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The Influence and Adaptation of Observatories in Islamic Civilization: A Case of Malaysia

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Abstract

This article explores the historical development of observatories for astronomical pursuits within the context of Muslim civilization. It aims to provide an overview of how observatories evolved alongside advancements in astronomy during the Islamic caliphate. The study investigates the parallels between Malaysian astrofiqh observatories and those established during the Islamic civilization era, employing a qualitative approach involving instrument observation, interviews, and document analysis. The findings reveal that the 'Abbasid caliphate led in establishing observatories for educational and research purposes in astronomy. Key factors contributing to the success of observatory development include the rulers' support, intellectual dedication, and political stability. Furthermore, the study highlights specific similarities between Malaysian astrofiqh observatories and their historical counterparts, encompassing various aspects such as objectives, physical features, instruments, and nomenclature.

Keywords: Observatory, Islamic civilization, astrofiqh observatories, Islamic astronomy

Introduction

Observatories are typically linked with the study and theories regarding celestial bodies, the spaces between them, and the universe overall. The technology for constructing observatories has been available since the 8th century AD, with the Islamic civilization leading the way in their development, evolving over time.[1] An observatory can be described as a structure equipped with specific tools that enable scientists to observe and predict various phenomena such as weather patterns, star positions, and more.[2] Even today, observatories continue to be erected worldwide, evolving into more modern and sophisticated forms like robotic, airborne, and space observatories.[3] Initially, in the early historical years of the Muslim civilization, observatories were primarily used for observational purposes. As observatories became equipped with better facilities and tools, scientists found it easier to conduct thorough and effective observations. Eventually, these observatories transformed into hubs for research, where scientists gathered to collaborate on group projects, exchanging ideas and opinions in the pursuit of their research goals. Over time, observatories also evolved into valuable scientific educational institutions, with many scientists not only conducting research within their walls but also sharing their knowledge through teaching.[4]

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[1] Thomas T. Arny and Stephen E. Schneider (2010), *Explorations: An Introduction to Astronomy*, The McGraw- Hill Companies Inc.
[2] Nurazmallail Marni and Haron Zulkiflee (2008), *Institusi Pengajian Syariah & Sains: Era Kegemilangan Tamadun Islam*, Johor Bahru, Penerbit Universiti Teknologi Malaysia
[3] Ibnor Azli Ibrahim, Mohd Razlan Ahmad, Mohd Hafiz Safiai and Wan Kamal Mujani (2012), "Islamic Astronomy and the Establishment of Al-Khawarizmi Complex in Malaysia," *Advances in Natural and Applied Sciences*, Vol. 6, No. 3, pp. 316-320.
[4] Seyyed Hossein Nasr (1987), *Science and Civilization in Islam*, The Islamic Text Society.

Literature Review

This study commences on a review of past literatures in Malaysia such as *Peranan Institusi Balai Cerap dalam Pembangunan Ketamadunan Islam: Satu Sorotan*,[5] Human Resource Development Issues in the Field of Islamic Astronomy: Analysis of the Langkawi National Observatory, Malaysia,[6] *Hala Tuju Balai Cerap di Malaysia*,[7] Functions of Astrofiqh Observatories in Malaysia in Solving Astrofiqh Issues,[8] Observatories in Malaysia: Descendants of Islamic Civilization Superiority,[9] Identifying Light Pollution Sources at Two Major Observatories in Malaysia,[10] and Analysis of Issues on Human Resource Development in Astronomical Observatories.[11] In reality, writings regarding observatories in Malaysia are severely lacking. This should not be the case considering that observatories are one of the crucial scientific institutions involving aspects of education, research, and astronomical tourism. This contrasts with the situation outside Malaysia where there is a wealth of writings related to observatories.

In addition, this study has referred to several previous works on observatories undertaken at the international academia such as The Heavens on Earth: Observatories and Astronomy in Nineteenth-Century Science and Culture,[12] Muḥyi al-Din al-Maghribi's Lunar Measurements at the Maragha Observatory,[13] Observatories, Laboratories and Experiments in Geographical Information Science,[14] Route of Astronomical Observatories Project: Classical Observatories from the Renaissance to the Rise of Astrophysics,[15] An Observatory to Gather and Disseminate Information on the Health-Related Effects of Environmental And Climate Change,[16] The Evolution of Astronomical Observatory Design,[17] dd[18] DARWIN/XLZD: A Future Xenon Observatory for Dark Matter and other Rare Interactions,[19] Celebrating 10 Years of the Global Observatory for Physical Activity-GoPA,[20] Geomagnetic Field Variations Due to Solar Tides at the Indian Observatories,[21] Results of scrutiny of those works find that foreign countries, especially in Europe, conducted quite a number of studies and publications on observatories and this highlights the rapid growth of observatories outside Malaysia. Hence, the objective of this research is to look closely the history of observatory development in Islamic civilization and its influence on observatories in Malaysia. After scrutiny, it seems that the number of studies which chronicle observatories in Malaysia in a chronological, whole and in-depth manner is lacking.

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[5] Khadijah Ismail et al. (2008), "Peranan Institusi Balai Cerap dalam Pembangunan Ketamadunan Islam: Satu Sorotan," *Seminar Kebangsaan Kecemerlangan Tamadun Islam dalam Agro, Sains dan Teknologi,* Universiti Malaya, Kuala Lumpur.

[6] Khadijah Ismail, Fairos Asillam and Aizan Ali Mat Zin (2014), "Human Resource Development Issues in the Field of Islamic Astronomy: Analysis of the Langkawi National Observatory Malaysia," *International Journal of Social Science and Humanity*, Vol. 4, No. 6, pp. 463-467.

[7] Mohd Zambri Zainuddin (2010), "Hala Tuju Balai Cerap di Malaysia," *Persidangan Hala Tuju Balai Cerap Semalaysia 2010*, Kepala Batas, Pulau Pinang.

[8] Ibnor Azli Ibrahim, Mohd Hafiz Safiai and Ezad Azraai Jamsari (2015), "Functions of Astrofiqh Observatories in Malaysia in Solving Astrofiqh Issues," *Mediterranean Journal of Social Sciences*, Vol. 6 No. 1, pp. 112-119.

[9] Ibnor Azli Ibrahim et al. (2017), Observatories in Malaysia: Descendants of Islamic Civilization Superiority, *International Journal of Civil Engineering and Technology*, Vol. 8, No. 12, pp. 782-795.

[10] Mohammad R. Tahar, Nazhatulshima Ahmad and Nur H. Ismail (2020), "Identifying Light Pollution Sources at Two Major Observatories in Malaysia," *Sains Malaysiana*, Vol. 49, No. 2, pp. 439-445.

[11] Khadijah Ismail, Mohd Hafiz Safiai and Ezad Azraai Jamsari (2021), "Analysis of Issues on Human Resource Development in Astronomical Observatories," *International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies*, Vol. 12, No. 2, pp. 1-10.

[12] Aubin, David, Charlotte Bigg and H. Otto Sibum (eds.) (2010), *The Heavens on Earth: Observatories and Astronomy in Nineteenth-Century Science and Culture*, London: Duke University Press.

[13] Seyyed Mohamad Mozaffari (2014), "Muḥyī al-Dīn al-Maghribī's Lunar Measurements at the Maragha Observatory," *Archive for History of Exact Sciences*, Vol. 68, No.1, pp. 67-120.

[14] Franz-Benjamin Mocnik (2015), "Observatories, Laboratories and Experimentsin Geographical Information Science," *2nd Workshop on Geographic Information Observatories (GIO)*, pp. 1-8.

[15] Gudrun Wolfschmidt (2016), "Route of Astronomical Observatories Project: Classical Observatories from the Renaissance to the Rise of Astrophysics," *Astronomy in Focus, Volume 1, Focus Meeting 2 XXIXth IAU General Assembly*, August 2015, pp. 124-128.

[16] Christovam Barcellos et al. (2016), "An observatory to gather and disseminate information on the health-related effects of environmental and climate change," *Rev Panam Salud Publica*, Vol. 40, No.3, pp. 167-173.

[17] Miguel Angel Castro Tirado and Alberto J. Castro-Tirado (2019), "The Evolution of Astronomical Observatory Design," *Journal of the Korean Astronomical Society*, Vol. 52, pp. 99-108.

[18] Fiona Williamson (2023), "An Ocean Apart: Meteorology and the Elusive Observatories of British Malaya," *Isis*, Vol. 114, No. 4, pp. 710-724.

[19] Laura Baudis (2024), "DARWIN/XLZD: A Future Xenon Observatory for Dark Matter and other Rare Interactions," *Nuclear Physics B*, Vol. 1003.

[20] Michael Pratt, Andrea Ramfrez Varela and Pedro C. Hallal (2024), "Celebrating 10 Years of the Global Observatory for Physical Activity-GoPA," *Journal of Physical Activity and Health*, Vol. 21, No. 5, pp. 423- 424.

[21] Divyanshu Dwivedi and Chandrasekhar N. Phani (2024), "Geomagnetic Field Variations Due to Solar Tides at the Indian Observatories," *Earth, Planets and Space*, Vol. 76, No. 1.

Therefore, a study on this is proper and timely to add information and at the same time give awareness and exposure to the community on the importance of observatory. Moreover, this study can indirectly promote cooperation between national and international observatories to enhance *falak* knowledge in Malaysia.

The Development of Observatories in Islamic Civilization

As is known, the development of astronomy in the Islamic civilization flourished during the time of Caliph al-Ma'mun of the 'Abbasid Dynasty and the history of building observatories also began at this time.[22] While during the Fatimid rule in Egypt, three caliphs played pivotal roles as patrons of intellectual pursuits: Caliphs al-Mu'izz bin al-Mansur, al-'Aziz billah, and al-Hakim bi Amrillah.[23] The splendor of the Fatimid administration was greatly influenced by the caliphs' interest in science and philosophy. Consequently, fundamental knowledge sources like the al-Quran and al-Hadith were enriched and firmly established alongside advancements in science and philosophy, particularly evident in educational institutions like al-Azhar.[24] Corresponding to the era's scientific progress, several observatories were constructed to support the research endeavors of scholars.[25] Among the observatories built were:

Shammasiyyah Observatory

The Shammasiyyah Observatory, constructed in Baghdad, stands as the first observatory in the annals of Islamic civilization. Commissioned by Caliph al-Ma'mun, it commenced operations in 828 AD.[26] Sanad bin 'Ali, initially a Jew who converted to Islam, was appointed by al-Ma'mun to oversee the observatory's maintenance. Formerly tasked with building worship houses in Baghdad, Sanad bin 'Ali played a crucial role in inventing and constructing astronomical instruments for the observatory.[27] Among the scientists handpicked by Caliph al-Ma'mun for the observatory were Yahya bin Abi Mansur and al-'Abbas bin Sa'id al-Jawhari. Yahya bin Abi Mansur, esteemed as a highly skilled astrologist, authored the renowned 'Zij al-Mumtahan' (Tested Tables), which gained significant acclaim in the field of astronomy.[28] Al-'Abbas bin Sa'id al-Jawhari, renowned for his expertise in geometry, planetary movements, and astronomical calculations, was also among the early scientists appointed by al-Ma'mun.[29]

Furthermore, Caliph al-Ma'mun tasked his scientists with determining the accurate Qiblat direction for Baghdad. Through continuous observation of a lunar eclipse conducted in both Baghdad and Mecca, al-Ma'mun successfully determined the latitude and longitude of Mecca, contributing valuable data to research endeavors.[30]

Qasiyun Observatory

Under the directive of Caliph al-Ma'mun, scientists were tasked with constructing the Qasiyun Observatory. It is believed that this observatory was erected either in late 830 AD or early 831 AD on Qasiyun Mountain in Damascus. Supervising this endeavor was Khalid bin 'Abd al-Malik al-Mawrudhi, personally chosen by Caliph al-Ma'mun. Al-Mawrudhi was instructed to enhance the astronomical equipment and conduct observations of celestial objects for a year at Dayr Murran to improve data accuracy on the movements and positions of the sun and moon. However, after nearly four years of operation, both the Shammasiyyah and Qasiyun Observatories experienced a significant decline following the sudden death of Caliph al-Ma'mun in 833 AD. His demise led to the discontinuation of observation activities under his patronage.[31]

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[22] Roziah Sidik@Mat Sidek and Wan Kamal Mujani (2012), "Muslim and Non-Muslim Collaboration: Catalyst to the Scientific and Technological Excellence of the Abbasid Era," *Advances in Natural and Applied Sciences*, Vol. 6, No. 3, pp. 268-274.
[23] Gustav Edmund Von Grunebaum (1970), *Classical Islam - A History 600-1258*, George Allen & Unwin Ltd.
[24] Fadzlullah Shuib (1995), *Kecemerlangan Ilmu dalam Sejarah dan Tamadun Islam: Penginstitusian Ilmu di Zaman Abbasiyah 750-125 S.M.*, Kuala Lumpur: Pustaka Warisan.
[25] Wan Kamal Mujani, Ibnor Azli Ibrahim and Mohd Hafiz Safiai (2012), "Observatories in Islamic History," *Advances in Natural and Applied Sciences*, Vol. 6, No. 8, pp. 1370-1373.
[26] Abu al-Qasim Said bin Ahmad bin Said al-Andalusi (1912), *Tabaqat al-Umam*, Impremerie Catholique.
[27] Yahya Shami (1997), *'Ilmu al-Falak: Safhat min Turath al-'Ilmi al-'Arabi wa al-Islami*, Dar al-Fikri al-'Arabi.
[28] Mohammad Sayeed Quraishi (1983), "A holistic view of Muslim science in the 13th & 14th centuries A.D.," International Conference on Science in Islam Organized by Ministry of Science & Technology, National Hijra Centenary Committee and Organization of Islamic Conference, Islamabad, November 19-24.
[29] 'Umar Rida Kahhalah (1972), *'Ulum al-Bahtah fi al-'Usur al-Islamiyyah*, al-Maktabat al-'Arabiyyah.
[30] Zakaria Virk (2001), "A Brief History of Observatories in the Islamic World," *Review of Religion*, Vol. 96. No. 9.
[31] Aidin Sayili (1960), *The Observatory in Islam and its Place in the General History of the Observatory*, Turkish Historical Society.

Banu Musa Observatory

However, following the passing of Caliph al-Ma'mun, Banu Musa persisted in their observational pursuits, notably in Samarra'. Their observations included studying the lunar eclipse and the autumnal equinox. Additionally, they conducted observations in Baghdad concerning stars, the sun's minimum and maximum altitudes, latitude determinations, and the preparation of Zij tables. Noteworthy among their achievements was the observation of the star Ursa Major around the year 863 AD. Their residence by the River Tigris served as their primary location for astronomical observations and became widely recognized in Baghdad's vicinity as the Banu Musa Observatory.[32]

Al-Battani Observatory

Al-Battani, also known as Abu 'Abd Allah Muhammad bin Jabir bin Sinan al-Battani (919-997 AD), hailed from Battan in Iraq.[33] He established an observatory in Raqqa, Syria, where he engaged in observational activities for approximately 40 years.[34] Al-Battani authored the Zij al-Sabi, also referred to as The Sabian Tables, a seminal work that served as a cornerstone of modern Islamic astronomy and significantly impacted scientific progress in Europe. Originally penned in Arabic, it was later translated into Latin by Western scholars and utilized as a reference for centuries.[35]

Ibn al-'Amid Observatory

The Ibn al-'Amid Observatory belonged to Ibn al-'Amid, also known as Abu al-Fadl Muhammad bin al-Husayn bin Muhammad, who was also titled al-Ustadh al-Ra'is.[36] One of his notable accomplishments was the collaborative measurement of the tilt line in the sun's path with al-Khazini, also known as Abu Mansur (or Abu al-Fath al-Mansur, or Abu Ja'far) 'Abd al-Rahman al-Khazini.[37]

Al-Hakim Observatory

During his reign (996-1020 AD), Caliph al-Hakim bi Amrillah established the Al-Hakim Observatory. Initially serving as his residence, it was subsequently transformed into an observatory under his direction. Positioned on Jabal al-Muqattam, it was purportedly integrated into Dar al-'Ilm. For over a century, Dar al-'Ilm has stood out as a hub of knowledge, where scholars from various fields such as astronomy, mathematics, grammar, logic, medicine, linguistics, law, and others conducted research, delivered lectures, and collaborated. It maintained an open-door policy, remaining unaffected by political or ideological pressures. Dar al-'Ilm yielded significant advancements, including contributions in optics by the versatile scholar Ibn al-Haytham, and in astronomy by Ibn Yunus, who flourished in the late 10th and early 11th centuries. Their charts, tables, experiments, and empirical studies would later influence European scientists and intellectuals.[38]

Ibn Yunus Observatory

Ibn Yunus, also known as Abu al-Hasan 'Ali bin 'Abd al-Rahman bin Ahmad bin Yunus al-Sadafi al-Misri, was an esteemed astronomer who enjoyed the patronage of Caliph al-Hakim of the Fatimid Dynasty in Egypt. He is credited as the earliest individual to utilize a minaret as an observatory.[39] (Al-Zirikli, 1995). Renowned for his meticulous observation techniques, Ibn Yunus surpassed the accuracy of previous observations, showcasing his exceptional prowess as an astronomer of his time. His dedication and thoroughness in observation strongly suggest the possible establishment of the Ibn Yunus Observatory. His renowned masterpiece, the monumental al-Zij al-Hakimi al-Kabir, stands as an astronomical compendium (zij) containing meticulous records of observations and comprehensive tables. In this work, he not only meticulously documented his own astronomical observations spanning from 977 to 1003 but also juxtaposed them with those of his predecessors, novel empirical approach unprecedented in Islamic

[32] Muhammad al-Hasini 'Abd al-'Aziz (1973), *al-Hayat al-'Ilmiyyat fi al-Daulat al-Islamiyyah*, Wakalah al- Matbu'at.
[33] Mirfat Al-Sayyid 'Aud and Mustafa Kamal Mahmud (2000), *'Ilmu al-Falak al-'Am*, Dar al-Fikr al-'Arabi.
[34] Umar Farrukh (1970), *Tarikh al-'Ulum 'Inda al-'Arab*, Dar al-'Ilm li al-Malayin.
[35] Thomas F. Glick, Steven John Livesey and Faith Wallis (2005), *Medieval Science, Technology, and Medicine: An Encyclopeadia*, London: Taylor & Francis Group.
[36] Ahmad bin Muhammad Ibn Miskawayh (1914), *Tajarib al-Umam*, Matba'at Sharikat al-Tamaddun al- Sina'iyyah.
[37] Aidin Sayili (1960), *The Observatory in Islam and its Place in the General History of the Observatory*, Turkish Historical Society.
[38] Anuar Al-Rifa'i (1982), *Al-Islam fi Hadaratih wa Nuzumih*, Dar al-Fikr.
[39] Khayr al-Din Al-Zirikli1(1995), *al-A'lam - Qamus Tarajim li Ashhar al-Rijal wa al-Nisa' min al-'Arab wa al- Musta'ribin wa al-Mustashriqin*, Vol. 1., Dar al-'Ilm li al-Malayin.

astronomy. Moreover, the text unveils additional insights where it reveals his consideration of atmospheric refraction of the sun's rays at the horizon where applicable, showcasing a level of precision previously unseen. His tables detailing solar, lunar, and planetary longitudes and latitudes are hailed as the most precise of the medieval Islamic era. Additionally, he furnished instructions for converting dates across Muslim, Coptic, and Syrian calendars, along with methods for determining the meridian, locating the qibla (the direction of Makkah), and predicting lunar phases.[40]

Al-Afdal al-Bataihi Observatory

The Al-Afdal al-Bataihi Observatory was located in Cairo and its construction commenced in 1120 AD, concluding in 1125 AD. Two individuals, namely al-Afdal Shahanshah and al-Afdal al-Ma'mun al-Bataihi, were appointed as overseers to ensure the observatory's completion. Initially, there was a proposal to erect the observatory at Masjid al-Tannur on Jabal al-Muqattam. However, due to logistical challenges in transporting construction materials from the distant location to Cairo, a new site was chosen at Masjid Fila in Jarf, north of Birka al-Habash. Subsequently, the observation facilities at Masjid Fila were relocated to Masjid Juyushi, also known as Masjid al-Rasd, as the former site was deemed unsuitable for achieving satisfactory observation results. Eventually, the facilities at Masjid Juyushi were moved to Bab al-Nasr in Cairo, where the main observatory, known as the Al-Afdal al-Bataihi Observatory, was established. Among its primary functions were the compilation of astronomical tables and the comparison of its calendar with that of Syria. Additionally, observational studies on the orbits of celestial bodies, as well as solar and lunar eclipses, were conducted. [41]

Al-Dinawari Observatory

There existed an observatory believed to be situated in Dinawar, owned by a Muslim scientist of that era. This private facility belonged to al-Dinawari, also known as Abu Hanifa Ahmad bin Dawud bin Wanand al-Dinawari, born in 815 AD, renowned as both a physicist and a scholar of astronomy.[42] He penned a book titled Kitab al-Rasad, which documented observations conducted from 849 to 850 AD along with a Zij. Al-Dinawari's extensive observation activities spanned numerous years. His ownership of this private observatory earned him the title of 'Sahib Rasad,' meaning the owner of an observatory, among many. However, the specifics regarding the equipment he utilized for observation remain undetermined. Al-Dīnawarī pursued philological studies in the Iraqi cities of Basra and Kūfah, where he imbibed a systematic approach to learning. This methodical approach is evident in the extant fragments of his Kitab al-Nabat ("Book of Plants"), renowned as one of the early Muslim era's most prominent botanical works. Primarily lexicographical in nature, it encompasses both oral and written Arabic botanical traditions along with a substantial amount of Persian material. Notable for its elegant prose, it remained a standard reference in the field for generations. Unfortunately, none of al-Dinawari's works on mathematics or the Qurʾān have survived, though there are fragmentary remains of his astronomical observations in Kitāb al-Anwāʾ. The sole complete work to endure is Al-Akhbar al-Tiwal (The Long Narratives), a historical account of Persia written from a Persian perspective rather than an Arabic one.[43]

Sharaf al-Dawlah Observatory

The Sharaf al-Dawlah Observatory was commissioned by Sharaf al-Dawlah, a ruler from the Bani Buwayh dynasty.[44] It was constructed within the gardens of the ruler's residence in Baghdad, hence earning the alternate name of Bayt al-Rasad. Sharaf al-Dawlah placed significant value on knowledge and provided support to all endeavors aimed at enhancing observational activities within the observatory. This observatory gained renown for two distinctive features: i) It operated as a royal observatory with a well-structured system of organization and administration, overseen by a director known as Sahib, who was identified as al-Quhi. ii) The observation activities conducted were notably precise, encompassing

[40] Tom Verde (2019), "Cairo's House of Knowledge," *Aramco World*, retrieved April 30, 2024, https://www.aramcoworld.com/Articles/January-2019/Cairo-s-House-of-Knowledge.
[41] Aidin Sayili (1960), *The Observatory in Islam and its Place in the General History of the Observatory*, Turkish Historical Society.
[42] Yahya Shami (1997), *'Ilmu al-Falak: Safhat min Turath al-'Ilmi al-'Arabi wa al-Islami*, Dar al-Fikri al-'Arabi.
[43] Edna R. Green, Susan Heyner Joshi and Kara Rogers (1998), "Al-Dinawari Astronomer, Botanist and Historian," *Britannica*, retrieved April 30, 2024, https://www.britannica.com/science/biology.
[44] Abu al-Faraj 'Abd al-Rahman bin 'Ali bin Muhammad Ibn al-Jawzi (1992), al-Muntazam fi Tarikh al-Umam wa al-Mulk, Vol.14, Dar al-Kutub al-'Ilmiyyah.

observations of all seven planets over numerous years. At this observatory, notable observations included determining the sun's position during the appearance of the Cancer zodiac constellation in June 988 AD. Three months later, another observation was conducted to ascertain the sun's position during the appearance of the Libra zodiac constellation. These observations garnered the participation of renowned scientists such as Abu Ishaq al-Sabi', Abu Sa'd al-Fadl, and Abu al-Wafa al-Buzjani. Additionally, observation activities related to the sun, solstice, and equinox were also carried out at this observatory.[45]

Maragha Observatory

The Maragha Observatory, conceived by Hulagu Khan and his brother Mangu Khan, was entrusted to Nasir al-Din al-Tusi to oversee its construction.[46] Some studies suggest that Nasir al-Din al-Tusi himself proposed the idea and later presented it to Hulagu Khan. Situated atop a hill in the outskirts of Maragha, Azerbaijan, construction began in 1259 and was completed over a span of five years. Despite its elevated location, water supply was ensured through specialized tools and a water mill. Additionally, the observatory boasted amenities such as a mosque and a library housing over 400,000 books. Its strategic high altitude, coupled with a suitable dome, rendered it ideal for astronomical observations. Moreover, a dedicated residence for Hulagu Khan was erected on the same hill.[47] Operational for approximately 53 years, even after Hulagu Khan's demise in 1265, the observatory continued to thrive. With a multitude of astronomers and comprehensive facilities, including the extensive library, it set a standard for subsequent observatories, embodying the ideal characteristics of a scientific institution that fostered the exchange of ideas and information among astronomers. Its crowning achievement was the creation of the Ilkhanic Tables, also known as Zij Ilkhani in Persian, a compendium of astronomical tables detailing planetary movements. However, in 1336, after over 50 years of operation, the Maragha Observatory ceased its activities due to the downfall of the Il-Khan kingdom in 1339.[48]

Ulugh Beg Observatory

The Ulugh Beg Observatory, erected by Muhammad Turgay Ulugh (1394-1449), known more widely as Ulugh Beg, originated from his personal interest in mathematics and astronomy, stemming from his birthplace in Sultaniyeh, Azerbayjan.[49] Inspired by the Maragheh Observatory, Ulugh Beg spearheaded the construction project, enlisting the expertise of various scientists such as Ghiyath al-Din Jamshid and Muin al-Dini Kashi to devise the building plans.[50] Situated atop a hill on the outskirts of Sultaniyeh, the observatory was furnished with modern facilities and cutting-edge instruments. Construction commenced in 1420, and by 1421, the observatory commenced its operations. Ulugh Beg's vision was to transform Samarqand into a hub for mathematical and astronomical studies, leading him to invite esteemed scientists like Salah al-Din Qadizada, 'Ala al-Din 'Ali Qushji, and Mu'ayyad al-Din al-Urdi to work at the observatory. At a time when knowledge was rapidly advancing, the establishment of observatories became imperative, and the Ulugh Beg Observatory marked a pinnacle achievement during his reign in the history of Islamic observatory establishments. Notable accomplishments included the development of star tables, charts, and astronomical catalogues by Ulugh Beg and his colleagues at the observatory. Operational for over 30 years during his reign, the observatory continued its scientific endeavors until a few years following Ulugh Beg's demise, when he was killed by his own son, Abd al-Latif, in 1450.[51]

Istanbul Observatory

The Istanbul observatory, established by Taqi al-Din al-Rasid, born in Damascus in 1521, was situated in Tophane, on the European side of the Bosporus, during the reign of Sultan Murad III (1574-1595). Taqi al-Din, appointed as the Chief Astrologer by Sultan Selim II, proposed the idea of founding the observatory to Sultan Murad III. Initially, Taqi al-Din conducted astronomical observations from the Galata Tower, but

[45] Aidin Sayili (1960), *The Observatory in Islam and its Place in the General History of the Observatory*, Istanbul: Turkish Historical Society.
[46] Bernard R Goldstein (1985), *Theory and Observation in Ancient and Medieval Astronomy*, London: Variorum Reprints.
[47] Imad Ad-Deen Ahmad (1992), *Signs in the Heavens: A Muslim Astronomer's Perspective on Religion and Science*, Maryland: Writers' Inc. International.
[48] Salah Zaimeche (2002), *A Cursory Review of Muslim Observatories*, Manchester: Foundation for Science Technology and Civilisation.
[49] Salim Ayduz (2008), Ottoman Contributions to Science and Technology: Examples from Geography and Astronomy, Manchester: Foundation for Science Technology and Civilisation.
[50] Kevin Krisciunas (1992), "The legacy of Ulugh Begh," in H. B. Parksoy (ed.), *Bulletin of the Association for the Advancement of Central Asian Research (AACAR)*, Vol. 5, No. 1, pp. 5-19.
[51] Aydin Sayili (2004). *Turkish Contributions to Scientific Work in Islam*. Manchester: Foundation for Science Technology and Civilisation.

the limited space proved inadequate for the large astronomical instruments. Consequently, he advocated for the establishment of a dedicated observatory in Istanbul. Grand Vizier Soqullu Muhammad Pasha and Khwaja Sa'd al-Din supported his proposal. This observatory stood as one of the largest constructed in the 16th century.[52]

Jaipur Observatory

The Jaipur Observatory or also known as Jantar Mantar comprises a series of architectural astronomical instruments, commissioned by Sawai Jai Singh II in 1729, a Rajput monarch, stands as one of the world's most precise pre-modern observatories. It reflects the concerted efforts of the eighteenth century to enhance comprehension of planetary and celestial movements. This observatory is part of a set of five built by the same monarch across northern India, with others located in Delhi, Ujjain, Mathura, and Varanasi.[53] Derived from Sanskrit, 'jantar' translates to instruments, and 'mantar' signifies calculator. Thus, each yantra within the complex serves a mathematical function: some function as sundials, indicating local time and marking the sun's position across the hemisphere, while others track the movements of constellations and planets, discerning zodiacal signs and aiding in astrological predictions. Among these, the Jaipur observatory is the largest and most renowned. Regrettably, shortly after its completion, the observatory began to deteriorate rapidly and had fallen into disrepair by the late nineteenth century. Maharaja Ram Singh initiated its restoration and reconstruction in 1901, resulting in the remains that stand today.[54]

Astrofiqh Observatories in Malaysia

In Islamic civilization, observatories typically fall into two categories: those serving as educational institutions and those dedicated solely to astronomical observation. Observatories functioning as educational institutions were equipped with facilities conducive to academic activities and provided amenities for astronomers to conduct both individual and collaborative research efforts.[55] The establishment of observatories is closely associated with observational studies and theories concerning celestial objects, the spaces between them, and the universe as a whole. Furthermore, with the existence of observatory construction technology dating back to the eighth century. At that time, the era of Islamic civilization marked the beginning of observatory construction, followed by evolution over time. In terms of terminology, Mazlan defined an observatory as an institution where astronomy experts study the universe.[56] These experts investigate radiation from celestial objects to form theories about the cosmos. Meanwhile, Mohd Zambri stated that an observatory is a facility with basic equipment essential for astronomers to explore a small part of the universe.[57] Two observatories stand out as paramount in the annals of Islamic civilization's astronomical history, leaving an enduring imprint, which are the Maragheh Observatory and the Ulugh Beg Observatory. Belonging to the first category of observatories, both establishments were meticulously designed with state-of-the-art facilities to facilitate astronomical research and serve as centers for learning and education in astronomy. During their peak periods of operation, these observatories boasted cutting-edge equipment and offered comprehensive programs for the study of astronomy, attracting a multitude of astronomers and mathematicians.

The construction of observatories in Malaysia is one of the government's pure efforts to ensure the continued development of astronomy in Malaysia. If we look at the history of the development of astronomy in our country, the construction of observatories is also a result of the development of astronomy from the Islamic civilization. According to the history, the construction of observatories has been given special attention, and the idea of their construction was initiated by Islamic scientists as facilities for them to conduct research, education, and determination of worship related to astronomy. This aspect distinguishes observatories in

[52] Kemal Ozdemir (1999), *Istanbul Observatory*, Istanbul: Istanbul University Library.
[53] Vipul Jain (2002), *A Hand Guide to Astronomical Observatory of Jaipur*, New Delhi: Mittal Publications.
[54] Garrett A, Guleri C (1902), *The Jaipur Observatory and Its Builder*, Allahabad: Pioneer Press.
[55] Shirin Haque-Copilah (n.d.), "The Role of Astronomy in Islam," *MoonSighting*, retrieved March 15, 2024, https://moonsighting.com/articles/roleofislam.html.
[56] Mazlan Othman (1993), "Kepentingan balai cerap dalam penyelidikan astronomi," *Seminar Ilmu Falak Peringkat Kebangsaan 1414H/1993*, Anjuran Kolej Ugama Sultan Zainal Abidin (KUSZA), Kuala Terengganu, August 23-24.
[57] Mohd Zambri Zainuddin (2002), "Institusi Balai Cerap: Peranannya dalam Pendidikan, Penyelidikan dan Pelancongan*." Seminar Penghayatan Ilmu Falak*. Anjuran Kerajaan Negeri Melaka & Jabatan Mufti Negeri Melaka dengan kerjasama Persatuan Falak Syarie Malaysia. Air Keroh d"Village Resort, April 7-8.

Islamic civilization from observatories in Western civilization because the aspect of determining worship is an important element given special attention in their studies.

The Astrofiqh observatory in Malaysia also shares similar characteristics, conducting research, education, and determining Islamic worship. Although it is a modern observatory, its foundation is based on astronomy knowledge derived from Islamic civilization. For example, the use of the rubu' mujayyab instrument, discussions on the methods of lunar observation, and zij introduced by prominent figures in astronomy during Islamic civilization.[58]

The Astrofiqh Observatory is a combination of two words, namely 'observatory' and 'astrofiqh.' The word observatory linguistically means a building or structure specially constructed for a particular purpose.[59] Meanwhile, the term observe means to perceive or observe a phenomenon, and to receive something through the senses such as sight and hearing. Therefore, an observatory is defined as a building equipped with specific equipment to enable scientists and others to observe and predict weather phenomena, the positions or conditions of stars, and so on. The term 'astrofiqh' was introduced by Ibnor Azli in conjunction with the term 'cosmic jurisprudence' (cosmofiqh). This term ultimately forms a new body of knowledge that combines space science and Islamic jurisprudence. He defines Astrofiqh and Kosmofiqh as 'a science that discusses the universe regarding the positions and movements of celestial objects to determine calendars, find directions, and establish times related to the laws in aspects of worship, creed, and morality based on Islamic law.' Astrofiqh also encompasses discussions on cosmofiqh related to the aspects of the creation of the universe and the objects within it. It is a branch of knowledge with no end as knowledge about the universe is indeed too vast to be fully explored.[60]

Therefore, the Astrofiqh Observatory can be defined as: a government-managed observatory that functions to conduct research activities, educate in the field of astronomy, and serve as a place for determining Islamic worship practices and calendars in Malaysia. Thus, it can be seen here that the Astrofiqh Observatory is a community-friendly center of knowledge through its activities. Moreover, it also serves as a medium for spreading Islamic teachings through the field of astronomy.[61]

There are five Astrofiqh Observatories in Malaysia conducting research studies, educating in astronomy, and determining Islamic worship practices. These Astrofiqh Observatories are the Pusat Falak Sheikh Tahir, Kompleks Falak Al-Khawarizmi, Balai Cerap Al-Biruni, Kompleks Baitul Hilal Telok Kemang and Balai Cerap Selangor. These observatories are also listed as official observatories in our country. The initial construction of these observatories began in 1980 when there was a need for an Islamic astronomy center to conduct research studies and develop related scientific knowledge. In essence, these five observatories were originally the sites of monthly lunar sighting activities conducted in the past. They were later developed into observatories to further expand their functions and roles in disseminating astronomical knowledge to the public. The first Astrofiqh Observatory built was the Pusat Falak Sheikh Tahir, officially opened on Wednesday, October 9, 1991, corresponding to the 30th of Rabiul Awal 1412H. This center is located in Pantai Acheh, Balik Pulau, Pulau Pinang, at coordinates of 5º 21' North latitude and 100º 12' East longitude, with an elevation of 40 meters above sea level. Its strategic location has made it a center for astronomical research in various aspects such as lunar sighting, sunset studies, atmospheric refraction, and dispersion, among others. This observatory is managed by the Penang State Mufti Department.[62]

The second Astrofiqh Observatory is the Kompleks Falak Al-Khawarizmi. This complex was officially opened by Dato' Seri Abdullah bin Haji Badawi, the fifth Prime Minister of Malaysia at the time, on December 1, 2007. It is managed by the Melaka State Mufti Department. Located at an elevation of 38 meters above sea

[58] Frangky Suleman and Djamila Usup (2021), "The Role of Modern Observation in Understanding the Beginning of the Hijri Month," *Jurnal Ilmiah Al-Syir'ah*, Vol. 19, No. 1, pp. 106-121.
[59] *Kamus Dewan* (2005), Ed. ke-4, Kuala Lumpur: Dewan Bahasa dan Pustaka.
[60] Ibnor Azli Ibrahim (2010), "'Ilm falak wa al-tanjim min al-manzur al-syar'i," PhD thesis, International Islamic University Malaysia.
[61] Ibnor Azli Ibrahim and Radzuan Nordin (2005), "Peranan Balai Cerap Al-Khawarizmi Sebagai Medium Dakwah Berasaskan Sains di Malaysia," *Seminar Internasional Dakwah Serumpun Malaysia-Indonesia*, IAIN Imam Bonjol, Padang, Indonesia, August 23-26.
[62] Mohammad Ilyas (2003), *Astronomi Islam dan Perkembangan Sains: Kegemilangan Masa Lalu Cabaran Masa Depan*, Kuala Lumpur: Institut Terjemahan Negara Malaysia.

level, it is situated at 02° 17' 39" North latitude and 102° 05' 06" East longitude in Kampung Balik Batu, Tanjung Bidara, Melaka. Meanwhile, the third Astrofiqh Observatory is the Balai Cerap Al-Biruni in Tanjung Dumpil, Putatan, Sabah. It was officially opened by TYT Yang Dipertua Negeri Sabah, Tun Ahmad Shah Abdullah, on October 29, 2007. This observatory is located at 05º 54' 18.51" North latitude and 116º 02' 09.09" East longitude. The fourth and fifth Astrofiqh Observatories are the Kompleks Baitul Hilal Telok Kemang and Balai Cerap Selangor. The Kompleks Baitul Hilal Telok Kemang began operations in March 2012, operated by the Negeri Sembilan State Mufti Department in collaboration with the University of Malaya.

Currently, this observatory is managed by the Negeri Sembilan State Islamic Religious Council and overseen by a manager and an assistant manager. The observatory is located in Teluk Kemang, Port Dickson, Negeri Sembilan, at coordinates of latitude 02° 26' 42.7" North and longitude 101° 51' 16.4" East.[63] Meanwhile, the Balai Cerap Selangor was inaugurated by the Sultan of Selangor, Sultan Sharafuddin Idris Shah, on July 20, 2012, in a ceremony attended by the Chief Minister of Selangor, Y.A.B Tan Sri Dato' Ahmad Khaled bin Ibrahim, after almost half a year of operation. This observatory is located in Sg. Lang, Sg. Air Tawar, Sabak Bernam, with latitude 3° 49' 9" North and longitude 100° 48' 57" East at an elevation of 7m above sea level.[64]

All of these Astrofiqh Observatories play the same role, which is to conduct research, education, and determine the timing of Islamic worship. The research conducted includes astrometry, which is the branch of astronomy that involves determining the positions of celestial bodies such as observing the new moon, solar eclipses or lunar eclipses, the positions of planets, the positions of newborn stars or the discovery of comets, and photometry, which is the field for determining the intensity/brightness/magnitude of celestial bodies through selected or determined wavelengths using photometer equipment or Charge Coupled Device (CCD) cameras, atmospheric refraction studies at the horizon, sunrise studies, and Qibla studies of the sun's path.[65]

The studies on sky brightness are also conducted to refine physical parameters with the times of the Isha and Fajr prayers. This study is conducted to observe the brightness of the sky after the sun has set below the horizon for the start of the Isha prayer and before the sun rises in the eastern horizon for the start of the Fajr prayer. This study is carried out with the help of specialized equipment known as high-sensitivity photometers. These devices can measure the amount of light received so that even very low light during the darkness of the night can be measured. Meanwhile, the educational activities in astronomy conducted at the observatories include organizing courses, workshops, seminars, observations, and visits. Astronomy courses cover topics such as an introduction to astronomy, the use of astronomical equipment, techniques for lunar observations, astrophotography techniques, determining the direction of the Qibla, calculation of prayer times, and calendar calculations.[66]

As for observational activities, they include observations of the night sky, phenomena such as solar and lunar eclipses, planet transits, meteor showers, and so on. Visitation programs to the observatories can provide exposure and astronomical knowledge to visitors through video presentations, exhibition galleries, and guided tours of the Astrofiqh observatories.[67] Additionally, astronomy enthusiasts known as amateur astronomers can also contribute to disseminating astronomical knowledge to the public through lectures, talks, seminars, or as facilitators in programs organized at the observatories.[68] What is more important, the role and uniqueness of the observatories can be highlighted to the public through astronomical activities. The role played by the Astrofiqh observatories in determining the prayer times for the Muslim community includes moon sighting

[63] Muzamir Mazlan (2013), "Balai Cerap Teluk Kemang," *Interview*, December, 18.
[64] Anon (2012), "Sultan Selangor rasmi balai cerap jabatan mufti," *Arkib Utusan Malaysia*, retrieved April 21, 2024, http://www.utusan.com.my/utusan/Kota/20120721/wk_02/Sultan-Selangor-rasmi-Balai-Cerap-Jabatan-Mufti.
[65] Mohd Zambri Zainuddin, Amran Muhammad and Mohammaddin Abdul Niri (2008), "Pentafsiran Ilmu Astronomi dalam Sorotan Sains Moden dan Islam," *Jurnal Pengajian Sains dan Teknologi Malaysia*, Vol. 6, pp. 35-48.
[66] Abdul Halim Abdul Aziz (2006), "Penyelidikan Ilmu Falak di IPT," *Seminar Penghayatan Ilmu Falak Peringkat Kebangsaan 2006*. Anjuran Jabatan Mufti Negeri Melaka dan Jabatan Agama Islam Melaka. Hotel Legacy Melaka, November 25.
[67] Baharrudin Zainal (2007), "Pengkamilan Mekanisme Sains dan Agama dalam Konteks Ilmu Falak: Perlaksanaannya di Universiti Darul Iman Malaysia (kini dikenali sebagai UniSZA)," *Seminar Ilmu Falak Sempena Sambutan 20 Tahun Persatuan Falak Syarie Malaysia*, Anjuran Persatuan Falak Syarie Malaysia, Universiti Tenaga Nasional (UNITEN), Bangi, Selangor, July 13-14; Mohd Hafiz Safiai (2013), "Balai Cerap Astrofiqh di Malaysia: Perkembangan dan Peranannya sebagai Pusat Fiqh Falak Bersepadu," Master's thesis, The National University of Malaysia.
[68] Shahrin Ahmad (2007), "Potensi Aktiviti Astronomi Amatur di Malaysia." *Seminar Ilmu Falak Sempena Sambutan 20 Tahun Persatuan Falak Syarie Malaysia*. Anjuran Persatuan Falak Syarie Malaysia, Universiti Tenaga Nasional (UNITEN), Bangi, Selangor, July 13-14.

(hilal) and solar observations. These observation programs are conducted at the observatories to study the sighting of the crescent moon (hilal) relevant to the fasting month of Ramadan, the Eid al-Fitr and Eid al-Adha festivals, as well as the Islamic pilgrimage (hajj). Moreover, the Astrofiqh observatories have been declared as the official moon-sighting sites by the Conference of Rulers.[69] Other related observation activities include performing voluntary prayers (salat sunnah) during solar and lunar eclipses, as well as the forenoon prayer (salat ad-Duha). These roles are similar to those performed at observatories in the past in the West Asia region. However, the difference lies mainly in the use of equipment, as Astrofiqh observatories now employ modern tools such as telescopes, theodolites, and binoculars compared to observatories in West Asia. The Ulugh Beg Observatory in Samarqand used tools such as the sextant, astrolabe, armillary sphere, azimuth quadrant, and equinoctial armillary. However, their purpose remains the same: to conduct research, education, and determine the prayer times for the Muslim community.[70]

The Continuation of Islamic Astronomy through Malay Scholar-Astronomers.

Looking at the development of the Astrofiqh Observatories in Malaysia, it is undoubtedly a continuation of astronomical knowledge from the West Asia region. This continuity has had a significant impact on the advancement of astronomy through Malay scholar-astronomers. These scholars have sought astronomical knowledge in West Asia, such as Sheikh Muhammad Arshad Al-Banjari (1710-1812 CE), Sheikh Mohammad Tahir Jalaluddin (1869-1956 CE), Sheikh Mohammad bin Ismail Daud Al-Fatani, Sheikh Abdullah Fahim, and many others. They were also well-versed scholars in the field of jurisprudence (fiqh) and had expertise in astronomy, following in the footsteps of figures like Al-Khawarizmi, Al-Kindi, Al-Batani, Al-Fazari, Al-Buzjani, and others. The first astronomer scholar was Sheikh Muhammad Arshad Al-Banjari (1710-1812 CE). He was born on the 13th of Safar 1122 AH/1710 CE in Kampung Lok Gabang, Martapura, Banjarmasin, Indonesia. He traveled to Mecca and pursued his studies there. During his time in Mecca, he diligently studied in Masjidil Haram in various fields of knowledge. He studied under many renowned scholars of that time, such as Sheikh Ataillah bin Ahmad al-Misriy, Sheikh Muhammad bin Sulaiman al-Kurdiy, Sheikh Muhammad bin Abd Karim al-Qadiri, Sheikh Ahmad bin Abd Mun'im al-Damanhuri, Sheikh Hasan bin Ahmad 'Akisy al-Yamani, Sheikh Salim bin Abdullah al-Basri, and many others. He also studied in Medina for 5 years, where he learned from Sheikh Muhammad Bin Sulaiman al-Kurdie, who came from Egypt. He wrote various religious books, including books on astronomy.[71]

Sheikh Mohammad Tahir Jalaluddin (1869-1956 CE) was the second astronomer. He was better known as Sheikh Muhammad Tahir Jalaluddin al-Falaki al-Azhari. His full name was Sheikh Muhammad Tahir bin Muhammad bin Jalaluddin Ahmad bin Abdullah al-Minangkabawi al-Azhari. He was born on December 9, 1869, in Ampek Angkek Buki Tinggi, West Sumatra, and passed away on October 26, 1956, in Kuala Kangsar, Perak. Sheikh Tahir studied astronomy in Egypt at al-Azhar University. There, he also studied various other subjects besides astronomy, such as Quran and Hadith studies, theology, Islamic jurisprudence, principles of jurisprudence, exegesis, and computational science. Upon his return to the homeland, he was very active in spreading astronomical knowledge. He was appointed by Sultan Idris, the Sultan of Perak, on October 3, 1900, as the examiner of mosque qibla in the state due to his expertise in determining the qibla direction. He was also entrusted with significant responsibilities and positions, such as being a member of the Council of Great and Learned Men of Perak in 1943, principal at Madrasah al-Masyhur in Penang in 1923, supervisor of Islamic schools in Johor in 1925, headmaster at Madrasah Haji Muhammad Taib in Parit Jamil, Muar, and also as an educator.[72]

Furthermore, the third astronomical scholar is Sheikh Abdullah Fahim. He is also a well-known figure in the Malay astronomical world for being a reference in determining the date of Malaya's independence in 1957. He was born in the year 1286H corresponding to 1869M in Sha'ab Ali Village, Mecca. He was the son of Sheikh Ibrahim bin Tahir from Kubur Panjang, Kedah. His father migrated to Mecca and became a Quran

[69] Majlis Raja-raja (2024), "Sejarah Cerapan Anak Bulan," retrieved May 1, 2024, http://www.majlisraja-raja.gov.my/index.php/bm/profil/sejarah-cerapan-anak-bulan#section=p1
[70] Illias M. Fernini (2011), "Astronomy at the Service of the Islamic Society," *The Role of Astronomy in Society and Culture Proceedings IAU Symposium*, No. 260, pp. 514-521.
[71] Wan Mohd Shaghir Abdullah (2004), "Ahli Falak Dunia Melayu," *Utusan Malaysia*, monday, June 7.
[72] Wazir Jahan Karim (2010), "Personaliti Bersejarah: Sheikh Tahir Jalaluddin," *Buletin Majlis Dato"- Dato" Negeri Pulau Pinang*, Vol. 3, p. 6.

teacher at Masjid al-Haram. His grandfather, Haji Tahir, hailed from Pattani, Thailand. Following his family lineage, Sheikh Abdullah Fahim is of Maghribi Arab descent.[73] He received education from many scholars in Mecca and Medina. His teachers were Sheikh Muhammad Sai'd Babsail (Mufti of Mecca), Sheikh Muhammad Sulaiman Hasbullah al-Makki, and Syed Abu Bakri Syatha (compiler of the book I'anah at-Talibin). Additionally, he also studied under several Malay scholars in Mecca such as Sheikh Muhammad bin Ismail Daud al-Fathani (compiler of the books Mathla al-Badrain and Majma' al-Bahrain), Sheikh Wan Ali bin Abdur Rahman Kutan al-Kelantani (compiler of the books Jauhar al-Mauhub and Lum'ah al-Aurad), and Sheikh Wan Ahmad bin Muhammad Zain al-Fathani (founder of the association of Malay scholars in Mecca). Ismail Awang (1977) stated that Sheikh Abdullah Fahim learned astronomy from a teacher in Mecca, namely Sheikh Muhammad Mukhtar al-Jawi. He taught Sheikh Abdullah Fahim about astronomical calculations such as determining the qibla direction (miqat), prayer times, and the crescent moon (hilal).[74]

The fourth astronomical scholar is Sheikh Muhammad bin Ismail Daud al-Fathani. His full name is Syeikh Muhammad Shaghir bin Ismail bin Ahmad al-Fathani. He is known as Syeikh Nik Mat Kecik Patani. He had a paternal grandfather named Syeikh Daud bin Abdullah al-Patani, who was also a prominent Malay scholar in the 18th century. He was born in 1260H/1844M on Pulau Duyung Kecil, Kuala Terengganu. He received his education in Mecca, studying various fields under Syeikh Abdul Kadir bin Abdul Rahman al-Fathani. He pursued various disciplines such as fiqh, usul fiqh, and others, including astronomy.[75]

The Heritage of Astronomy Knowledge from the Islamic Civilization

Looking at the background of astronomical scholars in the Malay world, there are undoubtedly various contributions related to astronomy that have been left as a heritage of astronomical knowledge. This heritage has been used to develop the astronomy knowledge acquired from teachers in the West, especially in Mecca, Medina, and Egypt. It has been produced in the form of books, tables, and other references that are still used today. Among the astronomical heritage is the Book of Astronomy, written by Sheikh Muhammad Arshad Al-Banjari. He wrote methods for calculating solar and lunar eclipses events in Arabic. Furthermore, the writings by Sheikh Mohammad Tahir Jalaluddin include 'Natijah al-Umur' which discusses methods of calculation in the Hijri and Gregorian calendars, the method of determining the qibla direction, and calculating prayer times and meanwhile 'Jadual Pati Kiraan' shows methods of calculating prayer times and determining the qibla direction. Similarly, the heritage left by Sheikh Abdullah Fahim in astronomy is noteworthy. Among the legacies he left behind are 'Taqwim Waktu Sembahyang' (Prayer Time Schedule), the method of determining the qibla direction and prayer times using the 'Jam Zawal,' the Star Observation Well, the Calculation Method of Malaysia's Independence Day, and the Star Constellation Identification Method.[76] All of these legacies left by astronomical scholars have become references for contemporary astronomers and academics to disseminate to the public. These legacies are valuable contributions from astronomical scholars in the Malay world that should be preserved to this day. They also represent a continuation of the astronomical scholars from the West who produced many books, tables, and astronomical instruments. Some of their legacies such as 'Zij al-Sindhind' by al-Khawarizmi, 'Kitab al-Zij' by al-Battani, 'Figures of Stars' by Abdul Rahman al-Sufi translated into English, and 'Kanun al-Mas'udi' by al-Biruni, among many other.[77]

Observatories Names

In addition to the astronomy brought by astronomical scholars in our country, the name Astrofiqh Observatory is also influenced by the names of astronomical figures. These names are undoubtedly chosen after considering their significant contributions to the field of astronomy. There are three Astrofiqh observatories that use the names of astronomical figures, such as the Sheikh Tahir Astronomy Center, the Al-Khawarizmi Astronomy Complex, and the Al-Biruni Observatory.

[73] Mohamad Subky (2004), *Kisah Abdullah Fahim*, Pulau Pinang: Majlis Bicara sejarah Tokoh Ulama Haji Abdullah Fahim, March 27.
[74] Ismail Awang (1977), "Hj. Abdullah Pak Him," *Pengasuh*, Vol. 428, December.
[75] Wan Mohd Shaghir Abdullah (2005), "Sheikh Nik Mat: Hakim Mahkamah Syarie di Mekah," *Utusan Malaysia*, April 25.
[76] Nor Azam Mat Noor (2010), *Warisan Falak Sheikh Abdullah Fahim*, Georgetown: Jabatan Mufti Negeri Pulau Pinang.
[77] Zaheril Zainudin (2007), "Sumbangan Sains Islam kepada Tamadun Manusia," *Seminar Sains Islam Merentasi Zaman*, Bandar Baru Nilai: Universiti Sains Islam Malaysia.

The Sheikh Tahir Astronomy Center, located in Penang, takes its name from our country's astronomical figure, Sheikh Mohammad Tahir Jalaluddin (1869-1956 CE). Originally, this center was known as the Pusat Astronomi Islam in 1988 and changed to Pusat Falak Sheikh Tahir in 1991 after its official opening in October 1991.[78] Meanwhile, Kompleks Falak Al-Khawarizmi takes its name from the Islamic civilization astronomical figure born in Khwarazm, namely Al-Khawarizmi. His famous work is al-Kitab al-Mukhtasar fi Hisab al-Jabr wa al-Muqabalah. Similarly, the name Al-Biruni has been given to the astrofiqh observatory in Sabah, namely Balai Cerap Al-Biruni. In addition to being proficient in astronomy, he was also skilled in mathematics, geography, and physics, and one of his famous works is the Kanun al-Mas'udi.[79]

Ancient Islamic Astronomical Instrument

One of the continuations of astronomy from Islamic civilization still utilized in the astrofiqh observatories is traditional astronomical equipment. Traditional astronomical equipment mostly consists of non-optical types designed based on geometric principles. Most of them are used in time measurement and direction determination.[80] Now, these instruments have been turned into artifacts in the form of models in the gallery of astrofiqh observatories. These instruments are exhibited to visitors in the astrofiqh observatories as a source of knowledge and reference regarding the contributions of astronomy from Islamic civilization. The traditional astronomical equipment that still persists in our country includes the rubu' mujayyab, the sundial, the meridian stick, and the astrolabe. Rubu' mujayyab or Islamic quadrant is a tool shaped like a protractor used to calculate trigonometric functions and measure angles. The meridian stick, on the other hand, is a traditional method for determining the position of the meridian line, i.e., the north or south direction from a location. Meanwhile, the sundial is a type of instrument used to measure time and determine the entry of Asr and Zuhr prayer times, as well as the changes in the position of the sun.[81] Rubu' mujayyab and sundial were once used by Sheikh Abdullah Fahim when teaching astronomy in the past. He used the rubu' mujayyab to calculate prayer times throughout the year and to make observations to determine the positions of the constellations in the sky. Rubu' mujayyab is a circular quadrant with lines and squares indicating values from 0 to 90 degrees. It includes the names of constellations and prayer times. Sheikh Abdullah Fahim also used the sundial to determine the direction of the Qibla and prayer times. He recorded the Qibla directions for different states in the prayer timetable he produced.[82]

Conclusion

Based on the discussion above, it is clear that Muslim scholars had played an important role in building observatories since the 8th Century AD. Their ideas and works had greatly contributed to the development of astronomy in Europe. The continuity of astronomy in the astrofiqh observatories in Malaysia from Islamic civilization can be seen through the contributions of astronomers in the Malay world. They play a crucial role in disseminating astronomical knowledge to the community until today. This proves that the astronomy learned and transmitted from Islamic civilization has shaped the development of astrofiqh observatories in Malaysia. The defined scope of work for these observatories by the government also demonstrates this continuity. The astrofiqh observatories serve as a new platform for Muslims in Malaysia to delve into astronomy through the activities conducted. Additionally, they serve as a medium for religious outreach to both Muslim and non-Muslim communities through the integration of jurisprudence and science. The knowledge linkage from astronomers in Islamic civilization to Malaysia is exceptionally unique as it culminates in the establishment of government-funded astrofiqh observatories. This is a rare occurrence and may not have happened in any other country in the world.

[78] Mohammad Ilyas (1996), *Islamic Astronomy and Science Development: Glorious Past, Challenging Future*, Subang Jaya: Pelanduk Publication.
[79] Zaheril Zainudin (2007), "Sumbangan Sains Islam kepada Tamadun Manusia," *Seminar Sains Islam Merentasi Zaman*, Bandar Baru Nilai: Universiti Sains Islam Malaysia.
[80] Baharrudin Zainal (1999), "Kaedah tradisional falak: Adakah masih relevan?" *Seminar Penghayatan Ilmu Falak Menjelang Alaf Baru, Negeri Kelantan 1420H/1999*. Anjuran Jabatan Hal Ehwal Agama Islam Kelantan dengan kerjasama Persatuan Falak Syar'i Malaysia, BAKSA dan JUPM, Balai Islam Lundang, Kota Bharu, August 7-9.
[81] Baharrudin Zainal (2002), *Pengenalan Ilmu Falak*, Kuala Lumpur: Dewan Bahasa dan Pustaka.
[82] Nor Azam Mat Noor (2010), *Warisan Falak Sheikh Abdullah Fahim*, Georgetown: Jabatan Mufti Negeri Pulau Pinang.

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