THE ROLE OF *SINDHIND ZIJ* AS THE FIRST ISLAMIC ASTRONOMICAL CALCULATION TABLE IN INDIAN CIVILIZATION

Nur Faizah,[1] Nura'zirah binti Roslan,[2]
[1]Dar El Hikmah Islamic Boarding School Pekanbaru – Indonesia, 2Universiti Malaya – Malaysia
*Corresponding author. Email: nfaiza889@gmail.com

Abstract

Astronomy has developed in India since prehistoric times. However, astronomy's first work appeared during the Vedanga Jyotisa era, written by Lagadha, the oldest literary book in India. Using qualitative methods with a library research approach, it was found that Indian astronomers researched Astronomy and wrote books. One of the books that first made Muslim scientists interested in the world of astronomy was the book *Brāhmasphuṭasiddhānta*, which was translated into Arabic by Al-Fazari (d. 796 AD) during the Caliphate of Al-Manṣūr from the Abbasid dynasty. Al-Fazari (d. 796 AD) became the first Muslim astronomer to compile *Zij*, with his calculations converted into the Hijri Calendar. After Al-Fazari (d. 796 AD) collected this *Zij*, other *Zij*s were born, which became the forerunners for the composition of the epimeris and other counts. Around the beginning of the 11th century, Al-Biruni (973-1048 AD) spread da'wah to India and introduced the study of Islamic astronomy in India.

Keywords: *Astronomy; Indian Civilization; Sindhind Zij*

Abstrak

Astronomi sejatinya telah lama berkembang di India semenjak zaman Pra sejarah, namun ilmu astronomi pertama kali muncul saat masa Vedanga Jyotisa yang ditulis oleh Lagadha yaitu kitab sastra tertua di India. Dengan menggunakan metode kualitatif dengan pendekatan library research, ditemukan bahwa para astronom India meneliti astronomi hingga menulis buku. Salah satu buku yang membuat awal ilmuan muslim tertarik dunia astronomi ialah buku *Brāhmasphuṭasiddhānta* yang diterjemahkan ke dalam bahasa Arab oleh Al-Fazari (w. 796 M) pada masa khalifahaan Al-Manṣūr dari dinasti Abbasiyah. Al-Fazari (w. 796 M) menjadi astronom muslim pertama yang menyusun *zij*, dengan perhitungannya telah dikonversi ke dalam tahun Arab (tahun Hijriah). Setelah Al-Fazari (w. 796 M) menyusun *zij* ini, lahirlah *zij* yang lainnya yang menjadi cikal bakal tersusunnya epimeris dan terhitungan lainnya. Sekitar awal abad ke-11, Al-Biruni (973-1048 M) menyebarkan dakwah ke India dan memperkenalkan pembelajaran astronomi Islam di negara India.

Kata Kunci: *Astronomi*; *Peradaban India*; *Zij Sindhind*

A. Introduction

After Islam expanded from Andalusia to India, *hisab* and rukyat progressed through the sciences of Hisab (astronomy), astrology and mathematics, and other exact sciences. These sciences were grafted from Greece, Egypt and India and were then developed by conducting experiments, calculations, and observations.[1] Besides Greece, another civilisation that influenced much of the Islamic intellectual tradition was India, especially in the fields of mysticism and mathematics. Around 154/771, an Indian traveller introduced an astronomical text to Baghdad entitled *Siddhanta* (Arabic: *Sindhind*). This manuscript subsequently became an essential reference among Muslim scholars. The Indian traveller also brought with him a mathematical text. These numbers in Europe were called Arabic numerals, while the Arabs called Indian numerals (Hind). Later in the 9th century AD, Indians made significant contributions to mathematics, namely the decimal system.[2]

The birth of astronomical civilisation in Arab started from three astronomical societies that have a unique position in the development of astronomy, namely the astronomical society Yunani, the Persian astronomical culture, and the Indian astronomical civilisation.[3] Islam Astronomy received much attention from researchers and historians. Regis Morlan (a French orientalist and researcher of the history of classical phallic science) put forward several factors: the number of scholars who have been involved

[1] Li'izza Diana Manzil, "Korelasi Historisitas Ilmu Hisab Rukyat dengan Perkembangan Peradaban Islam," *Al-Istinbath : Jurnal Hukum Islam* 3, no. 2 (2018): 185, https://doi.org/10.29240/jhi.v3i2.432, 189.

[2] Jayusman, "Sejarah Perkembangan Ilmu Falak Sebuah Ilustrasi Paradoks Perkembangan Sains dalam Islam," *Al-Marshad: Jurnal Astronomi Islam dan Ilmu-Ilmu Berkaitan* 1, no. 1 (2017): 49.

[3] Alimuddin, "Sejarah Perkembangan Ilmu Falak," *Al Haudah*, Vol. 2, (2013), 181.

in the field of phallic science throughout history, the large number of works of scholars, a large number of documented observational (natural observation) data.[4] Meanwhile, Muḥammad Aḥmad Sulaymān (professor of phallic science at the National Institute of Astronomical and Geophysical Research, Helwan – Egypt) said, "*Astronomy is a mediator of the advancement of the nation's civilisation*".[5]

Indian astronomical civilisation started from astronomical figures used for Vedic rituals. Part of the ritual was to devise geometric schemes relating to the length of the solar and lunar years. The compilation of the Vedas is also according to astronomical rules.[6] Indian civilisation had a significant and considerable role in developing phallic science in Arabia. An astronomical book entitled "*Sindhind*" had a substantial influence on the development of phallic science, with its peak of glory in the Abbasid dynasty during the reign of Abu Ja'far Al-Manshur (775 AD). This book was summarised and translated into Arabic.[7] Muhammad ibn Ibrahim al-Fazzari was the one who got the mandate to work on this project and published an explanatory book entitled *al-Sind Hind al-Kabīr*.[8]

Based on this explanation, Islamic astronomy and the Islamic community need to understand the history of the development of astronomy and Islamic Astronomy in India so that it can have a significant impact on the development of Islamic Astronomy for the Muslim community.

B. Method

This research is included in library research, which collects data and information from books, journals, and other recorded documents relating to the history of astronomy in India and the role of Indian astronomical tables in the development of astronomy. The approach in this research is descriptive analysis. Researchers try to explain clearly, systematically, factually and accurately from relevant sources related to the history of

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[4] Regis Morlan, *Muqaddimah fī 'Ilm Al-Falak*, Edited by (Beirut: Markaz Dirāsat al-Wahdah al-'Arabiyyah dan Mu'assasah Abdul Hamīd Syūmān, 1997), 25.

[5] Muḥammad Aḥmad Sulaymān, *Sibāhah Faḍā'iyyah fī Āfāq 'Ilm al-Falak* (Kuwait: Maktabah al-'Ujayrī, 1999) 12.

[6] Subhash Kak, "History of Indian Science," *Louisiana State University*, 2002, https://www.ece.lsu.edu/kak/grolier.pdf, accesed September 21, 2023.

[7] David A. King and Julio Samso, "Astronomical Handbooks and Tables from the Islamic World (750-1900): an Interim Report," *Abstracta Iranica*, 2003, https://doi.org/10.4000/abstractairanica.34579, 33.

[8] Alimuddin, "Sejarah Perkembangan Ilmu Falak.", 2:182.

astronomy in India and the role of Indian astronomical tables in the development of astronomy.

C. Results And Discussion

1. History of Indian Astronomy

Astronomy has a long history in Indian civilisation, from prehistoric to modern times. Some of the earliest roots of Indian astronomy can be dated to the period of society in the Indus Valley or earlier.[9] Next, astronomy developed as the Vedanga discipline, or one of the additional disciplines associated with studying the Vedas, dating to 1500 AD or older. The oldest known text is the Vedanga Jyotisha, dated 1400–1200 AD (with extant forms possibly from 700 to 600 AD). Indian astronomy was influenced by Greek astronomy starting in the 4th century BC and through the early centuries AD, for example, by the Yavanajataka and Romaka Siddhanta, a Sanskrit translation of a Greek Text distributed from the 2nd century AD.

Indian astronomy flourished in the 5th-6th centuries, with Aryabhata, whose work, Aryabhatiya, represented the pinnacle of astronomical knowledge. Aryabhatiya consists of four sections, covering topics such as units of time, methods for determining the positions of the planets, causes of day and night, and several other cosmological concepts. Then, Indian astronomy significantly influenced Muslim astronomy, Chinese astronomy, and European astronomy.[10] Other astronomers from the classical era who described Aryabhata's work include Brahmagupta, Varahamihira and Lalla.

An identifiable indigenous Indian astronomical tradition remained active throughout the medieval period and into the 16th or 17th century, especially within the Kerala School of Astronomy and Mathematics. Some of the earliest forms of astronomy can be dated to the Indus Valley civilisation or earlier. Several cosmological concepts are present in the Vedas, as are ideas about the movement of the heavenly bodies and the course of the years. The Rig Veda is one of the oldest works of Indian literature. The Rig

[9] Pierre-Yves Bely, *A Question and Answer Guide to Astronomy* (Cambridge: Cambridge University Press, 2010), 197.

[10] Nick Kanas, *Star Maps: History, Artistry, and Cartography*, 2nd ed (New York: Springer, 2012), 17.

Veda 1-64-11 & 48 describes time as a wheel with 12 parts and 360 spokes (days), with a remainder of 5, referring to the solar calendar.[11]

As in other traditions, there was a close connection between astronomy and religion during the early history of science, with astronomical observation required by spatial and temporal requirements for the proper performance of religious rituals. Thus, the *Shulba Sutra*, the text dedicated to constructing altars, deals with advanced mathematics and fundamental astronomy. The Vedanga Jyotisha is one of the earliest known Indian texts on astronomy, including details about the Sun, Moon, nakshatras, and lunisolar calendars. Vedanga Jyotisha describes rules for tracing the motions of the Sun and Moon for ritual purposes. According to Vedanga Jyotisha, there are five solar years, 67 sidereal lunar cycles, 1,830 days, 1,835 sidereal days and 62 synodic months in the yugas or eras.[12]

Greek astronomical ideas began to enter India in the 4th century BC after the conquests of Alexander the Great. In the early centuries of our Common Era, Indi-Greek influence on the astronomical tradition is evident, with texts such as the *Yavanajataka* and *Romaka Siddhanta*. Astronomers later credited the existence of various *Siddhanta*s during this period, among them a text known as the *Surya Siddhanta*, now known to be from the Gupta period and accepted by Aryabhata.

The classical era of Indian astronomy began at the end of the Gupta era, in the 5th to 6th centuries. *Pañcasiddhāntikā* by Varāhamihira (505 AD) approaches the method of determining the meridian direction of the three image positions using a gnomon. At the time of Aryabhata, the motions of the planets were treated as being elliptical rather than circular. Other topics include the definition of different units of time, eccentric models of planetary motion, epicyclic models of planetary motion, and corrections of planetary longitude for various terrestrial locations.

Before the Vedic age, India's distant history was shrouded in mystery. As a result, it's difficult to determine how much the Indians knew about astronomy in the distant past. Basic astronomical knowledge is required for the everyday activities of those who live in villages and rely on agriculture. The fundamental driving forces are the urge to keep track

[11] B. G. Sidrath, "The Calendric Astronomy of the Vedas," *Bulletin of the Astronomical Society of India*, 1998, 107.

[12] Shubash Kak, "The Astronomy of the Age of Geometric Altars," *Quarterly Journal of the Royal Astronomical Society* 36 (1995),385-395.

of the passage of time and the necessity to know when to sow and reap a particular crop. Another motivator must have been the use of observable celestial events to foretell one's destiny (a topic now known as astrology). In ancient times, the Sanskrit name for astronomy and astrology remained the same, i.e. 'Jyotish'.[13]

As a result, it is reasonable to believe that the Indians were familiar with the fundamentals of astronomy before the advent of the Vedic era. His initial interest in astronomy must have been in observing the seasonal changes of the moons and moons, eclipses, star constellations, the rising and setting of the various heavenly bodies, and later compiling a somewhat imprecise lunisolar calendar based on observations of the Sun's motion and months to predict with reasonable accuracy the onset of various seasons important to a predominantly agricultural society. Another driving reason must have been the determination of the dates of various religious celebrations.

a. Lagadha (1200 AD / First millennium AD)

The Vedanga Jyotisa, penned by Lagadha, is the first astronomical work in India. The book describes several astronomical concepts typically used to fix the timing of social and religious events. In addition to outlining guidelines for actual observations, the Vednga Jyotia provides data on astronomical computations and calendar studies. The Vednga Jyotia has ties to Indian astrology and describes several crucial components of the times and seasons, including the lunar month, solar month, and their adjustment to the intercalary lunar month Adhimsa. This component is included because the books published around 1200 AD are primarily religious works. The cycle of conjunctions is another term used to represent this period (or portion thereof). Twenty-seven constellations, eclipses, seven planets, and twelve zodiac signs, according to Tripathi (2008).[14]

b. Aryabhata (476-550 AD)

Aryabhaa was the author of the ryabhatya and ryabhaasiddhnta, which mainly circulated in northern India and had a considerable impact on the formation of

[13] Chander Mohan, *The History of Astronomy In India* (New Delhi: Viva Books, 2015), 221.

[14] V. N. Tripathi, *Astrology in India : Encyclopaedia of the History of Science, Technology, and Medicine in Non-Western Cultures*, ed. oleh Edited by Helaine Selin, 2nd ed, 2008, 264-267.

Islamic Astronomy through the Iranian Sassanid Empire (224-651). Its contents have been retained to some extent in the writings of Varhamihira (about 550), Bhskara I (around 629), Brahmagupta (598-c. 665), and others. This book is one of the first astronomical works. Make an effort to start each day at midnight. Aryabhata expressly states that the Earth rotates on its axis, causing the stars to seem to migrate westward. He proposes in his book Aryabhata that the earth is spherical, with a radius of 24,835 miles (39,967 km). Aryabhata also remarked that sunlight reflection is beneficial.[15]

c. Brahmagupta (598-668 AD)

Brahmasphuasiddhnta (628 CE) is a book about Indian mathematics and astronomy. Brahmasphutasiddhanta was translated into Arabic around 771 in Baghdad, considerably affecting Islamic mathematics and astronomy. Brahmagupta supported Aryabhata's theory of a new day beginning at midnight. Brahmagupta also estimated a planet's instantaneous velocity, provided the correct parallax formulae, and offered some eclipse calculation information. His efforts introduced the Arab world to Indian mathematical notions based on astronomy. He also proposed that all things with mass are drawn to Earth.

d. Varahamihara (505 AD)

Varāhamihira was an astronomer and mathematician who studied Indian astronomy and many principles of Greek, Egyptian, and Roman astronomy. His *Pañcasiddhāntikā* is treatises and summaries drawn from several systems of knowledge.[16]

e. Bhaskara I (629 AD)

Bhaskara is the author of the astronomical works *Mahābhāskariya* (The Big Book of Bhāskaras), *Laghubhaskariya* (The Little Book of Bhaskara's), and *Aryabhatiyabhashya* (629 AD) (a commentary on the Ryabhatīya written by Aryabhata). Bhāskara I's work was followed by that of Vateśvara (880 AD), who, in

[15] K. V. Sarma, "Astronomy in India," in *In Encyclopaedia of the History of Science, Technology, and Medicine in Non-Western Cultures* (Kluwer Academic Publishers, 2008).

[16] Takao Hayashi, *Bhaskara I*, English (In Encyclopaedia Britannica, 2008).

eight chapters of his *Vateśvarasiddhānta*, devised a method for determining parallax in direct longitude, the motions of the equinoxes and solstices, and the quadrants of the Sun at any given time.

f. Lalla (800 AD)

Lalla is the author of the *Iṣyadhīvṛddhida* (Treatise That Expands the Intellect of the Student), which corrected some of the assumptions of the Ryabhaṭa. *Isyadhīvrddhida* of Laila itself is divided into two parts: *Grahādhyāya* and *Golādhyāya*. The *Grahādhyāya* (Chapters I-XIII) deals with planetary calculation, determination of mean and actual planets, the three problems related to the daily motion of the Earth, eclipses, rising and setting of the worlds, various zeniths of the Moon, planetary and cosmic conjunctions, and the complementary situation of the Sun and Moon. The second part—*Golādhyāya* (chapters XIV–XXII)— deals with graphic representations of the motions of the planets, astronomical instruments, and spheres and emphasises correcting and rejecting flawed principles. Lalla shows the influence of Aryabhata, Brahmagupta, and Bhāskara I. His work was later followed by the astronomers Rīpati, Vateśvara, and Bhāskara II. Lalla also wrote the *Siddhāntatilaka*.[17]

g. Satananda (1068-1099 AD)

Satananda uses centesimal numbering in his astronomy manual Bhasvati, published in 1099. The book has eight short chapters with 128 verses covering methods for preparing the Almanack. He also included a method for calculating the longitudinal positions of the planets. Using 528 CE as a reference, he calculated the annual precession rate as 1 minute.[18]

h. Bhaskara II (1114 AD)

Wrote *Siddhāntaśiromaṇi* (Head Jewel of Accuracy) and *Karaṇakutūhala* (Calculation of Astronomical Wonders) and reported on his observations of

[17] K. V. Sarma, "Laila," in *In Encyclopaedia of the History of Science, Technology, and Medicine in Non-Western Cultures* (Kluwer Academic Publishers, 2008).

[18] Sudhira Panda, "The Bhāsvatī Astronomical Handbook of Śatānanda," *Journal of Astronomical History and Heritage,* Vol. 22 (n.d.), 536-544.

planetary positions, conjunctions, eclipses, cosmography, geography, mathematics, and astronomical instruments used in his research at the observatory in Ujjain.

i. Sripati (1045 AD)

Srīpati was an astronomer and mathematician who followed the Brahmagupta school and wrote the *Siddhāntaśekhara* (Special Defined Doctrine) in 20 chapters, introducing several new concepts, including the inequality of the two Moons.[19]

j. Mahendra Suri (1400 AD)

Mahendra Sūri wrote *Yantra-rāja* (King of Instruments, written c. 1370), a Sanskrit work on the astrolabe, which was introduced in India during the reign of the 14th-century Tughlaq dynasty ruler Firuz Shah Tughlaq (1351–1388 AD). Sūri appears to have been a Jain astronomer in the service of Firuz Shah Tughluq. Verse 182 *Yantra-rāja* mentions the astrolabe from the first chapter onwards and provides the basic formulas and numerical tables for drawing the astrolabe. However, the proof itself has not been detailed. The longitudes of the 32 stars and their latitudes have also been mentioned. Mahendra Sūri also explained G*nomon*, equatorial coordinates and elliptic coordinates. Mahendra Sūri's work may have influenced later astronomers such as Padmanābha (1423 AD), author of *Yantra-rāja-adhikāra*, the first chapter of his *Yantra-kirṇāvali*.

k. Parameshvara Nambudiri (1380-1460 AD)

The creator of the *Drgganita* or Drag system, Parameshvara, belongs to the Kerala School of Astronomy and Mathematics. Parameshvara was a proponent of observational astronomy in medieval India and had made a series of observations of eclipses to verify the accuracy of the computational methods used then. Based on his eclipse observations, Parameshvara proposed several corrections to the astronomical parameters that had been in use since the time of Aryabhata.

[19] Takao Hayashi, *Shripati* (In Encyclopaedia Britannica, 2008).

l. Nilakantha Somayaji (1444-1544 AD)

In 1500, Nilakantha Somayaji of the Kerala school of astronomy and mathematics, in his Tantrasangraha, revised the Aryabhata model for the planets Mercury and Venus. His equations of the centres of the worlds remained the most accurate until Johannes Kepler in the 17th century. Nilakantha Somayaji, in his ryabhaṭīyabhāṣya, a commentary on the ryabhaṭīya ryabhaṭa, developed his computational system for the partially heliocentric planetary model, in which Mercury, Venus, Mars, Jupiter and Saturn orbit the Sun, which in turn orbits the Earth, similar to the Tychonic System later proposed by Tycho Brahe in the late 16th century. The Nilakantha system, however, is mathematically more efficient than the Tychonic system because it correctly considers the equations of the centre and latitude of Mercury and Venus. Most astronomers of the Kerala School of Astronomy and Mathematics who followed him accepted his planetary model. He also wrote a treatise entitled *Jyotirmīmāṁsā*, emphasising the necessity and importance of astronomical observations to obtain correct parameters for calculations.[20]

m. Acyuta Pisararti (1550-1621 AD)

Sphuṭanirṇaya (Determination of the True Planets) details the elliptical correction to the existing notions. Sphuṭanirṇaya was later expanded to become *Rāśigolasphutānīti* (Computing the True Longitude of the Zodiac Circles). Another work, *Karanottama*, deals with eclipses, the complementary relationship between the Sun and the Moon, and the 'declining mean planets and true planets'. In *Uparāgakriyākrama* (Eclipse Counting Method), Acyuta Piṣāraṭi suggests an improvement in the method of calculating eclipses.[21]

[20] George Gheverghese Joseph, *The Crest of the Peacock: Non-European Roots of Mathematics*, 3rd ed (New Jersey: Princeton University Press, 2011), 408.

[21] K. V. Sarma, "Acyuta Pisarati," in *In Encyclopaedia of the History of Science, Technology, and Medicine in Non-Western Cultures*, ed. oleh edited by Helaine Selin, 3rd ed (Kluwer Academic Publishers: Boston, 2016).

n. Dinakara (1550 AD)

The author of *Candrārk* used 33 verses to produce a calendar, calculating the positions of the Moon, Sun and stars.[22]

2. *Sindhind*: Adoption of Indian Astronomical Tables

Before the scientific advancement of Muslims in Baghdad and other cities, India had first experienced scientific development, including in astronomy. Indian astronomy was the first to significantly influence Islamic astronomy's advancement, first developed by Al-Fazari (d.796 AD). The first *zij* ever compiled by Muslim astronomers was that compiled by Al-Fazari (d.796 AD), a court astronomer of caliph Al-Manṣūr (753-774 AD) of the Abbasid Dynasty (750-1258 AD) in Baghdad. The *zij* is composed based on the book of Brahmasphuta-Siddhanta of India. However, the year Al-Fazari used in his calculations has been converted into an Arab (Hijri) year. After Al-Fazari, there were born other *zij*s of great numbers.[23]

Contents of the twenty-four chapters of the book of Brahmasphuta-Siddhanta of India:[24]

a. On the nature of the globe and the figure of heaven and Earth.
b. On the revolutions of the planets; on the calculation of time, i.e. how to find the time for different longitudes and latitudes; how to find the mean places of the worlds; how to find the sine of an arc.
c. On the correction of the places of the planets.
d. On three problems: how to find the shadow, the ancient portion of the day and the ascendance, and how to derive one from the other.
e. The planets become visible when they leave the rays of the Sun and become invisible when entering them.
f. On the first appearance of the Moon and about her two cusps.
g. On the lunar eclipse.

[22] Aditya Kolachana dan and Venketeswara Pai Clemency Montelle, "The Candrārkī of Dinakara: A Text Related to Solar and Lunar Tables," *Journal for the History of Astronomy* 49 (2018).

[23] Reza Akbar, "The History of the Development of Falak Science in Indian Civilization and Its Relation to Islam," *Islam Futura* 17 (2017).

[24] Eduard Sachau, "Alberuni's India," *Trubner's Oriental series*, 1962.

h. On the solar eclipse.

i. On the shadow of the Moon.

j. On the meeting and conjunction of the planets.

k. On the latitudes of the planets.

l. A critical investigation to distinguish between correct and corrupt passages in the texts of astronomical treatises and handbooks.

m. On arithmetic, on plane measure and cognate subjects.

n. Scientific calculation of the mean places of the planets.

o. Scientific calculation of the correction of the places of the planets.

p. Scientific calculation of the three problems (v. chap. 4).

q. On the deflection of eclipses.

r. Scientific calculation of the appearance of the new Moon and her two cusps.

s. On *Kuṭṭaka*, i.e. the pounding of a thing. The pounding of oil-producing substances is compared to the most minute and detailed research here. This chapter treats algebra and related subjects. Besides, it contains other valuable remarks that are more or less arithmetical.

t. On the shadow.

u. On the calculation of the measures of poetry and on metrics.

v. On cycles and instruments of observation.

w. On time and the four-time measures, the solar, the civil, the lunar, and the sidereal.

x. About numeral notation in the metric books of this kind.

These, now, are twenty-four chapters, according to his statement. However, there is a twenty-fifth one, called Dhyâna-graha-adhyâya, in which he tries to solve the problems by speculation, not by mathematical calculation. I have not enumerated it in this list because the pretensions he brings forward in this chapter are repudiated by mathematics.

To sum up, there are at least three Indian astronomical texts that played an essential role in the Islamic astronomical civilisation. First, the Aryabhatiya text was written by Aryabhata in 499 AD. Arab writers refer to this text as Al-Arjabhar. The second Khandakhadyaka text in Arabic literature, written by Brahmagupta (665 AD), is called *Zij* al Arkand. Third, the text of al-Muhasidhanta registered in the late 7th century AD or the beginning of the 8th century AD, has been transferred into Arabic under the title *Zij* as *Sindhind* (Table of *Sindhind*). The first two calculated texts have been lost and have not been found. As the remaining one, *Sindhind Zij Sindhind*'s text is the one that many Arab scientists follow and study. Through this work, Muslim astronomers gave birth to new books, such as that of Muhammad ibn Ibrahim al-Fazzari (d. 161/796), who wrote *al-Sindhind al-Kabīr*, which became the sole basis of astronomical science until the time of al-Ma'mūn. *Sindhind* is an Indian-language astronomical text that contains a complete introduction to the motion of celestial bodies over thousands of years.[25]

According to al-Qifthi (d. 646 H/1248 AD), Indian astronomical texts reached Islamic civilisation precisely before Caliph al-Manṣūr in 156 H/773 AD. when envoys from India came to Baghdad and faced the caliph with the Sanskrit-language astronomical text *Siddhānta* (Arabic: *Sindhind*) allegedly the work of an Indian astronomer and mathematician named Brahmagupta. The visit of the Indian envoy was an Arab introduction to the Indian caliphate. It marked a turning point in Arab intellectual history. According to al Qifthi's description again, the *Sindhind* text generally contains calculations of the motion of the stars, calculations of eclipses, the analysis of the position of the constellations (*maṭāli' al-burūj*), and other measures that are entirely contained in several chapters.

Al-Manṣūr (d. 158 H/775 AD), the second Abbasid caliph, known to be very interested in astrology and astronomy, asked the Indian envoy to write a summary of the book.[26] He further ordered to translate it into Arabic and immediately write a standard work on the calculation of the motion of the planets and the matters associated with them. History records that the people who received the mandate to translate this book were Muhammad ibn Ibrahim al-Fazzari (d. 180 H/796 M) and Yaqub ibn Thariq (2/8th century), who were official royal astronomers.[27]

The transfer of Sindhid's astronomical texts into Arabic occurred in the 2/8th century during the Abbasid rule. Some classical sources say the translation was done after 770 AD. Hitti mentions that this book was brought to Baghdad in 771 AD. After a year or

[25] Seyyed Hossein Nasr, *Science and Civilization in Islam*, ed. oleh Translation: J. Mahyudin, (Bandung: Library Publishers, Cet II, 1418/1997), 150.

[26] Ahmad Izzuddin, *Ilmu Falak Praktik*, (Semarang: Pustaka Rizki Putra, 2013), 8.

[27] Arwin Juli Rakhmadi Butar Butar, *Khazanah Astronomi Islam Abad Pertengahan* (Purwokerto: UM Purwokerto Press, 2016).

two of the translation, Ibrahim al-Fazzari gave birth to an explanatory book based on *Sindhind* titled *al-Sindhind al-Kabīr* (The Great Sindhid). According to Pingree, al-Fazzari included elements from Indian, Pahlevi, and Greek sources in a compilation of tables for astronomical calculations. Al-Fazzari's explanatory book continued to be studied and developed. It became the basis of astronomical science standards until al-Ma'mīn (d. 218 H/833 AD). According to Gutas, al-Fazzari's translation and his version of his incarnation, he combined with other factors to become the doctrine and standard of Arabic astronomy of all time. Al-Fazzari also wrote several astronomical notes in watershed verses and was the first Arab figure to make an astronomical tool called the astrolabe, which became a typical astronomical instrument in Islamic civilisation. Among al-Fazzari's works, *Qaṣīdah fī Ilm Nujūm* (Commentary on the Science of Necromancy), *Miqyas li al-Zawal* (Standardization of Zawal), *Al-Zayj 'alā Sin al-'Arab* (Table of Astronomers According to the Arabic Years), *Kitāb al-'Amal bi al-Usṭurlab Dzaw al-Ḥalq"* (The Book of Astrolabe Practices that Have Circles), and others.[28]

Meanwhile, Ya'qub ibn Ṭariq-who was a contemporary of al-Fazzari, studied with Indian teachers and became an expert in the field of astronomy. According to al-Nadim's account, Ya'qub bin Ṭariq was among the leaders of necromancer science in his time. He has several astronomical works, such as the book of *Mã Irtafa'a Min Qaws Nishf al-Nahar* (The Book of the Day Arc) and the *Kitab al-Zayj Mahlul fi al-Sindhind li Darajah Darajah* (*Zij*'s Solution Book of *Sindhind* on Each-Tip Degree). The latter book is divided into two parts: astronomy and lands. On the merits of these two figures (al-Fazzari and ibn Ṭariq), history records that both were the first to transfer Indian astronomy into the Arabic language and world. On their merits, the influence of Indian astronomy became dominant.[29]

In the Abbasid context, *Sindhind* was helpful for the development of knowledge. Through this book, Arab scholars are forced to struggle with all the astronomical issues in this book. *Sindhind*'s early translations led to efforts and syntheses between ancient and contemporary knowledge. *Sindhind*'s significant contribution is the inclusion of the

[28] Arwin Juli Rakhmadi Butar Butar, "Esain-Esai Astronomi Islam," *Kumpulan Buku Dosen*, 2018, 293.
[29] Butar, *Khazanah Astronomi Islam Abad Pertengahan*, 170.

dynamised sinus function, an essential contribution of India, which, in the era of the Islamic civilisation, was developed by Arab scientists as the basis for all calculations.[30]

In Sanskrit, Siddhanta or *Sindhind* means knowledge, science, and school. While terminologically, it means a book about astronomy and calculating the motion of all the planets and stars. Brahmasphutasiddanta is the original old-school *Sindhind* in Sanskrit, a revised version of the astronomical book dedicated to Brahma. The Arabic writers omitted some words from this title and left Siddhanta, then modified it slightly by adding the word hind (India) at the end to become al-*Sindhind*. Some contemporary circles refer to this book as *"al-Sindhind al-Kabīr"* to distinguish it from al-Khawarizmi's as *Sindhind*.

Al-Khawarizmi's *Sindhind* is a table (*zij*) with accurate calibration that provides a device and formulation for determining the position of the Sun, Moon, and planets. It also determines the time of day and night based on observations. Furthermore, more specifically, this *zij* is helpful for the formulation of prayer times for Muslims and the observation of the crescent Moon as a sign of the Islamic calendar. These tables are handy for stargazing without making time-consuming observations, as this phenomenon was rife in the early days of the Islamic era. Presumably, this is the biggest attraction of this l-table table. This *zij* can also be equipped with astronomical instruments to solve complex spherical geometry and timing problems. Over a thousand years after his declaration, al-Khawarizmi's *zij* is still used in the Islamic world, especially Egypt.[31]

The above Indian science works by India Delegation are primarily written as *shā'ir*, whose purpose is to be easily memorised. The description of the discussion is also generally brief. This work is a challenge for Arab translators in untangling the scientific content in solving the syndication of arithmetic and astronomy, which is relatively complicated. The Indian element that played an essential role in developing Arabic (Islamic) astronomical theories adhered to a unique method of calculating celestial bodies based on what in Sanskrit is called Kalpa. Kalpa is a thousand years of complete circulation of the Moon and Sun (*al-nayyirayn*) and five circulating planets (*al-khamsah al mutaḥayyirah*). The Indians considered all celestial bodies to be impermanent.

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[30] Butar, "Esain-Esai Astronomi Islam."
[31] Butar, *Khazanah Astronomi Islam Abad Pertengahan,* 171.

The Moon and Sun and all other celestial bodies were originally in a position to merge in one line at the point of Aries (vernal points of the equinox), subsequently moving at unequal speeds and in the following millennia would return in that same position at the end of the age of the world, which was also at the point of Aries. The sidereal years (*al-shamsiyyah* and *nujamiyyah*) that passed from one period of Kalpa conjunction to the next period of Kalpa conjunction is what is called Kalpa. The Kalpa's year number of the Claris based on the calculation of Brahmagupta is 4.320.000.000. The Arabs named the entirety of the Kalpa years the terms of the *Sindhind* years, while the days were called *Sindhind* days and world days.[32]

From the already mentioned historical evidence, the Indian system made a significant contribution to the construction of Arab astronomical theories. This system is apparent in the large number of Arab astronomers who emerged in the era of the early Abbasid caliphate. For example, al-Khawarizmi, a contemporary of al-Ma'mūn, wrote a *zij* entitled *Zij Sindhind al-Kabīr* (Table of the Great Sindhid), which was guided by the construction of al-Fazzari but differed in interpolation and declination calculations. It contains interpolation based on the Persian school of astronomy, while the Sun's declination is based on Ptolemy's astronomical school. This *zij* became the prototype of Indian astronomical tendencies-as- as reflected in the *Sindhind*-however al-Khawarizmi had tried to combine Indian and Greek elements. Arab astronomers of this period have been predominantly committed to developing the Indian astronomical system, as was seen when it was presented. The efforts of Arab astronomers are also reflected in the preparation of various *zij*s in which Indian elements are contained, mainly arithmetic models of the practice of astronomical tables and different modelling of planets—also, the inclusion of the sine formulation in the calculation of the spherical triangle. The latter element is an essential contribution to shaping the construction of the *zij* based on observing and calculating planetary motion, circulation, and position.

It is seen that the astronomical element of India is strongly influenced in detail by its arithmetic factors that do not apply geometric models in the calculation of the motion of the planets. This element can also be seen in the *zij*s compiled by Arab astronomers. This

[32] Butar, *Khazanah Astronomi Islam Abad Pertengahan*, 172.

arithmetic element confirms observational activities as a standard for *zij* development, where these *zij*s require calculation yearly. Subsequent actions, the compilation of *zij* formed the experimental foundation for the development of astronomy related to the positioning of the planets at certain times through observations that prompted Arab astronomers to compile various *zij*s as carried out by Yaḥyā ibn Abī Manṣūr, Al-Khawarizmi, Habash al-Hasib al-Marwazi, and others. *Zij*, among the Arabs, also developed towards revisions to some of the earlier astronomical works. Arab astronomers sought to examine the positions of the Moon, Sun, stars, and planets.

D. Conclusion

Astronomy has been developing in India for a long time since prehistoric times. However, astronomy first appeared during the Vedanga Jyotisa period, written by Lagadha, the oldest literary book in India. Many Indian astronomers researched Astronomy to the point of writing books. One of the books that interested early Muslim scientists in astronomy was the book Brāhmasphuṭasiddhānta, translated into Arabic by Al-Fazari (d. 796 AD) during the caliphate of Al-Manṣūr of the Abbasid dynasty. Then, Around the beginning of the 11th century, Al-Biruni (973- 1048 AD) spread proselytising to India and introduced the study of Islamic astronomy (Falak Science) in the Indian country.

Al-Biruni produced many written works, but only about 200 books are known. Among these is *Tarikh al-Hindi* (history of India), the first and best work ever written by Muslim scholars about India. In addition, he also wrote about other general knowledge such as the books *al-Jamāhir fi Ma'rifah al-Juwāhir* (mining science), *al-Shadala fi al-Ṭib* (pharmacy in medical science), *al-Maqālid Ilm al-Hay'ah* (about astrology) and *Kitāb al-Kusūf wa al-Hunūd* (book on the Indian view of the lunar eclipse event).[33]

E. Bibliography

Akbar, Reza. "The History of the Development of Falak Science in Indian Civilization and Its Relation to Islam." *Islam Futura* 17 (2017).

Alimuddin. "Sejarah Perkembangan Ilmu Falak." *Al Haudah* 2 (2013).

B. G. Sidrath. "The Calendric Astronomy of the Vedas." *Bulletin of the Astronomical Society of India*, 1998.

[33] Kohar, "Pemikiran Hisab Rukyah Abu Raihan Al-Biruni, 67."

Bely, Pierre-Yves. *A Question and Answer Guide to Astronomy*. Cambridge: Cambridge University Press, 2010.

Butar, Arwin Juli Rakhmadi Butar. "Esain-Esai Astronomi Islam." *Kumpulan Buku Dosen*, 2018, 293.

——. *Khazanah Astronomi Islam Abad Pertengahan*. Purwokerto: UM Purwokerto Press, 2016.

David A. King, dan Julio Samso. "Astronomical Handbooks and Tables from the Islamic World (750-1900): an Interim Report." *Abstracta Iranica*, 2003. https://doi.org/10.4000/abstractairanica.34579.

Hayashi, Takao. *Bhaskara I*. English. In Encyclopaedia Britannica, 2008.

——. *Shripati*. In Encyclopaedia Britannica, 2008.

Izzuddin, Ahmad. *Ilmu Falak Praktik*, 2013.

Jayusman. "Sejarah Perkembangan Ilmu Falak Sebuah Ilustrasi Paradoks Perkembangan Sains dalam Islam." *Al-Marshad: Jurnal Astronomi Islam dan Ilmu-Ilmu Berkaitan* 1, no. 1 (2017): 44–67.

Joseph, George Gheverghese. *The Crest of the Peacock: Non-European Roots of Mathematics*. 3rd ed. New Jersey: Princeton University Press, 2011.

K. V. Sarma. "Acyuta Pisarati." In *Encyclopaedia of the History of Science, Technology, and Medicine in Non-Western Cultures*, edited by Helaine Selin, 3rd ed. Kluwer Academic Publishers: Boston, 2016.

——. "Astronomy in India." *In Encyclopaedia of the History of Science, Technology, and Medicine in Non-Western Cultures*. Kluwer Academic Publishers, 2008.

——. "Laila." *In Encyclopaedia of the History of Science, Technology, and Medicine in Non-Western Cultures*. Kluwer Academic Publishers, 2008.

Kak, Shubash. "The Astronomy of the Age of Geometric Altars." *Quarterly Journal of the Royal Astronomical Society* 36 (1995).

Kak, Subhash. "History of Indian Science." *Louisiana State University*, 2002. https://www.ece.lsu.edu/kak/grolier.pdf.

Kanas, Nick. *Star Maps: History, Artistry, and Cartography*. 2nd ed. New York: Springer, 2012.

Kohar, Abdul. "Pemikiran Hisab Rukyah Abu Raihan Al-Biruni." *Al-Mizan* 14, no. 1 (2018): 63–79. https://doi.org/10.30603/am.v14i1.933.

Kolachana, Aditya, dan and Venkateswara Pai Clemency Montelle. "The Candrārkī of Dinakara: A Text Related to Solar and Lunar Tables." *Journal for the History of Astronomy* 49 (2018).

Manzil, Li'izza Diana. "Korelasi Historisitas Ilmu Hisab Rukyat dengan Perkembangan Peradaban Islam." *Al-Istinbath : Jurnal Hukum Islam* 3, no. 2 (2018): 185. https://doi.org/10.29240/jhi.v3i2.432.

Mohan, Chander. *The History of Astronomy In India*. New Delhi: Viva Books, 2015.

Morlan, Regis. *Muqaddimah fī 'Ilm al-Falak*. Edited by. Beirut: Markaz Dirāsat al-Wahdah al-'Arabiyyah dan Mu'assasah Abdul Hamīd Syūmān, 1997.

N. Tripathi, V. *Astrology in India: Encyclopaedia of the History of Science, Technology, and Medicine in Non-Western Cultures*. Edited by Helaine Selin. 2nd ed., 2008.

Nasr, Seyyed Hossein. *Science and Civilization in Islam*. edited by J. Mahyudin. Bandung: Library Publishers, n.d.

Panda, Sudhira. "The Bhāsvatī Astronomical Handbook of Śatānanda." *Journal of Astronomical History and Heritage* 22 (n.d.).

Sachau, Eduard. “Alberuni’s India.” *Trubner’s Oriental series*, 1962.
Sulaymān, Muḥammad Aḥmad. *Sibāhah Faḍā'iyyah fī al-Āfāq ’Ilm al-Falak*. Kuwait: Maktabah al-‘Ujayrī, 1999.

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