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Obelisk Monuments in Religious Practice and Astronomical Observations in Ancient Egypt

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ABSTRACT

The obelisk, a tall and slender stone monument, is an iconic element in the landscape of Ancient Egypt. This study examines the role of obelisks in religious practice and astronomical observations in Ancient Egypt. Based on an analysis of ancient texts, archaeology, and astronomy, the study suggests that obelisks had a dual role in Ancient Egyptian culture. First, the obelisk is an important religious symbol in rituals. They were associated with Ancient Egyptian gods, such as Ra and Atum, and were used in various rituals, including festivals and offerings. Secondly, the obelisk is used as a tool to see the sky. By its shape and position, Ancient Egyptian astronomers divided the day into two parts based on its shadow. It helps them understand cosmology, determine calendars, and predict astronomical events. This research improves our understanding of the function of obelisks in Ancient Egyptian culture. His discovery showed that the obelisk is a decorative monument and has religious and astronomical purposes.

I. Introduction

One of the most famous monuments of Ancient Egypt is the obelisk, with its distinctive shape of slender, tall, tapered pillars at the top. Its shape is rich in meaning and is the hallmark of the obelisk. Although most modern societies consider the obelisk an architectural symbol used in many countries around the world, the obelisk originated in Ancient Egypt and is strongly associated with religious practices and astronomical knowledge. The connection between this monumental architecture and the astronomical belief and knowledge system of Ancient Egypt provides an excellent picture of how they saw the world and their place in it.

Obelisks are of great importance in religion and astronomy. The ancient Egyptian astronomical tradition was powerful; Observation of the movements of the stars, sun, and other celestial bodies is essential for establishing calendars, predicting the flooding of the Nile River each year, and carrying out various religious rituals. Its towering shape and exact orientation make obelisks often used as gnomons or shadow pointers to calculate time and the sun's movement. It shows the connection between religion and science, an essential part of daily life in Ancient Egypt.[1]

In addition, the exact orientation of the obelisk shows how skilled the Ancient Egyptians were in astronomy. They use obelisks to know the time and season by looking at the shadows cast by the monument throughout the year. It is crucial to carry out an elaborate and ceremonial religious calendar as well as for agriculture. New studies show that these obelisks often align with the positions of certain stars, suggesting that the Ancient Egyptians understood very well how the earth and the cosmos were related.[2]

In Ancient Egypt, the interaction between religious practice and astronomical observation through obelisks showed a collaboration between science and spirituality. The Egyptians saw religion and science as complementary parts of their world understanding. In this situation, the obelisk symbolizes integration, combining beautiful architectural elements with scientific and religious purposes. It reflects a perspective on the vast world of Ancient Egypt, where humans, gods, and the cosmos are connected in a complex but peaceful network.[3]

Therefore, research on obelisks in Ancient Egypt provides insight into architecture and art and a broader understanding of how the people of Ancient Egypt used sophisticated astronomical knowledge in their daily religious practices and made it more than just stone monuments.

This study aimed to study how obelisks functioned in the religious and astronomical practices of Ancient Egypt, as well as how these monuments show synergies between two important elements in Egyptian civilization. By understanding this context, we can gain a deeper understanding of how the Ancient Egyptians understood the universe and their place in it and how they conveyed this understanding through monumental architecture.

II. Method

This study employs a qualitative descriptive approach to provide a detailed and comprehensive description of the phenomenon under investigation. It is achieved through in-depth data collection, which includes direct observation and documentation. Direct observation enables the researcher to engage with the Object or phenomenon in its natural setting, allowing for a nuanced understanding of the contextual details and subtle nuances that might be overlooked. Additionally, documentation serves as a complementary source of information, providing historical, procedural, or contextual background that can enhance the interpretive analysis.

The qualitative analysis process involves several key stages to uncover the collected data's underlying meaning and significance. Initially, data is categorized based on shared characteristics, allowing the researcher to identify patterns and recurring themes. These themes serve as the foundation for deeper analysis, helping to reveal the central aspects of the phenomenon that are most relevant to the research objectives. Through this process, a narrative is constructed, which summarises the findings and provides a cohesive explanation of the observed phenomena, highlighting any relationships, trends, or insights that emerge from the study. This narrative ultimately offers a holistic perspective that captures the essence of the research results in a descriptive and interpretive way.

III. Results and Discussion

The obelisk is one of the most iconic forms of architecture that originated in Ancient Egypt. Its slender, tapered, tall structure at the top became a timeless symbol of strength, power, and spiritual connection between the gods and the human world. Although many obelisks are currently found in various places worldwide, from Paris to New York, their history and significance are still strongly linked to Ancient Egyptian culture.

The tall, slender, tapered stone monument at the top is called an obelisk. The memorial is usually made of a single block of large stone, usually granite, which is carved and polished to fine. The shape is rectangular, with each side getting smaller and smaller towards the top, usually in the form of a small pyramid called a "pyramidion". Ancient Egypt called the obelisk "*tekhen*", meaning "axis of light".[4] Obelisks are often decorated with hieroglyphs that show feats and respect for the gods, especially *Ra*, the most revered sun god in Egyptian mythology.

Around 2500 BC, the obelisk was first made during the Old Kingdom of Egypt. However, they became prevalent during the New Kingdom, especially during the XVIII to XIX Dynasties (c. 1550 to 1070 BC). One of the oldest surviving obelisks today is the Obelisk of Heliopolis, built by Pharaoh Senusrej I in the XII Dynasty and was the centre of *Ra* worship in Egypt. The obelisk was first built in the Heliopolis area.[5]

The construction of an obelisk requires great engineering ability. First, granite stones are carved directly from the mines, usually in Aswan, hundreds of kilometres south of Heliopolis. Once carved, the stone was transported to the construction site via the Nile, a remarkable logistical effort given its size and weight of hundreds of tons. Immediately upon arrival at the site, the obelisk is lifted using a system of ramps, levers, and simple but useful equipment. Pharaohs and high priests often attended the obelisk's inauguration, an important ceremonial event. Once elevated, the pyramids at the top were often coated with gold or electrons to catch sunlight, strengthening their bond with the sun god *Ra*.[6]

In terms of Ancient Egyptian architecture and engineering, the construction technique of obelisks shows advancements in technology and skills to ensure that the obelisk remains balanced and does not crack during lifting. The carving process must be carried out carefully as it is constructed from large stone blocks. Using tools made of stone, copper, and wood to shape and smooth the stone's surface demonstrates exceptional engineering expertise and knowledge. The basic principles used in manufacturing and removing obelisks are still a testament to the ingenuity and technical expertise of the Ancient Egypt people, although modern technology has evolved.[7]

The obelisk had a symbolic and ritual meaning in Ancient Egypt society in addition to being an extraordinary architectural work. Obelisks are usually placed before significant temples, especially those explicitly erected for Ra, such as the Temple of Karnak in Luxor. This placement has religious value and serves as a decoration. Considered to represent the sunlight radiating from Ra to the earth and touching the world, the obelisk increased the power and power of the pharaoh as an intermediary between humans and the gods.[8]

There were several main functions of the obelisk in Ancient Egypt society:

a. Symbol of Power and Eternity: Pharaohs often made obelisks to show their power and to immortalize their names among the gods and their people. Hieroglyphs carved on obelisks show victory and dedication to *Ra* or other gods.[9] It indicates that the pharaohs had power on earth and a special relationship with the world of gods.
b. Ritual and Religious Instruments: In religious ceremonies, the obelisk is a ritual instrument representing sunlight. Most people believe that the obelisk can infuse the energy of heaven into the temple and protect the kingdom and its inhabitants. Obelisks link the human world and the cosmos because their position and orientation are often adjusted to astronomical events such as solstice.[10]
c. Astronomical Center: An obelisk is an astronomical instrument in addition to its religious function. Obelisks can show time with shadows, especially daylight and seasons. This function is essential for organizing religious calendars and ceremonies that depend on the solar and star cycles. The ancient Egyptians used obelisks as an important instrument for viewing the sky, and they were often placed so that their shadows were aligned with certain astronomical events.
d. Marker of Historical Events: Several obelisks were erected to commemorate important events in Egypt's history, such as military victories or the pharaoh's ordination ceremony.[11] In this case, the obelisk serves as a memorial monument that records history for the next generation. The cultural and historical heritage of Ancient Egypt has been preserved for thousands of years due to the presence of hieroglyphs on obelisks.

Overall, the obelisk is more than just a stone monument; As religious symbols, astronomical instruments, and historical markers, they show how the ancient Egyptian society combined their religious beliefs with scientific knowledge. A deep understanding of obelisks' history, manufacturing methods, and social role allows us to appreciate Ancient Egypt's rich cultural heritage and current influence. The obelisk shows a harmonious and holistic perspective of the world in which religion and science work together to solve the mysteries of the universe and reinforce the role of the pharaoh as the ruler of the world and the divine intermediary.[12]

The obelisk is one of the most famous monuments dating back to Ancient Egypt civilization. Its slender, tall, tapered shape at the top has a strong religious significance. His strong association with the sun god Ra and his role in various religious ceremonies and sacred temple sites throughout Egypt is one of the most important features of the obelisk. In a religious context, the obelisk bridges the human world and the gods. It is considered a representation of the concept of protection and rebirth given by God. *"Ra"* is a highly revered sun god in Ancient Egypt mythology who is considered the creator and ruler of the universe.

Considered a representation of sunlight radiating to the earth, an obelisk, or pyramidion, the obelisk that peaks are usually coated with gold or electrons to capture and reflect sunlight, confirming the direct relationship between the obelisk and Ra.

The obelisk is a symbol of rebirth. According to Egypt beliefs, the sun symbolizes the cycle of death and rebirth, with the sun setting each night and rising again in the morning. As a representation of sunlight, obelisks are thought to be able to transmit life energy from Ra to Earth, giving rebirth to nature and humans. Therefore, the obelisk is also considered a symbol of regenerative power that helps the kingdom and its people survive.

It is also believed that obelisks have protective powers. Due to its association with Ra, who was also considered the protector of the kings and people of Egypt, the obelisk could deter bad forces and maintain the balance of the world. They are placed in shrines and front of major temples as spiritual guardians protecting the sites from outside threats.[13]

In ancient Egypt's religious ceremonies, the obelisk played an important role. They are usually placed in front of large temples as markers of entrance to sacred areas. This placement has a deep symbolic meaning and is not only decorative with aesthetic purposes. The obelisk is considered a cosmic axis connecting the underworld (the afterlife), the human world, and the celestial world. Pharaohs stood before the temple and formed a direct path between them, and Ra and the other gods connected humans and gods.

In the context of rituals, the obelisk is often the centre of various religious ceremonies related to the worship of *Ra*. For example, during major festivals such as *Opet* and *Sed*, the obelisk becomes the centre of a procession performed to honour and ask for *Ra*'s blessings. In addition, the shadow produced by the obelisk is also used to determine the exact time for the execution of a particular ceremony, which often corresponds to an astronomical event coinciding.

The obelisk is important in large temples, such as the Temple of Karnak in Luxor. The temple became an important centre of worship, and pharaohs such as Thutmose I and Hatshepsut built large obelisks in honour of Amun-Ra, a combined image of Ra and the wind god Amun. These obelisks served as symbols of the political and spiritual power of the ruling pharaohs.

Many of Ancient Egypt's most famous obelisks have been moved from their place of origin, but some still exist today. Here are some significant examples:

a. Hatshepsut Obelisk in Karnak: One of the two obelisks built by Queen Hatshepsut is in the Temple of Karnak. One of the tallest obelisks ever erected in Egypt is 29.5 meters high. This obelisk, a symbol of the strength and maturity of Hatshepsut, the female pharaoh who ruled Egypt with an iron fist, has a gold coating on its top, indicating its connection to Ra.
b. Lateran obelisk in Rome: Thutmose III built this obelisk in the Temple of Karnak, but it was brought to Rome by Emperor Constantine II in the 4th century AD. At 32 meters tall, it is one of the tallest obelisks still in existence today. How Ancient Egypt's symbolism was adapted and adapted for the Roman Empire is evident from its new location in Lateran Square in Rome.[14]
c. Luxor obelisk in Paris: In the 19th century, Muhammad Ali, the ruler of Egypt, sent one of the two obelisks that Ramses II built in front of the Luxor Temple to France. This obelisk was moved to the Place de la Concorde in Paris. This 23-meter-tall obelisk is

decorated with hieroglyphs depicting the achievements of Ramses II. His move to Paris shows that Ancient Egypt's heritage still has a strong cultural influence outside Egypt.[15]

d. Washington Obelisk Monument: The Washington Monument in Washington, D.C., United States, is a tribute to George Washington, the first president of the United States. This monument, which is 169 meters tall, is the tallest obelisk structure in the world, although it is not an original Egypt obelisk. The design that resembles an Egypt obelisk suggests that Egypt's symbols representing power and eternity can be used in modern times.

With its close association with the sun god Ra, the obelisk was of great importance to the people of Ancient Egypt regarding religion and society. The obelisk serves as a physical monument and a spiritual marker connecting the human world with the divine. Obelisks, used in religious ceremonies and placed in sacred temples, demonstrate their function as a tool to channel divine energy and maintain a balance between the universes. We can see how the architectural and religious heritage of Ancient Egypt continues to evolve and be adapted to different cultures around the world by looking at examples of famous obelisks, such as those in Karnak, Rome, and Paris. Obelisks are historical artefacts and a timeless symbol of man's relationship with creation and the universe.[16]

In Ancient Egypt, astronomy was a rapidly growing field of science and was very important for people's lives. The Ancient Egyptians were known to be avid stargazers, and their knowledge of the sky was used to determine the time, navigation, and organize religious activities. The appearance of the star Sirius - also called Sothis by the Egyptians - is one of the astronomical phenomena highly respected by the Egyptians. It marked the beginning of the new year and also the arrival of the annual flood of the Nile, which was crucial to the agricultural well-being of the Egyptians.[17]

Great architecture, such as pyramids and temples, was often arranged around specific astronomical phenomena, demonstrating their astronomical knowledge. For example, the structure of the Great Pyramid of Giza faces the four cardinal directions. In addition, the Egyptians made a very accurate solar calendar. It consists of 365 days divided into twelve months, 30 days each, with an additional five days at the end of the year.

Obelisks played a significant role in Egyptian astronomy, particularly orientation and timekeeping. These towering structures, many of which are designed to be astronomical instruments, are frequently erected in front of sizable temples. Usually, a shiny substance, like gold or electrons, covers the top of the obelisk or pyramidion, making it highly reflective of sunlight. Obelisks may be used to determine time by measuring the shadows they cast. An obelisk may be used as a gnomon to tell the time by tracking the length and direction of shadows cast by the sun. Using a timetable, Egyptians can determine the precise time of day, which is crucial for religious observance and other necessary customs.

Obelisks are also used to determine the orientation of sacred buildings. Architects and builders often use the strategic placement of obelisks to guide their buildings to specific astrological phenomena. For example, on certain days in the ancient Egypt religious calendar, some temples were built with the main axis parallel to the rising or setting of the sun. The obelisk in front of the temple ensures that the orientation of the building corresponds to the position of the sun.

One example of how two seemingly different fields of knowledge can influence and support each other is the integration of religion and astronomy. Astronomy in Ancient Egypt was heavily influenced by religious beliefs and practices and was seen as the scientific study of the sky. The use of the obelisk, which has a dual role in astronomical and religious contexts, is a prime example of this integration.[18]

The religious beliefs of people in many ancient countries, including Ancient Egypt, greatly influenced how they viewed and used astronomy. For example, the Ancient Egyptians believed that their gods, including Ra (the sun god) and Osiris (the God of death and resurrection), had a connection with several celestial bodies. Most people consider the stars, sun, and moon representations of divine forces communicating with the human world.[19]

In a religious and astronomical context, the obelisk, one of the most iconic symbols of Ancient Egypt, is often considered a symbol of the sun and is associated with the sun god Ra. The obelisk has a tall and towering shape with a pyramid-shaped crest coated with gold or electrons, making it appear to shimmer in the sun, considered a reflection of power.[20]

Ancient Egypt priests used the obelisk as a tool to determine the time and orientation of sacred buildings. They can measure time accurately by studying the shadows created by the obelisk at various points throughout the day. The obelisk functions as a gnomon, a tool for determining time based on the sun's position. Additionally, obelisks help to set the orientation of buildings, ensuring that important structures such as temples are aligned with certain astronomical events, such as the sun's rising or setting on important religious calendar days.[21]

The integration between religion and astronomy in Ancient Egypt exemplifies how these fields can influence and support each other. Religious beliefs drove the development of astronomy as a tool to ensure that religious ceremonies and rituals were performed at the right time. On the other hand, astronomical instruments such as obelisks have both scientific and spiritual purposes. By investigating the case of the obelisk that served both purposes, we can see how religion and astronomy fused in Ancient Egypt civilization, creating a connection between heaven and earth and between man and God.

IV. Conclusion

The obelisk has both astronomical and religious purposes. The ancient Egyptians used obelisks as timekeepers and tools for astronomical orientation, suggesting a close relationship between their religious beliefs and scientific knowledge. The journal concludes that the obelisk has a dual meaning in terms of religion and astronomy and that it shows the culture of Ancient Egypt that combined these two aspects. Further research should look at the relationship between the architectural design of the obelisk and the astronomical knowledge possessed by the ancient Egypt people. Comparing the use of obelisks in Egypt with similar monuments in other countries could also provide new insights into the spread of astronomical technology and its cross-cultural impact. In addition, a more in-depth analysis of the construction techniques and astronomical orientation of mainland Egypt obelisks can also provide new insights into the spread of astronomical technology.

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Muslim Prayer Times on Astronomy and Fukaha

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ABSTRACT

Prayer is an obligation for every Muslim and one of the five pillars of Islam. The five daily prayers are a means of communicating with Allah throughout the day and night. Prayers are tied to certain times that cannot be carried out regularly. Still, they must follow the instructions of the Al-Qur'an and As-Sunnah. In this research, the problem to be studied is the influence of altitude and the sky's brightness on prayer times. To answer this problem, the author uses a qualitative descriptive-normative approach. In this modern era, it will not be difficult to know prayer times because there are many Islamic mass organizations, and even the government makes prayer time schedules as a reference performance of prayer. However, we need to know prayer times based on natural phenomena, so our knowledge is more comprehensive. Da- In practice, several scholars hold the same opinion regarding interpreting hadith and determining prayer times, exemplified by the Prophet. But there is. Some scholars have different views regarding the interpretation of determining some prayer time. For example, regarding the opinions of Imam Syafi'i and Imam Hanafi regarding the beginning of the time for the 'Asr prayer and the Isha prayer, there are different opinions on the interpretation of the hadith of the Prophet Muhammad.

I. Introduction

Muslim prayer times, known as Salat, hold significant religious importance as one of the Five Pillars of Islam. These prayer times are determined by the Sun's position, leading to their varying schedules throughout the year, depending on geographical location. The five daily prayers—Fajr, Dhuhr, Asr, Maghrib, and Isha—are each linked to specific solar events, such as Dawn, midday, afternoon, sunset, and nightfall [1]. Accurate determination of these times has long been a subject of interest for Muslim scholars, particularly in astronomy (Ilmu Falak) and jurisprudence (Fiqh).

Traditionally, the determination of prayer times relied on direct observation of the Sun's position, as practised by early Muslim communities [2]. However, with the advent of modern technology, astronomical calculations have become increasingly precise, allowing for the creation of prayer time schedules that are both reliable and accessible to Muslims worldwide [3]. This technological advancement has enabled Muslims to observe their religious duties more conveniently, even in regions where the Sun's natural visibility is limited.

This study explores the development and importance of accurate prayer time determination, focusing on the historical evolution of methods used by Islamic scholars and the integration of modern astronomical tools in the contemporary Muslim world. Furthermore, the study will examine the challenges Muslims face living in extreme latitudinal locations, where traditional methods may not provide sufficient guidance for determining prayer times [4]. Understanding the science behind prayer time calculations and their religious implications offers valuable insight into the dynamic relationship between science and religion within Islam.

Prayer, or salat, is a central pillar of Islam that Allah SWT commands all Muslims to observe daily. This essential act of worship is not only a personal duty but also a collective obligation, establishing a spiritual rhythm that connects Muslims across the globe. Prayer is mandated five times a day and night—at Dawn (Fajr), midday (Dhuhr), mid-afternoon (Asr), sunset (Maghrib), and night (Isha)—each marking specific intervals that align with the position of the Sun. This ritual is designed to remind Muslims of their devotion to Allah, integrating worship into daily life and reinforcing a continuous awareness of their faith.

The concept of prayer is foundational in Islam, as it represents both a duty and an opportunity for personal growth, humility, and spiritual reflection. The precise timing of each prayer is significant, as Allah SWT has ordained distinct times for each of the five prayers. These times are not arbitrary but based on divine wisdom and order, intended to structure a Muslim's day. As such, prayer cannot be performed at any random time but must align with the stipulated timings set forth by Allah SWT.

This strict adherence to prayer times is supported by clear guidance in the Qur'an and Hadith. Numerous Quranic verses, such as in Surah Al-Isra (17:78), instruct Muslims on the timing of prayers: “Establish prayer at the decline of the Sun until the darkness of the night and [also] the Qur'an of Dawn. Indeed, the recitation of Dawn is ever witnessed." Such verses underscore the necessity of performing prayer within its prescribed time window, without which the act would be deemed invalid.

Therefore, adhering to these timings is not merely a recommendation but a fundamental aspect of Islamic worship, ensuring that prayer is aligned with the divine will. In fulfilling this obligation, Muslims strengthen their connection with Allah SWT, continuously reinforcing the pillars of their faith through disciplined worship.**Surah Al-Isra (17:78)**

"أَقِمِ الصَّلَاةَ لِدُلُوكِ الشَّمْسِ إِلَىٰ غَسَقِ اللَّيْلِ وَقُرْآنَ الْفَجْرِ ۖ إِنَّ قُرْآنَ الْفَجْرِ كَانَ مَشْهُودًا "

Means: "Establish prayer at the decline of the Sun [from its meridian] until the darkness of the night and [also] the Qur'an of Dawn. Indeed, the recitation of Dawn is ever witnessed."
This verse refers to multiple important daily prayer times and guides when they should be observed, marking significant periods in a Muslim's day. Let's break down the key phrases:

1. **"لِدُلُوكِ الشَّمْسِ" (at the decline of the sun)**
   This phrase refers to when the Sun begins its descent from its zenith or highest point in the sky. This is traditionally interpreted as the time for the *Dhuhr* prayer (midday prayer), which begins when the Sun has passed its highest point.
2. **"إِلَىٰ غَسَقِ اللَّيْلِ" (until the darkness of the night)**
   This part of the verse covers the timeframe from the afternoon until nightfall, indicating two other prayer times:
   - *Asr* (afternoon prayer) is observed after *Dhuhr* and before sunset.
   - *Maghrib* (sunset prayer) is observed right after the Sun sets, marking the beginning of nightfall.

   The word غَسَق means deepening darkness, which could also imply *Isha* (the night prayer), observed after twilight has completely ended and full darkness has set in.
3. **"وَقُرْآنَ الْفَجْرِ" (and [also] the Qur'an of dawn).** It refers to the *Fajr* prayer, observed at Dawn before the Sun rises. The term "Qur'an of dawn" emphasizes the recitation of the Qur'an during the *Fajr* prayer, highlighting its significance. The Qur'an mentions that the angels witness this prayer, making it a highly virtuous time for worship.
4. **"إِنَّ قُرْآنَ الْفَجْرِ كَانَ مَشْهُودًا" (Indeed, the recitation of dawn is ever witnessed).** This statement stresses the spiritual importance of the *Fajr* prayer, witnessed by angels and the faithful who rise early to worship. Many commentators interpret this to mean that the angels attend this prayer, adding to its blessings.

This verse from Surah Al-Isra emphasizes the importance of establishing the five daily prayers by mentioning specific times linked to solar events: the decline of the Sun (Dhuhr), afternoon (Asr), sunset (Maghrib), night (Isha), and Dawn (Fajr). It underscores the harmony between the cycles of nature and acts of worship, reminding believers of the importance of maintaining these daily prayers at their specified times. Additionally, it highlights the special virtue of the *Fajr* prayer, which is witnessed by angels, marking it as a particularly blessed time of day for worship and Qur'anic recitation.

In this way, the verse connects the natural phenomena of day and night to the spiritual discipline of maintaining regular prayer, demonstrating Islam's integration of celestial signs into religious practices.

Surah Hud (11:114)

"وَأَقِمِ الصَّلَاةَ طَرَفَيِ النَّهَارِ وَزُلَفًا مِّنَ اللَّيْلِ ۚ إِنَّ الْحَسَنَاتِ يُذْهِبْنَ السَّيِّئَاتِ ۚ ذَٰلِكَ ذِكْرَىٰ لِلذَّاكِرِينَ"

Translation: "And establish prayer at the two ends of the day and the approach of the night. Indeed, good deeds do away with misdeeds. That is a reminder for those who remember."

This verse refers to key prayer times:

- *Fajr* (Dawn) as the "first end of the day."
- *Dhuhr* or *Asr* (midday/afternoon) as part of the daytime.
- *Maghrib* (sunset) as the approach of the night.
  The verse highlights the importance of performing prayers during these critical periods of the day to maintain regular worship and spiritual discipline.

Surah Taha (20:130)

"فَاصْبِرْ عَلَىٰ مَا يَقُولُونَ وَسَبِّحْ بِحَمْدِ رَبِّكَ قَبْلَ طُلُوعِ الشَّمْسِ وَقَبْلَ غُرُوبِهَا وَمِنْ آنَاءِ اللَّيْلِ فَسَبِّحْ وَأَطْرَافَ النَّهَارِ لَعَلَّكَ تَرْضَىٰ"

Translation: "So be patient over what they say and exalt [Allah] with praise of your Lord before the rising of the sun and before its setting; and [in part] of the night exalt [Him] and at the ends of the day, that you may be satisfied."

This verse outlines several prayer times:

- *Fajr* (before sunrise).
- *Maghrib* (before sunset).
- *Isha* (during part of the night).
  It emphasizes praising and remembering Allah during these times, connecting daily prayers to key solar transitions (sunrise and sunset) and nighttime worship.

Surah An-Nur (24:58)

" يَا أَيُّهَا الَّذِينَ آمَنُوا لِيَسْتَأْذِنكُمُ الَّذِينَ مَلَكَتْ أَيْمَانُكُمْ وَالَّذِينَ لَمْ يَبْلُغُوا الْحُلُمَ مِنكُمْ ثَلَاثَ مَرَّاتٍ ۚ مِّن قَبْلِ صَلَاةِ الْفَجْرِ وَحِينَ تَضَعُونَ ثِيَابَكُم مِّنَ الظَّهِيرَةِ وَمِن بَعْدِ صَلَاةِ الْعِشَاءِ ۚ ثَلَاثُ عَوْرَاتٍ لَّكُمْ ۚ لَيْسَ عَلَيْكُمْ وَلَا عَلَيْهِمْ جُنَاحٌ بَعْدَهُنَّ ۚ طَوَّافُونَ عَلَيْكُم بَعْضُكُمْ عَلَىٰ بَعْضٍ ۚ كَذَٰلِكَ يُبَيِّنُ اللَّهُ لَكُمُ الْآيَاتِ ۗ وَاللَّهُ عَلِيمٌ حَكِيمٌ"

Translation: "O you who have believed, let those whom your right hands possess and those who have not yet reached puberty among you ask permission [to enter] at three times: before the dawn prayer, when you put aside your clothing for rest at noon, and after the night prayer. These are three times of privacy for you. There is no blame upon you or them beyond these [periods], for they continually circulate among you—some of you, among others. Thus does Allah make clear to you the verses; and Allah is Knowing and Wise."

This verse mentions three specific times for privacy:

- *Fajr* (before dawn prayer).
- *Dhuhr* (midday, when people rest).
- *Isha* (after night prayer).
  It indicates that these are private moments for rest and reflection, showing the structured rhythm that prayer times bring to a Muslim's daily life.

The term early prayer time has been very popular among the community. However, does the beginning of the prayer time exist? The Qur'an has no term for the beginning of prayer time. What exists is only the term kitaban mauquta [5]. Then where can the term "beginning of prayer time" be found? Therefore, the term "beginning of prayer time" is the result of the scholars' ijtihad when interpreting the verses of the Qur'an and hadith related to the time of prayer.

The interpretation of the beginning of the prayer time carried out by the scholars has not been able to complete the problem. The interpretation of the beginning of the prayer time is still limited to natural signs, such as the time of Dhuhr, when the Sun has slipped to the west, the time of Ashar when the shadow is as long as the Object, and so on. This can be done when the weather is sunny, but if the weather is cloudy or even rainy, these signs cannot be obtained, so even the beginning of the prayer time cannot be obtained.

Prayer is obligatory for Muslims at night when the Prophet performs isra' mi'raj, which is about one year before the hijrah. According to the scholars of the Hanafi madhhab, the obligation to pray is set at night when the Prophet Muhammad SAW performs isra', the night of Friday on the 10th of Ramadan, one and a half years after the hijrah. Ibn Hajar al-Asqalani stated that the date was 27 Rajab, one and a half years before the Prophet Muhammad (SAW) migrated to Medina [6]. Prayer contains various wisdom for life. In terms of religion, for example, prayer is a rope that connects and binds a servant with his Creator. Through prayer, a servant can glorify the greatness of Allah SWT, get closer, surrender to Him, and create a sense of peace for those who pray in going through various problems in life. Through prayer, a servant gets forgiveness of sins and achieves victory.

Another wisdom of prayer is that there is peace in the heart, and one will not feel anxious when hit by a disaster. Loneliness can negate patience, which is the main reason for happiness. Kindness will not be prevented by those who always do it. Therefore, prayer is the main religion in Islam [7]. Prayer is to give thanks for all the blessings of Allah that have been given to humans, and prayer is one of the pillars of Islam that must be upheld under the word, except in certain circumstances.

In Indonesia, the sky's brightness is dimmer daily due to pollution and global warming. The sky brightness level in an area is highly dependent on the composition of aerosol particles and cloud particles present in the atmosphere of an area. A Bandung University of Technology solar expert, Dhani Herdiwijaya conveyed this [8]. From the results of research that has been carried out in several places in Indonesia, namely Kupang, Lembang, Yogyakarta, Cimahi and Bandung, a result has been obtained on the sky brightness data that varies from region to region. Kupang ranks in the sunniest areas, followed by Yogyakarta [9] and Lembang [10], and the last ranks are Cimahi and Bandung [8].

Based on the problems mentioned, it is necessary to make a breakthrough by integrating science and religion to answer the issues related to the beginning of prayer times. It will allow later results to be obtained about the right and accurate prayer time without depending on weather conditions and denying the existing evidence, both from the Qur'an and al-Hadith.

II. Method

This research adopts a literature study approach, exploring existing knowledge and scholarly perspectives on the subject matter. The data utilized in this study consists of a wide array of opinions, interpretations, and viewpoints from Islamic scholars gathered from various literary sources, including classical and contemporary works. These sources encompass books, articles, and journals providing insights into the subject from historical and modern contexts.

The collected data is then carefully examined and analyzed by referencing nash-nash al-Qurān (explicit textual evidence from the Qur'an) and nash-nash al-Hadīs (authentic narrations from the Hadith of the Prophet Muhammad, SAW). These primary Islamic sources serve as the foundational framework for assessing the scholars' opinions, allowing for a thorough analysis that aligns with the core principles of Islamic teachings. The method ensures that the interpretations harmonize with Islamic jurisprudence (Fiqh) and theology, thus providing a balanced understanding of the subject.

This study aims to critically engage with the diverse scholarly interpretations, assessing their relevance and application in contemporary contexts. The research highlights traditional views and explores how these teachings can be applied in modern-day scenarios. Integrating classical scholarship and scriptural analysis ensures a nuanced and well-rounded approach to the topic under investigation.

III. Results and Discussion

Method of Determining Prayer Time

The determination of prayer times in Islam is closely related to astronomy, as it relies on the positions of celestial bodies such as the Sun, moon, and Earth. Understanding how these heavenly bodies move and interact is essential for accurately determining the precise moments for Salat, the five daily prayers. In astronomy, celestial bodies like the Earth, moon, Sun, and stars serve as study material objects, as they are the entities under investigation [11]. The formal Object of astronomy, however, refers to the trajectories or orbits of these celestial bodies. In the context of determining prayer times, the formal Object is of particular importance, as it involves tracking the Sun's movement about the Earth's horizon—key to identifying times like Fajr (Dawn), Dhuhr (midday), Asr (afternoon), Maghrib (sunset), and Isha (night).

The formal object is particularly important in determining prayer times because it involves tracking the Sun's movement concerning the Earth's horizon. The Sun’s apparent movement across the sky is a key determinant in identifying the five daily prayer times prescribed in Islam: Fajr (Dawn), Dhuhr (midday), Asr (afternoon), Maghrib (sunset), and Isha (night). Each prayer time is linked to specific sun positions, which makes the formal object of astronomy—the study of the trajectories and orbits of celestial bodies—essential for accurate calculation. Explanation of Prayer Times Based on Sun Movements:

1. Fajr (Dawn)

The Fajr prayer begins with the first light of Dawn, known as Subh Sadiq (true Dawn), which occurs when the Sun is approximately 18 degrees below the horizon. At this point, a faint light appears on the eastern horizon before sunrise. This marks the beginning of the day in Islamic tradition, symbolizing spiritual awakening and purity as the day's first prayer. Tracking the Sun's position about the horizon is crucial to ensure the correct time for Fajr because it must be performed before the Sun rises.

2. Dhuhr (Midday)

The Dhuhr prayer is observed when the Sun declines after reaching its zenith, or highest point in the sky. This moment, known as Zawal, marks the midpoint of the day. As the Sun crosses the zenith and starts its descent, shadows start to lengthen again, signalling the entry of Dhuhr time. The position of the Sun in the sky, particularly its zenith and post-zenith decline, is essential for determining when this midday prayer should be performed.

3. Asr (Afternoon)

Asr prayer begins in the late afternoon when the shadow of an object is equal to its length, or in some Islamic jurisprudential interpretations, twice its length. It ends just before sunset. The determination of Asr thus relies on measuring the length of shadows as the Sun continues to descend. This prayer marks the transition from the day toward the evening, and its timing is directly linked to the changing angles of sunlight and the shadows they cast.

4. Maghrib (Sunset)

Maghrib prayer is performed immediately after the Sun has completely set when it disappears below the horizon. This is when the day officially ends, and the night begins. The sunset is a critical time marker, as Maghrib must be prayed before the twilight fades. The exact timing depends on observing the Sun’s disappearance, which is one of the easiest prayer times to confirm visually due to the clear horizon reference.

5. Isha (Night)

The time for Isha begins when the red twilight after sunset has completely vanished, and the sky is fully dark. This marks the end of twilight and the onset of true night. The Isha prayer can be performed any time during the night until Fajr, but it is preferred that it be done earlier. Isha's timing is based on observing the disappearance of twilight, which relies on astronomical knowledge of the Sun's position below the horizon.

The formal object in this context refers to the paths, positions, and movements of the Sun and other celestial bodies, which must be observed and calculated to determine precise prayer times. Islamic scholars have historically relied on astronomical principles (Ilm al-Falak) to develop methods for calculating these times accurately. Before modern timekeeping, Muslims used the position of the Sun and shadows as natural clocks to determine when each prayer was due. Today, astronomical calculations are crucial in determining prayer schedules, especially in regions where weather conditions or geographic locations (e.g., extreme latitudes) make direct observation difficult [12].

For example, Muslim astronomers calculate solar declination and use it to generate tables or algorithms for precise prayer times throughout the year. These calculations also account for factors like the equation of time, atmospheric refraction, and the observer's geographic location, ensuring that prayer times are accurate and consistent across different regions [5].

From this perspective, the determination of prayer times integrates various astronomical principles, particularly those related to the Earth's rotation and relationship with the Sun. Islamic scholars and astronomers utilize tools and methods derived from these scientific principles to create accurate schedules for daily prayers. For example, the Fajr prayer is based on the first appearance of light at Dawn, scientifically determined by the Sun's position 18 degrees below the horizon. Similarly, Maghrib corresponds to the moment of sunset, when the Sun crosses the horizon. These calculations, grounded in astronomy, have been refined over centuries and remain crucial for Muslim communities worldwide.

Data in Prayer Time Calculation

In the calculation of prayer time, knowing the data used in solving the formula is very important because it is the heart of the calculation of prayer time, in the sense that the correctness of the results of the calculation of prayer time is very dependent on the accuracy of the data used. Therefore, the researcher feels discussing the data needed to complete the prayer time determination formula is important.

a. Latitude and Longitude of the place,

In every calculation of prayer time, the latitude and Longitude of the place are very important because the results of the calculation will not correspond to an area if the latitude and Longitude do not match the latitude of the place, which is usually symbolized by fi (φ) is the distance of the imaginary line measured from the equator to a place to the pole. If the area is north of the equator, it is called North Latitude (LU) with a positive value (+), while the area in the southern hemisphere of the equator is called South Latitude (LS) with a negative value (-). 18 For example, Lhokseumawe +05° 10′ 48.36″ and the city of Semarang - 07° 00′. From these two areas, it can be confirmed that the city of Lhokseumawe is in the northern hemisphere of the equator with a distance of 5 degrees 10 minutes 48.36 seconds, and the city of Semarang is in the southern hemisphere of the equator with a value of 7 degrees 00 minutes. The determination of the equator as latitude 0 is not politicized by any party, where this determination occurs in line with the development of science about the Earth owned by humans.

b. Sun Angle

The angle of time of the Sun is the arc distance along the Sun's daily circle calculated from the upper culmination point to the Sun's presence. 20 The value of the Sun's time angle is 0 degrees when the Sun is at the upper culmination, or when the Sun is right on the celestial meridians, and 180 degrees when the Sun is at the lower culmination point. The value of the Sun's time angle is marked positively (+) when the Sun is in the Western Hemisphere and has a negative value (-) when the Sun is in the East. The Sun's time angle is formed at a single angle of 90 degrees at the North Pole.

c. Solar Declination

It is the value of the distance of a celestial body from the celestial equator, which is calculated based on the length of the time circle in degrees, minutes, and arc seconds; the declination value is usually symbolized by delta (δ). With the value of the Sun's declination known, the Sun's position relative to the Earth can also be determined. This is very useful in finding out how far the shadow reached by sunlight on the Earth's surface is the main data in determining prayer times and knowing the time benchmark in calculating prayer time.

Prayer Time According to Fukaha

1. Zuhr Time

According to Shafi'iyah scholars, the time of Zuhur begins when the Sun slips or is called "zawal asy-syams". Imam Shafi'I said that the beginning of Zuhr has arrived if one knows with certainty the arrival of the time of Zawal in the middle of the orbit of the sky (wast al-falak). According to Shafi'iyah, the time of Zuhur consists of three times: 1. The main time (waqt al-fadilah), 2. Time of choice (waqt al-ikhtiyar), 3. Time of 'uzr (waqt al-'uzr). The main time of the period is at the beginning of time. The selected period starts after prime time and lasts until the end. And the time of 'uzr is the time of Asr to the person who closes' Zuhu and Asar because he is on his way (traveller) or because it is raining.

2. Asar Time

According to Shafi'iyah, the time of Asar arrives when the shadow of an object is the same length. However, according to Abu Hanifah, the beginning of the Asar time arrives when the shadow of an object is twice the size of that object. This difference is due to the phenomenon that is used as a basis for two possible Asar periods; according to Imam Al-Ghazali (d.505/1111) there are four: 1. The main time (waqt al-fadilah) is at the beginning of the time, 2. The time of choice (waqt al-ikhtiyar) is the beginning of the time until the length of the shadow of an object is doubled, as stated by Gabriel, 3. Relative time (waqt al-jawaz) is after the chosen time until the Sun turns yellow (al-isfirar), 4. The forbidden time (al-karahiyyah) is when the Sun turns yellow.

3. Maghrib Time

According to Shafi'iyah, the time Maghrib arrives at sunset is based on the hadith of Jibril's imamah and other narrations. During this Maghrib prayer, there are two opinions of Imam Shafi'I (qadim vow and jadid vow). In the qadim vow, Imam Shafi'I said that the Maghrib time continued until the red cloud disappeared (shafaq). Meanwhile, in the al-al-athula, Imam Shafi'i said the Maghrib prayer time is only short since the Sun sets.

4. The Time of Isha'

Scholars agree that the beginning of the time of Isha' is when the "ash-shafaq" (cloud) disappears. Meanwhile, about the end of the time of Isha', there are two popular opinions (famous) among scholars; the first opinion states that the time of Isha' ends until a third of the night, and the second opinion states that it is until midnight.

5. Dawn Time

The time of Fajr prayer is from the Dawn of sadik (true Dawn) to the sunrise of the Sun. Scholars agree that Dawn begins when the second Dawn (al-fajr as-sany) is called al-fajr as-sadiq (the true Dawn) [13]. While the time of Dawn ends at sunrise.

Astronomical Data of Prayer Times

The most important astronomical data in determining the prayer schedule is the Sun's position in the horizon coordinates, especially the altitude, zenith distance, Dawn, sunrise, culmination, sunset and late dusk. In this case, astronomy plays a role in interpreting the phenomena mentioned in the Qur'an and Hadith and is applied as a formula for prayer times. In general, the data needed in the calculation (hisab) of the prayer time are latitude of the place, Longitude of the place, correction of regional time (KWD), horizon lowness, semi-diameter of the Sun, solar refraction, declination of the Sun, time equalizer, and ihtiyat.

The method of calculating the prayer time influenced by the sky's brilliance is the prayer time set by the shari'i based on the refraction of the Sun's light. This can be ascertained in the calculation of the time of the Isha and Fajr prayers because these two prayers are determined by the Qur'an and hadith based on the bias of dawn light and dusk light [10]. So far, the twilight level, the benchmark for the beginning of the Isha prayer time, is set when the Sun is at -18 degrees below the western horizon. In comparison, the level of Dawn light, which is the benchmark for the beginning of the Fajr prayer time, has been determined when the Sun occupies a position of -20 degrees below the eastern horizon [12].

IV. Conclusion

The formal object—tracking the Sun's trajectory relative to the Earth's horizon—is foundational in determining Islamic prayer times. Each prayer time corresponds to a specific solar event, from Dawn to nightfall, which has both religious significance and practical implications in the daily lives of Muslims. The reliance on the Sun's movements underscores the deep connection between Islamic practices and the natural world and the importance of astronomical knowledge in fulfilling religious obligations. This verse from Surah Al-Isra emphasizes the importance of establishing the five daily prayers by mentioning specific times linked to solar events: the decline of the Sun (Dhuhr), afternoon (Asr), sunset (Maghrib), night (Isha), and Dawn (Fajr). It underscores the harmony between the cycles of nature and acts of worship, reminding believers of the importance of maintaining these daily prayers at their specified times. Additionally, it highlights the special virtue of the Fajr prayer, which is witnessed by angels, marking it as a particularly blessed time of day for worship and Qur'anic recitation.

In this way, the verse connects the natural phenomena of day and night to the spiritual discipline of maintaining regular prayer, demonstrating Islam's integration of celestial signs into religious practices.

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Definition, Uses and Urgency of Islamic Astronomy

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ABSTRACT

This study explores astronomy as the science of understanding celestial bodies, particularly the Earth, Moon, and Sun, and their movements within defined orbits. A qualitative research method was employed, with the author as the primary instrument. Data collection and analysis were conducted continuously from the study's outset to data interpretation. These movements enable precise calculations of celestial positions and times on Earth. Astronomy has been recognized historically as one of the oldest sciences and has developed over centuries. It now includes applications critical to religious observances tied to time and space. This paper aims to trace the development of astronomy and its scope, especially its role in Islamic worship practices. Key focus areas within Islamic astronomy are Qibla direction, prayer times, the Islamic lunar calendar's beginning, and eclipses. These elements underscore astronomy's essential role in Islam, as accurate worship practices depend on precise astronomical knowledge.

I. Introduction

Astronomy is a science that studies the movement of celestial bodies, especially the moon and the sun, in their orbits systematically and scientifically. The word falak in Arabic means orbit (circulation) of celestial bodies (Al-mador yaibahu fihi al-jim as- samawy) in the Qur'an, this word is stated twice, and the meaning of orbit or trajectory is in QS Al-ambiya (21) verse 33 in Qs yasin (36) verse 40. Carlo Nillino in his work said that the word falak stated in the Qur'an does not come from Arabic, but comes from the Babylonian language, namely "pulukku".

By definition, Falak is a combination of two words from the origin of the words "science" and "falak". These two words are an absorption of words from the Arabic language. Knowledge comes from the word ilm (علم) which is a derivative of 'alim-ya'lam-'alim wa 'ilm (علم- يعلم- علم), which has the meaning of knowledge (knowing). The word ilm can also mean understanding, truly understanding, and feeling. The word "falak" is the same as the word "science" which comes from the Arabic absorption of "al-Falak" which is isim of the word flk (فلك) which is a derivative of the word falaka–yafluku–falakun (فلك– يفلك- فلك) which means "round". The word falak (الفلك) is a synonym of madar (المدار), which means the orbit, line or place of travel of celestial bodies.8 Ibn Mandzur explained that the word falak means "madr an-nujum" (مدار النجوم) the trajectory of the stars, with the plural form of aflak (أفلا) [1].

Meanwhile, at-tahanawi (12th century) , "astronomy" in the illustration of the astronomical sphere at the center of the astronomical observatory and geophysics of Egyptian animals says the astronomy is a science that studies everything related to the Universe in the form of celestial bodies outside the Earth's atmosphere, such as the sun, moon, stars, galactic systems, planets, satellites, comets, and meteors in terms of their origin, physical and chemical motion, and even biology [2].

According to the language of astronomy, an orbit is the orbital celestial body [3] Therefore, astronomical knowledge is the understanding of celestial bodies, especially earth bodies, and the moon and sun in each orbit to determine the position of each celestial body between one and the other and the time of day on the Earth's surface.

This science is called Falak science because this science studies the trajectory of celestial bodies. This science is also called hisab science, because this science uses calculations [4]. This science is also called rashd, and this science requires observation. This science is often called the science of miqad, because this science studies the limits of time. Of the four terms above that are popular in the community, they are "Falak science" and "Hisab science." [5]

From the various definitions above, it can be concluded that the formal object of astronomy is celestial bodies, while the material Object is the trajectory of celestial bodies.

Within the framework of Islamic law, Islamic teachings cannot be ignored when discussing prayer times, fasting days, and fasting days with all disputes. Determining the time of worship with the help of astronomy in the current period is still relevant and useful. Many technical problems of worship cannot be solved by hand, including the requirement for Falak contributions. Because of this urgency in literature, the author claims that "Fiqh is not pure without the guidance of Falak literature." Sometimes, the meaning of Ilm Falak is not interpreted as mentioned above; it is interpreted as the science of astrology, which is the science that can predict a person's future fate. This science is commonly called Astrology (the science of Astrology). Thus, the difference between astronomy and astrology is as follows:

1. Astronomy is a science of calculation that is studied to know the location, motion, size and circle of celestial bodies based on science. Then, with that knowledge, we can determine the number of years, months, and eclipse times. Meanwhile, astrology is a science of astrology that is studied by relating to predictions about events that have not yet occurred, including about the fate of human beings

2. Astronomers, on the other hand, are often fooled by the past. This means that the results of astronomy education can be formally confirmed. Many astrologers base their

predictions on rambles and rambles, so their results will be as follows before they can be confirmed.

3. Believing in the results of astronomical calculations, which means believing in an event based on facts, but believing in the results of astrological calculations, which according to Islamic teachings can threaten the non-acceptance of prayers for 40 nights, as stated in the hadith of the Prophet PBUH, which states, "Whoever comes to a fortune teller and asks for a prophecy and then believes in the results of the prophecy, then his prayer is not accepted for 40 days".

Astronomy, as defined, covers a vast range of topics, requiring not only foundational knowledge from fields such as Natural Sciences, Life Sciences [6], Surveying, and Algebra but also demanding highly complex investigations. Given the field's breadth and intricacy, astronomers have divided it into specialized areas: Astrometry, which involves determining positions and distances on Earth and in the sky and measuring the magnitude of celestial bodies; Astromechanics focused on the study of celestial motion, including rotation, orbital paths, changes in movement, and the laws governing these phenomena; Astrophysics, which explores the physical properties of celestial bodies, including temperature and atmospheric composition [7]; and Cosmogony, which examines the structure, form, and evolution of the Universe. Through this article, the author also intends to refresh our thinking about the world of science, especially in astronomy. This refreshment process must be carried out because we want to continue positioning astronomy as a recognized field of science that is always relevant to today's science and technology development. Do not forget that the results of the thinking in this paper should require criticism so that it can produce a common view and be useful for developing the field of Astronomy in Indonesia.

II. Method

This study employs a qualitative research methodology, where the author serves as the primary instrument for data collection, observation, and analysis. In this approach, data is gathered continuously throughout the research process, allowing for iterative analysis and reflection that enhances the depth and accuracy of the findings. Direct observation is a central technique in this study, enabling the researcher to examine the object of study within its natural context, ensuring that the observations align closely with the research scope and objectives. Additionally, relevant theoretical frameworks are integrated to support and contextualize the analysis, allowing a comprehensive exploration of the topic in line with the study's specific focus areas. Through this continuous observation and analysis, the study aims to yield insights grounded in authentic interactions with the research subject, supported by relevant theoretical perspectives.

III. Results and Discussion

The science of astronomy, also known as astronomy in Islam, has various definitions, uses, and urgency—astronomy studies celestial bodies such as the sun, moon, stars, and planets. Astronomy uses include determining the direction of the Qibla and the time of prayer and finding out the events of the solar or lunar eclipse. The urgency of astronomy in Islam lies in determining the beginning of the month of Ramadan, the month of Zulhijjah, eclipse prayers, zakat calculations, and the determination of Islamic holidays.

According to Muhammad Hadi Bashori, astronomy is studied to determine the position of each celestial body, and it has an important role in worship purposes, such as determining the direction of the Qibla and the time of prayer [8]. In addition, astronomy is also used to find out solar or lunar eclipse events. Studying astronomy revolves around four things: knowing the direction of the Qibla, the time of prayer, eclipse events, and the arrangement of celestial bodies. The urgency of astronomy in Islam lies in determining the beginning of the month of Ramadan, the month of Zulhijjah, eclipse prayers, zakat calculations, and the determination of Islamic holidays [9].

If viewed superficially, when Philosophy of Science is reviewed with Philosophy of Science, we have not found a writing specifically discussing Philosophy of Philosophy (this is what the author experienced during his search). But if you look carefully, the discussion has been widely mentioned through various writings, even listed in every book of the Philosophy of Science itself. This phenomenon occurs because of the naming of Astronomy, which has several other names, including Astronomy and Cosmology. When explaining the division of science, these two different names are always mentioned in various Philosophy of Science books. Cosmology is even considered one of the branches of philosophy [10].

Based on these various definitions, it can be concluded that Astronomy is an integrative field of science that studies things about objects in the Universe, including planet Earth, whether related to humans or not. Thus, it can be said that the breadth of this aspect of discussion distinguishes the field of Astronomy from other fields of science. Therefore, it is not difficult to explain the philosophical meaning of Astronomy, which, in principle, shows the relationship and approach of Astronomy with other fields of study. All the circumstances that take place in the Universe, whether examined through the perspective of space, physical, time, religion or others, are the formers of the field of study of Astronomy. Through the same process, other fields of study, such as Astronomy, Cosmology, and many others, were born. Thus, research results in other science fields will enrich (proliferate) the scope of Falak research.

Similarly, the results of research by Astrologists on certain topics can trigger the development of other fields of science. In this context, there is room for the formation of divergence symptoms in various branches of science that are more specific (specialization). Specializing in Astronomy is very easy if you look at the super broad dimensions of the study. The science of astronomy is also needed to determine the beginning of the month of qamariyah, which is the initial guideline for rukyat experts to carry out rukyatul hilal activities. With the science of Falak or the science of hisab, people can ascertain where the Qibla for a place is going. on the Earth's surface. With the science of Falak or the science of hisab, it can be determined that the time of prayer has arrived or the sun has set to break the fast. With it, the person who performs the rukyatul hilal can direct his gaze to the position of the hilal .

The core values of Islam are still largely dictated by prayer, fasting, pilgrimage, and other religious obligations. In addition, the core values of Islam require Muslims to understand the passage of time, day and night, and to do so by using the text of Falak or Hisab. Thus, the science of Falak or the science of hisab can increase a person's confidence in performing worship so that his worship is more solemn.

In classical Islamic treasures, astronomy has a variety of terms, including hai'ah, astrological astronomy, miaat and rasd. These various terms emerged as a result of human observation of celestial phenomena. In addition to these terms, there is one more term for this science that developed in the past: astronomy, 'astro' means star, and 'nomia' means science. This term appeared and developed since the Greek civilization.

In the Middle Ages, this science was better known as hai'ah than falak. According to Al-mas'udi, the term hai'ah is the equivalent of an astronomical term developed in the Greek period. However, astronomy is more widely circulated and used in this era. The use of the word falak anatar is also listed in "al-fihrist" by An-Nadim where when explaining the biography of Ya'qub bin Tariq, An-Nadim mentions the word falak as a branch of science that studies celestial bodies.

The urgency of astronomy / Important things in studying astronomy

The existence of Astronomy is one of the important Islamic thoughts. As one of the inseparable studies in the Islamic world, this science is increasingly felt in the Middle Ages, where many scholars (experts) such as Jabir bin Hayyan, Al-Fazari, Ibn Yunis, Al-Biruni, and many more were born. The importance of Astronomy in Islam has been realized since the time of the Prophet. Furthermore, the discussion has been clearly stated in the Qur'an al-Karim and al-hadith al-Syarif. Historically, the relationship between Astronomy and religion, including Islam, has played an urgent role in its existence. This is because its emergence as a science aligns with human needs for that knowledge. Falak Science follows the driving factors for the emergence of philosophy and science, especially in thauma (admiration). Humans have a sense of admiration for what the Creator has created, including admiration for the Sun, the Earth, itself and so on. This admiration then prompts humans to try to know what the Universe is "What and how did it originate?" (Cosmological problem).

Astronomy still exists today because it has great usefulness and beneficial value for Mankind, including being a reminder of God's greatness, the importance of protecting the Universe, and so on. For the sustainability of knowledge, it functions as the development of knowledge whose application can improve human welfare. However, since science is neutral, Astronomy's knowledge, whether it will be useful or even cause disaster for Mankind, is basically determined by the scientists themselves. For example, If satellite coordinate data is provided deliberately to mislead other parties, it is a disaster for its users because the information is inaccurate. As a result, satellite users do not provide the information they need after consuming many resources. In a war, coordinates can be a reliable weapon to outwit and defeat the enemy because the coordinates are deliberately changed so that the enemy weapon does not hit the target. However, this behaviour can cause innocent victims. In the dimension of worship, incorrect coordinates will also cause all calculation concepts to be inaccurate and inappropriate both in terms of time (such as; prayer time), as well as the accuracy of the direction (such as; determination of the direction of the Qibla) [11].

As Muslims, studying astronomy is very important so that this knowledge is not consumed by the times and lost in the future. Astronomy has a very large role in human life, whether it concerns worship or other matters. Without astronomy, then:

1. Without astronomy, Muslims will have difficulty determining the beginning of the prayer time, especially if it is cloudy or rainy. However, by knowing the science of astronomy, one can find out the beginning of the prayer time according to the desired place.
2. Without astronomy, Muslims will have difficulty in determining the direction of the Qibla. With this knowledge, Muslims can determine the direction of the Qibla easily and accurately, either using the help of compasses, theodolites, GPS or with the shadow of the sun.
3. Without the science of astronomy, Muslims will find it difficult to perform rukyatul hilal in determining the beginning of the month of qomariyah, especially the beginning of Ramadan, Shawwal and Dzulhijah.
4. Without astronomy, Muslims cannot know when a solar or lunar eclipse occurs, if when a solar and lunar eclipse occurs, Muslims are obliged to perform eclipse prayers

If the science of astronomy in its process is related to nash (the text of the Qur'an and Hadith), then it is only a tool to help human beings to know the will of nash, according to the limits of its method. In understanding nash, this science is like other auxiliary sciences to know God, which can be used as a means for humans to be able to grasp God's will that comes from the metaphysical region (for example, to know the direction of the Qibla, the beginning and end of prayer, the beginning of the beginning of the moon and to know the occurrence of an eclipse). Although astronomy is included to discuss the metaphysical realm, it does not necessarily mean that astronomy is part of the science that is in the transcendental realm. It remains in the realm of science with its empirical and logical nature.

IV. Conclusion

The existence and position of science in Islam have been recognized directly or indirectly by the pros and cons. This was marked by the birth of the discipline of astronomy, which bridged the encounter between science and religion within the framework of fiqh and ended the rush and polemic surrounding the relationship between science and religion (Islam) so far. However, this article is not about ending or discussing the conversation. However, in certain cases, science and religion are encountered. For example, in determining the direction of the Qibla, the existence of Astronomy reencounters Science and Religion in a narrative of integration and interconnection. The direction of the Qibla is related to the rites and rituals of worship, while the establishment activities are carried out using scientific approaches and methods.

Astronomy is a science that studies the movement of celestial bodies, especially the Earth, moon and sun in their respective circulations, to be taken for their phenomena in the context of human interests. This knowledge is especially useful for Muslims in determining the times of worship, such as prayer, fasting, Qibla, etc.

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Analysis Of Calendar System And Prayer Times In Almanac Djamiliyah By Saadoe'ddin Djambek (1953)

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ABSTRACT

Saadoe'ddin Djambek was an astrological reformer in West Sumatra who wrote many scientific books. Almanac Djamiliyah, one of his works, is a reference for determining the beginning of the month and prayer times. The calendar concept used in Almanak Djamiliyah comes from a combination of astronomical theories and scholarly thinking.

In addition, Saadoe'ddin Djambek's thought patterns underwent stages of progress so that he could produce an Islamic interpretation that could solve the problems of hisab thinking and the problems faced by his people. Although the Djamiliyah Almanac was intended for West Sumatra, some corrections make the prayer schedule usable for all countries up to 10° north and South of the equator.

In this paper, the author divides it into two problem formulations: how Saadoe'ddin Djambek made the Djamiliyah Almanac and how the concept of calendar and prayer times was used. It is hoped that this work will add to the collection of falak science and serve as a source of information and reference for future researchers.

I. Introduction

Almanac Djamiliyah is the work of a West Sumatran cleric named Saadoe'ddin Djambek, who contributed to the establishment of prayer times and other worship services in the West Sumatra region. Almanac Djamiliyah has been grounded for a long time in the people of West Sumatra. Almanac Djamiliyah is used as a prayer schedule to determine the beginning of the Qamariyah month in Indonesia. Until now, the Djamiliyah Almanac is still used by many large mosques that still truly state the validity of this Almanac. Saadoe'ddin Djambek's representative work is a valuable contribution. Traditional and moderate circles will always study it to develop hisab thinking in Indonesia.

The study of prayer timetables is closely related to the sun's position at each place on the earth's surface. Because the sun's position on the earth's surface looks different, astronomical calculations are needed to define each sign of the beginning of prayer time. In this paper, this difficulty is overcome by making correction lists so that the timetables can be used for all countries located up to 10° north and up to 10° South [1].

Although the master schedules in this book have been calculated for the Gregorian year 1953, they can be used for successive years. This is due to the small changes in the figures obtained yearly.

The primary aim of this paper is to explore Saadoe'ddin Djambek's perspectives on the calendar system and the method for determining prayer times. This exploration is particularly significant as it allows for the effective use of the prayer schedules in Almanac Djamiliyah by Saadoe'ddin Djambek for public purposes. By examining Djambek's methodologies, this research seeks to understand the principles and frameworks behind his calculations, providing clarity on their practical application for everyday use, especially for Muslim communities relying on accurate prayer times.

A notable feature of Djambek's method involves the rounding calculation results for simplicity and usability. All calculated outcomes, such as the main schedules and correction lists, are rounded to the nearest minute, with specific adjustments for seconds. Seconds less than 30 are disregarded, while those equal to or greater than 30 are rounded up to the next minute. This principle is extended to rounding degrees instead of minutes for declination schedules. Such rounding ensures that the presented data remains practical and accessible while retaining sufficient user accuracy.

This rounding system is applied in three stages to ensure consistency. Firstly, rounding occurs in the preparation of the master schedule. Secondly, it is implemented in the correction list, which adjusts specific variables. Lastly, it is applied when converting local time to regional time, accommodating regional variations in timekeeping. An exception to this process is the calculation of Zhuhr (midday) prayer time, where rounding occurs only twice. These meticulous steps highlight Djambek's attention to detail and commitment to balancing precision with practicality.

Despite the rigorous approach, the method does allow for minor calculation errors. By rounding up to three times in the process, the cumulative error can reach up to 1.5 minutes. This margin of error is considered acceptable given the schedules' purpose and usability for daily religious practices. The paper underscores Djambek's innovative timekeeping approach, which reflects his broader contribution to Islamic astronomy and is a valuable resource for communities needing reliable, user-friendly prayer time schedules [1].

This paper argues that Saadoe'ddin Djambek's thought process mirrors the developmental stages commonly observed in the intellectual journeys of reformers. His ideas evolved through careful reflection, critical analysis, and traditional and modern knowledge synthesis. Ultimately, Djambek successfully proposed an Islamic interpretation that he believed could address contemporary challenges in hisab (astronomical calculations) and provide practical solutions to the religious problems faced by his community. His work exemplifies how reformist thought can adapt to meet the needs of modern Muslim societies while remaining grounded in Islamic principles.

When examining the textual foundations of Djambek's ideas, it becomes evident that he sought to harmonize traditional interpretations by scholars with modern astronomical theories. This synthesis reflects his innovative approach to understanding religious texts in determining the beginning of prayer times. By integrating classical Islamic jurisprudence with contemporary scientific advancements, Djambek demonstrated a commitment to preserving the essence of Islamic teachings while ensuring their relevance in a changing world.

Djambek's efforts to merge these disciplines were theoretical and deeply rooted in practical application. His methodology emphasizes aligning religious observances with scientifically accurate calculations, ensuring precision without compromising spiritual significance. This approach underscores his belief in the compatibility of faith and science, offering a model for addressing similar challenges in other aspects of Islamic practice, such as calendar systems and fasting schedules.

Djambek's intellectual contributions ultimately represent a progressive yet grounded interpretation of Islamic thought. His ability to navigate the complexities of tradition and modernity provides a valuable framework for addressing contemporary issues in Islamic astronomy. Through his work, Djambek enriched the field of hisab and inspired a forward-looking perspective for integrating religious and scientific knowledge in the service of the Muslim community [2].

II. Method

This research employs a qualitative methodology, utilizing primary and secondary data to achieve its objectives. The primary data source is Saadoe'ddin Djambek's book, Almanac Djamiliyah, which is the foundational text for analyzing his methods of calendar systems and prayer time calculations. Secondary data are drawn from journals, scientific works, and encyclopedias that explore Djambek's contributions and Islamic astronomical thought. The researcher meticulously selects literature and studies directly relevant to the research theme to ensure the validity and depth of the analysis.

The data are analyzed using an inductive technique, which provides a descriptive framework for interpreting Djambek's methodologies. This approach facilitates a systematic synthesis of findings, allowing the study to highlight key aspects of his thought process and its practical applications. Then, combining insights from primary and secondary sources, the research aims to comprehensively understand Djambek's work, situating it within the broader discourse of Islamic astronomy and reformist scholarship.

III. Results and Discussion

A. Biography of Saadoe'ddin Djambek

His full name is H. Saadoe'ddin Djambek alias Datuak Sampono Radjo, born in Bukittinggi on 29 Rabi'ul Awal 1329 H, which coincides with March 24, 1911 M is the son of Shaykh Muhammad Djamil Djambek (1860-1957). His grandfather was Saleh Datuk Maleka, the head of Nagari Kurai. One very important element that is usually used as a basis for consideration in assessing the intellectual quality of a person, especially in recent times, is how much and to what extent the quality of scientific work has been produced. From this point of view, Saadoe'ddin Djambek is one of the hisab figures who left behind many scientific works [3].

The majority of Saadoe'ddin Djambek's professional activities and career were spent in the field of education, starting from elementary school to university level (lecturer). Saadoe'ddin Djambek became interested in and studied phalacology by studying with Sheikh Thaher Djalaluddin, a figure who greatly influenced his thoughts and insights into phalacology [4].

Besides being a phalacologist, Saadoe'ddin Djambek was active in organizations, including; in Palembang as a member of Muhammadiyah, leader of Hizbul Wathan West Sumatra (1930-1934), in Yogyakarta as a member of the Muhammadiyah Teaching section (1942-1943), member of the Sumatra and Central Sumatra Representative Council of the Islamic Faction (1946-1949), in 1958 appointed by the Government to attend the "Mathematical Education" Conference in India, in 1971 appointed by the Government to study the "Coprehensive School" system in India, Thailand, Sweden, Belgium, England, the United States and Japan in collaboration with UNESCO, in 1972 was assigned by the Minister of Religious Affairs of the Republic of Indonesia to research the development of astrology and social life in Mecca and in 1977 attended the invitation of King Abdul Aziz University Mecca in the meeting "First World Conference On Moslem Education" [5].

Saadoe'ddin Djambek's expertise in the science of hisab, falak science, astronomy and mathematics can be seen from the works he wrote [6]. Among his works are: Time and Schedule Popular Explanation of the Journey of the Earth, Moon and Sun (Tintamas: 1952), Almanac Djamiliyah (Tintamas: 1953), Qibla Direction and How to Calculate it by the Way of Spherical Triangle Measurement (Tintamas: 1956), Calculating the Beginning of Prayer Times (Tintamas: 1957), Comparison of Tarich (Tintamas: 1968), Guidelines for Prayer Times Throughout Time (Bulan Bintang: 1974), Prayer and Fasting in Polar Regions (Bulan Bintang: 1974), Hisab Awal Bulan Qamariyah (Tintamas: 1976) [7].

B. The History of the Formation of the Djamiliyah Almanac

Saadoe'ddin Djambek's thinking was a struggle between hisab experts and astronomers. The hisab expert who influenced his mindset was Sheikh Thaher Djalaluddin. This is as he himself admits in several of his books: "The path taken in calculating the times in this book is according to what is indicated by Jangmulia Sjech M. Thaher Djalalu'ddin in his book "Pati Kiraan on Determining the Five Times and Hala Qiblat with Logarithma" [1].

Saadoe'ddin Djambek's Almanac Djamiliyah generally uses Ulugh Beek As-Samarkandi's astronomical tables. In performing calculations, he uses the usual calculation method of adding (+), subtracting (-), multiplying (x), and dividing (:). Likewise, calculating the sun's altitude (irtifa') and hilal uses a simple method: the time of the sun is subtracted from the time of ijtimak and then divided by two [8].

Starting from the difficulty in the use of prayer time schedules which are generally only calculated for one particular place, and cannot be used for other places. Saadoe'ddin Djambek in his work Almanac Djamiliyah, the difficulty is overcome by organizing a list of corrections, so that in this way the schedules can be used for all countries located up to 10 ° north and 10 ° South of the equator [1].

C. Implementation of the Dating Concept in the Djamiliyah Almanac

The number of days in 1953 on each desired date:

Date	Name of the Month											
	Jan.	Feb.	March	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1	1	32	60	91	121	152	182	213	244	274	305	335
2	2	33	61	92	122	153	183	214	245	275	306	336
3	3	34	62	93	123	154	184	215	246	276	307	337
4	4	35	63	94	124	155	185	216	247	277	308	338
5	5	36	64	95	125	156	186	217	248	278	309	339
6	6	37	65	96	126	157	187	218	249	279	310	340
7	7	38	66	97	127	158	188	219	250	280	311	341
8	8	39	67	98	128	159	189	220	251	281	312	342
9	9	40	68	99	129	160	190	221	252	282	313	343
10	10	41	69	100	130	161	191	222	253	283	314	344
11	11	42	70	101	131	162	192	223	254	284	315	345
12	12	43	71	102	132	163	193	224	255	285	316	346
13	13	44	72	103	133	164	194	225	256	286	317	347
14	14	45	73	104	134	165	195	226	257	287	318	348
15	15	46	74	105	135	166	196	227	258	288	319	349
16	16	47	75	106	136	167	197	228	259	289	320	350
17	17	48	76	107	137	168	198	229	260	290	321	351
18	18	49	77	108	138	169	199	230	261	291	322	352
19	19	50	78	109	139	170	200	231	262	292	323	353
20	20	51	79	110	140	171	201	232	263	293	324	354
21	21	52	80	111	141	172	202	233	264	294	325	355
22	22	53	81	112	142	173	203	234	265	295	326	356
23	23	54	82	113	143	174	204	235	266	296	327	357
24	24	55	83	114	144	175	205	236	267	297	328	358
25	25	56	84	115	145	176	206	237	268	298	329	359
26	26	57	85	116	146	177	207	238	269	299	330	360
27	27	58	86	117	147	178	208	239	270	300	331	361
28	28	59	87	118	148	179	209	240	271	301	332	362

29	29	-	88	119	149	180	210	241	272	302	333	363
30	30	-	89	120	150	181	211	242	273	303	334	364
31	31	-	90	-	151	-	212	243	-	304	-	365

Notes: This list can be used to find out how many days are between two known dates. **Example**: On March 5, the number 64 is obtained, and on July 25, the number 206 is obtained. Then the distance between the two dates is 206 - 64 = 142 days [1].

D. Implementation of the Prayer Time Concept in the Djamiliyah Almanac

The prayer time schedule in Almanac Djamiliyah is calculated for the equatorial region. As for areas north and South of the Equator, it needs to be corrected first. The corrections are generally of two kinds. Except for the beginning of Zhuhr time, which only needs one correction.

1. Correction of Zuhr Time

   The Zhuhr time schedule is valid for all countries according to local time. The only correction to be made is to move it to local time. Example: What was the time of noon on February 25 for Bukittinggi City (longitude 100° 22' T). The time of noon on February 25 was 12:13. Bukittinggi is located 100° 22' - 97° 30' = 2° 52' east of the North Sumatra longitude. 2° 52' is rounded to 2° 45', which is equal to 11 minutes. Thus, on February 25, for the city of Bukittinggi, the time of noon entered at 12:13 - 11 minutes = 12:02 North Sumatra time.

   If local time is used as local time, then it should be remembered that for areas West of the guided longitude line the time difference must be added (+), while for areas to the east, the time difference must be subtracted (-) [1].

2. Correction for times other than Zhuhr

   The correction for times other than Zhuhr is of two kinds. First, as indicated by the relevant correction list. Secondly, due to equalization with local time. The correction lists are of two types, First, for the same declination and latitude, meaning if they are both equally South or equally North. Secondly, for different declinations and latitudes. By different declinations and latitudes, we mean if the declination of the sun is North and the latitude of the country is South; or if the declination of the sun is South and the latitude of the country is North.

Example: What is the time of maghrib on January 21 for the city of Jakarta. The sunset time schedule on January 21 shows 6:16 pm. The latitude of Jakarta is 6° 10' N-S or rounded to 6° N-S. The declination of the sun on January 21 is 20° South. Since declination and latitude are both South, a list of maghrib time corrections is taken which shows that for a declination of 20° and a latitude of 6°, the correction is +9. This shows that on the date in question the time of maghrib entered for the city of Jakarta at 18:16 + 9 minutes = 18:25 local time. Jakarta is located 112° 30' - 106° 49' = 5° 41' West of the longitude line of Javanese time. 5° 41' is rounded to 5° 45', and this equals a time difference of 23 minutes. The maghrib time on January 21 for Jakarta is 18:25 + 23 minutes = 18:48 Javanese time [1]. By following the calculation method shown in the examples above, it is possible to obtain all the times of the year for each region of interest [1].

The results show that the phalac theory developed by Saadoe'ddin Djambek in Almanac Djamiliyah is relatively easier with astronomical data from developed countries, such as the Nautical Almanac from America, Ephemeris from the Soviet Union and others. Saadoe'ddin Djambek was the first astrologer to develop the Nautical Almanac system in Indonesia. At that time, the Ministry of Religious Affairs depended on the Nautical Almanac, purchased annually from the Navy Hydro Oceanographic Service in limited quantities and generally could only be obtained in June or July each year. While there is a need for up-to-date astronomical data, especially for calculating the beginning of the month of Ramadan, Shawwal and Dhulhijjah is not always after June and July, but they depend on the Hijri calendar.[9]

Saadoe'ddin Djambek contains a way of calculating the beginning of the month with a nautical almanac, and the calculation uses the formulas of a spherical triangle whose solution uses a list of logarithms. When calculating the initial height of the hilal (h), the formula used is Sin h = Sin p. Sin d + Cos p. Cos d. Cos t. The result of the hilal height with the formula is then corrected with Parallax, refraction, semi-moon diameter, and low horizon or Dip.[10]

This paper is different from other studies. Studies that other researchers have studied tend to show the determination of the beginning of the month and the hisab of the beginning of prayer time. In comparison, this paper focuses more on the concept and background of the emergence of the calendar system and the method of hisab, the beginning of prayer time developed by one of the previous reformers of falak science using simple calculations.

Based on the results that have been shown in the result section, this paper can add to the scientific treasury, especially in the field of astrology. So that it can be used as a guide for the community in recognizing the history and other methods offered in the Djamiliyah Almanac. As a scientific work, then this paper can be information and a source of reference for future researchers.

IV. Conclusion

Saadoe'ddin Djambek's thinking pattern in his work Almanac Djamiliyah was influenced by Sheikh Thahir Djalaluddin. The astronomical data in Almanac Djamiliyah is obtained from the astronomical data of developed countries, such as the Nautical Almanac from America, Ephemeris from the Soviet Union and others. Thus, Saadoe'ddin Djambek is known as a figure of phalacology who first developed the Nautical Almanac system in Indonesia.

The difficulty in using a prayer time schedule that has been calculated for one area and cannot be used for another, in the Djamiliyah Almanac can be overcome by organizing correction lists. For the purposes of worship, a final correction should be made to ensure that any errors that may have occurred during the calculation are avoided. The correction value is 1 or 2 minutes (for the beginning of Zhuhr time it is 1 minute, for the beginning of other prayer times it is 2 minutes. This research was limited to obtaining data, related documents, and did not conduct in-depth interviews. In fact, to get a more comprehensive understanding, comparative analysis is needed, which requires more diverse cases. In line with the limitations in this paper, further research is needed to obtain a better understanding.

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Gravitational Acceleration Measurement Using Simple Harmonious Motion at The Observatorium Ilmu Falak

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ABSTRACT

The gravity in various places varies, although not very significant. The measurement of gravitational acceleration in the city of Medan, especially in the Falak Science Observatory of the University Muhammadiyah of North Sumatra, was carried out to determine the magnitude value of gravitational acceleration as a reference for activity in the observatory area. The measurements were made using a simple instrument, Mathematical Swing, through simple harmonic motion. The research method used is experimental research. Data collection was carried out directly. In this study, the stages passed are single measurements and repeated measurements. The measurement was carried out by measuring the harmonious motion of a mathematical swing moved by the same angle θ for each experiment, and the duration of the movement was calculated when it reached ten swings. The experiment was conducted on the OIF UMSU outdoor area on the 7th floor/rooftop of the UMSU's Postgraduate Building. From the research, a single measurement result is (9.463777 ± 0.009) m/s^2, and the repeated measurement method obtained the result gravitation is (9.59825 ± 0.001) m/s^2.

I. Introduction

Gravitational acceleration is the acceleration experienced by an Object due to the mass of itself. In an Object, gravity then affects and causes the Object to have weight [1]. In addition, gravity is also different for each place on the Earth's surface. Newton's Universal Law of Gravity shows that a simple equation is a motion almost towards the Earth's center or perpendicular to the ground surface [2]Gravitational acceleration is the acceleration of a material experienced by an object moving under the influence of attraction on the Earth's surface towards the Earth's core. Objects of any magnitude and mass that, if dropped, will move towards the Earth's surface because there is a pull to the Earth's core. The NASA GRACE mission [3] measures the Earth's gravity map, which shows gravity deviations on the Earth's surface, as shown in Figure 1.

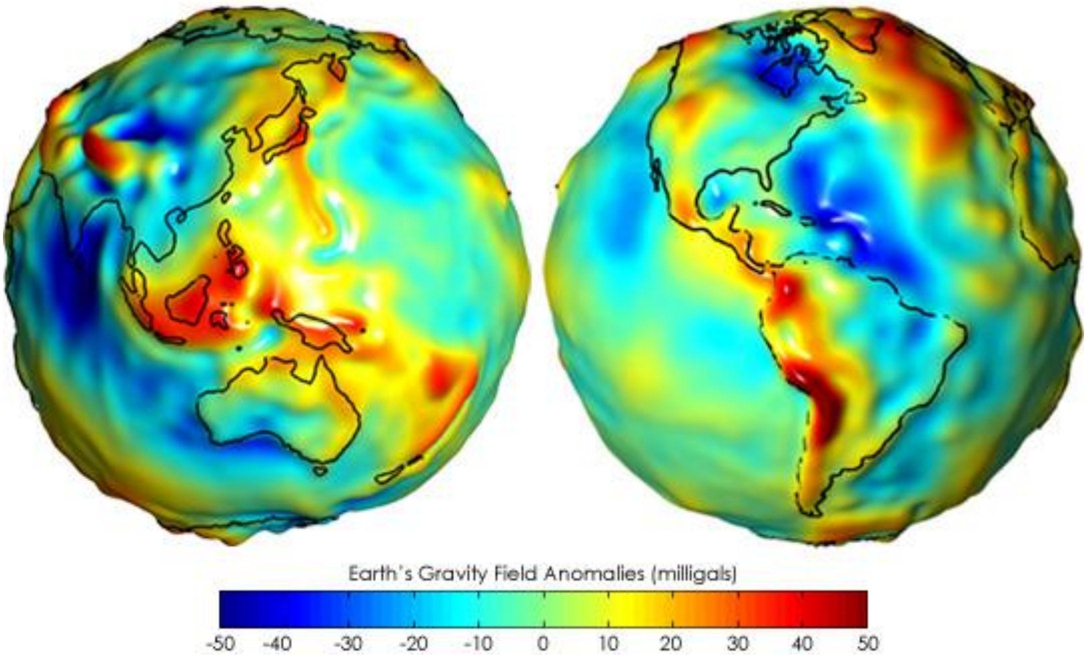

Figure 1. These "gravity anomaly" maps show where models of the Earth's gravity field are based on GRACE data. Red shows the areas where gravity is stronger than the smooth, standard value, and blue reveals areas where gravity is weaker.

Large measurements of gravity have been widely performed and applied in recent years. The magnitude of gravity is needed in several fields related to the position, height, and dimensions of objects on the Earth's surface. Its main application is to conduct investigations of structures/basins. Gravity measurements are also affected by many parameters such as topography, altitude from sea level, etc. Furthermore, it is reduced by applying appropriate corrections [4]. Gravity measurements have become a fundamental tool in various scientific and engineering disciplines, with significant advancements and widespread applications in recent years. Precisely measuring gravitational forces is essential in several fields, particularly those concerned with determining objects' position, height, and dimensions on the Earth's surface. These measurements are critical for a broad range of applications, including but not limited to geophysical surveys, infrastructure development, and environmental assessments. One of the primary uses of gravity data is to investigate subsurface structures and geological basins, as the variations in gravitational acceleration can reveal important information about the composition and physical properties of the Earth's crust. However, it is important to note that gravity measurements are subject to various influencing factors, such as local topography, altitude relative to sea level, and the Earth's dynamic surface conditions. These parameters can cause fluctuations in the observed gravitational values, making it essential to apply corrections to ensure accuracy and consistency in the data. For example, topographic and altitude corrections are commonly used to account for varying terrain and elevation effects. It allows for a more precise assessment of gravitational anomalies concerning Earth's surface.

Moreover, the magnitude of gravitational acceleration varies across different locations on the planet, with notable differences observed between the equatorial and polar regions. At the equator, the gravitational acceleration is approximately 9.78 m/s^2, whereas at the poles, it increases to around 9.83 m/s^2. This variation is primarily due to the Earth's slightly oblate shape and the centrifugal force generated by its rotation. As such, accurate gravity measurements are essential for understanding the Earth's physical characteristics and making informed decisions in the planning and design of engineering projects, where structural integrity and the ability to withstand gravitational forces are critical considerations.

Thus, the application of gravity measurements and the subsequent corrections for local environmental conditions play a crucial role in ensuring the reliability and relevance of the data in various scientific, industrial, and geophysical investigations. In everyday life, this gravitational phenomenon is very difficult to see because the interaction between objects and relatively small masses makes the gravitational force between the two very small, but we can see its effect on a broader view, such as the behaviour of celestial bodies and satellites that move on their trajectories due to the gravitational force [5]

On the Earth's surface, the magnitude of gravitational acceleration can be determined by several methods, including parabolic motion [2], a mass-spring system [6] and a pendulum system [7]. The magnitude of local earth gravity acceleration will be carried out in the research using a pendulum system or a mathematical swing [8]. The big difference in gravity in each area is due to the height of an area. Simple harmonic motion is the motion of an Object moving back and forth through a certain reference point (in this case, the equilibrium point) compared to the number of oscillations of the Object that occur in each constant unit of second. The motion exists because of the force that resists the change in the position of the Object to return to the equilibrium point, which is why simple harmonic motion occurs [9]

Simple harmonic motion is an Object that goes back and forth through a certain equilibrium point with the number of vibrations of objects in units of seconds [10], as shown in Figure 2. This motion oscillates at the equilibrium point due to the recovery force acting on the system. An example of simple harmonic motion can be found in one of the simple instruments, namely the mathematical pendulum. The pendulum swings continuously and back and forth [11]. A mathematical pendulum is a point that is hung on a light string that does not stretch and then swings so that it will undergo oscillation. The factors that affect it are the frequency, period, gravity and length of the string on the pendulum [12]. Experimentally, the magnitude of the Earth's gravitational acceleration can be determined by the mathematical oscillation method. An object is hung at a fixed point with a rope that is considered to be massless; then the rope is deflected at an angle θ to the vertical line [13].

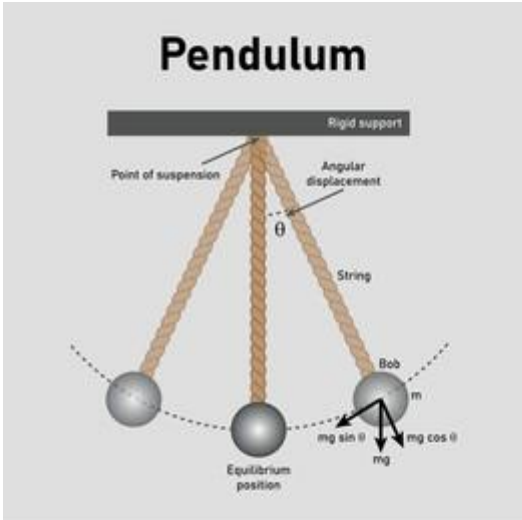

Figure 2. Simple Harmonic Motion of a Pendulum

The magnitude of the acceleration of gravity also needs to be known in some places, especially in big cities. Medan is one of the cities in the province of North Sumatra. It is located at 95° 43' East Longitude and 03° 34' N (North Latitude)[14]. However, the magnitude of the acceleration of gravity in the city of Medan, especially in the environment of the UMSU astronomy observatory, is not yet known. This research on the acceleration of gravity in the city of Medan is important to be used as a consideration in activities [15] and capacity in development when designing buildings and outdoor instruments, considering that there are limitations on the capacity of rooftop floors for public activities at the UMSU astronomy observatory [16]

II. Method

The research method used is experimental research. Data collection was carried out directly. In this study, the stages passed are (1) single measurement with a rope length of 30 cm and (2) repeated measurements with several rope lengths of the same and different. The measurement was carried out by measuring the harmonious motion of a mathematical swing moved by the same angle θ for each experiment, and the duration of the movement was calculated when it reached 10 swings.

To calculate the acceleration of gravity using equation (1) as follows [13]

$$g = 4\pi^2 \frac{l}{T^2} \qquad (1)$$

Next, to calculate the error using the equation (2):

$$S_g = \sqrt{\frac{\Sigma(g_i - g)^2}{N(N-1)}} \qquad (2)$$

III. Results and Discussion

The data collection for this study was conducted in the UMSU OIF Planetarium room, where precise measurements were taken to investigate the relationship between rope length and swing period. Two primary analysis methods were employed: single measurement and repeated measurement. In the single measurement method, the rope length (l) and the swing period (T) were measured only once for each trial, providing initial data for analysis. For the repeated measurement method, the rope length was varied systematically, and each length was tested with a total of 10 swings to ensure the accuracy and reliability of the results. The full set of observations, including the measured values of rope length and swing period, are documented in Tables 1 and 2, respectively. These tables provide detailed information on the specific measurements and the corresponding periods recorded during each trial, offering a comprehensive overview of the experimental data for further analysis and interpretation.

Table 1. Single Measurement

Length (l)	Number of swings (n)	Time (t)	Gravity Acceleration (m/s²)
30 cm	10	11.06 s	9,378403

Tabel 2. Pengukuran Berulang pada variasi panjang dengan n = 10

No	Length (l)	Time (t)	T Periode (s)	Frequency (Hz)	T2	Gravity Acceleration (m/s²)
1	30 cm	11,01 s	1,101	1/1,101	1,212201	9,463777
2	30 cm	10,9 s	1,09	1/1,09	1,1881	9,655753
3	40 cm	12,64 s	1,264	1/1,264	1,597696	9,573786
4	40 cm	12,57 s	1,257	1/1,257	1,580049	9,680712
5	50 cm	14,1 s	1,41	1/1,41	1,9881	9,617222
Rata2						9,598250

The magnitude of the acceleration of the Earth's gravity g in the astronomy observatory measured by the mathematical pendulum swing is determined after the magnitude of the pendulum's swing period is known. The relationship between the periods is inversely proportional to the acceleration of Earth's gravity, as shown in equation (1). The result of the theoretical calculation of the Earth's gravity using Newton's Law of Gravity is g = 9.806 m/s2. In a study by [13] at the UAD Basic Physics Laboratory, Yogyakarta gave a large result of gravity in a single measurement method of (9,689 ± 0.009) m/s2, while repeated measurements obtained a gravitational magnitude at (9,832 ± 0.001) m/s2 [13] Meanwhile, according to [1] in Metro cities it is 9.86 ± 0.011 m/s^2.

The UMSU Astronomical Science Observatory experiments provided valuable data on the gravitational acceleration at the observatory's location. Using the single measurement method, the calculated value for gravitational acceleration was $g=(9.463777\pm0.009)\ m/s^2$. This result was obtained through a series of measurements of the rope length and swing period, using a simple pendulum setup to observe the period of oscillation under the influence of Earth's gravity. The small uncertainty of $\pm0.009\ m/s^2$ indicates a relatively high degree of precision in the measurement, though it reflects the method's natural variability and experimental limitations. The repeated measurement method, which involved varying the rope length and performing multiple trials (10 swings for each variant), provided a slightly higher value for gravitational acceleration: $g=(9.59825\pm0.001)\ m/s^2$. This method allowed for greater accuracy by averaging the results of several repeated measurements, thus reducing random errors and providing a more reliable estimate of the gravitational acceleration at the location. The much smaller uncertainty of $\pm0.001\ m/s^2$ reflects the increased precision achieved through multiple trials and careful results averaging.

When comparing these experimental values to those obtained by other researchers, [17] obtained an average gravitational acceleration of 9.796 m/s2 in gravity measurements using free-fall motion. By knowing the magnitude of this gravitational acceleration it can be used as a reference in several activities at OIF UMSU related to visiting game instruments such as water rockets, qibla pendulums, and information references to visitors in the environment of the Astronomical Observatory of the University of Muhammadiyah North Sumatra. In addition, the amount of gravity is a reference for the durability and maximum capacity of the number of visitors in the rooftop yard of OIF UMSU, such as in the canopy platform in the east and the capacity in the main courtyard, which is estimated to be a maximum of 150 people for mobile activities according to an interview with the civil engineering team of the UMSU graduate building.

IV. Conclusion

In the experiment of accelerating the Earth's gravity at the Astronomical Observatory of the University of Muhammadiyah North Sumatra, Medan gave results with various measurement methods; in a single measurement of g = (9.463777 ± 0.009) m/s2, the repeated measurement method gave the result g = (9.59825 ± 0.001) m/s2, the gravity obtained was lower than the theoretical gravity and received by other researchers in other locations. This value will be used as a reference and an excellent reference for the acceleration of gravity to visitors, variables in instruments related to acceleration and capacity in the environment of the Ilmu Falak Observatory, University of Muhammadiyah North Sumatra.

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Lunar Crescent Visibility Criteria in Determining the New Islamic Month in Malaysia

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ABSTRACT

The visibility of the lunar crescent holds fundamental importance in determining the start of new months in the Islamic calendar, a practice deeply embedded in Islamic culture and religious obligations. In Malaysia, the method of establishing the beginning of an Islamic month has evolved, reflecting a blend of historical tradition and modern scientific advancements. This article comprehensively analyses the historical, cultural, and religious factors that have shaped the criteria for lunar crescent visibility in Malaysia. Traditional methods, primarily reliant on naked-eye observations known as rukyah, have long played a central role, guided by religious teachings and communal practices. However, with growing advancements in astronomical knowledge, Malaysia has incorporated hisab (astronomical calculations) to predict and verify the visibility of the crescent Moon more accurately.

In recent years, adopting the NEO MABIMS has marked a significant advancement. This framework combines traditional practices with scientific precision, offering standardized guidelines incorporating parameters such as the Moon's altitude, elongation, and age at sunset. This study underscores the complexities and regional challenges in determining the start of Islamic lunar months. The committee's findings indicate that the 1978 Istanbul Resolution, while foundational, was not directly applicable to Malaysia due to its unique geographical latitude and visibility conditions.

I. Introduction

The Islamic calendar (Hijri) is a lunar calendar based on the Moon's cycles. Determining the start of a new month is a crucial element in Islamic worship. The beginning of months, such as Ramadan and Shawwal, determines the timing of fasting, Eid al-Fitr, and other religious obligations. In many other Muslim-majority countries, the methods for determining the new Islamic month have evolved, incorporating traditional and modern scientific techniques.

Traditionally, Islamic months were determined by the sighting of the Moon with the naked eye, a practice rooted in the teachings of Prophet Muhammad. This method, known as rukyah, is still followed in many parts of the Muslim world, including Malaysia. However, with the advancement of astronomical knowledge, they have adopted hisab, or astronomical calculations, to predict the visibility of the new Moon.

Malaysia's history of using these methods dates to colonial times when various local rulers used different moon-sighting methods, leading to discrepancies in the observance of religious events. In the post-independence era, a concerted effort has been made to unify these methods under a central authority, ensuring consistency and avoiding confusion among the Muslim population.

Previously, studies reported the criteria based on variables measured in crescent moon sighting activities. Among the early Arabic astronomers, Al-Tabari utilized the Sun's depression angle to determine the crescent Moon's visibility. The crescent would be considered visible during the moonset if the Sun's altitude was 9.5° below the horizon) [1].

The sighting of the lunar crescent is a vital practice in Islam, marking the commencement of new months in the lunar calendar. In Malaysia, this practice reflects both religious significance and cultural identity. This article investigates the origins of lunar crescent visibility criteria in Malaysia, focusing on historical practices and the integration of modern methodologies such as NEO MABIMS [2].

Traditionally, determining the lunar crescent's visibility was based on direct visual observation. Early Islamic jurisprudence established Moon sighting as a method to initiate months [3]. In Malaysia, local communities played a pivotal role in observing the Moon, with decisions often made based on collective sightings, influenced by the geographical and climatic conditions unique to the region.

Lunar crescent visibility is influenced by several astronomical factors, including the Moon's age, altitude, and atmospheric conditions. Standard criteria for visibility typically require that the Moon be at least 18 degrees above the horizon and 30 hours old to enhance the likelihood of successful observation. These criteria were traditionally guided by empirical observations but lacked standardization, leading to discrepancies in the Islamic calendar [4].

The significance of lunar crescent sightings in Malaysia extends beyond the religious context; it fosters community engagement and cultural cohesion. Gatherings for moon sightings serve as social events that reinforce collective identity among Muslims. However, varying practices across regions often lead to confusion regarding the start of important religious events, necessitating a more uniform approach. While Malaysia's combination of rukyah and hisab provides a balanced approach to determining the new Islamic month, challenges remain [5]. Occasionally, there are discrepancies between the sighting reports and the hisab calculations, leading to debates among scholars and the public. These differences can be confusing, mainly when neighbouring countries such as Indonesia and Brunei make different announcements.

Malaysia's method of determining the Islamic month is significant for its local Muslim population and neighbouring countries. Malaysia works closely with Brunei, Indonesia, and Singapore to ensure they follow similar practices, promoting regional unity in observing Islamic events. Malaysia's approach has also been influential in the broader Muslim world, where discussions about integrating astronomical calculations with traditional moon-sighting practices continue to evolve.

The observation process begins by observing the Sun first until sunset or the Sun is not visible because it is covered with clouds. Once the Sun sets, the officers point the observation device toward the Moon's position. Observation of the hilal is carried out until the hilal is visible, or if the hilal is not visible, the observation is carried out until the sunset of the Moon, according to the data that has been provided.

Officers on duty at each location must report the Moon sighting results to the Mufti, who acts as the Chairman of the Rukyah Anak Bulan Committee. The Mufti will then report the results to the Great Seal Guard Office Kingdom (PMBRR). Important information that must be reported to PMBRR includes observation results, sunset data, observation start time, horizon conditions, and weather at the observation time [6].

All procedures for moon sightings must be carried out so that the moon sightings can run and be accepted by all parties and the appearance of the Moon can be ensured [7]. Several lunar belief procedures must be met To ensure a confirmed sighting of the Moon:

a. Observations of the Moon are done through the eyes or eyepieces.
b. The appearance of the Moon is acceptable with the help of technical equipment such as theodolites, telescopes, binoculars, and the like.
c. The rule of seeing the Moon with the naked eye with the help of optical equipment is a must.
d. The appearance of the Moon using imaging techniques is required with the parameters set by JAKIM through the Guidelines/Procedures for Belief in the Sighting of the Moon Through Imaging Techniques. (2021 Malaysian National Council for Islamic Religious Affairs (MKI) Conference)
e. If witnessed by someone other than the committee, the group leader must conduct further investigation with the help of an experienced person. Their appearance can be rejected at the discretion of the Group Chairman or Rukyah Committee Member.
f. The appearance of the hilal in the context of the official appearance of Ramadan, Syawwal, and Zulhijjah must be reported to the Keeper of the Great Seal of Kings by the appointed Mufti/Leader of the Group/Reporter.
g. The number of witnesses proving the month of Ramadan should consist of one fair witness for the month of Ramadan and two witnesses for non-Ramadan. Meanwhile, the imaging technique must be witnessed by two impartial Muslim witnesses and the women's testimony at the Moon's sighting.
h. The hilal should be observed after sunset until the Moon has completely set.

II. Method

This research utilizes a qualitative approach, focusing on in-depth analysis through library-based methods. Data collection was conducted through a rigorous examination of academic resources available in various electronic databases, including prominent sources such as the International Journal. The primary emphasis was extracting insights related to lunar observations, a critical area in Islamic Astronomy. The search strategy involved several specific keywords to identify relevant articles and studies. These keywords included "crescent," used to locate studies on the lunar crescent; "naked eye," targeting articles on unaided observational methods; "telescope," aimed at gathering resources on telescopic usage; "binocular," associated with the use of binoculars in observation, "image processing," focusing on digital techniques in lunar imagery, and "observation," which broadly encompassed scholarly insights on various aspects of lunar observation practices. By employing these keywords strategically, this study ensures a comprehensive and nuanced collection of literature directly relevant to the research objectives.

III. Results and Discussion

It is known that the Moon is the only natural satellite of the Earth that can be seen showing different phases through the point of view of an observer on Earth. In general, we as Muslims know that when we see the full Moon, it is a sign that we have arrived in the middle of the Hijrah month, while if we do not see it directly (with the naked eye), we are already in the middle of the Hijrah month—the end of the month and approaching the new Moon.

From the perspective of sharia, the appearance of the moon (hilal) as a (physical) sign that determines the beginning of the new month of Hijrah, is contained in several verses of the Quran, such as in the 189th verse of Surah al-Baqarah:

۞ يَسْـَٔلُونَكَ عَنِ ٱلْأَهِلَّةِ ۖ قُلْ هِىَ مَوَٰقِيتُ لِلنَّاسِ وَٱلْحَجِّ ۗ وَلَيْسَ ٱلْبِرُّ بِأَن تَأْتُوا۟ ٱلْبُيُوتَ مِن ظُهُورِهَا وَلَـٰكِنَّ ٱلْبِرَّ مَنِ ٱتَّقَىٰ ۗ وَأْتُوا۟
ٱلْبُيُوتَ مِنْ أَبْوَٰبِهَا ۚ وَٱتَّقُوا۟ ٱللَّهَ لَعَلَّكُمْ تُفْلِحُونَ ١٨٩

Meaning "They asked you (O Muhammad) about the (circulation) of the moon children. Say: "(The circulation) of the children of the Moon marks the times (affairs and deeds) of man, especially the Hajj. And it is not a matter of virtue: you enter the house from behind (when you wear ihram), but that virtue is the deed of a pious person, and enter into the house through its door, and fear Allah that you may be lucky."

In 1983, Malaysia introduced the Imkanur Rukyah criteria, a system derived from the Istanbul Resolution yet adapted with specific modifications to suit local contexts better. This adaptation introduced several changes to the visibility criteria, including a minimum altitude requirement of 5.5° for the crescent Moon, an elongation of 7.5°, and an age criterion of 8 hours, considering this as the minimum threshold for a new lunar crescent, or "child of the Moon," to be visible as shown in figure 1.

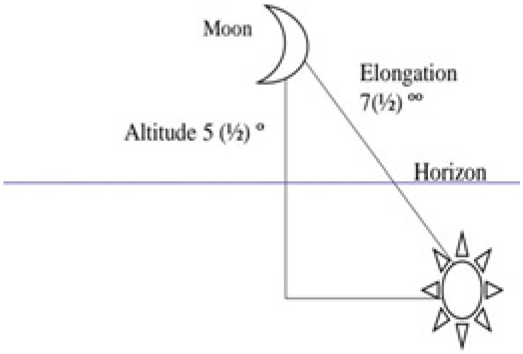

Figure 1. Showing configuration of Hijri's new month

Since 1984, Malaysia has officially implemented these Imkanur Rukyah criteria to standardize the determination of crescent visibility. Imkanur Rukyah, derived from Arabic, translates to "expected visibility" and establishes a set of minimum conditions under which the Moon can be sighted. These criteria form the foundation of Malaysia's approach to lunar observations, defining parameters that ensure visibility aligns with Islamic and scientific principles. Theoretically and practically, the issue of IIC science was initiated. The book's publication marked this phase: A Modern Guide to Astronomical Calculations of Islamic Calendar, Times and Qibla [8].

The criteria were later modified by the Ministers of Religion of Brunei, Indonesia, Malaysia, and Singapore (MABIMS) Meetings in 1992, which indicates that the Moon's altitude should not be more than 2 degrees, the elongation of the moon-sun should not be more than 3 degrees at sunset, and the age of the young crescent Moon must not be less than 8 hours after conjunction.

In Brunei, the imkan al-ru'yah (possibility of sighting) criteria are applied explicitly to all months in the Islamic calendar except for Ramadan, Shawwal, and Dzulhijjah. For these three important months, which mark the beginnings of fasting, Eid celebrations, and Hajj, respectively, the rukyah al-hilal method is used. This approach requires the physical sighting of the young crescent Moon to ensure that the start of these months is determined accurately, in alignment with traditional Islamic lunar observation practices.

After examining regional and scientific requirements, Malaysia officially adopted the imkan al-ru'yah criteria in 1995. These criteria were developed to streamline and standardize the observation process, making it more predictable and based on specific, observable conditions. Malaysia's criteria were set to ensure that the crescent Moon is considered sightable if it meets a minimum altitude of 2° above the horizon and an elongation of 3° from the Sun, thresholds that were determined suitable based on calculations that the crescent would generally be about 8 hours old by this point. This age threshold is considered adequate to identify the crescent as a "child of the Moon" — a term that signifies it is newly formed and potentially visible [9].

These parameters are critical because they provide a precise formula under which the imkan al-ru'yah criteria operate, removing much of the ambiguity associated with lunar sightings. Since 1995, Malaysia has adhered to this system, which has created consistency in the sighting process across the country and provided a framework that aligns with religious observance and scientific calculation. The minimum altitude of 2° ensures that the crescent has risen enough above the horizon to reduce atmospheric distortion and is sufficiently separated from the Sun for its faint light to be discerned. In contrast, the 3° elongation supports adequate angular distance for better visibility. This standardized approach meets the technical criteria for lunar visibility and harmonizes with the cultural and religious significance of crescent sightings in Islamic practice. This system establishes the following minimum thresholds that must be met for a crescent sighting to be considered possible:

- During sunset:
  The altitude is not more than 2°, AND
  The elongation of the moon-sun is not more than 3°.
- During the moonset:
  The age of the Moon is not less than 8 hours.

Therefore, further research is necessary to explore the origins and development of the lunar crescent visibility criteria and to assess whether these selection criteria are grounded in scientific principles. This paper investigates the historical process of formulating these criteria chronologically, examining how standards for crescent sighting have evolved within the region. A notable instance of divergence in criteria application occurred in 1983, when the states of Perak and Johor marked the beginning of Ramadan 1403 on June 12, while other states in Malaysia commenced the observance on June 13. This discrepancy was due to differing methods for determining the lunar month's start. The Perak and Johor state governments based their decision on the presence of al-hilal, which signifies that the Moon is positioned above the horizon at sunset, even if it is not necessarily visible. This method emphasizes the presence of the Moon as the primary criterion for beginning the month.

In contrast, under national guidance, other states in Malaysia adopted the imkan al-ru'yah (expected visibility) criteria, which require not only the presence of the Moon but also the potential for it to be sighted under specific conditions. The imkan al-ru'yah method incorporates minimum altitude and elongation, providing a framework to estimate the likelihood of the crescent being seen. This approach, which aligns with astronomical standards and religious observance, aims to reduce inconsistencies in lunar month commencement by relying on standardized visibility parameters. Thus, This paper seeks to analyze these criteria and their historical applications, evaluating whether they are scientifically justified and how they have shaped regional practices. By tracing the development of these methods, this research seeks to clarify the basis for current standards in crescent sighting and address the implications of these differing approaches in the Islamic astronomical context.

The Review Committee was then formed by the Department of Islamic Religious Affairs (under the Prime Minister's Office) on December 14 1989, after realizing the nature of the differences that arose. This committee. Majid Abd. Hamid. The committee argued that the criteria for the appearance of the Moon in the Istanbul Resolution were not appropriate for Malaysia due to the difference in latitude. Following their geographical location, the resolution's provisions are suitable for application in several European countries. Observation of the sighting of the Moon child at 15 observation locations in Malaysia, review of observation reports, and study of the Moon's age criteria (8 hours) have been actively carried out.

However, observations at 15 observation sites are not the only alternative to reaching an agreement on determining the best Moon sighting criteria. Observations at Rombang Beach, Melaka, witnessed the sighting of the Moon with an extension at sunset of 4° 46', while the Moon's height was recorded at 1° 43', with the Moon's age at sunset 15 hours 39 minutes. These findings prove. The child of the Moon can be seen based on the provisions agreed in the Istanbul Resolution.

The Eight (8) Hour Criterion

In November 1978, the International Conference for Determining the Beginnings of Lunar Months was held in Istanbul, bringing together experts and representatives to establish standardized criteria for crescent visibility. A key outcome of this conference was the Istanbul Resolution, which outlined essential visibility conditions to determine when the crescent Moon could be considered visible. The resolution specified that one of the following conditions must be met: (1) the angular separation between the Sun and Moon at sunset should be at least 8°, or (2) the altitude of the crescent Moon at sunset should not be less than 5°. These conditions aimed to set a reliable baseline for determining the start of each lunar month.

Malaysia was represented at the Istanbul Conference by three prominent figures: Md. Khair Md. Taib, an expert in Islamic astronomy (ahl falak); Abdul Hamid Mohd Tahir, a professor from the University of Technology; and the Mufti of Kuala Lumpur, Mohsein Salleh. During the conference, Md. Khair Md. Taib proposed an additional requirement for determining crescent visibility: he recommended that the age of the crescent Moon should be no less than 8 hours after conjunction. This additional criterion was intended to provide further visibility assurance, ensuring the crescent had developed sufficiently to be potentially sighted.

Several pieces of evidence support Md. Khair's introduction of the 8-hour criterion:

1. Md. Khair's Written Accounts (1987). In 1987, Md. Khair documented his involvement in the Istanbul Conference and mentioned his proposal to incorporate the 8-hour age criterion into the resolution. His writings confirm that he advocated adding this criterion to refine the visibility requirements further.
2. Md. Khair's Presentation in July 1987. At an Islamic Astronomy Conference held in July 1987, Md. Khair discussed the crescent Moon's visibility from a Syariah perspective. In his address, he emphasized that the 8-hour criterion had been endorsed as one of the guiding principles by the religious council, stipulating that the crescent Moon must have been formed at least eight hours before sunset on the observation day for it to be considered.
3. Correspondence with the Director of the Muslim Centre (1983). In a letter dated May 12, 1983, addressed to the Director of the Muslim Centre in Kuala Lumpur, Md. Khair

referred to his suggestion of the 8-hour criterion as a critical addition to the Istanbul Resolution. This correspondence highlights his commitment to advocating for this criterion in official communications.

However, it is notable that Abdul Hamid Mohd Tahir, another Malaysian delegate at the Istanbul Conference, did not support the inclusion of the 8-hour criterion. Upon his return from Istanbul, Abdul Hamid gave a public talk on the Istanbul Resolution, where he only discussed the two original conditions (the 8° separation and 5° altitude criteria) without mentioning the 8-hour criterion proposed by Md. Khair. The divergence in perspective was further highlighted by Abdullah Ibrahim, the President of the Malaysian Islamic Astronomy Society, who reported that Abdul Hamid exclusively presented the two established resolutions from the Istanbul Conference, omitting the third criterion proposed by Md. Khair. This difference in views among the Malaysian representatives illustrates the initial debates surrounding the adoption of the 8-hour criterion. This aspect became a distinguishing element of Malaysia's approach to crescent visibility standards. This historical context highlights the significance of the 8-hour criterion in shaping Malaysia's criteria for lunar crescent visibility, underscoring the nuanced discussions that influenced its adoption as part of Malaysia's imkan al-ru'yah guidelines.

The Altitude 2° and Elongation 3° Criteria

Following the 1978 Istanbul Resolution, which provided foundational guidelines for determining the beginning of lunar months, further developments in crescent visibility criteria significantly influenced regional practices. These advancements were notably shaped by the need for more precise, practical criteria that could be applied consistently.

On April 5 and April 25, 1983, Malaysia's Committee for Marking Early Ramadan and Syawal reviewed and refined the criteria for determining the lunar month's start. They established that the crescent Moon could be considered visible if it met one of the following minimum conditions:

- The altitude of the crescent Moon at sunset must be at least 2° above the horizon.
- The elongation, or angular separation, between the Moon and the Sun, must be no less than 3°.

These criteria were developed to provide a practical and scientifically informed standard for determining the lunar month's start, complementing the Istanbul Resolution's original requirements. By setting the altitude to a minimum of 2°, the criteria ensured that the Moon was positioned high enough above the horizon to account for atmospheric interference, which can obstruct visibility when the crescent is too close. Additionally, the 3° elongation requirement was designed to allow for an adequate angular distance between the Moon and the Sun, increasing the likelihood of the crescent being visible at dusk.

Adopting these refined criteria provided a standardized method that balanced scientific rigour with the requirements of Islamic lunar observance. These 2° altitude and 3° elongation parameters have since become integral to Malaysia's imkan al-ru'yah framework, establishing a consistent approach applied to sight the crescent Moon for significant lunar months, such as Ramadan and Syawal.

In 1983, polemics arose in certain parts of Malaysia while applying these criteria. For instance, the states of Perak and Johor set the date of early Ramadan 1403 for June 12 1983, while the rest of the country set it for June 13. Consequently, to solve this issue, on December 14 1989, the Department of Muslim Affairs, under the Prime Minister's Office, formed a revision committee and appointed Abd Majid Abd Hamid as its Chairman. It was recognized that the existing lunar crescent visibility criteria in Malaysia could lead to discrepancies and potential disputes among the Muslim community. A dedicated committee was formed with the following tasks:

1. **Re-examining the 1978 Istanbul Resolution on Crescent Moon Visibility.** The committee undertook a comprehensive review of the 1978 Istanbul criteria, which had initially guided crescent visibility standards. However, they found these criteria unsuitable for Malaysia due to differences in geographical latitude, which affected the visibility conditions specific to the region. The committee's findings were supported by prior research, including studies from the French astronomer André Danjon (1932), who had explored limits on crescent visibility, and observational data from Turkey's Kandili Observatory. These sources highlighted the need for latitude-specific adjustments to the criteria.
2. **Collecting and Analyzing Historical Crescent Moon Sightings.** The committee gathered and reviewed records of past lunar sightings, including data from prominent Islamic astronomers such as Haron Din (1983) and Rasli Ramin (1981) and documentation from the 1987 Islamic Astronomy Conference. However, the committee found these records incomplete, indicating a need for more consistent and systematic data collection to support reliable crescent sighting standards.
3. **Conducting Systematic Observations Across Malaysia.** Due to the incomplete historical data, the committee organized systematic crescent observations in 1972. These observations were conducted by the Department of Religious Affairs (*Jabatan Agama Islam*), the Department of Survey and Mapping Malaysia, and members of the Islamic Astronomy Committee and Revision Committee. Observations were conducted at 15 locations across Malaysia from January to June 1991 to gather current sighting data. However, in six months of observations, only the Pantai Rombang site in Melaka produced visible crescent results. According to the Istanbul criteria, the crescent's altitude should have been 4° 46' at sunset, but the observed altitude was only 1° 43'. The age of the Moon at sunset on this day was 15 hours and 39 minutes, further indicating that the existing criteria did not fully match actual visibility outcomes in Malaysia.
4. **Seeking Additional Data from Indonesia**. The committee sought crescent sighting data from Indonesia, a neighboring country with similar latitude and visibility conditions to supplement their findings. Committee members visited religious departments and councils in Jakarta and Bandung, reviewing 29 reports of crescent sightings documented between 1964 and 1990. After careful examination, the committee verified and accepted 12 reports as credible, providing additional insight into regional crescent visibility.

The committee's findings underscored the need to refine Malaysia's lunar visibility criteria to reflect regional conditions better and improve lunar month determinations' accuracy and consistency. Through their extensive analysis and cross-border data collection, the committee laid a foundation for revising the crescent sighting standards to align with scientific findings and the practical realities of observing the Moon in Malaysia. From the research conducted by the revision committee during a meeting on November 4 1991, suitable criteria were proposed for application in Malaysia, along with the approval from the committee responsible for determining early Ramadan and Syawal. The requirements are as follows:

The crescent Moon is considered seen when the calculations fulfil one of the following requirements:

- During sunset:
  The altitude of the crescent Moon is not more than 2°, AND
  The elongation of the moon-sun is not more than 3°.
- During moonset:
  The age of the Moon is not less than 8 hours.

Challenges faced in observing the Moon include light pollution that affects the brightness of the night sky (generally, the appearance of celestial bodies is determined by the brightness of the object of observation compared to the brightness of the sky) at the time of its appearance, new moons, and meteorological factors such as weather.

The determination of the beginning of the month of Ramadan is not only based on observing the Moon but also supported by other methods such as calculation (calculation), witnessing (which is undoubted), and practising traditional tips. Without raising any technique to dominate the determination of the beginning of the Islamic month, this diversity can be considered as "triangulation" in qualitative research. Each has its advantages and disadvantages, balancing each other.

Malaysia and the New Criteria

Experts in Shariah, astronomy, and Islamic authorities have met in MABIMS countries since 2016 to discuss moon sightings and the Islamic calendar. In 2019, based on a thorough analysis of Moon sighting data within the countries, they agreed to use a new criterion based on analyzing Moon sighting data within the country. This new imkan al-rupiah criterion requires the Moon's altitude be at least 3 degrees and the sun-moon elongation to be at least 6.4 degrees at sunset on the 29th day of the Hijri month. Since 2021, MABIMS countries have used this new criterion [2].

The support of the state's Department of Islamic Religion and the joint efforts of astronomers, religious scholars, and mathematicians are important to increase the need to establish new criteria. Malaysia has implemented the Hilal apparition rule (by MABIMS) since Muharram 1443. Malaysia, which practices the rukyah (crescent moon sighting) and hisab (star counting) methods, refers to the condition for the appearance of the Moon (imkanur rukyah) to compile the Hijrah calendar - meaning that we practice calculations but still want to know the position of the Moon; which is the data researched on 29 Ramadan

(May 1, 2022). The Child of the Moon is considered invisible if it does not meet the new requirements at sunset; the next day is completed as the 30th day of Ramadan.

The NEO MABIMS initiative emerged to address the inconsistencies in lunar crescent visibility practices among Malaysia, Brunei, Indonesia, and Singapore. This framework emphasizes the integration of scientific principles into traditional moon-sighting practices. NEO MABIMS provides standardized guidelines for determining crescent visibility, incorporating criteria such as the Moon’s elongation, altitude, and the observer's location. It encourages using astronomical software and calculations to accurately predict crescent visibility accurately, thus reducing reliance on subjective visual observations [10]. By doing so, NEO MABIMS enhances the reliability and consistency of moon sightings across member countries, promoting unity in the Islamic calendar.

The adoption of NEO MABIMS has led to a significant cultural shift in how lunar crescent sightings are approached in Malaysia. While traditional practices remain valued, scientific methods are increasingly accepted among communities. This dual approach facilitates more accurate determination of the Islamic months and strengthens community ties through organized, collaborative Moon sighting efforts [11].

The criteria for lunar crescent visibility in Malaysia have evolved from traditional observational practices to a more scientifically informed approach through initiatives like NEO MABIMS. This evolution reflects a broader trend of integrating modern scientific understanding with cultural and religious practices. As Malaysia continues to navigate these changes, the interplay between tradition and science will shape the future of lunar crescent visibility criteria, ensuring the timely observance of important Islamic dates.

IV. Conclusion

The review and analysis of Malaysia's lunar crescent visibility criteria underscore the complexities and regional challenges in determining the start of Islamic lunar months. The committee's findings indicate that the 1978 Istanbul Resolution, while foundational, was not directly applicable to Malaysia due to its unique geographical latitude and visibility conditions. Supported by insights from both local observations and international data, including studies from astronomers like André Danjon and sighting records from Indonesia, the committee found that modifications were necessary to create a more accurate and consistent standard.

The historical records and recent observations highlighted gaps in data that hindered reliable crescent visibility predictions. Through extensive observational efforts, the committee gathered new data from multiple sites across Malaysia, though successful sightings were limited, emphasizing the need for locally adapted criteria. Collaborative efforts with Indonesia also provided valuable comparative insights that reinforced the regional distinctions affecting lunar visibility.

This investigation reaffirms the importance of adapting lunar sighting criteria to local conditions, balancing scientific precision with the practical requirements of religious observance. The findings support the need for ongoing research and regional data collection to refine these criteria further, ensuring that they meet both astronomical and religious standards for crescent sightings in Malaysia.

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