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THE USE OF RADIO TELESCOPES TO OBSERVE THE NEW LUNAR CRESCENT IN MALAYSIA

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ABSTRACT

The moon, or "luna" in Latin, holds significant cultural and religious importance, serving as a natural calendar for various societies throughout history. In Islam, the new moon, specifically the first visible crescent, plays a crucial role in determining important events like Ramadan, Eid al-Fitr, and pilgrimage. However, traditional methods of moon sighting face challenges such as cloudy weather conditions and rain. This study aims to explore the potential use of radio telescopes as an alternative tool for hilal observation in Malaysia. For that, a qualitative method has been used, which involves interviewing experts, doing library research, comparing optical and radio telescopes through the lens of science, and then analysing from a syariah perspective. The study found that radio telescopes cannot be used as the main method in hilal observation. This is due to three main reasons preventing the use of radio telescopes in Malaysia: wavelength disparities, challenges in interpreting radio telescope data, and influential fatwa decisions favouring optical instruments. Even though radio telescopes are not permitted to be used as the primary method for determining the hilal, they can still be used as support data, enhance the precision of hilal observation, and aid in improving the accurate calculation and criteria for the determination of the beginning of Islamic lunar months. Therefore, further discussion and research to enhance the accuracy of hilal observation by using a radio telescope need to be developed.

Keywords: *New lunar crescent, hilal, radio telescope, observation, Islamic astronomy*

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Introduction

The moon, or in Latin, luna, is the biggest and closest celestial body to earth. It is the only natural satellite earth has. It also has been recognised from prehistoric times to be the brightest object in the sky after the sun (Burke, 2023). Humans have used the moon as a calendar for thousands of years by observing one full moon to the next full moon, as the time it takes is about the same (Choi, 2023). In detail, the moon has eight phases in total consisting of four primary phases (new moon, first quarter, full moon, last quarter) and four intermediate phases (waxing crescent, waxing gibbous, waning gibbous, and waning crescent) (Buckle & Jones, n.d.). But in Islam, there is one most vital phase of the moon that is used to perform worship, which is the new moon.

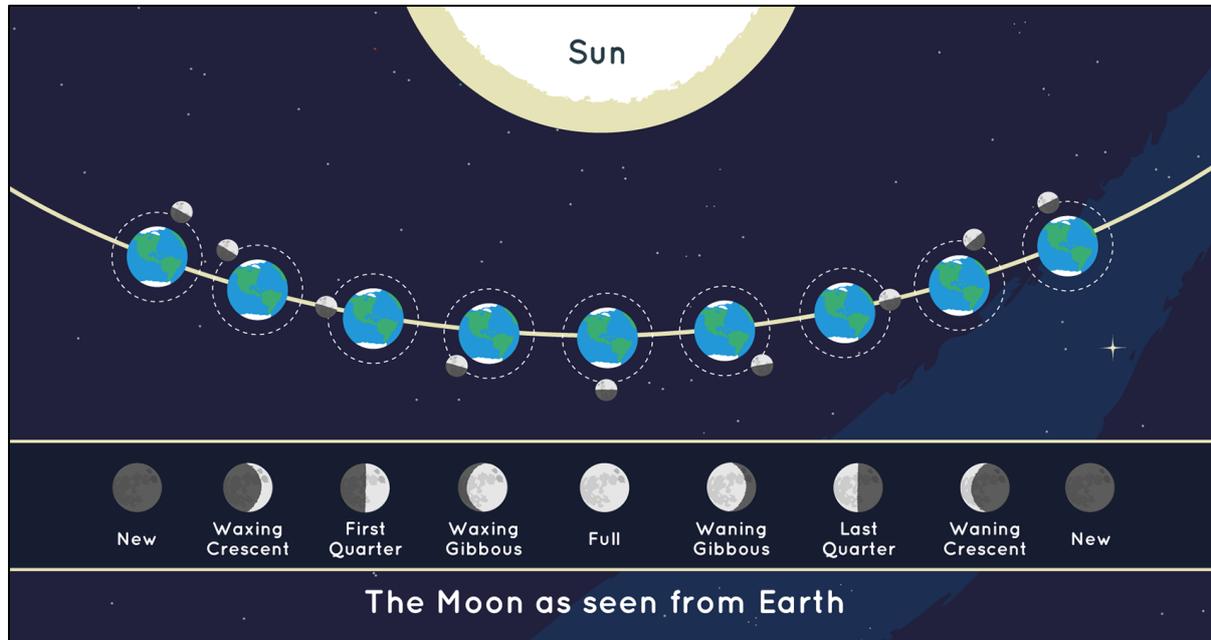


Figure 1. The Moon as Seen from The Earth

This figure illustrates the positions of the moon and sun throughout each of the moon's phases, along with the moon as seen from earth during each phase. The new moon is astronomically invisible due to the illuminated side of the moon facing the sun and the dark side facing the earth. In this phase, the moon rises and sets about the same as the sun. From the earth perspective, the moon looks passing near the sun but not exactly passing between sun and earth because the moon's orbit inclination (NASA, n.d.). If these three objects (sun, and moon and earth) in a straight line, solar eclipse will occur. However, Muslims has differentiated between new moon and Islamic new moon (hilal) due to religious obligation (Shariff et al., 2017). To be precise in terms of terminology, the Islamic new moon is the first visible crescent moon. But in the context of this article, the term new moon shall be employed to denote the Islamic new moon for the sake of simplicity and clarity.

In general, Islamic new moon can be defined as the first visible crescent moon that appears after the conjunction or is likely to be visible after the sunset (Wahid et al., 2019). This phase of the moon is important to Muslims, as they use it to perform worship. They used it to determine the beginning of the month of Ramadan for fasting, Shawwal for Eid al-Fitr and Dhul Hijjah for pilgrimage. This lunar-based calendar or also known as the Hijri calendar, is not just used by Malaysia but also by all Islamic countries around the world, such as Saudi Arabia, Iraq, and Indonesia (Muztaba et al., 2023). So, it is now not only a national issue to find an accurate lunar calendar but a global issue.

To determine the beginning of the Islamic months of the Hijri calendar, one needs to observe the new moon, also known as hilal in Arabic. But this is not easy work to do as there are many challenges like weather, clouds, atmosphere, the hilal being too tiny, and more. Many scientific methods and criteria have been explored just to identify the exact time of the first visible lunar crescent, but no one finds the absolute solution. There are at least fourteen lunar crescent visibility criteria in the modern era, but each of these criteria is different from one another, and sometimes the reports of visibility contradict each other (Faid et al., 2023). Hence, a concrete solution must be found.

In this article, the author attempts to see the reasons Malaysia does not use alternative methods to observe the new moon, which are by using the radio telescopes to counter and overcome the clouds when using the optical telescopes or to add more data to reduce the uncertainty of the calculation or *hisab* method. In order to achieve this, the discussion in this study is divided into 4 main sections. The first section discusses the concept of radio telescopes, while the second discusses the difference between radio and optical telescopes. The third section discusses the syariah perspective on new lunar crescent sighting based on the views of the fuqaha. The last section discusses the reasoning behind why Malaysia may not extensively use radio telescopes on the hilal observation.

Problem Statement

Malaysia is a prominent and advance country in the development of falak industry. Numerous studies have been explored and many universities courses have been lectured on the various topic related to Islamic calendar, the determination of prayer times, qiblah directions and the beginning of lunar month. This effort has been done initially by Haji Mohd Khai in National University of Malaysia (UKM) and then continued by University of Malaya (UM), University of Science Malaysia (USM) and University Sultan Zainal Abidin (UniSZA), University of Technology Malaysia (UTM) (Man et al., 2012).

Among the studies that are being actively conducted now is related to the visibility of the new moon. One of the famous research projects on this matter is Ahmad et al. (2022) that analyze 22 years observation data of the new moon at Telok Kemang Observatory. In this study they come out with suggestion of the need to change the value of the visibility of Imkanur Rukyah criteria 1995 to a more potentially observable criterion. This is due to the study found that none of the data or images of the young crescent moon was recorded or observed at the minimum criteria of Imkanur Rukyah 1995 (moon's altitude is not less than 2° , and the elongation of the moon-sun is not less than 3° at sunset). In addition, this work has been successfully detected through a digital camera only with the smallest elongation, $e = 6.81^\circ$ and the moon's altitude, $a_m = 3.37^\circ$ when the sun was below the horizon of 2.64° (Ahmad et al., 2022).

In year 2023, we can see that many analyses are be done by using new technology such as python programming language and machine learning. For instance, Faid et al. (2023) that use phyton to create HilalPy software. This programme is a tool for comparing the lunar crescent criteria. This software comes with database ranging from Babylonian, Medieval eras, and modern eras.

In Malaysia, there is an issue related to the visibility of the new moon that happened on Eid al-Fitr 2022. Many people at that time were surprised by the announcement of Eid that early than the time in the calendar. As reported by Utusan Malaysia, The Keeper of the Rulers Seal, Tan Sri Syed Danial Syed Ahmad announced that Hari Raya Aidilfitri will be celebrated by Muslims in Malaysia tomorrow 2 May 2022 (Utusan Malaysia, 2022). Meanwhile, in the calendar, the Eid should be on May 3rd. This is due to the people at Labuan saw the hilal even though the criteria of Imkanur Rukyah not fulfilled. In 2022 Eid data, the moon altitude was $5^\circ 27'$ and elongation of moon-sun was $5^\circ 57'$. This is contradicted to the criteria of Imkanur Rukyah 2021 which is moon altitude more than 3° and elongation more than 6.4° . Even though, the data not fit the criteria it still can be seen. As published by Kosmo, there were 30 people seen the hilal at 6.38 pm, which is 10 minutes after sunset and the period lasted for seven minutes with all the witnesses being satisfied (Ahmad, 2023).

This accident is really shocked as the Kriteria Imkanur Rukyah (KIR) 2021 has not been fulfilled but people at Labuan can see the hilal. After just 1 year KIR 2021 has been used officially, the prediction was not precise. This means that the criteria are still immature, unripe and imperfect. After many years of observation and many summit and discussion was held, the researchers are still cannot find the perfect criteria to predict the first sightable crescent moon.

As the Muzakarah Rukyah Dan Takwim Islam unanimously chose Odeh (2004) criteria which is Danjon Limit 6.4° , it is weird and impossible for hilal Syawal 2022 can be seen. To make it more interesting, Malaysia with their KIR 2013 which had been researched more than 20 years had chosen elongation of 5° before this, which is seen to be more precise and relevant at the present time.

This accident also shows the researchers that they actually still do not have enough data to make a good model and formula to predict lunar crescent visibility. As the data and current models are not precise,

researchers must evaluate the criteria back. If this thing happens again, it will make folk doubt the authority and knowledge. Due to the above problems, the author sees radio telescopes as an alternative to observing the hilal and collecting more data on it, as they can penetrate clouds and other atmosphere-related problems.

Literature Review

There are many methods, techniques, and instruments that have been used for moonsighting, and this activity is not a new thing people do. When we look back into history, this activity of moonsighting can be traced back to the age of Babylon around 568 BCE to 74 BCE (Fatoohi et al., 1999, 52). The enhancement and improvement of moonsighting to see the first visible crescent moon have been developed since then.

At the time of the Prophet, there was no technology like telescopes or cameras. They basically use the naked eye to see the hilal (Niri et al., 2012). After a long time of the Prophet period, another method was introduced, like the reflection of light through the surface of glass (lens) or water. These kinds of methods using specific instruments have sparked debate among scholars. Some scholars, like Ibn Hajar, do not accept this method. Meanwhile, many other scholars accept it, such as Yusuf al-Qaradawi, Abd al-Karim Zaydan, al-Muti'i, and 'Abd al-Hamid al-Syarwani (Nizam et al., 2014). In Malaysia, the second opinion is applied as the use of telescopes can help witness the moon.

According to Wahid et al. (2019), based on data collected by the Islamic Crescents' Observation Project (ICOP), there are at least six techniques used in moon sighting. Among them are 1) the naked eye, 2) observation of the moon using optical assistance (binoculars and telescopes), 3) observation of the moon performed during the day, 4) normal imaging (contrast and brightness editing), as well as 5) Charged Coupled Device (CCD) imaging, and finally, 6) Circular Hough Transform (CHT). Another method that is used for lunar crescent sighting but does not have data from ICOP is the radio telescope. This is weird because the radio telescope does not have any data with its ability to observe in cloudy day, which shows us that not many researchers explore this type of equipment.

One of the first attempt to observe the new moon using the radio telescope was made by Hafez et al. (2014). In the paper titled A Radio Determination Of The Time Of The New Moon, they compare the relative brightness of the moon and the Sun. This approach allows for greater visibility of the new moon relative to the sun and, as a result, allows us to detect the moon far closer to the sun than optical observation permits. In theory, this might shift the start of the lunar calendar month by up to one day. From this research, we can conclude that radio telescopes can be one of techniques for observing the new moon.

Another paper that talks about radio telescopes in determining the new moon is Umar et al. (2017). In their research, they looked at aspects of syariah. They found that radio telescopes in terms of syariah can be used to see the new moon, which would benefit the Islamic community rather than relying on optical telescopes individually. They made a comparison between a radio and an optical telescope. Then, come up with related Quranic passages, hadith, fatwas, and exegesis. But no data is presented clearly on the accuracy or what the image looks like, as in terms of the syariah perspective, the hilal must be seen in the range of the visible light spectrum, but this paper does not detail that.

In Malaysia, the primary method that has been used now is a combination of *hisab* and *rukayah* methods, which has been called Imkanur Rukyah (Ahmad et al., 2022). Actually, the criteria in Malaysia have changed for several times. According to Nawawi et al. (2015), the application of this method in Malaysia is believed to start from Istanbul Conference in 1978 with the altitude of the moon being more than 5° and the elongation of the moon-sun being more than 8° . But Malaysia added one more criterion which is age of moon 8 hours. Then, it changes to moon altitude more than 2° and elongation more than 3° or moon age more than 8 hours in 1995 (Nawawi et al., 2015). And now, the latest criteria are moon altitude more than 3° and elongation more than 6.4° (Izzatulnajah, 2022).

In recent years, we have seen many papers published on hisab methods. Year by year, the calculation (*hisab*) becomes more complex. Many use coding techniques like machine learning and python to

calculate the probability of hilal visibility. One of them is Al-Rajab et al. (2023). They use machine learning algorithms to help predict the visibility of the new crescent moon. Another example is Utama et al. (2023) that use video data with combinations of computer vision techniques. Muztaba et al. (2023) develop an automated moon detection system with deep learning integrated with the robotic telescope OZT-ALTS with an infrared camera. Meanwhile, Faid et al. (2023) developed an analysis tool for hilal in the form of a Python library named HilalPy with an integrated lunar crescent database.

However, according to Faid et al. (2023) study, a pilot investigation discovered that at least six data sets of lunar crescent visibility reports contradict each other when recalculated using the Skyfield library, with a maximum contradiction of $2^{\circ}05'$. This means that even with complex and sophisticated calculations, they can still be inconsistency. Due to this inconsistency, radio telescopes can be seen as an alternative tool to observing the hilal and collecting more data on it, as they can be observed on a cloudy day.

Methodology

Radio telescopes are something new, and not many studies about them related to hilal observation have been done. It needs depth and vast knowledge of both syariah and science to do research on it. Hence, this research adopts a qualitative methodology to investigate the compatibility of optical and radio telescopes from both scientific and syariah perspectives. Qualitative methods are chosen for their capacity to provide in-depth insights and understanding, particularly in exploring complex topics such as the intersection of science and religious principles. Firstly, data from the interview and library research were collected. In-depth interviews have been conducted with experts in the fields of astronomy, and Islamic studies. These experts were chosen based on their profound knowledge in the respective areas to gather comprehensive insights into the scientific and syariah aspects of telescopes. At the same time, a comprehensive review of relevant literature, including academic journals, books, and research papers, has been conducted. This step seeks to offer a thorough understanding of the technical characteristics of optical and radio telescopes, as well as existing scientific viewpoints on their use.

Next, second phase of research was doing data analysis. Optical and radio telescopes are systematically compared in terms of their technical specifications, capabilities, and applications. This comparative analysis serves as the foundation for evaluating their compatibility with scientific principles. Then, an analysis from the syariah perspective has been done, with a focus on principles outlined in Islamic law and evidence from Al-Quran and hadith. The evaluation includes considerations such as the permissibility of astronomical observations and the alignment of telescope usage with Islamic fatwas and opinions. Last but not least, the findings from the science and syariah analyses are then integrated to draw conclusions regarding the usability of radio telescopes with both scientific principles and Islamic points of view. This integration aims to provide a holistic understanding of the topic and come up with suggestions for what can be done next. However, it is important to acknowledge the limitations of this study. The qualitative nature of the research may have potential researcher bias, and the findings are context dependent. Additionally, interpretations of syariah principles may vary, and this study reflects a specific interpretation based on the perspectives obtained from the selected experts.

Findings and Discussion

Radio Telescope

Radio telescope is a combination of two words: radio and telescope. Radio is basically one of electromagnetic wave consisting of radio waves, infrared radiation, visible light, ultraviolet radiation, X-rays, and gamma rays. This kind of wave does not need a medium like water or sound to move (Mohyedin, 2020). It can travel in vacuum. The wavelengths of radio waves can range from thousands of metres to 30 cm, equivalent to frequencies as low as 3 Hz and as high as 1 gigahertz (10^9 Hz) (Britannica, 2023). Meanwhile, a telescope is a tool that is used by astronomers to see far objects like stars and galaxies. This device is used to magnify images of distant objects by collecting radiation from celestial objects (Kellermann & Klock, 2023). Usually associated with the visible light spectrum of electromagnetic radiation. Ranging from 380 to 700 nanometres (National Aeronautics and Space

Administration, 2010). A combination of these two words makes radio telescopes, a telescope that collects radio wave electromagnetic radiation to see faraway objects.

Radio telescopes operate slightly different from usual telescopes. This telescope operates by measuring the intensity of the radiation received from the sky objects (Findlay, 1964). According to the Australia Telescope National Facility (n.d), a radio telescope consists of three basic components: 1) antennas to collect the radio waves; 2) a receiver and amplifier to improve the weak radio signal to a measurable level; and 3) a recorder to keep a record of the signal data.

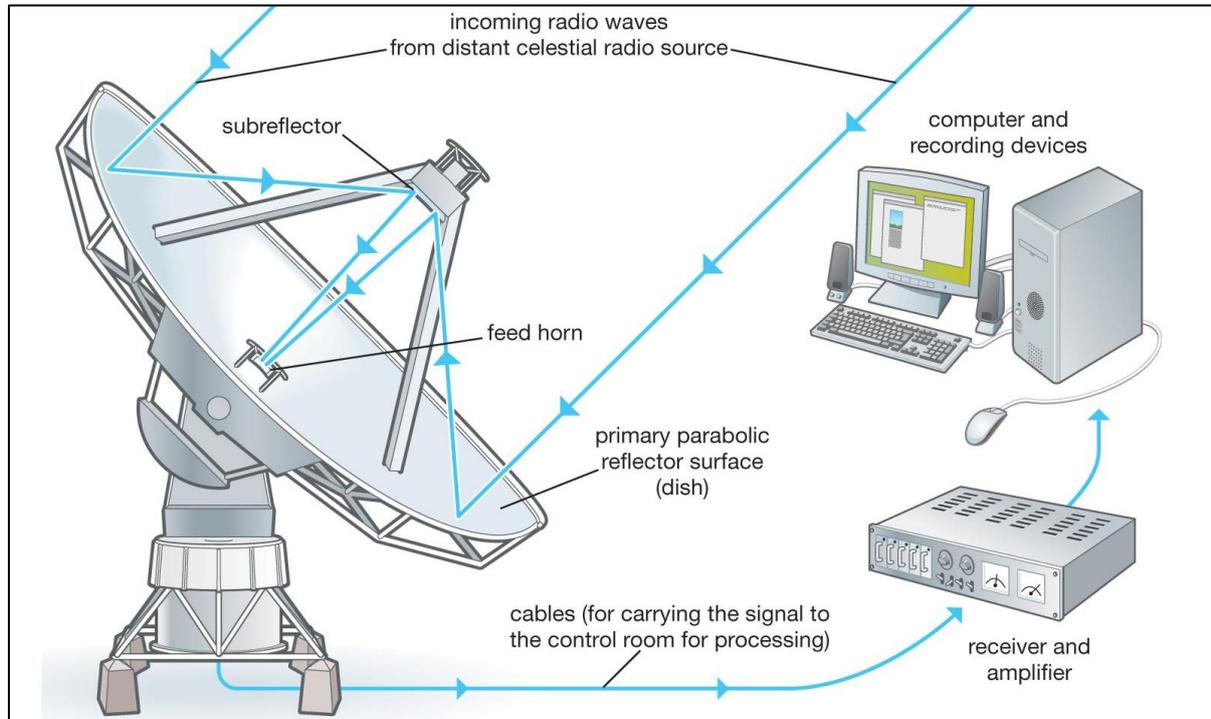


Figure 2. Basic Radio Telescope System

This figure illustrates how radio wave data travels from the antenna, gets amplified, and then gets recorded. In Malaysia, radio astronomy has rapidly grown. This thanks to the efforts of two graduates, Abdul Halim Abdul Aziz and Zamri Zainal Abidin, who studied at the University of Manchester's Jodrell Bank Centre of Astrophysics. They started the Radio Cosmology Research Lab (RCRL) in 2005 at the University of Malaya, where they focus on studying things like dark matter and galaxy dynamics. The RCRL has trained many students, and their success led to the creation of similar radio astronomy groups in other Malaysian universities. They achieved a major milestone by building the UPSI-UM Radio Astronomical Observatory, Malaysia's first radio telescope observatory, which is now being tested with telescopes in China and Japan. The RCRL is also planning a bigger observatory in collaboration with the Shanghai Astronomical Observatory. In 2019, agreements were signed with the East Asian Observatory (EAO), allowing Malaysian astronomers access to global collaborations and facilities like the James Clerk Maxwell Telescope. These efforts show Malaysia's growing role in the world of radio astronomy. (Abidin et al., 2020, 1116)

The Distinction Between Radio and Optical Telescopes

In Malaysia nowadays, many state observatories use optical telescopes attached to DSLR cameras for hilal observation. For example, Telok Kemang Observatory in Negeri Sembilan has been using a DSLR camera attached to a telescope since June 2006 (Ahmad et al., 2022, 3416). The use of this equipment is good compared to using naked eyes only because of the limitations of the eyes to see something tiny, far, and dim, like a hilal. The combination of a DSLR camera and telescope really boosts the visibility of hilal at Telok Kemang Observatory. This can be seen with the increase in visibility of hilal on the 29th of Hijri, from zero visibility using naked eyes to 7 visibilities of hilal when using a telescope attached to a digital camera (Ahmad et al., 2022, 3421). However, there is a major difference and distinction between a radio telescope and an optical telescope, which is the wavelength that it receives.

This will affect the outcome of the images and affect the visibility on a cloudy day. In this section, we will see the differences between these two in detail.

The distinction between radio and optical telescopes can be divided into 11 significant differences. These encompass the wavelength range, observational targets, atmospheric interference, observation time, penetration of dust and gas, amplification technology, resolution, observational challenges, cost, tracking moving objects, and mapping large areas. Table 1 shows 11 major differences between radio and optical telescopes in depth comprehensively. From this table, we can conclude that dissimilarities exist between radio and optical telescopes. Moreover, the distinctions also serve as a foundation for understanding why radio telescopes have not been extensively employed in hilal observation in comparison to optical telescopes, which will be elucidated further in subsequent sections.

Table 1. 11 Key Distinctions Between Radio and Optical Telescopes

Feature	Radio Telescopes	Optical Telescopes
Wavelength Range	Operate in the radio frequency range	Operate in the visible light spectrum
Observational Targets	Studying radio sources like galaxies, quasars, pulsars, and cosmic microwave background radiation	Studying visible light emitted by stars, galaxies, nebulae, and other celestial objects
Atmospheric Interference	Less affected by earth's atmosphere	Atmospheric conditions can impact observations, especially during cloudy or turbulent weather
Observation Time	Can observe day and night, not affected by sunlight	Generally, observe during the night due to interference from sunlight during the day
Penetration of Dust and Gas	Can penetrate dust and gas clouds, allowing observations of regions where optical light is obscured	Limited penetration of dust and gas, making it challenging to observe certain regions obscured by interstellar material
Amplification Technology	Use amplifiers to enhance weak signals	Use detectors such as photomultiplier tubes or charge-coupled devices (CCDs) to capture and amplify optical signals
Resolution	Generally lower resolution compared to optical telescopes	Higher resolution for fine details in optical images
Observational Challenges	Less affected by light pollution	Susceptible to light pollution from artificial sources at night
Cost	Can be cost-effective for large-scale arrays	Cost can vary, but large optical telescopes can be expensive to build and maintain
Tracking Moving Objects	Well-suited for tracking the motion of celestial objects, such as planets or radio-emitting sources	Effective for tracking the apparent motion of celestial objects, but rapid movement may present challenges
Mapping Large Areas	Well-suited for mapping large areas of the sky quickly	Suitable for detailed imaging of smaller areas with higher resolution

Syariah Perspective on The New Lunar Crescent Sighting

In Islam, moonsighting is very important because it is related to worship, as Islam uses the Hijri calendar. This consists of many things, especially fasting in Ramadan, Eid al-Fitr in Shawwal, and pilgrimage in Dhul Hijjah. It is also related to determining the validity of the child's lineage, the determination of Eid al-Adha and iddah for women. According to Putra & Rahmawati the term hilal appears in various passages of the Quran, but only in al-Baqarah Juz 2 verse 189 discusses the signs of the new moon in detail (Putra & Rahmawati, 2023, 356).

Translation: They ask you (O Prophet) about the phases of the moon. Say, “They are a means for people to determine time and pilgrimage.” Righteousness is not in entering your houses from the back doors. Rather, righteousness is to be mindful (of Allah). So, enter your homes through their (proper) doors, and be mindful of Allah so you may be successful.

(Surah Al-Baqarah, 2:189)

Al-Tabari in explaining this verse said that the *asbab nuzul* of this verse is due to the question of companion. Abu Ja'far said: It has been mentioned that the Messenger of Allah (peace be upon him) was asked about the increase and decrease of the crescent (moon) and its different states. So, Allah the Almighty revealed this verse as an answer to their inquiry about it (Al-Tabari, n.d.). According to Al-Baghawi, this verse was revealed regarding the companions Mu'adh bin Jabal and Tha'labah bin Ghanm, the Ansar. They say, "Why does the new moon look small like a thread, then it becomes bigger, so it is round (like a full moon), then gets smaller and smaller and shrinks back to its original state?" (Al-Baghawi, 1997).

Al-Maraghi, in his tafsir, explained in detail the words Al-Ahila and Mawaqit. He said that Al-Ahila is the plural of Hilal. It refers to the crescent moon, which is the moon on the first two or three nights at the beginning of the month. This is because people raise their voices in remembrance upon seeing it. Meanwhile, Mawaqit is the plural of Miqat. It refers to the appointed times, and it is what is known as the designated time, which is the specific and determined time (Al-Maraghi, 1946). From this verse, we can see that this revelation from Allah on the new moon is an indicator for determining prayer times, fasting, and pilgrimage or as a pillar of Islam itself (Putra & Rahmawati, 2023, 357). This also means that sighting moon is something very important in syariah.

Another important *dalil* on the moonsighting is from hadith. According to Nizam et al. (2014, 66), there are 3 main hadith that significant as the base of hilal observation among scholars.

First hadith reported by Abu Hurairah:

Translation: Start fasting on seeing the crescent (of Ramadan) and give up fasting on seeing the crescent (of Shawwal), and if the sky is overcast (and you cannot see it), complete thirty days of Sha'ban.

(Al-Bukhari. Sahih al-Bukhari, Hadith No. 1909)

Second hadith narrated Ibn `Umar:

Translation: We are an illiterate nation; we neither write, nor know accounts. The month is like this and this, i.e., sometimes of 29 days and sometimes of thirty days.

(Al-Bukhari. Sahih al-Bukhari, Hadith No. 1913)

Third hadith narrated by `Abdullah bin `Umar:

Translation: Do not fast unless you see the crescent (of Ramadan), and do not give up fasting till you see the crescent (of Shawwal), but if the sky is overcast (if you cannot see it), then act on estimation (i.e., count Sha'ban as 30 days).

(Al-Bukhari. Sahih al-Bukhari, Hadith No. 1906)

In the book *Fiqh al-Siyam*, al-Allamah al-Syeikh Dr. Yusuf al-Qaradawi draws conclusions from the aforementioned hadiths, outlining three different approaches to determining the start of the Hijri month. These methods are as follows: (1) the *rukayah* method, which involves visual observation of the crescent moon; (2) the *istikmal* method, which is used when the crescent moon remains unseen and the lunar month is thus considered complete in 30 days; and (3) the calculation method (*hisab*), which involves the use of astronomical calculations (Al-Qaradawi, 1993).

There are two prominent issues debated among scholars in relation to these methods. First, there is a question of whether *rukayah*, or crescent moon observation, can be done using instruments such as a telescope. Second, there is a disagreement among scholars over the permissibility of the calculation method (*hisab*).

Answering the first question on the use of telescopes, 'Abd al-Karim Zaydan said that the obligation to perform the fasting worship is based on the new moon observation. The mandatory requirement for fasting is further reinforced by physically sighting the new moon with the naked eye. However, it is not prohibited to use optical instruments such as telescopes and cameras to observe the new moon (Nizam et al., 2014).

To answer the second question on the use of the calculation method (*hisab*) to determine the new moon, Ahmad Syakir says in his book *Awa'il Syuhūr al-'Arabiyyah* that the reason for the *rukyaḥ* of the moon was because the Muslims at that time were illiterate. They were unable to read or write at that time. However, now the reason for *rukyaḥ* has been replaced by the calculation method (*hisab*). This is due to this era; the advancement of science and technology has developed rapidly, causing a shift in the *wasilah* or method used. With this change in method of observing, the new method can provide *rukhsah* or facilities to the observers to perform *rukyaḥ* activities easily, especially when done during cloudy weather (Nizam et al., 2014).

During the 14th Fatwa Committee Conference of the National Council for Islamic Religious Affairs of Malaysia (MKI Muzakarah Committee) on July 14, 1977, the conference has discussed on the conviction of hilal Ramadan and Shawwal. They concluded that, if hilal Ramadan and Shawwal cannot be visible due to covered by clouds (*ghaim*) but according to the calculations (*hisab*) of the syarie astronomers the moon is still there and can be seen, so the calculation (*hisab*) of the syarie astronomers can be used. But if the weather is good and the new moon is not visible then the number of days of the month should be completed by 30 days (Jawatankuasa Muzakarah MKI, 1977). From this fatwa we can conclude that the use of calculation method (*hisab*) is permissible in syariah.

In conclusion, it is permissible to use calculation methods (*hisab*) and tools like a telescope for hilal sighting in syariah. But is a radio telescope permissible, as there are a lot of differences between them, as we listed in the comparison section above?

Reasoning Behind Why Malaysia Not Extensively Use Radio Telescopes on The Hilal Observation

Falak, or astronomy, has been actively discussed in Malaysia nowadays. Numerous studies have been proposed related to hilal observation to determine the accurate beginning of the month. But the inaccuracy still happened. To increase accuracy, one study by Roslan Umar et al., (2017) proposed the use of radio telescopes. However, no follow-up research has been done on this particular tool and technique. As mentioned in Table 1 before, some of the advantages of a radio telescope compared to an optical one is that it can penetrate clouds and is less affected by light pollution or the earth's atmosphere. These features of radio telescope can solve the lack of data on cloudy days. Even so, it has not been used widely. This section will discuss in detail why this happens.

1) Wavelength disparities

First and foremost, one of the most significant reasons radio telescopes have not been used is due to the different wavelengths they observe (Umar, 2023). Compared to optical telescopes that detect the visible light wavelength, radio telescopes detect the radio wavelength. This is absolutely contradictory to the hadith, which states that the hilal observation is by seeing the crescent. When hadith uses the word seeing, it indicates something that can be seen with the eyes. In terms of science, something that ranges in the visible light wavelength is something that can be observed with the eyes. So, the use of any tools in the range of visible light is still permissible, such as an optical telescope. But the radio telescope is out of that wavelength, making it invisible to the eyes.

This is in line with what has been said by Mohd Saiful Anwar Mohd Nawawi in the forum *Pencerapan Anak Bulan di Malaysia: Menjalin Tradisi & Inovasi*. He said when presenting the paper of *Pengimejan, anak bulan dari perspektif syariah dan astronomi*, that whatever tools and techniques are used, they must be in the range of the visible spectrum, which is 400–700 nanometres. And if the tools and techniques are out of this range, they are not permissible to use. This is due to hadith *صوموا لرؤيته*, meaning fasting when you see it, not because the moon is there but because you see it (Nawawi, 2023). So, it is obvious that any spectrums other than visible light cannot be employed for hilal observation because it cannot be seen with the eyes. As a result, radio telescopes cannot be used seeing hilal.

2) Challenges in interpreting radio telescope data

The second reason the radio telescope has not been used to observe hilal is because the data or image from the radio telescope is not suitable for analysis corresponding to hadith seeing hilal. As we know, radio telescopes collect the radio wavelength in the form of intensity. So, the image will be translated or depicted as a whole moon, just like a full moon, not a crescent moon in hadith.

The image below presents a comparative view captured by both a radio telescope and an optical telescope.

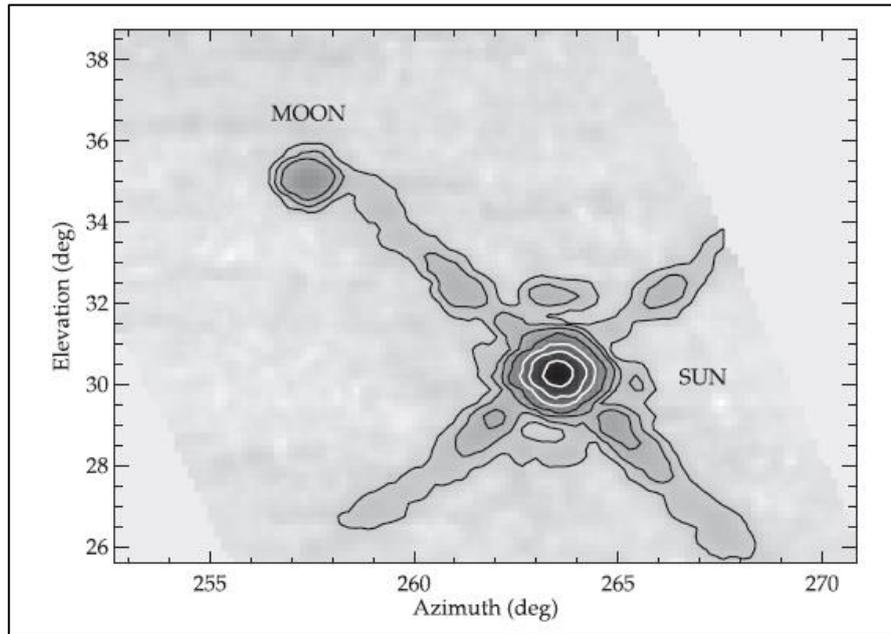


Figure 3. New Moon and Sun Through Radio Telescopes

This figure displays a captured image of the moon and sun through the utilization of a radio telescope.

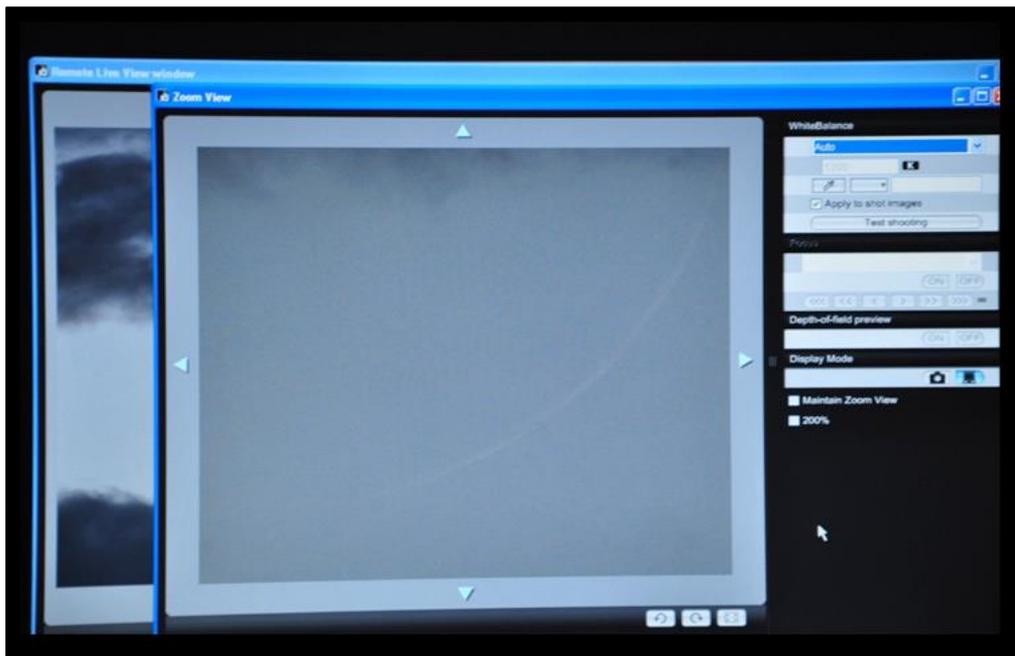


Figure 4. New Moon Through Optical Telescope

This image depicts the New Moon as observed through an optical telescope attached to a DSLR camera and displayed on a computer screen. From this comparison between images captured by radio and optical telescopes, it is clear that it is hard and challenging to analyse the Islamic new moon through the radio data as it fails to depict the crescent moon as described in the hadith, which is it looks like a small thread. Hence, not many researchers go into depth in this area.

3) Influential fatwa decisions favouring optical instruments

Another contributing factor explaining the negligible use of radio telescopes is the issuance of fatwas (Umar, 2023). These states fatwa may have discouraged the use of radio telescopes in certain contexts, potentially influencing the approach taken by researchers or practitioners in this field. When we see the fatwa from Selangor decided on 18 Mei 2021 (Jawatankuasa Fatwa Negeri Selangor, 2021), it states that:

- i. The law of seeing the moon through the naked eye with the help of optical equipment is permissible
- ii. The sighting of the moon using imaging techniques is required with the parameters set by JAKIM through the Guidelines/Procedures for the Conviction of the Sighting of the Moon through Imaging Techniques.
- iii. The appearance of the moon must meet the criteria of Imkanur Rukyah.

The same fatwa decision can also be seen in Perak in Irsyad Hukum (Panduan Hukum) Bil. 9. (Jawatankuasa Fatwa Negeri Perak, 2022). From these fatwas, we can see that they highlight and focus specifically on the use of optical and Imkanur Rukyah criteria. Because of that, we can see that many researchers and studies today revolve around improving the method of calculation (*hisab*) and enhancing the optical tools. This also might be more align with fatwa and will give more benefits to society (Mamat et al., 2025; Alias et al., 2024). Therefore, it can be concluded that the issuance of fatwas in this matter has a significant influence on the research landscape concerning radio telescopes, leading to a limited exploration of this area.

Even though radio telescopes are not permitted to be used as the primary method for determining the hilal, they can still be used as support data, enhance the precision of hilal observation, and aid in improving the accurate calculation (*hisab*) and criteria of the Islamic lunar months (Umar, 2023). Therefore, further discussion and research to enhance the accuracy need to be developed.

Conclusion

In conclusion, the observation of the new lunar crescent holds immense significance for Muslims worldwide, particularly in determining crucial events such as the start of Ramadan, Eid al-Fitr, and pilgrimage. Despite advancements in *hisab* methods using machine learning and computer vision, challenges and inconsistencies persist in predicting the visibility of the new crescent moon accurately. While traditional methods, including visual sightings and optical telescopes, have been employed widely, this article explored why radio telescopes are not used for hilal observation, especially in Malaysia, even though they can penetrate clouds. There are three reasons behind Malaysia's limited exploration of radio telescopes for hilal observation which is wavelength disparities, challenges in interpreting radio telescope data, and the influential fatwa decisions favouring optical instruments. The analysis suggested that the current focus on optical instruments aligns more closely with fatwa guidelines, contributing to the limited exploration of radio telescopes. Even though it cannot be used as the primary method for determining the hilal, it can still be used to support eye observation and enhance the precision of hilal observation. In essence, while radio telescopes offer potential advantages in overcoming challenges posed by clouds and atmospheric conditions, their use for hilal observation faces fundamental obstacles related to Islamic requirements. Future research may benefit from addressing these challenges and finding innovative ways to integrate technology while respecting religious obligations. As advancements continue, a harmonious balance between technological tools and religious principles may pave the way for more accurate and reliable lunar observations in the future.

References

- Abidin, Z., Asillam, M. F., & Koay, J. Y. 2020. Expanding Astronomy Research in Malaysia. *Nature Astronomy*, 4(12), 1115–1117. <https://doi.org/10.1038/s41550-020-01230-x>
- Ahmad, A. 2023. *Raya Terkejut 2022 Sah, 30 Lihat Anak Bulan di Labuan*. Kosmo Digital. Retrieved December 9, 2023, from <https://www.kosmo.com.my/2023/04/13/raya-terkejut-2022-sah-30-lihat-anak-bulan-di-labuan/>

- Ahmad, N., Mohamad, N. I. N., Wahab, R. A., Nawawi, M. S. A. M., Zainuddin, M. Z., & Mohamed, I. 2022. Analysis Data of the 22 Years of Observations on the Young Crescent Moon at Telok Kemang Observatory in Relation to the Imkanur Rukyah Criteria 1995. *Sains Malaysiana*, 51(10), 3415–3422. <https://doi.org/10.17576/jsm-2022-5110-24>
- Al-Baghawi, Abu Muhammad Al-Husain Ibn Mas'ud. 1997. *Tafsir al-Baghawi*. Riyadh: Dar Taibah lil al-Nashr wa al-Tawzie. <https://Shamela.Ws/Book/41/230>
- Al-Bukhari, Muhammad Ibn Isma'il Abi 'Abd Allah. n.d. *Sahih al-Bukhari*. <https://sunnah.com/bukhari>
- Alias, M. A. A., Mohd Jailani, M. R., Wan Ismail, W. A. F., & Baharuddin, A. S. (2024). The integration of five main goals of shariah in the production of science and technology for human well-being. *AL-MAQASID: The International Journal of Maqasid Studies and Advanced Islamic Research*, 5(1), 1–16.
- Al-Maraghi, Muhammad Mustafa. 1946. *Tafsir al-Maraghi*. Egypt: Sharikah Maktabah wa Matbaeah Mustafaa al-Babaa al-Halabii wa 'Awwaduh <https://shamela.ws/book/23608/312#p1>
- Al-Qaradawi, Yusuf. 1993. *Fiqh Al-Siyam*. Beirut: Muasasah al-Risalah. <https://www.al-qaradawi.net/sites/default/files/pdf/981f3-fakh-elsiame-.pdf>
- Al-Rajab, M., Loucif, S., & Risheh, Y. A. 2023. Predicting New Crescent Moon Visibility Applying Machine Learning Algorithms. *Scientific Reports*, 13(1). <https://doi.org/10.1038/s41598-023-32807-x>
- Al-Tabari, Muhammad ibn Jarir. n.d. *Jami` Al-Bayan*. Mecca: Dar al-Tarbiya wa al-Turath. <https://shamela.ws/book/43/1688>
- Australia Telescope National Facility. n.d. *How Does a Radio Telescope Work?* Retrieved December 9, 2023, from <https://www.atnf.csiro.au/outreach/education/pulseatparkes/radiotelescopeintro.html>
- Britannica. 2023. *Radio Wave | Examples, Uses, Facts, & Range*. Encyclopedia Britannica. Retrieved December 9, 2023, from <https://www.britannica.com/science/radio-wave>
- Buckle, A. & Jones, G. n.d. *The Phases of the Moon*. Retrieved December 9, 2023, from <https://www.timeanddate.com/astronomy/moon/phases.html>
- Burke, J. D. 2023. *Moon | Features, Phases, Surface, Exploration, & Facts*. Encyclopedia Britannica. Retrieved December 9, 2023, from <https://www.britannica.com/place/Moon>
- Choi, C. Q., & Dobrijevic, D. 2023. *The Moon: Everything You Need to Know About Earth's Companion*. Space.com. Retrieved December 9, 2023, from <https://www.space.com/55-earths-moon-formation-composition-and-orbit.html>
- Faid, M. S., Nawawi, M. S. A. M., & Saadon, M. H. M. 2023. Analysis Tool for Lunar Crescent Visibility Criterion Based on Integrated Lunar Crescent Database. *Astronomy and Computing*, 45, 100752. <https://doi.org/10.1016/j.ascom.2023.100752>
- Fatoohi, L., Stephenson, F. R., & Al-Dargazelli, S. 1999. The Babylonian First Visibility of the Lunar Crescent: Data and Criterion. *Journal for the History of Astronomy*, 30(1), 51–72. <https://doi.org/10.1177/002182869903000103>
- Findlay, J. 1964. Radio telescopes. *IEEE Transactions on Antennas and Propagation*, 12(7), 853-864. <https://ieeexplore.ieee.org/document/1138344>
- Hafez, Y. A., Trojan, L., Albaqami, F. H., Almutairi, A. Z., Davies, R. D., Dickinson, C., & Piccirillo, L. 2014. A Radio Determination of the Time of the New Moon. *Monthly Notices of the Royal Astronomical Society*, 439(3), 2271–2280. <https://doi.org/10.1093/mnras/stt2476>
- Izzatulnajah. 2022. *Perkembangan Kriteria Astronomi dalam Meramal Kenampakan Anak Bulan*. Ehilal. Retrieved December 9, 2023, from <https://www.ehilal.my/perkembangan-kriteria-kebolehnampakan-anak-bulan/>
- Jawatankuasa Fatwa Negeri Perak. 2022. *Irsyad Hukum (Panduan Hukum) Bil. 9. Pengisbatan Anak Bulan Dari Perspektif Syariah Dan Astronomi*. https://mufti.perak.gov.my/images/perkhidmatan/koleksi_umum/warta_kerajaan/irsyad/bulan.pdf
- Jawatankuasa Fatwa Negeri Selangor. 2021. *Pandangan Hukum Syarak; Pengisbatan Anak Bulan dari Perspektif Syariah dan Astronomi*. <https://www.muftiselangor.gov.my/2023/10/27/pandangan-hukum-syarak-pengisbatan-anak-bulan-dari-perspektif-syariah-dan-astronomi/>
- Jawatankuasa Muzakarah MKI. 1977. *Kesabitan Anak Bulan Ramadhan & Syawal*. <http://e-smaf.islam.gov.my/e-smaf/fatwa/fatwa/find/pr/15188>

- Kellermann, K. I., & Klock, B. 2023. *Telescope / History, Types, & Facts*. Encyclopedia Britannica. Retrieved December 9, 2023, from <https://www.britannica.com/science/optical-telescope>
- Mamat, Z., Wan Ismail, W. A. F., Abdul Mutalib, L., Hashim, H., & Baharuddin, A. S. (2025). Penerimaan jawatankuasa fatwa negeri terhadap keputusan hukum produk halal oleh Muzakarah Majlis Kebangsaan bagi Hal Ehwal Agama Islam (MKI). *LexForensica: Forensic Justice And Socio-Legal Research Journal*, 2(1), 19-34.
- Man, S., Zainuddin, M. Z., Nor, M. R. M., Ramli, M. A., Rahim, R. a. A., Ramli, R., & Ahmad, R. B. 2012. The Development of Islamic Astronomy Studies in Higher Learning Institutions in Malaysia. *Middle-East Journal of Scientific Research*. [http://www.idosi.org/mejsr/mejsr12\(1\)12/19.pdf](http://www.idosi.org/mejsr/mejsr12(1)12/19.pdf)
- Mohyedin, Z. 2020. Genesis Kosmologi Dan Dunia Kuantum. *Patriots Publication*.
- Muztaba, R., Malasan, H. L., & Djamal, M. 2023. Deep Learning for Crescent Detection and Recognition: Implementation of Masked R-CNN to the Observational Lunar Dataset Collected with the Robotic Lunar Telescope System. *Astronomy and Computing*, 45, 100757. <https://doi.org/10.1016/j.ascom.2023.100757>
- NASA. n.d. *Moon Phases*. Retrieved December 9, 2023, from <https://moon.nasa.gov/moon-in-motion/phases-eclipses-supermoons/moon-phases/>
- National Aeronautics and Space Administration, Science Mission Directorate. 2010. *Visible Light*. Retrieved December 9, 2023, from http://science.nasa.gov/ems/09_visiblelight
- Nawawi, M. S. A. M. 2023. *Pencerapan Anak Bulan di Malaysia - Menjalini Tradisi & Inovasi*. (Video). <https://www.youtube.com/watch?v=cMATgbelFR4>
- Nawawi, M. S. a. M., Man, S., Zainuddin, M. Z., Wahab, R. A., & Zaki, N. A. 2015. Sejarah Kriteria Kenampakan Anak Bulan di Malaysia. *Journal of Al-Tamaddun*, 10(2), 61–75. <https://doi.org/10.22452/jat.vol10no2.5>
- Niri, M. A., Nawawi, M. S. a. M., Ismail, K., Wahab, R. A., & Zaki, N. H. A. 2012. Kesan Penggunaan Hitungan Astronomi dan Alatan Moden dalam Cerapan Hilal di Malaysia: Satu Penelitian. *Jurnal Fiqh*, 9(1), 45–64. <https://doi.org/10.22452/fiqh.vol9no1.3>
- Nizam, N. K., Nawawi, M. S. A. M., Niri, M. A., Man, S., & Zainuddin, M. Z. 2014. Penggunaan Teleskop: Kesan Terhadap Hukum Ithbat Kenampakan Anak Bulan di Malaysia. *Jurnal Fiqh*. <https://doi.org/10.22452/fiqh.vol11no1.3>
- Odeh, M. 2004. New Criterion for Lunar Crescent Visibility. *Experimental Astronomy*, 18(1–3), 39–64. <https://doi.org/10.1007/s10686-005-9002-5>
- Putra, S., & Rahmawati, L. E. 2023. Unraveling Hilal's Characteristics (Perception of Similarities the Physical Meaning of Hilal). <https://oarep.usim.edu.my/jspui/handle/123456789/21129>
- Shariff, N., Hamidi, Z. S., & Faid, M. S. 2017. The Impact of Light Pollution on Islamic New Moon (Hilal) Observation. *International Journal of Sustainable Lighting (Online)*, 19(1), 10–14. <https://doi.org/10.26607/ijsl.v19i1.61>
- Umar, R., Kamarudin, M. K. A., Khairuldin, W. M. K. F. W., Nawawi, M. S. a. M., & Jusoh, D. a. J. M. 2017. Observations of the New Moon Using Optical Telescopes and Radio Telescope from the Perspective of Islam. *International Journal of Academic Research in Business & Social Sciences*, 7(8). <https://doi.org/10.6007/ijarbss/v7-i8/3262>
- Umar, Roslan. Associate Professor. East Coast Environmental Research Institute. Universiti Sultan Zainal Abidin. (Video call interview). 22 October 2023.
- Utama, J. A., Zuhudi, A., Prasetyo, Y., Rachman, A., Riadi, A., Nandi, S., & Riza, L. S. 2023. Young Lunar Crescent Detection Based on Video Data with Computer Vision Techniques. *Astronomy and Computing*, 44, 100731. <https://doi.org/10.1016/j.ascom.2023.100731>
- Utusan Malaysia. 2022. *Ramai Terkejut Hari Raya Aidilfitri Esok*. Retrieved December 9, 2023, from <https://www.utusan.com.my/nasional/2022/05/ramai-terkejut-hari-raya-aidilfitri-esok/>
- Wahid, K., Nawawi, M. S. A. M., Man, S., & Ahmad, N. 2019. Teknik Cerapan Anak Bulan: Satu Penelitian Literatur (Observation Techniques of Crescent: A Literature Review). *UMRAN*, 6(3), 47–55. <https://doi.org/10.11113/umran2019.6n3.349>