FROM ALFRAGANUS TO ULUGH BEG: UZBEKISTAN, THE CRADLE OF ASTRONOMIC RENAISSANCE

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ABSTRACT

This article explores the significant contributions of four prominent figures in the history of astronomy: Alfraganus, Qadi-zadeh Roumi, Al-Kashi, and Ulugh Beg. These scholars, hailing from the region now known as Uzbekistan, played pivotal roles in the astronomic renaissance of the Turkic and Islamic Golden Age. Their work in astronomy laid the foundation for many modern principles in the field. Alfraganus provided revised and accurate data on celestial motions, which were instrumental for later explorers. Qadi-zadeh Roumi's precise calculations and contributions to stellar catalogues advanced the understanding of celestial bodies. Al-Kashi's work on pi and trigonometric functions significantly impacted mathematical astronomy. Timurid governor, Ulugh Beg's establishment of an advanced observatory and his comprehensive star catalogue corrected many of Ptolemy's errors and provided a more accurate understanding of the night sky. Collectively, their contributions highlight Uzbekistan's pivotal role in the astronomic renaissance and continue to inspire modern scholars, specially the Jadids, who want to revive science in Central Asia.

Keywords: *Alfraganus, Qadi-zadeh Roumi, Al-Kashi, Ulugh Beg, Uzbekistan, Islamic-Turkic Golden Age, astronomy, celestial motions, stellar catalogue, trigonometry, observatory.*

Özet

Bu makale, astronomi tarihindeki dört önemli figürün katkılarını incelemektedir: Alfraganus, Qadi-zadeh Roumi, Al-Kashi ve Ulugh Beg. Bu bilim insanları, günümüzde Özbekistan olarak bilinen bölgeden gelmiş olup, Türk İslam Altın Çağı'nın astronomik rönesansında önemli roller oynamışlardır. Astronomi alanındaki çalışmaları, modern bilimsel prensiplerin temelini atmıştır. Alfraganus, göksel hareketler üzerine revize edilmiş ve doğru veriler sağlayarak, sonraki kaşifler için önemli bilgiler sunmuştur. Qadi-zadeh Roumi'nin hassas hesaplamaları ve yıldız kataloglarına katkıları, gök cisimlerinin anlaşılmasını ilerletmiştir. Al-Kashi'nin pi ve trigonometrik fonksiyonlar üzerine çalışmaları, matematiksel astronomiye önemli etkiler yapmıştır. Timurlu hükümdar Ulugh Beg'in ileri düzeyde bir gözlemevi kurması ve kapsamlı yıldız kataloğu, Ptolemy'nin birçok hatasını düzeltmiş ve gece

gökyüzünün daha doğru anlaşılmasını sağlamıştır. Toplu olarak, bu katkılar Özbekistan'ın astronomik rönesanstaki merkezi rolünü vurgulamakta ve modern bilim insanlarına, bilhassa, Orta Asya'da bilimi canlandırmak isteyen Cedidlere ilham vermeye devam etmektedir.

Anahtar Kelimeler: Alfraganus, Qadi-zadeh Roumi, Al-Kashi, Ulugh Beg, Özbekistan, İslam-Türk Altın Çağı, astronomi, göksel hareketler, yıldız kataloğu, trigonometri, gözlemevi.

INTRODUCTION

Uzbekistan, a land rich in history and culture, was a central hub for astronomic advancement during the Islamic Golden Age. The development of science and thought in Transoxiana, one of the centers of world civilization, dates back to ancient times and reached its peak especially in the Middle Ages (Celal, 2016: 221).

Moreover, the current Uzbek president, Shavkat Mirziyoyev, is trying to restore Uzbekistan's glory by reviving the country's glorious literary and scientific past at the cultural and academic levels, such as Ulugh Beg. In a speech, the President states: "*Mirzo Ulugh Beg was not only a prominent scholar of his time but also a great statesman who elevated enlightenment to the highest level of values. He made unprecedented discoveries in science, particularly in the fields of astronomy and mathematics, contributing significantly to the advancement of science worldwide*." Shavkat Mirziyoyev recognizes Mirzo Ulugh Beg not only as a great astronomer and mathematician but also as a true enlightened statesman according to Khudoyberdiyeva (2025: 481-489).

Certainly, it is Uzbekistan that hosted the First and Second Renaissance of the Muslim world. This is why this Turkish country has been the cradle of literary and scientific advancement since the 18th century. From the Qarakhanids to the Mughals (Babur Empire), the Uzbeks have been initiators of artistic and scientific Renaissance in the Turkish world at various levels: literary, artistic, cultural, linguistic, mathematical, physical, astronomical... The Uzbek lands have hosted scientific centers such as Samarkand, Bukhara, and Khiva, where madrasas taught advanced knowledge compared to others (Абдуҳалимов, 2010). From the 9th century onwards, during the reigns of the Samanids, Karakhanids, Khwarezmshahs, and Timurids in the regions of Transoxiana and Khorasan, science, especially astronomy, began to develop rapidly. During this period, significant results were achieved through the invention and development of astronomical instruments, the establishment of scientific centers, the development of the science of astronomy, the construction of

observatories, and research related to astronomical experiments (Celal, 2016: 221). Moreover, in Samarkand, in the 15th century, under a Timurid prince, the construction of Ulugh Beg's astronomical observatory brought together the world's greatest scientists, astronomers, etc., who developed the Sultanian tables, whose precision remained unmatched for two centuries. Humans were interested in observing the appearances of celestial bodies, their positions, and their movements for simple reasons related to their daily lives. Nomadic peoples, particularly sailors and trade caravans, guided themselves by celestial bodies, whether on land or at sea (Oliew, 2023: 91).

Samarkand became a major center for astronomical studies. The Timurid governor was also a learned astronomer and invited students to study and work there. This madrasa gained great prestige, with more than sixty astronomers active at its peak. The construction of the observatory began in 1424 and was completed five years later. Beg entrusted the responsibility of the new observatory to his deputy Ali Qushji, who remained in office until Ulugh Beg's assassination. However, advanced astronomical research did not begin with the Timurids. Indeed, six centuries earlier, Alfraganus, a famous Turkic astronomer, was a globally studied scientist. He was known for his most famous work, Elements of Astronomy on the Celestial Motions, which is a comprehensive synthesis of Ptolemy's Almagest, with revised and more accurate data. This work was widely disseminated in Arabic and Latin, influencing many European scientists before Regiomontanus.

Thus, This article delves into the lives and contributions of four key figures: Alfraganus, Qadi-zadeh Roumi, Al-Kashi, and Ulugh Beg. Their collective work not only advanced the field of astronomy but also influenced future generations of astronomers. Alfraganus provided revised and accurate data on celestial motions, which were instrumental for later explorers. Qadi-zadeh Roumi's precise calculations and contributions to stellar catalogues advanced the understanding of celestial bodies. Al-Kashi's work on pi and trigonometric functions significantly impacted mathematical astronomy. Ulugh Beg's establishment of an advanced observatory and his comprehensive star catalogue corrected many of Ptolemy's errors and provided a more accurate understanding of the night sky. Collectively, their contributions highlight Uzbekistan's pivotal role in the astronomic renaissance and continue to inspire modern scholars.

1. The beginnings of Turkic astronomy: Alfraganus (c. 800 – 870)

The Uzbek country has always been famous for its talents. Alfraganus, also known as Al-Farghani, a prominent internationally renowned scholar, was no

exception. After his works were translated into Latin in 1145 and 1175 in Europe, the name Al-Fargani was Latinized, becoming famous in the West as Alfraganus (Usmonova, 2024: 387). His contribution to astronomy, as one of the most important astronomers of his time, developed the most advanced scientific ideas and theories of his era. Al-Fargani is known not only as an astronomer but also as a mathematician, geographer, and scholar. His works, notably "Al-Fusul al-Mu'kadiyya" and "Zij al-Sanji," are among the most important astronomical tables of his time and constitute an essential source for scientific research (Zayniddin o'g'li, 2024: 179).

Al-Farghani's books gained a reputation as encyclopedic treatises, and his inventions, reference books, and catalogs are still relevant today. This scholar was born as Abû'l Abbas Ahmad b. Muhammad b. Kathîr al-Farghânî al-Hâsîb, known as Alfraganus in the West. He was the most famous astronomer who worked during al-Ma'mûn's dynasty (813-833). He was born in Kuva, in the Farghânâ Valley, present-day Uzbekistan, and studied engineering there (Unat, 2007: 3)[1].

Alfraganus was a renowned astronomer in the Abbasid court in Baghdad. In adulthood, Al-Farghani lived in Baghdad, where he conducted scientific activities at the Islamic academy founded in the 9th century, the House of Wisdom. His favorite place at the academy was the observatory, which at the time was equipped with the most advanced technology for observing the stars. The academy was presided over by the great Al-Khwarizmi, whose writings and wisdom certainly influenced Al-Farghani.

Alfraganus wrote numerous works such as: "The Book of Thirty Chapters" and "The Book on the Construction of Sundials". "The Book of Thirty Chapters" was translated into Latin by Gerard of Cremona, with several manuscripts preserved today in various libraries across Europe, including the Bodleian Library at Oxford.

In the 9th century, Muslim scholars made great strides in the study of astronomy and surpassed Europeans. At that time, the study of astronomy was vital. Astronomical works served as navigators and were used by travelers, sailors, pilgrims, and merchants to navigate by the stars and celestial bodies. These astronomical works were translated and disseminated in Europe. Al-Farghani's treatises became famous worldwide and had a major impact on global science (Dreyer, 1906).

He wrote "The Elements of Astronomy" and "Kitab fi Jawani" around the year 833. These works deal with celestial movements, including a comprehensive study of the stars, and consist of thirty chapters. It is one of the targeted books for this science and its aspect of translation at that time. It is classified by Ahmad ibn Muhammad ibn

[1] Unat, Y. (2007). Alfraganus and the Elements of Astronomy. *Foundation for Science Technology and Civilisation*, 1-15.

Kathir al-Farghani (died after 861), who was one of the most distinguished astronomers of the House of Wisdom in Baghdad. He wrote this book in Arabic, which was later translated into Latin under the title "Elementa Astronomica". This translation had a great influence on European astronomy in the Middle Ages. The original Arabic text consists of thirty chapters. Al-Farghani's work significantly influenced medieval European astronomy through Latin translations like "Elementa Astronomica" (Unat, 2007: 4).

In this work, he wrote on important themes such as the movement of the moon and planets in latitude; the magnitude of fixed stars and the positions of the most notable among them; lunar mansions; the distances of planets from the earth; the magnitudes of planets compared to the magnitude of the Earth; meridian transit; rising and setting, as well as ascensions, declinations, and occultation; phases of the moon; lunar emergence; alignment of the five planets; lunar eclipses; solar eclipses; the interval between two eclipses… (Unat, 2007: 5). This great Turkic scholar improved the knowledge of astronomy from Ptolemy's Almagest. Alfraganus provided the distance per degree at the equator, and in chapter 8, he determined the diameter of the Earth to be 6,500 miles (Nasr, 2001).

A shape from the Latin translation of Alfraganus' book of astronomy.


DE RVDIMENT. ASTRON. 43

Hîc cadit figura infrà posita.

Cuſpis autem circuli ſignorum, qui eſt circulus ſtellarum fixarum eſt cuſpis terræ. Cuſpides vero cæterarum ſtellarum ſeptem, quæ ſunt ſphæræ planetarum erraticorum, ſunt remotæ à cuſpide terræ in partibus diuerſis. Et in vnaquaque harum ſphærarum 8 eſt circulus abſcindens ſphæra per duas medietates ab Oriente in Occidentẽ,

source: Unat, Y. (2007). Alfraganus and the Elements of Astronomy. *Foundation for Science Technology and Civilisation*, 1-15.

Alfraganus agreed with Ptolemy on the theory of precession but believed that it affects not only the stars but also the apogee of the sun. The stars do not move by themselves since precession affects all planets except the sun. According to Sarton

(1927: 463), the Elements of Astronomy were translated into French in the 14th century, and this translation was based on an Italian translation by Beccadelli. The 20th chapter of the Elements of Astronomy was published with Sacrobosco's Sphaera in 1566 and 1581. The Elements of Astronomy existed as a text used to teach astronomy at the University of Paris, where it was known as Tractatus de Sphera. It is believed to have been written by Sacrobosco, who also wrote a commentary on Ptolemy's Almagest. The Elements of Astronomy is often called The Sphere or De sphaera mundi. These translations are among many others.

In summary, the Elements of Astronomy was one of the most popular books on astronomy both in the East and the West and was used as a reference in astronomy until the 15th century. Alfraganus was also known as the first Muslim astronomer to write an astronomical manual. By summarizing and simplifying the Almagest, Alfraganus made Ptolemaic astronomy accessible to Muslims and Christians in Europe. Al-Fargani, holder of encyclopedic knowledge, was hailed by scholars as "the first pedagogue in the history of astronomy" according to Usmonova (2024: 386). Indeed, his works helped great European astronomers understand what astronomy is and begin to develop it. Among European scholars, D'Alembert, Brockelmann, H. Suter, I. Yu. Krachkovsky, A. P. Yushkevich, A. Rosenfeld highly appreciated Al-Farghani's works and scientific legacy (Usmonova, 2024: 388).

The book was translated into Latin by John of Seville in 1135, and Gerard of Cremona (died in 1187) also used Alfraganus's book. Adelard of Bath (died in 1152) also wrote a commentary on it. Al-Farghani's books gained a reputation as encyclopedic treatises, and his inventions, reference books, and catalogs are still relevant today. They were used by students as educational tools. It is interesting to note that in 1669, Al-Farghani's work was retranslated and republished by the Dutch scholar Jacob Golius. For 700 years, Al-Farghani's work remained a reference in astronomy and served as the basis for manuals and encyclopedias.

The infinite respect for his legacy was reflected by the international celebration of Al-Farghani's 1200th anniversary in 1998, the creation of a park named Al-Farghani in the city of Fergana, the erection of a statue of Al-Farghani in the ancient city of Kuva, UNESCO events in 1998, the decision of the Cabinet of Ministers of the Republic of Uzbekistan "On the celebration of the 1200th anniversary of the birth of Ahmad al-Farghani" (November 27, 1997), scientific conferences, artistic exhibitions, the publication of new books, the staging of plays such as "Piri koinot" by Hayitmat Rasul, "Farg'ona farzandi" by Yuldosh Sulaymon, "Bashar allomasi" by Nurullohon haji Abdullah o'g'li, the production of films, and the naming of a square, a street, and a school in the city of Fergana, as well as a large crater of 20 km on the

Moon in the name of Ahmad al-Farghani (Usmonova, 2024: 388) & (Spain, 2009: 80). Alfraganus is an impact crater on the visible side of the Moon. The name was officially adopted by the International Astronomical Union (IAU) in 1935, in reference to Al-Farghani (805-880).

2. The beginnings of Timurid astronomy

2.1. Ulugh Beg (1394 – 1449)

From the 1360s onwards, the independence movement led by Amur Timur (1336–1405) against the Mongol invasion resulted in the emergence of a powerful state in the Mavarannahr and Khorasan regions (Khairullaev, 1994). This situation led to the revival of a period previously referred to as the "Golden Age" of the Islamic world. His grandson, Ulugh Beg, elevated astronomy to new heights.

Ulugh Beg, the son of Shahrukh and grandson of Timur, was born in 1394 in the city of Sultaniye, in western Iran, during his grandfather's military conquests (Buyuk Iste'dod Sohiblari, 2002). As the eldest son of Shahrukh, he was given the name Muhammad Taraghay. However, from a young age, he was called "Ulugh Beg," a name that later became his official title (Ma'naviyat Yulduzlari, 2001). Ulugh Beg means "Great Emir" in Turkish (Islamic Encyclopedia, 2012). His childhood coincided with his grandfather's conquests, and by the age of 17, he was appointed as the governor of Mavarannahr and Turkestan.

According to van Dalen, B. (2007: 1157) and Özcan (2021: 229), Ulugh Beg is said to have spoken Arabic, Persian, Turkic, Mongolian, and some Chinese.

Balibeyoğlu (1997: 158) wrote, "*He was a great astronomer and mathematician. But most importantly, he was perhaps the first ruler-scientist in history.*" Ulugh Beg transformed Samarkand into the center of Islamic civilization as a scholar, a man of letters, and an artist. While many statesmen before him had supported science and art, none had been a scholar-ruler like him.

Oliew (2023: 92) wrote, "*He fulfilled his grandfather Timur's dream of making Samarkand a center of Islamic civilization. He gathered great writers, mathematicians, and astronomers, providing them with opportunities to expand their studies and research in astronomical sciences*." As a result, astronomy developed in two directions: the establishment of astronomical schools and the construction of astronomical observatories. Among the activities of these observatories, he created astronomical tables to calculate the movements of stars and other celestial bodies.

Although he was the grandson of Emir Timur, Ulugh Beg was less interested in territorial conquest and more devoted to science and the arts. As such, he spent his time educating himself and invested in research, particularly in astronomy and mathematics, including the works of Qadi Zadeh al-Rumi, who was born in Anatolia

in 1364. In 1417, he founded a madrasa (a religious school or college) in Samarkand, which can still be seen today on Registan Square. This madrasa became a center of research in Asia. During his reign, students came from all over the East to benefit from the teachings of the best professors in theology, literature, science, and poetry (Luminet, 2018: 3). In this institution, unlike other madrasas, mathematics and astronomy were among the most important subjects taught. The most prominent professor was Qāḍīzāde al-Rūmī, who was later joined by Kāshī, according to van Dalen (2007: 1157).

After the destruction of Baghdad, all astronomical works and scholars were transferred to the Islamic East, notably to Maragha and Samarkand. Under the reign of Ulugh Beg, the astronomy school (madrasa) of Samarkand became a center specialized in astronomical research. He attracted astronomers who effectively managed the school, and he was their main supporter, providing them with all the known astronomical instruments of his time. He entrusted the direction of the school to Qadi Zada Rumi and adorned it with mosaics and beautiful decorations (Oliew, 2023:93). Ulugh Beg worked closely with the professors of the school, accompanying them in all their activities. During his work with them, he invented new instruments and developed new ideas to advance astronomy and assist students in their joint research. Thanks to the efforts of this school, Samarkand became one of the world's centers of astronomical sciences. The school was a comprehensive scientific center and a hub of cultural radiance, combining astronomy, mathematics, and engineering. It is reported that he built this school and next to it, he erected a zawiya (religious school) in Samarkand. The astronomical observatory was built on the hill of Kuhak, located in the outskirts of Samarkand. Ulugh Beg was the first director of this observatory, and Qadi Zada was the second director (Oliew, 2023: 95). The observatory, which rose over three floors, was equipped with observation instruments renowned for their quality and precision. According to Khudoyberdiyeva (2025: 489), *this observatory became a top-level scientific center, furnished with state-of-the-art astronomical instruments and equipment for its time.*"

This institution was not only significant for astronomy but also played a crucial role in advancing other scientific fields. The observatory housed an exceptional array of instruments, unmatched in the medieval world, with more than ten distinct types of astronomical tools. One of the most remarkable was a massive quadrant, featuring a double arc with a radius of 40.2 meters. This instrument was used to measure key astronomical constants, such as the angle between the celestial equator and the ecliptic, the annual precession rate, the length of the tropical year, and other fundamental astronomical parameters.

The courses were organized according to a teaching system where students studied under the direction of their professors, such as Qadi Zada and others. Ulugh Beg was both a professor and supervisor of the observatory's work. He also attended the courses to benefit from them. It is said that he sometimes attended the courses and, when he discovered errors in the old observations, he decided to start new observations. Ehgamberdiev (2016: 150) writes about the Observatory that *"Undoubtedly the Samarqand's observatory was unique and an original construction erected by genius scientists such as Ulugh Beg and his co-workers"*.

Ulugh Beg, a Timurid sultan, was not only a ruler but also a distinguished astronomer and mathematician. He established the Ulugh Beg Observatory in Samarkand, which was one of the most advanced observatories of its time (Chorievna, 2025: 142). The astronomical observatory, whose work predated that of the best astronomers in Europe one and a half centuries later. At its height, the Samarkand madrasa housed up to 70 scholars, with the apotheosis being the construction of a giant observatory started in 1424 and inaugurated with great fanfare in 1429 (Luminet, 2018: 3). According to Luminet (2018), Ulugh Beg, is a prince of Stars.

Frontpage of Prodromus Astronomiae (1690) by Johannes Hevelius, showing Ulugh Beg sitting near Urania with Ptolemy, Copernicus and Tycho Brahe (detail)

SOURCE: Luminet, J. P. (2018). Ulugh Beg, Prince of Stars. *arXiv preprint arXiv:1804.08352.*

In the period between Greek Antiquity and the Renaissance, science in Europe was at a standstill. Astronomy in the muslim world, on the other hand, was marked by doubts about the Greek astronomer Ptolemy's system and by the construction of increasingly accurate instruments, of which the Samarkand observatory is a fine

example. Nurmatova (2017: 37) wrote that "*Accuracy tables Ulugbek was able to surpass the scientist Tycho Brahe*", Danish astronomer of the Western Renaissance.

In 1429, Samarkand—a major stop along the Silk Road—was more vibrant than ever. The largest observatory ever built had just been inaugurated. Ambassadors from around the world flocked to witness a 40-meter-wide sextant housed in a 40-meter-deep pit, a gigantic sundial with exterior walls adorned with a fresco of the zodiac, and a terrace equipped with the most advanced instruments for measuring time and space: water clocks, astrolabes, and more. The visionary behind this architectural marvel was Ulugh Beg. Not only was he the director of the observatory, but he was also a prince and governor of Samarkand. He was deeply passionate about science and sky, but a poor politician and soldier - which ultimately caused his death. Ulugh Beg "*surrounded himself with the best astronomers of the time, observing and calculating the positions of a thousand stars. One of the most important measurements made by the Samarkand atromers was the obliqueness of the ecliptic, i.e. the angle that the Sun's trajectory plane in the celestial sphere makes with the plane of the equator. It is essential to measure it accurately for astronomical calculations and for the calendar*" wrote (Luminet, 2018:6). The value obtained was 23 degrees 30 minutes and 17 seconds, only 32 seconds out from the value recalculated today. The sidereal year, namely the length of time it takes the sun to return to the same position compared to the stars in the celestial globe, is given at 365 days 6 hours 10 minutes and 8 seconds, the error was less than a minute, a difference of 58 seconds (0.04%) with the modern value of 365.25636304 days (Luminet, 2018:6), (Usmonova, 2024: 109), (Jovbo'riyeva, & Xurramova, 2024: 71); (Nurmatova 2017: 37). He determined the inclination of the Earth's axis..

Modern statues representing Ulugh Beg with his favourite astronomers Qadi-Zadeh, Al-Kashi and Ali-Qushji (Samarkand Museum).

SOURCE: Luminet, J. P. (2018). Ulugh Beg, Prince of Stars. *arXiv preprint arXiv:1804.08352.*

The most important part of Ulugh Beg's scientific legacy is the famous *"Zic-i Ulugbek"* work. This work is also referred to as *"Zici Cedid-i Guragoni"* (Маънавият Юлдузлари, 2001). *Zij-i Sultani* is a star catalogue, containing the positions of 992 stars and correcting many of Claudius Ptolemy's errors (100 – 160s/170s AD), the Greek astronomer. The catalogue of the Greek astronomer included 1022 stars in his book *Almagest*. Upon examining this catalogue, Ulugh Beg noticed some errors. Consequently, he began new observations with the scientists around him and prepared the star catalogue known as *"Ziyc-i Gürgani"*, *"Ziyc-i Cedidi Sultan"*, or *"Ziyc-i Uluğ Bey"* (Balibeyoğlu, 1997: 161). It contains astronomical tables that allow the movements of stars to be known and calendars to be calculated year after year. It includes numerous mathematical tables that determine the positions of planets in their orbits, the rules for knowing the months and days, past dates, and the positions of planets in terms of height and declination (Oliew, 2023: 95). He estimated that the solar year contains 365 days, 5 hours, 49 minutes, and 15 seconds, which is very close to modern estimates (Khudoyberdiyeva, 2025: 489).

Additionally, there is the *"Risale-i Ulugbek"* work related to astronomy. The only copy of this work has survived to the present day and is located in the library of Aligarh University in India. Ulugh Beg's *"Zic"* work continued the tradition of astronomy initiated in the 8th-9th centuries, but it is accepted that the scientific level of this work is very high. The influence of the works of Ulugh Beg was felt first in Asia, through he development of Turkic astronomy and the construction of observatories inspired by the one in Samarkand (Salikhovna, 2017: 11). This was the case in India with the five observatories - all called Jantar Mantar - built at the start of the 18th century by the Maharajah Jai Singh II, a huge admirer of Ulugh Beg.

"Zij of Ulugh Beg" had become one of the scientific masterpieces of the Muslim world in 15th (Ehgamberdiev, 2016: 151). However, the Sultani Astronomical Tables only arrived in Europe in the 17th century. The Astronomical Manual was soon translated into Latin and, together with the astronomical tables of Claudius Ptolemy Almagest and King Alfonso XV, was a guide to astronomy in all the observatories of Europe (Mashhura, 2025: 110). Already in 17th-century England, various parts of the Zīj were published in edition and/or translation. The work conducted in his observatory was translated and edited for the first time in Oxford in 1648 (Luminet, 2018: 9) & (Mashhura, 2025: 110). d. The work was prepared for printing and commented by John Grieves (1602 – 1652), professor of astronomy at Oxford University. Thomas Hyde (1636-1703), a scientific curator at the Bodleian Library in Oxford, an English orientalist and translator, prepared a new edition of the

(E)ISSN: 2181-1784
5(6), 2025
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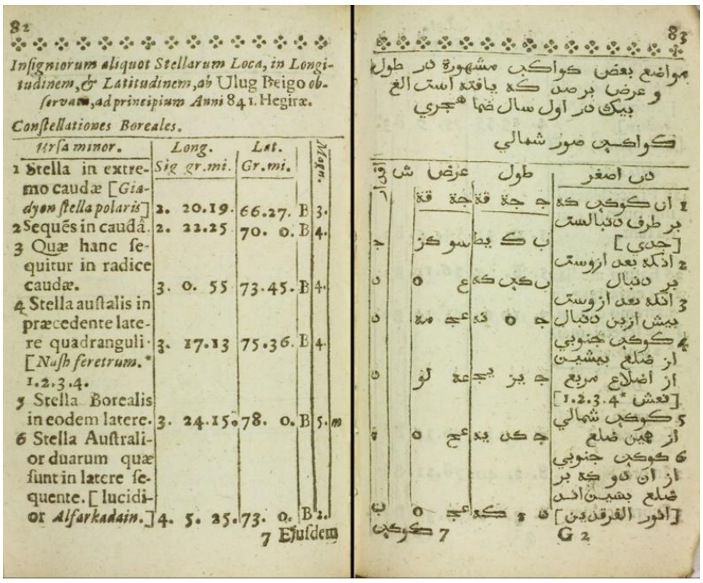
Samarkand catalogue entitled "Tabulae Long, as Lat. Stellarum Fixarum, ex Ulugh (Mashhura, 2025: 110).

Ulugh Beg's Zīj was highly influential and continued to be used in the Islamic world until the 19th century. It was soon translated into Arabic by Yaḥyā ibn ʿAlī al-Rifāʿī and into Turkish by ʿAbd al-Raḥmān ʿUthmān. Reworkings for various localities were made in Persian, Arabic, and Hebrew by scholars such as ʿImād al-Dīn ibn Jamāl al-Bukhārī (Bukhara), Ibn Abī al-Fatḥ al-Ṣūfī (Cairo), Mullā Chānd ibn Bahāʾ al-Dīn and Farīd al-Dīn al-Dihlawī (both Delhi), and Sanjaq Dār and Husayn Qusʿa (Tunis). Commentaries to the Zīj were written by Qūshjī, Mīram Chelebī, Bīrjandī, and many others.

Hundreds of manuscript copies of the Persian original of Ulugh Beg's Zīj are extant in libraries all over the world (van Dalen, 2007: 1158). "This work was extensively studied by Ottoman astronomers. *Uluğ Bey Zîci*, which was widely used in Ottoman scientific life, was taught both in madrasas and in private lessons (Aydüz, 2003: 144). An example of the recognition and widespread use of *Uluğ Bey Zîci* even in the eighteenth century is provided by Abdurrahman el-Cebertî (d. 1822) (Aydüz, 2003: 145). In the Ottoman Empire, the chief astronomers, who officially managed astronomical affairs, used *Uluğ Bey Zîci* for all calendar and prayer time calculations for centuries (Aydüz, 1995: 170). One of the astronomers and teachers living in Egypt, Abdurrahman b. Osman (17th century), translated the work into Turkish by order of Hasan Ağa, the head of the Azaplar Corps in Cairo (Aydüz, 2003: 150)."

During his lifetime, the scientific works of Ulugbek were known all over the world. Chinese wrote and talked about him and used the astronomical calculations of Ulugbek (Jovboʻriyeva, & Xurramova, 2024: 71).

A page of the first western edition of Ulugh Beg's catalog, translated and commented by John Greaves (Oxford, 1648)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Insigniorum aliquot Stellarum Loca, in Longitudinem, & Latitudinem, ab Ulug Beigo *observata, ad principium Anni* 841. Hegiræ.

Constellationes Boreales.

Ursa minor.	*Long.* Sig gr.mi.	*Lat.* Gr.mi.		*Magn.*	
1 Stella in extremo caudæ [*Giadyon stella polaris*]	2. 20.19.	66.27.	B	3.	
2 Sequēs in caudâ.	2. 22.25	70. 0.	B	4.	
3 Quæ hanc sequitur in radice caudæ.	3. 0. 55	73.45.	B	4.	
4 Stella australis in præcedente latere quadranguli. [*Nash feretrum.* * 1.2.3.4.	3. 17.13	75.36.	B	4.	
5 Stella Borealis in eodem latere.	3. 24.15.	78. 0.	B	5.	m
6 Stella Australior duarum quæ sunt in latere sequente. [lucidior *Alfarkadain.*]	4. 5. 25.	73. 0.	B	2.	

7 Eiusdem

SOURCE: Luminet, J. P. (2018). Ulugh Beg, Prince of Stars. *arXiv preprint arXiv:1804.08352.*

Oliew (2023: 95) wrote that "*there is no doubt that the personality of Ulugh Beg is one of the most prominent historical figures who have formed a presence in the field of scientific research among Muslims throughout historical times and to this day".,* his achievements in the field of astronomical sciences and their development had a clear impact on the obvious progress of Islamic Civilization*) regardless of the political role and the different vision of historians about the personality of Ulugh Beg, but he was one of the most princes and sultans who contributed to the advancement of Muslim knowledge in Islamic sciences

2.2. Qadi-zadeh Roumi (1364 – 1436)

Qadi-zadeh Roumi, born Salah al-Din Musa Pasha, was a Turkic astronomer and mathematician who worked at the Samarkand observatory.

He studied religious and rational sciences with his grandfather and Molla Fenârî, a famous scholar during the reign of Murad I. He then went to Konya with Bedreddin Simâvî, one of his grandfather's students, and took astronomy lessons from Müneccim Feyzullah. One of his teachers in Anatolia was Safarşah er-Rûmî. In the early 1400s, despite opposition from his family members, with the encouragement of his teacher Molla Fanārī, he went to the region of Māverānaynehir and Khorasan, where the scholarly heritage of the Merāga mathematical-astronomical school remained alive, and from 1411, he attended the courses of the theologian-mathematician Sayyid Sharīf al-Jurjānī, one of the greatest scholars of the time, in Samarkand (Ceyhan, 2024).

He had left the Ottoman Empire, fallen into the hands of Emir Temur, and completed his studies in the Timurid empire's renowned madrasas (a madrasa is a school which served as a university in the Muslim world. The most ancient preserved example, in Ispahan, dates from 1175). Qadi Zadeh knew how to awaken a taste for study and reflection in his pupil, who proved very talented for all the disciplines of the mind, from astronomy to mathematics, including music, poetry, and calligraphy (Luminet, 2018:3). Qadīzāda, who met Ulugh Beg in Samarkand, quickly gained the love and respect of the sovereign and became his personal tutor; he was then appointed head of Ulugh Beg's madrasa and head of the Samarkand observatory, built after Jamshīd al-Kāshī. Kadızâde, whose courses were attended by Ulugh Beg and other professors, attached great importance to scientific autonomy (Kahya, 2003: 16).

Qadīzāda's most important astronomical activity was his participation in the Samarkand Observatory and the committee for the composition of Zīj-i Uluġ Bey.

Although his contribution to Zīj-i Uluġ Beg, which is a team effort, has not been determined in detail, the fact that he personally supervised the observations and the astronomical mathematical calculations based on these observations after Jamshīd al-Kāshī at the head of the observatory shows that Kadızāde played an important role in the preparation of this work.

Şerḥu'l-Mülaḫḫaṣ fī ʿilmi'l-heyʾe. A commentary on *al-Mülaḫḫaṣ fi'l-heyʾe* by Chagmīnī, written in 814 (1412) and presented to Ulug Beg (Süleymaniye Ktp., Ayasofya, no. 2662); it was copied from Chagmīnī's work and from the author's copy. This is Qadīzāda's most important work in the field of theoretical astronomy. It was taught as an intermediate-level textbook in Ottoman madrasas, and more than 300 copies of the work have survived to this day, along with various editions (TAHiR, K. M. KADizADE-i RÜM).

He is best known for his precise calculation of the sine of 1° to an accuracy of 10^-12. His contributions to the Zij-i-Sultani, a comprehensive stellar catalogue, were significant in the field of astronomy.

2.3. Al-Kashi (c. 1380 – 1429)

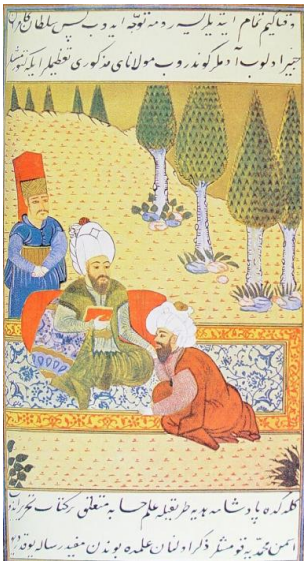
Ghiyath al-Din Jamshid al-Kashi was a Persian mathematician and astronomer who made substantial contributions to both fields. He is renowned for his work on the calculation of pi and the sine of 1°. Al-Kashi's "Treatise on the Chord and Sine" and his work at the Samarkand observatory under Ulugh Beg were pivotal in advancing mathematical and astronomical knowledge.

Ali Qushji was called 'my son' by Ulugh Beg, who said that he confided his secrets to him (Oliew, 2023: 95). The development of Astronomy in the Timurid reign is evident in the contributions of Ulugh Beg (796 AH-853 AH/1394-1449) historical study. After the fall of the Timurids, Samarkand was ransacked, and the astronomer Ali-Qushji was able to flee Samarkand with his family, taking with him the precious manuscript of astronomical tables. Following an epic journey, he arrived in Constantinople, where he ceremoniously handed the work over to Sultan Mehmet II. He published the works under the title of *Sultani Astronomical Tables*.

Timurid astronomy impacted Ottoman astronomy. When it comes to zīc in the Ottomans, especially from the beginning of the sixteenth century, *Uluğ Bey Zīci* inevitably comes to mind. This zīc became widespread in the Ottomans under the name *Zīc-i Uluğ Bey*. The zīc was probably brought to Istanbul for the first time by Ali Qushji and became widespread through him. On the other hand, Fethullah Shirvani, another carrier of the Samarkand school, also made significant contributions to the spread of this zīc and school. In the Ottoman Empire, astrologers and timekeepers used this zīc in almost all their work, especially in the preparation of

calendars, until the Cassini Zīc was translated into Turkish by Halifezâde Çinârî İsmail Efendi (d. 1790) (Aydüz, 2003: 143).

Ottoman miniature showing Sultan Mehmet II receiving the Sultani Astronomical Tables from the hands of Ali-Qushji



SOURCE: Luminet, J. P. (2018). Ulugh Beg, Prince of Stars. *arXiv preprint arXiv:1804.08352.*

Through the study of astronomy, AI Kashi became an engineer of astronomical devices and an authority in numerical analysis. He computed rr literally to horsehair precision, for a circle whose diameter is 600,000 times the Equator; that is, his estimate for the limit of the universe: "the equator on the sphere of fixed stars. Juhel, A. (2007: 46).

3. Importance of the scientific past in national construction today

The President of the Republic of Uzbekistan, Shavkat Mirziyoyev, noted, "We must deeply study the legacy of our enlightened ancestors. The more we explore this spiritual treasure, the more we will find correct answers to the many questions that concern us today. The more actively we promote this invaluable wealth, the more our people, especially our youth, will understand the value of today's peaceful and free life" (Usmonova, 2024: 385). The scientists in the history of Uzbekistan, such as Ahmad Al-Fargani, Ulugh Beg, ... by making their invaluable contributions to the progress of humanity, continue to spread the fame of Uzbekistan worldwide and are forever etched in the pages of the history of the scientific world.

Mashhura (2025: 107) wrote that "*In recent years, at the end of the 20 th century and the beginning of the 21 st century, particularly after the Republic of Uzbekistan gained the independence, the historical, cultural, practical, scientific , social aspects of studying and researching on the significance of the role and actions*

of Ulugbek in the history of the Republic of Uzbekistan and the history of all over the globe".

CONCLUSION

The contributions of Alfraganus, Qadi-zadeh Roumi, Al-Kashi, and Ulugh Beg highlight Uzbekistan's pivotal role in the astronomic renaissance of the Islamic Golden Age. Their work laid the groundwork for many modern principles in astronomy and continues to inspire scholars today.

Alfraganus' calculations were used by explorers such as Christopher Columbus. In addition to his contributions to astronomy, Alfraganus oversaw construction projects in Egypt, including the Nilometer, which measured the height of the Nile during floods. The Alfraganus lunar crater bears his name, testifying to his lasting impact on the field of astronomy. As for Ulugh beg, his work and his astronomers reached a large international audience and acquired international fame, as shown in a few allegorical engravings made in Europe. The depth of Ulug Beg's knowledge of mathematics and astronomy went beyond expertise to create a school. His work, Zij-i Sultani stands out as one of the most detailed and precise star catalogs of its time.

It is important to know that as early as the 19th and even the 15th century, the Jadids in Uzbekistan supported the revival of science and critical thinking. This reflects a reawakening of the scientific spirit in Uzbek territories like in the past. At the end of the 19th and the beginning of the 20th century, significant scientific progress was made, and the Jadids played a key role in this development.

They began to develop historical research for educational purposes. Instead of portraying history as merely a succession of khans, sultans, and emirs, the Jadids started to teach students that the people themselves are the true makers of history. The historian and journalist Mulla Alim Makhdum Hoji wrote 'Tarihi Turkistan' (History of Turkestan). This work, published in Uzbek, chronicles the events in Turkestan from antiquity to the early 20th century. It became known as the first historical work written in the Uzbek language. The Jadids placed great importance on history in the education of the literate and scholarly classes of Turkestan (Farxodjon ogli, 2024).

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