hebrew month based on Gregorian month.

Hebrew month	Regular simple year (5578 AM)	Days	Long simple year (5580 AM)	Days
1 Tishrie	21 September 2017	30	30 September 2019	30
1 Marcheshvan	21 October 2017	29	30 October 2019	30
1 Kislev	19 November 2017	30	29 November 2019	30
1 Tevet	19 December 2017	29	29 December 2019	29
1 Shevat	17 January 2018	30	27 January 2020	30
1 Adar	16 February 2018	29	26 February 2020	29
1 Nisan	17 March 2018	30	26 March 2020	30
1 Iyar	16 April 2018	29	25 April 2020	29
1 Sivan	15 May 2018	30	24 May 2020	30
1 Tammuz	14 June 2018	29	23 June 2020	29
1 Av	13 July 2018	30	22 July 2020	30
1 Elul	12 August 2018	29	21 August 2020	29
	Total	354		355

Source: Hebrew App Calendar

The Jewish calendar uses the calculation or ḥisab of molad which is same like Islam that using hilal or little waxing crescent moon as the determination of Hijri month. So, the number of each month has been set previously without using observation. So, if the 1 Enoch is compared with the Hijri year and Jewish calendar, the total number of lunar years are same as them. While 1 Enoch did not consider the leap year.

The number of days in lunar month is basically 29 or 30 days. While in 1 Enoch, beside 29 and 30 days, it also mentioned other number of days. In chapter 78:9 explained that in lunar system in certain months the Moon has 29 days in each month and once 28 days. While there is no other explanation about 28 days and the changing of number of lunar years. Then, if the 28 days got into a calculation with one year is 354 days, the number of 29 days month and 30 days month are changing. When the 354 days subtracted by 28 days it produces 326 days. A simple table will easier for searching how many 29 days month and 30 days month.

Table 4. The possibly number of months with once 28-day

Month of 29-day	Month of 30-days	Total Days
1	10	30
2	9	29
3	8	30
4	7	29
5	6	30
6	5	29
7	4	30
8	3	29
9	2	30
10	1	29

Source: Authors' own calculation

In Charles opinion, this book is related with eight-year cycle of the Greek. There is a cycle which called cycle of Callippic that consist of 76 years. The Callippic cycle has emended the Metonic cycle that used by Jewish in their lunisolar system calendar. The Metonic cycle consist of 19 years with seven lunar months were intercalated in 19 lunar years; 3, 5, 8, 11, 13, 16 and 19. Thus, this month had only 28 days as in the text.

The reason why there is another intercalation for the lunar year because the number of days in one lunar year is 354 days which is compared to the real lunar year that has 354.36708 in a year (One synodical month is 29.53059 multiple by 12 months). There is an excess of 0.36708 day. Then, it needs 2.27765064836 years to make up 1 day excess. Then to accomplish the Metonic cycle, Callippus make Callippic cycle that consist of multiple one Metonic cycle (19 years) with four. Then it produces an excess of 28 days. However, the number of the cycle is not exactly 76 years to get 28 days. To get 28 days need 76.27765064836 years.

Besides, the reason why 1 Enoch stated 28 days because of the Moon's orbit as defined with respect to the celestial sphere of apparently fixed starts (the International Celestial Reference Frame or ICRF) is known as a sidereal month because it is the time it takes the Mon to return to a similar position among the stars (27.321661 days or 27 days 7 hours 43 minutes 12 seconds). This type of month has been observed among cultures in the Middle East, India, and China by dividing the heaven into 27 or 28 lunar mansions, one for each day of the month, identified by the prominent star(s) in them. Then, this is also the reason why 1 Enoch gave the description of Moon illumination with fraction with 28 parts while the number of one month is 29 or 30 days.

Besides, the 28 days also related with another period of the Moon such as the sidereal month, tropical month. Draconic month and anomalistic month. Them during its 28-day orbital cycle, the Moon rotates on its axis once. And the one month also could be 28 days if the determination of the beginning of the month is using observation. If the little crescent is unable to see then the first day is the following day. Then at the end of month, the Moon is able to see after conjunction in the 28th day.

3.5. Callippic Cycle

Callippus, a Greek philosopher and student of the Exodus school of astronomy, created the Callippic cycle, a mechanism for multiplying years.[23] This system is also known as the 4-Metonic cycle. Before the Callippic cycle, Meton, an astronomer from Athens, developed the Metonic cycle. This cycle is associated with the use of the lunisolar calendar. The lunisolar calendar is based on mathematical computations of two celestial bodies, the Sun and Moon. The Metonic cycle was developed because at some point in time within a given amount of time, the cycle will repeat itself. More specifically, it is the time when the phases of the Moon repeat in the same sequence and on the same days. Meton calculates that 19 solar years are equivalent to 235 lunar months.[24] The Metonic cycle is used to calculate the length of years and where intercalary months should appear in the ancient Greek calendar.

[23] Swinburne University, "Callippus," Study Astronomy Online at Swinburne University, n.d.

[24] J. K. Fotheringham., "The Metonic and Callippic Cycles," *Monthly Notices of the Royal Astronomical Society* 84, no. 5 (1924): 383–92, https://doi.org/10.1093/mnras/84.5.383.

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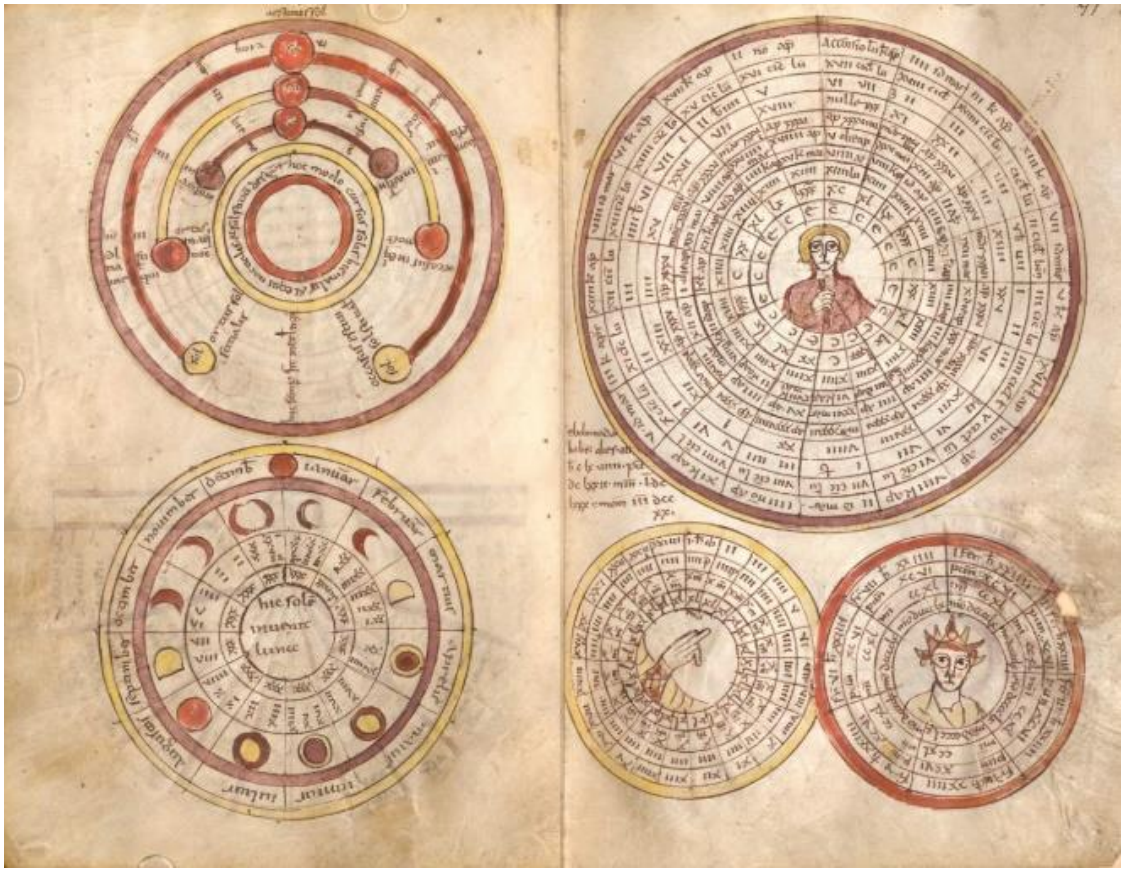

Figure 1. Depiction of Metonic cycle as a wheel

Source: *9th-century computistic manuscript made in St. Emmeram's Abbey*[25]

Callippus proposed modifying the Metonic Cycle around 330 BC. He agreed with Meton's work and continued to use 19 years for his computations. However, he believed that the number 365 1/4 was more accurately representing the length of days in a solar year. Then, he multiplied the 19-year cycle by 4 to get an integer number of days, and then deleted one day from the final 19-year cycle. So, one Callippic cycle is equivalent to 76 solar years or 940 lunar months. Furthermore, scientists have decoded the Antikythera mechanism, which uses both the Metonic and Callippic cycles.

[25] Dbachmann, "Depiction of Metonic Cycle," World History Encyclopedia, 2015.

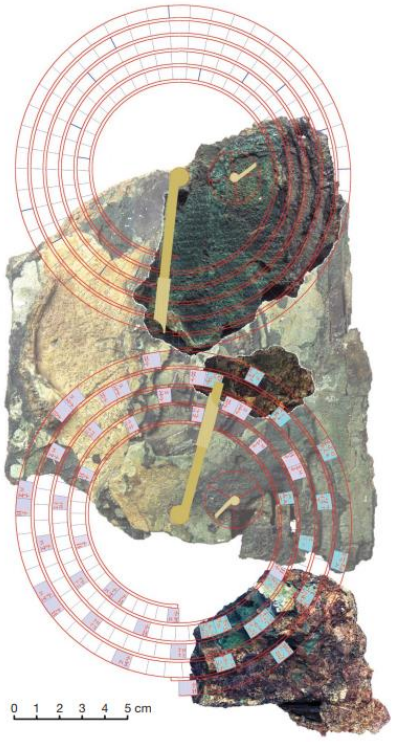

Figure 2. Depiction of reconstruction of the back dials of Antikythera,

Source: T. Freeth, et.al, Decoding the ancient Greek astronomical calculator known as the Antikythera Mechanism[26]

4. Conclusion

Each tribe, belief, and era uses a distinct name for the Moon phases. When compared to Islamic astronomy, the Book of Enoch has a more comprehensive naming system. However, compared to modern astronomy, it is much simpler. According to the authors' findings, modern astronomy provides the most comprehensive naming of Moon phases. However, it does not rule out the potential that there is a tribe, belief, or culture that has a more extensive and intricate system of designating lunar phases, perhaps even paying more attention to the Moon than modern astronomy.

The Moon location based on the research is in the northern hemisphere even if all of the Moon phase is not indicated and specific to the northern hemisphere (where in all around the world experience the same shape of the Moon but in different direction). The Moon phase in the Book of Enoch has same explanation with science nowadays.

When doing research with a manuscript related to direction, every author must first determine the location of the area portrayed. As in this research, the translation of right and left is related to the moon's location. This is connected to the difference in moon sightings between the northern and southern hemispheres. If there is a misconception, it will cause a time inaccuracy in the document. For example, moon sightings in Australia differ from those in Germany. The waxing

[26] T. Freeth et al., "Decoding the Ancient Greek Astronomical Calculator Known as the Antikythera Mechanism," *Nature* 444, no. 7119 (2006): 587–91, https://doi.org/10.1038/nature05357.

crescent in Germany looks exactly like the waning crescent in Australia, and vice versa. When a text refers to time in relation to the appearance of the moon, a misconception of time occurs if the direction and location of the place are ignored. As a result, observations on the orientation of the direction and location of the site are critical in any research.

The book of Enoch explained that the moon's location fluctuates because its path of travel differs from that of the sun. The book also emphasized that each phase has a different position in relation to the sun, as well as a different sunrise and sunset times. Furthermore, the book was aware that the sun's light is stronger than the moon's, thus when the moon was close to the sun, the moon's light became less apparent.

The Moon's phase in the Book of Enoch is explained by showing the Moon's position towards the Sun and in which day it appears. There are two kinds of month: the 29-day month and the 30-day month. The 29-day month has 14 days for waxing phase from New Moon to Full Moon while the 30-day month has 15 days for waxing phase. Both months has 15 days to complete the waning phase (full moon to new moon). The New Moon occurs when the Moon has conjunction with the Sun. While the Full Moon happens when the Moon is in the opposite side from the Sun. So, when the Sun rises the Moon sets and vice versa.

The total of synodical period in one year equal to only 354 days and don't use the leap year. While the Hijri month has 354-day for common year and 355-day for leap year. The Hebrew calendar has six kinds of year; regular simple year (354 days), long simple year (355 days), long leap year (385 days), short simple year (353 days), regular leap year (384 days) and short leap year (383 days). The order of the day-month in Enoch lunar month is alternately same as the Hijri Urfi month. While in the reality, the synodical month order is not constantly alternate. Then the statement in the Book of Enoch about "once the month is 28-day" is based on the using of Callippic cycle in Charles opinion while in the author's opinion that the Book of Enoch shows the sidereal month cycle. In that time, men had knowledge about the movement of the Moon.

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