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Astronomers in Islamic Civilization and Their Scientific Contributions: A Study of Selected Models

علماء الفلك في الحضارة الاسلامية واسهاماتهم العلمية "دراسة نماذج"

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Abstract:

Across the ages, Arabs and Muslims have made outstanding contributions to various fields of science and knowledge, with astronomy among the most prominent. They devoted themselves to studying the astronomical heritage of earlier civilizations by translating works from Greek, Persian, and Sanskrit, and then enriching them with their own research and discoveries. Over time, their writings became fundamental references in the field worldwide. Their role extended beyond theory: they invented instruments and devices that advanced the practice of celestial observation, produced detailed star charts, and determined planetary and stellar positions using sophisticated methodologies.

This article highlights the leading Muslim astronomers and their contributions to astronomy, surveying their most celebrated figures and works, which had a profound impact on the advancement of the science and on human civilization as a whole.

Keywords: astronomy, Muslim scholars, astrolabe, Islamic civilization, sundial

المخلص:

على امتداد العصور كان للعرب والمسلمين إسهامات بارزة في مختلف مجالات العلوم والمعرفة، ومن أبرز هذه المجالات علم الفلك، فانكبوا على دراسة التراث الفلكي للأمم السابقة، فترجموا المؤلفات من اللغات اليونانية والفارسية والهندية، وأضافوا إليها بحوثهم واكتشافاتهم، حتى تحولت مؤلفاتهم إلى مراجع أساسية في هذا العلم على مستوى العالم. ولم يقتصر دورهم على الجانب النظري، بل ابتكروا الآلات والأجهزة التي طوّرت عملية الرصد الفلكي، ورسموا الخرائط وحدّدوا مواقع الكواكب والنجوم بطرق علمية متقدمة.

تسلّط هذه المقالة الضوء على أبرز أعلام الفلك المسلمين وإسهاماتهم في علم الفلك، والتعرّف على أشهر أعلامهم ومؤلفاتهم، والتي كان لها أثر بالغ في تقدّم هذا العلم وخدمة الحضارة الإنسانية.

الكلمات المفتاحية: علم الفلك، علماء المسلمين، اسطرلاب، الحضارة الإسلامية، مزولة.

1. INTRODUCTION

Islamic civilization represents a landmark in the history of scientific development, distinguished by its openness to the legacy of earlier cultures and its commitment to expanding human knowledge across all disciplines. Among these disciplines, astronomy—intertwined since antiquity with religious observance and daily life—enabled humankind to measure time, determine directions, and comprehend celestial phenomena. Under the Abbasid and Andalusian dynasties, this science reached an unprecedented zenith as Muslim scholars translated Greek, Persian, and Indian texts into Arabic, then augmented them with original research and discoveries that resonated throughout the East and West.

Although numerous studies have examined Islamic civilization generally, many have overlooked a detailed focus on the Muslim pioneers of astronomy and their distinctive scientific achievements. This raises the following question: To what extent did Muslim astronomers in Islamic civilization advance the science of astronomy, and what were their most significant accomplishments that left a lasting mark on human history? From this problem emerge the following hypotheses: that Muslim astronomers made substantial contributions to developing astronomy through the translation and enhancement of earlier works; that they invented precise astronomical instruments and established advanced observatories; that they formulated new theories that influenced the course of the discipline; and that their writings remained essential references for European scholars in later centuries.

This paper aims to underscore the role of Muslim astronomers in advancing and enriching astronomy, to identify the foremost figures and their principal works within Islamic civilization, and to examine the key innovations and achievements in astronomy realized during the Islamic era.

To achieve these objectives, the study employs a descriptive-analytical

methodology based on a review and analysis of the historical and scientific sources addressing astronomy under the Muslims, with the goal of elucidating the nature and impact of their scientific contributions.

First, we address the definition of astronomy and its conceptual scope. We then turn to a section entitled “Astronomy Across History,” tracing the origin and evolution of the discipline among ancient civilizations such as the Babylonians, Egyptians, and Greeks, up to the Islamic period.

In the third section, titled “Pioneers of Astronomy in Islamic Civilization and Their Scientific Contributions,” we profile the most prominent scholars in the field, examine their principal writings and discoveries, and consider their role in advancing observational instruments. The study concludes with a summary of key findings and includes a selection of illustrative figures—depicting historical astronomical instruments and diagrams devised by Muslim scientists—to enrich the reader’s understanding of the subject.

2. Definition of Astronomy

Astronomy is one of the oldest sciences of humanity, concerned with observing and studying events occurring beyond Earth and its atmosphere, and predicting celestial phenomena. It examines the objects visible in the sky, their evolution, their physical and chemical properties, and their associated events.

Originally, astronomical instruction was delivered by temple priests. Both the ancient Egyptians and Babylonians maintained their own celestial systems. Calendars inscribed on the lids of Pharaonic sarcophagi dating from 2000–1600 BCE have been discovered, and ceilings of New Kingdom tombs are painted with the constellations known at the time, each bearing its traditional name. In Mesopotamia, star patterns were recorded in clay tablets, and the Babylonians accurately predicted solar and lunar eclipses.

3. Astronomy Across History

The study of the heavens dates to

prehistory, when early humans pondered the movements of the sun and moon and the cycle of night and day. A prime example is Stonehenge, located on Salisbury Plain in southern England, which dates from between 3000 and 2000 BCE. Its massive standing stones are arranged with precise geometric alignment toward the points of sunrise at the summer and winter solstices—evidence that prehistoric people understood the sun's cycle and the moon's motion. Recent studies have demonstrated that Stonehenge (Figure 13) enabled ancient observers to predict celestial events such as eclipses with the accuracy of a modern observatory, indicating a sophisticated grasp of astronomical phenomena¹.

The Sumerians conceived of Earth as a flat plateau or disc surmounted by a heavenly dome, itself supported by a high wall at its distant edges. They believed stars and planets—including the sun and moon—moved within this celestial sphere. Their worldview stands among the earliest human attempts to understand the form of Earth and sky, laying the groundwork for the birth of astronomy and religious cosmologies in Mesopotamia².

The Babylonians, in turn, visualized Earth as a flat disc floating on a surrounding ocean, with the firmament overhead, beyond which lay the primeval waters. They imagined the sun and moon traversing chariots that passed through an eastern gate to emerge from a western gate³.

The ancient Egyptians depicted Earth as a rectangular plane bisected by the Nile—a cosmic axis that regulated life's rhythms. They conceived the Nile as flowing from a vast primeval water known as "Nun," from which the cosmos and deities emerged. The sky was portrayed as a solid, vaulted structure supported by mountains at the world's four corners, from which stars and deities descended. The sun occupied a central role in this cosmology⁴.

Ancient Chinese scholars believed Earth was a massive cart with China at its center, supported at its corners by pillars that upheld a solid celestial dome. The "Heavenly

River" (the Milky Way) ran across this cart, evoking the Yellow River on Earth. The North Star marked the celestial pole and the abode of the Supreme Deity. Solar and lunar eclipses were explained as celestial dragons devouring the sun or moon⁵.

4. Pioneers of Astronomy in Islamic Civilization and Their Scientific Contributions

Astronomy was one of the foremost areas of scientific excellence in Islamic civilization. Muslim interest in the subject extended beyond its religious applications—determining prayer times, the qibla, and the Hijri calendar—to encompass both theoretical and practical investigations of celestial motions and cosmic structure. The extensive translation movement that rendered Greek, Persian, and Indian works into Arabic, combined with original innovation, established rigorous scientific traditions that made the Islamic world a global center for astronomical study, especially during the Abbasid and Andalusian eras. Numerous luminaries emerged whose contributions left an indelible mark on the evolution of astronomical thought.

4.1 Muhammad ibn Ibrahim al-Fazari

According to al-Zarkali, Muhammad ibn Ibrahim ibn Muhammad ibn Habib ibn Samura ibn Jundub al-Fazari (d. ca. 180 AH/796 CE), the first Muslim to construct and work with an astrolabe (Figure 01), was a scholar of astronomy⁶ born in Kufa to an Arab family of noble lineage descended from the Banu Fazara (a branch of Dhubyan from Gautfan among the Adnanite Arabs). He produced numerous celestial charts and composed a celebrated poem on the science of the stars. His treatise addressed several key astronomical topics, including the use of the plane astrolabe (Figure 02), the ring astrolabe, and the application of the sundial for determining the moon's position.

Muhammad al-Fazari is regarded as the foremost Muslim astronomer and mathematician of his time—also noted as a linguist, translator, and philosopher. He played a pivotal role in the early transmission and development of Arabic and Islamic

astronomical teachings derived from Indian, Sasanian, and Greek sources. Although few of his original works survive today, he remains credited with introducing the first astrolabe into Islamic science⁷.

The history of Muslims and Arabs abounds with brilliant scholars whose writings and treatises enriched scientific and intellectual life across disciplines such as geography, history, literature, medicine, astronomy, chemistry, physics, mathematics, jurisprudence, and exegesis. Among these luminaries stands the distinguished figure of Muhammad al-Fazari, celebrated for his mastery of mathematics and astronomy. He attained great scholarly renown for his work in astrology and calendrical science, compiling astronomical tables to calculate celestial positions during the caliphate of al-Mansur and subsequent Abbasid rulers.

Al-Fazari migrated to Baghdad in 144 AH (747 CE) to deepen his knowledge under the leading scholars who had made the city the intellectual center of the time. He devoted special attention to foreign languages—most notably Sanskrit—which he mastered in order to access the astronomical observations of ancient Indian scientists. His linguistic skills earned him a place on the translation team at the House of Wisdom, founded by Caliph Abu Ja'far al-Mansur, who held al-Fazari in high esteem and provided him with generous patronage.

At the House of Wisdom, al-Fazari translated astronomical and mathematical works from Sanskrit into Arabic. His firsthand engagement with Indian empirical astronomy led him to ground the science on inductive reasoning and direct sensory observation of celestial phenomena. He constructed the first astrolabe in the Islamic world and was so passionate about observational astronomy that he composed a celebrated poem on the stars, which became proverbial among Arab and Muslim astronomers⁸.

In 155 AH, an Indian delegation arrived with the Siddhānta—a text rich in astronomical data that became known in Arabic as the Sindhind. Caliph al-Mansur

commissioned al-Fazari to translate this work into Arabic and to produce a companion treatise, the Great Sindhind, which remained a principal reference for astronomers through the reign of al-Ma'mūn.

Later, Muhammad ibn Mūsā al-Khwarizmi abridged al-Fazari's translation into the Lesser Sindhind, supplementing it with knowledge drawn from Greek and other sources. Al-Khwarizmi's version eventually supplanted al-Fazari's original treatise following al-Fazari's death around 180 AH (796 CE).

In Sanskrit, *siddhānta* denotes “eternal doctrine.” The Sindhind profoundly influenced the geometric models of planetary motion used in the Arab and Islamic lands and spawned numerous observational programs. Al-Fazari also authored a manual—The Use of the Plane Astrolabe—detailing how to operate this instrument.

Among the writings of Abu Abdullah Al-Fazari in the field of astronomy are the following:

"Poem on the Science of Stars", "On the Measurement of Noon (Kitab al-Miqyas li-l-zawal)", "Zij", "Astronomical tables according to the years of the Arabs", "The Use of the Ring Astrolabe", "The Use of the Plane Astrolabe", "Calculation of the Planetary Means in the Arabic Chronology," and participated at the request of the Abbasid caliph in translating many astronomical texts in Sanskrit⁹.

4.2 Sind ibn Ali (Abū al-Tayyib)

Sind ibn Ali, known by his kunya Abū al-Tayyib, was born and raised in India and became one of the foremost mathematicians and astronomers of the Arab-Islamic world. A contemporary of Caliph al-Ma'mūn, some accounts report that he converted from Judaism to Islam under the caliph's patronage. His scholarly achievements made a decisive impact on the scientific and cultural flourishing of the Abbasid state.

Raised in a family that valued learning and research, Abū al-Tayyib aspired from youth to the highest levels of knowledge and recognition. His research and discoveries earned him a global reputation across both

the Arab and Western worlds, and his works became encyclopedic references for generations of scholars.

Ibn al-Tayyib was famous for his science and knowledge, which no one was able to surpass. Through his research, studies and achievements, he was able to achieve international fame that reached the farthest regions of the Arab and Western world. Abu al-Tayyib was able to achieve many achievements and contributions that played a major role in his fame. It was also a scientific encyclopedia to which many professors and students of science refer. Among the most famous of these contributions, Abu al-Tayyib Sanad bin Ali was able to establish the Baghdad Observatory. He also succeeded in developing a number of astronomical tables that he called al-Ma'mun, which made these tables one of the most important and best references to which many astrologers return in his time or even after his death. Abu al-Tayyib also presented a large set of astronomical instruments that are used in the observations of stars and planets. In addition, he succeeded in making astrolabes. Abu al-Tayyib succeeded in determining the places and positions of some of the planets, in addition to that he contributed to the measurement of ground and astronomical areas by order of al-Ma'mun, and Abu al-Tayyib was able to From the translation and modification of one of the most important and famous astronomical tables known at that time as the Sindhand Zij.

Sanad bin Ali, known as Abu al-Tayyib, like other scientists, was able to present a number of books and writings that had a great and clear role in his development and prosperity, in addition to their role in his progress and increasing his scientific and cultural thought. It may be said that a large part of these writings still exist to this day. One of the most famous of these books is: «Separates and averages in stars and arithmetic»: This book is considered one of the most important books presented by Abu al-Tayyib, which is related to astronomy, as it dealt with everything related to the movement of stars and how to calculate the

distance between each planet and another¹⁰.

4.3 Muhammad ibn Jābir ibn Sānān al-Battānī

Abu Abdullah Muhammad bin Jabir bin Sinan al-Raqi al-Harrani, nicknamed al-Batani, was born in 858 AD in the city of Harran on the Euphrates River, 38 km southeast of Urfa, an ancient city of Mesopotamia. He was named Ptolemy of Arabia for being the greatest astronomer in the Arab world in the Middle Ages. He worked in the manufacture of astronomical instruments and instruments in the city of Harran. He was interested in studying astronomy and mathematics and was educated for the first time by his father, Jabir bin San'an al-Batani, who was also a well-known scientist. Then he moved to the city of Raqqa on the bank of the Euphrates, where he received a lot of education. While in the city of Raqqa, Al-Batani made many accurate astronomical observations about Antakya and Raqqa in Syria. All these observations were taken into account when Caliph Harun al-Rashid built several palaces in it. Al-Batani presented many achievements in the field of astronomy. Perhaps the most important of these achievements is that he cataloged nearly (489) stars, calculated the annual equinoxes (summer and winter), used geometric methods such as triangular methods to measure the distance between the sun and the earth. He wrote many books, including: Al-Zij: It is a book consisting of (57) chapters in addition to an introduction in which Al-Batani advised future generations to improve his scientific output. The book included all that was known in his era of the heavens and the layers of the universe. It also dealt with many astronomical issues, and the Book of Knowledge of the Horoscope among the Quarters of Astronomy: It is a book in which he discussed some innovative ways to calculate some astronomical problems, and a book in the evidence of readings and eclipses: It includes an explanation of the astronomical constellations and many astronomical explanations regarding the conjunction of Saturn and Jupiter¹¹. Historians agreed that Al-Batani died in 317 AH coincidences of

929AD¹².

4.4 Abū al-Rayḥān Muḥammad ibn Aḥmad al-Bīrūnī

Abū al-Rayḥān Muḥammad ibn Aḥmad al-Bīrūnī (2 Dhu al-Hijjah 362AH/5 September 973AD - 29 Jumada al-Akhirah 440 AH/9 December 1048AD) was a Muslim scholar who was a traveler, philosopher, astronomer, geologist, geologist, pharmacologist, historian and translator. He was described as one of the greatest minds known to Islamic culture. He said that the Earth rotates around its axis in his book: The Key to Astronomy. He also classified books up to one hundred and twenty.

Al-Biruni dedicated 95 of his 146 known books to the study of astronomy and mathematics and related topics such as mathematical geography. His religion contributed to his scientific studies related to astronomy. Proper prayer requires a good knowledge of the direction of the Qibla and the possibility of determining this direction from everywhere. This requires accurate astronomical studies. Al-Biruni's studies related to astronomy (Figure No. 03) were mostly focused on mathematical and scientific texts. As for astronomical prediction, it was only the last chapter. Al-Biruni was not an astrologer, so he came to describe the astronomical horoscopes as just sorcery. Al-Biruni admitted that he is unable to prove or deny the movement of the earth, but he commented positively on the suggestion that the earth is moving.

One of his most prominent works is the book "the Qānūn Mas'ūdī" (Figure No. 04), is a comprehensive encyclopedia of astronomy, geography, and arithmetic, dedicated to Sultan Mas'ūd of Ghazna. Composed in the fifth/fourteenth century, it surveys the achievements of earlier civilizations and contemporary scholars, critically evaluating their methods and conclusions. The work compiles observational data, discusses planetary and stellar motions (Figure 05 and Figure 06), and outlines the measurement techniques used by his predecessors and peers.

Al-Bīrūnī's death in 1048 CE (440

AH) marked the end of an era; his scientific contributions profoundly influenced both the Islamic world and medieval Europe, cementing his status as a historical pioneer¹³.

4.5 Abu Al-Hassan Al-Sufi:

Abū al-Ḥasan 'Abd al-Raḥmān ibn 'Umar al-Rāzī, known as the Sufī, was born in the city of al-Rī near Tehran in 903AD and died in 986 AD¹⁴, where the Būyḥīn had a strong influence in the Abbasid state. The Sufi gained the confidence of King Adud al-Dawla bin Buyyah and became one of the scholars accredited to the court, until the king established his own observatory in Shiraz to monitor the sky and accomplish his scientific discoveries, and he spent a lot of time in this observatory.

One of his most prominent achievements was his writing of the book Kitāb Ṣuwar al-Kawākib al-Thābita (The Book of the Constellations of the Fixed Stars), (Figure 07), which represented a qualitative leap in astronomy, as the Sufi not only conveyed the knowledge of the ancients, but also compared what was mentioned in the famous Almagest book of Ptolemy with what he observed himself, correcting the positions of the stars, and determining their colors, sizes, and degrees of brightness with remarkable accuracy. He also provided accurate illustrations of stars and constellations, (Figure 08) in which the stars appear as seen in the sky with the naked eye, which is a characteristic of this work compared to previous astronomical works, and divided it into 3 sections. The first section includes comments on the Ptolemy index with sporadic corrections to the sizes of stars, while the second section deals with materials derived from the Arab astronomical heritage and specifies the names of stars in Arabic. The third section includes the star catalog, and the Sufi added new stars that did not exist in the previous catalogs¹⁵.

Abu Al-Hassan Al-Sufi died in the city of Shiraz in Persia on 13 Muharram 376 AH, coinciding with the year 986AD, and the influence of the Sufi continued for centuries until after his death, as his book remained a reference for astronomers in the Islamic and

Western worlds, and the International Astronomical Union honored him by naming one of the lunar craters "Sufi" in recognition of his pioneering scientific contributions.

4.6 Al-Kindi:

Abu Yusuf Ya'qub ibn Ishaq ibn al-Sabbah ibn 'Imran ibn Isma'il ibn Muhammad ibn al-Ash'ath ibn Qays al-Kindi, a member of the Kinda tribe, was born in Kufa, Iraq, in the nineteenth century AD. He was an Arab Muslim polymath celebrated as the "Philosopher of the Arabs" and is regarded as the first Arab Muslim philosopher in history, earning him the status of an Arabic encyclopaedia. Renowned for his insights in astronomy, philosophy, physics, and mathematics, al-Kindi received his early education in Kufa and spent his youth in Basra studying kalām (Islamic theology). He later returned to Baghdad during the Abbasid golden era to continue his scientific and cultural pursuits under the tutelage of leading scholars. Caliph al-Ma'mun appointed him supervisor of the House of Wisdom, and Caliph al-Mu'tasim entrusted him as the private tutor to his sons, reflecting his wisdom and intelligence. Al-Kindi was also one of the most distinguished translators of his age. It is said that many of his writings were lost during the Mongol sack of Baghdad, leaving only eight works extant. Among the most important are his philosophical and astronomical treatises: *Risāla fī zāhiriyyāt al-falak*, *Risāla fī al-ālam al-aqsā*, and *Risāla fī šinā'at Baṭlimūs al-falak*. He died alone in Baghdad during the reign of Caliph al-Mu'tadid ibn 'Abbād, after suffering a severe ailment in his knees that spread throughout his body and reached his head. He passed away at the age of sixty-eight in 259 AH/873 AD.

After Al-Kindi's death, all his works and books were lost, and as the search for them continued, a few were found.

The topics in which Al-Kindi wrote about astronomy varied, but he summarized them in a few books, including: the book «*De Radiis*», "A Treatise on the Explanations of the Events of the Atmosphere" in addition to the book «A Treatise on the

Phenomenology of Astronomy" and "A Treatise on the Workmanship of the Astrolabe".

4.7 Al-Khwarizmi:

He is Abu 'Abd Allāh Muḥammad ibn Mūsā (182–232 AH/798–846 AD), known as al-Khwarizmi after his native Khwarezm (in modern-day Uzbekistan). This region was one of the foremost centres of Islamic culture, a thriving hub of scientific activity that produced numerous scholars connected with Caliph al-Ma'mun's House of Wisdom in Baghdad. Al-Khwarizmi had every opportunity to master mathematics and astronomy, and he is credited as the first to write comprehensively on al-jabr wa-l-muqābala (algebra and balancing)¹⁶. Although he became better known for his mathematical works, some biographical accounts mention only his astronomical fame. His writings include two versions of the *Zij*, the *Kitāb al-Rukhāma*, and the *Kitāb fī al-'amal bi-l-astrulāb*.¹⁷

He also composed a summary of Indian astronomy known as the *Sindhind* for Caliph al-Ma'mun. Having acquired extensive expertise in mathematics and astronomy in Khwarezm, al-Khwarizmi contemplated relocating to Baghdad—the capital of the Caliphate and the residence of the Caliph—a destination much sought after by distinguished scholars. It is likely that al-Ma'mun, an ardent patron of learning, had become aware of al-Khwarizmi's genius and invited him to join the intellectual circle in Baghdad. Al-Khwarizmi readily gained the Caliph's favour and was appointed to a high office in the House of Wisdom. He was also dispatched on scientific missions to neighbouring lands, including Afghanistan, to conduct research, investigations, and scholarly exchanges. All extant biographical sources, Eastern and Western alike, agree that al-Khwarizmi devoted himself entirely to the Ma'munid House of Wisdom from his arrival in Baghdad, engaging in every aspect of scientific activity until al-Ma'mun entrusted him with its leadership.

4.8 Thabet Ibn Qurrah Ibn Zahran Al-Harrani Al-Saabi:

Thābit ibn Qurra was born in Harran in 836 AD, a town situated on the Jazīra between the Tigris and Euphrates rivers. He was prolific in authorship, precise in translation, and exceptional in astronomy. He began his career as a money changer and earned the community's trust. Leaving his native Harran, he travelled to Kafartūmā where he met the eminent scholar Muḥammad ibn Mūsā al-Khwarizmi. Impressed by Thābit's intellect and scholarly aptitude, al-Khwarizmi brought him to Baghdad, the capital of the Abbasids, where he found a culture deeply invested in translating the works of the ancients. Thābit pursued knowledge for its own sake and savoured the intellectual pleasure of his studies in astronomy, mathematics, philosophy, and medicine. He conducted precise observations of the sun's motion, and one of his greatest astronomical discoveries was the phenomenon known as the "equinoxal precession." Scholars of the history of science have credited him with some 180 books across disciplines such as mathematics, medicine, natural philosophy, ethics, jurisprudence, hadith, biology, geometry, algebra, and calculus. Notable among these are works on sundials and astrolabes, treatises on the causes of eclipses and lunar visibility, and his translation of Ptolemy into Arabic, in which he enriched Ptolemy's terminology. He was also the first to calculate the solar year's length with remarkable precision—365 days, 6 hours, 9 minutes, and 12 seconds—erroneous by only two seconds.

Thābit ibn Qurra died in 901 AD at the age of seventy-seven.

4.9 Ibn al-Shāṭir:

Abu al-Hasan Ala' al-Din Ali ibn Ibrahim ibn Muhammad al-Ansari al-Muwaqqit, known as Ibn al-Shatir, lived between 1304 and 1375 CE in Damascus. His father died when he was six years old, so he was raised by his grandfather, and later by his paternal cousin—who was also his maternal aunt's husband—who taught him the craft of ivory inlay, from which he acquired the nickname "al-Mut'im" (the Inlayer). He

amassed considerable wealth, which he used to travel between various cities in pursuit of knowledge in mathematics and astronomy. He journeyed to Alexandria and Cairo, where he spent a period receiving education.

He spent most of his life in the function of timing and the presidency of the muezzins in the Great Umayyad Mosque in Damascus, and gained great fame among the scientists of his time as an astronomer, and developed astronomical theories of high scientific value, and he has books specialized in making devices such as astrolabes and solar practices, and he made a sundial to set the time of prayer, which he called "simple" and placed on one of the minarets of the Umayyad Mosque. (Figure 12) This innovation shows that Ibn al-Shatir was the first creator of the first metal mechanical watch, after the watchmaking was based on hard wood and on the power of water in its rotation. He also created an astrolabe that is still preserved in the Bibliothèque nationale de Paris, which he wrote that it was presented to Sheikh Ali bin Mohammed Al-Darbandi.

Ibn al-Shatir was able to determine the orbits of "Mercury" and "the Moon", which puzzled astronomers for a long time, taking advantage of the achievements of the "Maragha" school of astronomy led by the great astronomer "Nasir al-Din al-Tusi", and he developed two theories of the movement of these two bodies that are the first step to get rid of Ptolemy's theory that all bodies revolve around the Earth and achieve the first steps on the road to modern science. Nicolaus Copernicus used the same theories a century and a half later. This correspondence, discovered in the 1950s, raised an interesting question about the likelihood that Ibn al-Shatir's theory of planets would move to Europe. This question has been the subject of a number of scientific researches, but the answer has not yet been decided, and Copernicus is known to have reproduced Ibn al-Shatir's theory about the movement of the planet Mercury. (Figure 09)

Ibn al-Shatir also corrected the solar practices that have been circulating for centuries in both the Levant, Egypt, and

various parts of the Ottoman Empire, and responded to the invitation of the Ottoman Sultan Murad I to compose a Zij containing astronomical theories and new information. Ibn al-Shatir also succeeded in measuring the angle of deviation of the zodiac circle and reached a very accurate result. In this, George Sarton says: «Ibn al-Shatir is a superior scientist in his intelligence. He studied the movement of the celestial bodies accurately and proved that the angle of deviation of the zodiac circle is equal to 23 degrees and 31 minutes in 1365, knowing that the correct value reached by scientists in the twentieth century is 23 degrees, 31 minutes and 19.8 seconds".

Ibn al-Shatir was interested in composing with his work as a muezzin and timer in the Umayyad Mosque, so he wrote more than thirty books, a number of which are still missing, including the book "Nihāyat al-Ghāyāt fī al-A'māl al-Falakiyyāt (The Ultimate Goals in Astronomical Operations)", *Risāla fī al-Arṣād* (Treatise on Observations), "al-Ashrāq al-Lāmi'a fī al-'Amal bi-l-Āla al-Jāmi'a (The Shining Radiance on the Use of the Universal Instrument)" and *Urjūza fī al-Kawākib* (Didactic Poem on the Planets), he wrote several books on stars, geography and mathematics¹⁸.

Among the works referenced by al-Zirikli in his book "Al-A'lām" is the "al-Zij al-Jadīd" (The New Astronomical Handbook), which Ibn al-Shatir composed at the request of the Ottoman Sultan Murad I, who ruled Syria between 1360 and 1389 CE. In this work, Ibn al-Shatir presented astronomical models grounded in experimentation, observation, and sound inference. Another of his works is "Ta'līq al-Arṣād" (Comments on Observations), in which he detailed his objections to the hypotheses and ideas of the Greek astronomer Ptolemy. Although this book is now lost, Ibn al-Shatir mentioned it in the introduction to his work "Nihāyat al-Su'āl," stating: "We have pursued those doubts raised about those principles and explained them in a book we called 'Ta'līq al-Arṣād.'" Other

works include "Idāh al-Mughīb fī al-'Amal bi-l-Rub' al-Mujīb" (Clarification of the Hidden in the Use of the Responding Quadrant), "Urjūza fī al-Kawākib" (Didactic Poem on the Planets), and "Risāla fī al-Asturlāb" (Treatise on the Astrolabe). His books on the astrolabe and sundials remained in circulation for several centuries in Syria, Egypt, throughout the Ottoman Empire, and across the Islamic world, where they were relied upon for timekeeping in the Muslim world¹⁹.

Among the most important works of Ibn al-Shatir, the astronomical records and tables to determine the times of prayer, Ramadan, Hajj and Islamic holidays, and determine the paths of both the moon and the planet Mercury, (Figure No. 10) and (Figure No. 11) and correct the solar practices that have been circulating for centuries in both the Levant and various parts of the Ottoman Empire, also determine the measurement of the angle of deviation of the zodiac circle, and reach a very accurate result [He proved that the angle of deviation of the zodiac circle is equal to 23 degrees and 31 minutes in 1365AD, noting that the exact value reached by scientists in the twentieth century by calculators is 23 degrees and 31 minutes and 19.8 seconds, and his correction of the theory of Claudius Ptolemy, which states that the Earth is the center of the universe, and the sun is the one that revolves around it, and that all celestial bodies revolve around the Earth once every twenty-four hours.

Ibn al-Shatir, Alaa al-Din Abu al-Hasan Ali bin Ibrahim bin al-Shatir al-Dimashqi, died in 777AH / 1375AD in the city of Damascus, his hometown, after a scientific career full of achievements in astronomy and the manufacture of accurate astronomical instruments²⁰.

5. CONCLUSION

This overview demonstrates that Muslim astronomers left an indelible legacy in the history of science. They made foundational contributions to astronomy through their rigorous writings, the invention of precise astronomical instruments, and the

establishment of observatories unprecedented in organisation and accuracy. Their influence extended to East and West, with European universities relying on their works and modern astronomy building upon their discoveries. Recalling the lives of these scholars today is not merely an act of historical acknowledgement but a reminder of the spirit of scientific inquiry and innovation that characterised the Islamic Golden Age. In sum, Muslim astronomers played a crucial role in advancing astronomy and made enduring contributions that continue to shape the field.

Appendices

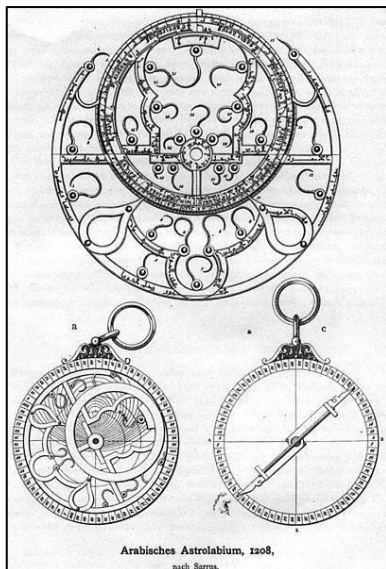


Figure 01: Representing an Arab astrolabe



Figure 02: Representing an Islamic astrolabe dating from the fifth century AH

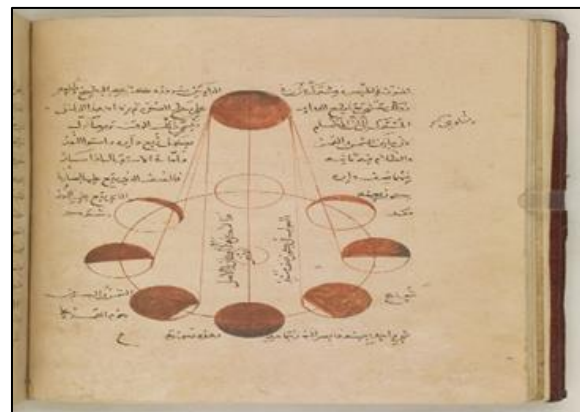


Figure 03: Illustration of the phases of the Moon

Source: The Manuscript of Understanding for the Early Astrology Industry the Book of Understanding for the Early Astrology Industry of Al-Biruni



Figure 04: The front of the Masoudi Law Book of Al-Biruni

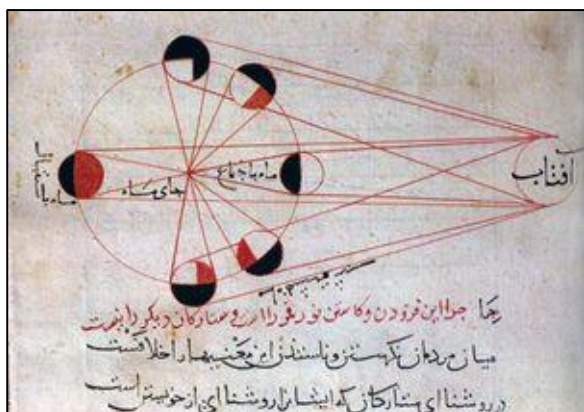


Figure 05: Illustration of the phases of the Moon

Source: Al-Tafhim manuscript by Al-Biruni in Persian showing the phases of the moon.

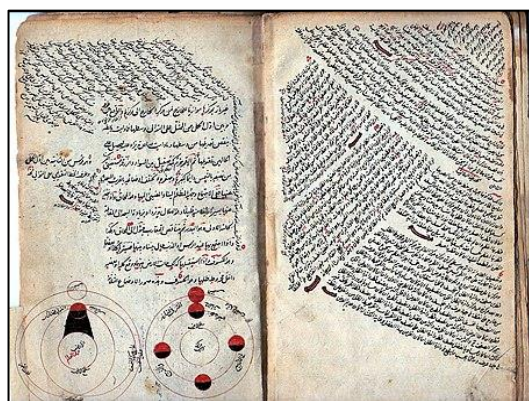


Figure 06: An illustration in Al-Tafhim by Al-Biruni in Persian showing the phases of the moon.

Source: Manuscript of an Arabic book on astronomy showing the houses of the moon



Figure 07: An image from The Sufi's Book of the 48 Planets in the 10th century is on display today at the Metropolitan Museum of Art in New York.



Figure 08: Images from Sufi's 48 planets represent the descriptor of more than a thousand stars in detail and the first to give the specifications of the Serial Woman galaxy and the Great Magellanic Cloud. The constellation shown in the picture is the constellation Sagittarius.

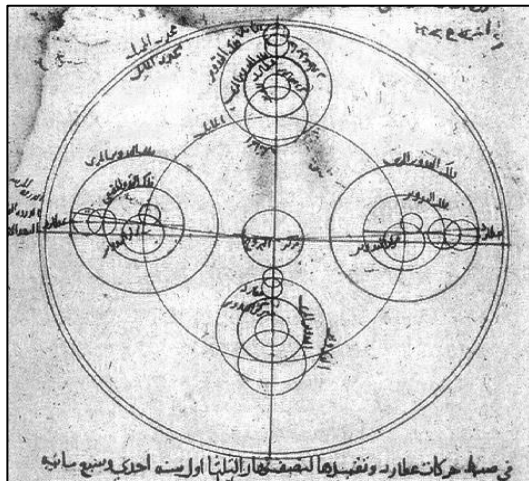


Figure 09: A manuscript by Ibn al-Shatir illustrates the appearance of Mercury.

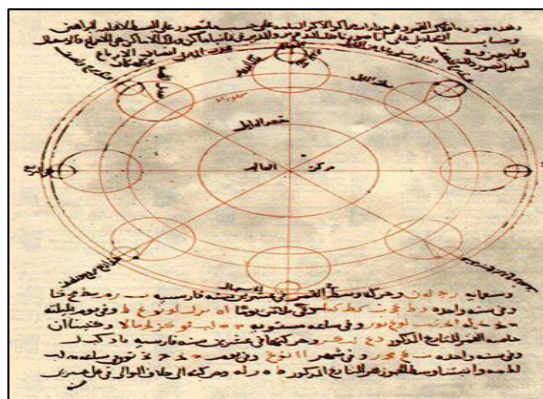


Figure 10: One of Ibn al-Shatir's drawings about the heliocentrism of the solar system in opposition to Ptolemy's theory



Figure 11: Represents the lunar model of Ibn al-Shatir.



Figure 12: Two sundials made by Ibn al-Shatir in the Umayyad Mosque in Damascus

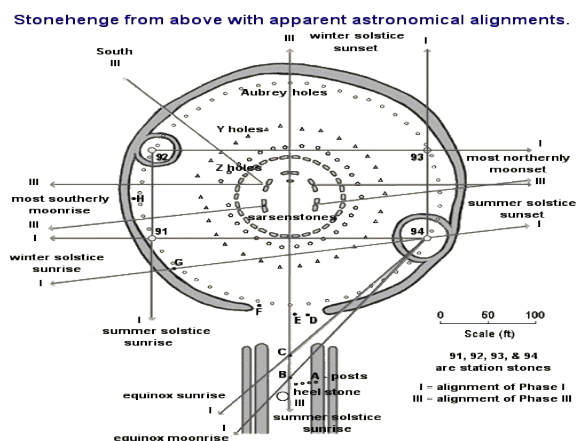


Figure 13: A diagram showing the relationship between Stonehenge and astronomy, with a scientific analysis of solar alignment and associated astronomical phenomena

Source: Sky at Night Magazine – “Stonehenge and Astronomy” (<https://www.skvatnightmagazine.com/space-science/stonehenge-astronomy/>)

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