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Astronomy Awareness for the Growing Global Civilisations

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ABSTRACT

Astronomy is an in-depth study of celestial bodies such as planets, stars, galaxies, and other universe phenomena. Characterized by rapid advances in technology and space exploration, astronomy not only provides insight into the origins of the universe but also has an increasing urgency in an ever-evolving globalized world. The science of astronomy lies in various aspects, including understanding the origin of the universe, the evolution of stars, and the study of planets outside the Solar System.

These discoveries contribute significantly to technological advancement and global security. In a globalized world that proved to be quite reliable this year. International growth is expected to slow down to 2.7 percent in 2024 which was the lowest annual growth since the pandemic in 2020.

The world's two largest economies, the US and China, are expected to decline in growth next year, which will affect the globalized world. In this research, the author uses the research method of analysis Data collected from telescopic observations, and space missions can be analysed mathematically and statistically to understand the characteristics of the universe, such as the distance of stars, the composition of planetary atmospheres, or the patterns of galactic motion.

From this research, it can be concluded that astronomy is not only about researching and exploring the universe but also about its urgency and relevance in an increasingly connected global world.

I. Introduction

Astronomy has played a significant role in human and technical advancement from the dawn of time. The capacity to forecast the motions of the Sun and stars, which are crucial components in many areas, has made the sky a source of amazement. The deep curiosity regarding the origin and history of the Sun, Moon, stars, galaxies, and the Universe itself stems from a need to know more about our origins.

Human soul and public imagination are stimulated by astronomy. The outcomes of the contemporary astronomical study have already profoundly influenced our society, with words like "black hole," "big bang," and "light-year" becoming commonplace. Any well-stocked bookshop will have an astronomy section with enormous, gorgeous picture books of the universe and technical books about the cutting edge, written by journalists, writers with astronomy degrees, and practicing astronomers.

Astronomy could have a significant impact on global conditions and world civilization [1]. One of the worldwide factors influencing global civilization is astronomy. The study of events and objects, such as stars, planets, and galaxies, both inside and outside the Earth system, is known as astronomy. A contemporary example of the long history of astronomy's contributions to science and technology is the 1960s NASA experimentation in X-ray astronomy, which was extended to the production of X-ray inspection systems for airports, military installations, and border control agencies. Astronomers' image-processing methods are now widely used in arthroscopic surgery, industrial settings, and even in the tracking of critically endangered wildlife. Now, scheduling software created for the Hubble Space Telescope is being used to streamline semiconductor production and control patient flow in medical facilities.

In a globalized world that has proven to be quite reliable this year, it is expected to slump next year due to the pressures of war, inflation, and still-high interest rates. International growth is expected to slow to 2.7 percent in 2024 from a pace of 2.9 percent this year, which was the lowest annual growth since the pandemic in 2020. The world's two largest economies, the US and China, are expected to decline in growth next year, which will affect the globalized world [2].

Indonesia is feeling the vibration of the impact of the global demand slowdown as a major test in 2024. The challenges of the global economy in 2024 can be summarised into several main aspects, such as weakening global demand, changes in trade policy, uncertainty related to global monetary policy, and tensions in international trade.

Global warming has become a major issue in the world, a challenge that must be faced by all countries in the 21st century. It impacts global climate change because of the greenhouse effect and fulfillment of emissions. Global warming occurs because of the massive exploitation of natural resources that are not in this condition will occur from year to year which is a serious problem for the world because of climate change [3]. The urgency of astronomy in 2024 on the global with the effects that appear in the middle of world civilization is an important topic in explaining the impact and influence of astronomy on global conditions and world civilization. The impact of astronomy on global conditions and world civilization will continue to grow and needs to be dealt with in an effective way [4].

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II. Method

The research method used in this study is a literature analysis research method conducted to obtain information about the influence and urgency of astronomy on the global, as well as the effects that appear in the middle of world civilization. Data collected from observations and space missions can analysed mathematically and statistically to understand the characteristics of the universe, such as the distance of stars, the composition of planetary atmospheres, or the patterns of galactic motion. Multi-faceted study of a theory that is based on objective knowledge assumptions and then written about in various sources of information. The references are sourced from journals and books.

III. Results and Discussion

The global significance of astronomy in 2024 with its effects on world civilisation can be seen through the various astronomical phenomena that will occur during 2024. Total Solar Eclipses, planetary alignments, the emergence of new star nests, global boiling, and more extreme weather will affect world civilization. The schedule of astronomical phenomena that will occur will also increase the interest and excitement of scientists and astronomy enthusiasts. The alignment of the planets and the moon will produce a beautiful sight when viewed from Earth, while a total solar eclipse will make Earth's conditions dark as night, but only for a short time interval [5].

The emergence of new star nests or star nurseries will allow scientists to study the mysterious things that happen in the Antennae region. Global warming and more extreme weather will affect the world's civilization, including increases in global temperatures, daily temperatures, and monthly temperatures. The El Niño that emerged from June 2023 also plays an important role in increasing global temperatures. The schedule of astronomical phenomena that will occur in 2024 increases the interest and excitement of scientists and astronomy enthusiasts. There are dozens of astronomical phenomena to watch, including new Moon phases, full Moon, and Solar and Lunar eclipses. The global significance of astronomy in 2024 can be seen through the various astronomical phenomena that will occur during 2024 [6].

Some of the astronomical phenomena that occurred include the Total Solar Eclipse that occurred on 8 April 2024, which is a very rare once-a-year phenomenon. The Total Solar Eclipse will make for a beautiful sight when viewed from Earth, which could lead to eclipse-chasing tours and expeditions. There is the phenomenon of planetary alignment or planetary conjunction, which will produce a beautiful sight when viewed from Earth. The alignment of the planets will produce a beautiful sight when viewed from Earth, which can become a tourist activity and expedition to chase planetary conjunctions. There is the phenomenon of new star nests or star nurseries appearing, which is a rare occurrence. The appearance of new star nests or star nurseries will allow scientists to study the mysterious things happening in the Antennae region. The year 2024 will see global warming and more extreme weather, which will affect world civilization. This includes increased global temperatures, increased daily and monthly temperatures, total solar eclipses, planetary alignments, and the emergence of new star nests. The Covid-19 pandemic has affected the global economy, causing demand for exported and imported goods to decline. Astronomy 2024 will have an impact on the demand for export and import goods, such as regional and global supply

chains, the Fourth Industrial Revolution (4IR) and the digital era, and the increase in Free Trade Agreements/Regional Trade Agreements in the world, such as the ASEAN Regional Comprehensive Economic Partnership (RCEP) [7].

Astronomy in 2024 affects public policy, such as the DKI Jakarta government which made a Large-Scale Social Restrictions (PSBB) policy and replaced it with the Enforcement of Restrictions on Community Activities (PPKM) as an instrument to prevent the spread of COVID-19. Astronomy 2024 will affect education, such as the face-to-face school policy that has sprung up school clusters (SD, SMP, and SMA) [8]. Astronomy 2024 will affect social behaviour, such as sanctions given to residents who do not use masks and social work for one hour. Astronomy 2024 will affect health, such as the DKI Provincial Government's policy of controlling events that occur by making control measures on other variables that may affect the event. Astronomy 2024 will affect science, such as the research methods of science, which have the main characteristics of being arranged systematically and coherently using the scientific method. So, astronomy 2024 will have a global effect on world civilization in several aspects, such as global economic recovery, public policy, education, social behaviour, health, and science [9].

Astronomy 2024 will affect world civilization through various factors, which will affect weather, climate, human behaviour, technology, and global political and economic stability. Global warming will continue, caused by greenhouse gases accumulating in the atmosphere. This will affect global weather and climate, which will become a top global risk by 2024 [10]. Several rare astronomical phenomena will occur in 2024, such as total solar eclipses, planetary alignments, and the emergence of new star nests. Solar storms are expected to peak in 2024, which will affect power grids, GPS signals, and satellites. 2024 will be a general election year for presidential candidates in Indonesia, which will be synonymous with the risk of "misinformation and disinformation"& "polarisation of society" [11].

Global warming will affect climate change, which will affect weather, natural events, and human behaviour. The use of technology to process raw materials will affect the earth's temperature, which will be a top global risk by 2024. Some regional conflicts and crises will potentially spill over to the global sphere, which will affect global political and economic stability. On this occasion, astronomy 2024 will affect world civilization through various factors, which will affect weather, climate, human behaviour, technology, and global political and economic stability [12]. The astronomical urgency of 2024 for the global is a phenomenon that can influence human behaviour, technology, and global political and economic stability. Global warming is a phenomenon that can affect human behaviour, technology, and global political and economic stability. Global warming will continue, caused by greenhouse gases accumulating in the atmosphere [13]. This will affect global weather and climate, which will become the top global risk in 2024. Global warming is a phenomenon that can affect human behaviour, technology, and global political and economic stability. This is caused by greenhouse gases accumulating in the atmosphere, which will affect global weather and climate. Greenhouse gases are gases that can affect global weather and climate [10].

Greenhouse gases are formed when organic materials such as carbon dioxide, methane, and nitrogen oxide are obtained by microorganisms and plants, and then accumulate in the atmosphere. The effects of global warming are changes that occur in global weather and climate, which can affect human behaviour, technology, and global political and economic

stability. The effects of global warming include changes in weather, natural events, and human behaviour. Global warming will be the top global risk in 2024. This is caused by changes in global weather and climate which can affect human behaviour, technology, and global political and economic stability [13].

Rare astronomical phenomena are phenomena that can influence human behaviour, technology, and global political and economic stability. Several rare astronomical phenomena will occur in 2024, such as a total solar eclipse, the alignment of planets, and the emergence of new star nests. Rare astronomical phenomena are phenomena that can influence human behaviour, technology, and global political and economic stability. Several rare astronomical phenomena will occur in 2024, such as a total solar eclipse, the alignment of planets, and the emergence of new star nests. A total solar eclipse is a phenomenon that occurs when the Moon completely blocks the Sun's light from reaching Earth. The peak of the solar eclipse which will occur on April 8th, 2024, is expected to last less than 10 minutes. The emergence of new star nests is a phenomenon that can influence human behaviour, technology, and global political and economic stability. This new star nest will influence weather, natural events, and human behaviour.

The sun could cause changes in GPS signals because GPS signals depend on the radio signals used to send and receive GPS signals. If the radio signal is disrupted, the GPS signal can be disrupted directly, which can cause a loss of precision and accuracy of the GPS signal [14]. Solar storms can cause changes in satellite performance because the radio signals used to control and regulate satellites depend on GPS signals. If the GPS signal is disrupted, satellite performance can be directly disrupted, which can cause damage and loss of satellite connections [15].

Climate change will affect the weather and seasons, which will affect human life. Throughout 2023, there will be 4,938 natural disasters in Indonesia, causing at least 265 people to die. The impacts of climate change will be felt in 2023, which will increase the risk of natural disasters. The most significant impact of climate change is that the climate and seasons become more uncertain. Climate change will affect natural disasters, which will affect human life. The deadliest natural disasters in Indonesia are forest and land fires, floods, and extreme weather [12]. It is necessary to make efforts to reduce disaster risks, which include meteorological disaster control, landslide disaster control, and storm disaster control. Climate change will affect human behaviour, which will affect human life. It is necessary to adopt climate change-informed behaviour, such as optimizing the function of water resources infrastructure in urban and rural areas [16].

Technology has great potential in processing raw materials, which will affect the earth's temperature, which will be the top global risk in 2024. The use of technology to process raw materials, such as processing oil, natural gas, and metals, will affect the earth's temperature. This is caused by greenhouse gas emissions and others produced by the processing of raw materials. Processing raw materials will produce greenhouse gas emissions, which will increase the earth's temperature. Greenhouse gas emissions occur when raw materials are converted into final products, such as plastics, fuels, and building materials. The use of technology to process raw materials will affect the earth's temperature because the resulting greenhouse gas emissions will increase the earth's temperature. This will influence the weather, natural events, and human behaviour [17]. To reduce greenhouse gas emissions

produced using technology to process raw materials, solutions need to be implemented such as using clean fuel, using more efficient technology, and reducing the use of unnecessary raw materials. The use of technology to reduce greenhouse gas emissions, such as technology that converts carbon dioxide into fuel, will help reduce greenhouse gas emissions produced by processing raw materials [18].

The urgency of astronomy in 2024 on a global scale with its emerging effects on world civilization can be viewed from various perspectives, starting from global warming, and rare astronomical phenomena, to the impact on global political and economic stability.

Some factors impacts that arise [19] Global Warming Global warming will continue, caused by greenhouse gases accumulating in the atmosphere. This will affect global weather and climate, which will become the top global risk in 2024. Several rare astronomical phenomena will occur in 2024, such as a total solar eclipse, the alignment of planets, and the emergence of new star nests. The Quadrantids meteor shower is an amazing celestial phenomenon with a high level of activity. This meteor comes from the dust of comet 2003 EH1, which was first discovered in 2003. This meteor shower occurs on January 1-5, reaching its peak on the night of the 3rd and the morning of the 4th. A penumbral lunar eclipse is an astronomical phenomenon that occurs when some light The Sun's path to the Moon is blocked by the Earth. This event will occur on March 25, 2024 [20].

A Total Solar Eclipse or Ring Solar Eclipse is a phenomenon that occurs when the Moon completely blocks the Sun's light from reaching Earth. The peak of the solar eclipse which will occur on April 8, 2024, is expected to last less than 10 minutes. The alignment of the planets or planetary conjunction is a phenomenon that was the first- and last time astronomers observed an event like this. The emergence of new star nests is a phenomenon that can influence human behaviour, technology, and global political and economic stability [20].

To overcome the impact of astronomical phenomena that occur in 2024, several steps can be taken with education and knowledge about the astronomical phenomena that occur that can help overcome the impact. Skywatchers and scientists can provide information about these phenomena, as well as explain their impact on human behaviour, technology, and global political and economic stability. Observations and plans can be made to reduce the negative impacts of astronomical phenomena. For example, observations of the Quadrantids meteor shower can be made in 2024, which will occur from January 3 to 4. During the peak phase, dozens of meteors will be visible every hour, and clear sky conditions and minimal light pollution can affect the quality of observations [21].

Astronomy has various influences and hopes for the future of world civilization. Astronomy is a science that studies natural phenomena in outer space, which can be observed from Earth. Every month, astronomical phenomena change because of the movement of celestial bodies that have different orbits and speeds. Some astronomical phenomena occur once every ten or hundreds of years, which are called rare astronomical phenomena. Global boiling and more extreme weather affect world civilization, including increasing global temperatures, increasing daily and monthly temperatures, and more extreme weather.

The schedule of astronomical phenomena that will occur in 2024 will also increase the interest and happiness of scientists and astronomy fans. Rising global temperatures will bring hotter conditions in some regions, which will affect agriculture, health, and the

environment. Increasing daily and monthly temperatures will affect human health because it can cause dehydration, lung disease, and other health problems. More extreme weather, such as heavy rain, and direct rain will affect infrastructure, roads, and the environment.

Protection and control can be carried out to reduce the negative impact of astronomical phenomena. For example, a total solar eclipse occurs on April 8, 2024, which will last less than 10 minutes. To reduce the negative impact of a total solar eclipse, protection and control can be done, such as using glass in buildings, stopping dangerous activities, and adjusting work schedules. Health and safety measures can be taken to reduce the negative impacts of astronomical phenomena. For example, health can be done by arranging work schedules, using masks, and arranging the scope of work. Safety can be done by arranging a travel schedule, using gloves, and arranging the scope of the trip.

Astronomy influences human life in various ways, such as increasing global temperature will affect agriculture, health, and the environment. Rising global temperatures will bring hotter conditions in some regions, which will affect agriculture, health, and the environment. [22].

Increases in daily and monthly temperatures will affect human health because they can cause dehydration, lung disease, and other health problems. More extreme weather, such as heavy rain, heavy rain, and direct rain, will affect infrastructure, roads, and the environment. A total solar eclipse is a solar eclipse that occurs when the disk of the Sun is completely covered by the disk of the Moon. When this eclipse occurs, the disk of the Moon can appear as large as the disk of the Sun, or even larger. The alignment of the planets will produce a beautiful view when viewed from Earth, which can become a tourist activity and expedition to pursue planetary conjunctions. The emergence of new star nests or star nurseries will allow scientists to study the mysterious things happening in the Antenna region.

Indonesia's astronomical position is a position that is influenced by imaginary lines, namely latitude and longitude. This line is a line that does not exist on the earth's surface but influences Indonesia's astronomical location. Astronomical science in the branches of biological science, such as genetics, biochemistry, and biotechnology, can influence human life in the development of technology and knowledge.

The influence of astronomy on world civilization can be seen through various astronomical phenomena that will occur during 2024, such as a total solar eclipse, the alignment of planets, the emergence of new star nests, global boiling, and more extreme weather.

IV. Conclusion

Astronomy in the global world can be seen through various astronomical phenomena that will occur during 2024, such as a total solar eclipse, the alignment of planets, the emergence of new star nests, global boiling, and more extreme weather. A total solar eclipse will produce a beautiful view when viewed from Earth, which can become a tourist activity and expedition to chase the eclipse. The alignment of the planets will produce a beautiful view when viewed from Earth, which can become a tourist activity and expedition to pursue planetary conjunctions. The emergence of new star nests or star nurseries will allow scientists to study the mysterious things happening in the Antenna region. Astronomical phenomena that occurred in April 2024 such as Solar Eclipse to meteor shower, Total Solar Eclipse on

April 8, 2024, and Lyrid meteor shower on April 21-22, 2024. Apart from that, there are also rare astronomical phenomena such as the alignment of planets, the emergence of new star nests, global boiling, and more extreme weather. Scientists and astronomy enthusiasts in Indonesia and internationally will collect the latest information about astronomical phenomena in 2024 and share information through various sources, such as websites, social media, and observatories.

Global warming and more extreme weather will affect world civilization, including increasing global temperatures, increasing daily and monthly temperatures, and more extreme weather. The schedule of astronomical phenomena that will occur in 2024 will also increase the interest and happiness of scientists and astronomy fans. The global urgency of astronomy in 2024 can affect world civilization in various ways, such as increasing global temperatures, increasing daily and monthly temperatures, total solar eclipse, and alignment of planets.

Increasing global temperatures, increasing daily and monthly temperatures, and more extreme weather will affect world civilization in various ways. Rising global temperatures will bring hotter conditions in some regions, which will affect agriculture, health, and the environment. Increasing daily and monthly temperatures will affect human health because it can cause dehydration, lung disease, and other health problems. More extreme weather, such as heavy rain, heavy rain, and direct rain, will affect infrastructure, roads, and the environment.

The global urgency of astronomy in 2024 could affect world civilization in various ways, such as increasing global temperatures, increasing daily and monthly temperatures, a total solar eclipse, the alignment of planets, and the emergence of new star nests.

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Solar and Lunar Eclipses in the Perspective of Shar'i and Astronomy

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ABSTRACT

The moon is a satellite that has its orbit and goes around the sun at the same time as the Earth. So that the special position between the Sun, Earth, and Moon can cause an eclipse. To complete this research, the author uses qualitative methods, namely descriptive methods. In this study, two approaches were carried out, namely: the Shari's approach which refers to Al-Qur'an and Hadith as the main legal foundation, and the Astronomy approach as a tool for studying the object of research in depth.

The results of the study can be concluded, solar eclipses are stated to occur when the position of the moon is located between the earth and the sun so that it closes part of the sun's light. In general, there are four types of solar eclipses, namely total solar eclipses, partial solar eclipses, ring solar eclipses, and hybrid solar eclipses. A lunar eclipse is a natural phenomenon that occurs when the sun, earth, and moon are on the same longitude when the moon is in opposition (i.e. at the time of the full moon) so that at that time the moon will pass through the earth's shadow. Lunar eclipses are divided into two types, namely penumbra lunar eclipses and umbra lunar eclipses. The calculation (Hisab) of the eclipse is carried out with the Ephemeris Hisab Rukyat system, which is used for the calculation of Qibla direction, prayer time, the beginning of the month Kamariah and the calculation of the eclipse.

I. Introduction

The solar system consists of diverse celestial objects, among them the Sun, eight planets (Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune), and other elements in the solar system such as Comets, Meteors, Asteroids and Satellites. The moon is a satellite that has its orbit and circles the sun at the same time as the Earth. So that the special position between the Sun, Earth, and Moon can cause an eclipse. [1]

The term eclipse is familiar to us, eclipse is darkness that occurs when the shadow of an object moves in front of another object to block its light. Eclipse events occur every year, but the type of eclipse varies from region to region. For ordinary people, eclipses are common and sometimes often ignore the events of this step. But not infrequently also this eclipse phenomenon is said to be a sign of the coming disaster or mystical things according to the beliefs of ancient people. In the time of the Prophet SAW, the eclipse event was believed by the community as a sign of death or the birth of someone. But it was denied by the Prophet SAW in a hadith narrated by Al-Bukhari and Muslims which reads:

قال النبي صلى الله عليه وسلم "إن الشمس والقمر آيتان من آيات الله لا يخسفان لموت أحد ولا لحياته" متفق عليه

Means: "*The Prophet (peace be upon him) said: Verily the sun and the moon are two signs of the greatness of Allah, neither of which experience an eclipse because of a person's death nor because of his life*" *(Muttafaq 'alaihi)* (HR. Bukhari Muslim). [2]

Based on this hadith, it can be understood that the occurrence of eclipses is not caused by the death or life of a person, but a natural phenomenon that deserves wisdom and as one of the signs of the greatness of Allah SWT. Through the eclipse event, the Prophet SAW gave guidance if we see an eclipse then we are encouraged to perform the eclipse sunnah prayer.[3]

The term eclipse in English is *eclipse,* which is an astronomical phenomenon that occurs when a celestial body covers another celestial body because of the moon's revolution around the earth and the earth's revolution around the sun. In Islam, eclipses that have something to do with worship are twofold: solar eclipse and lunar eclipse. Solar eclipse in Arabic *al-kusuf* means "to cover", this describes the phenomenon of the moon covering the sun. Then a lunar eclipse in Arabic *al-khusuf* means "to enter", this describes the phenomenon where the moon enters the shadow of the earth. [4] To know more about lunar or solar eclipses their calculations will be explained in the next discussion.

II. Method

The method in this study uses qualitative methods, which are methods that are descriptive and focus on in-depth observation. Data collection techniques through *library*

research provide systematic, normative, and accurate explanations of the object that is the subject matter, using valid data.

This research approach includes two approaches, namely: the *shari'i* approach, where this approach is carried out through Islamic law using verses of the Qur'an and Hadith as the main legal foundation. And astronomical approach, this approach is used as a tool in studying in the depth of the object of research.

The source of data in this study is by the type of classification in library research, so the data used are data obtained through searching scientific books and other secondary reading sources. Where secondary data is data obtained by researchers from existing sources.

III. Results and Discussion

A. Solar eclipse (*al-kusuf*)

A solar eclipse is said to occur when the position of the moon lies between the earth and the sun so that it closes some or all of the sun's light.[5] Although the moon is smaller, the moon's shadow can block sunlight completely, this is because the moon which is an average distance of 384,400 (three hundred eighty-four thousand four hundred) kilometers from the earth is closer than the sun which has an average distance of 149,680,000 (one hundred forty-nine million six hundred eighty thousand) kilometers. Butar-Butar, Pengantar Ilmu Falak Teori, Praktik dan Fikih.

In astronomical studies, solar eclipses are somewhat more special than lunar eclipses. This is because, between these two celestial bodies, the sun has more objects of study. But in Islam, both get the same appreciation. Astronomically, a solar eclipse occurs when the umbra and/or penumbra of the moon falls to the Earth's surface. Because the moon is smaller than the sun, the shadow of the moon that falls on the surface of the earth only covers a narrow area.

In general, there are four types of solar eclipses, namely: (1) total solar eclipses, (2) partial solar eclipses, (3) ring solar eclipses, and (4) hybrid solar eclipses.**Alimuddin, "Solar Eclipse Astronomical Perspectives," Journal of Al-Daulah 3, no. 1 (2014): 72–79.** A total solar eclipse (*al-kusüf al-kully*) is when the sun's disk is completely covered by the moon's disk. A partial solar eclipse (*al-kusüf al-juz'iy*) is when the lunar disk at the time of the eclipse only partially covers the solar disk. A ring solar eclipse is when the lunar disk during an eclipse only covers part of the solar disk where the size of the lunar disk is smaller than the solar disk so that when the lunar disk is in front of the solar disk it is not entirely covered by the lunar disk. The part of the solar disk that is not covered by the lunar disk is around the lunar disk and looks like a luminous ring. Whereas hybrid solar eclipses are eclipses that shift between a total eclipse and a ring eclipse, these hybrid eclipses are relatively rare. For more details, you can see an illustration of the occurrence of a solar eclipse in the picture below.

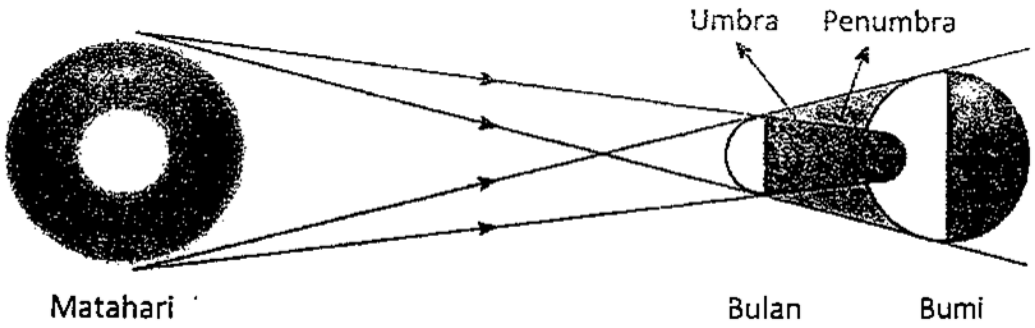

Figure 1. Solar Eclipse Illustration

B. Lunar eclipse (*al-khusuf*)

A lunar eclipse is a natural phenomenon that occurs when the sun, earth, and moon are on the same longitude when the moon is in opposition (i.e. at the time of the full moon) so that at that time the moon will pass through the earth's shadow. In this case, the shadow formed by the earth has two parts, namely the outermost shadow (*penumbra*) and the innermost shadow (*umbra*). Based on these two shadows, lunar eclipses are divided into two types, namely *penumbra lunar eclipses and* umbra *lunar eclipses*.

The phenomenon of *a penumbra eclipse* occurs when the moon passes through the earth's *penumbra* shadow which can only be seen when the lunar disk has entered more than half of the earth's *penumbra* shadow. While an *umbra lunar eclipse* occurs when the moon has passed through *the earth's umbra where at that time the entire lunar disk passes through the entire* umbra shadow*, the latter is called a total lunar eclipse, and if it passes through part of* the earth's umbra *it is called a partial lunar eclipse*.[2] Butar-Butar, Pengantar Ilmu Falak Teori, Praktik dan Fikih.

When a lunar eclipse occurs, the moon darkens as it enters the Earth's shadow, but there is still sunlight refracted by the atmosphere around the Earth. Clouds pollution, and dust can affect the color and brightness of the moon at the time of an eclipse and make it fade red. For more details, you can see an illustration of the occurrence of a lunar eclipse in the picture below.[7]

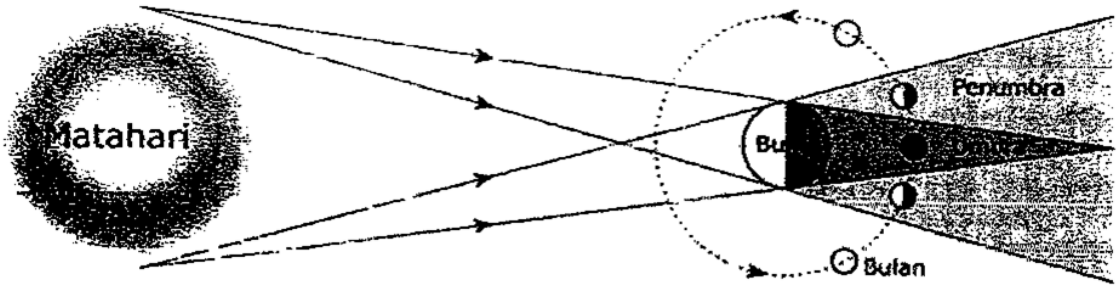

Figure 2. Ilustrasi Gerhana Bulan

C. Hisab Eclipse

The calculation (hisab) of eclipses can be done with the Ephemeris System Hisab Rukyat, more briefly called Ephemeris, is a set of astronomical data compiled by the Ministry of Religious Affairs of the Republic of Indonesia to be used as a reference in the problem of hisab and rukyat.[8] Ephemeris data is generally divided into two, namely

the sun and the moon. Both data are commonly used for calculating the direction of Qibla, prayer time, the beginning of the month of Kamariah, and the calculation of eclipses by Islamic mass organizations, falak institutions, and observers of hisab rukyat. The calculation of solar and lunar eclipses with the Hisab Rukyat Ephemeris System can be done with the following steps:

1. **Hisab Solar Eclipse**[9]
   1) Calculates the probability of a solar eclipse using data in *the majmu'ah*, *mabsuṭah* and lunar tables. These three data are added according to the month and year to be searched for the possibility of an eclipse. Furthermore, a solar eclipse may occur if the result of the sum is between the values of 00° to 20°, 159° to 190° and 348° to 360˚.
   2) Convert from the Hijri calendar used in calculating the probability of an eclipse to the Gregorian calendar used in the Ephemeris Hisab Rukyat data.
   3) Track the smallest *Fraction Illumination* (FIB) of Moon data in Hisab Rukyat Ephemeris according to the conversion date or around the conversion date.
   4) Looking at the certainty of a solar eclipse from the value of the *Moon's Apparent Latitude* at the time of the smallest *Fraction Illumination*, if the absolute value of *Apparent Latitude* > 1° 32' 02" then there is no solar eclipse, if the absolute value of *Apparent Latitude* < 1° 24' 10" then there must be a solar eclipse and if the absolute value of *Apparent Latitude* between 1° 32' 02" and 1° 24' 10" then there is a possibility of a solar eclipse.
   5) Calculate the time of the first ijtima', with the following steps:
      a. Calculate *the solar sabaq* (B1), by finding the difference between the solar *ecliptic longitude* (ELM) at the smallest FIB hour and the hour after it.
      b. Calculating the *Moon Sabaq* (B2), by calculating the difference between the *Apparent Longitude* of the Moon (ALB) at the smallest FIB hour and the hour after it.
      c. Calculates the distance between the Sun and Moon (MB), with the formula **MB = ELM – ALB**
      d. Calculating Sabaq *Mu'addal* Moon (SB), with formulas **SB = B2 - B1**
      e. Calculate ijtimak point (TI), with formula **TI = MB : SB**
      f. Calculating the time of the first ijtima' (Ijt1), **Ijt1 = jam FIB + TI**
   6) Prepare calculation data in the form of Semi diameter of the Moon (SDB), *Horizontal Parallaks* of the Moon (HPB), *Apparent Latitude* of the Moon or latitude of the Moon's ecliptic (LB), Semi diameter of the Sun (SDM), *True Obliquity* of the Sun (Obl) and *Equation of Time* (e).
   7) Calculates the middle time of the eclipse, with the following steps:
      a. Calculates *the Meredian Pass* (MP), with the formula **MP = 12 – e**
      b. Calculates the second ijtima (Ijt2), with the formula **Ijt2 = Ijt1 + (λ : 15)**
      c. Calculating ijtima distance (JI), **JI = [MP – Ijt2] x 15˚**
      d. Calculating *the first Āshir* (A1), with the rule that if **Ijt2 < MP**, then **A1 = ELM – JI**, jika **Ijt2 > MP**, then **A1 = ELM + JI**
      e. Counting *the first Mail Āshir* (MA1), **Sin MA1 = sin A1 x sin Obl**

f. Counting *the first Irtifa' Āshir* (IA1), **IA1 = 90 – [MA1 – φ]**
g. Calculating auxiliary angles (SP), **Sin SP = (sin SB x cos MA1) : (sin HPB x sin IA1)**
h. Counting *Sā'ah Bu'du al-Wasaṭ* (SBW), **SBW = sin JI : sin SP**
i. Calculates the middle of the eclipse (tgh) by the rule if **Ijt2 < MP**, maka **tgh = Ijt2 – SBW**, jika **Ijt2 < MP**, maka **tgh = Ijt2 + SBW**
j. Calculates the middle of an eclipse with the time area (TGH), TGH = tgh + (λD – λ) : 15.

8) Calculates the time of the beginning and end of a solar eclipse, with the following steps:
   a. Calculating eclipse distance (JG), **JG = [MP – tgh] x 15**
   b. Calculate the second *Āshir* (A2), with the rule if **tgh < MP**, then **A2 = ELM – JG**, then **tgh > MP**, then **A2 = ELM + JG**
   c. Counting *Mail Mail Āshir* Second (MA2), **Sin MA2 = sin A2 x sin Obl**
   d. Calculating *Irtifa' Second Āshir* (IA2), **IA2 = 90 – [MA2 – φ]**
   e. Counting *Ārḍu Iqlīm al-Rukyah* (AIR), **AIR = 90 – IA2** *Ārḍu Iqlīm al-Rukyah* Can be negative or positive, the determination is carried out with the following rules:
      1. If MA2 < 0 and φ > 0, then *Ārḍu Iqlīm al-Rukyah* is positive
      2. If MA2 > 0 and φ < 0 then *Ārḍu Iqlīm al-Rukyah* is negative
      3. If MA2 > 0 and φ > 0 then
         a) If [MA2] > [φ], then *Ārḍu Iqlīm al-Rukyah* is negative
         b) If [MA2] < [φ], then *Ārḍu Iqlīm al-Rukyah* is positive
      4. If MA2 < 0 and φ < 0 then
         a) If [MA2] > [φ], then *Ārḍu Iqlīm al-Rukyah* is worth positive
         b) If [MA2] < [φ], then *Ārḍu Iqlīm al-Rukyah* is worth negative
   f. Calculating *Ikhtilāf al-Arḍ* (IkA), **Sin IkA = [cos IA2 x sin 0° 51' 22"]** If AIR > 0, then *Ikhtilāf al-Arḍ* is negative while If AIR < 0, then *Ikhtilāf al-Arḍ* is positive.
   g. Counting *Ārḍu al-Qamar al-Mar'i* (LB'), **LB' = [LB + IkA]** If LB > 0, then *Ārḍu al-Qamar al-Mar'i* is positive, while if LB < 0, then *Ārḍu al-Qamar al-Mar'i* is negative. With reference to the value of *Ārḍu al-Qamar al-Mar'i*, the types of eclipses can be determined by looking at the values of the Semidiameter of the Sun and Semidiameter of the Moon using the following rules::
      1. If LB' < (HR + SDB), then:
         a) If SDB < (HR + LB'), then a partial eclipse occurs
         b) If SDB > (SDM + LB'), then a total eclipse occurs
         c) If HR < (SDB + LB'), then a ring eclipse occurs
      2. If LB' = 0 and HR = SDB, then there is a total eclipse of just a few seconds.
   h. Calculating *al-Jam'u* (J), **J = [SDB + SDM + [LB']]**
   i. Calculating *al-Bāqī* (B), **B = [SDB + SDM – [LB']]**
   j. Calculating *Daqāiq al-Kusūf* (DK), **DK = √ (J x B)**
   k. Calculating *Sabaq al-Mu'addal* (SM), **SM = SB - 0˚ 11' 48"**
   l. Calculating *Sa'ah al-Suqūṭ* (SS), **SS = DK : SM**

m. Calculates the beginning and end of an eclipse,

9) Calculating the Eclipse Width (LG), **LG = ((B : (SDM x 2)) x 100**
10) Calculating the eclipse width value in units of *usbu'* (LG'), **LG' = LG x 12**
11) Calculates total start time and total end, with steps:
    a. Counting *Sa'ah al-Mukśi* (SMk) **SMk = [12 – LG'] : 15**
    b. Calculates the beginning and end of the total phase, **Total beginning = TGH – SMk, Total end = TGH + SMk**.

2. Lunar Eclipse Calculation

1) Calculate the probability of a lunar eclipse using data in the eclipse table, by summing data from the year group table, year unit table and lunar eclipse table. Furthermore, a lunar eclipse may occur if the sum results range between 000˚ s/d 014˚, 165˚ s/d 194˚ dan 345˚ s/d 360˚.
2) Converting from the Hijri calendar to the Gregorian calendar is the date of the possible lunar eclipse and will only occur during the full moon, around the 15th of the Kamariah Month.
3) Find the largest *Fraction Illumination* (FIB) in the FIB column in the Hisab Rukyat Ephemeris according to the conversion date or around the conversion date.
4) Seeing the certainty of a lunar eclipse from the value of the *Moon's Apparent Latitude*, if the absolute price of the Moon's Latitude > 1° 05' 07" then there will be no lunar eclipse, if the absolute price of the Moon's Latitude < 1° 00' 24" then there will be a lunar eclipse.
5) Calculate the time of the first ijtima', with the following steps:
    a. Calculate *the solar sabaq* (B1), by finding the difference between the solar *ecliptic longitude* (ELM) at the largest FIB hour and the hour after it.
    b. Calculating the *Moon Sabaq* (B2), by calculating the difference between the *Apparent Longitude* of the Moon (ALB) at the largest FIB hour and the hour after it.
    c. Calculates the distance between the Sun and Moon (MB), with the formula **MB = ELM – (ALB – 180)**
    d. Calculating the Sabaq of the Moon *of Mu'addal* (SB), with the formula **SB = B2 - B1**
    e. Calculates the istiqbal point (TI), with formulas [**TI = MB : SB]**
    f. Calculates istiqbal time (IS), with formulas **[IS = Waktu FIB + TI – 00 : 01 : 49.29]**
6) Tracking data from ephemeris in the form of Semi Diameter Moon (SD), *ƒ Horizontal Parallaks* Moon (HP), *ƒ Apparent Latitude* of the Moon or latitude of the Moon's ecliptic (L), Semi Diameter of the Sun (SD), and Earth's Distance (JB) in the *ƒ True Geocentric Distance column*.
7) Calculates the Horizon Parallax (HP), with formulas:
   Sin Pho = sin 08.794" : JB
8) Calculates the distance of the month from the node (H), with formulas:
   Sin H = sin L*ƒ* : sin 5˚
9) Calculates the corrected maximum lunar latitude (U), with formulas:
   tan U = (tan L*ƒ* : sin H)

10) Calculates the minimum corrected lunar latitude (Z), with formulas:
Sin Z = (sin U x sin H)
11) Calculates the correction of the speed of the moon relative to the sun (K), with the formula: **K = cos L*f* x SB : cos U**
12) Calculates the magnitude of the semidiameter of the shadow of the Earth's core (D), with the formula: **D = (HP*f* + HP – SD) x 1,02**
13) Calculates the distance of the center of the Earth's core shadow to the center point of the moon when the lunar disk begins to come into contact with the shadow of the Earth's core (X), with the formula **X = D + SD*f***
14) Calculates the distance of the center of the shadow of the Earth's core to the center point of the moon when the entire lunar disk begins to enter the shadow of the Earth's core (Y), with the formula **(Y = D - SD*f*)**
15) Calculates the distance of the moon's center point when the lunar disk begins to come into contact with the shadow of the Earth's core (C), with the formula **Cos C = Cos X : Cos Z**
16) Calculates the time it takes for the moon to run from when the lunar disk comes into contact with the shadow of the Earth's core until when the center point of the moon aligns with the shadow of the Earth's core (T1), with the formula **T1 = C: K**. If Y is smaller than Z, there will be a partial lunar eclipse. Therefore, E and T2, do not need to be calculated.
17) Calculates the distance of the center point of the moon when it is in line with the shadow of the earth's core to the center point of the moon when the entire lunar disk enters the shadow of the earth's core (B), with the formula **(Cos E = Cos Y : Cos Z)**
18) Calculates the time it takes for the moon to run from the center point of the moon when it aligns with the shadow of the Earth's core to the center point of the moon when the entire lunar disk enters the shadow of the Earth's core (T2), with the formula **(T2 = E : K)**
19) First correction to the speed of the moon (Ta), with the formula:
Ta = Cos H : Sin K
20) The second correction to the speed of the moon (Tb), with the formula:
Tb = Sin L*f* : Sin K
21) Calculates eclipse time (T0), with formula **T0 = [Sin 0,05 x Ta x Tb]**
22) To calculate the time of the midpoint of an eclipse (Tgh) by: Note the Moon's latitude (LÄ) in the Moon's *Apparent Latitude column* at the largest FIB hour and in the next hour. If the absolute price of the Moon's Latitude is getting smaller, then **Tgh = Istiqbal + T0 - AT**. If the absolute price of the Moon's Latitude gets bigger then **Tgh = Istiqbal –T0 - AT**.
    a. AT is the correction of TT time to GMT
    b. To change to WIB, add 7 hours
    c. If the sum is more than 24, subtract by 24. Then the rest is the time of the midpoint of the eclipse.
23) Calculates eclipse start time, with formula:
Start Eclipse = Tgh – T1
24) Calculates the start time of a total eclipse, with formulas:

Total Start = Tgh – T2

25) Calculates the end time of a total eclipse, with formulas:
Total Completion = Tgh = T2
26) Calculates the eclipse end time, with the formula: **Eclipse Complete = Tgh + T1.** A lunar eclipse will be visible at night, so if the beginning of the eclipse is greater than sunrise, or the end of the eclipse is smaller than the sunset time of the sun somewhere then the lunar eclipse cannot be seen from that place.

If there is a partial lunar eclipse (Y < Z), then calculating the width of the eclipse (LG) or *magnitude*, namely the width of the lunar disk that enters the shadow of the earth's core can be done with the formula, **LG = ((D + SD – Z): 2 x SD) x 100%. *ff***. If the unit of measurement is desired with *ushbu*' (fingers), then the calculation of the width of this eclipse is multiplied by 12

IV. Conclusion

An eclipse is an astronomical phenomenon that occurs when a celestial body covers another celestial body due to the revolution of the moon around the earth and the revolution of the earth around the sun. In the Islamic context, eclipses related to worship are solar eclipses and lunar eclipses. A solar eclipse is a natural phenomenon that occurs when the position of the moon lies between the earth and the sun so that it closes some or all of the sun's light. In general, there are four types of solar eclipses, namely total solar eclipses, partial solar eclipses, ring solar eclipses, and hybrid solar eclipses. A lunar eclipse is a natural phenomenon that occurs when the sun, earth, and moon are on the same longitude when the moon is in opposition (i.e. at the time of the full moon) so that at that time the moon will pass through the earth's shadow. Lunar eclipses are divided into two types, namely *penumbra lunar eclipses and* umbra *lunar eclipses*.

Calculation (hisab) eclipses can be done with the Hisab Rukyat Ephemeris System, which is a set of astronomical data compiled by the Ministry of Religious Affairs of the Republic of Indonesia to be used as a reference in the problems of hisab and rukyat. Ephemeris data is generally divided into two, namely the sun and the moon. Both data are commonly used for the calculation of Qibla direction, prayer time, the beginning of the month of Kamariah, and eclipse calculations

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Determination of Qibla Direction on a Ship According to the Falak Science Perspective.

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ABSTRACT

The rapid development of the times from time to time, the determination of the direction of Qibla on a Sea Ship can be known using a software-based method (Application). The determination of the direction of Qibla is very important for the benefit of Muslims in carrying out fardhu and sunnah worship when they are doing safar or long trips using ship vehicles. the objectives to be achieved in this writing are 1) To know and understand the method of determining the direction of Qibla on board a Ship, and 2) To determine the determination of the direction of Qibla on a Sea Ship Perspective of Falak. The author uses qualitative research types with syar'i and sociological approaches. The main data collection technique is obtained from the use of the Muslim Pro application in determining the direction of Qibla on board ships. And not only that, but the author also uses data collection techniques obtained through other people or from documentation in the form of written material to complete the data that will be described and analyzed from literature readings that have a relationship with the determination of the direction of Qibla on a Sea Ship from the perspective of science.

I. Introduction

Y Islamic Sharia is taught, there is a provision for the ummah to carry out worship according to Islamic teachings. The issue of worship is a basic teaching ordained for all Mukallaf. Carrying out a prescribed worship is required to be sincere, sincere and only hoping for a

reward from Allah Almighty.[1] While the worship taught in Islam is muwaqqat worship, it is worship that is determined by the times, even the space that must be fulfilled in worship. In determining in which direction a Qibla place is located on the surface of the Earth, it can study the Science of Falak.[2] So that the urgency of studying Science of Falak is not only as an interest for the development and mastery of science and technology of Human civilization, but also studying Science as well as a need for worship.[3] Performing prayers facing Qibla is a valid requirement.[4] In general, scholars agree that there are seven legal requirements for a prayer, namely Muslim, holy from small or large hadiths, holy from unclean, intelligent, covering, entering time, and facing the Qibla.[5] The performance of prayers that do not lead to Qibla is automatically considered invalid. As is generally known that only the direction of Qibla on a Sea Ship is something that not many people know in which direction the Qibla direction is located or leading, when traveling long distances using ships. Similarly, scholars have agreed that leading to Qibla when prayer is mandatory.[6]

According to the translation of QS al-Baqarah 149-150, the meaning is more general that wherever you come and travel, then turn your face towards the Kaaba[7] when performing prayers according to the word of Allah Almighty. The emphasis in the next verse interprets that the Kaaba is the Qibla of Muslims. From this verse, it can be illustrated how very important it is to worship facing the direction of the Grand Mosque. The obligation to pray binds toddlers who are at home, at work, and on trips who are using vehicles on land such as bicycles, cars, and buses, to using planes and ships. The direction of Qibla is a direction in performing worship, and to achieve perfection of worship requires foresight and accuracy in praying and burying the dead.[8] The issue of Qibla is none other than talking directions, the direction in question is a cube-shaped place (Kaaba) in Mecca.

There are various ways to determine the direction of Qibla on a Ship, you can use the help of the universe as a reference or use modern tools. Using the help of nature for example with the rising and setting of the Sun, using the shadow of an object or using constellations, and so on. Various ways or methods can be done for a determination of Qibla's direction. The development of Qibla direction determination can be seen from various tools that can be used to measure such as istiwa sticks, Qibla bows, compasses, GPS, and Muslim Pro applications on smartphones. Scholars give varying definitions of the direction of Qibla, although it boils down to one object of study, the Kaaba. Based on this it can be concluded that Qibla is the closest direction from a person to the Kaaba and every Muslim is obliged to face towards him when performing prayers.

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[5] Ahmad Sarwat, Shalat di Kendaraan (Cet. I; Jakarta Selatan: Rumah Fiqih Publishing, 2018), h. 9
[6] Sippah Chotban, "Membaca Ulang Relasi Sains Dan Agama Perspektif Nalar Ilmu Falak", Elfalaky 4, no 2 (2020): h. 225.
[7] Ka'bah adalah bangun persegi empat serta merupakan tempat atau arah untuk beribadah bagi seluruh umat Islam di Dunia yang berpusat di Masjidil Haram. Muh. Ma'rufin Sudibyo, Sang Nabi pun Berputar, Arah Kiblat dan Tata Cara Pengukurannya (Cet. I; Solo: PT Tiga Serangkai Pustaka Mandiri, Desember 2011), h.
[8] Rahmatiah, H. L, "Pengaruh Human Eror Terhadap Akurasi Arah Kiblat Masjid dan Kuburan di Kabupaten Gowa Provinsi Sulawesi Selatan", Elfalaky 4, no. 2 (2020): h. 172

It is different for people who perform prayers on land and those on ships, as is done every day praying fardhu five times or sunnah prayers. Many people are confused and do not know the method of determining the direction of Qibla when traveling by ship. Even though performing prayers is an obligation for Muslims.[9] In general, the method carried out by the community in determining the direction of Qibla prayer is only based on the direction of sunrise (*shuruq*) and sunset (*ghurup*)[10] next to the horizons of East and West. It has become a habit to determine the direction of Qibla in the West, as the reason Saudi Arabia is the place where the Kaaba is in the West of Indonesia.[11] While in Falak Science, the determination of the direction of Qibla is carried out carefully and accurately. In this case, the researcher used an application called "Muslim Pro".

II. Method

The type of research used by the author for this research is Library Research or literature research that explains according to normative, organized, and systematic and has accuracy in the object of study which is the subject matter. This research approach is an approach syar'i

III. Results and Discussion

The direction is the closest distance measured through a large circle. In Indonesian it is explained that the word direction has two meanings, namely towards and facing a certain point.[12] While the word *al-qiblat* in Arabic means *al-jihat* i.e. "direction". The word is derived from the word قِبْلَةٌ one of the derivation forms of قَبِلَ, يَقْبِلُ meaning to face. Facing means the center of view when a Muslim is performing prayers. Qibla is the most important part of Muslims in carrying out prayers, both fardhu and sunnah prayers. In this case, Qibla means facing oneself parallel to the position where the Kaaba is located. Every Muslim who will perform prayers should face Qibla. Every Muslim must know the guidelines for knowing the direction of Qibla, so that when he wants to perform prayers on a long journey for example, and there are no Qibla directions, he can use the Qibla direction guidelines, in determining the direction of Qibla when he wants to perform prayers.

Based on the postulates, the scholars agree that Muslims who are far from the Kaaba, must face right in the direction of the Kaaba, or in the direction of *the ainul Kaaba*. As for Muslims who are far from the Kaaba and do not see the Kaaba, then simply facing the direction of *the Kaaba jihatul* must be done based on the maximum ijtihad possible and can be done. The Kaaba in pre-Islamic times was a building that served as a place of worship of idols used by the people in the city of Mecca. Islamic treatise brought by His Holiness the Holy Prophet Muhammad. Slashing down these idols, until this building is used as a place of worship and used as a Qibla for Islamic prayer.

[9] Muhammad Ridha Muslih and Rahma Amir, "Akurasi Arah Kiblat Musala Stasiun Pengisian Bahan Bakar Umum (Spbu) Di Kota Makassar", Hisabuna : Ilmu Falak, 1, no 1 (2020): h. 139.

[10] A. Jamil, Ilmu Falak Teori dan Aplikasi (Cet. IV; Jakarta: Amzah, 2016), h. 36.

[11] Watni Marpaung, Introduction to Falak (cet. I; Jakarta; Prenadamedia Group, 2015), p. 61.

[12] Ghazna Lutfi Amrillah dan Ahmad Haziq Shiddiqie Bin Harrizan, "Pengertian dan Sejarah Arah Kiblat", Program Studi Perbandingan Mazhab Unida Gontor (Agustus 2020): http://pm.unida.gontor.ac.id/pengertian-dan-sejarah-arah-kiblat/ (Akses 31 Februari 2021).

Determination is a word that means to determine, determine, or ensure in terms of achieving goals and objectives.[13] The direction of the Qibla is the direction of one central point of all Muslims to face the Qibla when performing prayers, either the five daily fardhu prayers or the sunnah prayers.[14] From this understanding, it can be explained that the determination of the direction of the Qibla is a determination to ascertain in which direction the center point of a Qibla of the Islamic ummah faces when performing prayers. The determination of the direction of Qibla in Falak Science is carried out carefully and accurately. Muslim Pro application is an application found on smartphones that can be installed easily. Installation can be done through "Google Play Store" on Android-based smartphones. This application is very efficient for users in carrying out worship, as well as finding out the schedule of five prayers at a time, especially for the determination of the direction of Qibla on a Ship. This application can be used anywhere when traveling long distances to a place, both while on land and while in the ocean.

Tools that can be used to determine the direction of Qibla on a ship are smartphones. A smartphone is a phone that has the performance of using an operating software system that provides a relationship with application development. This tool is a tool that presents advanced features such as the internet, such as letters and electronic books and even as a container for data or document irregularities. Smartphones are also understood as oral and written communication tools both near and even long distances. This tool is very practical to use as a communication tool that can be carried anywhere because there is no need to use cables like a landline.[15] Determination of Qibla direction smartphones can be used as a tool to find out the direction of Qibla on ships.[16] This smartphone was created to be carried anywhere while traveling because it is one of the main daily needs for most of its users. Where this tool can also be used to download a Qibla direction determination application. One application that can be downloaded for the determination of the direction of Qibla on a ship is the Muslim Pro application which is a digital compass feature or a software-based compass.

The method that can be used for determining the direction of Qibla on a ship is based on the software (Application) is the Muslim Pro application. The Muslim Pro application is a sophisticated application for determining the direction of Qibla on a Ship. Before using this application, it can first be downloaded on the Google Play Store/apps store on android/ios smartphones. Downloading the application should be done before traveling long distances using ship vehicles. Because when the ship is in the middle of the sea there is no cellular network, because downloading the application requires a cellular data network. In general, it can be known that on the way to a ship the network is lost or errors when in the middle of the ocean.

[13] Rizky Maulana dan Putri Amelia, Kamus Lengkap Bahasa Indonesia (Surabaya: Cahaya Agency, 2013). h. 101.
[14] Lailatul Maskhurriyah, "Penentuan Arah Kiblat di Atas Kapal Menggunakan Alat Navigasi", Skripsi (Surabaya: Fak. Syariah dan Hukum UIN Sunan Ampel, 2019), h. 19.
[15] al-Imam, "Pengaplikasian Smartphone Sebagai Media Komunikasi Internasional Dikalangan Pegawai di Kementrian Agama Kabupaten Aceh Barat", Internasional Jurnal of Islamic Studies and Social Sciences 1, no. 2 (September 2019): h. 354.
[16] https://teknologi.bisnis.com/read/20201121/84/1320604/apa-itu-aplikasi-muslim-pro-yang-disorotkemenkominfo (Access 23 November 2021).

Linguists say that the word Science of Falak is a combination of two Arabic words: Ilm and al-Falak. The word Ilm is a mashdar of the word 'Alima Ya'lamu (knowing). In al-Munawwir's Dictionary, this word has the same meaning as the words 'Arafa (knowing, knowing) and Fahima (understanding, knowing).[17] So literally the word Ilm means Ma'rifah which means "Knowledge" or al-Idrak (fahm) which means "Understanding". And when asked by the owner of the language (Arabic) about Ilm, of course, the answer is "Knowledge that is certain to be under existing reality" or "Understanding of the nature of something optimally".[18] According to the language, "Falak" comes from the Arabic al-falak (الفلك) which means the orbit or trajectory of celestial bodies (madar al nujum). The word Falak (al-Falak) according to the linguistic sense is Majral Kawakib, meaning "Place of travel of the planets". In the Big Dictionary Indonesian is defined as "The path traveled by a celestial body in its circulation around another celestial body with a greater gravitational force". From this understanding, it can be understood that Falak Science is the science that studies celestial bodies. Science of Falak is a science that studies the trajectory and movement of celestial bodies (especially the Earth, Moon, and Sun) in their respective circulation lines to study their phenomena in the framework of human interests. In definition, science is a science that studies the intricacies of celestial bodies in terms of shape, size, physical state, position, movement and interrelationship between one another.

Falak Science functionally becomes a testament[19] or as a place to be able to carry out worship correctly, appropriately, and legally. Because the presence of Falak aims to perfect a worship carried out by Muslims. The benefits of Falak Science are as a science that can determine in which direction the Qibla position of place on Earth and to ensure prayer times have entered or the Sun has set as a sign of breaking the fast. The existence of this Science of Falak Muslims can do rukyatul Hilal so that it can be a direction of view precisely towards the position of Hilal, also can even know that there will be a solar eclipse or lunar eclipse. With Falak Science can grow confidence in carrying out worship, so that worship is more solemn.[20]

Qibla in Falak Science is an obligation that must be known accurately to the determination of the direction of Qibla. To know the direction of Qibla requires a deep understanding. The determination of the direction of Qibla on Land is not only based on the West and East positions. In practice, the determination of the direction of Qibla on Land requires instruments with a high level of accuracy. Qibla is one of the legal requirements for performing fardhu and sunnah prayers.[21] Therefore, the determination of the direction of Qibla requires a deep understanding to use an instrument of determination of the direction of Qibla. Instruments that are generally most often and widely used today for the determination of Qibla direction on land are Istiwa Stick, Qibla Tracker, Qibla Bow and so on. From these instruments, it is not possible to use on ships in the determination of Qibla direction, because it requires a flat plane that does not move and takes a long time to use.

[17] Ahmad Warson Munawwir, The Most Complete Arabic – Indonesian al-Munawwir Dictionary, (Surabaya: Pustaka Progressive, 1995), p. 1156.
[18] Ar-Raghib al-Ashfahany, Mu'jam Mufradat Alfadzil Quran (Beirut: Darul Fikri, t.th), pp. 355.
[19] https://almanhaj.or.id/2461-hukum-wasilah-tawassul.html (Access December 25, 2021).
[20] Fatmawati, Ilmu falak (Cet. I; Watampone: Syahadah, 2016), h. 15-17.
[21] 7Nur Khalifa and Rahma Amir, "The Existence of Falak Science in Determining the Direction of Qibla and the Beginning of Prayer Times", Hisabuna: Science of Falak 2, no 1 (2021): p. 36.

While the Sea Ship that is running has a route/lane that is not straight to the destination point leaning.

It is different from the determination of the direction of Qibla on a Ship. In general, most people know that when they want to pray on a ship that is in a state of walking, it is only based on where the position of the sun rises and is listed. As for those who use compas for determining the direction of Qibla on board ships, because at night Qibla determination cannot be done. However, in Falak, the determination of the direction of Qibla on a ship can be done by the constellation method. This method also requires a deep understanding because to be able to find out the position of the constellations is not easy. This method cannot be done if the sky is cloudy. But along with the rapid development of the times, the method of determining the direction of Qibla is now very sophisticated because there have been various kinds of software-based methods (applications). One method that can be used to determine the direction of Qibla on a ship is by using the Muslim Pro application.

The accuracy of Muslim Pro application in determining the direction of Qibla on board ships is very accurate because this application can be used non-network or in a state of inactive smartphone cellular data, so users are greatly facilitated in determining the direction of Qibla on ships. The advantage of this application is that it can be used both day and night. Not only can it be used on board ships, but this application can be used wherever and whenever someone travels or travels long distances when they cannot know the position of the Qibla direction. The Muslim Pro application makes it very easy for someone to carry out worship and daily activities of Muslims in the world. This application is also a very efficient method of determining the direction of Qibla because it does not require data to be included in the determination of the direction of Qibla like some other software methods. The Muslim Pro app automatically works to show the position of the Qibla direction and only takes less than a minute to detect the location of the Qibla direction leading. Based on this method, Muslims are very facilitated to perform prayers when they do not know which direction Qibla leads somewhere either on the Sea or on Land. This can also make it easier to perform prayers promptly. And there is no longer any reason for Muslims to pray only wherever the most important thing is that the intention of praying leads to the Kaaba alone, especially "praying on a ship" when unable to know the direction of Qibla. This method can be used in urgent circumstances only to know the Qibla on Land when traveling far if you cannot find the mosque on the way, but still want to perform fardhu prayers on time.

IV. Conclusion

The method used for determining the direction of Qibla on a ship based on software (Application) is the Muslim Pro application which is an application in which there are several features such as prayer time instructions, the Qur'an, colored tajweed, digital prayer beads, and especially the determination of the direction of Qibla on board ships.

In the perspective of Falak, the determination of the direction of Qibla on a Ship using the Muslim Pro application is very effective and efficient because this method allows Muslims to carry out the worship of shalat fardhu on time when doing safar or long trips, especially using ship vehicles. The advantage of this method is that it can detect the position

of the Qibla direction quickly, and can be used wherever and whenever the user is because it does not require a cellular data network

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Implementation of AstroCamp Data with *Besselian Elements* Towards Solar Eclipse Hisab

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ABSTRACT

Ephemeris is the main reference calculation for the Falak science in solar eclipses calculation, the data can be obtained from various sources, one of which is from the AstroCamp program by Muhammad Faqih Taufiq. There are several eclipse calculation methods using *Ephemeris* data, ranging from low-accuracy to high-accuracy calculations. The *Ephemeris* are used continuously to find Bessel Elements in the solar eclipse calculation. Currently, the calculation of solar eclipses using *Besselian Elements* data is considered the most powerful calculation method regarding eclipse prediction. This study aims to determine the accuracy of *Ephemeris data* from AstroCamp which is processed into Bessel elements in the solar eclipses calculation. To determine the accuracy of these calculations, researchers conducted qualitative research on the Hybrid Solar Eclipse on April 20, 2023, with a comparative approach to analyze the accuracy of the calculations. The result shows that the solar eclipse estimate obtained from calculations utilizing the Bessel Element of the *AstroCamp Ephemeris* has a significant difference between NASA predictions and the reality of the eclipse.

I. Introduction

The solar eclipse is one of the celestial phenomena that is also discussed in science, because it can be seen from the many studies that discuss solar eclipses in falak literature from time to time. The study includes the understanding of the Solar Eclipse, the position of the solar eclipse in a religious view, the priorities that can be done during the eclipse, the view of the solar eclipse from an astronomical perspective, and the calculation of the solar eclipse itself.

Even often the object of study, until now the calculation of solar eclipses has many varieties that are scattered in circulation. Even though astronomical data has been used to calculate solar eclipses, each calculation has pros and cons and yields a unique result.

Leaving aside the *Human Error* aspect, the different results of solar eclipse calculations can be caused by two factors. That is the use of astronomical data and the calculation methods used. Until now, while utilizing astronomical data, the author found three types of calculations. First, the use of astronomic data and calculation methods prepared by the author in the same book or book. Second, calculate the astronomical data that will be used and the solar eclipse that will occur. Third, the use of astronomical data in other literature outside the calculation method is to be used.

Of the three types of calculations that the author found, the third type of calculation allows the author to combine one calculation method by utilizing certain astronomical data, which in general *ephemeris data* will be obtained from the Ministry of Religious Affairs of the Republic of Indonesia (KEMENAG) through his book published throughout the year, namely the book "*Ephemeris Hisab Rukyat*" and *ephemeris* data accessed through the Winhisab application.

However, a unique case occurred when the author found a computer-based software program called AstroCamp by Muhammad Faqih Taufiq, one of which contained *Ephemeris* data, and found that it was possible to use the data for solar eclipse calculations.

Many solar eclipse calculation methods use *ephemeris* data from the Sun and Moon, both calculations with low *accuracy* and high accuracy. Some techniques that are considered to have high accuracy in the determination of eclipse prediction are the Bessel method [1]. Astronomical organizations frequently employ this method to forecast eclipses; NASA is well known for its accuracy in this regard.

So far calculations with this method using ready-made Bessel Elements, Bessel numbers can be known from the book *Elements of Solar Eclipses 1951 – 2000* by Jean Meuss [2]. It can also be seen in Kitab *Al-Dūrru Al-Anīq* by KH. Ahmad Ghazali Muhammad Fathullah and can be found in books by other falak experts [3]. Based on the search that the researchers carried out, the researcher just found a study that discusses in detail how to get the values of the Bessel Element, namely the research conducted by Alfan Maghfuri in his thesis entitled *Reformulation of the Solar Eclipse Hisab Algorithm Using Hisab Rukyat Ephemeris Data which was* later made into a book entitled "*Eclipse Algorithm (Study of Solar Eclipse Calculation with Ephemeris Hisab Rukyat Data)*". In the thesis or book, it is explained how to find the values of the Bessel Element by utilizing the data of *Ephemeris* Hisab Rukyat and its calculations about the approximate contact time of the solar eclipse.

By looking at the problems that have been described, the researcher wants to study more deeply and conduct research on the eclipse of the Sun using the *Besselian Elements* method, where the value of the Bessel Element is obtained from the calculation output using *ephemeris* data in the AstroCamp application, with the title: "Implementation of AstroCamp Data with *Besselian Elements* Against the Hisab of Solar Eclipse (Case Study of Hybrid Solar Eclipse April 20, 2023)".

According to the description of the background of the problem above, it can be stated the core problem that the author wants to make the focus of research, namely: "How is the

accuracy of calculating solar eclipses using AstroCamp data with *the Besselian Elements* method?".

This study aims to determine how accurate the calculation of solar eclipses using AstroCamp data with the Besselian Elements method is. In addition to the above objectives, this research is expected to present theoretical and practical benefits. Theoretically, it can provide in-depth information and knowledge about the method of calculating solar eclipses using *Besselian Elements* and the accuracy of the calculation results using these methods. Practically, it is expected to make it easier for students and students to learn the calculation of solar eclipses using *Besselian Elements*.

II. Method

The research uses a type of qualitative methodology with a comparative approach [4]. The study presents the calculation of the solar eclipse using *AstroCamp's Ephemeris* data with *the Besselian Elements method*, followed by an assessment of the accuracy of the calculated results. To assess the accuracy of solar eclipse calculations using *AstroCamp's Ephemeris* data using *the Besselian Elements* method, researchers compared these results with eclipse estimates made by an international agency known for its accuracy, NASA [5]. This research involves field research activities [6], where these writing researchers made observations at the time of the hybrid solar eclipse which will take place on April 20, 2023, in Indonesia, Australia, and Papua New Guinea [7].

Data collection techniques include observation, interviews, and documentation. Regarding this, the author interviewed directly the creators of the AstroCamp program, direct observations of the partial eclipse that will occur in the Jepara area and observations of the hybrid solar eclipse of April 20, 2023, as well as documentation on the timing of the early eclipse, middle eclipse and end of the eclipse. The type of data used is primary data in the form of *the book Eclipse Algorithm (Study of Solar Eclipse Calculation with Hisab Rukyat Ephemeris Data)* by Alfan Maghfuri and an interview with the maker of the AstroCamp application, Muhammad Faqih Taufik, while secondary data is taken from several past studies that are still related to this study. The researchers' data analysis involved comparative analysis data, to demonstrate the process of calculating solar eclipses using AstroCamp *Ephemeris* data with *the Besselian Elements* process. In that phase, data is used to obtain accurate information that is used to answer the research questions asked in this study.

III. Results and Discussion

From research on *Besselian Elements* calculations using *AstroCamp Ephemeris* data, the author found several things, namely as follows:

A. AstroCamp

AstroCamp is a software program or application based on a Windows PC that contains data on astronomical objects better known as *Ephemeris*. This application was designed and formed by a student of Ma'had Aly TBS Kudus named Muhammad Faqih Taufiq.

Muhammad Faqih Taufik more familiarly called Faqih was born in Lau Village, Dawe District, Kudus Regency on January 8, 2001. Faqih began his formal education at

MI NU Al-Munawwaroh, then continued his education at MTs NU TBS and MA NU TBS while staying at the Al-Maimuniyyah Langgardalem Kudus Islamic Boarding School. Starting to know Falak since studying at MTs, after graduating from the aliyah bench then continued his education at the S1 level by taking the Takhassus Ilmu Falak program at Ma'had Aly TBS Kudus.

Since entering the world of lectures, Faqih himself often participates in webinars about science that he feels are interesting to him. One of them was a webinar held in Ramadan in mid-2020 which was held by LF PBNU at that time. In the webinar, one of the speakers was Dr. Ing. Khafid and his participants received the Mawaqit program and received permission to change the program [8].

From there, Faqih took the initiative to create an application containing *Ephemeris* data which was later named AstroCamp, to make it easier to find Sun and Moon data so that it could be used for all versions of Windows [8]. In making AstroCamp, the creator only grafted calculations from the Mawaqit program and spoke them in a visual basic language based on Visual Studio 2019. The calculation algorithm used in AstroCamp refers to the VSOP87 algorithm and the ELP2000 which are both algorithms used in the Mawaqit program.

The main features of the AstroCamp application are divided into three following the appearance of the menu, namely:

1. Home

   This menu is the *default* display when you first open AstroCamp, this menu contains Sun and Moon data which is presented in real referring to *Universal Time*, even on the menu Faqih also affixes the state of the moon, such as the position of the moon according to its distance to the Earth, according to the constellation of stars, and according to the field of seasons *(Solstice)*.

2. Ephemeris

   The display of *ephemeris* data in this menu seems the same as the display in the Winhisab application, this makes it easy for users to understand and this menu is also embedded with a print feature that can allow users to export *the desired* ephemeris data.

3. Prayer Time

   In the Prayer Time menu, Faqih designed the appearance of this menu like the Imsakiyah schedule (in one month) covering five prayer times, Imsyak, sunrise, Dluha, midnight, and the last third of the night.

   Users can choose a place based on the coordinate name and date based on the Gregorian calendar system, this is what causes the output of prayer times produced not in a month of the Hijri calendar, but a month in the Miladi calendar.

Because one of the discussions in this study is AstroCamp *ephemeris*, the following are the steps for taking *ephemeris data* on the AstroCamp application:

1. Open AstroCamp, then click the Ephemeris menu.

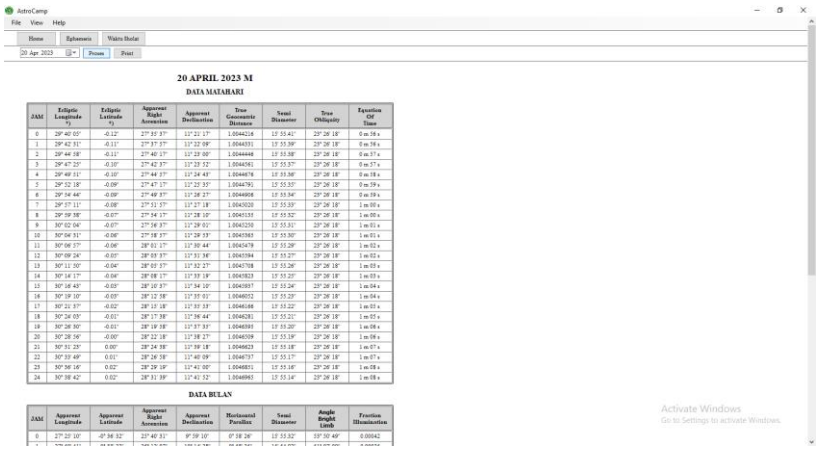

Figure 1. AstroCamp App start menu

2. Set the date

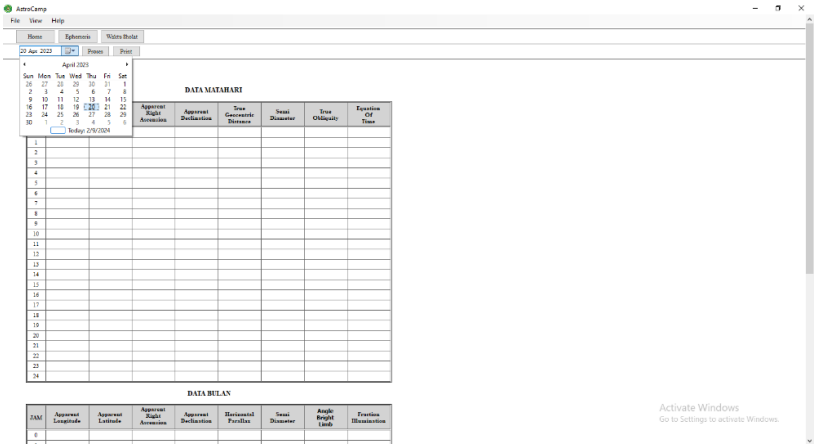

Figure 2. Display on the Ephemeris menu (the author is determining the date searched)

3. Click process, to display the *ephemeris data* you're looking for.

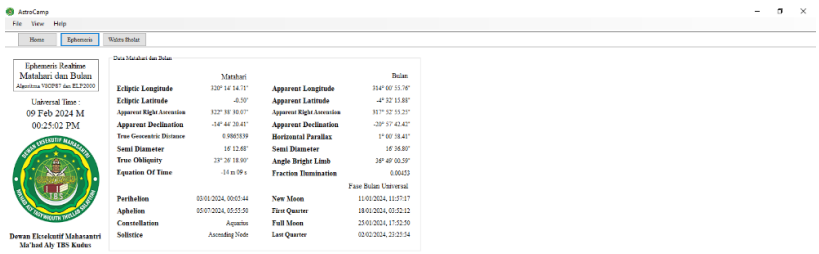

Figure 3. *Display on the Ephemeris menu (the application is processing data)*

4. Data *Ephemeris* AstroCamp

20 APRIL 2023 M

DATA MATAHARI

JAM	Ecliptic Longitude *)	Ecliptic Latitude *)	Apparent Right Ascension	Apparent Declination	True Geocentric Distance	Semi Diameter	True Obliquity	Equation Of Time
0	29° 40' 05"	-0.12"	27° 35' 37"	11° 21' 17"	1.0044216	15' 55.41"	23° 26' 18"	0 m 56 s
1	29° 42' 31"	-0.11"	27° 37' 57"	11° 22' 09"	1.0044331	15' 55.39"	23° 26' 18"	0 m 56 s
2	29° 44' 58"	-0.11"	27° 40' 17"	11° 23' 00"	1.0044446	15' 55.38"	23° 26' 18"	0 m 57 s
3	29° 47' 25"	-0.10"	27° 42' 37"	11° 23' 52"	1.0044561	15' 55.37"	23° 26' 18"	0 m 57 s
4	29° 49' 51"	-0.10"	27° 44' 57"	11° 24' 43"	1.0044676	15' 55.36"	23° 26' 18"	0 m 58 s
5	29° 52' 18"	-0.09"	27° 47' 17"	11° 25' 35"	1.0044791	15' 55.35"	23° 26' 18"	0 m 59 s
6	29° 54' 44"	-0.09"	27° 49' 37"	11° 26' 27"	1.0044906	15' 55.34"	23° 26' 18"	0 m 59 s
7	29° 57' 11"	-0.08"	27° 51' 57"	11° 27' 18"	1.0045020	15' 55.33"	23° 26' 18"	1 m 00 s
8	29° 59' 38"	-0.07"	27° 54' 17"	11° 28' 10"	1.0045135	15' 55.32"	23° 26' 18"	1 m 00 s
9	30° 02' 04"	-0.07"	27° 56' 37"	11° 29' 01"	1.0045250	15' 55.31"	23° 26' 18"	1 m 01 s
10	30° 04' 31"	-0.06"	27° 58' 57"	11° 29' 53"	1.0045365	15' 55.30"	23° 26' 18"	1 m 01 s
11	30° 06' 57"	-0.06"	28° 01' 17"	11° 30' 44"	1.0045479	15' 55.29"	23° 26' 18"	1 m 02 s
12	30° 09' 24"	-0.05"	28° 03' 37"	11° 31' 36"	1.0045594	15' 55.27"	23° 26' 18"	1 m 02 s
13	30° 11' 50"	-0.04"	28° 05' 57"	11° 32' 27"	1.0045708	15' 55.26"	23° 26' 18"	1 m 03 s
14	30° 14' 17"	-0.04"	28° 08' 17"	11° 33' 19"	1.0045823	15' 55.25"	23° 26' 18"	1 m 03 s
15	30° 16' 43"	-0.03"	28° 10' 37"	11° 34' 10"	1.0045937	15' 55.24"	23° 26' 18"	1 m 04 s
16	30° 19' 10"	-0.03"	28° 12' 58"	11° 35' 01"	1.0046052	15' 55.23"	23° 26' 18"	1 m 04 s
17	30° 21' 37"	-0.02"	28° 15' 18"	11° 35' 53"	1.0046166	15' 55.22"	23° 26' 18"	1 m 05 s
18	30° 24' 03"	-0.01"	28° 17' 38"	11° 36' 44"	1.0046281	15' 55.21"	23° 26' 18"	1 m 05 s
19	30° 26' 30"	-0.01"	28° 19' 58"	11° 37' 35"	1.0046395	15' 55.20"	23° 26' 18"	1 m 06 s
20	30° 28' 56"	-0.00"	28° 22' 18"	11° 38' 27"	1.0046509	15' 55.19"	23° 26' 18"	1 m 06 s
21	30° 31' 23"	0.00"	28° 24' 38"	11° 39' 18"	1.0046623	15' 55.18"	23° 26' 18"	1 m 07 s
22	30° 33' 49"	0.01"	28° 26' 58"	11° 40' 09"	1.0046737	15' 55.17"	23° 26' 18"	1 m 07 s
23	30° 36' 16"	0.02"	28° 29' 19"	11° 41' 00"	1.0046851	15' 55.16"	23° 26' 18"	1 m 08 s
24	30° 38' 42"	0.02"	28° 31' 39"	11° 41' 52"	1.0046965	15' 55.14"	23° 26' 18"	1 m 08 s

DATA BULAN

JAM	Apparent Longitude	Apparent Latitude	Apparent Right Ascension	Apparent Declination	Horizontal Parallax	Semi Diameter	Angle Bright Limb	Fraction Illumination
0	27° 25' 10"	-0° 36' 32"	25° 40' 31"	9° 59' 10"	0° 58' 26"	15' 55.32"	53° 50' 49"	0.00042
1	27° 59' 41"	-0° 33' 22"	26° 12' 07"	10° 14' 28"	0° 58' 25"	15' 54.92"	51° 07' 09"	0.00025
2	28° 34' 10"	-0° 30' 12"	26° 43' 43"	10° 29' 43"	0° 58' 23"	15' 54.52"	46° 05' 30"	0.00013
3	29° 08' 38"	-0° 27' 02"	27° 15' 22"	10° 44' 53"	0° 58' 22"	15' 54.12"	34° 25' 04"	0.00005
4	29° 43' 03"	-0° 23' 52"	27° 47' 02"	11° 00' 00"	0° 58' 20"	15' 53.71"	355° 18' 09"	0.00001
5	30° 17' 27"	-0° 20' 42"	28° 18' 43"	11° 15' 02"	0° 58' 19"	15' 53.30"	288° 56' 54"	0.00002
6	30° 51' 49"	-0° 17' 32"	28° 50' 26"	11° 30' 00"	0° 58' 17"	15' 52.89"	266° 40' 46"	0.00008
7	31° 26' 09"	-0° 14' 22"	29° 22' 11"	11° 44' 55"	0° 58' 16"	15' 52.48"	258° 53' 11"	0.00017
8	32° 00' 28"	-0° 11' 12"	29° 53' 58"	11° 59' 44"	0° 58' 14"	15' 52.06"	255° 07' 18"	0.00031
9	32° 34' 44"	-0° 08' 02"	30° 25' 46"	12° 14' 30"	0° 58' 13"	15' 51.64"	252° 57' 10"	0.00050
10	33° 08' 59"	-0° 04' 53"	30° 57' 36"	12° 29' 11"	0° 58' 11"	15' 51.21"	251° 34' 07"	0.00072
11	33° 43' 12"	-0° 01' 43"	31° 29' 28"	12° 43' 47"	0° 58' 10"	15' 50.79"	250° 37' 37"	0.00099
12	34° 17' 23"	0° 01' 26"	32° 01' 23"	12° 58' 19"	0° 58' 08"	15' 50.36"	249° 57' 33"	0.00131
13	34° 51' 32"	0° 04' 36"	32° 33' 19"	13° 12' 47"	0° 58' 06"	15' 49.93"	249° 28' 21"	0.00166
14	35° 25' 40"	0° 07' 45"	33° 05' 17"	13° 27' 09"	0° 58' 05"	15' 49.49"	249° 06' 45"	0.00206
15	35° 59' 45"	0° 10' 53"	33° 37' 17"	13° 41' 27"	0° 58' 03"	15' 49.06"	248° 50' 41"	0.00250
16	36° 33' 48"	0° 14' 02"	34° 09' 19"	13° 55' 39"	0° 58' 02"	15' 48.62"	248° 38' 45"	0.00299
17	37° 07' 50"	0° 17' 10"	34° 41' 23"	14° 09' 47"	0° 58' 00"	15' 48.17"	248° 30' 02"	0.00351
18	37° 41' 50"	0° 20' 18"	35° 13' 29"	14° 23' 50"	0° 57' 58"	15' 47.73"	248° 23' 50"	0.00408
19	38° 15' 47"	0° 23' 26"	35° 45' 38"	14° 37' 47"	0° 57' 57"	15' 47.28"	248° 19' 42"	0.00469
20	38° 49' 43"	0° 26' 33"	36° 17' 49"	14° 51' 39"	0° 57' 55"	15' 46.83"	248° 17' 15"	0.00534
21	39° 23' 37"	0° 29' 40"	36° 50' 02"	15° 05' 26"	0° 57' 53"	15' 46.38"	248° 16' 13"	0.00603
22	39° 57' 29"	0° 32' 47"	37° 22' 17"	15° 19' 08"	0° 57' 52"	15' 45.93"	248° 16' 21"	0.00676
23	40° 31' 18"	0° 35' 53"	37° 54' 35"	15° 32' 44"	0° 57' 50"	15' 45.48"	248° 17' 31"	0.00754
24	41° 05' 06"	0° 38' 59"	38° 26' 55"	15° 46' 15"	0° 57' 48"	15' 45.02"	248° 19' 35"	0.00835

Figure 4. AstroCamp Sun and Moon (Ephemeris) data dated April 20, 2023

The author used the AstroCamp tool to obtain Ephemeris data, which was then used to calculate Besselian Elements.

B. Besselian Elements *Calculation Results* Using AstroCamp *Ephemeris* Data

The following are the results of the calculation of Bessel elements using AstroCamp *Ephemeris* Data on April 20, 2023:

Table 1. *Besselian Elements calculation results using AstroCamp Ephemeris*

X0	*Y0*	*d0*	*M0*	*L10*	*L20*	Tan *f1*
X1	*Y1*	*d1*	*M1*	*L11*	*L21*	Tan *f2*
0.033297	-0.421855	11.41161	240.2411	0.54680	0.0007	0.00465
0.49503	0.2441388	0.01374	15.00342	0.00011	0.00011	0.00463

To see how far the difference in the calculation results of *the Besselian Elements* Calculation Using *AstroCamp Ephemeris* Data, the author compared the results of the calculation of the Bessel elements above with the results of the calculation of NASA's Bessel elements. Here are *Nasa's* Besselian Elements [9]:

Table 2. *NASA's Besselian Elements calculation*

	X	*Y*	*d*	*M*	*L1*	*L2*	Tan *f*
0	0.0268500	-0.427366	11.411789	240.243	0.5468040	0.0006630	0.00466
1	0.4950182	0.2441992	0.013741	15.0034	0.0001216	0.0001210	0.00463
2	0.0000135	-0.0000494	-0.000003	0.00000	-0.0000116	-0.0000115	0.00000
3	-0.0000071	-0.0000037	0.000000	0.00000	0.000000	0.000000	0.00000

Judging from the two tables above, there is a difference between the value *of Besselian Elements* from AstroCamp calculations and *Besselian Elements* used by NASA, with a

significant difference in *Besselian Elements* X0 which has a difference of 0.006447. In addition to this difference, the *Besselian Elements* displayed by NASA have values up to four different orders from the *Besselian Elements calculations* carried out by researchers, which only display two orders of elements. Of course, these differences will give birth to different results later in determining the contact time of the eclipse.

C. Solar Eclipse Testing Using AstroCamp Data with *Besselian Elements Method*

To see this difference, researchers made a comparison between eclipse calculations using the Bessel Element from AstroCamp and eclipse predictions from NASA with the fact of eclipse time contact from direct observations or observations. The eclipse on April 23, 2023, is a hybrid solar eclipse. This type of eclipse is a combination of a total solar eclipse with a ring solar eclipse [10]. For the Indonesian region, almost all regions can see the eclipse, especially the eastern part of Indonesia through which this ring eclipse passes. The following presents several data comparisons from observations of the hybrid eclipse phenomenon on April 20, 2023.

Here the author will divide the testing based on the eclipse that occurs, namely::

1. Partial Eclipse

First, researchers made direct observations during the eclipse. Only a partial solar eclipse, which happened in the Jepara region, was observed by the researchers. This observation was made by researchers together with the Al-Aqrob Falak Community located in Tigajuru, Mayong District, Jepara Regency. When viewed from Google Earth, the location is located at coordinates -06 45' 09'' S and 110 44' 34'' E, at an altitude of 8 masl. Estimates predicted by NASA regarding the coordinates show that the eclipse will occur at 09:29:33 WIB and end at 12:18:38 WIB, with the middle of the eclipse occurring at 10:51:31 WIB [11].

While the calculation data using the Bessel Element through AstroCamp data obtained the eclipse began at 09:28:15 WIB and ended at 12:17:04 WIB, while the middle of the eclipse occurred at 10:50:03 WIB.

Table 3. *Partial Solar Eclipse between Besselian Elements using Ephemeris AstroCamp, NASA's Besselian Elements, and the observations*

Contact	Result	Besselian AstroCamp	Besselian AstroCamp Difference	Besselian NASA	Besselian NASA Difference
Beginning Eclipse	--:--:--	09:28:16 WIB	-----	09:29:33 WIB	-----
Middle of the Eclipse	--:--:--	10:50:05 WIB	-----	10:51:31WIB	-----
End of Eclipse	12:18:11 WIB	12:17:07 WIB	01 Minutes 04 seconds	12:18:38 WIB	27 seconds

However, due to the lack of preparation during the observations, researchers could not get an initial contact image of the eclipse. In addition to the initial contact of the eclipse, in the middle of the eclipse, also give No. results. To get the middle of the eclipse when observations are obtained from the end of the eclipse minus the beginning of the eclipse then divided by two. These results are then added to the beginning of the eclipse, it will be obtained in the middle of the eclipse. The observations during the eclipse using the method of capturing images from the eclipse contact, No. image from the beginning before the occurrence of the eclipse to the end of the eclipse takes place.

Second, to see the contacts of a partial solar eclipse from beginning to end, researchers used other data to examine eclipse contacts in real-time observations. The data was taken from a real-time observation video uploaded by the TBS KUDUS TV channel [12], where the video shows the documentation of the Falakiyyah Ma'had Aly Team of TBS Kudus along with live observation time. The observation was made on the Rooftop of TBS Multipurpose Building in Kudus which is located at coordinates -06 48' 03'' LS and 110 50' 09'' BT, with an altitude of 25 meters above sea level.

Estimates predicted by NASA regarding the coordinates show that the eclipse occurred at 09:29:29 WIB and finished at 12:18:52 WIB, with the eclipse taking place at 10:51:35 WIB [11]. While the calculation data using the Bessel Element and AstroCamp data obtained the eclipse began at 09:28:10 WIB and ended at 12:17:18 WIB, while the middle of the eclipse occurred at 10:50:08 WIB.

Table 3. *Calculation comparison of the Partial Solar Eclipse between Besselian Elements using Ephemeris AstroCamp, NASA's Besselian Elements, and the observation video Ma'had Aly TBS Kudus*

Eclipse Contact	Observation Video	Besselian AstroCamp	Besselian AstroCamp	Besselian NASA	Besselian NASA Different
Eclipse Start	09:29:50 WIB	09:28:12 WIB	01 menit 38 seconds	09:29:29 WIB	21 seconds
Mid Eclipse	10:54:18 WIB	10:50:10 WIB	04 menit 08 seconds	10:51:35 WIB	02 Minutes 43 seconds
Eclipse End	12:18:46 WIB	12:17:20 WIB	01 menit 26 seconds	12:18:52 WIB	06 seconds
Eclipse Duration	02:48:56	02:49:08	12 seconds	02:49:23	27 seconds

From the table above shows calculations using the Bessel Element from AstroCamp culminating results that are quite significant with the fact of eclipse contact, which is with an average difference of 1 minute 32 seconds while the middle of the eclipse has a difference of 4 minutes 8 seconds. For predictions, NASA has an

average difference of 13.5 seconds, while in the middle of the eclipse there is a difference of 2 minutes 43 seconds from the reality of the middle of the eclipse.

2. Ghybrid Eclipse

In addition to the partial solar eclipse contact that researchers have described above, on April 20, 2023, there will also be a total solar eclipse. Some of the areas through which the total eclipse passes are Exmouth City, Westren Australia. Researchers then searched the data and found a video of observations made by Perth Observatory uploaded by the TimeAndDate channel [13]. The video shows live coverage of the process of a total solar eclipse and at the beginning of the video the situation around the observation site has been shown. Researchers traced the location using the Google Earth application, and thought the Perth Observatory carried out eclipse observations in a field around the city of Exmouth, namely at coordinates -21 57' 31'' LS and 114 07' 55'' E with an altitude of 5 meters above sea level.

Estimates predicted by NASA regarding the coordinates show that the eclipse occurred since 10:04:25 WITA and ended at 13:02:25 WITA, the total phase began at 11:29:41 WITA and finished at 11:30:38 WITA. As for the middle of the eclipse occurred at 11:30:09 WITA [11]. While the calculation results using the Bessel Element with AstroCamp data found that the eclipse began at 10:03:09 WITA and ended at 13:00:59 WITA, the total phase began at 11:28:21 WITA and finished at 11:29:13 WITA. As for the middle of the eclipse occurred at 11:28:47 WITA.

Table 4. *Comparison of the results of the calculation of the March 20, 2023 Partial Solar Eclipse between Besselian Elements using Ephemeris AstroCamp, NASA's Besselian Elements, and video observations made by the Perth Observatory*

Eclipse Contact	Exmouth	AstroCamp	Difference	Predictions	Different from NASA
Eclipse Start	10:04:27 WITA	10:03:09 WITA	01 Minutes 18 seconds	10:04:25 WITA	2 seconds
Total Start	11:29:28 WITA	11:28:21 WITA	01 Minutes 07 seconds	11:29:41 WITA	13 seconds
Mid Eclipse	11:29:57 WITA	11:28:47 WITA	01 Minutes 10 seconds	11:30:09 WITA	12 seconds
Total End	11:30:26 WITA	11:29:13 WITA	01 Minutes 13 seconds	11:30:38 WITA	12 seconds
Total Duration	58 seconds	52 seconds	6 seconds	57 seconds	1 seconds
Eclipse Duration	02:57:47	02:57:50	3 seconds	02:58:00	13 seconds

From the table above, the evidence shows that the results shown from calculations using the Bessel Element from AstroCamp have an average difference of 1 minute 12.6 seconds while from NASA's prediction the average difference is 10 seconds from the reality of the eclipse time. From the results of the data analysis that the researchers have described above, there is a significant difference in the calculation of the Bessel Element from AstroCamp, which is up to 1 minute more. Whereas usually in calculations using Bessel Elements only bring up the difference in seconds, besides the significant difference there is also a component of elements that are not in the Bessel algorithm in *Alfan Maghfuri's* Eclipse Algorithm Book.

To see if the results of the Bessel Element component with two orders have an effect on the eclipse contact results, the author attempts to make a comparison using the Bessel Element in the Book of *Al-Dūrru Al-Anīq* by KH. Ahmad Ghazali Muhammad Fathullah. This attempt was made to prove the influence of the order on the results of the eclipse calculation.

Table 5. *The Value of Bessel Elements in Kitab Al-Dūrru Al-Anīq dated April 20, 2023*

X0	*Y0*	*d0*	*M0*	*L10*	*L20*	Tan *f1*
X1	*Y1*	*d1*	*M1*	*L11*	*L21*	Tan *f2*
0.02699	-0.42732	11.41178	240.24296	0.54681	0.00067	0.00465
0.49495	0.24417	0.01374	15.00342	0.00011	0.00011	0.00463

Then the author made calculations using the Bessel Element from Kitab *Al-Dūrru Al-Anīq* and carried out a comparison with the total eclipse observation data in the City of Exmouth.

Eclipse Contact	Eclipse Start	Total Start	Mid Eclipse	Total End	Eclipse End
Exmouth Observation Video	10:04:27 WITA	11:29:28 WITA	11:29:57 WITA	11:30:26 WITA	13:02:14 WITA
Al-Durru Al-Anīq	10:04:22 WITA	11:29:39 WITA	11:30:08 WITA	11:30:36 WITA	13:02:24 WITA
Different	5 seconds	11 seconds	11 seconds	10 seconds	10 seconds

From the above comparison, it can be seen that although the Bessel Element component of Kitab *Al-Dūrru Al-Anīq* contains only two orders, the results obtained

have a difference of seconds not up to minutes and the difference shown is also close to NASA's prediction data.

IV. Conclusion

Solar eclipse calculations using AstroCamp data with the Besselian Elements method are included in contemporary manifold calculations. Based on the analysis that the researchers have done, the application of AstroCamp data with Bessel elements resulted in a difference from the observational reality of about 1 minute 4 seconds to 4 minutes 8 seconds. Although the calculation of the Bessel element with AstroCamp has a difference in the order of minutes, it is still very accurate, considering that only with *data can Ephemeris* approach the calculation results with NASA-level algorithms.

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Visual Quality Assessment of Night Sky in Binjai City

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ABSTRACT

Finding a Good Night Sky in North Sumatra is a challenge since some developing city contribute more light to the night. A short distance city from Medan is Binjai City. This study was conducted to measure the night sky's quality visual in Binjai City, North Sumatra, Indonesia. This activity is carried out by conducting a process of direct observation and taking pictures in several stages with a camera followed by calculating between naked eye visibility and image results. With this comparison, we will find the visibility and quality value ratio of the night sky in the city of Binjai. The results obtained from this study show that Binjai City is in the level 5 category on the light pollution scale.

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I. Introduction

Artificial light at night affects the quality of the sky location far from the location of the light source through scattered light in the sky. The light in the sky can even be seen from underdeveloped areas hundreds of kilometers away from major cities. This degrades the quality of night sky visibility and can alter the night environment and visual performance in all organisms. The pristine sky, free from artificial skylight, provides the greatest opportunity to experience the phenomenon of the natural night sky [1].

Large cities produce light pollution and form bright light domes along the horizon to some zenith parts of their locations, even affecting relatively remote areas that experience significant degradation of sky quality. When night streetlights are dispersed from a city light source, it greatly impacts the visual level of observers at that location as seen in Figure 1. The existence of light pollution also reduces the visibility of dim celestial bodies even high light pollution in a place can eliminate opportunities for people to observe stars, meteor showers to comets.

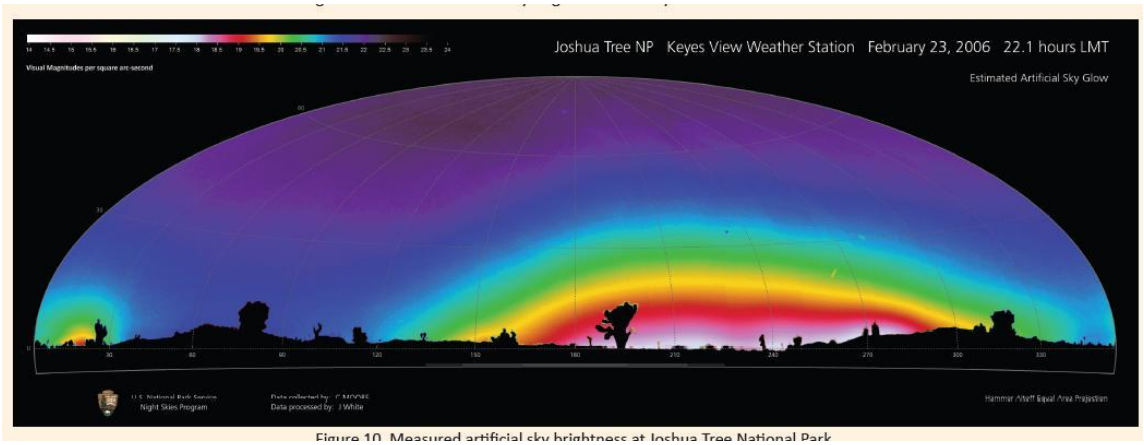

Figure 1. Example: Light pollution from a big city seen from the suburbs

Light pollution alters the natural light levels of the night sky The effect of urban lighting, also known as light pollution, can reach surprisingly far [2]. Natural light comes from celestial bodies, especially the Moon, natural emissions of the atmosphere (airglow), stars and galaxies of the Milky Way, and the light of the Zodiac. On a moonless night, illumination from a clear night sky will be able to display galaxies and zodiac light worth about 22 magnitudes per second of quartic arc (mag/arcsec 2) [3]. Artificial light scattered across the sky in the atmosphere increases the illumination of the night sky, producing visible negative effects from light pollution. What's more, it hinders optical astronomical observations from inside the Earth.

A map of the earth showing light pollution in the sky published in July 2015 has provided estimates of the geographical position and severity of light pollution in the place [4]. In recent times, everyone has been able to access the hay pollution map online on the site that provides the information. However, it is not as accurate as direct observations, but mostly based on the help of night satellite imagery.

A detailed comparison between map predictions of naked-eye limiting magnitudes and visual estimates requires observations made (i) at a large number of sites, (ii) by a large number of observers in each site to have a statistical treatment of eye capabilities, (iii) on nights with the same vertical extinction and horizontal visibility assumed in the map computation, (iv) on many similar nights to smooth atmospheric fluctuations by averaging, (v) in the same period in which the satellite image was taken, and (vi) with accurate geographical positions (better than 15 arcsecs) [5].

Binjai City itself is a city that is quite far from the big city – Medan City – which is the largest source of light pollution in North Sumatra. The management of the distribution of lighting on infrastructure has followed a good procedure for handling the distribution of streetlights to the sky with the use of battery-powered white LED model spotlights and solar panels pointing only downward reducing light pollution in the city. Although there are still advertising media lighting lights such as billboards that scatter light into the night sky. Visual observations in Binjai City can show many constellations with complete and good star parts. The sky is quite black and not reddish like the sky in a big city. Night photography

environment monitoring and modeling are necessary for informed management actions. The light pollution around Binjai City can be seen in Figure 2 below.

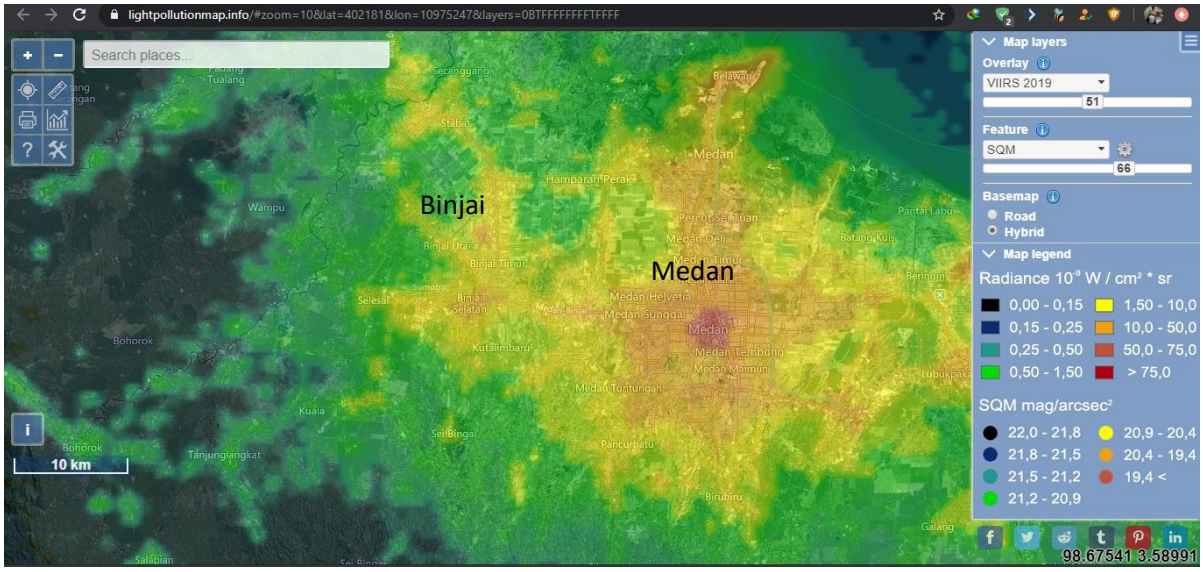

Figure 2. Medan and Binjai light pollution maps (source: lightpollutionmap.info)

Communicating information about the state of resources and their relationship to the distribution of light in Binjai City through geospatial models helps raise public awareness. And it helps for society to enjoy the night sky full of stars.

Novice astronomers usually assess their skies by finding the magnitude of the faintest star on naked-eye observations depending on the observational ability and sharpness of the observer's eye. And there are capabilities relative to different observers. To help observers assess the level of darkness of the night sky in a place, a scale with 9 levels was made based on 50 years of experience known as the Bortle scale [6].

As a comparison for the night sky simulation software such as Stellarium to see the full night object. In Stellarium, there is also a feature that can show simulations of celestial conditions that are in light pollution levels in certain classes so that they can match the state of the sky and the visibility of the number of stars in a condition at the place where the observation is located [7].

II. Method

The Artificial Sky Brightness Map utilizes upward light measures from the Suomi NPP Day/Night Band. With the separation of assumptions into emission functions, including Lambertian reflection from the ground (a), scattering light at low angles to the horizon from partially shielded fixtures (b), and pointing upwards at one higher angle (c), three separate geospatial models of artificial sky prediction of peak brightness were lowered. In this way, the model can be more accurately set to a specific region using ground-based sky brightness measurements for calibration.

The steps include the approximation of artificial components, with a natural background modeled and subtracted from observations in data reduction. The brightness of the artificial zenith sky is significantly measured, the brightness can be considered significant to the the entire sky degradation. The artificial skylight from a collection of sources is the result of the linear addition of each source. Light pollution levels of artificial skies are easily revealed as thematic maps in a false color representing geometric scales of increased brightness of different skies. Next, the data obtained was matched to Bortle scale readings to obtain a night sky class score in Binjai city. The comparison of the number of stars in the observed sky area will be juxtaposed with the sky in the Stellarium software which can display stars well according to their position and magnitude value.

III. Results and Discussion

On the light pollution map of Binjai city, it can also be shown the estimated amount of Radiance (radiation) and the estimated value of Sky Quality Meter readings which are very helpful in planning observations and research in the city.

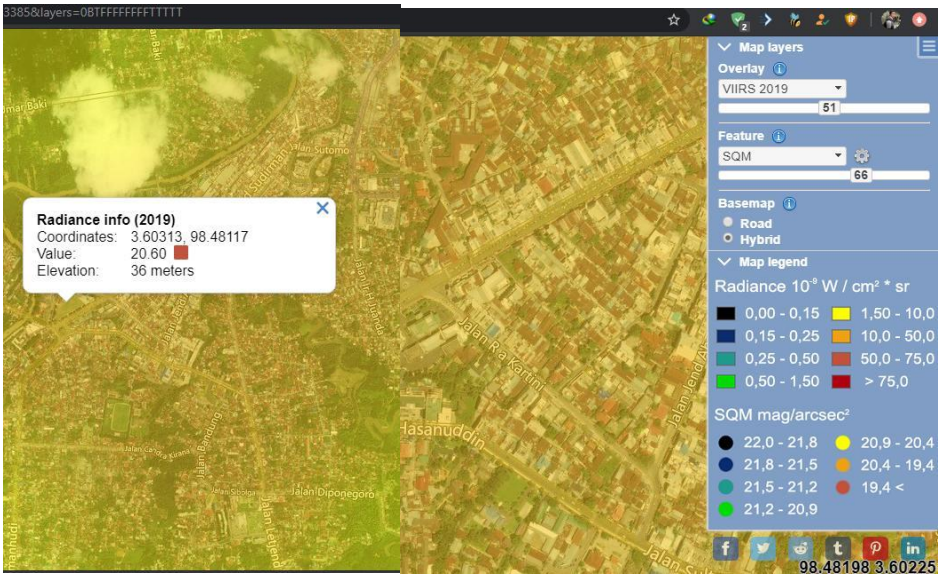

Figure 3. Overview of Light Pollution Readings

The reading of the light pollution map in Figure 3, shows a sky brightness reading with a value of SQM in the range of 19.4 – 21.2 (marked in orange, yellow, and green) which shows a fairly low level of light pollution because it does not show red or brighter. Binjai City is in class 5 or the suburban sky on the Bortle scale.

In observations made on the night sky in the city of Binjai, the results of the visibility of stars are quite good and numerous. Observers can mark the main stars of large constellations, but small constellations still have difficulty finding companion stars in that constellation. The experiment conducted by comparing the number of stars seen over the area between the constellations Taurus and Aries to avoid mixing large stars and dark skies. On naked eye observation in the western sky of Binjai City, near the constellation Aries are 4 stars visible (Hamal, Sheratan, Mesarthim, and Baharani), and in the constellation Taurus, there are 4

stars and 1 star cluster (Atlas, Hyadum, λ Tau and o Tau). Other stars that can be seen are Menkar, Khaffaljidhma, Zaurak, Rana, Ran, and Azha. The constellation seen from Binjai and compared with Stellarium in the light pollution level can be seen in Figure 4.

Figure 4. Comparison of the night sky in Binjai City (left) and Stellarium at the level 5 Light pollution (right)

With the number of visible stars less than 14, the estimated western threshold of visibility (Naked Eye Limit Magnitude) is in the range of 5.6 – 6.0. The NELM value range shows that the city of Binjai is in class 5 on the Bortle scale. These stars matched the position of stars in the Stellarium, and it verified the star. Small and faint stars are difficult to see because the sky from the observation site still gets artificial light sources from residential locations.

IV. Conclusion

Binjai city's night sky is in good condition with low light pollution levels. The night sky shows a bluish-dark night and gives some visible stars. However, it cannot display galaxies and other faint celestial bodies. NELM value is in the range of 5.6 – 6.0 and puts Binjai City in the class 5 category on the Bortle scale.

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The Role of Astronomy and Islamic Philosophical Wisdom through Muslim Philosophical Thought in Understanding the Phenomena of the Universe

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ABSTRACT

The study of the role of astronomy and the wisdom of Islamic philosophy in understanding the phenomena of the universe has become an important subject in the dialog between science and religion. Astronomy, with its critical and empirical methods, has provided a deep understanding of the structure and dynamics of the universe. On the other hand, the wisdom of Islamic philosophy, especially through Muslim philosophical thought, offers a deeper perspective on the meaning and purpose behind the phenomena of the universe. It provided a conceptual framework for understanding the universe. Concepts such as tawhid (the oneness of God), fitrah (nature), and 'ilm al-kalam (the science of theology) help in explaining the essential relationship between creator and creation. In addition, Muslim philosophical thought also highlights the ethical and moral aspects of man's relationship with the universe. The integration of astronomy and Islamic philosophical wisdom brings great benefits in deepening man's understanding of the universe and his place in it. This integration not only enriches intellectual insights but also expands the spiritual dimension of man. Conceptual analysis method to be able to analyze key concepts in astronomy and Islamic philosophy, such as tawhid, fitrah, and hikmah, to understand how they interact with each other and contribute to human understanding of the universe.

I. Introduction

Since ancient times, humans have looked up at the night sky with awe and curiosity. Observations of the motion of the stars and planets have been the basis for the development of astronomy. Meanwhile, in the Islamic intellectual tradition, philosophical thinking has been a vehicle for deepening understanding of the meaning and purpose behind the phenomena of the universe. The combination of astronomy and Islamic philosophical wisdom through Muslim philosophical thought provides a solid foundation for the study of the universe that includes physical, spiritual, and metaphysical aspects. In this context, astronomy gives us a deep understanding of the structure of the cosmos, planetary motion, and other astronomical processes. Through methods of observation, measurement, and data analysis, astronomy leads us to a deeper understanding of the vast complexity of the universe [1].

The wisdom of Islamic philosophy provides a spiritual and moral dimension to the universe. Concepts such as tawhid (the oneness of God), fitrah (nature), and 'ilm al-kalam (the science of theology) form an important conceptual framework for understanding the relationship between creator and creation. Muslim philosophical thought invites us to reflect on the purpose and meaning behind the existence of the universe and humanity's place in it [1].

By integrating astronomy and Islamic philosophical wisdom through Muslim philosophical thought, we can deepen our understanding to the universe holistically. This approach not only enriches our intellectual horizons but also expands the spiritual and ethical dimensions of viewing the reality of the universe. Therefore, the role of astronomy and Islamic philosophical wisdom in understanding the phenomena of the universe has an important relevance in human efforts to explore the meaning and purpose of our existence in this vast cosmos.

Understanding the universe has been the focus of human attention since ancient times. In this context, astronomy and Islamic philosophy play an important role in providing deep insights into the phenomena of the universe. Astronomy allows humans to observe, analyze, and understand the motion and behavior of celestial bodies such as planets, stars, and galaxies. Through rigorous research, astronomy helps us understand the structure and evolution of the universe. In the context of Islamic philosophy, Muslim philosophers have made significant contributions to the understanding of natural phenomena. This thinking is reflected in the concept of tawhid (oneness of God) in Islam, which states that the universe is manifestation of the power of the Almighty God. In addition, through the thinking of Muslim philosophers, there is an attempt to combine astronomy with the principles of Islamic philosophy [1]. They try to explain the phenomena of the universe by using a framework of thought that is following Islamic teachings, such as the concepts of tawhid, sunnatullah (God's sunnah in the universe), and qadar (God's decree). One of the wisdoms of Islamic philosophy in understanding the phenomena of the universe is the encouragement to explore and understand the universe as part of worship to Allah. In Islam, scientific knowledge is seen to get closer to the Creator, because understanding His work is a form of exaltation and

respect. Muslim philosophers also highlighted the importance of ethics in the use of astronomical knowledge. They taught that scientific knowledge should be used for the good of humanity and the welfare of mankind, not for personal gain or harming others [2].

II. Method

The research method used in this study is the literature analysis research method which involves the study of classical and contemporary texts in astronomy, Islamic philosophy, and Muslim philosophical thought to identify concepts and theories relevant to the understanding of the phenomena of the universe. The conceptual analysis method is to be able to analyze key concepts in astronomy and Islamic philosophy, such as tawhid, fitrah, and hikmah, to understand how they interact with each other and contribute to human understanding of the universe. This method is a broad study and for use in various fields on the discussion of a theory that departs from objective knowledge assumptions and is then written in various sources of information. The sources of information that the author sources are from journals and books.

III. Results and Discussion

Muslim philosophers also remind us of the limitations of human knowledge in understanding the universe. Although astronomy has brought humans to a deeper level of understanding of the universe, there are still many mysteries. This teaches humans to remain humble and not to be arrogant about their knowledge. In this context, astronomy and Islamic philosophy can also be a source of inspiration for the development of modern science and technology. Through deep philosophical thinking, humans can develop new theories and technologies that can help in further understanding and exploration of the universe. However, it is important to remember that astronomy and Islamic philosophy are not the only approaches to understanding the phenomena of the universe [1].

The role of astronomy and the wisdom of Islamic philosophy in understanding the phenomena of the universe is very important. Astronomy provides a more technical understanding of the motion and behavior of celestial bodies, while Islamic philosophy provides a spiritual and ethical dimension [3], both of which can lead humans to a more holistic and in-depth understanding of the universe and its meaning in human life. Here's how astronomy plays a role in understanding the phenomena of the Universe:

A. Understanding the Origin and Fate of the Universe

I. The origin of the universe: The most dominant theory in explaining the origin of the universe is the Big Bang Theory [3]. This theory states that the universe began as an extremely dense and hot singularity about 13.8 billion years ago. At that moment, the universe exploded and began to expand. During this initial phase of expansion, energy, matter and space-time were formed.
Evidence for the Big Bang Theory, namely
- Cosmic Microwave Background Radiation (CMB)

According to the Big Bang Theory, the CMB originated at the very beginning of the universe, about 380,000 years after the Big Bang. By then, the universe had expanded and cooled so that electrons could combine with atomic nuclei, forming neutral atoms. This allowed light to travel long distances unhindered by interactions with charged particles [4].

- Abundance of light elements

The abundance of light elements in the context of the Big Bang Theory refers to the proportion of light elements such as hydrogen, helium and lithium in the early universe. The Big Bang Theory predicts that in the early stages of the universe's development, temperature and density were so high that primary nuclear reactions occurred, resulting in the formation of simple elements. The process of formation of light elements are

Nuclear Synthesis: In the early phase of the universe, about 1 to 3 minutes after the Big Bang, the temperature and density were so high that primary nuclear reactions could occur. These reactions, known as primary nucleosynthesis, took place as the temperature dropped to about a billion degrees Kelvin.

Hydrogen and Helium Dominance: During this phase, the amount of hydrogen and helium increases significantly due to nucleosynthesis, while the amount of heavier elements such as lithium and other heavy elements remains relatively low [5].

II. The fate of the universe;

The fate of the universe is a topic that is still debated and studied in astronomy. Some of the main scenarios proposed for the fate of the universe are as follows:

- Big Freeze (Heat Death): In this scenario, the universe continues to expand until the temperature of the universe reaches absolute zero. As a result, all physical activity would cease, causing a "heat death" where no energy is available to do mechanical work.
- Big Crunch: In this scenario, gravity finally overcomes the expansion of the universe and begins to reverse its direction. The universe would then experience "compression" back to the point of singularity, resembling the initial conditions before the Big Bang.
- Big Rip: In this scenario, the dark pressure or dark energy believed to be responsible for the accelerated expansion of the universe would become so strong that it would rip apart galaxies, stars and the basic matter of the universe itself sendiri [6].

B. Understanding the Movement of Celestial Bodies

- Rotational and Revolutionary Motion

Rotational Motion: Refers to the rotation of objects around their axes. For example, the earth's rotation causes the alternation of day and night.
Revolutionary Motion: Refers to the motion of an object around another object in orbit. For example, the Earth orbits the Sun, while the Moon orbits the Earth.

- Planetary Motion
  Retrograde Motion: Sometimes, planets appear to move backward in the sky before resuming their forward motion. This is called retrograde motion, which is caused by the difference in the orbital speeds of the planets and the Earth.
  Conjunction and Opposition: Conjunction occurs when the planet and the Sun are on the same side of the Earth, while opposition occurs when the planet and the Sun are on opposite sides of the Earth.
- Star and Galaxy Motion
  Star Motion: Stars appear to move in the sky due to the Earth's motion throughout the year. This motion is relative to the background of other stars.
  Galaxy Motion: Galaxies also move through the Universe. On a large scale, galaxies interact with each other through gravity.
- Celestial Motion
  Daily Motion: Occurs due to the rotation of the earth. Celestial objects appear to rise and set in the sky throughout the day.
  Monthly Motion: Occurs due to the Moon's revolution around the Earth. The Moon appears to move in the sky from east to west every night.
  Annual Motion: Occurs due to the Earth's orbit around the Sun. The stars appear to move in the sky throughout the year.

C. Philosophical Interpretation of the Universe

Islamic philosophy teaches that the universe is proof of the majesty and wisdom of Allah [7]. Understanding the universe can bring humans closer to Allah SWT, because through this knowledge, humans can admire and respect His creation. Here are some philosophical concepts that are often used to interpret the universe [8]:

- Ontology: Ontology is a branch of philosophy that studies the nature of existence. In the context of the universe, ontology addresses the fundamental questions of what exists, how existence is defined, and whether there is a fundamental origin or substance upon which the universe is based.
- Epistemology: Epistemology is the study of the nature, origin, and limits of knowledge. In the context of the universe, epistemology includes questions about how we gain knowledge of the universe, whether that knowledge is trustworthy, and whether there are limits to human knowledge of the universe.

- Cosmology: Cosmology is the study of the origin, structure, and evolution of the universe as a whole. Within this framework, philosophical cosmology attempts to answer the questions of how the universe came into being, whether there is a purpose or direction in its development, and whether there is meaning in the universe's existence.
- Teleology: Teleology is the study of the purpose or end of an entity or process. In the context of the universe, the concept of teleology is used to consider whether there is a purpose or design behind the structure and evolution of the universe, and whether there is an intelligence or plan behind it.
- Metaphysics: Metaphysics is a branch of philosophy that deals with the nature of reality, including the nature of the universe. Metaphysical thinking about the universe includes concepts such as existence, consciousness, time, space, and the relationship between parts and the whole.
- Ethics: Ethics addresses questions of value, purpose, and right or wrong actions. In the context of the universe, ethical considerations may include how we should treat the universe.

D. Science as Worship

Science as Worship links efforts to understand the phenomena of the universe with spiritual and moral values in certain religions, especially Islam. This idea underlines that human efforts to gain knowledge about the universe are not only an intellectual act but also a form of worship or devotion to God. The following Science as Worship can be applied to understanding the phenomena of the universe [8]:

I. Respect for the Creator
   In the Islamic context, studying the universe and the phenomena within it is considered a form of respect and appreciation for Allah as the Creator. By expanding knowledge of His creation, man shows recognition of the majesty and wisdom of Allah.
II. Development of Potential
   Islam teaches that humans are given reason and intelligence by Allah to use in understanding the universe. By using that mind and intelligence to explore the universe, humans are utilizing the gifts given by Allah, and such use is considered a form of worship to Allah.

E. An understanding of Tawhid, or the oneness of God

This understanding has profound implications for understanding the universe in the context of Islam. Tawhid is a fundamental concept in Islam that states that Allah is the only God who has no partners, is undivided, and cannot be compared to anything. In the context of

understanding the universe, Tawhid guides us to see everything in creation as a manifestation of one divine existence that has infinite power, wisdom, and dominion.

The understanding of Tawhid impacts the understanding of the universe: [9].

- Recognition of the Existence of God: The concept of Tawhid emphasizes that everything in the universe exists because of the will of Allah. Every natural phenomenon, from the simplest to the most complex, is seen as a sign of Allah's existence and power. This leads to the understanding that the universe itself is proof of Allah's existence.
- Order and Harmony: In the understanding of Tawhid, the universe is understood as a manifestation of Allah's divine wisdom and plan. Everything in the universe works in orderly harmony, demonstrating the infinite wisdom and planning of the Creator. This includes the laws of nature, the cycle of life, and the overall orderliness of the cosmos.
- Dependence on Allah: The understanding of Tawhid also teaches that the universe and everything in it is dependent on Allah. Nothing stands alone or has independent power everything is in existence because of Allah's will and power. Therefore, an understanding of Tawhid encourages us to respect and appreciate the diversity of the universe, including various life forms, ecosystems and other natural phenomena.
- Human Responsibility: In Islam, the understanding of Tawhid also reinforces the concept of human responsibility as khalifah or Allah's representative on earth. Humans are given the power and wisdom to care for and maintain the universe in accordance with Allah's will. Therefore, humans have a moral responsibility to care for the environment and maintain ecological balance as a form of respect for God who created the universe.
- Understanding of Order and Justice: In the understanding of Tawhid, the universe is seen as a mirror of God's wisdom and justice. Observation of the orderliness of the universe, including natural cycles and physical laws, inspires awareness of His wisdom and decree. It also inspires humans to seek justice in social and environmental interactions, in line with the principles reflected in the universe created by Allah.
- Deepening Awe and Devotion: An understanding of Tawhid not only deepens awe of Allah's greatness manifested in the universe, but also strengthens a sense of devotion to Him. Observing the beauty and complexity of the universe becomes a means of drawing closer to Allah and increasing awareness of man's absolute dependence on Him.

1. Al-Biruni (973-1048 M)

Figure 1. Al-Biruni (Left) and Ibn Sina (Right)

Abu Rayhan al-Biruni (figure 1, Left) was an astronomical thinker who lived in the 11th century. He came from Persia and was known as a versatile scientist who had great contributions in various fields, including astronomy. Al-Biruni conducted extensive and in-depth research in astronomy. He observed and measured the positions of the stars, planetary movements, and other phenomena. One of his most famous works is "Kitab Al-Qanun Al-Mas'udi". This work discusses various astronomical topics such as planetary motion, lunar circulation, and stargazing. Al-Biruni used scientific and mathematical methods to explain the phenomena of the universe. This work not only made an important contribution to the development of science in his time, but also influenced the development of science in the western world through its translation and dissemination. Al-Biruni was an astronomical thinker who was very influential in the development of science. His work includes not only accurate observations and measurements, but also important theoretical contributions in understanding the universe.

2. Ibn Sina (980-1037 M)

Ibn Sina (figure 1, right) was a Muslim polymath who played an important role in the history of science. In addition to his work in medicine, Ibn Sina also made major contributions in philosophy, astronomy, and mathematics. In his famous work, "Kitab al-Shifa" (The Book of Healing), Ibn Sina discussed the concepts of astronomy and physics. He explored ideas about the universe, planetary motion, and the nature of matter. Ibn Sina also introduced the concept of equilibrium motion, which became the basis for the understanding of planetary motion in the universe [11].

3. Ibn al-Haytham (Alhazen)

Abu Ali al-Hasan ibn al-Hasan ibn al-Haytham (965-1040 M), better known as Ibn al-Haytham in figure 2 on the left, was a leading Muslim scientist in optics, mathematics, and physics. His understanding of the nature of light and vision also impacted the understanding of the universe, especially in the context of astronomy. One of his famous works, "Kitab al-Manazir" (The Book of Optics), was an important contribution to the understanding of optics and astronomy in his time [12].

4. Nasir al-Din al-Tusi

Figure 2. Ibn Al-Haytam (Left) and Nasir Al-Din al-Tusi (Right)

Nasir al-Din al-Tusi (1201-1274 M) was a 13th century Muslim scientist known for his work in mathematics, astronomy, and philosophy shows in figure 2 on the right. He led the construction of the leading scientific observatory in Maragha, Iran, which became the center of astronomical and mathematical research in his time. His works in astronomy, including "Tahrir al-Majisti" (Commentary on the Almagest), helped advance the understanding of the universe [13].

5. Al-Khwarizmi (Algorithm)

Figure 3. Al-Khawarizmi

Muhammad ibnu Musa al-Khwarizmi (780-850 CE) was a 9th century Muslim mathematician, astronomer, and geographer. One of his famous contributions was the introduction of the concept of algebra and the Hindu-Arabic numeral system. Although he is best known in mathematics, his works also cover the field of astronomy. In his work entitled "Al-Majisti", al-Khwarizmi discusses astronomy and scientific calculations, which provide a deeper understanding of the universe and the movement of celestial bodies [14].

To explain the phenomena of the universe, these scientists used mathematical and scientific methods, including planetary motion, the nature of light, and the circulation of other celestial bodies. They also formulated theories that were important in understanding the universe, such as the concept of equilibrium motion introduced by Ibn Sina.

IV. Conclusion

Astronomy and Islamic hagiography give important lessons and Astronomical knowledge imparts about the periodic table and its structure using critical and empirical methods. The primary source of Islamic philosophy found in another Muslim discipline offers a more critical perspective on the goals and nature of the periodic table. The collaboration between astronomy and Islamic philosophy develops our understanding of the universe. This does not only influence intellectual capacity, but it also influences human spiritual dimensions. Through this integration, humanity can understand the universe in its entirety, including both spiritual and physical aspects. Hikmah philosophy Islam, mainly through Muslim intellectual contributions abroad, has provided a moral and spiritual dimension to the study of the world. Concepts like tawhid, fitrah, and knowledge al-kalam have formed important conceptual conditions that highlight the primary relationship between creator and creation.

Besides that, Islamic philosophy emphasizes the importance of ethics in the application of astronomy knowledge and predicts a decline in human understanding of the universe. The joint efforts of astronomy and Islamic philosophy have yielded significant benefits in helping people understand the nature of the universe. Through this holistic approach, humanity can transcend itself not only as a physical object but also as a manifestation of the will and mercy of Allah SWT. This strengthens human intellect while also strengthening moral and spiritual dimensions in governing cosmic reality.

Several of the most eminent Muslim scholars, such as Al-Biruni, Ibnu Sina, Ibnu al-Haytham, Nasir al-Din al-Tusi, and Al-Khwarizmi, are also mentioned. Their contributions to scientific knowledge, particularly in the field of astronomy, have had a significant impact on the advancement of human understanding of space exploration. In general, the relationship between astronomy and Islamic philosophy as expressed in Muslim philosophy has important implications for humankind's efforts to understand the nature and purpose of our limited existence. With it being said

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