The Samarqand Mathematical-Astronomical School: A Basis for Ottoman Philosophy and Science

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In order to understand the outlook of a civilization that underlies its system of philosophy and science, one needs to analyze the opportunities in its physical environment that enabled the system to be formed as well as the contextual basis of its world view and its general conception of the universe. Thus to comprehend the scientific and philosophical attitudes in the Ottoman State, one must look for the historical foundations of these attitudes that are reflected in the scientific continuity maintained by the *ʿulama'* (the learned) in *Dār al-Islam* (the Land of Islam). Despite different political contexts, there was a common tradition that unified this scientific continuity. However, reducing this tradition to some essentialist element should be avoided, inasmuch as non-manifest and complex variables often affect the formation of mental attitudes. It was rather the common consciousness and conceptualization of the world that flowed through the depths of the divided political geography of Islam that kept the framework of the emergent philosophy-science system in Islamic civilization together and ensured its historical longevity.

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The Ottoman philosophy-science system is a composite reflecting the spectrum of information produced in *Dār al-Islam* from which it naturally followed. If this composite were to be regarded as a rug, it would be essential, in order to comprehend the wholeness of this rug, to analyze the individual threads that come from the depths of history and the knots that keep these threads together, and to determine where it was woven and the sagas of the people who wove it. However, the most important thing to understand is the conceptual base, which gives this rug its own characteristics that make it just such a rug with regard to its historical context.

In the first part of this study, the conceptual base of the Samarqand mathematical-astronomical school, which is one of the most important pillars/threads of the Ottoman philosophical-scientific system/rug, is described within its physical and historical context; the mental attitudes of the philosopher-scientists that built this conceptual base are analyzed; and the ways in which and the people by whom these attitudes were passed on to Ottoman lands are examined, all in the light of the principles stated above. The second part presents the report of a lecture recorded by Fatḥallāh Shirwānī—one of the prominent figures of the Samarqand mathematical-astronomical school—from his *Sharḥ al-Tadhkira fī ᶜilm al-hay'a*, together with the translation and the critical text of his license/diploma *(ijāza)* given by his teacher Qāḍīzāde. This license is then evaluated with reference to the framework described in the first part of the article; new issues and questions that arise from this examination are discussed based upon what we know of the history of the Samarqand mathematical-astronomical school.

PART ONE: *The Samarqand Mathematical-Astronomical School*

I. Introduction: Political Background

The Tīmūrid State was established by Tīmūr Lang ("Timur the Lame"; d. 807 H/1405 CE)[1] in the regions of Transoxiana and Khurāsān, and it lasted from the end of the fourteenth century (771/1370) until the beginning of the sixteenth century (913/1507). Shāh Rukh (d. 850/1447), the youngest son of Tīmūr, who was appointed governor of Khurāsān in 799/1396, succeeded to some extent in suppressing the turmoil occurring after the death of his father and captured Samarqand in 811/1409. Living in Herat, Shāh Rukh used this city as his capital while he governed the region from Transoxiana to Kāshghar through his son Mughīth al-Dīn Ulugh Beg (19 Jumādā al-awwal 796/22 March 1394–10 Ramaḍān 853/27 October 1449). As a result, Tīmūr's capital Samarqand became simply a major, not a capital, city. Upon the death of his father, Ulugh Beg would rule the country for only two years, until he was killed by his son ᶜAbd al-Laṭīf (d. 854/1450). After a short

[1] The first date listed is hijra (H); the second, after the slash, is the Christian era date (CE). When only one date is given, it is CE.

period of turmoil, Abū Saᶜīd b. Muḥammad b. Mīrān Shāh (d. 873/1469) captured Samarqand in 855/1451. The Tīmūrid State, with Samarqand as its capital, was ruled by the sons and grandsons of Abū Saᶜīd after he was killed by Aq Qoyunlu Ḥasan Beg, and its power was finally ended by the Uzbek khāns and begs in 906/1500-1. The political, scientific, and cultural heritage of Samarqand was passed on to another Tīmūrid State that was founded by Ḥusayn Bāyqarā (d. 912/1506) in 873/1469, with Herat as its capital. Bāyqarā ruled for 37 years until his death at which time this Tīmūrid State was defeated by the Shaybānīs (of Uzbek origin) and the Tīmūrid State finally ceased to exist.[2]

II. Herat and Samarqand: A Tale of Two Cities

Tīmūr established his state as a construct composed of Turkic, Mongol, and Persian roots even as its fundamental basis was according to Islam.[3] He valued belonging to this tradition, and this can be exemplified by many historical instances: that he went to Yasī after 799/1397 to visit the tomb of Khwāja Aḥmad Yasawī and ordered the construction of a large hospice that took two years to build;[4] that he declared himself to be an *Ulugh beg* rather than a *khān*, thus adhering to the ancient political tradition of being part of a divinely-chosen cosmic family, even though he held all the political and military power; and that he recognized Suyurghatmish, a descendant of Ögedey Khān from the Chagatai Khānate, as the *khān*.[5] After Tīmūr, however, the importance and interpretation of each composite root, and the sensitivity towards each, differed according to the dominant political power.

II.1. *Herat: Religion and Art*

Shāh Rukh made Herat his capital and did not follow his father's Turco-Mongol sensitivity; thus he did not use any title reflecting the Chagatai tradition and felt content with the honorific title *bahādur*. In 813/1411 he annulled some of the official Turco-Mongol common laws and took the titles of *sultan* and *caliph* in order to use them in his political struggle within the Islamic world.[6] As Shāh Rukh was

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[2] For general information regarding the foundation, development, and collapse of the Tīmūrid State, see Roemer; Manz; Barthold, *Ulugh-Beg*; and Aka, *Timur ve Devleti* and *Mirza Şahruh*. For a primary source about Tīmūr and his rising Tīmūrid State, see Ibn ᶜArabshāh al-Dimashqī (d. 854/1450), *ᶜAjā'ib al-maqdūr*.

[3] For more information, see Yalçın. See also Ibn ᶜArabshāh (p. 455) who singles out discussions among the *ᶜulama'* in which Tīmūr and other Central Asian states adopted laws of Genghis Khan.

[4] Aka, *Timur ve Devleti*, pp. 116–117.

[5] In many cases, Tīmūr adhered to the notion of divinely-chosen, "cosmic" families. Indeed, Ṭāshkubrīzāde (*ŞN*, p. 43) reports that, in a debate between al-Sayyid al-Sharīf and Taftāzānī, Tīmūr took the side of al-Sayyid al-Sharīf by saying to Taftāzānī: "Although you are equal within the scientific realm, al-Sayyid al-Sharīf has an *honorable ancestry*."

[6] Subtelny-Khalidov, p. 211.

inclined towards religious and mystical (*ᶜirfānī*) knowledge, he provided qualified and skilled individuals with state positions to ensure stability, and he made Herat and its surroundings a center for religious studies according to Sunnī doctrine. Shāh Rukh's strict Sunnī policy was mainly the result of the recurring Shīᶜī religious and social movements at that time. His policy was led at the theoretical level by the Sunnī *ᶜulama'* working at his *madrasa'*s in Herat, and at the public level by the mystical order of the Naqshbandiyya, who were his representatives. However, with the coming of the Ṣafawid movement in Iran (at the end of the fifteenth century and the beginning of the sixteenth century), nomadic tribes who resisted urbanization and were difficult to approach became susceptible to the Shīᶜī tide.

Although Ḥanafī and Shāfiᶜī interpretations of Sunnī doctrine were dominant in the Transoxiana and Khurāsān regions under the rule of Tīmūr and Shāh Rukh, the Shīᶜa, especially the Twelvers (the *Ithnā-ᶜasharī*s) and the Ismāᶜīlīs, were widespread in many regions. As historical sources also point out, in both the political and public spheres there were ongoing interchanges between the Sunnī and the Shīᶜī faiths.[7] This atmosphere of religious ambiguity provided an environment that promoted the blossoming of new religious and sectarian interpretations. For example, some extreme creeds (*ṭarā'iq*) and excessively mystic interpretations took root among nomadic tribes, who were mostly unsettled and illiterate. Indeed, during this period Ḥurūfism (founded by Faḍlallāh Astarābādī with influences from Hermetic and Jewish cabalist traditions) developed in this climate. Faḍlallāh was prosecuted by Tīmūr and killed by Tīmūr's son Mīrān Shāh. During the rule of Shāh Rukh, there was growing unrest and a militant named Aḥmad-i Lur, one of Faḍlallāh's followers, attempted to assassinate Shāh Rukh on 23 Rabīᶜ al-thānī 830/21 February 1432 in Herat.[8]

Herat became a center for religious studies as a result of both Shāh Rukh's inclinations and the policies he pursued as mentioned above. Moreover, Herat evolved into a city known for its literature and art because of the interests of Shāh Rukh's son Bāysunghur (d. 837/1433) in poetry, calligraphy, gilding, miniatures, book binding, and painting. One outcome was that in both calligraphy and painting a *Bāysunghurī* style emerged, and all the artists working for him were known by the title *Bāysunghurī*.

In short, although the foundations for a cultural life in Herat were laid in the Tīmūrid period, its development was accomplished as a result of the steady and steadfast policies of Shāh Rukh and his son Bāysunghur; this occurred not only in the building of *madrasa'*s and libraries, but also in the teaching of religious studies, literature, and arts that occurred in them. As a result of these policies, many scholars, poets, musicians, calligraphers, and artists would become educated and

[7] For instance, upon coming to power in Herat, Ḥusayn Bāyqarā wanted the *khuṭba* (sermon) to be delivered in the name of the Twelfth Imām; however, he was persuaded to change his mind about this by leading state officials, particularly by ᶜAlī Shīr Nawā'ī.

[8] Aka, *Mirza Şahruh*, pp. 208–209.

influential within Islamic civilization. Undoubtedly, the most prominent and notable among these were ᶜAlī Shīr Nawā'ī and ᶜAbd al-Raḥmān al-Jāmī, who resided in Samarqand for a period and took lessons with Qāḍīzāde (about whom more below). The legacy of Herat continued through the Ḥusayn Bāyqarā period, which began in 873/1469 and included the contributions of ᶜAlī Shīr Nawā'ī,[9] and survived until the collapse of the Herat-Tīmūrid State in 913/1507.[10]

II.2. *Samarqand: Platonist Mathematics*

Ulugh Beg chose Samarqand, his grandfather Tīmūr's capital city, as the center of his activities. Unlike his father Shāh Rukh, he remained loyal to the Turco-Mongol laws and Genghis Khanite customs, and he relied on the Mongol traditions throughout his reign. In contrast to the religious and mystical (*ᶜirfānī*) orientation of Herat, Ulugh Beg emphasized the practice of the mathematical sciences. This statement should certainly not imply that he was not a patron of religious studies, or works in other spheres such as literature, art, or architecture; rather it means (as will be discussed in detail below) that the emphasis and practice was in the sphere of the mathematical sciences.[11] Moreover, Ulugh Beg and his brother Bāysunghur had different opinions about literature as well as about many other fields. For instance, Bāysunghur admired the *Khamsa* (Five poems) of Amīr Khusraw, whereas Ulugh Beg preferred the *Khamsa* of Niẓāmī. The fact that the two brothers argued frequently about issues such as this—as well as many others—is mentioned in the historical sources.[12]

The reason for Ulugh Beg's mathematical-philosophical orientation and his transformation of the city of Samarqand into a center for the mathematical sciences should not be reduced solely to the effect of his visit to the Marāgha Observatory when he was a child, as Jamshīd al-Kāshī mentioned in both his letters to his father. Needless to say, there are political, economic, military, social, and even commercial reasons behind every kind of civil endeavor. Therefore explaining any historical event with a single reason is insufficient for accurately determining an outcome with such a complex and complicated framework. On the other hand, a core principle or set of principles may underlie an historical event. Given this, we may say that the reasons for Samarqand to have had this distinctive quality are

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[9] Agâh Sırrı Levend, *Ali Şir Nevai*.

[10] For Herat, see Uslu 1997 and id., "Herat."

[11] In fact Jamshīd Kāshī wrote in his second letter to his father that Ulugh Beg had memorized the Qur'ān almost entirely and was able to recite two sections of it before the *ḥāfiẓ*'s (specialists in memorizing the Qur'ān) using the appropriate techniques of melodic recitation (*tajwīd*); in addition, Ulugh Beg knew most of the commentaries, made his own comments about verses by quoting the statements of commentators, and was also knowledgeable in language, literary studies, and logic; see Sayılı, *Uluğ Bey*, p. 77.

[12] Dawlatshāh, p. 240 (Turkish trans., vol. 2, pp. 295–296).

primarily related to the historical context in addition to Ulugh Beg's own individual orientation and personal disposition.

Historically, the regions of Transoxiana and Khurāsān shared a 700-year Islamic past as part of Islamic civilization.[13] Traces of the Marāgha mathematical-astronomical school still remained, especially since the influence of Naṣīr al-Dīn al-Ṭūsī and Quṭb al-Dīn al-Shīrāzī was carried on by their students. In short, because of this historical background, this ostensibly weak environment (for the mathematical sciences) bore the potential necessary for renewed and vigorous activity.[14] Furthermore, Ulugh Beg's disposition, scientific-philosophical concerns, and outlook favored mathematics. The most detailed information depicting Ulugh Beg's disposition are described by his colleague Jamshīd al-Kāshī in the two letters he wrote to his father. (See further Fatḥallāh al-Shirwānī's text, which is examined in this study, and other historical sources.)[15] Ulugh Beg's most important partner in shaping his outlook was Qāḍīzāde, his tutor and the head teacher of the Samarqand *madrasa*. Studies of Qāḍīzāde and his extant works clearly display their dispositional closeness and partnership. Therefore, the question that needs to be answered to bring light on this subject is: "Who is Mūsā Qāḍīzāde of Bursa?" In order to address this question, two other prominent figures also need to be discussed, namely Sa^{c}d al-Dīn al-Taftāzānī and al-Sayyid al-Sharīf al-Jurjānī. (For a further

[13] One important question to ask while investigating the history of Islamic philosophy and science is *how long* a territory has been part of Islamic civilization so as to understand its philosophical and scientific legacy. For example, one would get two different answers if this question were asked about Islamic lands dominated by Mongol and Tīmūrid rule (ca. 700 years) and then for Islamic lands that thrived under the Ottoman State (ca. 100 or 150 years) before the conquest of Constantinople. It would thus be futile to compare the Ottoman State and the Tīmūrid Period before the conquest in terms of their philosophy and science, irrespective of the potential of their historical traditions. The reason for this is that for the most part the Tīmūrid territories already contained regional and individual endeavors in these fields; the main task was to centralize, unite, patronize, and direct them. On the other hand, in the Ottoman territories the task was to *invent* and to *produce* traditions in science and philosophy. The Ottoman State's establishment of a stable domination over the ancient Islamic territory began in the first half of the sixteenth century with Sultan Selīm I (Yavuz); however, the Ottoman State never fully benefited from the legacy of the regions of Transoxiana, Khurāsān, and Iran (the so-called philosophical and scientific *granaries* of Islamic civilization) except for migrating scholars from these regions and the works that made it to Ottoman lands. On the other hand, it is inadvisable to assume that different political dominations over different territories actually meant separate worlds within *Dār al-Islām*. For despite these variations there was a common ground in *Dār al-Islām*, namely elements of a shared intellectual outlook and a common consciousness, both of which were also the roots of a common world view and conception. This "commonness" in its broadest sense was constructed, protected, and sustained by the *^{c}ulamā'*.

[14] Some cities in the Transoxiana and Khurāsān regions already had a pre-Islamic legacy. For example, the Chinese traveler Suan Tsan points out that in the seventh century Samarqand children were taught how to *write* and *calculate* beginning when they were five years old, and when they were old enough were then sent to caravansaries to learn commercial affairs; see Eshenkulova, p. 37.

[15] For example, see Bāqirī and Sayılı, *Uluğ Bey*.

discussion of Samarqand and Platonist mathematics, see the sections below on the Samarqand Observatory and Qāḍīzāde.)

III. The Court of Mathematical Wisdom: Ulugh Beg's Samarqand *Madrasa*

Transoxiana and Khurāsān are recognized as the regions where the first *madrasa'*s were founded.[16] Nājī Maᶜrūf states that 165 years before the Niẓāmiyya *madrasa* in Baghdad (whose building was begun in 457/1064 and completed in 459/1066), there already existed a number of *madrasa'*s in the regions of Transoxiana and Khurāsān.[17] In addition, Barthold argues that the first *madrasa'*s were built in the Eastern Islamic world, around the Balkh shores of Āmū Daryā River, especially to counter other religions such as Buddhism and Manichaeism.[18] These arguments, whatever their specifics, all suggest that these regions had a longstanding connection with educational institutions in the history of Islamic civilization. The construction of *madrasa'*s as official governmental institutions, which began in the tenth century with the Kara Khanate period, continued throughout the Ghaznawid, Great Seljuk, and Khwārazm-shāh periods. In sum, between the tenth and twelfth centuries, and before the Mongol invasions, numerous *madrasa'*s were built in Transoxiana and Khurāsān; thus education as a stable means of transferring information through generations was ensured.

*Madrasa'*s in these regions, like all the other civil institutions, were affected by the extensive destruction brought on by the Mongol invasions. In order to gain a better understanding of this devastation, one particular example should suffice: Before the Mongol invasion in 617/1220, there were 400 *madrasa'*s in Balkh; with the invasion, all of them were destroyed.[19] Although major activities for reconstruction began in the Īlkhānid period and many *madrasa'*s were built, the wounds clearly did not heal easily for a very long time. As a matter of fact, on his visit to Bukhara in 733/1333, the famous traveler Ibn Baṭṭūṭa stated that the mosques, *madrasa'*s, and market places were still in states of ruin; and similarly Balkh and Marw were destroyed.[20] The Kart Dynasty, which came to power after the Īlkhānids, continued to some extent with reconstruction activity in various cities, primarily in Herat, and many *madrasa'*s were built. Tīmūr (who ended the Kart Dynasty by capturing Herat in 782/1381) and his successors carried on

[16] Barthold, *Ulugh-Beg*, p. 5. See also Sayılı, *Higher Education*, pp. 73–74.
[17] Maᶜrūf, *Madāris*, p. 8 and *ᶜUlamā'*, p. 56.
[18] Barthold, *Ulugh-Beg*, p. 5.
[19] Mirbabayev, p. 38.
[20] On Ibn Baṭṭūṭa, see Kattānī, pp. 408, 425. Barthold, *Turkestan* gives detailed information about the conditions of the cities in the Transoxiana and Khurāsān regions before the Mongol invasion, the extent of Mongol devastation of these cities, and the conditions after the invasion.

reconstruction efforts; besides building new institutions they also continued using the Kart institutions.[21]

Despite the destruction still evident in the territories he conquered, Tīmūr established many civil institutions as well as *madrasa'*s, particularly in his capital Samarqand and in other prominent centers like Herat and Bukhara. In fact, Tīmūr built a *külliyye* (a complex of buildings, such as a *madrasa*, hospice, library, etc., that was built around a mosque) in nearly every city.[22] Successive rulers (mīrzās, khānums, viziers, begs) and other prominent people continued this practice, which resulted in the rise of a new and centralized scholarly environment in the Samarqand, Herat, and Bukhara triangle. The research of Kishimjan Eshenkulova determined that the Tīmūrids built 69 *madrasa'*s: 50 in Transoxiana, 10 in Khurāsān, and 9 in other regions; these numbers are just from the available historical sources, so one may presume that they are lower than the actual number.[23] Among these *madrasa'*s, we should highlight two of particular significance: the Ulugh Beg *madrasa* in Samarqand (which is examined below) and the *madrasa* of Shāh Rukh in Herat (completion: 820/1417), where many important debates took place and from which the Sunnī faith was consolidated and spread. Moreover, in addition to the Samarqand *madrasa*, the *madrasa* Ulugh Beg established in Bukhara (completion: 820/1417) was noted for its high artistic value and became a model for the architectural characteristics of *madrasa'*s in Central Asia. According to the research of Eshenkulova, it was in this *madrasa*, which was decorated with astronomical figures over the arches and walls, that ᶜAlī al-Qushjī was a teacher for a period of time.[24] The Russian traveler N. Khanykov, who visited this *madrasa* in 1841-2, stated that it was fully active and functioning.[25]

III.1. *Construction and Development*

The Tīmūrid *madrasa* that holds an important place not only in Islamic civilization but also in the general history of philosophy and science is undoubtedly the Ulugh Beg *madrasa* that was built in Samarqand. Construction of the *madrasa*, situated in the center of the city, began in 820/1417 and was completed in 823/1420. The interior of the *madrasa* was decorated with geometrical figures; Dawlatshāh particularly emphasizes the high aesthetic value of the Samarqand *madrasa* and notes that it had one hundred students.[26] The *madrasa* continued its educational activities for many years. However, during an incident that occurred at the beginning of the eighteenth century, rebels who invaded the Samarqand Castle

[21] Uslu, "*Herat*."
[22] Yalçın, p. 111.
[23] Eshenkulova, pp. 49–81; cf. Valihocayev.
[24] Eshenkulova, p. 78.
[25] Barthold, *Ulugh-Beg*, pp. 119–120 (Turkish trans. p. 104).
[26] *Dawlatshāh*, p. 362 (Turkish trans. vol. 3, p. 429).

demolished the upper section of the *madrasa,* which was higher than the Castle. It was then used as a grain cellar until the middle of that century. In the nineteenth century (during the period of Amīr Ḥaydar [1799-1825]), instructional activities recommenced and have existed until our time, albeit with a great deal of change from what it once was.[27]

III.2. *The Road to Mathemata: The Scientists of Mathematics*

According to the findings from studies that began in the second half of the nineteenth century and have continued until the present, Ulugh Beg personally tested the teaching staff before they were allowed to teach in the Samarqand *madrasa*; those who passed the test successfully would join the teaching faculty.[28] Mawlānā Muḥammad Khwāfī was one of the applicants for such a position; he passed the test and became the first teacher of the *madrasa*. Interestingly, historical sources emphasize that, except for Ulugh Beg and Qāḍīzāde, none of the 90 teachers could understand Khwāfī's first inaugural lecture.[29] In his first letter to his father, Jamshīd Kāshī mentioned the names of Qāḍīzāde, Mawlānā Abū al-Fatḥ, and Mawlānā Muḥammad Khwāfī as the teachers of the *madrasa*;[30] sources also indicate that Ulugh Beg himself would give lectures in the *madrasa*. Besides being the tutor of Ulugh Beg, Qāḍīzāde was the head of the teachers in the Samarqand *madrasa*;[31] in other words he was the principal of the *madrasa*.[32]

Ulugh Beg would attend lectures on certain days of the week; on these days all the teachers and scholars would also be present.[33] Ulugh Beg especially wanted the lecture that he attended to be about the mathematical sciences, and he would debate in a way "beyond description"[34] (as Jamshīd Kāshī put it) with the teachers and the

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[27] Barthold, *Ulugh-Beg*, pp. 119–122.

[28] This information confirms what we find in Fatḥallāh al-Shirwānī; see the second part of this study.

[29] Barthold, *Ulugh-Beg*, pp. 120–121. With this lecture, Khwāfī wanted to prove his superiority over the other teachers and to demonstrate this in the presence of the Sultan.

[30] Bāqirī, pp. 41–42.

[31] *ŞN*, p. 16.

[32] In his first letter to his father, Jamshīd Kāshī clearly states that Mawlānā Muḥammad Khwāfī was the most prominent mathematician-astronomer in Samarqand when the *madrasa* was founded and consequently he was appointed as the first teacher of the *madrasa*. He was then surpassed by Qāḍīzāde (due to his diligence), who was appointed as the head-teacher in his place. In his turn, Qāḍīzāde was surpassed as the most knowledgeable mathematician by Kāshī after he arrived in Samarqand (see Bāqirī, pp. 42–43 and Bagheri, p. 246). But then this leads us to the following question: Although Jamshīd Kāshī was the more superior intellect, as historical sources and individual works testify, why did Qāḍīzāde continue to be both the tutor of Sultan Ulugh Beg and the head-teacher of the *madrasa*? Was this due to the dispositional closeness between the Sultan and Qāḍīzāde? Jamshīd Kāshī was known as a *ḥāsib* (calculator), but whether or not he possessed *geometrical wisdom* is not clear.

[33] This information confirms what we find in Fatḥallāh al-Shirwānī; see the second part of this study.

[34] Sayılı, *Uluğ Bey*, pp. 78, 91.

students; in short, many scientific discussions would take place among the Sultan, teachers, and the students.[35]

As stated below, there were many people in the teaching staff of the Samarqand *madrasa*; but among them the names that were especially prominent in the mathematical sciences were Jamshīd Kāshī, Qāḍīzāde, ᶜAlī al-Qushjī, Sayyid al-Munajjim, and Ulugh Beg himself. In addition to these, we know the names of Muᶜīn al-Dīn Kāshānī, Manṣūr Kāshānī, ᶜAlī Shīr Nawā'ī, ᶜAbd al-Raḥmān Jāmī, Fatḥallāh al-Shirwānī and ᶜAbd al-ᶜAlī al-Birjandī, who gave or attended lectures in this *madrasa*, or were somehow involved with it.[36]

III.3. *The Road to Learning: The Courses*

There is not much information about the *madrasa'*s of the Tīmūrid period regarding their teaching staff and its hierarchical structure, the organization of students, and the educational program in terms of courses and books that were taught. Pictures that have formed regarding the lives of active scholars of the Tīmūrid period are full of missing parts. The selection of subject matter by both the administrators and teachers further complicates this issue. For instance, the biographies (*ṭabaqāt*) and history books provide detailed information about the religious instruction in the *madrasa'*s in and around Herat, but give only general evaluations about the mathematical education. The situation is just the opposite for Ulugh Beg's Samarqand *madrasa*; the sources emphasize the mathematical readings of this *madrasa* but provide little regarding religious and literary studies. For example, we know from the biography of the renowned recitation (*qirā'a*) scholar Ibn al-Jazarī (who was taken by Tīmūr from the entourage of Sultan Bāyazīd I after the Battle of Ankara and brought to Tīmūrid territory) that the readings he gave were mostly on studies of *qirā'a* and *ḥadīth* (recorded sayings and customs of the Prophet Muḥammad) in the Kesh *madrasa* as well as in the *madrasa'*s of Bukhara and Herat.[37] In addition, the field of religious studies is also stressed in ᶜAlī Shīr Nawā'ī's 886/1481-2 *waqfiyya* (religious endowment) given in the Chagatai language,[38] in the *waqfiyya'*s of Khwāja ᶜUbaydallāh Aḥrār, and also in the diploma of a scholar named Jalāl al-Dīn al-Qāyinī.[39]

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[35] This information confirms what we find in Fatḥallāh al-Shirwānī; see the second part of this study.

[36] For these names, see Barthold, *Ulugh-Beg*, pp. 129–143; Sayılı, *Observatory*, pp. 265–268; Eshenkulova, pp. 87–90.

[37] Altıkulaç.

[38] Subtelny 1991.

[39] For an article that evaluates sources such as ᶜAlī Shīr Nawā'ī's *waqfiyya* and the *waqfiyya'*s of Khwāja ᶜUbaydallāh Aḥrār as well as the diploma of Qāyinī, see Subtelny-Khalidov.

IV. The Temple of Mathematical Wisdom: The Samarqand Observatory

In his letters to his father, Jamshīd Kāshī implied that Sultan Ulugh Beg established the Samarqand Observatory mainly as a result of having visited the Marāgha Observatory (founded by Naṣīr al-Dīn al-Ṭūsī in 657/1259) when he was a child.[40] As expressed above, it is my belief that Ulugh Beg's disposition contributed to his establishing the observatory; in ancient times, dealing with the mathematical sciences typically lead to the establishment of an observatory.[41] According to ancient theories, the language of mathematics belonged to the celestial region, which was made up of aether, moved with circular motion, had a soul and an intellect, and was immune from generation or corruption, whereas the sublunar region was formed of the four elements, moved in a linear fashion, and was subject to generation and corruption. Because of this, the processes in this celestial region were constant and could only be read using mathematical language, which was also rational because the celestial region had a correspondence with the intellects of human beings. This was the most important reason for astronomy having been included in the mathematical sciences in Mesopotamia, especially in the Sumerian-Babylonian-Chaldean heritage of science; in Mesopotamia this mathematical approach was in the form of arithmetic-algebra, whereas the Greeks demonstrated it more through the use of geometry. It is for the same reason that the Greeks regarded the sublunar region, which was a part of the natural world, as unreadable in terms of mathematics since it was a world of generation and corruption.[42] As a matter of fact, the Aristotelian classification of theoretical philosophy into high, middle, and low corresponded to an ontological division: cosmologically, the sublunar region was the realm studied in the natural sciences, which were the lowest sciences (*al-ᶜulūm al-adnā*), since they involved the lowest place; the celestial region was studied in the mathematical sciences, which were the middle sciences (*al-ᶜulūm al-awsaṭ*), since they involved the middle region between the lunar sphere and the highest (*aṭlas*) sphere; and the realm beyond the highest sphere was studied in metaphysics or the theological sciences, which were the highest sciences (*al-ᶜulūm al-aᶜlā* or *ᶜāliya*, since it was the realm of the Divine beyond the physical orbs.[43] For the reasons listed above, a

[40] Sayılı, *Uluğ Bey*, p. 80.

[41] For a general account of observatories in Islamic civilization, see Sayılı, *"Rasathane."* For detailed information, see Sayılı, *Observatory* and Abdullah O. Al-Omar's Arabic translation; the latter contains the actual passages in classical Arabic from the astronomical sources and works that Sayılı had originally presented in English translation.

[42] The language of the sublunar region, on the other hand, was logic because it investigated that which was unchanging (essence) as opposed to that which was changing.

[43] Conceptualizations of the celestial and sublunar regions greatly influenced the understanding of knowledge in ancient times inasmuch as the *subject* is the essential part (*jihat al-waḥdat al-dhātiyya*) of a science and every scientific branch examines its subject's substantial accidents (*al-aᶜrāḍ al-dhātiyya*). Within this framework, for instance, rational musical studies were regarded among the mathematical sciences not only because of the quantitative ratio between the sound and the string, but

mathematical worldview for the ancients inevitably demanded that an observatory be built for observations of the celestial region.[44] Moreover, determining the effects of the intelligent and active celestial region (*al-ajrām al-ᶜulwiyya*) on the passive sublunar region (*al-ajsām al-sufliyya*) according to the ancient cosmology—in other words, astrology—required knowledge of this region's language. Forecasting future events, such as in the science of meteorology, is also related to the celestial region and taking necessary precautions necessitated the knowledge of astronomy, i.e. the language of the celestial region.[45] Within this framework, historical sources note that the relationship between Ulugh Beg and his son ᶜAbd al-Laṭīf, who shared the same keen interest in astronomy, deteriorated as a consequence of an astrological forecast (*ṭālīᶜ*) that predicted that one of them would destroy the other; consequently, they both watched for this event and in the end ᶜAbd al-Laṭīf did kill his father.[46] Thus this kind of astrological motivation might also have contributed to

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also because they were seen as the embodiment or imitation of the sounds made by the objects that belonged to the celestial region. Similarly, *ᶜilm al-manāẓir* (optics), which mostly dealt with the theme of "light," was also regarded as a branch of mathematical, especially geometrical, science. The most important reason for this was because the source of light was the Sun, which was in the celestial region. In the end, everything that originated from the celestial region, even when they came down to the sublunar region, brought in a characteristic that could be spoken of with the language of mathematics.

[44] Because of these reasons, the answer to the question *why would an observatory be established in premodern times* also addresses the question *why would an observatory be destroyed*. From a modern perspective, this point may seem difficult to comprehend. In Islamic and other civilizations, most observatories were either directly destroyed or decayed from abandonment once certain circumstances and conditions ceased to exist. Therefore, it is necessary to understand what these *certain circumstances and conditions* were in order to begin understanding the reasons why observatories were either established or destroyed. Undoubtedly, these *certain circumstances and conditions* were rooted in understandings of ancient cosmology. Within this framework, observatories were a place in which the Platonist/mathematical wisdom was discussed and was considered a means to establish contact with the celestial region; therefore one could possibly regard them as *temples*—like mosques. Also one finds great significance in the role of astrology (insofar as it is involved in mathematical wisdom) and its relationship to the bureaucracies and conquest policies of individual states. Astrology caused certain conduct and therefore was a way to determine the possible effects of the celestial region on the sublunar region by means of mathematical depictions of the positions and relations within the celestial region; astrological determinations were a way to foresee the future by using these determinations. Finally one of the most important things to keep in mind as far as the observatories were concerned is that according to ancient cosmology the inhabitants of the celestial regions were active and possessed intellect and soul and, as a whole, had a special way of living that was peculiar to them. Observations of this life (through observatories) disturbed their privacy; they could get angry and this might lead to their rage towards the sublunar region, and this rage might cause bad (ominous) events to happen in the sublunar region.

[45] For these reasons, astrology in premodern times was an extremely important discipline as a military science, which was used by the Sultans for certain military projects. For detailed information on this, see Fazlıoğlu 2001a. Furthermore, sources indicate that Tīmūr also had the intention of establishing an observatory; see Sayılı, *Observatory*, p. 260.

[46] Barthold, *Ulugh-Beg*, pp. 141–143; Sayılı, *Observatory*, pp. 277–278; Ünver, p. 217.

the establishment of the Observatory. As Jamshīd Kāshī mentioned in his letters, the astronomical education given in the Samarqand *madrasa* and the discussions of the astronomical works of the time (primarily the *zīj*'s [astronomical tables] and theoretical studies) contributed to the establishment of such an observatory.[47] Jamshīd Kāshī refers to these matters in both of his letters and gives information and makes certain criticisms about the establishment of the Observatory and observational devices.[48]

IV.1. *Establishment and Adventure*

Sources suggest a number of different dates for the establishment of the Samarqand Observatory. Chronologically, the earliest date given among these is 823/1420 by ᶜAbd al-Razzāq Samarqandī and Ḥāfiẓ-i Abrū. Sayılı adopted this date as the generally accepted one in the sources.[49] Some authors suggest that the construction of the Observatory was started four years after the *madrasa*. The *madrasa* was built between 820/1417 and 823/1420. Therefore, if we use its completion date for the construction of the Observatory, it must have started in 827/1424; if we use the starting date, then construction must have commenced in 824/1421.[50] According to Bagheri, the Observatory was completed either in 825/1422 or 827/1424; he also has stated that Jamshīd Kāshī administered the observations for five to seven years until his death in 832/1429 and that the *Zīj* was completed in 841/1437.[51] On the other hand, Rukn al-Dīn Āmulī, who was an astronomer and contemporary of Ulugh Beg, noted that construction of the Observatory began in 830/1427 and that the observational activities went on for thirty years.[52] In the classical sources, it is emphasized that the establishment of the Observatory was completed under the administration of Ulugh Beg with the supervision of Jamshīd Kāshī.[53] The sources stress that the Observatory was actually administered by Ulugh Beg until his death but that first Jamshīd Kāshī and, after his death, Qāḍīzāde, and then, after the latter's death, ᶜAlī al-Qushjī were the administrators of the observational activities as the deputies of Ulugh Beg.[54] Only Dawlatshāh states that, upon the deaths of Jamshīd Kāshī and Qāḍīzāde (which happened before they finished their studies), Ulugh Beg completed the study; ᶜAlī al-Qushjī's name is not mentioned as an ad-

[47] Sayılı, *Observatory*, p. 272.
[48] Sayılı, *Uluğ Bey*, pp. 76, 80–81.
[49] Sayılı, *Observatory*, p. 271.
[50] Qurbānī, p. 8.
[51] Bāqirī, p. 10.
[52] Sayılı, *Observatory*, p. 270.
[53] Mīrkhwānd stated that the observatory was established under the supervision of Jamshīd Kāshī and Muᶜīn al-Dīn Kāshī (vol. 6, pp. 231–232).
[54] Samarqandī (pp. 45–46), in particular, stated that the *Zīj* was completed by ᶜAlī al-Qushjī.

ministrator of the activities.[55] Finally, almost all the sources state that the activities of the Observatory lasted for thirty years.[56]

In both his letters to his father, Jamshīd Kāshī wrote in detail about the Observatory as well as the construction of instruments; he also provided information about the *madrasa* and the teachers surrounding Ulugh Beg.[57] Many of Jamshīd Kāshī's statements imply that the *madrasa* was completed and that educational activities were being administered during the construction of the Observatory and observational instruments. All these inferences indicate that the construction of the Observatory was started after or just before the total completion of the *madrasa*; they also show that the completion date of the Observatory was definitely after the completion date of the *madrasa*. In any case, if the starting date of the *madrasa* was 820/1417, then the Observatory's starting date could be 824/1421; and if the completion date of the *madrasa* was 823/1420, then the Observatory's starting date could be 827/1424.[58]

IV.2. *The Picture of the Heavens:* Zīj-i Ulugh Beg

One of the most significant works in the history of science is undoubtedly the *Zīj-i Ulugh Beg* (Ulugh Beg's *Zīj*); this was a collaborative work of the Samarqand mathematical-astronomical school that was prepared in accordance with both the theoretical discussions that took place in the *madrasa* and the observations that were made at the Observatory. It is generally accepted that the work was initially prepared in Persian and then translated into Arabic and Turkish; however, according to Sayılı who agrees with Sarton, the *Zīj* may have originally been written in Turkish or Arabic.[59] The *Zīj* consisted of four sections bearing the titles: On Calendars and Dates; On Times; On the Positions of the Stars; and, On Astrology.

It is accepted that *Zīj-i Ulugh Beg* was completed in 841/1437 inasmuch as the positions of the planets specified within the *Zīj* tables start from 841/1437. ᶜAlī al-Qushjī also gave the starting date of the planetary tables as 841/1437 in his *Risāla dar ᶜilm al-hay'a*.[60] Although Barthold agreed with this date, he claimed that activities related to it continued until the death of Ulugh Beg in 853/1449, at which point the work was considered completed. In this regard, Barthold cited the part in the *Zīj* where the *Hijrī calendar* (the Islamic lunar calendar) and the Chinese calendar were compared with a starting date of the Shangyuan period as Tuesday, 8

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[55] *Dawlatshāh*, pp. 361–362 (Turkish trans., vol. 3, pp. 428–429).

[56] The activities of the Observatory continued after the death of Ulugh Beg due to his son ᶜAbd al-Laṭīf's interest in astronomy; however, they gradually diminished.

[57] Bāqirī, pp. 41–42; Sayılı, *Uluğ Bey*, p. 88.

[58] For detailed information regarding this matter, see Sayılı, *Observatory*, pp. 270–271. See also Eshenkulova, pp. 125–126.

[59] Sayılı, *Observatory*, p. 272.

[60] ᶜAlī al-Qushjī, *Risāla dar ᶜilm al-hay'a*, p. 27.

Shawwāl 847/28 January 1444.[61] Abū Ṭāhir Samarqandī also adopted and stated the generally accepted view that the *Zīj* was completed in 841/1437.[62]

Undoubtedly, many scholars both from the *madrasa* and the Observatory contributed to the *Zīj,* with Ulugh Beg being in the forefront. But Ulugh Beg mentioned three names specifically in his preface to the work, namely Jamshīd Kāshī, Qāḍīzāde, and ᶜAlī al-Qushjī (whom he refers to as "my virtuous son" and "my confidant"). Information has already been provided above on these three individuals with respect to the Observatory, their successive supervisions of observational activities, and the various interpretations regarding this. An additional important point that deserves attention is that in his *Sharḥ-i Zīj Ulugh Beg*, ᶜAlī al-Qushjī attributed the errors contained in the *Zīj* to Ulugh Beg.[63] This raises many issues regarding the preparation of the *Zīj* as well as the individuals who prepared it (which will be discussed further below).

With respect to the subsequent history of science in Islam, the *Zīj-i Ulugh Beg* was the most studied of its type and had the highest number of commentaries written on it. Among these commentaries, the most noteworthy are: the commentary written by ᶜAlī al-Qushjī; the *Dustūr al-ᶜamal fī taṣḥīḥ al-jadwal* written by Mīram Čelebī (d. 931/1525), who was the great grandchild of ᶜAlī al-Qushjī; and the *Sharḥ al-jadīd al-sulṭānī* written by ᶜAbd al-ᶜAlī al-Birjandī. In addition there are sizable numbers of other commentaries, *ḥāshiya'*s (annotations), *ikhtiṣār'*s (summaries), new compilations, and Arabic and Turkish translations.[64]

V. Ulugh Beg's Companions

As pointed out above, the Tīmūrid State ruled for 137 years over an Islamic civilization that was approximately seven hundred years old. Despite a changing political rule, continuity was maintained through the entire range of administrative and civil activity, including scientific activities. Moreover, Tīmūr was forcibly bringing in scholars from conquered territories.[65] Noteworthy among these scholars were Masᶜūd Taftāzānī and al-Sayyid al-Sharīf as well as Ibn al-Jazarī, Sirāj al-Dīn Muḥammad Ḥalabī and Ibn ᶜArabshāh. It is also clear that, in spite of the destructiveness of Tīmūr, his courtesy and attention towards the erudite resulted in certain

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[61] Barthold, *Ulugh-Beg*, p. 133. For discussions regarding this matter, see Sayılı, *Observatory*, pp. 271–272.

[62] Samarqandī, p. 46.

[63] Heidarzadeh 1997, p. 7 discussed this issue in detail and provided various comments with examples (pp. 44–49). However, the major problem with his discussion is that he accepted 840/1436 as Qāḍīzāde's date of death, agreeing with Hamid Dilgan and other researchers; see Dilgan, p. 227. The following pages of this study will show that this date is not accurate.

[64] For further information on the *Zīj-i Ulugh Beg*, see Aydüz and İzgi, vol. 1, pp. 414–420.

[65] Al-Sayyid al-Sharīf al-Jurjānī clearly states this fact in the introduction of his commentary, *al-Miṣbāḥ*, Istanbul, Süleymaniye Library, Turhan Valide Sultan MS 287, f. 1b.

scholars gathering around him of their own accord.[66] The scientific discussions that took place in the assembly of Tīmūr, especially the debates between Taftāzānī and al-Sayyid al-Sharīf, were famous among the *ᶜulama'*; Sheikh Badr al-Dīn (the son of the Judge [*qāḍī*] of Samāwnā), upon the request of Ibn al-Jazarī, attended such a gathering in Shiraz and provided his own judgments of the debates.[67]

In addition to its earlier, historical significance, the regions of Transoxiana and Khurāsān became the most prolific locales of science and scholarship in the Islamic world between the end of the fourteenth century and the beginning of the sixteenth. This was due to the special efforts made by Tīmūr and his successors in bringing scholars from conquered territories, and in educating many more at home by opening new institutions and libraries.[68] This region's *ᶜulama'* had inherited the legacy of the mathematical-astronomical school of Marāgha, especially the mathematical and philosophical tradition of Naṣīr al-Dīn al-Ṭūsī and Quṭb al-Dīn al-Shīrāzī, the wisdom (*ḥikma*) heritage of Ibn Sīnā, and the theology (*kalām*) scholarship of Fakhr al-Dīn al-Rāzī. As a result, many new scholars emerged such as Jalāl al-Dīn al-Dawānī, ᶜAbd al-Raḥmān al-Jāmī, ᶜAlī Shīr Nawā'ī, ᶜUbaydallāh Aḥrār, and Khwāja Pārsā—the fruit of the tension between al-Sayyid al-Sharīf and Taftāzānī.

Within the Tīmūrid State, the *ᶜulama'* settled in either Herat or Samarqand, two distinct cities (as noted above). Each city represented a different attitude; however, sometimes a combination of the two would be adopted that form a kind of meta-language. In Samarqand, Tīmūr advocated the approach of al-Sayyid al-Sharīf, whereas Ulugh Beg favored Qāḍīzāde; on the other hand, in Herat, Shāh Rukh preferred Taftāzānī.

Almost all of the sources, particularly Jamshīd Kāshī's two letters, indicate that Samarqand was full of scholars during the time of Ulugh Beg.[69] It is noteworthy that most of these scholars specialized in the mathematical sciences. Jamshīd Kāshī points out that there were sixty-seventy prominent mathematicians in Samarqand, and occasionally he provides detailed information about their levels and studies.[70] The sources mention the following as the first and second generation of scholars at the Samarqand mathematical-astronomical school: Mūsā Qāḍīzāde, Jamshīd Kāshī, Muᶜīn al-Dīn Kāshānī, his son Manṣūr Kāshānī, ᶜAlī al-Qushjī, Fatḥallāh al-Shirwānī, Sayyid Munajjim, ᶜAbd al-ᶜAlī al-Birjandī, as well as others.[71]

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[66] Ibn ᶜArabshāh (pp. 454–455) particularly emphasized Tīmūr's respectfulness and care towards the erudite.
[67] *ŞN*, pp. 51–52.
[68] Niẓām al-Dīn Shāmī, pp. 241–242, 287–288 (Turkish trans., pp. 289, 342–343); *ŞN*, pp. 43–44.
[69] Sayılı, *Uluğ Bey*, pp. 76, 78, 82, 91.
[70] Sayılı, *Uluğ Bey*, p. 78.
[71] For the scholars of the Tīmūrid period and their works, see Khwandamir, vol. 4, pp. 34–38 (English trans., part 2, pp. 369–371). See also Eshenkulova, pp. 87–90, 103–114, 130–142. Eshenkulova's study requires revision as some of the works mentioned are wrongfully attributed to certain scholars

VI. The Mathematical Sciences: People and Works

The mathematical sciences had a deep-rooted historical presence in the regions of Transoxiana and Khurāsān. The notable students of Quṭb al-Dīn al-Shīrāzī, particularly Kamāl al-Dīn al-Fārisī, and the students of many other scholars, such as Ibn al-Khawwām, Jamāl al-Dīn al-Turkistānī, ᶜImād al-Dīn al-Kāshī, and ᶜIzz al-Dīn al-Zanjānī, all of whom were educated in the Marāgha mathematical-astronomical school that Naṣīr al-Dīn al-Ṭūsī had established, sustained the region's dynamism in the mathematical sciences by traveling throughout these regions. Indeed, Qāḍīzāde, who had pursued his earlier education in the Anatolian city of Bursa but wished to advance further in the mathematical sciences, went to this region on the advice of his teacher Mullā Fanārī; in short, one can say that Qāḍīzāde immigrated to this region because he found his intellectual *place* (*wajada makānahu*).[72]

Furthermore, as mentioned above, Jamshīd Kāshī pointed to a similar situation in both letters he wrote to his father, emphasizing that there were sixty-seventy notable mathematicians in Samarqand about whom he provided information regarding their studies. In particular, Kāshī stated that at the time he was writing his letters some of these mathematicians were working on Sirāj al-Dīn al-Sajāwandī's *al-Tajnīs fī al-ḥisāb*, while some others were working on Shams al-Dīn al-Samarqandī's *Ashkāl al-ta'sīs*, and that some astronomers were working on Maḥmūd al-Jaghmīnī's *al-Mulakhkhaṣ fī al-hay'a*.[73] As stated above, such an advancement in the field of mathematical sciences had its origins in Ulugh Beg's personal disposition and kind regard towards these sciences; indeed, Jamshīd Kāshī in particular emphasized that Ulugh Beg had become proficient in the mathematical sciences and that he continued to improve.[74] Again, according to what Jamshīd Kāshī stated, Ulugh Beg would attend the lectures in the *madrasa* several days every week, each time asking the teachers to lecture on the mathematical sciences.[75] Moreover, Ulugh Beg would personally give lectures on Naṣīr al-Dīn al-

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and some of the information provided regarding the language and the content of certain works need to be corrected. For instance, the work that is attributed to Birjandī (the second part is meaningless since it is written incorrectly), the *Tezkire al-ahbab fi beyan al-attalâb(?)* (p. 111), is probably the *Tadhkira al-aḥbāb fī bayān al-tuḥābb* of Kamāl al-Dīn al-Fārisī, which was about number theory and was written as a supplement to his *Asās al-qawāᶜid fī uṣūl al-fawā'id* (Mawaldi 1994). Secondly, the *Şerhu't-tezkireti'n-nasiriyye fi'l-hey'e* (p. 131), which she attributes to Qāḍīzāde, is actually Birjandī's commentary on Naṣīr al-Dīn al-Ṭūsī's *Tadhkira*. Moreover, I have shown that *al-Risāla al-ṣalāḥiyya fī al-qawāᶜid al-ḥisābiyya,* which is also attributed to Qāḍīzāde (p.108), could not have been written by him; see Fazlıoğlu 1999c and 2001b. A final example concerns the language of a work: Birjandī's *Sharḥ al-Tadhkira* is not in Persian (p.138), but in Arabic.

[72] See *ŞN*, pp. 14–17.

[73] Sayılı, *Uluğ Bey*, p. 78.

[74] Sayılı, *Uluğ Bey*, pp. 77, 86. This information verifies the accuracy of Fatḥallāh al-Shirwānī; see the second part of this study.

[75] Sayılı, *Uluğ Bey*, pp. 77–78.

Ṭūsī's *al-Tadhkira fī ᶜilm al-hay'a* and Quṭb al-Dīn al-Shīrāzī's *al-Tuḥfa al-shāhiyya fī al-hay'a*.[76]

Jamshīd Kāshī provided significant information about the works that were subjected to research, which ones were emphasized, and the ones that were read as textbooks. The point to be noted is that their focus was on *mathematics*, and more importantly on *geometry*. In addition to the works mentioned above, the studies of Naṣīr al-Dīn al-Ṭūsī, i.e. the studies of the Marāgha mathematical-astronomical school, and in particular the so-called intermediate books *(al-mutawassiṭāt),* had significant places.[77] According to the information Jamshīd Kāshī gave, the following works were read in the Samarqand *madrasa*: Euclid's *Elements*, Ptolemy's *Almagest* and the *Recensions (taḥārīr)* that Naṣīr al-Dīn al-Ṭūsī wrote on these two works; the *Zīj-i Īlkhānī*, which was a collaborative production of the Marāgha mathematical-astronomical school; the notable commentaries by Niẓām al-Dīn al-Nīsābūrī and al-Sayyid al-Sharīf, which they wrote on the famous *al-Tadhkira fī ᶜilm al-hay'a* of Naṣīr al-Dīn al-Ṭūsī; Quṭb al-Dīn al-Shīrāzī's *al-Tuḥfa* and *Nihāyat al-idrāk fī dirāyat al-aflāk*; and, interestingly, Abū al-Rayḥān al-Bīrūnī's *al-Qānūn al-Masᶜūdī*.[78]

VII. The Impact of the Tīmūrids: A Path to Tranquility

Throughout the history of philosophy and science, knowledge preferred cities, where a certain tranquility to pursue learning was assured based upon material and spiritual security.[79] When this tranquility was breached, such as occurred upon the death of Ulugh Beg in Samarqand and that of Ḥusayn Bāyqarā in Herat, scientific activities were interrupted. One result, especially after the death of Ulugh Beg, was that the mathematical knowledge that was produced in the Samarqand *madrasa* and the Observatory came to be spread across several territories by various scholars as they immigrated; and in the end it affected many parts of the Islamic world including India, Egypt, and, especially, the Ottoman State. Upon Shāh Ismāᶜīl's rise to

[76] Ibid.

[77] For the term *mutawassiṭāt,* see İzgi, vol.1, pp. 294–297. The most important points to be noted about the meaning of this term can be listed as follows: (1) these works were given the name *mutawassiṭāt* (=intermediate works) because they were read in-between Euclid's *Elements* and Ptolemy's *Almagest;* (2) the *Mutawassiṭāt* consisted of approximately fifteen works, one of which belonged to the sons of Mūsā (Banū Mūsā), while all the others were produced in the school of Alexandria; (3) rather than the original Baghdad translations, the *Recensions* on them by Naṣīr al-Dīn al-Ṭūsī were mainly used; (4) all the works were on geometrical philosophy; in other words, the *mutawassiṭāt* can be regarded as introductory books for applied geometrical philosophy, i.e. Platonist philosophy.

[78] Sayılı, *Uluğ Bey*, pp. 82–83. The strong emphasis on astronomy in the education of the Samarqand mathematical-astronomical school is evident from the sixty-three astronomical works produced there; see Eshenkulova, pp. 130–142.

[79] Regarding this subject, see Fazlıoğlu 2001a, pp. 152–153.

power in Persia, this diffusion and immigration continued among the second and third generation students of the Samarqand mathematical-astronomical school, and they easily found recognition in those territories that shared a common scientific heritage. The effects of the scholars of the Samarqand mathematical-astronomical school and their works turned out to be permanent and long lasting, not only within Islamic civilization but also in the non-Muslim philosophical and scientific circles of Western Europe and India. In particular, the *Zīj-i Ulugh Beg,* the great collaborative work of the Samarqand mathematical-astronomical school, had an influence in Ottoman lands, India, China, and Europe.

One can trace the impact of the Samarqand mathematical-astronomical school in a variety of ways. Many people from various territories came to Samarqand to become students and, after completing their education, they returned to their own lands and started educating new generations by teaching in the local *madrasa'*s. Because of the turmoil that broke out after the death of Ulugh Beg and the rise to power of Shāh Ismāᶜīl, scholars took refuge in surrounding countries, primarily the Ottoman State, either by invitation or on their own initiative. Thus the works in the field of the mathematical sciences written by the scholars of the Samarqand mathematical-astronomical school were spread to places throughout the world. As far as the Ottoman Empire is concerned ᶜAlā' al-Dīn ᶜAlī al-Qočḥiṣārī and Fenarīzāde ᶜAlī Čelebī (d. 903/1498) are examples of scholars belonging to the first category.[80] Scholars becoming refugees (the second category) in the Ottoman State became a relatively common and continuous phenomenon, one that extended over a long period of time. Undoubtedly, the foremost examples of this within the field of the mathematical sciences were ᶜAlī al-Qushjī, Fatḥallāh al-Shirwānī, and ᶜAbd al-ᶜAlī al-Birjandī, who were from the second generation.[81] The best example for the third category is the entire history of philosophical and scientific activities after Samarqand: the products of mathematics and astronomy that were written by Jamshīd Kāshī, Qāḍīzāde, Sayyid Munajjim, ᶜAlī al-Qushjī, Fatḥallāh al-Shirwānī, and ᶜAbd al-ᶜAlī al-Birjandī affected not only the entirety of the Islamic territories but also Europe as well as the regions of India and China.

The fact that the classical Islamic works of philosophy and science spread throughout the various parts of the Islamic world, were collected in libraries, and were reproduced (and multiplied due to the many copyists) were other important

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[80] See *ŞN*, pp. 105–106, 181–185.

[81] For a detailed study into this matter, see Heidarzadeh 1998. Heidarzadeh's usage of the term *Iranian*, which is used throughout the article, is problematic as far as the period being examined is concerned, and it reflects a modern ideological point of view. Moreover, the author continually refers to Ottoman scholars as *Iranian*s even though there is no connection whatsoever; for example, see his discussion of Mīram Çelebī on p. 222 (no.13). In addition the author regards some Ottoman scholars as *Iranian*s who had visited *Iranian* regions for educational purposes and then returned to their homelands afterwards, which is also not in line with the title of the article (see pp. 218–219, etc.). Finally, in his list of scholars Heidarzadeh left out some prominent names, even though he actually includes them in his conceptualization of being *Iranian*.

outcomes of the Samarqand mathematical-astronomical school. Indeed, the libraries that were established by Shāh Rukh in Herat and by Ulugh Beg in Samarqand, as well as those of Bāysunghur and ᶜAlī Shīr Nawā'ī in Herat, were of great significance for Islamic civilization because of the works they possessed.[82] Some of these works would later be passed on to new territories by the scholars who fled an environment of turmoil.[83]

Many examples can be given of the effect of the Samarqand mathematical-astronomical school on the history of philosophy and science. With the aim of providing an indication for just how extensive this was, two very important examples will be discussed in this study. First, in his work entitled *Risālah-i mir'atiyya*, which was in the field of optics and written in Persian, Ḥasan al-Dihlawī (one of the students of Jalāl al-Dīn al-Dawānī who came from Shiraz to Istanbul during the period of Bāyazīd II) explained the optical features of a mirror which was sent by the scholars from Europe (*Franjastān*) to Khurāsān for examination.[84] This shows that the scientific level of the Transoxiana and Khurāsān regions were known in a wide range of territories. The second example is that the astronomical works produced in the Marāgha and Samarqand schools, especially the ones by Naṣīr al-Dīn al-Ṭūsī and ᶜAlī al-Qushjī, were translated into Sanskrit, and Indian scholars used these in order to compile the Ṭūsī-Qushjī version of Aristotelian-Ptolemaic astronomy. In particular, the following works were translated into Sanskrit and studied: the *Risāla dar ᶜilm al-hay'a* by ᶜAlī al-Qushjī; and the part of the commentary by ᶜAbd al-ᶜAlī al-Birjandī on Book II, Chapter 11 of Ṭūsī's al-*Tadhkira fī ᶜilm al-hay'a* that included Naṣīr al-Dīn's new model now called the "Ṭūsī-couple" and in which Birjandī discussed the views of other prominent astronomers such as Ibn al-Haytham and Quṭb al-Dīn al-Shīrāzī.[85]

VIII. Three Architects of the Framework: al-Taftāzānī, Qāḍīzāde al-Rūmī, and al-Sayyid al-Sharīf al-Jurjānī

When the curricula that were actually in effect in the Ottoman *madrasa'*s are examined, it is hard to say that there was a formal curriculum, that is one that had a framework determined by political authority with a uniform character. Instead, one sees that there was a flexible curriculum that was formed by the *ᶜulama'* through a

[82] See Subtelny-Khalidov, p. 213; Uslu 1997, p.41. For detailed information about the libraries of the Tīmūrid period, see also Humāyūn Farrukh.

[83] For instance, many of the preserved works in the Military Museum (*Askeri Müze Yazma Eserler Kataloğu*, Istanbul, n.d.), as well as some other works in various museums that contain manuscripts, were brought to Istanbul in this way; then, upon Sultan Meḥmed the Conqueror's personal request, they were reproduced through copying.

[84] This work has two versions. For the first version, see Istanbul, Süleymaniye Library, Aya Sofya MS 2463; for the second version, see Istanbul University, Farsca Yazmalar (Persian manuscripts) MS 946. See also İzgi, vol. 2, pp. 129–130.

[85] See Pingree 1978 and 1996 and Kusuba-Pingree.

historical process and determined by scientific consensus. Furthermore, it was possible to make adjustments according to the dictates of faith, jurisprudence, and disposition as well as the orientations of the political authorities.[86] One example is the curriculum mentioned in the *Kawākib-i sabᶜa* that was composed in 1155/1741 by an Ottoman teacher upon the request of the French government. The *madrasa* courses were arranged along the lines one finds in *Kitāb irshād al-qāṣid ilā asnā al-maqāṣid*[87] of Ibn al-Akfānī and *Miftāḥ al-saᶜāda wa-miṣbāḥ al-siyāda*[88] of Ṭāshkubrīzāde. According to this arrangement, the courses were divided into three main levels: for the beginner, abridgements *(ikhtiṣār)*; for the intermediate student, middle works *(iqtiṣād);* and, for the advanced, detailed works *(istiqṣā');* each of these was in turn divided into lower, middle and higher. The names of the works to be read were given under each of these subdivisions. When this division of *Kawākib-i sabᶜa* and the accepted views given above are taken into consideration, and the *curricula* of the Ottoman period *madrasa*'s as well as the lists of the works to be read are examined, it can be said that the names of Taftāzānī in the field of language studies, of al-Sayyid al-Sharīf in the fields of logic and theological sciences, and of Qāḍīzāde in the fields of geometrical-mathematical and astronomical sciences are most prominent.[89] In my opinion, as will be pointed out below, this picture of the curriculum in the Ottoman *madrasa*'s had been drawn, to a large extent, within the Tīmūrid State and afterwards passed on to Istanbul by the hands of ᶜAlī al-Qushjī and Fatḥallāh al-Shirwānī.

VIII.1. *Saᶜd al-Dīn Masᶜūd Taftāzānī: Herat*

As the student of ᶜAḍud al-Dīn al-Ījī (d. 756/1355) and Quṭb al-Dīn al-Rāzī (d. 766/1364), Saᶜd al-Dīn Masᶜūd Taftāzānī (d. 792/1390),[90] who was inclined towards the Ḥanafī school in jurisprudence and Māturīdism in faith, produced many works in various fields; however, he was mostly regarded as a linguist, methodologist and an intermediate-level theologian in Ottoman *madrasa*'s. Since he did not have students at the advanced level, his influence was mostly through the dissemination of his works. Taftāzānī, who had almost no works in the fields of mathematics or philosophy, was not favored by Tīmūr. As noted above, Shāh Rukh, upon becoming the ruler of the Tīmūrid State, transferred the capital from Samarqand to Herat, where he established a large *kulliyya* (college) to which he appointed *ᶜulama'* representing the Sunnī as opposed to the Shīᶜī faith. Because of his responsibilities as leader of the State, Shāh Rukh decided to follow a different political path from that of his father and rather than al-Sayyid al-Sharīf (who was

[86] For detailed information see Fazlıoğlu, Ş 2003b, p. 213.
[87] See Ibn al-Akfānī, *Irshād al-qāṣid.*
[88] See Ṭāshkubrīzāde, *Miftāḥ.*
[89] İzgi, vol.1, pp. 67–108,163–178; Fazlıoğlu, Ş 2003a and 2003b, pp. 191–221.
[90] For Taftāzānī´s life, works, and scholarly perspectives, see Salāma and Madelung.

superior in the mathematical and philosophical sciences), he appointed Taftāzānī, who was engaged predominantly in language and religious studies. It was done in such a way that Taftāzānī, his children, and even his grandchildren assumed the position of *shaykh al-Islam* (the chief religious official) in Herat over the course of many years.[91] This scholarly preference persisted throughout the periods of Ḥusayn Bāyqarā and ᶜAlī Shīr Nawā'ī as well. Another interesting point to consider is Taftāzānī's attitude towards *ᶜirfānī* (religious and mystical) knowledge, especially the *taṣawwufī* (mystical) line of Ibn al-ᶜArabī. Because of the delicate situation, Shāh Rukh (despite his *ᶜirfānī* nature), supported the line of Taftāzānī, who was against the *waḥdat al-wujūd* (oneness of being), so much so that he wrote a refutation of Ibn al-ᶜArabī's *Fuṣūṣ al-ḥikam*. Again, because of the political situation in his realm, Shāh Rukh preferred the *Naqshbandī* order instead of other *taṣawwufī* approaches, inasmuch as it was more closely aligned with *sharīᶜa* (Islamic law) and was not involved with *ᶜirfānī* perspectives at that time. In accordance with the framework summarized above, the works of Taftāzānī that were read in the Ottoman *madrasa*'s were:

(a) *al-Muṭawwal* (the long, first *sharḥ*) and *al-Mukhtaṣar* (the short, second *sharḥ*) are two important commentaries that Taftāzānī wrote on the summary (*ikhtiṣār*) entitled *Talkhīṣ al-miftāḥ fī al-maᶜānī wa-'l-bayān.* This latter work, written by Jalāl al-Dīn Muḥammad b. ᶜAbd al-Raḥmān Qazwīnī (d. 739/1338), was based upon the third part of the *Miftāḥ al-ᶜulūm,* a linguistics work by Sirāj al-Dīn Abū Yaᶜqūb Yūsuf b. Abū Bakr al-Sakkākī (d. 626/1228) that included sections on rhetoric (*bayān*) and semantics (*maᶜānī*).[92] These two works of Taftāzānī, which were popular in the Ottoman *madrasa'*s and influential for the understanding of language among the Ottoman erudite, were translated into Turkish by Abdünnafi İsmet during the Tanẓīmāt period.[93] The author of the *Kawākib-i sabᶜa* stated that the *Talkhīṣ* was to be read at the beginning, the *Mukhtaṣar* at the intermediate, and the *Muṭawwal* at the advanced levels. As can be seen, Taftāzānī's works in rhetoric and semantics were taught at almost every level and sublevel.

(b) *al-Talwīḥ fī kashf ḥaqā'iq al-Tanqīḥ* is the *sharḥ* Taftāzānī wrote on another *sharḥ* entitled *al-Tawḍīḥ fī ḥall jawā'iz al-tanqīḥ,* written by Ṣadr al-Sharīᶜa ᶜUbayd Allāh b. Masᶜūd al-Bukhārī (d. 747/1347) on his own *Tanqīḥ al-uṣūl.* This *sharḥ* of Taftāzānī was in great demand and took its place among the most taught works of the *madrasa'*s; many Ottoman scholars wrote commentaries on it.[94]

(c) *Sharḥ al-ᶜAqā'id al-Nasafiyya* is the commentary that Taftāzānī wrote on Najm al-Dīn ᶜUmar b. Muḥammad al-Nasafī al-Samarqandī's (d. 537/1142) *al-*

[91] Subtelny-Khalidov, pp. 211, 213, 214.
[92] Kātib Čelebī, vol.1, cols. 473–479.
[93] Sadeddin Mesud b. Ömer et-Taftazanî, *Nef'u'l-muavvel tercemetu't-telhis ve'l-mutavvel*, I-II, translated by Abdünnafi İsmet (Bosnia-Istanbul, 1289-90/1872-3).
[94] Kātib Čelebī, vol.1, cols. 496–499.

ᶜAqā'id al-nasafiyya, which was a work written according to the tenets of Māturīdism.[95]

(d) *Sharḥ al-Maqāṣid*: This consists of a text Taftāzānī wrote in the field of theology (*kalām*) entitled *al-Maqāṣid fī ᶜilm al-kalām* and the commentary he wrote on it. Nasafī's *Matn al-ᶜaqā'id* and Taftāzānī's *Sharḥ* were taught at the beginning level in the *madrasa*'s, while Taftāzānī's *Sharḥ al-Maqāṣid* was taught at the intermediate level.[96] Therefore it can be said that *Sharḥ al-Maqāṣid* played an important role in the conceptualization of philosophy and science at the intermediate level of theology among Ottoman *ᶜulama'*.[97]

VIII.2. *Qāḍīzāde: Samarqand*

Ṣalāḥ al-Dīn Mūsā b. Muḥammad b. al-Qāḍī Maḥmūd al-Bursawī al-Rūmī (called Qāḍīzāde; died after 13 September 1440) grew up in Bursa, the capital city of the Ottoman *Beylik,* was a student of Mullā Fanārī (d. 834/1431), and undertook to be educated in mathematics and astronomy. He wanted to pursue a higher degree of scientific learning than that being offered in Ottoman-Turkish lands, which was still in a formative period. So with encouragement from Mullā Fanārī he traveled to the regions of Transoxiana and Khurāsān, in which rational and mathematical sciences were still relatively active pursuits within the framework of the mathematical and astronomical heritage of the Marāgha school.[98]

Qāḍīzāde was seen in Shiraz around 811/1408-9 and arrived at Samarqand around 814/1411-2. In Transoxiana, he took lessons from al-Sayyid al-Sharīf, but due to Qāḍīzāde's preference for mathematics, they fell into disagreement, and he stopped taking lessons with him. Al-Sayyid al-Sharīf was also a mathematician, but he was known to have said about Qāḍīzāde that "mathematics predominates in his nature"[99] by which he meant it ran contrary to the natural and theological methods in effect at the time. Qāḍīzāde had a more mathematical disposition, especially for geometry, and so he would actively seek the existing knowledge in that discipline. Indeed, Qāḍīzāde produced many works within the fields of mathematics (especially geometry), but he did not write any remarkable work within the fields of natural philosophy or theology, which clearly supports this contention.

As was pointed out above, upon meeting Ulugh Beg Qāḍīzāde became his tutor and was appointed to be the head-teacher of the Samarqand *madrasa*.

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[95] Kātib Čelebī, vol. 2, cols. 1145–1149.

[96] İzgi, vol. 1, pp. 72–73, 165.

[97] For the *sharḥ*'s and *ḥāshiya*'s of *al-Maqāṣid*, see Kātib Čelebī, vol. 2, cols. 1780–1781. Cf. ᶜUmayra.

[98] al-Sayyid al-Sharīf is said to have visited Bursa, and it was reported that instruction in the Ottoman *madrasa*'s was weak during these years, inasmuch as it was still in a developmental stage; see Gümüş, p. 89.

[99] *ŞN*, p. 16: "وقال السيد الشريف في حقه : 'غلب على طبعه الرياضيات' ".

According to the information given in the sources, he was put in charge of administering the observations after the death of Jamshīd Kāshī; and, after Qāḍīzāde's death, ᶜAlī al-Qushjī replaced him.

Qāḍīzāde was exposed to both *ᶜirfānī* (religious and mystical) and *burhānī* (scientific) approaches, both of which were vigorously pursued within Islamic civilization during this period, through Mullā Fanārī who combined the *kalāmī* (theological) line of Fakhr al-Dīn al-Rāzī and the *taṣawwufī* (mystical) *waḥdat al-wujūd* line of Ṣadr al-Dīn al-Qūnawī. Before that, there was also the mystical-theological approach represented by the first Ottoman *madrasa* teacher Dāwūd Qayṣarī, which was still to be found among Ottoman scholars of the time.[100] However, Qāḍīzāde's inclination was towards pursuing geometry and other mathematical sciences; therefore, he left for Transoxiana where he believed he would find the highest level of expertise in that discipline. In my opinion, the dispositional closeness between Ulugh Beg (who also had a mathematical inclination) and Qāḍīzāde played an important role in Ulugh Beg's high regard of Qāḍīzāde.

As Fatḥallāh al-Shirwānī stated in his work entitled *Sharḥ al-Tadhkira fī ᶜilm al-hay'a*, Qāḍīzāde encouraged his students to go to the Ottoman State. ᶜAlī al-Qushjī, who was one of his students, later came to Istanbul and became one of the most influential people in shaping the Ottoman scientific outlook. Fatḥallāh al-Shirwānī also came to Anatolia and disseminated the accumulated knowledge of the Samarqand mathematical-astronomical school in the *madrasa*'s of various regions. Although Qāḍīzāde himself did not live or pursue his scientific activities within Ottoman territory, he was regarded by Ṭāshkubrīzāde as one of the most significant Ottoman scholars and as belonging to its second group, i.e. those who flourished during the period of Sultan Murād I. The privileged position that was accorded him was a result of his contributions to Ottoman scientific life: the students he directed and the content of his work. Levels of proficiency for the curricula of the Ottoman *madrasa*'s, which were most likely determined by ᶜAlī al-Qushjī, were such that Qāḍīzāde's *Sharḥ Ashkāl al-ta'sīs* was considered an intermediate level textbook in geometry and his *Sharḥ al-Mulakhkhaṣ fī al-hay'a* became an intermediate level astronomy textbook.

The commentary entitled *Tuḥfa al-ra'īs fī sharḥ ashkāl al-ta'sīs* of Qāḍīzāde,[101] written on the *Ashkāl al-ta'sīs* of Shams al-Dīn Muḥammad b. Ashraf al-Samarqandī (d. 701/1302) and completed on 28 Jumādā al-awwal 815/ 9 September 1412 whereupon it was presented to Ulugh Beg, is his most signifi-

[100] For detailed information, see Fazlıoğlu 1998a, pp. 25–42.

[101] For the title, see Istanbul, Süleymaniye Library, Aya Sofya MS 2743, f. 31. See also Suwaysī. According to the report of Kātib Čelebī, Qāḍīzāde was writing a *ḥāshiya* on Naṣīr al-Dīn al-Ṭūsī's *Taḥrīr uṣūl al-handasa*; however, he managed only to reach the seventh section (*maqāla*).

cant work in terms of theoretical geometry.[102] This work, besides the technical content that concerns the history of geometry,[103] has some significant features:

(a) It was taught and studied as an intermediate level geometry textbook in the Ottoman *madrasa*'s for many years and numerous commentaries and supercommentaries were written on it.[104]

(b) It contains different approaches for understanding geometry that had been refined over the centuries in Islamic civilization.

(c) Since it contains some examples from Euclid's "geometrical algebra," it enabled the continuity of the tradition of using geometrical ("continuous") quantity (*al-ᶜadad al-muttaṣil*) to do algebra and arithmetic in Ottoman mathematics. Here, taking Qāḍīzāde's intellectual background into consideration, we should take note of one of his comments. He states that sciences like arithmetic (*ḥisāb*) and algebra were based on geometry (*handasa*) and adds: "Geometrical figures are based on geometrical quantity, namely on amounts (*maqādīr*); however transferring or translating the amounts into numbers is very easy."[105] Qāḍīzāde's statement shows that, given improvements that had occurred in number theory, he basically accepted that it was possible to make translations between quantities and numbers. Thus one could read Euclid according to the numerical/algebraic methods of al-Khwārizmī (d. ca. 850) and also read Khwārizmī's arithmetic and algebra according to Euclid's geometrical methodology.

(d) Besides providing basic geometrical concepts and theorems, it concisely explains geometrical theory and proof.

(e) As a textbook on geometrical logic at the intermediate level, it was used for instruction in Ottoman and other Islamic countries for centuries, and it determined the basic geometrical training of the *ᶜulama'* at the intermediate level.

(f) Another important feature of this work has, in my opinion, so far gone unnoticed. As will be stressed below in some detail, Qāḍīzāde was a Platonist. Indeed, many historical sources refer to him as "the Plato of the time" (*Aflāṭūn al-zamān*). Given this context, the question can then be asked: Why did many teachers in the Samarqand *madrasa,* and in particular Qāḍīzāde (according to Jamshīd Kāshī's letters), prefer dealing with this small work of Shams al-Dīn al-Samarqandī (which was then more than a hundred years old) when there were other, more significant works in the field of geometry?[106] Let us examine this question first from a linguistic point of view. The name of the work is made up of the words *ashkāl* and *ta'sīs,* which modern researchers have translated into English as *fundamental propositions*, in other words as *basic theorems/propositions*. But when compared with Euclid's work, it can undoubtedly be said that Samarqandī chose neither *all*

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[102] Kātib Čelebī, vol.1, col. 105.
[103] For a new study about the technical geometrical content of *Ashkāl al-ta'sīs,* see De Young.
[104] Kātib Čelebī, vol.1, col. 105; İzgi, vol.1, pp. 275–284.
[105] Qāḍīzāde, *Sharḥ Ashkāl al ta'sīs* (Suwaysī, pp. 35–36).
[106] De Young (p. 58) regards this situation as a mystery.

the basic geometrical theorems nor the *most* basic ones.[107] For these reasons, we are justified in reexamining the term *ashkāl.* We first note that it is the plural form of the word *shakl,* meaning theorem; however, inasmuch as ancient Euclidean geometry was a synthetic geometry, "creating a geometrical situation in accordance with certain required conditions" was also called a *shakl*.[108] Within this framework, *shakl* also means *form* or *image,* just as the analogous form ("image") in logic is called *shakl*. Moreover, the word *ta'sīs* cannot simply be translated as "basic." In my opinion, the most accurate translation of *ta'sīs*, by considering the word's other meanings such as "establishment," "facility," "institution," and "organization," is "the existent." To examine this point further let us see what Qāḍīzāde says in the introduction of his *Sharḥ* regarding both the *theoretical/conceptual* and the *practical*/*applied* aspects of geometry.

> فإن الهندسة ، مع متانة مسائلها ، ووثاقة دلائلها بحيث لا يأتيها الباطل من بين يديها ولا من خلفها ، علم يحتاج إليه الكملة المتفكرون في خلق السماوات والأرض من الحكماء ، والمهرة المتفنّنون للفتاوى من الفقهاء ، ولا يستغني عنه العملة من أصحاب الديوان وأرباب دار القضاء ، إذ لا يتيسّر بدونه الارتقاء في مدارج السماء ، والإحاطة بحال المسالك والممالك على بسيط الغبراء ، ويتعسّر على فاقده الإقامة على رعاية المنصفة بين الشركاء في الأنصباء /.../ غير أنّ فيه إجمالاً يفتقر إلى مزيد <من> تفصيل ، وأعمالاً من تنبيه وتعليل ، وإخلالاً لطريقة من المنهج القويم والصراط المستقيم ، أعني طريقة شيخ الصناعة ، وإمام الجماعة ، الألمعي السري ، أقليدس الصوري...[109]
>
> Since geometry [deals] with serious matters and its proofs are reliable—whereby nothing untrue comes from it, either within itself or from what issues from it—all philosophers who inquire into the creation of the Heavens and the Earth are in need of it; experts among the legal scholars [*fuqahā'*] [need it] in issuing legal opinions [*fatāwā*]; and officials in government offices [*dīwān*] and those in charge of the courts [*dār al-qaḍā'*] cannot do without it. For it is not easy without [geometry] to ascend the stairs to Heaven [*al-samā'*=celestial region], or to grasp the situation of the roads and countries on the surface of the Earth. People who lack its

[107] De Young (p. 61) rhetorically asks: according to which criterion are Samarqandī's theorems the *basic* ones?

[108] For detailed information on this point, see Fazlıoğlu 2002.

[109] Qāḍīzāde, *Sharḥ Ashkāl al-ta'sīs* (Suwaysī, pp. 31–32).

> knowledge find it difficult to undertake overseeing the distribution of shares among partners. /.../ However it [i.e. *Ashkāl al-ta'sīs*] contains a summary and does not include many details, nor guidance and explanation; it violates the proper methodology and the straight path, I mean the method of the master of the discipline, the leader of the [mathematical] community, the sagacious, the eminent—Euclid of Tyre...

In summary, by keeping in mind that Euclid's *Elements* was also basically written as an introduction to the philosophy of Plato, the name of Samarqandī's work can be translated as the *Basic forms of the existent*. Such a translation not only shows the purpose of the work as indicated by its author, but it also points to the Platonist philosophy. Indeed, the most important feature of Shams al-Dīn al-Samarqandī's *Ashkāl al-ta'sīs*, as indicated by its name, is that it examines the basic geometrical forms (*ashkāl*) that are considered to represent the world of the existent (*al-ta'sīs*). Thus this work was prepared as an introduction to the idea of geometrical existence, namely the Platonist philosophy as it had developed in the Islamic world. It was on account of its cosmological perspective based on geometrical forms that it was prominent in the Samarqand *madrasa* and a commentary was written on it by Qāḍīzāde.

Samarqandī applied this conceptualization that had determined the framework of the *Ashkāl al-ta'sīs* to theology in his work entitled *al-Ṣaḥā'if al-ilāhiyya*.[110] He later wrote a commentary on it called *al-Maᶜārif fī sharḥ al-ṣaḥā'if*. Thus Samarqandī can be seen as the founder of the movement in the Islamic world that may be called "geometrical theology."[111]

Qāḍīzāde's geometrical approach in his *Sharḥ Ashkāl al-ta'sīs* is evident in the commentary he wrote and presented to Ulugh Beg in 814/1412. Entitled *Sharḥ al-Mulakhkhaṣ fī ᶜilm al-hay'a,* this is a commentary on the work of Maḥmūd b. ᶜUmar al-Jaghmīnī al-Khwārizmī (d. ca. 619/1221) called *al-Mulakhkhaṣ fī al-hay'a al-basīṭa,* which was intended as a textbook that summarized contemporary astronomy.[112] The commentary by Qāḍīzāde was used as an intermediate level astronomical textbook in the Ottoman *madrasa*'s.[113] Eleven Ottoman astronomers–

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[110] Istanbul, Süleymaniye Library, Şehid Ali Paşa MS 1688.

[111] What I mean here is that both Shams al-Dīn al-Samarqandī and Qāḍīzāde had a dual agenda in their work. Adopting geometry as a way of wisdom for determining the truth of the object is the hidden/esoteric aspect of this double agenda, while the practical/applied and even rationalistic aspects, which are important for people who do not adopt the language of geometrical wisdom, is the more manifest/useful part of their agenda. Indeed, Samarqandī himself stated that he had written his treatise (*risāla*) as an *introduction* and a *tool* for the arithmetical sciences and that it was based on the basic theorems he had chosen from Euclid's book, which were constructed from fundamental/basic theorems/propositions; see Qāḍīzāde, *Sharḥ Ashkāl al ta'sīs* (Suwaysī, p. 36).

[112] Kātib Čelebī, vol. 2, col. 1819.

[113] Istanbul, Süleymaniye Library, Aya Sofya MS 2662, f. 71, copied from the author's autograph.

three of whom are anonymous–wrote supercommentaries or glosses on Qāḍīzāde's commentary, among which the most famous was the one written by ᶜAbd al-ᶜAlī al-Birjandī, who was from the second generation of the Samarqand mathematical-astronomical school; this was an advanced level textbook for instruction in the Ottoman *madrasa*'s.[114]

Jaghmīnī's work was in the tradition of Ibn al-Haytham's *Hay'at al-ᶜālam* and Naṣīr al-Dīn al-Ṭūsī's *al-Tadhkira fī ᶜilm al-hay'a*. The most important characteristic of these works is that they discuss astronomy both in purely mathematical terms, as in Ptolemy's *Almagest,* and in physical terms as it was dealt with in Aristotle's *De Caelo* and *Metaphysics* as well as by Ptolemy himself in the *Planetary Hypotheses*, written during the last years of his life. In accordance with his mathematical and geometrical orientation, Qāḍīzāde argued with Jaghmīnī in this commentary as he did with Samarqandī in the *Sharḥ Ashkāl al-ta'sīs*. Thus in the introduction of his commentary, he analyzed Jaghmīnī's statements according to his mathematical orientation:[115]

{إنيّ ألّفت هذا الكتاب} في بيان {هيئة} لبسائط الأجسام {العالم} وهو ما يعلم به الشيء غلب فيما يعلم به الصانع تعالى من الجواهر والأعراض ، ويمكن أن يكون المراد بهيئة العالم علم الهيئة الذي يبحث فيه عن أحوال الأجرام البسيطة العلوية والسفلية من حيث الكمّية والكيفية والوضع والحركة اللازمة لها وما يلزم منها ؛ وإنّما أطلقنا القول في البسائط السفلية لأنّ المتأخرين ومنهم المصنّف تعرّضوا لها مطلقاً، وإن لم يتعرّض صاحب المجسطي منها إلاّ لكرتي الأرض والماء معاً تذكرة ما يتذكّر به .[116]

In his commentary on the statement by the author—"I wrote this book in order to explain the world's system (*hay'a*)"—Qāḍīzāde interpreted the word *hay'a* as the components of the world and stated that by the phrase *hay'at al-ᶜālam* was meant the science of *hay'a* that "investigates the states of the simple bodies, both superior (*ᶜulwiyya,* i.e. celestial) and inferior (*sufliyya,* i.e. sublunar) in terms of quantity, quality, condition and movement..." He also stated that he was leaving aside a detailed examination of the inferior, simple bodies, inasmuch as the recent [i.e. Islamic] astronomers, including Jaghmīnī, had already done so. On the other hand, he noted that Ptolemy only dealt with the inferior bodies to the extent of the sphericity of the Earth and water. Beliefs regarding the inferior existents differed

[114] See İzgi, vol. 1, pp. 370–392.

[115] In the Arabic text, the expressions in curly brackets belong to the original author and the statements following them belong to the writer of the commentary.

[116] *Sharḥ al-Mulakhkhaṣ li-'l Jaghmīnī,* Istanbul, 1290 H., p. 4. Cf. Istanbul, Süleymaniye Library, Fatih MS 3403, ff. 2b–3b for a good manuscript copy of Qāḍīzāde's *Sharḥ al-Mulakhkhaṣ*.

from author to author, whereas mathematical truths peculiar to the celestial region did not differ. Furthermore, since the ultimate goal of astronomy was investigating *al-ajrām al-ᶜulwiyya* [the celestial region], it was not appropriate to deal with sublunar, physical objects, namely *al-ajsām al-sufliyya.* Investigating composite bodies in the sublunar realm was also not of great value within the framework of astronomy except for such cases as the sphericity of the Earth.[117]

While commenting on Jaghmīnī's text, Qāḍīzāde elsewhere emphasized this viewpoint:

> {مقالتين} يبحث في إحديها عن أحوال الأجرام العلوية وفي الأخرى عن أحوال البسائط السفلية ، ولا يخفى وجه الحصر فيها .[118]
>
> {(in) two parts} In one of them, he investigates the circumstances of the higher bodies [or celestial region: *al-ajrām al-ᶜulwiyya*] and in the other part the circumstances of the lower [*al-sufliyya*], simple bodies [i.e. the elements of the sublunar regions]. The limitations inherent [in the second] are well-known.

Qāḍīzāde thus defined the structure of objects in the sublunar region in a Platonist, i.e. geometrical way, and designated them as mathematical objects. He then reiterated that the emphasis should be on the celestial realm in the science of astronomy:

> {المقدمة في أقسام الأجسام} الطبيعة التي هي جواهر يمكن أن يفرض في كل منها خطوط ثلاثة تقاطع على زوايا قوائم[119] . وقد يطلق الجسم على مقدار يمكن أن يفرض فيه الخطوط المذكورة ويسمّى جسماً تعليمياً {على الإجمال} إذ بيانها على التفصيل متعذّر ، ولأنّ تفصيل الأجرام العلوية هو المقصد الأقصى في هذا الفنّ فلا يناسب أن يذكر في المقدمة.[120]
>
> {The introduction concerns the divisions of the bodies} In any nature that is a substance, one may assume there are three lines intersecting each other at right angles. "Body" may be used to designate an amount [geometrical quantity] in which the above-mentioned lines can be assumed; it may then be called a mathe-

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[117] Nevertheless, a separate section on the *configuration* of the Earth, *hay'at al-arḍ,* distinguished Islamic from Greek astronomical works; see, Ragep 1993, vol. 1, p. 38.

[118] Qāḍīzāde, *Sharḥ al-Mulakhkhaṣ*, p. 5.

[119] < قائمة >

[120] Qāḍīzāde, *Sharḥ al-Mulakhkhaṣ*, p. 5.

> matical body. {in general.} Since it would be difficult to explain [the bodies] in detail and since the ultimate goal of this science is the details regarding the celestial bodies [*al-ajrām al-ᶜulwiyya*], it is therefore inappropriate to go into these details in the introduction.

Qāḍīzāde advocated a geometrical approach as indicated by his adoption of Plato's definition of body as found in the *Timaeus*. He thus was disturbed that the astronomy of his time seemed to be veering away from a purely mathematical astronomy. For example, the position favored by Ibn Haytham was a synthesis of the perspectives of the natural philosopher and the mathematician,[121] a position also represented in the works of Jaghmīnī and Naṣīr al-Dīn al-Ṭūsī. That he found this a troubling development is indicated by Qāḍīzāde in the introduction of his *Sharḥ al-Mulakhkhaṣ*:

> (...) وأنه في زماننا هذا قد اندرس مدارس العلوم الحقيقية ومعالم التعليم لا سيّما الرياضي من بينها ؛ فإنّ رياضها قد ظلّت ناضبة الماء ، ذاهبة الرواء ، مصفرة النجوم والأزهار ، ومغبّرة الأرجاء والأقطار . قد اتخذه القوم ظهرياً وظنّوه شيئاً فرياً وطالبوه كالحبارى في الصحارى لا يهتدون إلى منازله سبيلاً ، ولا يجدون إلى جداوله مرشداً ودليلاً . فقلت لهم يا معاشر الإخوان إنيّ آنست ناراً في بوادي هذه الفنون ، آتيكم منها بخبر وقبس ، لعلّكم تصلحون . [122]
>
> In our time, the schools [*madrasa*'s] of the true sciences and the places of instruction, especially mathematical, have been eliminated. Mathematics remains dried up, its freshness gone, its stars and luminaries faded, its neighborhoods and lands deserted. People used it in a superficial way and supposed that it was something slanderous. They sought it, as if it were an imprint in the desert: they could not discover the path to its home nor find an advisor or guide to its registers. So I said to them: O my brothers! I have discerned the flame in the deserts of these [mathematical] sciences, and I bring you knowledge and a firebrand, in hopes that you will be reformed.[123]

These statements by Qāḍīzāde are clearly geared for Ulugh Beg for whom this work was written. As mentioned above, Ulugh Beg was inclined towards the

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[121] See Ibn al-Akfānī, p. 80.
[122] Qāḍīzāde, *Sharḥ al-Mulakhkhaṣ*, pp. 2–3.
[123] Also see Istanbul, Süleymaniye Library, Fatih MS 3403, f. 1b.

mathematical sciences and his school (*madrasa*) was the major center of the time for the study of these sciences. Therefore, what Qāḍīzāde intended by his remarks was that the mathematical attitude (and for him this was geometrical) no longer existed or at least it was not considered to be that important in the *madrasa*'s within the overall territory in which they lived. These statements can be viewed as complaints about the current situation and as voicing concern to Ulugh Beg. Qāḍīzāde gave Ulugh Beg the nickname *Mughīth* (the one who helps) and described him as *Mughīth al-milla wa-'l-ḥaqq wa-'l-dīn* (the one who helps the community, Truth, and religion,[124] and as *Mughīth al-ḥaqq wa-'l-dunyā wa-'l-dīn* (the one who helps Truth, the world, and religion).[125] This metaphorical description can be rephrased as "the person who helps mathematical wisdom recover from its existing condition." In light of the fact that Qāḍīzāde wrote and presented both *Sharḥ Ashkāl al-ta'sīs* and *Sharḥ al-Mulakhkhaṣ* to Ulugh Beg in 815/1412 (the year he arrived in Samarqand), it should be clear that he came to Samarqand with this perspective and then became close to Ulugh Beg because of their shared values; it was thus an easy step to invite the ruler to *salvation* through the mathematical sciences.

As we have stated in an earlier study, this approach of Qāḍīzāde can be better understood by examining the efforts of his student ᶜAlī al-Qushjī to undermine the natural philosophy aspect of Ibn al-Haytham's synthesis. Qushjī did this through his own works, the astronomical textbook *al-Fatḥiyya fī ᶜilm al-hay'a* and his theological commentary *Sharḥ al-Tajrīd fī ᶜilm al-kalām*, and by placing his *al-Fatḥiyya* and his teacher Qāḍīzāde's *Sharḥ al-Mulakhkhaṣ* into the curriculum of Ottoman *madrasa*'s; these latter two works complemented one another in promoting a mathematical perspective.[126]

VIII.3. *al-Sayyid al-Sharīf al-Jurjānī: Herat + Samarqand = Istanbul*

ᶜAlī b. Muḥammad, also known as al-Sayyid al-Sharīf al-Jurjānī, was taught by Quṭb al-Dīn al-Rāzī, as Taftāzānī had been, and then in Cairo by Rāzī's students Mubārakshāh and Akmal al-Dīn Bābartī (d. 786/1384). He traveled to Herat, Damascus, Aqsarāy (in Anatolia), and Cairo. After ten years of education in Cairo, he went to Bursa in Anatolia and then to Shiraz; upon Tīmūr's capture of Shiraz, he was forcefully sent to Samarqand (789/1387). He stayed in Samarqand until the death of Tīmūr (807/1405); here he participated in many scientific debates with the Transoxiana *ᶜulama'* around Tīmūr, especially with Taftāzānī. During his eighteen

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[124] Qāḍīzāde, *Sharḥ al-Mulakhkhaṣ*, p. 4.
[125] Qāḍīzāde, *Sharḥ Ashkāl al ta'sīs* (Suwaysī, p. 33).
[126] For the life, works and ideas of Qāḍīzāde, see İ. Fazlıoğlu 1999c and 2001b. Also see: *ŞN*, pp.14–17; Mehmed Tahir, vol. 3, p. 291; Süreyya, vol. 4, p.520; İsmail Paşa, vol. 2, p. 480; Dilgan; Salih Zeki, vol.1, pp.133–139, 186–190; İzgi, vol.1, pp. 275–285, 370–388; *OALT*, vol.1, pp. 5–21; *OMALT*, vol.1, pp. 3–18.

years of residence in Samarqand, he not only wrote works of great significance but also educated hundreds of students. Upon Tīmūr's death, he returned to Shiraz, where he was engaged in writing and instruction until his death on 6 Rabīᶜ al-thānī 816/7 July 1413.[127]

Al-Sayyid al-Sharīf lived at the time of the well-known scholars Ibn Khaldūn in the Maghrib, his classmate Mullā Fanārī in Bursa in the Ottoman State, and his rival Taftāzānī in Tūrān and Iran. While his contemporaries stood out in specific fields, he was a scientist who proved himself competent, and almost at the same level of proficiency, in both the rational (*ᶜaqlī*) and revealed (*naqlī*) sciences. The scientific framework or paradigm he developed in his works and passed on to his students continued in the Ottoman lands, in Tūrān and in Iran, and remained almost unrivalled for five hundred years.[128] Successive generations knew him by the nickname *Sayyid al-Sanad* (the authoritative Master), and he was given the title *Ustādh al-bashar wa-'l-ᶜaql al-ḥādī ᶜashr* (the teacher of humanity and the eleventh mind) by the prominent figures of his time. Here the question one might ask is: What made al-Sayyid al-Sharīf unique and exceptional?

I believe that the most significant feature of the framework constructed by al-Sayyid al-Sharīf was that it provided roles for insights from a variety of sources that had developed over a long historical process within Islamic civilization, namely *kalāmī* (theological), *ṭabiᶜī* (natural philosophical/physical), *riyāḍī* (mathematical), and *ᶜirfānī* (religious and mystical).[129] On this basis, al-Sayyid al-Sharīf could be a bridge between the Marāgha mathematical-astronomical school and that of Samarqand, thus maintaining continuity for both science and other forms of wisdom. Indeed, within the Islamic world at the end of the fourteenth and beginning of the fifteenth centuries, he re-initiated studies of science by writing voluminous, high-level, and important commentaries (*sharḥ*'s) and glosses (*ḥāshiya*'s) on several important works such as *al-Tadhkira fī ᶜilm al-hay'a* by Naṣīr al-Dīn al-Ṭūsī (the founder of the Marāgha mathematical-astronomical school) and *al-Tuḥfa al-shāhiyya fī ᶜilm al-hay'a* by Quṭb al-Dīn al-Shīrāzī (a very important member of the same school) as well as *al-Mulakhkhaṣ fī ᶜilm al-hay'a al-basīṭa* of Maḥmūd al-Jaghmīnī, who was important in continuing the traditions of Ibn al-Haytham's *ᶜilm al-hay'a* (astronomy) and Euclid's *Elements*. Moreover, what is remarkable about al-Sayyid al-Sharīf is that he became proficient in the mathematical sciences at such a high level that he could enter discussions with Jamshīd Kāshī, one of the greatest mathematicians and astronomers in the history

[127] For information about al-Sayyid al-Sharīf's life, teachers, students, works, with details from classical sources, see Gümüş.

[128] This fact can best be exemplified by the diplomas, starting in the fifteenth century, that indicate al-Sayyid al-Sharīf as one of the most significant links in the chains of authority.

[129] At this point it should be remembered that al-Sayyid al-Sharīf was a *Naqshī* member, following Khwāja ᶜAlā' al-Dīn ᶜAṭṭār al-Bukhārī (d. 802/1400) who was one of the prominent *caliph*s of Shaykh Bahā' al-Dīn Naqshband (d. 791/1389). Al-Sayyid al-Sharīf personally took *taṣawwuf* lessons from Khwāja ᶜAlā' al-Dīn and experienced the pleasure of *ᶜirfānī* wisdom in his presence.

of science.[130] In addition to these, some of the *ḥāshiya*'s he wrote became masterpieces in the fields of theology and logic in the Ottoman State, Tūrān and Iran, such as the *ḥāshiya*[131] he wrote on *Taḥrīr al-qawāᶜid al-manṭiqiyya fī sharḥ al-shamsiyya*, which was the *sharḥ* his teacher Quṭb al-Dīn al-Rāzī wrote on *al-Shamsiyya fī al-manṭiq* by Najm al-Dīn al-Qazwīnī, and the *ḥāshiya*[132] he wrote on the *Sharḥ* that was also written by his teacher Quṭb al-Dīn al-Rāzī on Sirāj al-Dīn Maḥmūd al-Urmawī's (d. 682/1283) *Maṭāliᶜ al-anwār fī al-ḥikma wa-'l-manṭiq*. In addition, the texts, *sharḥ*'s, and *ḥāshiya*'s he wrote in the fields of linguistics, religious studies, and theology were widely influential in the Islamic world.

The scientific worldview of the Tīmūrids was split between Herat and Samarqand, between Taftāzānī and Qāḍīzāde, but there was a metaphysical unity that somehow united them. This unity was provided by al-Sayyid al-Sharīf who imperceptively surrounded both cities and both towering figures, bringing them within this larger framework. The content and works of this scientific worldview were passed on to Istanbul by ᶜAlī al-Qushjī, Fatḥallāh al-Shirwānī, and many other school members. The Ottomans constructed a hierarchical composite, which included both Taftāzānī and Qāḍīzāde, and by extension ᶜAlī al-Qushjī. In this composite every aspect was studied on a variety of levels; however, al-Sayyid al-Sharīf and his work *Sharḥ al-Mawāqif fī ᶜilm al-kalām* occupied top positions in this hierarchy. This commentary, written by al-Sayyid al-Sharīf in 807/1404 in Samarqand, was one of the works meant to be read at the advanced [*istiqṣā'*] level in the Ottoman *madrasa*'s. It thus became one of the most significant works that determined the theological, philosophical, and scientific perspectives at the advanced level for the Ottoman *ᶜulama'*. As an indication of its importance, we note that approximately forty Ottoman scholars wrote glosses (*ḥāshiya*'s) on this *Sharḥ* of al-Sayyid al-Sharīf.[133] This commentary, even today, is recognized as one of the classic works of theological philosophy and science in the Islamic world.[134]

PART TWO: *Fatḥallāh al-Shirwānī as a Student of Qāḍīzāde*

In this part, I present an account of the life and works of Fatḥallāh al-Shirwānī, the student of Qāḍīzāde and a member of the Samarqand mathematical-astronomical school. He is of particular interest since, on the recommendation of his teacher, he conveyed his accumulated knowledge to the Ottoman State. Without going into details, I hope to provide a better understanding of the teaching process by bringing

[130] Kātib Čelebī, vol. 1, col. 223.
[131] Kātib Čelebī, vol. 2, col. 1063.
[132] Kātib Čelebī, vol. 2, col. 1716.
[133] For the *sharḥ*'s and *ḥāshiya*'s of *al-Mawāqif,* see Kātib Čelebī, vol. 2, cols. 1891–1894.
[134] For the text of *al-Mawāqif,* al-Sayyid al-Sharīf's *Sharḥ,* and the *Ḥāshiya*'s of Ḥasan Čelebī and Siyālkūtī, see Dimyāṭī.

forth his description of the authorization/diploma (*ijāza*) he received from Qāḍīzāde. I present below the texts of the lecture and the critical edition of his diploma and their translations. I then interpret the content of both the description and the diploma, and compare them with information that was previously available regarding this matter. Finally, I pose new questions raised by this pedagogical description and diploma with respect to the history of the Samarqand mathematical-astronomical school.

I. Fatḥallāh al-Shirwānī: His Life and Works

Fatḥallāh b. Abū Yazīd b. ᶜAbd al-ᶜAzīz b. Ibrāhīm al-Shābarānī al-Shirwānī al-Shamāhī was a member of the Samarqand mathematical-astronomical school and continued this school's tradition in theoretical astronomy through his published works. Besides being an astronomer and mathematician, he was a scholar-teacher who extended the Samarqand school's work in the mathematical sciences to the Ottoman State, particularly in Anatolia where he educated many students.

He was born around 820/1417 in the Shamāhī region of Shirwān, which is now within the borders of the Republic of Azerbaijan. His early education was given by his father; he then continued his education in Sarakhs and Ṭūs. In Ṭūs, he studied al-Sayyid al-Sharīf's *Sharḥ al-Tadhkira fī ᶜilm al-hay'a* with the Shīᶜī scholar Sayyid Abū Ṭālib. Around the middle of 839/1435, he went to Samarqand and in the Samarqand *madrasa* he studied the sciences of mathematics, astronomy, theology, and linguistics with Qāḍīzāde; he received his diploma on 15 Rabīᶜ al-thānī 844/13 September 1440. While a student, he seems to have been responsible for various astronomical activities, particularly the observations at the Observatory. With Qāḍīzāde, he studied Niẓām al-Dīn al-Nīsābūrī's commentary on Ṭūsī's *Tadhkira* (*Tawḍīḥ al-Tadhkira fī ᶜilm al-hay'a*), a work that we also know from al-Kāshī was intensively studied at the Samarqand *madrasa.* Clearly Ṭūsī's *Tadhkira* and its commentary tradition occupied an important place both in the *madrasa* and in Fatḥallāh al-Shirwānī's education.

While Shirwānī was in Samarqand, he also wrote a commentary on Jamāl al-Dīn Yūsuf ibn Ibrāhīm al-Ardabīlī's *al-Anwār li-aᶜmāl al-abrār*, a work on Shāfiᶜī jurisprudence and presented it to Ulugh Beg. After five years of education in Samarqand, he went back to Shirwān (844/1440) where he gave lectures in the *madrasa.* Later he took the advice of his teacher Qāḍīzāde and went to Anatolia towards the end of the rule of Sultan Murād II (1421-44, 1446-51). With the support of Çandaroğlu Ismāᶜīl Beg in Kastamonu, he gave lectures in the *madrasa*'s of that city. He taught *al-Tadhkira* to his students as well as the works of his teacher Qāḍīzāde on mathematics and astronomy. Among his many students, from Iran,

Turkistan, and Anatolia, were Muḥyī al-Dīn Muḥammad ibn Ibrāhīm al-Nīksārī[135] and Kamāl al-Dīn Masᶜūd b. Ḥusayn al-Shirwānī.[136]

Fatḥallāh al-Shirwānī went to Bursa in 857/1453 and dedicated a Qur'ān commentary (*tafsīr*) to the Ottoman Grand Vizier Çandarlı Khalīl Pasha. About the same time, he presented his work entitled *Majalla fī al-mūsīqī* to Sultan Meḥmed the Conqueror. However, after the conquest of Istanbul, the political situation changed and Khalīl Pasha was hanged; having lost his patron, Fatḥallāh al-Shirwānī went back to Kastamonu. After this incident, he wrote a supercommentary (*ḥāshiya*) entitled *al-Farā'iḍ wa-'l-fawā'id* to Qāḍīzāde's *Sharḥ al-Mulakhkhaṣ fī ᶜilm al-hay'a* and presented it to Sultan Meḥmed the Conqueror, as a way to get close to the Ottoman palace, but he was unsuccessful.

Shirwānī set off for the Ḥajj in 870/1465, with a stopover in Iraq; he remained in the region and became an instructor in several *madrasa*'s. After completing his pilgrimage, he stayed in Mecca (871/1467) and gave lectures there. On his way back, he stopped in Cairo and engaged in some scientific activities before going to Istanbul. In Istanbul he was mostly active in writing and teaching. As he did not receive the attention he had hoped for in Istanbul, Fatḥallāh al-Shirwānī returned to his hometown of Shirwān in 883/1478. He died in Shamāhī in Ṣafar 891/February 1486.

In addition to his expertise in the religious and rational sciences, Fatḥallāh al-Shirwānī also specialized in literature, linguistics, and jurisprudence, in which fields he wrote six works. Primarily, though, he should be thought of as a scientist who transferred and disseminated the mathematical and astronomical heritage of the Samarqand school to Anatolia and Istanbul along with ᶜAlī al-Qushjī. He presented his works to sultans, such as Sultan Meḥmed the Conqueror and Bayāzīd II, and to notable Ottoman statesmen such as Çandarlı Khalīl Pasha. In the field of theology, he composed three different studies on *al-Mawāqif fī ᶜilm al-kalām*, which he had read with his teacher Qāḍīzāde; especially remarkable is the voluminous *Ḥāshiya* he wrote on the *Sharḥ* of the *Mawāqif* by al-Sayyid al-Sharīf. Furthermore, the *Sharḥ* he wrote on Masᶜūd Taftāzānī's *Tahdhīb al-manṭiq wa-'l-kalām* indicates his continuing interest in both logic, which was the scientific language of the time, and theological issues.

Fatḥallāh al-Shirwānī also wrote *Majalla fī al-mūsīqī* in the field of music (*mūsīqī*), which was considered to be a branch of the mathematical sciences in his time; he dedicated this work to Sultan Meḥmed the Conqueror. It was written

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[135] *ŞN*, pp. 16, 108, 386.

[136] Kamāl al-Dīn Masᶜūd al-Shirwānī, who is also known as Masᶜūd al-Rūmī (d. 905/1499), taught at the Gawharshād *madrasa* (completed: 837/1434) in Herat. A learned scholar of the time in the fields of logic and theology, he also gave lectures, according to a condition of the *waqfiyya,* in the Ghiyāthiyya *madrasa*, where a number of important Khurāsān scholars were also teaching. Notable scholars and the erudite of Herat, including ᶜAlī Shīr Nawā'ī, attended his lectures there; see Khwandamir, vol. 4, p. 343 (English trans., part 2, p. 522) and *OALT*, vol.1, p. 66.

within a wide historical perspective which included ideas of the Greek philosophers on this matter as well as the opinions of famous Islamic music theorists such as Ṣafī al-Dīn al-Urmawī and ᶜAbd al-Qādir al-Marāghī as well as philosophers such as Ibn Sīnā and Naṣīr al-Dīn al-Ṭūsī.[137]

Fatḥallāh al-Shirwānī wrote another work in the field of geometry, namely a *ḥāshiya* on the commentary his teacher Qāḍīzāde wrote on Shams al-Dīn Samarqandī's *Ashkāl al-ta'sīs*. This *ḥāshiya* probably also included the knowledge Qāḍīzāde provided orally. However, since no copy of this work has survived to our time, it is impossible to say anything definitive about its content.

The first significant work of Fatḥallāh al-Shirwānī in the field of theoretical astronomy was the voluminous *ḥāshiya* he wrote on Qāḍīzāde's commentary on Jaghmīnī's *al-Mulakhkhaṣ fī ᶜilm al-hay'a al-basīṭa.* The full name of this *ḥāshiya*, which is variously recorded in the sources and catalogues, is actually *al-Farā'iḍ wa-'l-fawā'id fī tawḍīḥ sharḥ al-Mulakhkhaṣ.* This work of Fatḥallāh al-Shirwānī is of great significance for the history of Islamic astronomy because of his use of other commentaries to explain the difficult parts of Qāḍīzāde's commentary as well as his notes from Qāḍīzāde's lectures in the Samarqand *madrasa*. In the preface of *al-Farā'iḍ,* he wrote that he had started taking the initial notes for the book while in Samarqand. When he set off for Anatolia, his work was nearing completion, and he prepared his book out of his drafts in 878/1473, whereupon he presented it to Sultan Meḥmed the Conqueror in Istanbul. This work, which has not yet been examined, discusses the basic issues of *ᶜilm al-hay'a* primarily from the viewpoint of Qāḍīzāde and the Samarqand school.[138]

The most remarkable work of Fatḥallāh al-Shirwānī in the field of theoretical astronomy is, without doubt, the commentary he wrote on Naṣīr al-Dīn al-Ṭūsī's *al-Tadhkira fī ᶜilm al-hay'a*. He read the commentary that al-Sayyid al-Sharīf wrote on this work in his early years of education when he was in Ṭūs; he also read, listened to, and examined Nīsābūrī's commentary on the *Tadhkira* for five years in Samarqand with his teacher Qāḍīzāde; he had given special importance to this work both as a student and as a teacher, a point he makes explicitly in the preface of his *sharḥ*. He also emphasized there that he wrote it because his advanced-level students in the field of astronomy were in need of such a commentary. In this work, which was completed on 3 Ramadan 879/11 January 1475, he not only made use of previous commentaries on the *Tadhkira* but also used his notes from Qāḍīzāde's lectures and his own insights.[139]

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[137] In 1986, Fuat Sezgin published a facsimile of a copy of the *Majalla* (Istanbul, Topkapı Palace Museum Library, Ahmed III, MS 3449).

[138] Istanbul, Topkapı Palace Museum Library, Ahmed III, MS 3294.

[139] Istanbul, Topkapı Palace Museum Library, Ahmed III, MS 3314; Istanbul, Süleymaniye Library, Damat İbrahim Paşa MS 847; Kitābkhāna-i Markazī-i Dānishgāh-i Tihrān, majmūᶜa-i Mishkāt, MS 493.

In this commentary (examined below), Fatḥallāh al-Shirwānī provided significant information about a discussion that occurred among Qāḍīzāde, Ulugh Beg, himself, and other students in the Samarqand *madrasa* regarding a theorem in Euclid's *Elements*. He also included a copy of the license/diploma that he received from Qāḍīzāde. Although ostensibly a work on astronomy, Shirwānī's commentary extensively covered geometry and optics, considered here as ancillary fields of astronomy. In particular, in the section on physics, optics (*ʿilm al-manāẓir*) was broadly discussed, and Shirwānī stated that this part could be regarded as a separate treatise.[140] In this work, he surveyed in a comprehensive manner the various theories put forth by Islamic thinkers in the fields of optics and visual theory, mentioning the names of various works and people in the field including Ibn al-Haytham, Kamāl al-Dīn al-Fārisī, al-Naẓẓām, Ibn Sīnā, Quṭb al-Dīn al-Shīrāzī, al-Sayyid al-Sharīf, and the Ishrāqī School. He also made references to Ptolemy and stated his own opinion when necessary.[141] This text of Fatḥallāh al-Shirwānī, which dealt with the views of physicists (*ṭabīʿiyyūn*), mathematicians (*riyāḍiyyūn*), and "people of optics" (*nāẓirūn*), indicates that the optical views of Ibn al-Haytham and Kamāl al-Dīn al-Fārisī had become prevalent in the Islamic world, particularly in the Ottoman territories after the eighth/fourteenth century, through the Samarqand mathematical astronomical school. This also means that their approach was the one that was applied in the field of astronomy. In this text, which has yet to be analyzed in detail, Shirwānī's overall attitude indicates that he was aware of the revolution Ibn al-Haytham and his follower Kamāl al-Dīn al-Fārisī had effected in optical and visual theory by integrating the approaches of physics and geometry; it also shows that this revolution was subject to serious discussions among members of the Samarqand school.

In his commentary on the *Tadhkira*, Shirwānī discussed in detail the *ʿilm al-hay'a* system as put forward by Naṣīr al-Dīn al-Ṭūsī and its physical and geometrical foundations; he also provided a broad range of information about ancient calendar systems, particularly the Turkish calendar. It is evident that he used earlier commentators on the *Tadhkira* and incorporated their writings along with his own, which bore the distinctive marks of the Samarqand school. His understanding of *ʿilm al-hay'a* mostly followed the approach of Ibn al-Haytham, who had sought to combine the mathematical and natural philosophical aspects of astronomy. Significantly, he did not try to remove the Aristotelian principles of physics and metaphysics, as had his contemporary ʿAlī al-Qushjī.

In sum, Fatḥallāh al-Shirwānī continued to work within the general parameters of the Samarqand school and helped to disseminate its overall perspective through his works and teachings in various places of the Ottoman State, particularly in

[140] Kitābkhāna-i Markazī-i Dānishgāh-i Tihrān, majmūʿa-i Mishkāt, MS 493, ff. 23a–42a.
[141] Ibid., ff. 28b, 29a.

Anatolia. The technical contributions of Fatḥallāh al-Shirwānī to the astronomy of the Samarqand school still await investigation.[142]

II. A Lecture and a License to Teach: Copies, Critical Text, Translation

As was stated above, in his work entitled *Sharḥ al-Tadhkira fī ᶜilm al-hay'a,* Fatḥallāh al-Shirwānī provided a description of a lecture at the Samarqand *madrasa* and his license/diploma. For this study, I examined three extant copies of his *Sharḥ al-Tadhkira,* and I have prepared a critical text of the description and the license. Variants, as well as notes made above or below the lines or in the margins, have been recorded in the footnotes. Spelling has been standardized according to the rules of modern Arabic, but these sorts of changes are not recorded in the notes. Editorial additions are given between angle brackets < >. The three copies mentioned above and the folios that include the description and license are as follows:

1. Istanbul, Topkapı Museum Library, Ahmed III, MS 3314. It was copied from an autograph; 368 folios, 23 lines/page, *taᶜlīq* script.[143] It is marked by the letter ح in the critical apparatus. The description and the license occur on folios 15b–17a.

2. Istanbul, Süleymaniye Library, Damat İbrahim Paşa, MS 847. It was copied from an autograph in the year of the author's death; 212 folios, 21 lines/page, *taᶜlīq* script.[144] It is marked by the letter د in the critical apparatus. The description and the license occur on folios 14b–16a.

3. Tehran, Kitābkhāna-i Markazī-i Dānishgāh-i Tihrān, majmūᶜa-i Mishkāt, MS 493. The date of copying is unknown; 242 folios, 25 lines/page, *taᶜlīq* script. It is marked by the letter ت in the critical apparatus. The description and the license occur on folios 11a–12a.

II.1. *The Text*

[145]/وكنت من السامعين لشرح النظام على شيخي وأستاذي قاضي زاده الرومي - ذلك الإمام الذي لم يسمح بمثله الأدوار ما دار الفلك الدوّار - بسمرقند عند قراءة بعض أعالي[146] مجلسه

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[142] For the best biography of Fatḥallāh al-Shirwānī, see Akpınar. See also: Sakhāwī, vol. 4, p. 340 and vol. 6, pp.166–167; *ŞN*, pp. 15–16, 107–108, 273; Kātib Čelebī, vol.1, cols. 36, 67, 443 and vol. 2, cols. 1819, 1893; İsmail Paşa, vol.1, p. 815; Mehmed Tahir, vol. 3, p. 392; Brockelmann, vol. 2, pp. 255, 269, 279, Suppl. II, p. 290; Neubauer; Ragep 1993, vol.1, pp. 62–63; *OALT*, vol.1, pp. 42–45 (no.16); *OMULT*, pp. 15–17.

[143] *OALT*, vol.1, p. 45.

[144] *OALT*, ibid.

[145] ت: 11a؛ ح: 15b ؛ د: 14b .

الشريف معروفاً بالذكاء والعلاء في مدرسته ؛ وإليها[147] السلطان بن السلطان ألغ بيك كوركان بعد أن كنت قرأت شرح السيد الشهاب الثاقب على السيد الأيّد أبي طالب بمشهد الإمام علي الرضا رضي الله عنهم أجمعين . فقال السلطان ذلك الفيلسوف يوماً - وقد حضر مجلس الدرس ، وكان يحضره في أسبوع يوماً أو يومين ، ووصل الدرس هذا[148] المحلّ : «لم قال : الكائنة [149]/ في سطح ، وما الفائدة بالتقييد[150] به ؟» فبادر أحد المدرّسين[151] في مدرسته - وكان يحضرون[152] مع حضوره - إلى الجواب وقال : «لأنّ أقليدس برهن في كتابه على أنّ الخطوط المتوازية لا تكون إلاّ في سطح واحد .» وكنت يومئذ فارغاً بتوفيق الله تعالى من مطالعة اثنتي عشرة [153]/مقالة وحلّها من ذلك الكتاب[154] مستحضراً لها ، ولم يطّلع على حالي ذلك أحد إذ كنت أطالعه في أيّام العطلة مستخفياً ، فوقفت على خطائه ورجمه بالغيب . وكان الظنّ أنّ السلطان أيضاً اطّلع عليه ، إذ كان مستحضراً لذلك الكتاب بل لسائر فنون الرياضي أصوله وفروعه . لكنّي لم أبادر إلى تخطئته والردّ عليه كي يتقرّر[155] خطأه في الأسماع[156] إذ كان من دَيدَن السلطان ودأبه أن يعود إلى التفتيش ثانياً أو ثالثاً ، وكأنه في ذلك [157]/كان ممتحناً بنفسه لمن في مدرسته بعد أن كان عيّن لامتحان طلبتها المرتّبين[158] أعالي وأواسط وأداني لبعض المدرّسين خمسين ولبعضهم أربعين جماعة غيرهم من عدول الأفاضل وفحول الأماثل كان الحيف عندهم فيمن يدين كالكفر في الدين .

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[146] أعالي] +وهو خوجه شهاب الدين : د(فوق السطر) .
[147] وإليها] إليه : ت .
[148] هذا] هذا الدرس : ت («الدرس» مشطوبة) .
[149] ح: 16a .
[150] بالتقييد] في التقييد : د .
[151] المدرّسين] +وهو مولانا علاء الشاشي : د (فوق السطر) .
[152] يحضرون] يحضرونه : د .
[153] ت: 11b .
[154] الكتاب] الكاب : د .
[155] يتقرّر] يتفرد : ت .
[156] الأسماع] الأسماء : ت ، ح .
[157] د: 15a .
[158] المرتّبين] الا المرتبين : ت («الا» مشتوبة) .

فلمّا أفاض القارئ بعد مكث في قراءة تعريف السطوح المتوازية آض[159] السلطان إلى الفتش فعاد المجيب إلى ما بادر إليه أولاً . فقلت حينئذ[160] : «بل الأمر في ذلك الكتاب على خلاف ما قلت» . فاشرأبّ[161] السلطان لي ، وطأطأ[162] القارئ رأسه إذ هو كان بيني وبين السلطان على سمت شعاع البصر قريباً منه ومن الأستاذ ، وكان[163] يقعدون على زوايا مثلّث كل ضلع من أضلاعه ذراع تقريباً . فقال : «كيف ذلك؟» قلت : «قال أقليدس في تاسع[164] الحادية عشرة من كتابه[165]: الخطوط المتوازية لخط وإن لم يكن جميعاً في سطح فهي متوازية ، ثم برهن عليه» . فتوجّه إلى الأستاذ مصدّقاً لي ومستحسناً لمقالي فوق مرتين ، ثم توجّه هكذا إلى كل من ارتضاه من قاعد أو قائم ؛ فإنّ كثيراً من فحول العلماء الملازمين له كانوا يوم حضوره قائمين بين يديه . وكان المجيب ساعتئذ مطأطئ[166] الرأس ناكسة . فلمّا فرغ السلطان من ذلك الفعل الجميل رفع هو رأسه فقال : «لعلّ ما قال أقليدس في تلك المقالة هو أنّ كل زاويتين توازت أضلاعهما النظائر ، ولم يكن الجميع في سطح فيهما متساويتان ، لا ما نقلتَه» . قلت : «هذا الشكل يلي ذلك ويتلوه» . فأعاد السلطان جميله ، فجاء[167] إفحامه على أبلغ وجه ، فختم السلطان الكلام[168] على الإفحام فقام . وكان ذلك اليوم آخر أيّام التحصيل من الأسبوع ، فعزل في ذلك الأسبوع القارئ من القراءة ونصبني لها مكانه ، فابتدأت في أوّل الأسبوع التالي لذلك الأسبوع من تعريف السطوح [169]/المتوازية . فمرض المعزول[170] كثيراً ثم جلا إلى هرات وتوارى المفحم[171] أكثر من شهر ثم خرج فظهر الحياة .

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[159] آض] +أي صار : ت (تحت السطر) .
[160] حينئذ] ح : ت .
[161] فاشرأبّ] فاثراب : ح ، د .
[162] وطأطأ] وطأمن : ت ، ح ، د .
[163] وكان] وكانوا : د .
[164] تاسع] د (فوق السطر) .
[165] كتابه] كتاب : ت ، ح .
[166] مطأطئ] مطاطئ : ح .
[167] فجاء] فجاء : ت = فجا : ح («ء» فوق السطر) .
[168] الكلام] ح (فوق السطر) .
[169] ح: 16b .
[170] المعزول] +وهو خوجه شهاب الدين : د (فوق السطر) .

ورأيت وجه الأستاذ حين أفحمته قد تورّد كالورد في أول تفتّحه إذ كان في رأسه على ما سمعت شيء من الباطل دعوى معالمة ذلك الجناب . وكان من شأن أفلاطون وأرسطاطاليس وبطلميوس وأقليدس أن يستحيوا من ذلك لو[172] كان[173] لهم الإياب . فقال بعد خروج السلطان ورجوعه من التشييع متعجباً على تبسّم مليح : «أفلانٌ قد طالعتَ أنت المجسّمات أيضاً من كتاب أقليدس .» قلت : « بمن[174] مجلس الأستاذ ، لكن بقيت مطالعة ثلاث مقالات ، ولا أجد نسخة .» فأمر الفتوح من غلمانه بإحضار نسخته ، فانتسخت منها البقية وأتّممت مطالعة ذلك الكتاب[175] /بتسديد الله تعالى وكتبت في آخر نسختي حالي العجب في حالّه .

وأمّا قراءة الشرح فكنت فيها على ما اختاره الأستاذ البرهان لأجل السلطان من قليل قليل في زمان طويل فيما نقصت طولاً زادت بأضعافه عرضاً وبما يسرت كما كثرت بأمثاله كيفاً ؛ وتمّت بتيسير الله تعالى في خمس سنين تقريباً ، وثمّ بتمامها تحصيل العلوم قراءة وسماعاً ومطالعة . وحينئذ[176] ورد الوالد – أورده الله تعالى جنّات النعيم في مقام كريم – سمرقند برسل[177] من قِبَل ملك الشروان – جزاه الله الرحمٰن جزاء أهل العرفان – في طلبي ، فأجازني السلطان في الإياب – والأستاذ فيه – في[178] العلوم[179] /بالكتاب ؛ وها أنا أذكره تبركاً وأجعله فيها تمسّكاً . قال :

بسم الله الرحمٰن الرحيم . الحمد لله الذي[180] جرى عادته على فتح الأبواب العلم لأهله بعد ما جدّ وجدّ في سلوك خرق[181] طريقه وسهله ، والصلوة على النبي الأمي الذي أمر بطلبه ولو كان بالصين ، وعلى آله وأصحابه رجوم الجهل ونجوم اليقين . وبعد :

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[171] المفحم] +هو مولانا علاء(؟) : د (فوق السطر) .
[172] لو] او : ت .
[173] كان] كانوا : د .
[174] بمن] بمن : ت .
[175] د: 15b .
[176] وحينئذ] ح : ت .
[177] برسل] برسول : د .
[178] في] وفي : ح .
[179] ت: 12a .
[180] الذي] د(فوق السطر) .
[181] خرق] خرن : ح = خزن : د .

فإنّ ممن امتثل هذا الأمر لتحصيله وارتكب مشاقّ الشقّة في تقويمه وتعديله الشابّ الفاضل بل الذي في مضمار الأفاضل فاضل زبدة الفضلاء وقدوة الأذكياء **مولانا فتح الله ابن المولى النبيه الفرضي الفقيه أبي يزيد الشابراني الشرواني** – يسّر الله آمالها وأصلح أحوالها – فإنّه سافر لاكتسابه من الجانب الغربي نحو الشرقي[182] وجاب النجد والغور وخرق الطود والخرق حتى نزل بمحروسة سمرقند لدينا ، وقرأ شرح التذكرة علينا وسمع كل ما جرى من ذلك الزمان إلى هذا الأوان في مجلس مدارسنا مع الأصحاب أولى البصائر والألباب . فانتظم في سلك الأعالي من المولى ذوي الفضائل والمعالي ؛ وكان له قلب أو ألقي سمع ، وهو شهيد ؛ فتنبّه على كل رمزه[183] ، وإن كانت من مكان[184] بعيد حتى بلغ منتهى السؤل[185] والأمل [186]/بسماعه شرح المختصر في علمي[187] الأصول والجدل؛ وحقّق مقاصد الحكماء وعقائد علماء الإسلام بالإصغاء إلى شرح المواقف في صناعة[188] الكلام ، ومهر في سائر الفنون وبهر واشتهر بين الأكابر صيته وانتشر ، فلمّا انتهى أمره إلى هذا الأمد وجاء والده ليرجع به إلى ذلك البلد ، فإنّ العود أحمد والوالد أحقّ بالولد ، استجازني فأجبته وأجزت أن يروي عني جميع ما سمع مني بل جميع ما صحّ عنده ، أنّه يجوز روايته لي[189] ، [190]/وأوصيته بالديانة والتقوى خصوصاً في الرواية والفتوى ، عصمنا الله وإيّاه عن الخطأ والزلل في القول والعمل . وأنا الفقير إلى الله الغني **موسى بن محمد بن محمود المدعو بقاضي زاده الرومي** <أجزته> تحريراً في أواسط ربيع الآخر سنة أربع وأربعين وثمانمائة .

II. 2. *Translation*

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[182] الشرقي] الشرق : د .
[183] رمزه] رمزة : ح ، د .
[184] مكان] كان : ت ، ح .
[185] السؤل] السؤال : د .
[186] ح: 17a .
[187] علمي] علم : ت ، د .
[188] صناعة] د(في الهامش) .
[189] لي] ح(فوق السطر) .
[190] د: 16a .

I was one of the auditors for the [reading] of Niẓām [al-Nīsābūrī's] commentary[191] [on the *Tadhkira* of Naṣīr al-Dīn] under my master and professor Qāḍīzāde al-Rūmī, the Imām whose like has not been sanctioned since the celestial sphere has turned, in Samarqand during the recitation at [Ulugh Beg's] school by one of his noble assembly[192] known for his intelligence and high rank. I had [come] to this [*madrasa*][193] of the Sultan, son of the Sultan, Ulugh Beg Gūrkān [in Samarqand[194]] after having read the commentary[195] of al-Sayyid al-Shihāb al-Thāqib[196] with al-Sayyid al-Ayyid Abū Ṭālib[197] at the Shrine[198] of Imām ᶜAlī Riḍā [may God be pleased with all of them]. One day the philosopher-Sultan, who would attend the lectures one or two days every week and was attending the lecture that day when the subject came to this topic,[199] asked: "Why did he say 'it is in a plane'? And what is the purpose of restricting it [to the plane]?" One of the teachers in the *madrasa*[200]—[teachers] would also attend [the lectures] when the [Sultan] came—quickly responded, saying: "Because in his book[201] Euclid proved that parallel lines could only be in a single plane." I had by that day—with the help of God most High—completed the study and analysis of twelve books of this work and had them well in mind. Since I had studied the book secretly during the vacation period, no one was aware of my situation. Thus I realized his error and that he was guessing. Evidently the Sultan was also in command of this book since he had at his disposal not only it but also the rest of the mathematical sciences, [both] their principles (*uṣūl*) and details (*furūᶜ*). However, I did not immediately point out his error and respond to it, which would have allowed his error to be taken notice of; for it was one of the habits and practices of the Sultan to return to [his] questioning a second or third [time]. Thereby it was as if he were personally testing those in the school who had been assigned to test the students. [Students] were arranged into advanced, intermediate, and beginner [levels], with some teachers having fifty students while another group had forty each. For these honorable eminences and

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[191] Niẓām al-Dīn al-Nīsābūrī's *Sharḥ al-Tadhkira fī al-hay'a*.

[192] In the Damat İbrahim Paşa copy of the text, the name of the *qāri'* (the person who recites) is given as Khwāja Shihāb al-Dīn.

[193] This is the *madrasa* Ulugh Beg had established in which Qāḍīzāde would give lectures primarily to Ulugh Beg and other scholars around him.

[194] Fatḥallāh al-Shirwānī arrived in Samarqand at the beginning of the year 839/the middle of the year 1435.

[195] I.e., the *Sharḥ al-Tadhkira fīᶜilm al-hay'a* by al-Jurjānī.

[196] I.e., al-Sayyid al-Sharīf al-Jurjānī. His nickname *al-Shihāb al-Thāqib* means the penetrating meteor.

[197] A well-known Shīᶜī scholar of the time.

[198] This Shrine (*mashhad*=martyr's tomb) was in the city of Ṭūs (modern-day Mashhad).

[199] Shirwānī is referring to the topic of "parallels."

[200] In the Damat İbrahim Paşa copy of the text, this person is stated to be Mawlānā ᶜAlā' al-Shāshī. His name is listed as one of teachers at the Samarqand *madrasa*.

[201] Euclid's *Elements*. The version that was probably taught in the *madrasa* was the *Taḥrīr* [recension] of Naṣīr al-Dīn al-Ṭūsī.

outstanding personalities, doing wrong to those to whom they were obligated would have been [as bad] as disbelief in religion.

When the reader (*qāri'*) became prolix, having spent a long time reading the definition of parallel planes, the Sultan returned to questioning, and the one who had answered repeated what he had, without hesitation, said in the first place. It was just at this point that I said: "On the contrary, what is in the book is different from what you have stated." The Sultan craned his neck [to see] me; and the reader, who was near the [Sultan] and the teacher, bowed his head since he was in the line of sight between me and the Sultan, the [three] of them each sitting at the corner of a triangle each of whose sides was approximately one cubit. "How is that?" asked the Sultan. I answered: "In Proposition 9 of Book XI, Euclid says: 'Lines that are parallel to a line, even if they are not all in the [same] plane, are parallel'; he then proves it." Then [the Sultan] turned to the professor, agreeing with me and approving what I had said more than twice. Similarly, he then turned to those in agreement, whether sitting or standing; for many of the eminent scholars who accompanied him would stand before him during the day(s) he attended [the lectures]. The person who had answered hung his head. Then when the Sultan had finished being polite, he raised his head and said: "Perhaps what Euclid said in that Book was that 'every two angles whose corresponding sides are parallel, and which are not all in the same plane, are equal,' and not what you have reported." I replied: "That proposition follows from the previous one and comes right after it." The Sultan repeated his kind gesture, but then he became extremely brusque, and so closed the discussion with brusqueness and rose. That day was the last day of the lectures for the week. That very week the reader was dismissed from his position, and he appointed me to it in his place. So I began on the first [day] of the following week by [reading] the definition of parallel planes. The dismissed [reader][202] became seriously ill and moved to Herat. And the one who was treated brusquely[203] went into hiding for more than a month; later he resurfaced and showed signs of life.

When I silenced the professor with evidence, he became flushed with [the color] of a rose at its first blossoming. For, according to what I heard, he had something in mind of the erroneous claims of the other, contending side. Being ashamed of error, when there is a chance to turn from it, was a characteristic of Plato, Aristotle, Ptolemy, and Euclid. After the Sultan departed, the professor, having bid him farewell, returned with a look of wonder and a pleasant smile and said: "Did you also study the part on solid geometry in Euclid's book?" I answered: "[I studied] the ones [available] in the professor's classroom, but there are three books left to be studied and I have yet to find a copy." He ordered one of his servants, the one responsible for preparing the lecture assemblies, to bring his copy. From that I copied the other books and, with the help of God most High, I finished

[202] Khwāja Shihāb al-Dīn.
[203] Mawlānā ᶜAlā' al-Dīn al-Shāshī.

studying [Euclid's entire] book; and at the end of my copy, I wrote about my remarkable circumstances.

As for the reading of the *Sharḥ*,[204] I followed the method the most knowledgeable professor [Qāḍīzāde] chose for the Sultan, namely [to read] little by little over a long period of time. With the expenditure of much time, I was recompensed many times over with a greater depth and ease of [understanding] through the increased number of illustrative examples. By the facilitation of God most High, it was completed in approximately five years. With its completion thus came the attainment of the sciences through reading (*qirā'a*), listening (*simā*^{c}), and study (*muṭāli*^{c}*a*). At that time, my father—may God most High place him in a noble place in the comfort of Heaven—arrived at Samarqand at my request with the delegates of the ruler of Shirwān—may God the Compassionate reward him with the reward of those with enlightenment. The Sultan then gave authorization for my return and the Professor (Qaḍīzāde) gave written authorization in the sciences. And here I state this authorization as it is a blessing, and I produce it as written proof.

He said: In the name of God, the Beneficent, the Merciful. Praise be to God, who customarily opens the doors of knowledge to the ones who act seriously in pursuing its pathways and plains. And blessings upon the illiterate Prophet, who ordered us to "seek [knowledge] even if it is in China," and upon his family and companions, cursing ignorance and bringing forth certain knowledge.

Among those who follow this example in obtaining [knowledge] and undergoing the utmost hardship to elevate and improve it is this virtuous youth—indeed in the domain of the virtuous, the most virtuous of the cream of the virtuous—and a model of intelligence, Mawlānā Fatḥallāh ibn al-mawlā al-nabīh al-faraḍī al-faqīh Abū Yazīd al-Shābarānī al-Shirwānī—may God ease their way to their aspirations and ameliorate their circumstances. In order to acquire [knowledge], he traveled from West to East, traversing highlands and lowlands, and crossing the mountain until he reached us in the safeguarded city of Samarqand. He read the *Sharḥ al-Tadhkira*[205] with us; since the time of his [arrival] until now, he listened to everything that took place in the lecture assemblies of our schools, with those possessing the highest perspicacity and intellect. So he joined the community of the highest masters of preeminence and excellence. He had an inner core but would listen attentively and witness [that around him]. He was mindful of all puzzling allusions, even when they were obscure, until he reached the conclusion of [his] quest and aspiration [*muntahā al-su'l wa-'l-amal*] through listening to the *Sharḥ al-mukhtaṣar fī* ^{c}*ilmay al-uṣūl wa-'l-jadal*.[206] He ascertained the aims of the

[204] Niẓām al-Dīn al-Nīsābūrī's commentary on Ṭūsī's *al-Tadhkira fī* ^{c}*ilm al-hay'a.*

[205] Niẓām al-Dīn al-Nīsābūrī's *Sharḥ al-Tadhkira.*

[206] Jamāl al-Dīn ^{c}Uthmān b. ^{c}Umar (d. 646/1249), known as Ibn Ḥājib, wrote a work entitled *Muntahā al-su'l wa-'l-amal fī* ^{c}*ilmay al-uṣūl wa-'l-jadal* on the methodology of jurisprudence; later he summarized this work and changed its name to *Mukhtaṣar al-muntahā*. ^{c}Aḍud al-Dīn al-Ījī (d. 756/1355) wrote a commentary (*Sharḥ*) on this *Mukhtaṣar*. Qāḍīzāde refers to the work by alluding to the origi-

philosophers and the tenets of the Islamic erudite by listening intently to the *Sharḥ al-Mawāqif* in the field of *kalām*.[207] He became an expert in the other disciplines and was brilliant; his reputation rose among the senior [scholars] and spread. When he had reached this point, his father came to take him back to that city [i.e. Shirwān]; for returning was praiseworthy and a father has rights over his son. He asked for my authorization, and I responded positively. I gave authorization to him to transmit everything he heard [learned] from me, even all that which was corrected by him; he could transmit [all] this in my name. I directed him to [act according to] religion and piety, especially in matters of transmitting [knowledge] and legal opinion [*fatwā*]. May God protect us and him from error and oversight, in speech and in act. I, who am in need of God the Abundant, Mūsā ibn Muḥammad ibn Maḥmūd, known as Qāḍīzāde al-Rūmī, wrote this authorization in middle of the month of Rabīᶜ al-ākhir in the year 844.[208]

III. Content, Interpretation, and Issues Related to Shirwānī's Text

In the history of Islamic philosophy and science, texts that describe or depict the educational activities within the *madrasa*'s are rather few. The above text, which is taken from Fatḥallāh al-Shirwānī's *Sharḥ al-Tadhkira fī ᶜilm al-hay'a*, describes a moment of controversy in one of the lectures in the *madrasa* and includes the authorization (diploma) Qāḍīzāde gave to Fatḥallāh al-Shirwānī. The content provides information that supports the historical information we presented in the first part of this study regarding the Samarqand *madrasa* of Ulugh Beg; but in addition to enriching our knowledge, it also raises new questions and issues. For this reason, we compare the information we presented above with details in the text and provide analysis.

III.1. *Technical Content*

In this text, Fatḥallāh al-Shirwānī describes a discussion from a lecture, but unfortunately does not provide any details about the background to the discussion. We can fill in some of the details as follows: Ulugh Beg and all the teachers either forming part of his entourage or teaching in the *madrasa* itself were in attendance at a lecture under the supervision of Qāḍīzāde in which Niẓām al-Dīn al-Nīsābūrī's work *Sharḥ al-Tadhkira* was being studied. The *qāri'* was reading the definition of parallel lines from the first chapter of Naṣīr al-Dīn al-Ṭūsī's *al-Tadhkira,* which concerned that part of geometry (*handasiyyāt*) needed in astronomy. Shirwānī

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nal title and applying the art of ambiguity (*īhām*), thus reminding readers of the *matn* (original text); see Kātib Čelebī, vol. 2, col. 1853.

[207] al-Sayyid al-Sharīf wrote a commentary on ᶜAḍud al-Dīn al-Ījī's theological work in the field of *kalām*; see Kātib Čelebī, vol. 2, cols. 1891–1894.

[208] I would like to thank Mr. Mahmud Kaya who reviewed the Arabic of this text.

referred to this discussion when he commented on this definition in his *Sharḥ al-Tadhkira*:

> والخطوط المستقيمة الكائنة في سطح مستوٍ التي لا تتلاقى وإن أخرجت في الجهتين إلى غير نهاية هي المتوازية .
>
> Straight lines occurring in a plane that do not meet even if extended without limit in both directions are parallel.[209]

Ulugh Beg took the expression "*al-kā'ina fī saṭḥ* = occurring in a plane" from this definition and asked what the lines being in a plane meant, in other words he asked the reason for the plane to be a condition in order for the lines to be called parallel. One member of the assembly, ᶜAlā' al-Dīn Shāshī, answered this question by referring to Naṣīr al-Dīn al-Ṭūsī's *Taḥrīr* on Euclid's *Elements*, saying "Because in his book Euclid proved that parallel lines could only be in a single plane." Thus Shāshī claimed that being in a plane was a necessary condition for the lines to be parallel. Since Ulugh Beg was not satisfied with this response—in fact it was incorrect—he restated his question; when Shāshī insisted on his opinion, Shirwānī interjected and contradicted what Shāshī had said. Ulugh Beg wanted to know the basis of Fatḥallāh al-Shirwānī's opinion. By referring to Ṭūsī's *Taḥrīr al-uṣūl,* Shirwānī insisted that Euclid did not make being in the same plane a condition of parallelism; on the contrary, he proved in XI.9 that lines may be parallel even when they are not in the same plane. Ulugh Beg interpreted Shirwānī's reference to Euclid actually to be the proposition that "every two angles whose corresponding sides are parallel, and which are not all in the same plane, are equal." But Shirwānī objected, answering that this was not what he was referring to but another proposition that came immediately after XI.10. If one checks a modern edition of Euclid's *Elements*, one finds that the propositions have the same numbers as referred to by Shirwānī and indicate that he was in fact correct.[210]

Unfortunately, Fatḥallāh al-Shirwānī provided only a minimum of detail. Nevertheless, it may be significant that the discussion concerned parallel lines, a matter of considerable importance in the history of mathematics that eventually led to the rise of non-Euclidean geometry.[211] As a way to understand the discussions revolving around parallels in Samarqand, it would be very helpful to have Shirwānī's own comments, which he claimed he placed at the end of the text he copied from *Taḥrīr al-uṣūl*; however, as far as I know, this copy is not extant. The

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[209] Ragep 1993, vol.1, pp. 94–95. Also see Istanbul, Topkapı Palace Museum Library, Ahmed III, MS 3314, f. 15b; Süleymaniye Library, Damat İbrahim Paşa MS 847, f. 14b; Tehran, Kitābkhāna-i Markazī-i Dānishgāh-i Tihrān, majmūᶜa-i Mishkāt, MS 493, f. 11a.

[210] Heath, vol. 3, pp. 290–292.

[211] For the place of parallels in the history of Islamic mathematics see: Jaouiche; Rozenfeld-Youschevitch; and Faber.

Ḥāshiya that Shirwānī wrote on Qāḍīzāde's *Sharḥ al-ashkāl* is also missing, further removing us from knowing his opinions on this issue. It is clear that further research is needed on the geometry texts by members of the Samarqand school and their Ottoman successors.

III.2. *People Mentioned in Shirwānī's Account*

In the beginning of his account, Fatḥallāh al-Shirwānī provided information on his previous educational activities before coming to the Samarqand *madrasa*. Of particular interest is his remark that he had read al-Sayyid al-Sharīf's *Sharḥ al-Tadhkira fī ᶜilm al-hay'a* from a renowned Shīᶜī scholar of the time, Sayyid Abū Ṭālib at Imām ᶜAlī Riḍā's shrine in the city of Ṭūs. This point shows that he had already reached a certain level of proficiency in the mathematical sciences before he arrived in Samarqand. Indeed, in the authorization he gave to Fatḥallāh al-Shirwānī, Qāḍīzāde used the attributive names *al-Faraḍī* and *al-Faqīh* for his father, indicating that his father was known as a jurist and had reached a certain level of proficiency in the field of ᶜ*ilm al-farā'iḍ,* a mathematical discipline used for inheritance law. (As we know, Shirwānī took his first lessons from his father.) Moreover, the fact that Shirwānī was one of Qāḍīzāde's students confirms information from other sources that Qāḍīzāde gave lectures in the *madrasa* to teachers and advanced students, i.e. ones that had already reached a certain level of proficiency in their science education.

As Jamshīd Kāshī did in the letters to his father, Fatḥallāh al-Shirwānī highlighted two personages at the Samarqand *madrasa*: Qāḍīzāde and Ulugh Beg. However, unlike Jamshīd Kāshī, Fatḥallāh al-Shirwānī considered Qāḍīzāde more important. Indeed, we are immediately drawn to his use of the words "master" and "professor" with the first person singular possessive pronoun when referring to Qāḍīzāde and the description he used for him—"whose like has not been sanctioned since the celestial sphere has turned"; furthermore, he showed the depth of his esteem for Qāḍīzāde by bestowing upon him the title *al-burhān* (most knowledgeable) to indicate the extent of his demonstrative (i.e. scientific) knowledge in the Aristotelian sense. On another matter, there are some indications of a possible rivalry between Jamshīd Kāshī and Qāḍīzāde. One should keep in mind that Fatḥallāh al-Shirwānī was a student of Qāḍīzāde who compared his teacher with Plato, Aristotle, Ptolemy and Euclid, at least insofar as these great men were open to criticism and were not averse to correcting their mistakes. In any event, Shirwānī's self-image of superiority and self-praise is clearly discernable. A similar situation can be seen in both letters of Jamshīd Kāshī, who maintained his own superiority among the erudite around Ulugh Beg; while praising Ulugh Beg he also singled out Qāḍīzāde from amongst the other teachers in the *madrasa*, with whom he did not bother to compare himself. The way Kāshī presented the situation tends to indicate a conflict between himself and Qāḍīzāde. In his first letter,

Jamshīd Kāshī stated that Mawlānā Muḥammad Khwāfī had been the most prominent mathematician-astronomer in Samarqand and then Qāḍīzāde surpassed him; Kāshī then claims that he himself surpassed Qāḍīzāde after coming to Samarqand.[212] The information Jamshīd Kāshī gave about Bīrūnī's famous astronomy book *al-Qānūn al-Masᶜūdī* clearly shows that from time to time he tried to put Qāḍīzāde in difficult positions, thereby shaking his reputation in the eyes of Ulugh Beg.[213] We may infer that the reason Jamshīd Kāshī ranked Qāḍīzāde highly was related to a number of factors: Qāḍīzāde's scientific attainments; his reputation in Ulugh Beg's eyes that had led to his being the Sultan's tutor and the head-teacher of the *madrasa*; and that Kāshī owed Ulugh Beg's invitation to Samarqand in 824/1421 at least in part to the recommendation of Qāḍīzāde. Fatḥallāh al-Shirwānī's narrative also indicates that Qāḍīzāde demonstrated deep concern for providing for the scientific education of the students, even when they had contrary opinions.

The second person that Fatḥallāh al-Shirwānī emphasized in his text is Ulugh Beg, whom he referred to as the philosopher-Sultan. The information he provided regarding Ulugh Beg's level of scientific proficiency, and his relation to the *madrasa,* are in agreement with the information contained in Jamshīd Kāshī's letters and other historical sources: Ulugh Beg would attend the lectures one or two days every week; all the teachers of the *madrasa* would accompany him; and, every time Ulugh Beg attended these lectures he would want the instruction to be on the mathematical sciences. Shirwānī clearly emphasized, as did Jamshīd Kāshī, that Ulugh Beg was a master of all the mathematical sciences, particularly of *Taḥrīr uṣūl al-handasa*; thus Ulugh Beg is portrayed not only as a ruler who patronized science, but also as a scholar.[214] One also understands from the text that whenever Ulugh Beg came to the *madrasa,* he was not only accompanied by the teachers of the *madrasa* but also by high administrative officials who stood whereas the teachers were sitting.

Fatḥallāh al-Shirwānī referred to two other people in the text without providing their names: the reader (*qāri'*) and the person who answered Ulugh Beg's question. The Süleymaniye Library, Damat İbrahim Paşa copy of Shirwānī's *Sharḥ al-Tadhkira fīᶜilm al-hay'a* supplies the names of these people between the lines in two places, perhaps by a person who was present during the discussion. From these records it appears that the *qāri'* was a more mature teacher of the *madrasa* named Khwāja Shihāb al-Dīn.[215] The person who answered Ulugh Beg's question was ᶜAlā' al-Dīn al-Shāshī, whose name is given in the list of *madrasa* teachers and who apparently was a relatively prominent figure according to the information

[212] Bāqirī, pp. 41–42; Sayılı, *Uluğ Bey*, p. 90.
[213] Sayılı, *Uluğ Bey*, pp. 81–82.
[214] Cf. Kennedy.
[215] I could not find any information regarding the identity of Khwāja Shihāb al-Dīn in my research.

available in the sources.[216] The fact that Shirwānī did not directly provide the names of these two people indicates that he did not have any personal conflicts with them.

Finally, one may wonder why Fatḥallāh al-Shirwānī did not mention Jamshīd Kāshī. One can assume that he did not know him personally since Kāshī died in 832/1429, and Shirwānī came to Samarqand towards the middle of 839/1435.

III.3. *The Virtuous Youth–An Ideal Model*

Fatḥallāh al-Shirwānī showed great esteem for Qāḍīzāde, and the feeling from his teacher was reciprocated. As a matter of fact, just after the discussion, even though his opinion was different, Qāḍīzāde provided his student with the needed documentation by giving him his own copy of the work in question. Moreover, in the authorization/license he gave Fatḥallāh al-Shirwānī, Qāḍīzāde described him as a "virtuous youth" and a "model of intelligence." He also pointed out the hardships Shirwānī had to bear in obtaining his education in the sciences, his diligence in pursuing knowledge after coming to Samarqand, and how he advanced to an expert level. Qāḍīzāde exhibited great confidence in his student with his important statement of authorization: "I gave authorization to him to transmit everything he heard [learned] from me, even all that which was corrected by him; he could transmit [all] this in my name." As a teacher he directed his student to comply with principles of religion and piety in terms of transferring knowledge.

III.4. *Sayf al-Munāẓirīn: The Sword of the Debaters*

The description Fatḥallāh al-Shirwānī provided regarding Ulugh Beg's style of inquiry during the lecture concurs with the information reported by Jamshīd Kāshī in his letters. According to these, Ulugh Beg would not accept answers at face value regarding scientific matters; rather he would debate and discuss with the students all branches of science and would refuse to accept out of courtesy a scientific argument, waiting instead for a clear solution to emerge. He would also put forward a trick question/issue and embarrass whoever answered thoughtlessly by forcing a reexamination of the issue from the beginning.[217] He followed this method not only for the mathematical sciences, but also for religious and literature studies.[218] In short, as Jamshīd Kāshī put it, Ulugh Beg was a formidable debater and disputant.[219] According to our text, Ulugh Beg restated his question even though he understood that the answer given was wrong; he weighed the level of Fatḥallāh al-Shirwānī's answer by asking him a second question; and then he tried to confuse him with a different interpretation in order to test his knowledge of the

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[216] See Eshenkulova, p. 89; also see Barthold, *Ulugh-Beg*, p. 115, fn. 1.
[217] Sayılı, *Uluğ Bey*, pp. 76, 78, 82, 91.
[218] *Dawlatshāh*, p. 361 (Turkish trans., vol. 3, p. 428).
[219] Sayılı, *Uluğ Bey*, p. 91.

content. In each case, through his behavior, gestures, and facial expressions, he demonstrated his satisfaction to the people that were present at the lecture. Within this framework, the information Shirwānī provided when explaining the questioning attitude of Ulugh Beg is very important. According to this information, the students of the *madrasa* were divided into beginner, intermediate, and advanced, and each division was appointed a teacher. According to what may be understood from the text, within each division there were groups with varying numbers of students, and each group was supervised by a teacher. Moreover, Shirwānī's statements, which interpreted Ulugh Beg's act of questioning as a test for the teachers, concur with the information Jamshīd Kāshī gave in his letters regarding the strict testing process towards the teachers of the *madrasa*. The analogy Shirwānī made when interpreting the attitudes of the teachers towards their scientific and administrative responsibilities expressed the seriousness with which they held their duties: the teachers of the *madrasa* would see failing to uphold their obligations as an offense against Ulugh Beg and "would have been [as bad] as disbelief in religion."

III.5. *Lectures, Books, Methods*

Without a thorough examination of the framework of the ancient sciences within Islam, it would be misleading to speculate as to why certain subjects considered scientific today were or were not taught. Since this is beyond the scope of this article, we will simply state that the curriculum was determined by the priority given to natural philosophy, the mathematical sciences, or theology (metaphysics). Shirwānī's text, Kāshī's letters, and other historical sources indicate that courses were taught in nearly all fields of knowledge as exemplified by the range of works of Qushjī and Shirwānī, both of whom studied at Samarqand. Nevertheless, it is clear that the curriculum had a bias toward the mathematical sciences. One sign of this is the case of Abū Saᶜīd Awbīhī, who was disturbed by this scientific orientation when he was a student, and left the *madrasa* and went to Herat in order to be with the Naqshbandī shaykh Khwāja ᶜUbayd Allāh Aḥrār, who wielded enormous influence in the administrative and political affairs of the country. Apparently, he even left his books, probably on mathematics, to his friends at the Samarqand *madrasa*.[220] It would seem that transferring between the *madrasa*'s in Herat and Samarqand was a not infrequent event, depending on the needs and predilections of the students.

Several points can be made regarding the curriculum: Fatḥallāh al-Shirwānī had read al-Sayyid al-Sharīf's *Sharḥ al-Tadhkira fī ᶜilm al-hay'a* from the Shīᶜī scholar Sayyid Abū Ṭālib in Imām ᶜAlī Riḍā's shrine in Ṭūs before he came to Samarqand; and at the Samarqand *madrasa,* he read Niẓām al-Dīn al-Nīsābūrī's *Sharḥ al-Tadhkira fī ᶜilm al-hay'a* with his teacher. According to the information

[220] Eshenkulova, p. 56.

given above, Shirwānī studied Naṣīr al-Dīn al-Ṭūsī's recension on Euclid's *Elements* both with his teacher Qāḍīzāde and on his own. In the authorization, Qāḍīzāde emphasized that he taught texts in several subjects to Shirwānī; however, he particularly mentioned ᶜAḍud al-Dīn al-Ījī's *Sharḥ al-mukhtaṣar fī ᶜilmay al-uṣūl wa-'l-jadal* in the methodology of jurisprudence, al-Sayyid al-Sharīf's *Sharḥ al-Mawāqif* in theology, and Nīsābūrī's *Sharḥ al-Tadhkira* in astronomy.

Fatḥallāh al-Shirwānī also provided information regarding the way lectures were held in the *madrasa*. In the lecture assemblies of Qāḍīzāde, which the teachers and the advanced-level students would attend, a *qāri'* would read the text slowly and the subject would be examined in detail through mutual explanations and discussions. The *qāri'* would also establish connections between the texts and their sources. Shirwānī stated explicitly that this thorough method of reading the text took time; indeed, Nīsābūrī's *Sharḥ* took five years to get through, during which time he himself was the *qāri'*. In sum, Shirwānī indicates that there were three requirements for completing a text at the *madrasa*: reading (*qirā'a*), listening (*simāᶜ*), and study (*muṭāliᶜa*).

Let us now turn to the picture of the teaching and level of science in the eastern lands of Islam during the fifteenth-century that emerges from the example of Samarqand.

III.5a. *Geometry and Arithmetic*

All the sources mentioned above unanimously indicate that the main geometry texts studied at the Samarqand *madrasa* were Shams al-Dīn al-Samarqandī's *Ashkāl al-ta'sīs* and Naṣīr al-Dīn al-Ṭūsī's *Recension* of Euclid's *Elements*. As we have already stated, Qāḍīzāde wrote a commentary on the *Ashkāl*, which he completed on 28 Jumādā al-awwal 815/9 September 1412, and Shirwānī wrote a *ḥāshiya* on this commentary. Sakhāwī stated that al-Sayyid al-Sharīf al-Jurjānī also wrote a *ḥāshiya* on the *Ashkāl* but without indicating on which commentary it was written.[221] Such a *ḥāshiya* written by al-Sayyid al-Sharīf is significant as it shows an interest in integrating the geometrical books, as well as the astronomical books, at the Samarqand *madrasa*. Since Qāḍīzāde's commentary also included the original text, many *ḥāshiya*'s were later written on it by numerous members of the Samarqand school. Among these, the ones written by Qāḍīzāde's immediate students are worth noting since they contain traces of Qāḍīzāde's *madrasa* instruction.[222] Naṣīr al-Dīn al-Ṭūsī's *Recension* of Euclid's *Elements* was the most important geometrical text studied at the Samarqand *madrasa*, as Fatḥallāh al-Shirwānī stated.[223] Therefore, the fact that al-Sayyid al-Sharīf wrote a *ḥāshiya* on it is significant.[224] The influences of Ṭūsī's work are always discernable in the works written by members of the Samarqand school.

Another geometry work that was carefully examined at the Samarqand *madrasa* was Apollonius's great work on conics (*Kitāb al-makhrūṭāt*). Other works on conics that were taught included: Ṭūsī's *Taḥrīr kitāb Abūlūniyūs fī al-makhrūṭāt fī ʿilm al-handasa;*[225] Abū al-Ḥusayn ʿAbd al-Malik b. Muḥammad's *Taṣaffuḥ kitāb Abūlūniyūs fī al-makhrūṭāt;*[226] and Maḥmūd b. Qāsim b. al-Faḍl al-Iṣfahānī's *Kitāb talkhīṣ al-makhrūṭāt fī al-handasa.*[227] It was because of these teachings that ʿAbd al-Razzāq Muḥammad, who was known as Muʿīn al-Munajjim al-Kāshānī, one of the important members of the Samarqand mathematical-astronomical school, was able to write his work entitled *al-Ashkāl allatī yuḥtāj ilayhā fī tashīl fahm Kitāb talkhīṣ al-makhrūṭāt fī al-handasa*[228] in 840/1436-7 in Bukhara, and Sayyid Munajjim, another notable member, was able to write the *Risālah-i shakl-i mughnī wa ẓilli*[229] in Persian for Ulugh Beg in 837/1433.[230]

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[221] Sakhāwī, vol. 5, p. 329.
[222] İzgi, vol. 1, pp. 283–284.
[223] İzgi, vol. 1, pp. 285–294.
[224] Kātib Čelebī, vol. 1, col. 139; Istanbul, Süleymaniye Library, Hüsrev Paşa MS 127.
[225] Istanbul, Library of the Military Museum, MS 3023.
[226] Istanbul, Library of the Military Museum, MS 3025/3, ff. 29b–43a.
[227] Istanbul, Library of the Military Museum, MS 3022/1, ff. 1b–74b.
[228] Istanbul, Library of the Military Museum, MS 3022/2, ff. 75b–251a (an autograph).
[229] Istanbul, Süleymaniye Library, Aya Sofya, Yazma Bağışlar MS 1362.
[230] For these works, see Fazlıoğlu 1998b.

According to Jamshīd Kāshī, the main work that was studied in the field of arithmetic [*al-ḥisāb al-hindī*, *al-ḥisāb al-hawā'ī, al-ḥisāb al-sittīnī*, *ᶜilm al-misāḥa,* and *ḥisāb al-majhūlāt*] was *al-Shamsiyya fī al-ḥisāb* by Niẓām al-Dīn al-Nīsābūrī, who was a member of the Marāgha mathematical-astronomical school.[231] ᶜAbd al-ᶜAlī al-Birjandī, who was a second-generation member of the Samarqand *madrasa*, wrote a commentary on this work.[232] Moreover, the works of mathematicians such as Ibn al-Khawwām, Kamāl al-Dīn al-Fārisī, and ᶜImād al-Dīn al-Kāshī, the students of Naṣīr al-Dīn al-Ṭūsī whose names were mentioned by Jamshīd Kāshī in his *Miftāḥ al-ḥisāb*, one of the most important books on arithmetic in the history of science, must have been in circulation among the school's members.[233]

III.5b. *Astronomy*

The astronomy works that were in circulation in the Samarqand school were mostly from two prominent scholars who were members of the Marāgha school: Naṣīr al-Dīn al-Ṭūsī's recension on Ptolemy's *Almagest* and his *al-Tadhkira fī ᶜilm al-hay'a,* which is regarded as one of the most significant works in the history of astronomy inasmuch as Ṭūsī sought to rectify the Ptolemaic system; and his student Quṭb al-Dīn al-Shīrāzī's two classic works, *al-Tuḥfa al-shāhiyya fī al-hay'a* and *Nihāyat al-idrāk fī dirāyat al-aflāk*. Moreover, the concise *al-Mulakhkhaṣ fī al-hay'a al-basīṭa* by Sharaf al-Dīn Abū ᶜAlī Maḥmūd b. Muḥammad b. ᶜUmar al-Jaghmīnī al-Khwārizmī (d. ca. 619/1221), was the most taught textbook at Samarqand. This work was a kind of bridge between the earlier *hay'a* works of Ibn al-Haytham and Abū Bakr Shams al-Dīn Muḥammad b. Aḥmad al-Kharaqī (d. 533/1138-9), and the works of the Marāgha school.

Within this framework, Qāḍīzāde wrote a *ḥāshiya* to the commentary that Nīsābūrī wrote on Ṭūsī's *Taḥrīr al-majisṭī*;[234] and the Samarqand school's second-generation member ᶜAbd al-ᶜAlī al-Birjandī, wrote a voluminous commentary on Ṭūsī's *Taḥrīr*.[235] As Jamshīd Kāshī emphasized in both of his letters, Quṭb al-Dīn al-Shīrāzī's works were also closely studied; however, no major commentaries were written on them. Apart from the *ḥāshiya* that Sakhāwī attributed to al-Sayyid al-Sharīf,[236] only ᶜAlī al-Qushjī started writing a commentary on *al-Tuḥfa* that was, however, never completed.[237]

The book that both Jamshīd Kāshī and Fatḥallāh al-Shirwānī put the most emphasis on was Ṭūsī's *Tadhkira*, which was extensively read, taught, discussed,

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[231] İzgi, vol.1, pp. 233–234.
[232] See Fazlıoğlu 1999a.
[233] For these works, see Fazlıoğlu 1998c; see also İzgi, vol.1, pp. 234–237.
[234] Kātib Čelebī, vol. 2, col. 1595.
[235] *OALT*, vol. 1, p.109; Fazlıoğlu 1999a.
[236] Sakhāwī, vol. 5, p. 329.
[237] Istanbul, Süleymaniye Library, Aya Sofya MS 3643.

and commented upon in Samarqand. In addition, it is clear from Shirwānī's text that Nīsābūrī's commentary entitled *Tawḍīḥ al-Tadhkira* was among the textbooks used in the Samarqand *madrasa*. Another commentary that was widely used was the *Sharḥ al-Tadhkira* that al-Sayyid al-Sharīf wrote in 811/1408 in Shiraz.[238] The fact that Fatḥallāh al-Shirwānī had read this work in Ṭūs before coming to Samarqand means that al-Sayyid al-Sharīf's *sharḥ* was used over a wide territory. We also have the evidence for this from Jamshīd Kāshī, who frequently mentioned the commentaries of Nīsābūrī and al-Sayyid al-Sharīf in his letters.[239] It was for these reasons that, as mentioned above, Fatḥallāh al-Shirwānī wrote a voluminous and important commentary on *al-Tadhkira* that included the knowledge he acquired from the commentaries of Nīsābūrī and al-Sayyid al-Sharīf, which he read as a student, the teachings of Qāḍīzāde, and his own insights. Later in 913/1507, ᶜAbd al-ᶜAlī al-Birjandī wrote an extensive commentary on *al-Tadhkira*.[240] In addition to the influence and diffusion of *al-Tadhkira* with its *sharḥ*'s and their copies in the Islamic world, there is considerable evidence of its influence in Europe. Copernicus seems to have been aware of Ṭūsī's work either directly or indirectly, and later Guillaume Postel (1510-81) showed considerable interest in this work during his travels to Istanbul.[241] Furthermore, part of Birjandī's commentary that dealt with Ṭūsī's non-Ptolemaic models was translated into Sanskrit.[242]

On the elementary level, Jaghmīnī's textbook *al-Mulakhkhaṣ fī al-hay'a al-basīṭa* held pride of place. More than ten commentaries were written on it by notable astronomers, both before and after Qāḍīzāde.[243] One of the more significant commentaries was that of al-Sayyid al-Sharīf.[244] Qāḍīzāde presented his own commentary on *al-Mulakhkhaṣ* to Ulugh Beg in 814/1412.[245] This commentary was widely taught, especially in Ottoman lands, and it was translated into Turkish and Persian. A number of *ḥāshiya*'s were written on it, including one by Shirwānī who presented it to Sultan Meḥmed the Conqueror in 878/1473.[246] Another *ḥāshiya* was written by Birjandī, who took refuge in the Ottoman State after Shāh Ismāᶜīl's rise to power and the imposition of Shīᶜism in Iran. This *ḥāshiya* was widely taught in the Ottoman *madrasa*'s.[247] The author of the *Kawākib-i sabᶜa* stated that when the commentary on the *Mulakhkhaṣ*, which was considered at the middle division of

[238] Kātib Čelebī, vol.1, col. 391; Istanbul, Süleymaniye Library, Mahmud Paşa MS 325.
[239] Sayılı, *Uluğ Bey*, p. 82.
[240] Istanbul, Ragip Paşa Library, MS 922; Kātib Čelebī, vol. 1, col. 392.
[241] For the connections between Islamic astronomy and Copernicus, see now Ragep 2007 and Saliba 2007.
[242] Kusuba-Pingree.
[243] İzgi, vol.1, pp. 389–391.
[244] Kātib Čelebī, vol. 2, col. 1819; Istanbul, Süleymaniye Library, Hasan Hüsnü Paşa MS 1294/2.
[245] Istanbul, Süleymaniye Library, Hacı Mahmud Efendi MS 5685.
[246] Istanbul, Library of Topkapı Palace Museum, Ahmed III MS 3294.
[247] Istanbul, Süleymaniye Library, Yusuf Ağa MS 308/3.

the intermediate level, was taught together with Birjandī's *ḥāshiya*, the level was then ranked as more advanced.[248]

The astronomical works that were taught as textbooks and studied in the Samarqand *madrasa* were definitely not restricted to those mentioned above. In the works of the Samarqand scientists, one also finds mentioned works by Ibn Sīnā and Mu'ayyad al-Dīn al-ᶜUrḍī (d. 664/1266), a prominent member of the Marāgha school.[249] It is also of considerable historical interest that *al-Qānūn al-Masᶜūdī fī ᶜilm al-nujūm* by Abū al-Rayḥān al-Bīrūnī (d. ca. 1050), who had worked at the Ghaznawid court, is mentioned by Kāshī as having been studied in Samarqand.[250] Finally, the *Zīj-i Īlkhānī,* which was prepared under the direction of Ṭūsī in Marāgha, was also studied in Samarqand.

III.6. *Conclusions*

Although the main orientation was mathematical at the Samarqand school, many other works in various fields were also taught, as was the case for every *madrasa*. Fatḥallāh al-Shirwānī's diploma clearly indicates this. Even though Qāḍīzāde only mentioned Ījī's *Sharḥ al-Mukhtaṣar* and al-Sayyid al-Sharīf's *Sharḥ al-Mawāqif*, there must have been many other works that were studied. Between these two works, the one that is of particular importance is the *Sharḥ al-Mawāqif* because it provided the opportunity for a mathematical and philosophical perspective within a theological framework. It is well-known that al-Sayyid al-Sharīf, who had also been a teacher of Qāḍīzāde, wrote multiple drafts of criticisms of the work but was unable to make a fair copy. In addition, Shirwānī conducted three different studies on this work, and other members of the Samarqand school also conducted studies on it.

In assessing the information presented so far regarding the curriculum of the Samarqand mathematical-astronomical school, we can make the following conclusions:

1. In Islamic civilization, there was a scientific continuity that was sustained by the *ᶜulama'* despite changing political powers and fortunes. This situation clearly shows that political time and cultural time cannot be assumed to act in tandem. This scientific continuity also formed the basis of the continuity for both the world-view and the world-conception in Islamic civilization.

2. In Islamic civilization, scientific continuity was sustained mainly through works that were written in and after the thirteenth century. These works were mostly based on the logical-theological terminology that was established in the works of Fakhr al-Dīn al-Rāzī and then developed by Naṣīr al-Dīn al-Ṭūsī, Najm al-Dīn al-Qazwīnī, Sirāj al-Dīn Urmawī, and Quṭb al-Dīn al-Rāzī. Underlying their

[248] İzgi, vol.1, pp. 381–388.
[249] Saliba 1990.
[250] Istanbul, Library of the Military Museum, MS 87.

terminology and conceptions were the theological-philosophical concepts earlier developed by Ibn Sīnā.

3. In Islamic civilization, the division between arithmetical concepts based on the use of number and geometrical concepts based on the use of magnitude (this division being inherited from Greek mathematics) was bridged after the thirteenth century, after which time there was complete flexibility for translating one into the other.

4. In Islamic civilization, the basic scientific approach was that which had been established by Ibn Haytham. In astronomy, for example, this meant the combining of the physical and mathematical aspects as we see in the works of Naṣīr al-Dīn al-Ṭūsī and Quṭb al-Dīn Shīrāzī of the Marāgha school and earlier in the works of al-Kharaqī and al-Jaghmīnī. The fact that Qāḍīzāde and especially his student ᶜAlī al-Qushjī tried to remove Aristotelian physical principles from astronomy resulted in a number of significant challenges to Ibn Haytham's synthesis that had important implications for the history of science both in Ottoman lands and in Europe.[251]

5. The Platonic mathematical approach (with its scientific, moral, and metaphysical implications) formed the foundation of the Samarqand school as it had been fashioned by Qāḍīzāde; later this approach was passed on to Istanbul at the hands of ᶜAlī al-Qushjī and Fatḥallāh al-Shirwānī.

6. In the field of theoretical astronomy, the main texts of the Samarqand school were Jaghmīnī's *al-Mulakhkhaṣ*, Naṣīr al-Dīn al-Ṭūsī's *al-Tadhkira,* and Quṭb al-Dīn al-Shīrāzī's *al-Tuḥfa* and *Nihāyat al-idrāk*. Among these, *al-Tadhkira* can be viewed as the culmination of the classic understanding of *hay'a* in Islam.

7. The Samarqand school modeled itself after and built upon the accomplishments of the Marāgha school. Both the framework itself and the works that sustained this framework were mostly constructed by the members of the Marāgha school.

8. As pointed out above, the bridge between Marāgha and Samarqand was, interestingly, the renowned theologian al-Sayyid al-Sharīf. His understanding of theology provided an opportunity for both mathematical and spiritual (*ᶜirfānī*) wisdom. He wrote voluminous, high-level, and significant *sharḥ*'s and *ḥāshiya*'s on *al-Mulakhkhaṣ*, *al-Tadhkira*, *al-Tuḥfa,* and Euclid's *Elements* that triggered scientific studies in the Islamic world at the end of the fourteenth and the beginning of the fifteenth centuries.

9. As stated above, this scientific perspective of the Samarqand school, along with its content and works, was passed on to Istanbul by ᶜAlī al-Qushjī, Fatḥallāh al-Shirwānī, and, at a later date, by ᶜAbd al-ᶜAlī al-Birjandī and by other members of the school. Through ᶜAlī al-Qushjī, the "Istanbul school" formed a composite of Samarqand and Herat, namely Qāḍīzāde and Taftāzānī. In this composite, every

[251] Ragep 2001.

component was taken up at multiple levels; however, at its core, al-Sayyid al-Sharīf and his work *Sharḥ al-Mawāqif fī ᶜilm al-kalām* took a key position. As a result, in Istanbul the Tīmūrid science and wisdom perspectives that had been divided between Herat and Samarqand, as represented by Taftāzānī and Qāḍīzāde, was kept together by al-Sayyid al-Sharīf.

III.7. *New Questions, New Issues*

The diploma Qāḍīzāde gave to his student Fatḥallāh al-Shirwānī was dated 15 Rabīᶜ al-thānī 844/13 September 1440. This raises some new questions about Qāḍīzāde and the chronology of events at the Samarqand school. These issues can be listed as follows with some possible answers provided:

1. Sources give very different dates for the death of Qāḍīzāde, varying from 814/1412 to 840/1436.[252] However, the diploma provides incontrovertible proof that Qāḍīzāde was alive in 844/1440, and one can assume that he lived for some time after this date.

2. Sources claim that after the Samarqand Observatory was built Jamshīd Kāshī was appointed as the principal administrator of observational affairs. Upon his death in 832/1429, Qāḍīzāde replaced him, and when he died in 840/1436 ᶜAlī al-Qushjī took over. The only exception to this chronology is Dawlatshāh, who stated that upon Qāḍīzāde's death observational affairs were completed by Ulugh Beg.[253] Since Qāḍīzāde was alive in 844/1440, the question regarding his position as principal administrator of the Observatory should be reexamined. Unless he willingly gave up this position or was discharged by the Sultan—which seems very unlikely—he must have remained the principal administrator until he died.

3. The majority of sources report that *Zīj-i Ulugh Beg* was completed in 831/1437; this date is also supported by most modern research. However, as is pointed out by Barthold, corrections to the *Zīj* continued until the death of Ulugh Beg in 853/1449. When this information is combined with what we have stated in our second point, it can be seen that the first version of the *Zīj* was completed at least three years before Qāḍīzāde died. Therefore, it can be said that throughout the preparation of the first version of the *Zīj* the principal of the Observatory was Qāḍīzāde, and not ᶜAlī al-Qushjī. However, the fact that Ulugh Beg thanked him in the preface of the *Zīj* for his special contributions shows that ᶜAlī al-Qushjī was working at the Observatory as a practicing astronomer. This comment makes

[252] Dilgan. In various places of the first volume of his *Osmanlı Medreselerinde İlim*, Cevat İzgi pointed out the probability that this date was after 844/1440, for he knew about Fatḥallāh al-Shirwānī's diploma. Cemil Akpınar also stated the same thing in his work cited above. Neither of these authors, however, examined other issues regarding this date that I have raised here. See also Fazlıoğlu 1999b, 1999c, and 2001b.

[253] *Dawlatshāh*, pp. 361–362 (Turkish trans., vol. 3, pp. 428–429).

Qushjī's remark in his commentary, in which he attributes most of the errors in the *Zīj* to Ulugh Beg, somewhat easier to understand.

4. Furthermore, it can be assumed that Qāḍīzāde worked on correcting and revising the original version of *Zīj-i Ulugh Beg*, which was completed in 831/1437, for at least three years. This would, without doubt, increase the contribution we should attribute to Qāḍīzāde for the final version of the *Zīj*.

In conclusion, the questions and issues listed above that arise from the date of the diploma Qāḍīzāde gave to Fatḥallāh al-Shirwānī necessitate a revision of the dating and understanding of several major events at the Samarqand school.

Bibliography

Agâh Sırrı Levend, *Ali Şir Nevai:* Agâh Sırrı Levend, *ᶜAlī Shīr Navā'ī.* Vol. 1: *Hayatı, Sanatı ve Kişiliği* (Ankara, 1965).

Aka, Timur ve Devleti: İsmail Aka, *Timur ve Devleti* (Ankara, 1991).

Aka, Mirza Şahruh: İ. Aka, *Mirza Şahruh ve Zamanı* (Ankara, 1994).

Akpınar: Cemil Akpınar, "Fethullah eş-Şirvani," *Türkiye Diyanet Vakfı İslam Ansiklopedisi*, vol. 12 (Istanbul, 1995), 463–466.

ᶜAlī al-Qushjī: See Qushjī

Altıkulaç: Tayyar Altıkulaç, "İbn'ül-Cezeri," *Türkiye Diyanet Vakfı İslam Ansiklopedisi*, vol. 20 (Istanbul, 1999), 552–553.

Aydüz: Salim Aydüz, "Uluğ Bey'in Zici'nin Osmanlı Astronomi Çalışmalarındaki Yeri ve Önemi," *Bilig*, 25 (Spring 2003), 139–172.

Bagheri: Mohammad Bagheri, "A Newly Found Letter of Al-Kāshī on Scientific Life in Samarkand," *Historia Mathematica,* 24 (1997), 241–256.

Bāqirī: Muḥammad Bāqirī (=Mohammad Bagheri), *Az Samarqand bih Kāshān: nāmahʹhā-yi Ghiyāth al-Dīn Jamshīd Kāshānī bih pidarash* (From Samarqand to Kāshān: letters of al-Kāshī to his father) (Tehran, 1996).

Barthold, Ulugh-Beg: Vassiliy Viladimirovic Barthold, *Four Studies on the History of Central Asia. Vol. 2: Ulugh-Beg* (Leiden: E. J. Brill, 1958). Translated from Russian into Turkish as *Uluğ Bey ve Zamanı* by İsmail Aka (Ankara, 1997).

Barthold, Turkestan: V. V. Barthold, *Turkestan down to the Mongol Invasion*, 4th ed. (London, 1977).

Brockelmann: Carl Brockelmann, *Geschichte der arabischen Litteratur* (Leiden: E. J. Brill, 1937–1949), 2 vols. plus 3 suppl. vols.

Dawlatshāh: Dawlatshāh Samarqandī, *Tadhkirat al-shuᶜarā'*. Edited in the original Persian with prefaces and indices by Edward G. Browne (London: Luzac, 1901). Translated from Persian into Turkish as *Tezkire-i Devletşah* by Necâti Lugal, 4 vols. (Istanbul, 1977).

De Young: Gregg De Young, "The Ashkāl al-Ta'sīs of al-Samarqandī: A Translation and Study," *Zeitschrift für Geschichte der Arabisch-Islamischen Wissenschaften*, 14 (2001), 57–117.

Dilgan: Hamid Dilgan, "Qāḍī Zāda al-Rūmī," *Dictionary of Scientific Biography*, vol.11 (New York, 1980), 227–229.

Dimyāṭī: Maḥmūd ᶜUmar al-Dimyāṭī (ed.), *al-Mawāqif fī ᶜilm al-kalām* by ᶜAḍud al-Dīn al-Ījī, with the commentary of al-Sayyid al-Sharīf al-Jurjānī and the supercommentaries of Ḥasan Čelebī and ᶜAbd al-Ḥakīm al-Siyālkūtī, 8 vols. (Beirut, 1998).

Eshenkulova: Kishimjan Eshenkulova, "Timurlular Devri Medrese Eğitimi ve Ulum el-Evail" (Matematik-Astronomi ve Tıb), Master's thesis, Istanbul University (Social Sciences Institute, History of Science Department), 2001.

Faber: Richard L. Faber, *Foundations of Euclidean and Non-Euclidean Geometry*, *Monographs and Textbooks in Pure and Applied Mathematics* (New York: Dekker, 1983).

Fazlıoğlu 1998a: İhsan Fazlıoğlu, "Osmanlı Coğrafyasında İlmi Hayatın Teşekkülü ve Dâvûd el-Kayserî (656-660/1258-1261–751/1350)," *Uluslararası Dâvûd el-Kayserî Sempozyumu Tebliğleri* (Kayseri, 1998), 25–42.

Fazlıoğlu 1998b: İ. Fazlıoğlu, "Hendese: Osmanlı Dönemi," *Türkiye Diyanet Vakfı İslam Ansiklopedisi*, 17 (Istanbul, 1998), 199–208.

Fazlıoğlu 1998c: İ. Fazlıoğlu, "Hesap: Osmanlılar'da Hesap," *Türkiye Diyanet Vakfı İslam Ansiklopedisi*, 17 (Istanbul, 1998), 244–257; "Osmanlılar'da Hesab-ı Hevai," ibid., 257–260; "Osmanlılar'da Hesab-ı Hindi," ibid., 262–265; "Osmanlılar'da Hesab-ı Sittini," ibid., 266–268; "Hesap Yöntemleri: (A) Hesab-ı A'adad-i Erbaat Mütenasibe, 268–269, (B) Hesab-ı Hataeyn, 269–271, (C) Hesab-ı Tahlil ve Teaküs, 271," ibid.

Fazlıoğlu 1999a: İ. Fazlıoğlu, "Abdulalī Bircendī," *Yaşamları ve Yapıtlarıyla Osmanlılar Ansiklopedisi*, 1 (Istanbul, 1999), 33–34.

Fazlıoğlu 1999b: İ. Fazlıoğlu, "Ali Kuşçu," *Yaşamları ve Yapıtlarıyla Osmanlılar Ansiklopedisi*, 1 (Istanbul, 1999), 216–219.

Fazlıoğlu 1999c: İ. Fazlıoğlu, "Musa (Kadı-zade)," *Yaşamları ve Yapıtlarıyla Osmanlılar Ansiklopedisi*, 2 (Istanbul, 1999), 255–258.

Fazlıoğlu 2001a: İ. Fazlıoğlu, "Selçuklu Döneminde Anadolu'da Felsefe ve Bilim-Bir Giriş-," *Cogito*, 29 (Istanbul, 2001), 152–168.

Fazlıoğlu 2001b: İ. Fazlıoğlu, "Kadızade-i Rumi," *Türkiye Diyanet Vakfı İslam Ansiklopedisi*, 24 (Istanbul, 2001), 98–100.

Fazlıoğlu 2002: İ. Fazlıoğlu, "Euclides Geometrisi 'Süreklilik Aksiyomu' Açısından Eleştirilebilir mi?" *Kutadgubilig*, 1 (Istanbul, 2002), 215–228.

Fazlıoğlu 2003: İ. Fazlıoğlu, "Osmanlı felsefe-biliminin arkaplanı: Semerkand matematik-astronomi okulu," *Dîvân İlmî Araştırmalar,* 14 (2003/1), 1–66.

Fazlıoğlu 2006: İ. Fazlıoğlu, "Anadolu Selçukluları ve Beylikler Dönemi Türk Felsefe-Bilim Tarihine Önsöz," in *Anadolu Selçukluları ve Beylikler Dönemi Uygarlığı*, ed. Ahmet Yaşar Ocak, vol. 1 [Sosyal ve Siyasal Hayat] (Ankara, 2006), 413–427.

Fazlıoğlu, Ş 2003a: Şükran Fazlıoğlu, "Manzume fi tertip el-kutub fi el-ulum ve Osmanlı Medreseleri'ndeki Okutulan Ders Kitapları," *Değerler Eğitimi Dergisi*, 1/1 (January 2003), 97–110.

Fazlıoğlu, Ş 2003b: Ş. Fazlıoğlu, "Nebi Efendi-zade'nin *Kaside fi el-kutub el-meşhure fi el-ulum'una* göre bir medrese ders talebesinin ders ve kitab haritası," *Kutadgubilig*, 3 (Istanbul, 2003), 191–221.

Fazlıoğlu, Ş 2005: Ş. Fazlıoğlu, "Ta'līm ile İrşād Arasında: Erzurumlu İbrahim Hakkı'nın Medrese Ders Müfredatı," *Dîvân-İlmî Araştırmalar,* 18 (2005/1), 115–173.

Gümüş: Sadreddin Gümüş, *Seyyid Şerîf Cürcânî* (Istanbul, 1984).

Heath: Thomas L. Heath, *The Thirteen Books of Euclid's Elements*, 3 vols. (New York: Dover, 1956).

Heidarzadeh 1997: Tofigh Heidarzadeh, "Ali Kuşçu'nun Astronomi Eserleri," unpublished Master's thesis, Istanbul University (Social Sciences Institute, History of Science Department), 1997.

Heidarzadeh 1998: T. Heidarzadeh, "İranlı Alimlerin Osmanlı Devleti'ne Gelişi ve Osmanlı Bilimine Katkıları (Timur Döneminin Başından Safevi Döneminin Sonuna Kadar)," *Osmanlı Bilimi Araştırmaları,* II (Istanbul, 1998), 211–242.

Humāyūn Farrukh: Rukn al-Dīn Humāyūn Farrukh, *History of Books and the Imperial Libraries of Iran* (Tehran, 1968). Translation by Abutaleb Saremi of *Kitāb va kitābkhānah'hā-yi shāhanshāhī-i Īrān*.

Ibn al-Akfānī: Muḥammad ibn Ibrāhīm ibn al-Akfānī, *Irshād al-qāṣid ilā asnā al-maqāṣid fī anwā' al-ᶜulūm*, eds. Maḥmūd Fākhūrī, Muḥammad Kamāl, and Ḥusayn al-Ṣiddīq (Beirut, 1998).

Ibn ᶜArabshāh: Abū al-ᶜAbbās Shihāb al-Dīn Aḥmad ibn Muḥammad Ibn ᶜArabshāh, *ᶜAjā'ib al-maqdūr fī nawā'ib Tīmūr,* ed. Aḥmad Fā'iz al-Ḥumsī (Beirut, 1986).

İsmail Paşa: İsmail Paşa al-Bağdadı, *Hadiyyat al-ᶜārifīn: asmā' al-mu'allifīn wa-āthār al-muṣannifīn*, 2 vols. (Istanbul, 1951–1955).

İzgi: Cevat İzgi, *Osmanlı Medreselerinde Ilim*. 2 vols. (Istanbul: İz, 1997).

Jaouiche: K. Jaouiche, *La Théorie des parallèles en pays d'islam: Contribution à la préhistoire des géométries non-Euclidiennes* (Paris: Vrin, 1986).

Kātib Čelebī: Kātib Čelebī, *Kashf al-ẓunūn ᶜan asāmī al-kutub wa-'l-funūn*, 2 vols. (Istanbul, 1941, 1943). [Pagination is according to columns.]

Kattānī: ᶜAlī al-Muntaṣir al-Kattānī, *Riḥlat Ibn Baṭūṭa*, vol.1 (Beirut, 1985).

Kennedy: E. S. Kennedy, "Ulugh Beg as Scientist," in *Astronomy and Astrology in the Medieval Islamic World* (Aldershot: Ashgate, 1998), chapter 10.

Khwandamir: Ghiyāth al-Dīn ibn Humām al-Dīn Khwānd Mīr, *Tārīkh-i ḥabīb al-siyar fī akhbār afrād bashar*, 4 vols. (Tehran: Khayyām Press, 1333/1954; reprinted in 1353/1974). Tome Three, parts one and two, translated into English by Wheeler M. Thackston (Cambridge: Department of Near Eastern Languages and Civilizations, Harvard University, 1994).

Kusuba-Pingree: Takanori Kusuba and David E. Pingree, *Arabic Astronomy in Sanskrit: Al-Birjandī on Tadhkira* II*, Chapter 11, and Its Sanskrit Translation* (Leiden: E. J. Brill, 2002).

Madelung: Wilferd Madelung, "al-Taftāzānī," *Encyclopaedia of Islam*, 2d ed., vol. 10 (Leiden: E. J. Brill, 2000), 88–89.

Manz: Beatrice F. Manz, "Tīmūrids," *Encyclopaedia of Islam*, 2d ed., vol. 10 (Leiden: E. J. Brill, 2000), 513–516.

Maᶜrūf, Madāris: Nājī Maᶜrūf, *Madāris qabla al-Niẓāmiyya* (Baghdad, 1393/1973).

Maᶜrūf, ᶜUlamā': N. Maᶜrūf, *ᶜUlamā' al-niẓāmiyyāt wa-madāris al-Mashriq al-Islāmī* (Baghdad, 1393/1973).

Mawaldi: Muṣṭafā Mawāldī (ed.), *Asās al-qawāᶜid fī uṣūl al-fawā'id li-Kamāl al-Dīn al-Fārisī* (Cairo: Institute of Arabic Manuscripts, 1994).

Mehmed Tahir: Bursalı Mehmed Tahir, *Osmanlı Müellifleri*, 3 vols. (Istanbul, 1334–1343 [1915-6–1924-5]).

Mirbabayev: A. K. Mirbabayev, "The Islamic Lands and Their Culture," *History of Civilization of Central Asia*, vol. 4, part 2 (UNESCO, 2000), 31–43.

Mīrkhwānd: Muḥammad ibn Khwāndshāh Mīrkhwānd, *Rawḍat al-ṣafā' fī sīrat al-anbiyā' wa-'l-mulūk wa-'l khulafā'*, vol. 6 (Tehran, 1960).

Neubauer: Eckhard Neubauer, "Neuerscheinungen zur arabischen Musik," *Zeitschrift für Geschichte der Arabisch-Islamischen Wissenschaften,* 1 (Frankfurt, 1984), 290–296.

Niẓām al-Dīn Shāmī: Niẓām al-Dīn Shāmī, *Ẓafarnāmah* (Tehran: Bāmdād, 1363 [1984]). Translated from Persian into Turkish as *Zafernâme* by Necâti Lugal (Ankara: Türk Tarih Kurumu Basımevi, 1949–1987).

OALT: Ramazan Şeşen, Cevat İzgi, Cemil Akpınar, and İhsan Fazlıoğlu (gen. ed. Ekmeleddin İhsanoğlu), *Osmanlı Astronomi Literatürü Tarihi*, 2 vols. (Istanbul, 1997).

OMALT: Ramazan Şeşen and Cevat İzgi (gen. ed. Ekmeleddin İhsanoğlu), *Osmanlı Matematik Literatürü Tarihi*, 2 vols. (Istanbul, 1999).

OMULT: Ramazan Şeşen, Gülcan Gündüz, and M. Serdar Bekar (gen. ed. Ekmeleddin İhsanoğlu), *Osmanlı Musiki Literatürü Tarihi* (Istanbul, 2003).

Pingree 1978: David Pingree, "Islamic Astronomy in Sanskrit," *Journal for the History of Arabic Science,* 2 (1978), 315–330.

Pingree 1996: D. Pingree, "Indian Reception of Muslim Versions of Ptolemaic Astronomy," in *Tradition, Transmission, Transformation: Proceedings of Two Conferences on Premodern Science Held at the University of Oklahoma,* eds. F. Jamil Ragep and Sally P. Ragep (Leiden: E. J. Brill, 1996), 471–485.

Qurbānī: Abū al-Qāsim Qurbānī, *Kāshānī'nāmah: aḥwāl wa-āthār-i Ghiyāth al-Dīn Jamshīd Kāshānī* (Tehran, 1350 [1971–1972]).

Qushjī, ᶜAlī al-, *Risāla dar ᶜilm al-hay'a* (Tehran, no date given [nineteenth-century lithograph]).

Ragep 1993: F. Jamil Ragep, *Naṣīr al-Dīn al-Ṭūsī's Memoir on Astronomy* (*al-Tadhkira fī ᶜilm al-hay'a*), 2 vols. (New York: Springer-Verlag, 1993).

Ragep 2001: F. J. Ragep, "Freeing Astronomy from Philosophy: An Aspect of Islamic Influence on Science," *Osiris,* 16 (2001), 49–71.

Ragep 2007: F. J. Ragep, "Copernicus and His Islamic Predecessors: Some Historical Remarks," *History of Science,* 45 (2007), 65–81.

Roemer: Hans R. Roemer, "Timurlular," *Milli Eğitim Bakanlığı İslam Ansiklopedisi*, 12/1 (Istanbul, 1974), 346–370.

Rozenfeld-Youshkevich: B. A. Rozenfeld and A. P. Youshkevich, *Naẓariyyat al-khuṭūṭ al-Mutawāziya fī al-maṣādir al-ᶜarabiyya*. Translated from Russian into Arabic by Sāmī Shalhūb and Kamāl Najīb ᶜAbd al-Raḥmān (Aleppo: Institute for the History of Arabic Science, 1989).

Sakhāwī: Muḥammad ibn ᶜAbd al-Raḥmān al-Sakhāwī, *al-Ḍaw' al-lāmiᶜ li-ahl al-qarn al-tāsiᶜ*, 12 vols. (Cairo, 1353–1355 [1935–1936]).

Salāma: Klūd (Claude) Salāma, "Introduction" to Saᶜd al-Dīn Masᶜūd ibn ᶜUmar al-Taftāzānī's *Sharḥ al-ᶜaqā'id al-nasafiyya fī uṣūl al-dīn wa-ᶜilm al-kalām*, ed. Klūd Salāma (Damascus, 1974).

Saliba 1990: George Saliba, *The Astronomical Work of Mu'ayyad al-Dīn al-ᶜUrḍī* (Kitāb al-Hay'a)*: A Thirteenth Century Reform of Ptolemaic Astronomy* (Beirut, 1990).

Saliba 2004: G. Saliba, "Reform of Ptolemaic Astronomy at the Court of Ulugh Beg," in *Studies in the History of the Exact Sciences in Honour of David Pingree*, eds. C. Burnett et al. *(*Leiden: E. J. Brill, 2004), 810–824.

Saliba 2007: G. Saliba, *Islamic Science and the Making of the European Renaissance* (Cambridge MA: The MIT Press, 2007).

Salih Zeki: Salih Zeki, *Asâr-ı bâkiye,* 2 vols. (Istanbul, 1329 [1913 or 1914].

Samarqandī: Abū Ṭāhir Samarqandī, *Samariyya,* ed. Īraj Afshār (Tehran, 1965).

Sayılı, Higher Education: Aydın Sayılı, "Higher Education in Medieval Islam: The Madrasa," *Annales de l'Université d'Ankara* (The Ankara University Yearbook), 2 (Ankara, 1948), 41–87. Translated into Turkish as "Ortaçağ İslam Dünyasında Yüksek Öğretim: Medrese" by Recep Duran, n.p., 2002, 1–39.

Sayılı, "Rasathane": A. Sayılı, "Rasathane," *Milli Eğitim Bakanlığı İslam Ansiklopedisi*, 9 (1964), 627–632.

Sayılı, Uluğ Bey: A. Sayılı, *Uluğ Bey ve Semerkand'daki İlim Faaliyetleri hakkında Giyasuddin-i Kaşi'nin Mektubu*, 2nd ed. (Ankara, 1985).

Sayılı, Observatory: A. Sayılı, *The Observatory in Islam and its Place in the General History of the Observatory* (Ankara, 1988). [Printed originally in Ankara: Turkish Historical Society, 1960. Translated into Arabic as *al-Marāṣıd al-falakiyya fī al-ᶜālam al-Islāmī* by Abdullah O. Al-Omar (Kuwait, 1995).]

ŞN: see Ṭāshkubrīzāde

Subtelny: Maria Eva Subtelny, "The Vaqfiya of Mir ᶜAli Şir Nava'i as Apologia," *Journal of Turkish Studies,* 15 (1991), 257–286.

Subtelny-Khalidov: Maria Eva Subtelny and Anas B. Khalidov, "The Curriculum of Islamic Higher Learning in Timurid Iran in the Light of Sunni Revival under Shāh-Rukh," *Journal of the American Oriental Society,* 115/2 (1995), 210–236.

Süreyya: Mehmed Süreyya, *Sicill-i Osmanî*, 4 vols. (Istanbul, 1308–1316 [1891–1898]).

Suwaysī: Muḥammad Suwaysī (ed.), *Ashkāl al-ta'sīs li-'l-Samarqandī* with the *Sharḥ Ashkāl al-ta'sīs li-Qāḍīzāde al-Rūmī* (Tunis, 1984).

Ṭāshkubrīzāde, ŞN: Aḥmad ibn Muṣṭafā Ṭāshkubrīzade, *al-Shaqāi'iq al-Nuᶜmāniyya fī ᶜulamā' al-Dawlat al-ᶜUthmāniyya*, ed. Ahmed Subhi Furat (Istanbul, 1985).

ᶜUmayra: ᶜAbd al-Raḥmān ᶜUmayra (ed.), S*harḥ al-Maqāṣid* by Masᶜūd ibn ᶜUmar Taftāzānī, 5 vols. (Beirut, 1989).

Ünver: Süheyl Ünver, "Türk Pozitif İlimler Tarihinden Bir Bahis: Ali Kuşci Hayatı ve Eserleri," in *İstanbul Risaleleri*, ed. İsmail Kara, vol. 2 (Istanbul, 1995), 203–307.

Uslu 1997: Recep Uslu, *Herat Tarihi* (Istanbul, 1997).

Uslu, "*Herat":* R. Uslu, "Herat," *Türkiye Diyanet Vakfı İslam Ansiklopedisi*, vol. 17 (Istanbul, 1998), 215–218.

Valihocayev: Baturhan Valihocayev, *Uluğ Bey Devri Medreseleri*. Translated into Turkish by Kishimjan Eshenkulova (Istanbul, 2004).

Yalçın: Alemdar Yalçın, *Tüzükat-i Timurin ve Cengiz Yasası* (Istanbul, 1974).