THE PROCEEDING OF THE 6TH INTERNATIONAL SYMPOSIUM ON ISLAM, CIVILIZATION AND SCIENCE (ISICAS 2015)

"Upholding the Dignity of Islamic Civilization"

15 – 16 Zulhijjah 1436H (29 – 30 September 2015)
Universiti Kebangsaan Malaysia.

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FOREWORD

All praises to Allah, the Almighty the Most Gracious and Most Merciful. With His Willingness and Blessness, the Proceeding of the 6th International Symposium on Islam, Civilization and Science (ISICAS 2015) successfully published by the Institute of Islam Hadhari, Universiti Kebangsaan Malaysia (UKM). With gratitude to Almighty Allah, this proceeding is presented to the participants of the ISICAS 2015 and readers, in the hope that we can share our research findings and thoughts on Islam, civilization and science.

The symposium is jointly organized by Institute of Islam Hadhari (HADHARI) Universiti Kebangsaan Malaysia (UKM); Center for Islamic Area Studies (KIAS), Graduate School of Asian and African Area Studies (ASAFAS); and Hadhari Center for Islamic Civilizational Studies (HADHARI – KU), Kyoto University, Japan, is a platform to discuss issues related to Islam, civilization, and science. It highlights the dignity and endurance of Islamic civilization. The papers presented in this proceeding focus on the theoretical, philosophical aspects of Islam, civilization, science, and case studies, so that the readers can appreciate the role of Islam in realizing civil society.

The contents and the ideas in this proceeding are the thoughts and studies by the authors and the participants presented in ISICAS 2015. The organizers sincerely hope that this proceeding will be useful and beneficial to the readers and participants who attended the symposium. We also like to extent our gratitude to the editors of the proceeding for their effort in publishing this proceeding. May Allah SWT reward all those involved in organizing this seminar with the best blessing and reward.

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Happy reading and may Allah bless us all.

Wassalam.

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ASTROFIQH OBSERVATORIES IN SERVICING ISLAM

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ABSTRACT

This article emphasizes astrofiqh observatories in Malaysia on their historical aspects of establishment and development. Studies on observatory are few in numbers in spite of it being an important Islamic institution apart from mosques and schools. Hence, this study is carried out with the aim of analyzing the role of astrofiqh observatories in Malaysia in servicing Islam. This research employed a qualitative method via document analyses, interviews and observations. Results of the study found that the history of the establishment of astrofiqh observatories in Malaysia commenced in the 1980's and the institution rapidly grew until 2015. Up to date, there are eight official observatories in Malaysia excluding hilal observation stations, mobile observatories and private observatories, be they mobile or stationary. Five of them are the astrofiqh observatories which function in servicing Islam for the advancement of astrofiqh (Islamic astronomy) in Malaysia in the fields of research, education and tourism such as in aspect of crescent or hilal sighting, determination of qiblah direction and prayer times calculation, simultaneously playing the role of solving current astrofiqh issues related to Muslims. The observatories indirectly give the Muslim community the exposure to understanding Islamic astronomy holistically.

Keywords: observatories, *marsad al-falak*, Islamic astronomy, astrofiqh, cosmofiqh

INTRODUCTION

The rapid growth in the science of astronomy (*falak*) can be witnessed during the golden age of Islamic civilization, especially during early in the 9th century during the rule of Caliph al-Ma'mun (813-833) of the Abbasid Caliphate. As a result, numerous Muslim scientists from various fields of knowledge, in particular astronomy were born and became world-renowned (Hassan, Abiddin & Ahmad, 2011: 37-38). In the rapid development of the knowledge, two observatories in the Islamic world became landmarks of its glory leaving great impact in the history of *falak*. They were the Maraghah Observatory in the south of Tabriz and the Ulugh Begh Observatory in Samarkand. Both observatories were built complete with facilities provided for astronomers to facilitate their work. In addition, the observatories also functioned as education centers of *falak* science which were well known at that time (Mujani, Ibrahim & Safiai, 2012: 1370).

This study commenced from reviews of previous works in Malaysia such as 'The Importance of Observatory in Astronomy Research' by Othman (1993), 'The al-Khawarizmi Falak Complex: Planning and Future Direction' by Bahali (2006a), 'Astronomical Seeing Measurement of Two Observatory Sites in Malaysia: The DIMM Method' by Zainuddin, Abd. Aziz, Arif, Ahmad and Haron (2006), 'Observatory Technology: Then until Now' by Aziz (2010) and 'Human Resource Development Issues in the Field of Islamic Astronomy: Analysis of the Langkawi National Observatory, Malaysia' by Ismail, Asillam and Zin (2014). In general, all the works only discussed the functions and roles of the observatories. A lack of research in the history of the observatories makes studies such as the one at hand important to be completed. In Malaysia, official observatories are categorized into three types: astrofiqh observatory, federal observatory and high education institution observatory. An astrofiqh observatory is an observatory which is operated by the State Mufti Department (Safiai, Jamsari & Ibrahim, 2014). Federal observatory is one that is under the custody of the National Space Agency or Agensi Angkasa Negara Malaysia (ANGKASA). ANGKASA is a Malaysian government agency which was established for the purpose of developing the education and research in space science, as well as helping the government in implementing the National Space Policy or Dasar Angkasa Negara (Amri, 2009: 23). Meanwhile, high education institution observatory is the observatory run by Universiti Sultan Zainal Abidin (UniSZA), Terengganu.

Through reviews of previous literatures on international observatories, this study has referred to several works such as 'The Royal Astrophysical Observatory of Potsdam' by Leuschner (1892), 'The Yerkes Observatory of The University of Chicago' by Hale (1892), 'The Royal Observatory, Edinburgh, Scotland' by Aitken (1898), 'The U.S. Naval Observatory' by Hall (1899), 'The Tananarive Observatory' by Hunt (1901), 'The University of Tokto Atacama Observatory 6.5m Telescope Project' by Yoshii et al. (2010) and 'National Astronomical Observatory in Japan' by Iye (2009). Analysis of the works reveals that foreign nations have long been working on and documenting the history of observatories for future works. Hence, the objective of the current study is to examine the role of astrofiqh observatories in Malaysia in servicing Islam.

ASTROFIQH OBSERVATORIES IN MALAYSIA

The Muslim society in Malaysia has long been influenced by the science of *falak* since ages ago. Then, observation activities were carried out traditionally, out of keen interest and on the basis of necessity of the society, on mosque towers and top of hills. The equipment used was typical instrument such as binoculars, telescope and teodolit because this equipment is portable and easy to handle. Observation activities at that time were done to see the crescent or *hilal* for determining the starting of Islamic calendar months, especially the months of *Ramadhan*, *Syawwal* and *Zulhijjah* which are related to fasting and celebration of the Muslims in Malaysia (Safiai, 2013).

The terminology 'astrofiqh' has been introduced and used by certain quarters in Malaysia to refer to the science of *falak shar'ie* (Islamic astronomy). Astrofiqh, from the angle of Islamic rule deliberation, involves familial issues such as '*iddah* duration, *nasab* calculation and other issues of worship such as *qiblah* direction, prayer times, starting day of the fasting month of *Ramadhan*, *Eid-ul-Fitr* and *Eid-ul-Adha* (Ibrahim, Mohamad, Samsuddin, Omar & Yahaya, 2009). The term was coined by Ibrahim (2010) by combining it with the term cosmofiqh. Coupling of the two terms eventually forms a new corpus of knowledge which combines space science and Islamic *fiqh*. He defined "*fiqh al-falak wa al-kawn*" (astrofiqh and cosmofiqh) as, "a field of knowledge which studies the universe on the position and movement of celestial objects to determine the calendar, direction, and times which relate to the rules in aspects of worship, creed and morals based on the Shari'ah".

Ibrahim (2010) added that astrofiqh also covers the debate on cosmofiqh which concerns the aspect of creation of the universe and objects within it. Astrofiqh is a branch of knowledge which is endless because the knowledge about the universe is too vast to explore. If we are to analyze as to the new definition of this *falak shar'ie* discipline, we will find that the scope of its studies is broadened to include topics of Islamic faiths and morals apart from the shari'ah rulings on matters concerning the universe on the whole. It is not limited to the studies of space only. Therefore, the Shari'ah stand on what is on earth such as the oceans, air, clouds, earthquakes, thunders and other geographical matters falls under *al-kawn* as meant in the definition.

In the Malaysian context, the use of the 'astrofiqh observatory' term refers to observatory which is handled by the State Mufti Departments. According to Ibrahim and Nordin (2005), an astrofiqh observatory means an integrated center of *falak fiqh* or sciences which carries out activities of educational, research and tourism nature related to the science of Islamic astronomy (*falak*), particularly in matters pertaining to Muslim worship rituals such as the determination of *qiblah* direction and calculation of prayer times. Until recently, there are five astrofiqh observatories in Malaysia, run by the respective State Mufti Departments (Ibrahim, Ahmad & Safiai, 2013; Safiai, Jamsari & Ibrahim, 2014) which are:

1. Sheikh Tahir Falak Centre

The history of astrofiqh observatory construction in Malaysia commenced in the late 1980's with the building of the Sheikh Tahir Falak Centre in Penang. This center was first built in 1988 and later officially opened on the 9th of October 1991. Its construction marked the beginning of the advancement of *falak* in Malaysia at that time. The center also functions as an astronomy and atmospheric science research station for the Penang State Mufti Department and the Falak and Atmospheric Sciences Research Unit, Universiti Sains Malaysia (Ilyas, 2003: 120). Sheikh Tahir Falak Centre is located in Pantai Acheh, which is in the westernmost part of Penang. The observatory's coordinates are latitude 5º 24' 44" N and longitude 100º 11' 52" E. It was built on a hill at a height of 40m from sea level. Its location which is far from the hustle and bustle of the city renders the observatory a suitable place to carry out observation activities (Observatori Negara Langkawi, 2009: 40). The 123th

Conference of Malay Rulers on the 18th of February 1982 consented to the observatory site being made an official site for hilal sighting for Ramadhan, Shawwal and Zulhijjah (Majlis Raja-raja, 2010). The Sheikh Tahir Falak Centre was named after an expert in the field of falak shar'ie in the Malay realm, Sheikh Tahir Jalaluddin. He was an Islamic scholar who received his high education in the Middle East and was well-renowned in the Malay Archipelago for his mastery in two disciplines of knowledge, namely fiqh and *falak* (Abdullah, 2004: 15).

2. Al-Khawarizmi Falak Complex

The Al-Khawarizmi Falak Complex, Malacca was built in 2002 and was later officially opened on the 1st of December 2007. Proposal for the construction of the observatory was mooted to expand and enable efforts of managing worship affairs of the Muslims involving *falak* such as determining the starting date of the Hijri months and calculating prayer time (Bahali, 2012). The Al-Khawarizmi Falak Complex is located in Kampung Balik Batu, Tanjung Bidara in the District of Alor Gajah and is about 25km from the city center of the Historical City of Malacca. Originally, this observatory was an ordinary observation site which was owned by a local resident by the name of Mr. Abdul Karim bin Mohd Amin. Later on, the land was donated or made a waqaf land to the State of Malacca Mufti Department to be gazetted as an official hilal sighting site (Bahali, 2012). Its location is on the shore facing the Straits of Malacca at a latitude of 02 º 17' 39" N and longitude 102 º 05' 06" E. It was also built to face the qiblah, which is at azimuth 292 º 52' 22" (Ibrahim, Ahmad, Safiai & Mujani, 2012: 318).

The position of the observatory at an altitude of 44m above sea level prevents it from any obstruction such as tall buildings and trees. In addition, it has a wide angle of west horizon view of 240º- 295º (Bahali, 2006b: 15). In the 185th Conference of Malay Rulers on the 23rd of March 2000, the observatory got the royal assent from the Council of Malay Rulers to become one of the official hilal observation sites for determining Ramadhan, Shawwal and Zulhijjah (Majlis Raja-raja, 2010). The Al-Khawarizmi Falak Complex was named after a highly knowledgeable Islamic figure for his knowledge in the fields of philosophy, mathematics, astronomy and history, namely Al-Khawarizmi. He was the most prominent mathematician who pioneered several important branches and fundamental concepts of mathematics. The term

'algebra' today is proof of his great contribution in the field of mathematics to the whole world (al-Daffa', 197: 13; Dedron & Itard, 1978, 153).

3. The Al-Biruni Observatory

In the year of 2004, the Al-Biruni Observatory in the State of Sabah began to be built. Construction of the observatory was not only for the purpose of hilal sighting but it also is to function as a catalyst for education, research and the tourism sector. In addition to that, this observatory plays the role of generating growth in the field of *falak* in Malaysia particularly in the state of Sabah. It was officially opened on the 29th of October 2007 (Rajak, 2011: 11). The observatory is in Tanjung Dumpil, Putatan about 15km from Kota Kinabalu and 1km from Putatan within the vicinity of Kg. Contoh, Petagas, Kg. Sri Pandan and Taman Pasir Putih Putatan. The coordinates of the observatory are latitude 05 º 54' 18" N and longitude 116 º 02' 09" E (Rajak, 2011: 16).

The building which is at 1.7m above sea level is oriented to face the South China Sea facing the Ka'bah, which is at azimuth 290 º 22' 31". Apart from that, it has a wide angle of the west horizon view, at azimuth 230º-310º. Gazettement of the observatory site as an official hilal sighting site for the state of Sabah was made on the 19th of October 2006/26 Ramadhan 1427H for the area of 7.760 hectares or 19.17 acres (Rajak, 2011: 17). The Al-Biruni Observatory was named to commemorate a prominent figure in the fields of mathematics, geography, physics and astronomy (Said 1979: 149). The eminence of al-Biruni in various disciplines of knowledge made him a scholar highly respected by rulers of the Islamic world then and he received special treatment and high position from them. He was once an advisor to the ruler of Khawarizm, Abu al-'Abbas al-Ma'mun (Said & Khan, 1992: 110).

4. The Selangor Observatory

Construction of official observatories in Malaysia continued to take place 2009 with the Selangor Observatory. Its construction began in 2009 and was finally completed and commissioned on the 1st of September 2010. The observatory which was then worth RM2.1 million is a building for *falak* studies fully operated by the Observatory Unit of the Falak Shar'ie Division, State of Selangor Mufti Department. The observatory which was officially opened on the 20th of July 2012 is a facility

provided by the State Mufti Department in efforts to study and explore the creation and secrets of the universe. Among the goals of its establishment are to become a research center for astronomers, an education center for the discipline of *falak* and simultaneously to be a medium to spread da'wah to the masses. In addition, it can also be an attractive tourist destination in Sabak Bernam (Balai Cerap Selangor, 2011).

The Selangor Observatory is located in Sungai Lang more than 20km away from the town of Sabak Bernam. The area of the observatory is approximately 4824 m2 and it is within a 100-acre land area of Pusat Dakwah Islamiah (Islamic Da'wah Centre). The observatory is positioned at latitude 03 º 49' 09" N and longitude 100 º 48' 57" E. Its position of 7 m above sea level facing the Straits of Malacca gives a broad view of the horizon and is strategic without being obstructed by obstacles to make surveillance activities (Jabatan Mufti Negeri Selangor, 2003: 1). In the 221st Conference of Malay Rulers on the 24th of June 2010, the observatory was made, by the royal assent of the Council of Malay Rulers, an official hilal sighting site (Majlis Raja-raja, 2010).

5. Teluk Kemang Baitulhilal Complex

The fifth official observatory built in Malaysia is the Teluk Kemang Baitulhilal Complex. Originally, it was only an ordinary hilal sighting station. However, redevelopment process of the observation station was started in the month of December 2009 and the complex was completed in November 2011. This observatory which returned to normal operation in March 2012 is operated by the Negeri Sembilan State Mufti Department in cooperation with Universiti Malaya (Anonymous, 2012). Teluk Kemang Baitulhilal Complex is located in Teluk Kemang, Negeri Sembilan. It is about 40km from the city of Seremban from where it takes about 35 minutes by drive to get there. The location is on the shore facing the Straits of Malacca and its position is latitude 02 º 26' 44" N and longitude 101 º 51' 21" E. It was also built to face the direction of qiblah, which is at azimuth 292 º 52' 22" (Jabatan Kemajuan Islam Malaysia, 2012).

In the 92nd Conference of Malay Rulers on the 16th of March 1972, the observatory site was given the assent by the Council of Malay Rulers to become one of the official hilal sighting places (Majlis Raja-raja, 2010). The complex was built on a land with an area of 1.2 hectares owned by the Majlis Agama Islam Negeri

Sembilan (MAINS). The complex construction project which cost approximately RM30 million was a joint effort between the Department of Waqaf, Zakah and Haj or Jabatan Wakaf, Zakat dan Haji (JAWHAR) and Majlis Agama Islam Negeri Sembilan (Jabatan Wakaf, Zakat dan Haji, 2011). The complex takes the role of being a center for hilal, star and universe observation activities in the effort to further the advancement of *falak*, having well-equipped with the most modern telescope in Southeast Asia and the biggest in Malaysia valued at RM1.8 million (Anonymous, 2012).

The complex consists of an observatory building, three apartments and a 3-star 4-storey hotel which has 82 rooms of which 43 are *superior rooms* and 39 *deluxe-type rooms*. It is built near the observatory building as a facility for visitors and tourists. The hotel is the only hotel in Malaysia which offers as a unique attraction a package for occupants of the hotel to observe objects of the universe (Anonymous, 2011). The complex has the privilege of having unobstructed view of the horizon. Its location is also among the most strategic point in Southeast Asia for *hilal* sighting activities. In Malaysia, it holds the record as the official *hilal* sighting site with the highest *hilal* visibility compared to other official *hilal* observation places all over the country (Shaharuddin, 2006).

ASTROFIQH OBSERVATORIES IN SERVICING ISLAM

The construction of astrofiqh observatories in Malaysia can further advance the science of *falak* of today. In addition to being a place for *hilal* surveillance activities, astrofiqh observatories also play the role of *falak* research centers and effective education institutions of *falak* sciences. Furthermore, they are also seen as potential sites for tourist attractions. In general, all of the observatories were built with a purpose of developing the science of *falak*, be it from the aspects of research, education or tourism. The roles of astrofiqh observatories in servicing Islam are further discussed later on.

1. Official hilal observation site (Determination of the start of Islamic month)

The history of official *hilal* observation activity in Malaysia began in 1970 when the National Council for Islamic Affairs was established and the council was chaired by the Yang Teramat Mulia Tunku Abdul Rahman Putra al-Haj. In line with the

establishment of the council, several official committees for *hilal* sighting for *Ramadhan* and *Syawwal* were appointed at three sites, which were Telok Kemang in Negeri Sembilan, Johor Bahru in Johore and Kampung Pulau Sayak in Kedah. At the early stage, *hilal* sighting activities were carried out at official *hilal* observation sites throughout Malaysia using the naked eyes only. However, after the involvement of *Jabatan Ukur dan Pemetaan Malaysia* or the Department of Survey and Mapping Malaysia (JUPEM), modern optical equipment such as theodolite began to be used (Unit Falak Bahagian Penyelidikan, 2001). The Council of Malay Rulers through the National Council for Islamic Affairs on the 14th of December 1989 established a committee named as Committee to Determine the Start of Fasting and *Hari Raya* (*Eid*). It was then chaired by the Director-general of the Bahagian Hal-Ehwal Islam or Islamic Affairs Division (BAHEIS) of the Prime Minister's Department. The committee functions as the coordinator for the determination of the starting date of the fasting month and the dates of *Hari Raya* (*Eid*) in Malaysia (Unit Falak Syarie, 1993).

In Malaysia, deciding the start of the Islamic calendar month is done based on the method of *rukyah* and *hisab* (*falak* calculation). Both methods are used in establishing the starting date of the months in the Islamic Hijri calendar, particularly the three important months of *Ramadhan, Syawwal* and *Zulhijjah*. The same methods are also used for the purpose of establishing the Islamic calendar (Bahali, 2006b). The decision on the start of the Hijri months used by the Muslim community in particular in deciding the start of *Ramadhan*, *Syawwal* and *Zulhijjah* is based on the movement of the moon and earth orbiting the sun. The moon's orbit around the earth is from the west to the east (Unit Falak Bahagian Penyelidikan, 2001). The orbits of the moon and the earth around the sun become the basis for calculating the start of the month and year which is very much related to the rites of fasting and its celebration, the day of *eid*. Establishing the fasting starting date and the date of *eid* in Malaysia is based on *rukyah* and *hisab*.

Through the rapid development and progress in Malaysia, the existing official *hilal* observation stations until today have been equipped with facilities such as viewing galleries, observatory equipment pole, restrooms and prayer rooms. This makes the observers more comfortable and indirectly facilitates the sighting activity to gain a better quality and more accurate result of *hilal* observation. Various efforts have been made to modernize the official *hilal* sighting stations through renovation

and addition of infrastructures at the observatories. As a result, official *hilal* sighting stations have undergone quality improvement process and good enhancement as witnessed today. Up until 2012, some 30 official *hilal* observation sites have been built throughout Malaysia (Jabatan Kemajuan Islam Malaysia, 2011).

Several astrofiqh observatories which are present at the moment originally were basic observation stations only. However, those stations underwent upgrading and were developed to become observatories considering the strategic locations of the observation sites which are suitable and able to meet the requirement of observation activities. The observatories are the Baitulhilal Complex in Teluk Kemang, the Al-Khawarizmi Falak Complex and the Al-Biruni Observatory. The Sheikh Tahir Falak Center and the Selangor Observatory were built from scratch and do not originate from an observation station. Nevertheless, both observatories, like other observatories, also function as official *hilal* sighting sites in their respective states.

2. Falak research centers

Parallel with current technological updates, *astrofiqh* observatories in Malaysia also play the role of *falak* research sites. Researchers are done with the objective of studying current astronomical phenomena and solving issues concerning the science of astronomy. Among the research carried out at these observatories are *hilal* visibility studies which are performed at every end of the Islamic month to record data of the moon and its motion. Preparation for the observation includes the process of obtaining data for the sun and moon motion. Observation may be done using the help of instruments such as theodolite, telescopes or binoculars. The use of such equipment is to facilitate the observer in focusing onto the correct direction while looking for the crescent (Aziz, 2006).

In studying *hilal* sighting, observation should be done carefully because the process of *hilal* sighting requires a combination of knowledge in *falak shar'ie*, mathematics and optical physics (Ibrahim et al., 2012). The necessity of possessing the combination of those disciplines is important to ensure that the characteristics of the *hilal* are identified correctly to avoid any mistake done during the observation process (Laporan Kumpulan Fizik Angkasa UM, 2000-2006). Studies such as those are crucially important to provide feedback and improvement to the process of *hilal* visibility criteria review which was once considered in Malaysia and Indonesia. This

was consequent to the criticism from professional groups about the unsuitability of the *hilal* visibility criteria used then. The criteria were said to be too low and deviated too much from the

Visibility data collected through surveillance in Malaysia and throughout the world (Aziz, 2006). These studies have been on-going at the Sheikh Tahir Falak Centre, Al-Khawarizmi Falak Complex, the Al-Biruni Observatory, the Selangor Observatory and the Baitulhilal Complex in Teluk Kemang which give more emphasis on local observation data in Malaysia.

In addition, sky brightness studies are also carried out to assess the brightness of the sky before sunrise and after sunset. The research is done to determine the position of the sun under the horizon to determine the time of the *Ishak* and *Fajar* prayers. With the help of equipment, sky brightness can be measured by looking at the effect of light scattering after sunset and this is linked with the sun's position under the horizon to decide the starting time of *Ishak* prayer (Niri et al., 2012). Meanwhile, for the dawn (*Fajar*) prayer time, the sky brightness is measured before sunrise. In practicality, the *Ishak* prayer time begins when 'red light' or *shafaq al-ahmar* disappears from the sky. This happens due to the position of the sun which is far below the horizon. The *Fajar* time meanwhile begins when 'white light' or *fajar sadiq* appears in the east horizon within the vicinity of the sunrise position (Shukor, Ahmad & Zainuddin, 2011). In Malaysia, the criterion used to determine the start of the *Ishak* prayer time is when the position of the sun is 18º below the horizon and, for the *Fajar* prayer time, 20º below horizon (Ahmad, Zainuddin, Ibrahim & Yahya, 2007). These studies have been done at the Sheikh Tahir Falak Centre and the Baitulhilal Complex, Teluk Kemang. Results of the studies found and confirmed that there is a difference in the angle of sunsets for prayer times of *Ishak* and *Fajar*. However, the obtained values do not undermine the existing values.

Among other researches carried out at the observatories are studies on refraction near the horizon. The purpose of this research is to determine the angle of refraction of celestial objects for a specific area which is usually done at the time the object rises and sets. Refraction correction is important in calculating the time of *Maghrib* and *shuruq* or sunrise. Also, it is important in knowing the effect of atmospheric refraction index factor on the position of *hilal* and the sun (Sadali, Sulung & Aziz, 2011). Refraction near horizon is a phenomenon which occurs due to

light refraction by earth atmospheric layers. Difference in density between outer space and the multi-layered earth atmosphere with each layer having different physical properties cause a light refraction towards the sight of the sun at sunsets (Zainuddin, Saadon & Ahmad, 2011). However, studies from time to time are best done to enable a production of a better refraction model for areas of the country which are located near the Equator and by the sea. In Malaysia, astrofiqh observatories which run horizon refraction studies are Sheikh Tahir Falak Centre and the Teluk Kemang Baitulhilal Complex.

Research on sunrise is also carried out to record the difference in positions of sunrise each month. Such study is done because recorded data related to the sun are useful to know the time and direction in our daily life (Vasiliev & Tataridou, 2013). This study employs a stationary station and it must have its own reference point. Through this study, photographs of the sun are recorded using a camera fixed at the stationary station. Normally, this observation study is done on the 17-25th of the month at a fixed time, which is at 8:30 in the morning. This work is carried out at the Selangor Observatory (Burhanuddin, 2012).

Finally, studies in sun-crossing *qiblah* are done to check and ensure that the schedule of sun-crossing *qiblah* produced by State Mufti Departments is correct and accurate. The work uses the existing schedule as a reference. Should there be any changes or improvement, observatory officers shall inform the state mufti departments for further actions. In Malaysia, the phenomenon of the sun being right above *qiblah* line occurs throughout the year except for certain days in January, June, July and December. Therefore, Burhanuddin (2012) carries the opinion that the method of the sun crossing give better opportunity for the Muslims to check and determine the direction of *qiblah* at any place as compared to the phenomenon of the sun being right above the Ka'bah which occurs only twice a year. This study is done at the Selangor Observatory.

3. Education institutions for falak science

In line with the progress of observatories in Islamic civilization, astrofiqh observatories in Malaysia also act as education centers for *falak science*. This is natural since Islam emphasizes on education, including *falak* education (Hassan, Abiddin & Ahmad, 2011). Numerous activities have been organized by the

observatories, be they at the observatory itself or at other locations. The activities received good response and support from the locals and this somewhat helps to advance the progress of *falak* in Malaysia. Organized activities include basic courses in *takwim* (calendar) and *hilal* sighting. Through these courses, in the Islamic calendar course for example, participants are exposed to the introduction of Islamic calendar existing in Malaysia. In addition, participants are also given guidance to the calculation methods of converting Gregorian dates to Hijri dates and vice versa. At the end of the program, the participants are given opportunity to observe *hilal* at sunset.

Al-Munajjid (2009) asserted that basic course in *qiblah* direction determination is run to give exposure to participants on the method of determining *qiblah* direction in theory and practice. In Malaysia, this course is run by experts in *falak*. Through this course, participants are informed of the procedures and guidelines in determining and checking *qiblah* direction in Malaysia. In addition, *astrofiqh* observatories also organize basic course in prayer time calculation. Through this course, participants are exposed to matters related to prayer including the history of commandment of the prayers. Since prayer time is determined based on the movement of the sun, some information related to the sun is also discussed (Niri et al., 2012; Man et al., 2012). Apart from that, participants are also taught how to calculate prayer time using a specific mathematical formula.

Other activities include basic course in *rubu' mujayyab* which introduces the use of traditional astronomical instrument by earlier Muslim scientists (Ali, 2011). Participants are exposed to the use of *rubu' mujayyab* and trigonometry in solving trigonometric equations using the instrument. In addition, several ways of constructing and preparing the instrument are also taught, apart from learning the correct techniques of using it. On top of that, *astrofiqh* observatories also run basic course in telescope operation with the aim of providing the participants with an understanding of the design of telescopes and its advantages, disadvantages and its suitability for use in current conditions. Besides, telescope operating procedures in technical aspects of observation and its correct and complete maintenance are also explained.

Further activities include night sky gazing program which is run with the objective of showing secrets of the universe and its contents such as the moon, planets

and stars to participants. Observing celestial objects is done using stationary or mobile telescopes at night depending on the astronomical phenomena which occur every month. In addition to that, participants of the program are able to directly see and know first-hand the structures of objects in the sky and their movement. Furthermore, eclipse observation program is also organized to explain to the public on the concept of sun and eclipse occurrence. In the program, the structure of the sun and the moon is also studied and understood through their movement using telescopes available at the observatory. Apart from that, the program also explains the types of sun and moon eclipse. Aside from carrying out observation activities, eclipse prayers are also offered among Muslim participants as a gratitude for the blessing bestowed by Allah. After performing the prayer, a sermon is delivered to remind the Muslims to always obey the commands of Allah as stipulated in Islamic teachings. During the time of eclipse, Islam encourages its adherents to do a lot of *zikr* to Allah.

Other activities include seminars and *falak* day celebration. Astrofiqh observatories in Malaysia also organize talks and seminars to broadcast information and explanation to the public on the science of *falak*. Such programs can stimulate public interest and enthusiasm towards the heyday of *falak* in history and Islamic civilization. Through them, the public can get to know the history and development of *falak* as well as famous Islamic scholars in the field. Meanwhile, *falak* day festival is held annually in May to encourage public participation in astronomical activities organized in *astrofiqh* observatories. Activities done on *falak* day among others include quizzes, photography contest, water rocket competition, video shows and exhibition (Bahali, 2006a).

CONCLUSION

As discussed previously, development of Islamic astronomy in Malaysia is realized by astrofiqh observatories which continuously play important roles in order to enhance the knowledge. The establishment of astrofiqh observatories has long occurred beginning in 1980 and has not stopped since then. In fact, its establishment is spread throughout Malaysia and follows the changes of time in order to offers services in Islam especially for the accurate determination of times, dates pertaining to Islamic rituals and worship such as prayer, Ramadan, Shawal and Zul Hijjah and the direction of *qiblah*. As a conclusion, the development of Islamic astronomy parallel with the

success of astrofiqh observatories, so that Malaysia will be well known by the entire world as one of world class Islamic astronomy center in the future.

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