

## *Suwar al-Kawakib:* **Bridging Greek and Islamic Astronomy in the History of Islamic Astronomy**

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This study examines the classical text *Suwar al-Kawakib al-Thabitah* by Abd al-Rahman al-Sufi, a tenth-century Islamic scholar who bridged Greek and Islamic astronomy. The work's influence spread throughout Europe from the tenth to the nineteenth century in three successive waves: its translation in Andalusia, its adoption into Renaissance star atlases such as the *Uranometria*, and its role in the standardization of modern international star catalogues. Using a historical method, this research traces the contribution of *Suwar al-Kawakib* to cosmology, Arabic star nomenclature, and astronomical observation, through which Islamic science became integrated into global scientific standards. The research employs a qualitative approach, applying historical analysis to examine the role of al-Sufi's *Suwar al-Kawakib* in the development of Greek and Islamic astronomy. Primary data consist of the original text, its translations, and literature related to the constellations. These data are analyzed to understand the work's impact from the tenth to the nineteenth century, including the integration of astronomy and astrology, star nomenclature, and observational methodology, in order to clarify the role of Islamic astronomy in shaping international scientific standards. The findings show that *Suwar al-Kawakib* not only advanced Islamic cosmology but also played a key role in establishing star-naming conventions that remain in use today. Al-Sufi's

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contribution extends beyond astronomy to include cultural knowledge that facilitated the transmission of learning between the Islamic world and the West. The book underscores the significance of Islamic astronomy's influence on the development of global astronomy and on the international scientific standards now widely recognized.

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#### ABSTRAK

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Penelitian ini mengkaji teks klasik *Suwar al-Kawakib al-Thabitah* karya Abd al-Rahman al-Sufi, seorang cendekiawan Islam abad kesepuluh yang menjembatani astronomi Yunani dan Islam. Pengaruh karya ini tersebar luas di seluruh Eropa dari abad kesepuluh hingga abad kesembilan belas dalam tiga gelombang berturut-turut: penerjemahannya di Andalusia, adopsinya ke dalam atlas bintang era Renaisans seperti *Uranometria*, dan perannya dalam standardisasi katalog bintang internasional modern. Dengan menggunakan metode historis, penelitian ini melacak kontribusi *Suwar al-Kawakib* terhadap kosmologi, nomenklatur bintang Arab, dan pengamatan astronomis, yang melaluinya sains Islam terintegrasi ke dalam standar ilmiah global. Penelitian ini menggunakan pendekatan kualitatif dengan menerapkan analisis historis untuk menguji peran *Suwar al-Kawakib* karya al-Sufi dalam perkembangan astronomi Yunani dan Islam. Data primer terdiri dari teks asli, terjemahannya, serta literatur yang berkaitan dengan rasi bintang. Data tersebut dianalisis untuk memahami dampak karya ini dari abad kesepuluh hingga abad kesembilan belas, termasuk integrasi astronomi dan astrologi, nomenklatur bintang, serta metodologi pengamatan, guna memperjelas peran astronomi Islam dalam membentuk standar ilmiah internasional. Temuan penelitian menunjukkan bahwa *Suwar al-Kawakib* tidak hanya memajukan kosmologi Islam tetapi juga memainkan peran kunci dalam menetapkan konvensi penamaan bintang yang tetap digunakan hingga saat ini.

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Kontribusi al-Sufi melampaui bidang astronomi, mencakup pengetahuan budaya yang memfasilitasi transmisi ilmu pengetahuan antara dunia Islam dan Barat. Kitab ini menegaskan pentingnya pengaruh astronomi Islam terhadap perkembangan astronomi global serta terhadap standar ilmiah internasional yang kini diakui secara luas.

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## INTRODUCTION

The *Suwar al-Kawakib al-Thabitah* is a classical work that served as a bridge in the development of Greek and Islamic astronomy. Now widely known as *the Book of the Fixed Stars*; a title that reflects its content as a depiction of the fixed stars, the work presents a catalogue of stellar constellations accompanied by remarkably distinctive illustrations, authored by the scholar Abd al-Rahman al-Sufi.<sup>1</sup> Written in the tenth century, al-Sufi's work offered a critical revision of Ptolemy's star catalogue in the *Almagest*, refining the position, magnitude, and color of the stars on the basis of more extensive and accurate observations. It also introduced Arabic star names such as "*Altair*", "*Deneb*," dan "*Rigel*".

These names carry not only scientific value but also symbolic meaning rooted in Arab-Islamic cosmology.<sup>2</sup> The spread of *Suwar al-Kawakib* was absorbed gradually through three major waves: its translation in Andalusia during the tenth to thirteenth centuries, its integration into Renaissance star atlases, and its standardization in modern catalogues in the nineteenth century. This trajectory demonstrates how Islamic

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<sup>1</sup>Ihsan Hafez, F Richard Stephenson, and Wayne Orchiston, "A Bdul-Ram ā n Al- Şū f ī and His Book of the Fixed Stars : A Journey of Re- 'A Bdul-Ra Hm . ā n Al- Şū f ī and His Book of the Fixed Stars : A Journey of Re-Discovery," no. May (2019), <https://doi.org/10.1007/978-1-4419-8161-5>.

<sup>2</sup>Hariyadi Putraga et al., "The Study of Arabic Constellation From the Book *Suwar Al-Kawakib Al-Thabita* Using Stellarium Software," *Journal of Islam and Science* 9, no. 2 (2022): 111-18, <https://doi.org/10.24252/jis.v9i2.31526>.

astronomy became an integral part of global cosmology.<sup>3</sup> However, despite this widely acknowledged influence, gaps remain in the scholarship regarding the process of cross-cultural adaptation, the role of symbolism in the translation of star names, and the integration of astrology into astronomy – a characteristic feature of al-Sufi's work.<sup>4</sup>

Research on al-Sufi's *Suwar al-Kawakib al-Thabitah* is of considerable importance, as the work not only revised Greek astronomical data but also bridged the development of astronomy between the Islamic world and Europe, a fact substantiated by previous scholarship.<sup>5</sup> Kennedy (1983), for instance, emphasizes the significance of al-Sufi's corrections to the data contained in the *Almagest*, which laid the groundwork for the accuracy of modern astronomy. Hafez (2019) argues that the precision of al-Sufi's astronomical data was crucial to the development of star catalogues in Europe, while Allen (1899) highlights the cultural and symbolic significance of the Arabic star names adopted into Western cosmology.

This demonstrates that al-Sufi's contribution exerted a significant influence on Islamic astronomy, both in observational practice and in the naming of stars that remain in use today.<sup>6</sup> However, although numerous studies have addressed the contribution of *Suwar al-Kawakib*, none has yet examined its influence on the star-naming system from historical, cultural, and methodological perspectives. Furthermore, little attention

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<sup>3</sup>Robert Lebling, "Arabic in the Sky," *Saudiaramcoworld* 61, no. 5 (2010): 24–33.

<sup>4</sup>Hariyadi Putraga et al., "Studi Konstelasi Peradaban Arab Dari Kitab Suwar Al-Kawakib Al-Thabita Menggunakan Software Stellarium," *YUDISIA: Jurnal Pemikiran Hukum Dan Hukum Islam* 13, no. 2 (2022): 313, <https://doi.org/10.21043/yudisia.v13i2.16965>.

<sup>5</sup>Ikhsan Latif and Ismail, "Mathematical Analysis of the Eight-Year Cycle in the Eight-Year Calculation Method: A Study of the Calendar System in the Book 'Ajā'ib Al-Makhlūqāt Wa Gharā'ib Al-Mawjūdāt,'" *KULMINASI: Journal of Falak and Sharia* 3, no. 1 (July 1, 2025): 1–16, <https://doi.org/10.22373/KULMINASI.V3I1.7978>.

<sup>6</sup>Laura Fernandez, "Arab Stars in the Castilian Sky: Al-Sūfī's Book of Fixed Stars amongst the Manuscripts of Alfonso X," *The Stars in the Classical and Medieval Traditions*, 2019, 93–114.

has been given to how the integration of astrology and astronomy within the *zīj* tradition influenced modern international astronomical standards.<sup>7</sup> This study further highlights a gap in the literature concerning the role of Arabic star names in shaping Western cosmology through processes of translation and cross-cultural adaptation.

This study aims to examine the influence of *Suwar al-Kawakib* on the global system of star nomenclature, with particular focus on the process of cross-cultural translation, the adaptation of Arabic star names, and the integration of astronomy and astrology within al-Sufi's work. In addition, this study seeks to examine how al-Sufi's observational methods influenced the evolution of astronomy up to the formation of the international standards used today.

The hypothesis of this study holds that *Suwar al-Kawakib al-Thabitah* made a significant contribution to the development of global astronomy through its system of star nomenclature, its corrections and accurate data, and its integration of cultural and astrological elements, thereby laying the groundwork for scientific standards that remain internationally recognized today. The work is regarded as having played a crucial role in establishing the foundations of astronomy, ultimately strengthening the interaction between Islamic and Western scientific traditions in the history of science.

## METHOD

This study employs a qualitative method, specifically the historical method, to analyze the role of *Suwar al-Kawakib* in the development of Greek and Islamic astronomy. The primary data consist of the original text of al-Sufi's *Suwar al-Kawakib*, its translations, and other scholarly works on astronomy related to the development of stellar constellations. These data are

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<sup>7</sup>Wahidul Anam, Mubaidi Sulaeman, and Zezen Zainul Ali, "Ulama Nusantara's Legacy: Study of Hadith in the Book of Nuṣūṣ Al-Akhyār Fī Al-Ṣawm Wa Al-Iftār in Hasan Hanafī's Hermeneutic Perspective," *Ulumuna* 28, no. 1 (September 19, 2024): 345–73, <https://doi.org/10.20414/ujis.v28i1.811>.

analyzed historically to trace the spread of the influence of *Suwar al-Kawakib* from the tenth to the nineteenth century, complemented by a conceptual analysis examining the book's influence on the integration of astronomy and astrology, the cultural influences of the tenth century, star nomenclature, and the evolving methodology of observation. These analyses are then synthesized to summarize al-Sufi's contribution to the formation of cosmology, the standardization of star nomenclature, and his influence on modern astronomy, highlighting how the influence of Islamic astronomy shaped scientific standards now recognized internationally.

## RESULTS AND DISCUSSIONS

Ptolemy's *Almagest* and al-Sufi's *Suwar al-Kawakib al-Thabitah* made substantial contributions to the development of astronomy, particularly in the system of star nomenclature and the correction of stellar data. The *Almagest*, translated into Arabic as *al-Majisti*, catalogued more than 1,000 stars across 48 constellations and served as the principal reference for the geocentric cosmological model, which depicted the Earth as the center of the universe surrounded by celestial spheres containing the Sun, Moon, planets, and stars revolving around it.<sup>8</sup> The translation of the *Almagest* into Arabic in the ninth century enabled the spread of Greek astronomy into the Islamic world, laying the groundwork for its subsequent development by Muslim scholars.<sup>9</sup>

Al-Sufi, whose full name was *Abu al-Husayn Abd al-Rahman al-Sufi*, was born in Ray, Persia, in the tenth century,<sup>10</sup> He was a renowned astronomer known for his detailed and accurate

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<sup>8</sup>Putraga et al., "Studi Konstelasi Peradaban Arab Dari Kitab Suwar Al-Kawakib Al-Thabita Menggunakan Software Stellarium."

<sup>9</sup>Sonja Brentjes, "The Stars in the Sky and on the Globe By," *Max Planck Institute for the History of Science* 2, no. 2021 (2022): 59–98.

<sup>10</sup>Abu Hussain Abd al-Rahman Al-Sufi, *Suwar Al-Kawakib At-Thabita*, 964.

observations of the night sky.<sup>11</sup> In his celebrated work *Suwar al-Kawakib al-Thabitah* (Depiction of the Fixed Stars), he produced a critical revision of Ptolemy's star catalogue in the *Almagest*.<sup>12</sup> Al-Sufi made significant corrections to the positions and magnitudes (brightness) of the stars, updating them on the basis of more accurate observations. In addition, he introduced new information, such as star colors, that had not previously been recorded in the *Almagest*, thereby adding greater detail to the stellar data available at the time.<sup>13</sup>

In addition to refining stellar data, al-Sufi developed a more explicit system of Arabic star nomenclature, which helped to situate astronomical knowledge within the context of Islamic culture.<sup>14</sup> Arabic star names had often been transmitted orally, without the precise astronomical positioning that al-Sufi provided. Well-known Arabic star names include "Deneb," meaning "tail," and "Vega," derived from the Arabic *al-wāqī'*, meaning "the falling one." These names gained wide acceptance throughout the Islamic world and, once translated back into Latin, came to be used in Europe as well, remaining in use today.<sup>15</sup>

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<sup>11</sup>Ihsan Hafez and Orchiston Wayne, "New Insights From Recent in Historical Studies Astronomy: Following in the Footsteps of F.Richard Stephenson," *Springer*, no. January 2011 (2018).

<sup>12</sup>Ihsan Hafez, "Abd Al-Rahman Al-Sufi and His Book of the Fixed Stars: A Journey of Re-Discovery. PhD Thesis, James Cook University.," *ResearchOnline@JCU*, 2010, 237–393.

<sup>13</sup>Hanif Ghalandari and Hassan Amini, "Kharaqī's Star Catalogue: A Star Table from Medieval Arabic Astronomy," *Journal for the History of Science* 20, no. 1 (2022): 1–45, <https://doi.org/10.22059/JIHS.2022.88985>.

<sup>14</sup>Mohammed H. Talafha and Ziad A. Talafha, "Symbols and Astrological Terms in Ancient Arabic Inscriptions," *Scientific Culture* 5, no. 2 (2019): 21–30, <https://doi.org/10.5281/zenodo.2649501>.

<sup>15</sup>Muh. Arif Royyani et al., "Typology and Characteristics of Typology and Characteristics of 9th Hijri/15th-Century CE Astronomical Manuscripts in CairoAstronomy Manuscripts of The 9th/15th Century in Cairo," *Ulumuna* 29, no. 2 (December 31, 2025): 876–99, <https://doi.org/10.20414/ujis.v29i2.1769>.



Figure 1. Picture of a bear

Figure 1 shows the illustration of the Bear found in *Suwar al-Kawakib* (the "Book of Star Images"), depicting the constellation Ursa Major (the Great Bear) as created by the Persian astronomer Abd al-Rahman al-Sufi in the tenth century, formed from a configuration of stars in accordance with traditional Arabic astronomical perception.

The work *Suwar al-Kawakib al-Thabitah* was not merely a revision of the *Almagest* but also an accurate guide to star names. Al-Sufi's corrections to stellar magnitude and color reflect his concern for accuracy, made possible by observational techniques more advanced than those employed by Ptolemy. The star names he provided, such as "*Aldebaran*," meaning "the follower," and "*Altair*," meaning "the flying one," carried both symbolic and systematic meaning, which facilitated the identification of stars throughout the Islamic world and were later adopted by many European scholars during the Renaissance.<sup>16</sup> Al-Sufi's contribution to star nomenclature and positional determination enriched global astronomy and laid the foundation for the star-naming system that remains in use today.

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<sup>16</sup>Muqowim, "Jaringan Keilmuan Astronomi Dalam Islam Pada Era Klasik," *Jurnal Kaunia* 3, no. 1 (2007): 70.



## The Historical Development of Stellar Constellations

Robert W. Lebling, a writer and researcher on Arab culture, highlights the contribution of Arabic astronomy to star nomenclature in the Western world. Lebling discusses how the star-naming system in al-Sufi's *Suwar al-Kawakib al-Thabitah* influenced international star nomenclature. In his work, he argues that the spread of *Suwar al-Kawakib*'s star names occurred in three waves. The first wave (tenth to thirteenth centuries) involved the translation of Arabic works in Spain; the second wave (sixteenth to seventeenth centuries) occurred when Johann Bayer incorporated Arabic names into his star atlas, the *Uranometria*; and the third wave (nineteenth century) occurred when these names were adopted into modern astronomical catalogues through the work of Giuseppe Piazzi and Richard Hinckley Allen.<sup>17</sup>

### 1. The First Wave.

In the first wave (tenth to thirteenth centuries), the influence of al-Sufi's *Suwar al-Kawakib al-Thabitah* gradually spread to the Western world through translations and adaptations carried out by Muslim and Christian scholars in Spain.<sup>18</sup> During this era, the Islamic world—Andalusia in particular—became a center for the development and exchange of knowledge that connected East and West. Many Christian scholars in Europe took a keen interest in the scholarly advances made by Muslim astronomers, who studied and refined classical Greek astronomical observations, particularly the work of Ptolemy.<sup>19</sup> *Suwar al-Kawakib* thus came to occupy an important role in the development of this body of knowledge.

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<sup>17</sup>Arwin Juli Rakhmadi and Muhammad Hidayat, "Falak Manuscripts: Windows into the Intellectual and Cultural History of Southeast Asia," *KARSA Journal of Social and Islamic Culture* 33, no. 2 (October 31, 2025), <https://doi.org/10.19105/karsa.v33i2.21576>.

<sup>18</sup>Robert Lebling, "Arabic in the Sky."

<sup>19</sup>Ghalandari and Amini, "Kharāqī's Star Catalogue: A Star Table from Medieval Arabic Astronomy."

As one of the most respected works in Islamic astronomy, *Suwar al-Kawakib* provided significant corrections and updates to Ptolemy's star catalogue in the *Almagest*.<sup>20</sup> Ptolemy's work, which listed 1,022 stars across 48 constellations, had previously served as the principal reference for cosmology and astronomy in both the Western and Islamic worlds. However, al-Sufi identified numerous inaccuracies in Ptolemy's data, particularly regarding the position and magnitude (brightness) of the stars.<sup>21</sup> Through direct observation, al-Sufi refined this data and provided additional information on star color and position that had not been accurately recorded by Ptolemy. For instance, several stars previously described by Ptolemy as "bright" were found to be fainter, and al-Sufi added information on star colors that Ptolemy had not addressed. These corrections made al-Sufi's work a more accurate and reliable reference, one subsequently recognized by both Muslim and Western astronomers.<sup>22</sup>

In addition to refining astronomical data, al-Sufi also introduced a more specific and systematic system of Arabic star nomenclature. Before al-Sufi, many Arabic star names had not been precisely identified in the night sky or linked to fixed astronomical positions. *Suwar al-Kawakib* assigned a name to each star within its constellations and incorporated Arabic names already known to the pre-Islamic Arabs, making them an integral part of astronomy in the Islamic world.<sup>23</sup> For example, al-Sufi designated "Deneb," meaning "tail" in Arabic, as the star at the tail of the constellation Cygnus, and "Aldebaran," meaning "the follower," as the star that follows the constellation Pleiades. These names carried not only descriptive meaning but also

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<sup>20</sup>Hafez, Stephenson, and Orchiston, "ʿA Bdul-Ram ā n Al- Šū f ī and His Book of the Fixed Stars : A Journey of Re- ʿA Bdul-Ra Hm . ā n Al- Šūf ī and His Book of the Fixed Stars : A Journey of Re-Discovery."

<sup>21</sup>Fernandez, "Arab Stars in the Castilian Sky: Al-Sūfī's Book of Fixed Stars amongst the Manuscripts of Alfonso X."

<sup>22</sup>Dilla Sri Junidar et al., "Islamic Astronomy in Modern Aceh: Sheikh Muhammad Amin Al-Tirawi and His Manuscript," *Journal of Indonesian Ulama* 1, no. 2 (December 30, 2023): 80–98, <https://doi.org/10.30821/JIU.V1I2.1139>.

<sup>23</sup> Brentjes, "The Stars in the Sky and on the Globe By."

facilitated the identification and recording of stellar positions in the sky.<sup>24</sup>

Andalusia, the Muslim-ruled region of Spain, played a central role as a bridge between the Muslim world and Europe, enabling Arabic astronomical knowledge to spread into Western Europe. The city of Toledo, in particular, became a major center of translation and scholarly activity, where Muslim and Christian scholars collaborated to translate important scientific works from Arabic into Latin. Among the works translated in Toledo was *Suwar al-Kawakib*, which allowed European astronomers to access the data compiled by al-Sufi without needing to learn Arabic.<sup>25</sup>

In this way, al-Sufi's work became part of the body of astronomical knowledge accessible to scholars throughout Europe. This data not only replaced Ptolemy's inaccurate figures but also provided more detailed and precise information, with the refined star nomenclature also proving useful for navigation and astronomical observation.

Strong interest in Islamic scholarship was further reinforced by works such as *the Libros del Saber de Astronomía*, compiled in the thirteenth century under King Alfonso X of Castile.<sup>26</sup> *Alfonso's Libros del Saber de Astronomía* contained various catalogues and star descriptions drawing on al-Sufi's data, including stellar position, color, and brightness. Through this work, the data compiled by al-Sufi became increasingly accessible to European astronomers, and the Arabic star names

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<sup>24</sup> Putraga et al., "Studi Konstelasi Peradaban Arab Dari Kitab Suwar Al-Kawakib Al-Thabita Menggunakan Software Stellarium."

<sup>25</sup> Encep Abdul Rojak and Ramdan Fawzi, "The Normative Basis of Islamic Astronomy For The Transformation of Prayer Schedules To Digital And Its Accuracy," *El-Ussrah: Jurnal Hukum Keluarga* 7, no. 2 (December 31, 2024), <https://doi.org/10.22373/UJHK.V7I2.22097>.

<sup>26</sup> Fernandez, "Arab Stars in the Castilian Sky: Al-Sūfī's Book of Fixed Stars amongst the Manuscripts of Alfonso X."

he had recorded came to be widely accepted throughout Europe.<sup>27</sup>



Figure 2. The Anatomy of an Astrolabe

The *astrolabe* shown in Figure 2 was one of the notable highlights of an Islamic art auction in London: a magnificent eleventh-century Umayyad brass astrolabe, signed by Muhammad ibn al-Saffar, was also among the items exhibited. An astrolabe is an intricate instrument designed to determine solar or stellar time at a given location, enabling its user to make a range of astronomical or astrological observations. Astrolabes were used by astronomers and navigators from classical antiquity through the Renaissance.<sup>28</sup>

During this period, astronomical instruments such as the astrolabe also played an important role in disseminating Arabic star names. Astrolabes developed by Muslim astronomers frequently bore Arabic star names engraved upon them, allowing Western astronomers who used these instruments to identify and adopt those names. Al-Sufi himself wrote a treatise

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<sup>27</sup>Muh Arif Royyani et al., "Religious Dialogue and Astronomy from the Perspective of Indonesian Muslim Scholars," *Samarah: Jurnal Hukum Keluarga Dan Hukum Islam* 7, no. 1 (March 31, 2023): 261–80, <https://doi.org/10.22373/SJHK.V7I1.12406>.

<sup>28</sup>James Evans and Alexander Jones, "The History and Practice of Ancient Astronomy," *American Journal of Physics*, 2000, <https://doi.org/10.1119/1.19412>.

on the astrolabe, explaining how the instrument could be used to measure stellar positions. Astrolabes inscribed with Arabic star names became essential tools for sailors, navigators, and astronomers in Europe who required orientation at night and guidance for navigation. Through these instruments, the star names recorded in al-Sufi's work became familiar to European scholars.<sup>29</sup>

Beyond serving as a center for translation and instrument use, *Suwar al-Kawakib* also influenced several European astronomers who compiled star tables in the thirteenth century, such as John of Paris, an astronomer active in that city. He referenced several stars by the Arabic names introduced by al-Sufi. This indicates that *al-Sufi's* works and the Arabic star names they contained had come to be recognized as a more reliable and accurate source for identifying stars in the sky. In time, the influence of *Suwar al-Kawakib* continued to grow, extending even into the Renaissance, when Arabic names began to be incorporated into star charts by astronomers such as Johann Bayer in his *Uranometria*.<sup>30</sup>

## 2. The Second Wave.

In the second wave, spanning the sixteenth to seventeenth centuries, the influence of *Suwar al-Kawakib al-Thabitah* advanced further and became integrated into European astronomy, particularly during the Renaissance. This period witnessed a major revival of interest in classical Greek scholarship and the Islamic world. European scientists, including astronomers, sought more accurate and detailed sources to expand their knowledge of stellar observation and celestial mapping. One of the key figures in the dissemination of Arabic star names during

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<sup>29</sup>Mohd Hafiz Safiai et al., "Astrolabe as Portal to the Universe, Inventions across Civilizations," *International Journal of Civil Engineering and Technology*, 2017.

<sup>30</sup>Ahmad Fauzi, "Ikhtiyat in The Epistemology of Astronomy Fiqh: An Integration of Conservatism and Contextualism," *TATHO: International Journal of Islamic Thought and Sciences*, September 1, 2025, 261-73, <https://doi.org/10.70512/tatho.v2i3.144>.

this period was Johann Bayer, a German astronomer who, in 1603, compiled the first modern star atlas in Europe, titled *Uranometria*.<sup>31</sup> This work was significant as a modern star atlas containing maps of the 48 constellations based on the Ptolemaic system, along with several new constellations of the southern sky that had not previously been included in classical Greek star maps. Bayer employed a designative system; naming stars according to their order of brightness within a given constellation using Greek letters, and also incorporated a number of Arabic star names drawn from al-Sufi's catalogue, such as "Altair," "Deneb," "Rigel," and "Betelgeuse," names that remain widely used today.<sup>32</sup>

These star names were first introduced by al-Sufi in his book *Suwar al-Kawakib*, in which he provided a detailed description of each star within its constellation, including its position, magnitude (brightness), and color. The names carried descriptive meanings related to the stars' characteristics: for example, "Deneb," meaning "tail" in Arabic, denotes the star located at the tail of the constellation *Cygnus* (the Swan), while "Altair," meaning "flying," refers to the bright star in the constellation *Aquila* (the Eagle). Bayer chose to incorporate these Arabic names because they were not only descriptive but also easier for astronomers to recognize and remember. Bayer's use of these Arabic names marked a key step in their acceptance into European star maps, and they subsequently became an integral part of international celestial cartography.<sup>33</sup>

In addition to Bayer's contribution, King Alfonso X's *Libros del Saber de Astronomía* (Book of the Knowledge of Astronomy)

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<sup>31</sup>Archenhold Sternwarte, "Johann Bayer : Uranometria 1603 ( Edited by Schaake and Berberich , Comments By" 1603, no. November (2014).

<sup>32</sup>Muhammad Khalil Mubarraq, Ismail Ismail, and Laiyina Ukhti, "Pluralisme Hukum Dalam Penentuan Ramadan: Otoritas Kitab Matla'ul Badrayn Sebagai Living Law Di Masyarakat Indonesia.," *QISTHOSIA : Jurnal Syariah Dan Hukum* 7, no. 1 (June 30, 2026): 1-12, <https://doi.org/10.46870/JHKI.V7I1.2121>.

<sup>33</sup>Mohd Hafiz Safiai et al., "The Modern Dimension of the Astrolabe as an Innovation of Ancient Technology," *International Journal of Innovation, Creativity and Change* 13, no. 5 (2020).

was a major compilation of astronomical knowledge, containing various star catalogues and descriptions drawn largely from the works of Muslim astronomers, including al-Sufi.<sup>34</sup> Containing star catalogues with positions, magnitudes, and Arabic star names, along with additional information on the constellations based on *Suwar al-Kawakib*, the *Libros del Saber de Astronomía* made it easier for European astronomers to access al-Sufi's astronomical data even without fluency in Arabic. This work played a major role in disseminating the Arabic star names recorded by al-Sufi throughout Europe, helping to ensure that these names became known to and accepted by European astronomers.<sup>35</sup>

In addition, the printing and reprinting of Latin translations of Ptolemy's work and that of other Muslim astronomers further accelerated the spread of Arabic star names in Europe. One example is the printed edition of Ptolemy's *Almagest*, translated from Arabic by Gerard of Cremona and printed in Venice in 1515. This edition included al-Sufi's Arabic star names adapted into Latin, broadening their circulation and leading more European scholars to adopt them.<sup>36</sup> Renaissance astronomers used this data in their own catalogues, and many began incorporating Arabic star names into their research because of the accuracy and clarity that al-Sufi's naming system provided.<sup>37</sup>

Within this second wave, the role of Ulugh Beg of Samarkand was also significant. Ulugh Beg, a Muslim prince and astronomer of the Timurid dynasty, built a major observatory at

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<sup>34</sup> Fernandez, "Arab Stars in the Castilian Sky: Al-Sūfī's Book of Fixed Stars amongst the Manuscripts of Alfonso X."

<sup>35</sup>Fika Afhamul Fuscha and Ahmad Izzuddin, "Zij Al-Jadid Ibn Asy-Syafir: Melacak Algoritma Awal Bulan Kamariah," *AL - AFAQ: Jurnal Ilmu Falak Dan Astronomi* 5, no. 2 (November 27, 2023): 237–49, <https://doi.org/10.1177/0021828616678508>.

<sup>36</sup> Robert Lebling, "Arabic in the Sky."

<sup>37</sup>Jean Pierre Luminet, "Ulugh Beg, Prince of Stars," no. April (2018), <https://doi.org/10.48550/arXiv.1804.08352>.

Samarkand in the fifteenth century, which became one of the largest astronomical observatories in the Muslim world. Ulugh Beg had a deep passion for science, particularly astronomy, and with the support of leading scholars, he produced the *Zij-i Sultani*, a star catalogue recording the positions of 994 stars. This catalogue drew on data from *Suwar al-Kawakib*, incorporating the Arabic names identified by al-Sufi alongside new observational data gathered at the observatory.

Ulugh Beg's catalogue was translated into Latin by the English orientalist Thomas Hyde in 1665, under the title *Tabulae longitudinis et latitudinis stellarum fixarum ex observatione Ulugh Beighi*. Hyde's translation and commentary made the star catalogues of Ulugh Beg and al-Sufi far more accessible in England and across Europe. This translation was of considerable importance, as the stellar data of al-Sufi and Ulugh Beg became a principal reference for European scientists seeking more accurate and systematic star data.<sup>38</sup>

The star names first recorded by al-Sufi eventually came into wider use in European star catalogues and maps. Thanks to the work of Johann Bayer and Thomas Hyde, together with Ulugh Beg's contribution, Arabic names such as "Vega," "Altair," "Deneb," and "Betelgeuse" began appearing across various European constellations and atlases, and ultimately became standard in international cosmology.<sup>39</sup> Al-Sufi's naming system that encompassing physical description, position, and stellar magnitude helped advance the development of more accurate and usable celestial maps.

### 3. The Thrid Wave

In the third wave, during the nineteenth century, the influence of al-Sufi's *Suwar al-Kawakib al-Thabitah* reached its peak through the consolidation and standardization of star names in the modern catalogues used worldwide. This period

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<sup>38</sup>Sajjad Nikfahm-Khubravan, "Ulugh Beg's Treatise on the Altitudae Circle," *Nazariyat İslam Felsefe ve Bilim Tarihi Araştırmaları Dergisi (Journal for the History of Islamic Philosophy and Sciences)* 11, no. 2 (November 15, 2025): 133–75, <https://doi.org/10.65643/Nazariyat.11.2.295en>.

<sup>39</sup>Richard Hinckley Allen, *Star-Name and Their Meanings* (Newyork: G.E. Stechert, 1899).



was marked by advances in telescope technology and observational methodology, which demanded star catalogues that were more accurate, systematic, and consistent. The Arabic star names first identified by al-Sufi ultimately became part of international standards, as astronomers and orientalists in Europe and America reorganized and refined them into new catalogues.

One of the key figures in this third wave was Giuseppe Piazzi, an Italian priest and Catholic astronomer renowned for his contributions to highly accurate stellar observation. Thanks to the advanced telescopes available at the time, Piazzi was able to observe and record stars with greater precision than earlier catalogues had achieved.<sup>40</sup> Piazzi drew on Thomas Hyde's Latin translation of Ulugh Beg's star tables, completed in 1665, in which Hyde had incorporated the Arabic star names introduced by al-Sufi. In his own catalogue, Piazzi adapted several of these Arabic names into Latinized forms, such as "*Altair*," "*Betelgeuse*," "*Aldebaran*," and "*Vega*," which remain in use today. Piazzi's star catalogue became a standard reference for astronomers across Europe and America. It served as a principal reference in numerous astronomical studies and was used by astronomical institutions worldwide,<sup>41</sup> affirming al-Sufi's role in establishing a star-naming system now internationally recognized.

In addition to Piazzi, Richard Hinckley Allen, an American scholar and researcher, also played a major role in introducing Arabic star names to the wider public through his book *Names of Stars and Their Meanings*, published in 1899. This work was a major compilation examining the origins and history of star names across various cultures, including the Arabic names introduced by al-Sufi. Allen investigated the mythological background and meaning behind these star names, providing information on terms such as "*Rigel*" (meaning "foot" in Arabic)

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<sup>40</sup>G. Fodera Serio, A. Manara, and P. Sicoli, "Giuseppe Piazzi and the Discovery of Ceres," *Asteroids III*, no. January 2002 (2021): 17-24, <https://doi.org/10.2307/j.ctv1v7zdn4.8>.

<sup>41</sup>Serio, Manara, and Sicoli.

and "Deneb" (meaning "tail").<sup>42</sup> Although Allen's etymological interpretations were not always accurate, his book proved highly influential and popular among both amateurs and academics, broadening the understanding of Arabic star names beyond the astronomical community. Allen's work remains an important reference used today and has introduced the history of Arabic star names to a much wider audience.

In addition to the contributions of Piazzzi and Allen, the republication of Ulugh Beg's star catalogue by Thomas Hyde also had a significant impact during this third wave. The *Tabulae longitudinis et latitudinis stellarum fixarum ex observatione Ulugh Beighi*, Hyde's translation of Ulugh Beg's star tables, was frequently reprinted during the eighteenth and nineteenth centuries, including by Gregory Sharpe at Oxford in 1767 and by Francis Baily in London, in *The Catalogues of Ptolemy, Ulugh Beigh, Tycho Brahe, Halley, and Hevelius*, in 1843.<sup>43</sup> The Arabic star names compiled by al-Sufi became a key reference for European astronomers interested in the accuracy of the data contained in this catalogue. These reprintings reinforced the place of Arabic star names within Western astronomical literature and kept them relevant among scientists through the end of the nineteenth century.

In addition, Ludwig Ideler, a German philologist and astronomer, also played an important role in introducing and refining the etymology of Arabic star names in 1809. Ideler divided Arabic star names into two categories: those originating from genuine Arabic terms, and those derived from Greek translations absorbed by Muslim astronomers.<sup>44</sup> Through this distinction, Ideler sought to provide a more scientifically grounded etymological basis for the star names found in al-Sufi's catalogue, thereby helping to reduce misunderstandings about star names and giving greater recognition to al-Sufi's

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<sup>42</sup>Allen, *Star-Name and Their Meanings*.z

<sup>43</sup>Robert Lebling, "Arabic in the Sky."

<sup>44</sup>Hafez, Stephenson, and Orchiston, "A Bdul-Ram ā n Al- Şū f ī and His Book of the Fixed Stars : A Journey of Re- 'A Bdul-Ra Hm . ā n Al- Şūf ī and His Book of the Fixed Stars : A Journey of Re-Discovery."

contribution to a more accurate and systematic system of star nomenclature.<sup>45</sup>

In this third wave, the star names first identified by al-Sufi were ultimately given formal recognition in major catalogues, and modern space organizations such as the American Nautical Almanac began incorporating these star names into their official publications, affirming al-Sufi's role in the worldwide system of star nomenclature. Names such as "Vega," "Altair," "Betelgeuse," and "Deneb" are now listed on celestial maps approved by international astronomical organizations, including the *International Astronomical Union* (IAU),<sup>46</sup> making these names an inseparable part of global astronomy.

These developments demonstrate that al-Sufi's Suwar al-Kawakib played a major role in the development of constellation maps, as well as in the naming system and accurate data that underpinned the advancement of astronomy worldwide. The journey of Suwar al-Kawakib's names and data toward becoming established in international constellation maps was not brief, but rather unfolded over the course of several centuries. These three periods in the development of Arabic-named constellations speak not only to the practice of astronomical observation, but also to the integration of astronomy and astrology, as reflected in the astronomical tables known as *zīj*.<sup>47</sup> Classical Muslim astronomers such as al-Sufi and Ulugh Beg took into account the relationship between stellar positions and astrological influence. The acceptance of astrological elements in Renaissance Europe reflects a transmission of Islamic knowledge that was, in turn, shaped by the local Western culture that received it.

In terms of nomenclature, Suwar al-Kawakib contains star names carrying distinct symbolic meanings within their respective cultural contexts. "Deneb," for instance, means "tail" in

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<sup>45</sup>Nikfahm-Khubravan, "Ulugh Beg's Treatise on the Altitudae Circle."

<sup>46</sup> Robert Lebling, "Arabic in the Sky."

<sup>47</sup> Kennedy, *Studies in The Islamic Exact Sciences*, American University, Beirut, 1983.

Arabic cosmology, yet may carry a different meaning within the Greek tradition. The Latin translation of such names likewise carried symbolic meanings that influenced Western cosmology.<sup>48</sup> In terms of observational methodology, Ptolemy's *Almagest* provided the foundation upon which Muslim astronomers improved their observational techniques. Ulugh Beg, for example, established an observatory in order to compile a more accurate *zīj* catalogue, an effort that was later embraced in Europe.

## CONCLUSION

The findings of this study show that al-Sufi's *Suwar al-Kawakib al-Thabitah* played a significant role in shaping modern astronomy through three waves of knowledge transmission. The first wave (tenth to thirteenth centuries) encompassed the translation of al-Sufi's works in Andalusia, which introduced a more accurate system of star names and data to Europe. The second wave (sixteenth to seventeenth centuries) took place during the *Renaissance*, when astronomers such as Johann Bayer incorporated Arabic star names into European star atlases, reflecting the influence of cross-cultural nomenclature that would later carry through to the modern catalogues of the third wave (nineteenth century). Figures such as Giuseppe Piazzi and Richard Hinckley Allen were instrumental in establishing Arabic star names as part of recognized international standards.

The discussion in this study shows that al-Sufi's contribution extended well beyond astronomical data alone. *Suwar al-Kawakib* also highlights the integration of astrology and astronomy within astronomical tables, or *zīj*, the influence of Arabic culture and language on star nomenclature, and methodological innovations in observation that paved the way for international standardization. This study thus concludes that *Suwar al-Kawakib* not only enriched astronomy in the Islamic world but also laid the cosmological foundation and the standard for star nomenclature that remains globally recognized in astronomy today.

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<sup>48</sup> Allen, *Star-Name and Their Meanings*.

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