Volume 5 No. 1 June 2026
P-ISSN: 2986-1675 E-ISSN: 2963-0290
Page: 71-92
DOI: https://doi.org/10.47766/astroislamica.v5i1.7299

ASTROISLAMICA
Journal of Islamic Astronomy

The Concept of *Syafaq Abyaḍ* in Determining the Beginning of the *ʿIshāʾ* Prayer Time

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ARTICLE INFO

Article history:
Submitted May 02, 2026
Accepted Jun 12, 2026
Published Jun 30, 2026

Keywords:
Isha Prayer Time,
Syafaq Aḥmar,
Syafaq Abyaḍ,
Sky Quality Meter,
Masalembu Island.

ABSTRACT

Prayer times are determined by the position of the Sun on the celestial sphere, including the Isha prayer, which begins with the disappearance of syafaq (twilight). Syafaq is classified into two types: syafaq aḥmar (red twilight) and syafaq abyaḍ (white twilight). The Shafi'i and Maliki madhhabs utilize syafaq aḥmar as their reference, whereas the Hanbali and Hanafi madhhabs rely on syafaq abyaḍ. In Indonesia, the Ministry of Religious Affairs (Kemenag RI) defines the start of Isha based on the disappearance of syafaq aḥmar at a solar altitude of -18°. However, light and air pollution significantly hinder the observation of this phenomenon. This qualitative field research aims to observe the disappearance of syafaq on Masalembu Island, an ideal location offering an unobstructed view of the western horizon and pristine, dark night skies (sky brightness value of 22.00 mag./arc sec²). Primary data were collected by recording night sky brightness using a Sky Quality Meter (SQM). The results indicate a discrepancy with the official regulations. While the Ministry of Religious Affairs establishes -18° as the threshold for the disappearance of syafaq aḥmar, field data reveal that even syafaq abyaḍ has completely vanished at this solar altitude. These findings emphasize the critical need for accurate twilight observations in pollution-free areas to ensure more precise determinations of Islamic prayer times.

ARTICLE INFO ABSTRACT

Waktu salat ditentukan oleh posisi Matahari pada bola langit, termasuk salat Isya yang tandanya merujuk pada hilangnya syafaq (cahaya senja). Terdapat dua jenis syafaq, yaitu aḥmar (merah) dan abyaḍ (putih). Mazhab Syafi'i dan Maliki menggunakan syafaq aḥmar sebagai acuan, sementara Mazhab Hambali dan Hanafi menggunakan syafaq abyaḍ. Indonesia (Kemenag RI) menetapkan awal waktu Isya berdasarkan hilangnya syafaq aḥmar pada ketinggian Matahari -18°. Namun, polusi cahaya dan udara saat ini sangat mengganggu observasi hilangnya syafaq. Penelitian lapangan (field research) kualitatif ini bertujuan mengobservasi hilangnya syafaq di Pulau Masalembu, sebuah lokasi ideal dengan akses langsung ke ufuk barat dan kondisi langit malam yang sangat gelap serta cerah (nilai kecerlangan mencapai 22.00 mag./arc sec²). Data primer diperoleh melalui perekaman tingkat kecerlangan langit menggunakan instrumen Sky Quality Meter (SQM). Hasil penelitian menunjukkan adanya temuan yang berbeda dari ketetapan dinas. Ketika posisi Matahari mencapai ketinggian -18° – yang secara regulasi Kemenag RI merupakan momen hilangnya syafaq aḥmar – data di lapangan justru menunjukkan bahwa syafaq abyaḍ pun telah hilang. Temuan ini menegaskan pentingnya akurasi data observasi fajar dan senja di wilayah yang bebas polusi untuk penentuan waktu ibadah yang lebih tepat.

INTRODUCTION

Ṣalāh (Islamic ritual prayer) occupies a fundamental position in Islam as the second pillar of the faith and constitutes one of the essential acts of worship that every Muslim is obligated to observe. As the pillar of religion, ṣalāh is regarded as indispensable to the practice of Islam. According to Islamic law (Sharīʿah), the five daily prayers must be performed within their prescribed times as established by the Qur'an and the Sunnah of the Prophet Muḥammad.[1]

[1]Ismail Ismail and Ikhsan Kamilan, "Dynamics of the Ministry of Religious Affairs in Managing Prayer Schedules in Indonesia," *Syarah: Jurnal Hukum Islam & Ekonomi* 12, no. 2 (December 27, 2023): 122–36, https://doi.org/10.47766/syarah.v12i2.1979.

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The prescribed prayer times are not arbitrary but are determined based on explicit textual evidence from the Qur'an and the Hadith. This principle is affirmed in the Qur'an, where Allah states: "*Indeed, prayer has been decreed upon the believers at specified times*" (Qur'an 4:103).[2] This verse establishes that each obligatory prayer must be performed within its designated time, making knowledge of prayer times a prerequisite for the validity of ṣalāh.

From an astronomical perspective, the prescribed prayer times correspond to specific positions of the Sun relative to the celestial sphere. Consequently, astronomical observations constitute the primary basis for determining the beginning of prayer times. The principal astronomical parameters include the Sun's altitude and several observable solar phenomena, such as morning twilight, sunrise, solar culmination, sunset, and evening twilight.[3]

Muslim jurists unanimously agree that prayer cannot be performed before its prescribed time begins, as the commencement of prayer time is one of the essential conditions for the validity of ṣalāh.[4] Nevertheless, scholarly disagreement exists regarding the determination of certain prayer times, particularly the beginning of the ʿIshāʾ prayer, primarily due to differing interpretations of the term *syafaq* (twilight). According to *Tafsīr al-Ṣāwī*, as cited by Shidqi Muḥammad Jamil, *syafaq* refers to the mixture of daylight and the darkness of night after sunset, producing a reddish glow in the western horizon. Similarly, Mustafa al-Marāghī defines *syafaq* as the red twilight visible in the western sky following sunset.[5]

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[2]Tim Penerjemah Departemen Agama RI, *Al-Qur'an dan Terjemahnya*, (Jakarta: PT. Sygma Examedia Arkanleema, 2009), 95.

[3]Susiknan Azhari, *Ilmu Falak*, 66.

[4]Ismail, Nazaruddin, and Ruslandi, *Membumikan Ilmu Falak Di Pesantren: Integrasi Tradisi Dan Modernitas* (Banda Aceh: Bandar Publising, 2024).

[5]Ahmad Mustafa al-Maraghi, *Tafsir al-Maraghi*, terj. Dari *Tafsir al-Maraghi* oleh Bahrun Abu Bakar, (Semarang: PT.Toha Putra, 1993), 84.

Al-Khalīl ibn Aḥmad describes *syafaq* as the red glow that appears after sunset and remains until the beginning of the ʿIshāʾ prayer, after which it disappears. A similar interpretation is presented by al-Jawharī, who defines it as the remaining sunlight and its reddish hue during the early part of the night until the approach of ʿIshāʾ time.[6] Likewise, ʿIkrimah interprets *syafaq* as the twilight occurring between Maghrib and ʿIshāʾ prayers.

In contrast, Abū Ḥanīfah defines *syafaq* as the white twilight (*syafaq abyaḍ*), which appears after the disappearance of the red twilight (*syafaq aḥmar*) and before complete darkness.[7] From an astronomical perspective, *syafaq* represents the residual scattering of solar radiation within the Earth's atmosphere after sunset.[8] Islamic astronomers generally associate the disappearance of *syafaq aḥmar* with the Sun reaching approximately –18° below the horizon, whereas the disappearance of *syafaq abyaḍ* is commonly associated with a solar altitude of approximately –20° below the horizon, corresponding to the onset of true darkness before dawn.[9]

Differences in the interpretation of *syafaq* have resulted in varying legal opinions among the classical schools of Islamic jurisprudence concerning the beginning of the ʿIshāʾ prayer.[10]

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[6]Rina Afriza, Ismail, and Hasna Tuddar Putri, "Comparison of Sky Brightness Levels in Determining the Subh Prayer Time in Highland and Lowland Areas," in *International Seminar on Islamic Astronomy (ISIA)* (Lhokseumawe, 2026), 117–28.

[7]Imam Qusthalaani, "KAJIAN FAJAR DAN SYAFAQ PERSPEKTIF FIKIH DAN ASTRONOMI," *Mahkamah : Jurnal Kajian Hukum Islam* 3, no. 1 (June 8, 2018): 1, https://doi.org/10.24235/mahkamah.v3i1.2744.

[8]Yuli Damayanti, Ismail, and Laiyina Ukhti, "Verification Test of the Beginning of Zuhr Prayer Time Using Solar Transit Hole on Shadowless Day," in *International Seminar on Islamic Astronomy (ISIA)* (Lhokseumawe: Penerbit Nahrasiyah UIN Sultanah Nahrasiyah Lhokseumawe., 2026), 145–55.

[9]Baharrudin Zainal, *Ilmu Falak*, (Kuala Lumpur: Dewan Bahasa dan Pustaka, 2004), 126.

[10]Siti Muslifah, "Telaah Kritis Syafaqul Ahmar Dan Syafaqul Abyadh Terhadap Akhir Maghrib Dan Awal Isya'," *ELFALAKY* 1, no. 1 (January 18, 2017), https://doi.org/10.24252/IFK.V1I1.3675.

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P-ISSN: 2986-1675 E-ISSN: 2963-0290
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a. According to the Ḥanafī school, the time for ʿIshāʾ begins after the disappearance of the white twilight (*syafaq abyaḍ*) following the disappearance of the red twilight (*syafaq aḥmar*), and extends until midnight.
b. The Mālikī school maintains that ʿIshāʾ begins with the disappearance of the red twilight and continues until one-third of the night has elapsed.
c. The Shāfiʿī school likewise considers the disappearance of the red twilight as the beginning of ʿIshāʾ time.
d. Although the Ḥanbalī school is frequently described as associating the beginning of ʿIshāʾ with the disappearance of *syafaq abyaḍ*, classical Ḥanbalī authorities generally regard the disappearance of the red twilight as the legal criterion, while acknowledging discussions regarding the white twilight in particular astronomical circumstances.

The distinction between *syafaq aḥmar* and *syafaq abyaḍ* is further elaborated in *Idhāḥ Qawl al-Ḥaqq fī Miqdār Inḥiṭāṭ al-Shams Waqta Ṭulūʿ al-Fajr wa Ghurūb al-Syafaq*, which explains that jurists and Arabic linguists differ in defining the meaning of *syafaq*.[11] While the majority of scholars interpret the term as referring to the red twilight, Abū Ḥanīfah interprets it as the white twilight. In Indonesia, however, Muslim scholars generally agree that the beginning of the ʿIshāʾ prayer is indicated by the disappearance of the red twilight in the western horizon, signifying the onset of complete night. In astronomical terminology, this phenomenon corresponds to the end of astronomical twilight.[12]

Accordingly, *syafaq aḥmar* serves as the conventional marker for the end of Maghrib time and the beginning of ʿIshāʾ. In contrast, the concept of *syafaq*

[11] Muhammad bin Abdul Wahab Razaq, *Idhah Qaul al-Haq fi Miqdar Inhitat al-Syams Waqtu Tulu'i al-Fajr wa Gurub al-Syafaq*, (tt: andalus, 2005), 18.

[12] A. E. Roy, D. Clarke, *Astronomy Principles and Practise, published by Adam Hilger*, (Bristol: Techno House, 1936), 83.

abyaḍ, as adopted within the Ḥanafī tradition, is generally applied under normal geographical conditions.[13] Variations in latitude and seasonal conditions influence the duration and visibility of twilight phenomena, resulting in differences in the disappearance of twilight across geographical locations and consequently affecting the determination of prayer times.[14]

To validate the determination of the beginning of the ʿIshāʾ prayer, numerous studies in Islamic astronomy and observational astronomy have investigated sky brightness during twilight. Conventionally, photometric techniques constitute the most reliable approach for measuring sky brightness.[15] One of the most widely used instruments is the Sky Quality Meter (SQM), a compact photometric device capable of recording night-sky brightness efficiently. Measurements obtained using the SQM provide continuous sky-brightness data throughout the night, enabling researchers to identify the disappearance of twilight as an indicator of the beginning of the ʿIshāʾ prayer.[16] These observational data have subsequently become an important empirical foundation for examining the concept of *syafaq* from both Islamic jurisprudential and astronomical perspectives, particularly regarding the existence and characteristics of *syafaq abyaḍ*.

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[13]Lidya Safrida and Machzumy Machzumy, "Analisis Astronomical Twilight Sebagai Tanda Penentuan Awal Waktu Salat Isya," *Astroislamica: Journal of Islamic Astronomy* 1, no. 1 (June 30, 2022): 47–72, https://doi.org/10.47766/ASTROISLAMICA.V1I1.687.

[14]Ismail Ismail, Dikson T. Yasin, and Laiyina Ukhti, "Tanda Masuk Waktu Salat Dalam Perspektif Hukum Islam Dan Ilmu Falak," *Syarah: Jurnal Hukum Islam & Ekonomi* 12, no. 1 (July 20, 2023): 91–106, https://doi.org/10.47766/syarah.v12i1.1621.

[15]Fotogrametri adalah sebuah proses untuk memperoleh informasi metris mengenai sebuah objek melalui pengukuran yang dibuat pada hasil foto baik dari udara maupun dari permukaan tanah. Defry Mulia dan Hepy Hapsari, "Studi Fotometri Jarak Dekat dalam Pemodelan 3D dan Analisis Volume Objek", *Geoid*, Vol. 10, No. 1, (Surabaya: Kampus ITS Sukolilo, 2014), 32.

[16]Laksmiyanti Annake Harijadi Noor, " Uji Akurasi Awal Waktu Shalat Shubuh Dengan *Sky Quality Meter*", *Skripsi* Program Sarjana UIN Walisongo Semarang (Semarang, 2016). 2-3. Tidak dipublikasikan.

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P-ISSN: 2986-1675 E-ISSN: 2963-0290
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Based on these considerations, this study investigates the phenomenon of *syafaq abyaḍ* in determining the beginning of the ʿIshāʾ prayer time through a case study conducted on Masalembu Island, Sumenep Regency, East Java Province, Indonesia (5°04′39″ S, 114°36′05″ E). Masalembu Island is characterized by exceptionally low levels of artificial light pollution, with a night-sky brightness of approximately 22.00 mag arcsec^{-2}, corresponding to Bortle Class 1, the darkest category of naturally observable night skies. Under such conditions, celestial objects—including stars, planets, the Moon, and even the Milky Way—are readily visible to the naked eye without optical assistance.[17]

The exceptionally dark sky over Masalembu Island is primarily attributable to the limited availability of artificial lighting, including streetlights, commercial facilities, public buildings, and motor vehicle traffic. The island also has limited electricity infrastructure, resulting in minimal anthropogenic light pollution.[18] These environmental conditions make Masalembu an ideal location for astronomical observations, particularly for investigating twilight phenomena. While the disappearance of *syafaq aḥmar* in Indonesia is generally associated with a solar altitude of approximately –18° to –19°, the disappearance of *syafaq abyaḍ* is expected to occur at a different solar altitude, potentially affecting astronomical calculations of the beginning of the ʿIshāʾ prayer. Accordingly, this study addresses two principal research questions: (1) What is the observational possibility of *syafaq abyaḍ* on Masalembu Island? and (2) How does *syafaq abyaḍ* compare with *syafaq aḥmar* in determining the beginning of the ʿIshāʾ prayer time in this location?

[17]Ismail Ismail, "Dinamika Jadwal Waktu Salat Di Indonesia," December 2021, https://eprints.walisongo.ac.id/id/eprint/16786/.

[18]Muhamad Syazwan Faid et al., *Python for Islamic Astronomy: Modern Computational Approaches to Hijri Calendar, Qibla, and Prayer Times* (Boca Raton: CRC Press, 2025), https://doi.org/10.1201/9781003649120.

METHODS

This study employed a qualitative research approach by integrating library research and field research. The library research involved a comprehensive review of classical Islamic jurisprudential texts, works on Islamic astronomy (*Ilmu Falak*), and relevant scholarly literature concerning the concept of *syafaq* and the determination of the beginning of the ʿIshāʾ prayer time. This approach was intended to examine the various interpretations of *syafaq*, particularly the distinction between *syafaq aḥmar* (red twilight) and *syafaq abyaḍ* (white twilight), from both jurisprudential and astronomical perspectives.[19]

Field research was conducted to obtain empirical data through direct observations of twilight phenomena. The observations aimed to identify the visibility and characteristics of *syafaq abyaḍ* under actual sky conditions and to compare the observational findings with the theoretical concepts derived from the literature. The field observations were carried out on Masalembu Island, Indonesia, a location selected for its exceptionally low level of artificial light pollution, which provides favorable conditions for astronomical observation.

The collected data were analyzed using an inductive qualitative approach, whereby empirical observations were interpreted alongside the findings from the literature review to formulate conclusions regarding the characteristics of *syafaq abyaḍ* and its implications for determining the beginning of the ʿIshāʾ prayer time.[20]

RESULTS AND DISCUSSION

Research Instrument

The primary instrument employed in this study was the Sky Quality Meter (SQM) LU-DL (Lens USB Data Logger), a photometric device designed to measure night-sky brightness.

[19] Sugiono, *Metode Penelitian Bisnis*, (Bandung: Alfabeta, 1999), 37.

[20] Lexy J.Moleong, *Metode Penelitian Kualitatif*, (Bandung: PT Remaja Rosda Karya, 2000), Cet. XX, 9.

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The instrument was used to continuously record sky brightness over the western horizon from sunset until complete darkness and over the eastern horizon from the pre-dawn period until sunrise. Variations in sky brightness recorded by the SQM served as the principal observational parameter for identifying the appearance and disappearance of *syafaq*, particularly *syafaq abyaḍ*, as an indicator of the beginning of the ʿIshāʾ prayer time.

The SQM LU-DL is equipped with an optical lens, USB connectivity, and an integrated data logger that enables autonomous data acquisition without requiring a continuous computer connection during field observations. This capability allows uninterrupted measurements throughout the twilight period. [21]

The principal technical specifications of the SQM LU-DL are summarized as follows:

Specification	Description
Dimensions	5.5 × 2.6 × 1.1 inches
Instrument weight	110 g
Battery pack weight	160 g
USB cable weight	140 g
Data logger memory	1 MB Flash memory
Storage capacity	Up to 32,768 data records (expandable to 1,048,576 records)
Time accuracy	Real-Time Clock (RTC)
Operating temperature	–40°C to 85°C
Temperature sensor accuracy	±2°C (maximum at 25°C)
Field of view	Approximately 20°–40°

[21]SQM-LU-DL Operator"s Manual. 2016, http://www.unihedron.com/projects/sqm-lu-dl/

Because the SQM measures sky brightness only within its limited field of view, the instrument was carefully aligned toward the western horizon, corresponding to the direction of sunset, to ensure that the recorded measurements accurately represented twilight conditions associated with the disappearance of *syafaq*.[22]

Technique for Observing *Syafaq Abyaḍ*

The procedure for observing *syafaq abyaḍ* is as follows:

1. Prepare the observation instruments, including the Sky Quality Meter (SQM), USB cable, tripod, and a laptop or computer.
2. Mount the SQM on the tripod and direct it toward the western horizon, where the Sun has set.
3. Position the SQM at an elevation angle of approximately 30°–45° above the horizon.
4. Connect the SQM to the laptop using the USB cable.
5. Install the Unihedron Device Manager (UDM) software.
6. Click "Find" until the indicator below the Find menu turns green, confirming that the SQM is successfully connected to the laptop.
7. Open the Data Logging tab and click "Set" under Device Clock to synchronize the SQM clock with the computer clock.
8. Click "Trigger" and set the recording interval to 5 seconds.
9. Click "Log Continuous" to enable the SQM to automatically record sky-brightness data at the specified interval. When the indicator light on the back of the SQM flashes every five seconds, the instrument is operating properly and recording data. The recorded measurements can be monitored through the Reading menu.

[22]Clara Yono Yatini et al., "An Overview of Sky Brightness Surrounding Timau National Observatory (TNO), Indonesia," *Indonesian Journal of Geography* 56, no. 2 (August 14, 2024), https://doi.org/10.22146/ijg.90436.

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10. After the observation is completed, transfer the recorded data from the UDM software and save them on the laptop or computer.

Presentation and Analysis of *Syafaq* Measurements Using the SQM LU-DL

The data obtained from the SQM LU-DL were processed using the following procedure:

1. Open Microsoft Excel and import the data file previously saved from the Unihedron Device Manager (UDM).
2. When the Text Import Wizard dialog box appears, select Delimited.
3. Select Tab, Semicolon, and Other, then enter the letter "T" in the Other field.
4. Select General, then click Advanced and adjust the decimal separator from a comma (,) to a period (.), or vice versa, depending on the system settings. Click Finish.
5. Arrange the worksheet columns to facilitate data interpretation.
6. Convert the time and date format from Custom to Date.
7. Generate a graph by selecting the Scatter chart type, with Time on the x-axis and Magnitude on the y-axis.
8. A blank chart will appear. Right-click the chart, select Select Data, and then click Add.
9. Specify the dataset by entering the file name as the series name, the Time column as the x-values, and the Magnitude column as the y-values.
10. The resulting graph displays the *syafaq* observation data.

Technically, the *syafaq* observations were conducted beginning at sunset.[23] The observations were carried out using a Sky Quality Meter (SQM), with data acquisition commencing

[23]Mohammaddin Abdul Niri et al., "Astronomical Determinations for the Beginning Prayer Time of Isha'," *Middle East Journal of Scientific Research* 12, no. 1 (2012): 101–7, https://doi.org/10.5829/idosi.mejsr.2012.12.1.1673.

approximately 5–10 minutes before sunset**.** The *syafaq* observation data collected at the beginning, middle, and end of the lunar month on Masalembu Island were subsequently processed using Microsoft Excel and plotted into graphical form, as presented below.

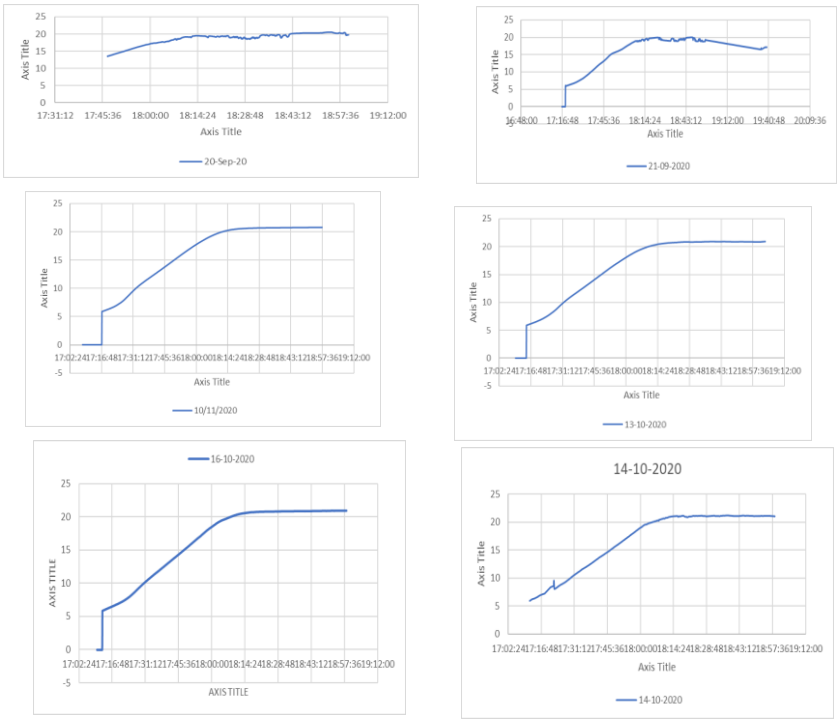

Figure 1. Twilight (*Syafaq*) Observation Data Collected During the Study on Masalembu Island

Analysis and Interpretation of Sky Quality Meter (SQM) Data

Observations of twilight sky brightness using **the** Sky Quality Meter (SQM LU-DL) produced quantitative photometric data representing variations in sky brightness throughout the observation period.[24] These data were recorded

[24]Laksmiyanti Annake Harijadi Noor and Fahmi Fatwa Rosyadi Satria Hamdani, "The Dawn Sky Brightness Observations in the Preliminary Shubuh Prayer Time Determination," *QIJIS (Qudus International Journal of Islamic Studies)* 6, no. 1 (July 2, 2018): 25–38, https://doi.org/10.21043/QIJIS.V1I1.2870.

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as numerical measurements (mag arcsec^{-2}) and subsequently processed into tabular and graphical forms to facilitate analysis of twilight evolution after sunset.[25]

Field observations were conducted beginning approximately 5–10 minutes before local sunset and continued until the sky reached complete darkness. Throughout the observation period, the SQM continuously measured changes in sky brightness over the western horizon, enabling the identification of twilight characteristics associated with the disappearance of *syafaq*.[26]

The data collected on 13 October 2020 at Masalembu Island were processed to generate a sky-brightness curve. The resulting curve exhibits an initial increase in sky brightness values followed by a distinct inflection point. This inflection marks a significant transition in the twilight phase and is interpreted as indicating the disappearance of *syafaq*. From the beginning of the observation period, the measured sky brightness increased progressively as the evening twilight evolved.

A noticeable change in the recorded measurements first appeared at 18:10:19 WIB (Western Indonesian Time), when the SQM recorded a sky brightness of approximately 20 mag arcsec^{-2}. This point corresponds to the onset of astronomical night, at which the SQM no longer detected residual twilight illumination (*syafaq*) over the western horizon. Prior to this time, the recorded sky-brightness values exhibited relatively large fluctuations, particularly around 17:54:14 WIB, reflecting the transitional nature of evening twilight. After 18:10:19 WIB, however, the measurements became considerably more stable,

[25]Muhamad Syazwan Faid et al., "Alteration of Twilight Sky Brightness Profile by Light Pollution," June 29, 2023, https://doi.org/10.21203/RS.3.RS-3108644/V1.

[26]M. Basthoni and Hendro Setyanto, "Typology of Dawn Light Curves in High and Low Light Pollution Areas," in *AIP Conference Proceedings*, vol. 2391, 2022, https://doi.org/10.1063/5.0073949.

indicating that twilight had effectively disappeared and the night sky had reached a relatively constant level of brightness.

Each observation session generated several thousand individual measurements owing to the high-frequency recording interval employed by the SQM. To facilitate interpretation, the processed numerical data were visualized as time-series graphs. These graphs provide a clear representation of the temporal evolution of sky brightness and allow the transition from twilight to astronomical darkness to be identified more precisely.[27] Figure 2 presents the sky-brightness curve obtained from observations conducted at Kramat Beach, Masalembu Island, on 13 October 2020.

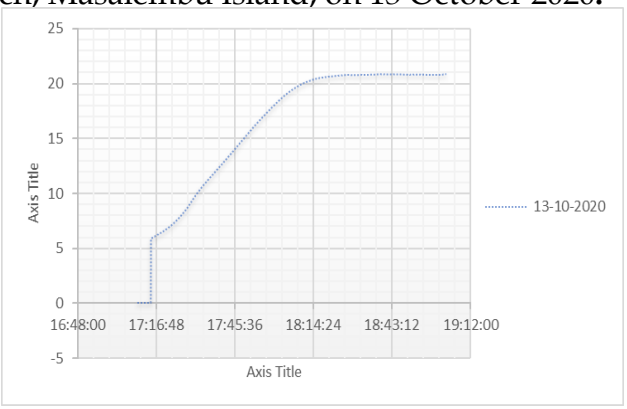

Figure 2. Processed Sky Brightness Data Obtained from the Sky Quality Meter (SQM) on 13 October 2020

Figure 2 illustrates the temporal variation in sky brightness recorded during the observation period, spanning from 17:19 WIB (Western Indonesian Time) until the onset of astronomical night at 19:03 WIB. The graph exhibits a gradual increase followed by a stable plateau, with the night-sky brightness reaching approximately 20.9 mag arcsec^{-2}.

The progressive increase in the recorded sky-brightness values reflects the gradual darkening of the sky following sunset. As the intensity of scattered solar radiation diminished,

[27]A. D. Azhar et al., "Night Sky Brightness Measurement at PERMATApintar Observatory," in *AIP Conference Proceedings*, vol. 1784 (American Institute of Physics Inc., 2016), https://doi.org/10.1063/1.4966789.

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the measured brightness approached a stable value, indicating that the twilight phase had ended and the sky had reached a relatively constant level of natural darkness. This stabilization is consistent with the disappearance of residual twilight (*syafaq*) and the establishment of fully developed night-time conditions.

To identify the transition point more precisely, the observational data were further processed and magnified using Microsoft Excel. This enhanced visualization enabled subtle changes in sky brightness to be detected more clearly, facilitating the identification of the characteristic inflection point associated with the disappearance of *syafaq*. The resulting enlarged graph is presented in Figure 3.

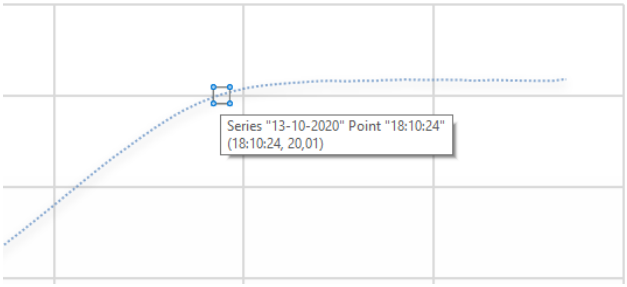

Figure 3. Enlarged Sky Brightness Curve Derived from the Sky Quality Meter (SQM) Observations on 13 October 2020.

The enlarged graph indicates that the section enclosed within the highlighted region corresponds to a relatively flat (stable) segment of the sky-brightness curve. This plateau is interpreted as marking the onset of astronomical night and, consequently, the disappearance of *syafaq*. The transition from a steadily increasing trend to a stable pattern reflects a positive change in the differential sky-brightness values, indicating that the influence of scattered solar radiation had diminished and that the night sky had reached a relatively constant brightness level.

Analysis of the Determination of the Beginning of the ʿIshāʾ Prayer Time Using the Sky Quality Meter

In Indonesia, the official method for calculating the beginning of the ʿIshāʾ prayer time, as standardized by the Ministry of Religious Affairs of the Republic of Indonesia (Kementerian Agama Republik Indonesia), defines the commencement of ʿIshāʾ as the moment when the Sun reaches an altitude of –18° below the horizon, corresponding to the disappearance of *syafaq aḥmar* (red twilight). This criterion is formally established in the national academic guideline for the standardization of *hisāb* (astronomical calculation) of the qibla direction and prayer times.[28]

The observational data obtained using the Sky Quality Meter (SQM LU-DL) were subsequently compared with the official *hisāb* calculations to evaluate the consistency between empirical twilight observations and the standardized criterion adopted by the Ministry of Religious Affairs. The comparative analysis yielded the following findings:

Table 1. Summary of the Processed Observational Data [29]

Date	Sunset Time	ʿIshāʾ Prayer Time (MORA Indonesia)	SQM Observations		Solar Altitude	
			Estimated *Syafaq Aḥmar*	Estimated *Syafaq Abyaḍ*	*Syafaq Aḥmar*	*Syafaq Abyaḍ*
20-09-2020	17:15 WIB	18:29 WIB	18:17:00 WIB	18:29:00 WIB	-16°	-18°
21-09-2020	17:15 WIB	18:29 WIB	18:18:00 WIB	18:29:00 WIB	-16°	-18°
03-10-2020	17:15 WIB	18:27 WIB	18:17:00 WIB	18:27:00 WIB	-16°	-18°
11-10-2020	17:14 WIB	18:26 WIB	18:17:00 WIB	18:26:40 WIB	-16°	-18°
13-10-2020	17:13 WIB	18:26 WIB	18:17:00 WIB	18:27:19 WIB	-16°	-18°
14-10-2020	17:13 WIB	18:26 WIB	18:18:00 WIB	18:27:13 WIB	-16°	-18°
16-10-2020	17:13 WIB	18:27 WIB	18:18:00 WIB	18:27:55 WIB	-16°	-18°

[28]Hariyadi Putraga et al., "Penentuan Waktu Malam Menggunakan Sky Quality Meter Dengan Pendekatan Moving Average," *ORBITA: Jurnal Kajian, Inovasi Dan Aplikasi Pendidikan Fisika* 8, no. 2 (2022): 313, https://doi.org/10.31764/orbita.v8i2.11363.

[29] Primary Data, Adjusted by the Authors (2020).

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Based on the data presented in Table 1, the observations conducted over a seven-day period indicate that the average disappearance of *syafaq aḥmar* occurred at approximately 18:17 WIB (Western Indonesian Time), corresponding to an average solar altitude of approximately –16° below the horizon, as determined from the Sky Quality Meter (SQM) observations.

In contrast, the average disappearance of *syafaq abyaḍ* was observed at approximately 18:27 WIB, when the Sun reached an average altitude of approximately –18° below the horizon. These findings demonstrate a measurable temporal difference between the disappearance of *syafaq aḥmar* and *syafaq abyaḍ*, reflecting the successive phases of evening twilight.

The observational results were subsequently compared with the official calculation method adopted by the Ministry of Religious Affairs of the Republic of Indonesia (Kementerian Agama Republik Indonesia). By integrating the empirical SQM measurements with the corresponding solar-altitude calculations, the following conclusions can be drawn:

Table 2. Comparison of the Beginning of the ʿIshāʾ Prayer Time Based on the *Hisāb* Method, Solar Altitude Adjustment, and Sky Quality Meter (SQM) Observations

Date	ʿIshāʾ Prayer Time (MORA Indonesia)	Solar Altitude	SQM Data
20-09-2020	18:29 WIB	-18°	18,71
21-09-2020	18:29 WIB	-18°	19,04
03-10-2020	18:27 WIB	-18°	20,33
11-10-2020	18:26 WIB	-18°	20,68
13-10-2020	18:26 WIB	-18°	20,81
14-10-2020	18:26 WIB	-18°	21,12
16-10-2020	18:27 WIB	-19°	20,83

Based on the data presented in Table 2, the beginning of the ʿIshāʾ prayer time was calculated using a mean solar altitude of –18°, as determined with Stellarium, and subsequently compared with the empirical sky-brightness measurements obtained from the Sky Quality Meter (SQM).

The comparison indicates that the standardized criterion adopted by the Ministry of Religious Affairs of the Republic of Indonesia (Kementerian Agama Republik Indonesia) differs from the observational results recorded by the SQM under the sky conditions of Masalembu Island. The SQM measurements suggest that the transition to complete darkness occurred later than the official criterion based on a solar altitude of –18°.

These findings provide preliminary evidence that, under the observational conditions of Masalembu Island, the determination of the beginning of the ʿIshāʾ prayer time based on SQM observations corresponds more closely to the disappearance of *syafaq abyaḍ* (white twilight) than to the disappearance of *syafaq aḥmar* (red twilight). Nevertheless, this conclusion should be interpreted within the scope of the present study and would benefit from further observations conducted under different atmospheric and seasonal conditions to evaluate the consistency and broader applicability of these findings.

CONCLUSION

The observations conducted on Masalembu Island demonstrate that the island provides highly favorable conditions for twilight observations owing to its exceptionally low levels of atmospheric and artificial light pollution. The sunset was generally observed under clear sky conditions, allowing both *syafaq aḥmar* (red twilight) and *syafaq abyaḍ* (white twilight) to be identified with a high degree of clarity. Although minor disturbances from artificial light sources, such as fishing vessels, were occasionally encountered during observations at the end of the lunar month, these had only a limited influence on the overall quality of the recorded data. Consequently, the Sky Quality Meter (SQM) successfully captured the temporal evolution of twilight and provided reliable measurements for identifying the disappearance of both *syafaq aḥmar* and *syafaq abyaḍ*.

A comparison between the observational results and the official *hisāb* method employed by the Ministry of Religious Affairs of the Republic of Indonesia (Kementerian Agama

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Republik Indonesia) revealed a notable difference in the astronomical indicators used to determine the beginning of the ʿIshāʾ prayer time. The official criterion associates the commencement of ʿIshāʾ with a solar altitude of –18°, corresponding to the disappearance of *syafaq aḥmar*. However, the empirical observations obtained using the SQM, with the corresponding solar altitudes determined using Stellarium, indicate that at approximately –18° below the horizon, the observable twilight more closely corresponds to the disappearance of *syafaq abyaḍ*, whereas the disappearance of *syafaq aḥmar* occurred earlier, at an average solar altitude of approximately –16°.

These findings suggest that, under the atmospheric and observational conditions of Masalembu Island, the empirical characteristics of twilight differ from the astronomical criterion currently adopted for determining the beginning of the ʿIshāʾ prayer time in Indonesia. Accordingly, the results provide empirical support for further investigation into the relationship between *syafaq aḥmar*, *syafaq abyaḍ*, and the astronomical determination of the ʿIshāʾ prayer time across different geographical and atmospheric conditions.

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