NAZARİYAT

Ghulām Sinān's Commentary on *al-Risāla al-Fatḥiyya*

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Abstract: Some of the scholars who were left without a patron due to the assassination of Ulugh Beg (d. 1449), the founder of the Samarqand Madrasa and Observatory, migrated to Anatolian lands. Scholars including Fatḥallāh al-Shirwānī (d. 1486) and ʿAlī Qūshjī (d. 1474) carried the Samarqand astronomical tradition to these lands. ʿAlī Qūshjī, who served as a scholar at the Ṣaḥn-i Thamān and Ayasofya madrasas, trained many students in what can be considered a short period of time and helped theoretical astronomy gain momentum in Ottoman lands. Among these students was Ghulām Sinān (d. 1506-7). Ghulām Sinān wrote a commentary on his teacher's work, which he had written under the title *al-Risāla al-Fatḥiyya* during his tenure as a scholar. This commentary, which Ghulām Sinān wrote under the title *Fatḥ al-Fatḥiyya*, is one of two extant commentaries on *al-Risāla al-Fatḥiyya*. The work is important not only because it is a commentary on one of the first theoretical astronomical works written in the Ottoman Empire, but perhaps more importantly because it conveys detailed testimonies about the teacher–student relationship of the period and about how lessons were actually taught. This approach, which is uncommon in the history of science, makes this work very important. The main purpose of this paper is not to explain the theoretical issues covered in the work, even if they are mentioned due to the subject. Rather, the focus of the study is on Ghulām Sinān's relationship with his teacher ʿAlī Qūshjī, which sometimes involved intellectual arguments and disagreements. In addition, through references to various individuals and books, an attempt is made to reveal the sources Sinān was drawing from.

Key words: Ghulām Sinān, ʿAlī Qūshjī, *al-Risāla al-Fatḥiyya, Fatḥ al-Fatḥiyya,* history of science, history of astronomy

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Ghulām Sinān's Life and Works

The sources give very little information about the life of Sinān al-Dīn Yūsuf, who came to be known as Ghulām Sinān. He was a slave of one of the viziers of Sultan Murad II (r. 1446-1451); hence the term Ghulām in his name. He received a good education from an early age. After completing his own madrasa education, he went on to work in the madrasa system, including the Manastir and Sulṭānīyah Madrasas in Bursa, and then was appointed as a *mudarris* in one of the Ṣaḥn-i Thamān madrasas with a daily salary of fifty dirhams. His salary was increased over time to eighty dirhams, and he retained this appointment until his death.[1] Some sources record that he died in 912 (1506-7) and that he also built the Elvān Mosque.[2] Ṭāshkubrīzāda Aḥmad b. Muṣṭafā (d. 1561) states that Ghulām Sinān spent all of his time in the pursuit of knowledge and in worship. He states that he saw Sinān's commentary on Qadi Naṣir al-Dīn al-Bayḍawi's (d. 1319) *Tafsīr* and that it was quite detailed.[3] A similar treatment is also seen in *Fatḥ al-Fatḥiyya*. Ghulām Sinān's only extant work other than *Fatḥ al-Fatḥiyya* is titled *Ḥāshiya ʿalā Sharḥ al-Wiqāya* or *Ḥāshiya ʿalā Ḥāshiya Ahī Čelebī ʿalā Sharḥ al-Wiqāya* and is a commentary on Ahī Čelebī's[4] (d. 1500) *Dhakhīrat al-ʿUqbā*[5] on *Sharḥ al-Wiqāya*.[6]

ʿAlī Qūshjī's Arrival in Istanbul

ʿAlī Qūshjī was one of the key individuals in charge at the Samarqand Observatory built by Ulugh Beg. He became the head of the observatory after the death of Qāḍīzāda al-Rūmī in 844/1440 and remained in this position until Ulugh Beg (r. 1447-1449.)

1 Aḥmad ibn Muṣṭafā Ṭāshkubrīzāda, *al-Shaqāʾiq al-Nuʿmāniyya*, trans. Muhammet Hekimoğlu (Yazma Eserler Kurumu Başkanlığı, 2019), 445.

2 Mehmed Thurayyā, *Sijill-i ʿUthmānī v. III* (Matbaa-i Āmire, 1311), 104.

3 Ṭāshkubrīzāda, *al-Shaqāʾiq*, 445.

4 Ahīzāda Yūsuf b. Junayd al-Tuqādī d. 905/1500). Ahī Čelebī, like Ghulām Sinān, served as a *mudarris* at the Bursa Sulṭānīyah Madrasa for a while and then moved to one of the Ṣaḥn-i Thamān madrasas. For the relationship between these two scholars, see Şükrü Özen, "Sahn-ı Sema'da Bir Atışma: Gulam (Köle) Sinan'ın Mektubu," *Osmanlı Araştırmaları* 38, no. 38 (2011): 160-92.

5 Şevket Topal and Seyit Badır, "Hanefî Fıkıh Yazıcılığında Hâşiye Geleneği: Ahîzâde'nin Zahîratü'l-Ukbâ Adlı Eseri Örneği," *Recep Tayyip Erdoğan Üniversitesi İlahiyat Fakültesi Dergisi*, no:21 (2022): 129.

6 For manuscripts see: Istanbul, Süleymaniye Library, Şehid Ali Pasha MS 2844 (ff. 96-105) and Istanbul, Süleymaniye Library, Bağdatlı Vehbi MS 2052 (ff. 89-111).

was killed by his son ʿAbd al- Laṭīf in 1449. The observatory did not survive long after Ulugh Beg's murder. The disruption of scientific research in Samarqand caused by political turmoil, as well as the difficulty of finding patronage, led ʿAlī Qūshjī and other scholars to seek safer places and patrons. Qūshjī therefore left Samarqand and traveled to Herat. Here he entered into the service of the Timurid ruler Abū Saʿīd Mīrzā (r. 1451-1469).

Qūshjī dedicated his commentary on Naṣīr al-Dīn al-Ṭūsī's (d. 1274) *Tajrīd al-iʿtiqād* to Abū Saʿīd. However, the treatment he received due to the ruler's lack of intellectual curiosity put him in a troubled situation. After Abū Saʿīd was defeated by the Aq Qoyunlu ruler Uzun Hasan (r. 1453-1478) in 1469, Qūshjī went to Tabriz. Uzun Hasan asked him to go to Istanbul and act as a goodwill envoy between himself and Sultan Mehmed II. Mehmed II welcomed Qūshjī, who arrived in Istanbul in 1470, and offered him to enter his service.[7] Qūshjī accepted the offer and set off for Istanbul after

7 Idrīs-i Bitlisī, one of the scholars at the time of Sultan Bāyezid II, in his work *Hesht Behisht*, attributes ʿAlī Qūshjī's arrival in Istanbul to the friendship established through Fanārīzāde Ali Čelebī (Idrīs-i Bitlisī, *Heşt behişt VII. ketîbe*, trans. Muhammed İbrahim Yıldırım (Türk Tarih Kurumu, 2013), 25-27.: "After ʿAbd al- Laṭīf, Mīrzā Ulugh Beg's son-in-law Mīrzā ʿAbd Allāh became sultan in Samarqand. Meanwhile, Abū Saʿīd, who had been imprisoned since the time of ʿAbd al- Laṭīf, escaped from prison with a few others and rebelled in Bukhara. He immediately moved towards Samarqand and seized the sultanate … Unlike Shahrukh's sons, Abū Saʿīd's temperament was inclined towards Islam and justice. He gradually began conquests.

During his reign, he was secretly devoted and affectionate towards Sultan Mehmed II (the Conqueror). He treated those who traveled to and from the land of Rūm with respect and reverence. During his time, the now deceased Fanārīzāde ʿAlī Čelebī had come to Herat to attend the circles of Mawlānā Shaykh Ḥusayn Muḥtasib, the Most Learned (*al-ʿallāma*) of his time, in order to study his knowledge. Before returning, he stopped by Ghāzī Sulṭān. The Sultan, who welcomed him very warmly and showed him honour and hospitality, facilitated his return and sent a letter to Sultan Mehmed II. In this way, the bond between the two Sultans strengthened. The friendship between the two Sultans gradually increased with the exchange of letters and ambassadors, as well as with the continued travel of merchants and caravans. In this way, Sultan Mehmed II was attracting the prayers and favor of the scholars of Māwarāʾ al-Nahr and Khurāsān.

Mawlānā ʿAlī Qūshjī, the observer of the sky from the clan of sages and scholars, the master of the mathematical sages, the resolver of the issues of the future and past scholars, each of his works is a source for scholars and each of his investigations is to the extent that it amazes the human mind; he left his homeland of Māwarāʾ al-Nahr and Khurāsān and came to the land of Rūm with all his relatives and dependants, attracting the Sultan's graces and grants like a magnet. He continued his scientific studies with the grants of the Sultan and his dynasty until the end of his life."

Although Bitlisī's claim that ʿAlī Qūshjī migrated to Ottoman lands without entering the service of Uzun Hasan is not correct, it is understood that the friendly relations established by Mehmed II with the Khurāsān region were a strong factor in ʿAlī Qūshjī's decision.

completing his ambassadorial mission. When Mehmed II heard of ʿAlī Qūshjī's departure, he sent men to meet him at the Aq Qoyunlu-Ottoman border and also asked for an travel allowance to be allocated for each stopover. He arrived in Istanbul with an entourage of about 200 people, and was welcomed with great ceremonies and gifts. When the news of his arrival in Uskudar was heard, Mehmed II had a ship prepared and sent some of the scholars of Istanbul to meet him. Among those who welcomed him was Hodjazāda Muṣliḥ al-Dīn Effendi (d. 1488), one of the famous scholars of the period. It is rumored that during the crossing of the Bosphorus, a conversation took place between Qūshjī and Effendi about the tide phenomenon. When he arrived in the Sultan's presence, he presented his mathematical work, *al-Risālah al-Muḥammadiyyah fī al-ḥisāb*, which he dedicated to him. He taught at Ṣaḥn-i Thamān Madrasa for a while. After the battle of Otluqbeli in 1473, Mehmed II appointed him as a *mudarris* at the Ayasofya Madrasa with a daily salary of two hundred *akche*. He died in Istanbul in 1474.[8]

ʿAlī Qūshjī's lectures on astronomy and mathematics were very popular among the scholars of Istanbul.[9] Important scholars of the period followed Qūshjī's lectures either in person or through their students. This included Mehmed II himself, who asked Sinān Pasha (d. 1486)–who was his own teacher at the time–to follow Qūshjī's lectures. Pasha assigned his student Mulla Lutfī (d. 1495) to this task, and so after Lutfī attended these lessons, he would convey them in the evenings back to Pasha.[10] Ghulām Sinān was also among the group of students who followed these lessons.

Ghulām Sinān wrote a commentary on his teacher ʿAlī Qūshjī's astronomical work, *al-Risāla al-Fatḥiyya*, under the title *Fatḥ al-Fatḥiyya*. This commentary is one of the two extant commentaries of the work. The other commentary was made by Mīram Čelebī (d. 1525) under the title *Sharḥ al-Fatḥiyya fī ʿİlm al-Hayʾa*.[11]

8 Ṭāshkubrīzāda, *al-Shaqāʾiq*, 269-271.

9 For a detailed study on the Samarqand mathematical-astronomical tradition and its reception in the Ottoman lands, see, İhsan Fazlıoğlu, "Osmanlı Felsefe-Biliminin Arkaplanı: Semerkand Matematik-Astronomi Okulu," *Dîvân İlmî Araştırmalar,* no.14 (2003): 1-66.

10 Ṭāshkubrīzāda, *al-Shaqāʾiq*, 293.

11 For a study analyzing ʿAlī Qūshjī's work through a consideration of his commentaries, see, Hasan Umut, "Theoretical Astronomy in the Early Modern Ottoman Empire: ʿAlī Qūshjī's Al-Risāla al-Fatḥiyya" (PhD diss., McGill University, 2019).

Fatḥ al-Fatḥiyya

According to the information given by Ghulām Sinān in the introduction to his work, ʿAlī Qūshjī named his work "*al-Fatḥiyya*" because he completed it near the time of the conquest of one of Uzun Hasan's castles during the last period of the caliphate of Sultan Mehmed II. A note in the text indicates that the castle in question was Karahisar Castle.[12] The fortress came under the Ottoman Empire's rule after the Battle of Otluqbeli between Sultan Mehmed II and the Aq Qoyunlu ruler Uzun Hasan in 1473. He also states that he named his work *Fatḥ al-Fatḥiyya* because the conquest of many of the castles in the country held by the strongest and fiercest of the infidels of the time was imminent at the time of Sultan Bāyezīd II (r. 1481-1512). The date of the book's writing is recorded as 890/1485 at the end of the work. Eight copies of the work are extant.[13] In this study, we use one of the oldest copies–which is very rich in marginal notes–held in Süleymaniye Library, Fatih, MS 5396/3, ff. 78b-188a.[14]

At the beginning of his work, Ghulām Sinān states that his teacher ʿAlī Qūshjī organized *al-Risāla al-Fatḥiyya* into three books (*maqālah*). The first book deals with the order and structure of the celestial spheres (*hay'a*) and related topics. The second book is about the *hay'a* of the Earth and related topics, and the third and last book deals with the size and distance of the celestial bodies.

Sinān states that the first book consists of an introduction (*muqaddimah*) and six chapters (*bāb*). The sixth of these contains four parts (*faṣl*). The second book consists of 10 chapters, and the third book consists of an introduction and six chapters. According to the author, the first book should be treated differently from the other two. This is because, according to him, as is clearly seen in al-Sayyid al-Sharīf al-Jurjānī's (d. 1413) *Sharḥ al-Tadhkirah fī al-hay'ah*, only the part beginning with the first book is an excellent introduction to astronomy.

According to Sinān, if his teacher does not explain something at the beginning of the work, it is because he will explain it in a summarized way further on at the appropriate time. Sinān states that this method is not used in the books of rhetoric, and gives as examples the works of Abū Yaʿqūb al-Sakkākī's (d. 1229) *Miftāḥ al-ʿUlūm*

12 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, Süleymaniye Library, Fatih, MS 5396/3, f. 78b.

13 For a list of copies see, Ekmeleddin İhsanoğlu, et al., *Osmanlı Astronomi Literatürü Tarihi* (IRCICA, 1997), 68.

14 I would like to thank Prof. Dr. Ömer Türker for his valuable help during my work.

and Saʿad al-Dīn al-Taftāzānī's (d. 1390) *Mukhtaṣar al-Maʿānī*, which were taught in Ottoman madrasas at the time.[15] In a matter related to grammar, he refers to ʿAlī b. ʿUmar al-Kātibī's (d. 1277) commentary on Fakhr al-Dīn al-Rāzī's (d. 1210) *al-Muḥaṣṣal*, entitled *al-Mufaṣṣal fī Sharḥ al-Muḥaṣṣal*.[16]

We see that some Ottoman scholars are referred to or criticized in the work. For example, after stating that the evidence for Avicenna's (d. 1037) claim that "the places on the equator are the most moderate regions" is given in detail in *Sharḥ al-Tadhkirah*, it is stated that the subject is explained more briefly in Ibn al-Nafīs' (d. 1288) *al-Mūjaz fī al-Ṭibb*, which summarizes Avicenna's *Al-Qānūn fī al-Ṭibb*. Then the following passage is quoted from a certain "Jamāl al-Dīn", who is referred to as the commentator of *al-Mūjaz*:

> "Preferred in terms of moderation are places where there are no terrestrial influences from mountains, seas and other things. The air of a place on a mountain is cold, the valley is the opposite, the proximity of the sea moisturizes and cools, and the land is the opposite."[17]

The commentator mentioned above must be Jamāl al-Dīn Aqsarāyī (d. 1388-89?),[18] who wrote a commentary on Ibn al-Nafīs' work under the title *Ḥall al-Mūjaz*. Fakhr al-Dīn al-Rāzī's description of the fourth climate (iqlīm) as the most moderate region seems to be the preference of Ghulām Sinān as well. In this section, he again quotes Aqsarāyī, stating "There may be obstacles to moderation at the equator, so it is outside the preferable region mentioned above."

The Introduction of *Fatḥ al-Fatḥiyya* is devoted to geometric objects. Here, topics such as point, angle, line, surface, and sphere are discussed. After giving his teacher's definitions, Sinān explains what he considers to be important about the subject, while also mentioning differences of opinion. For example, on the topic of the circular line he states:

15 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 79b.

16 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 178b.

17 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 146a.

18 His full name is Jamāl al-Dīn Meḥmed bin Meḥmed bin Meḥmed bin Meḥmed bin Imām Fakhr al-Dīn Muḥammad al-Rāzī. He was educated in the early Ottoman period and wrote works in the fields of *tafsīr*, language, literature and medicine. He was a scholar at the Zinjiriya Madrasa in Karaman. see, Ṭāshkubrīzāda, *al-Shaqā'iq*, 48-51.

> "The circular line is finite only in terms of quantity; it does not end with a point. As al-Sayyid al-Sharīf al-Jurjānī states in *Sharḥ al-Tadhkirah*, if the line has a pointable end, it is not finite in the sense of the circumference of the circle and similar such things that encircle a surface. However, it is finite in quantity. A finite quantity can measure it a finite number of times. As an objection to his [al-Jurjānī's] statement, *ustādh* [ʿAlī Qūshjī] said: "There is definitely an actual (*bi-l-fiʿl*) point on the circumference of the circle, even if it is on the circumference of ellipses and truncated cones."

Sinān adds that this statement is a strong objection to Hodjazāda Muṣliḥ al-Dīn Effendi's statement.[19] Another example of disagreement can be seen in the section defining an angle:

> "They disagree about the definition of the angle. Ibn al-Haytham said that the angle is in the position category. A non-investigator (*ghayr muḥaqqiq*) says that the angle is in the relativity category and justifies his view with Yaʿqūb al-Kindī's following statement in his definition of the angle: '[an angle] is the contact of two lines at a point so as to encircle the surface.' Shaykh Abū ʿAlī[20] refuted this view."[21]

In addition to being one of the first theoretical astronomy books written in Ottoman lands, Ghulām Sinān's work also contains valuable anecdotes about the author's dialogues with his teacher ʿAlī Qūshjī, his views, and how their lessons were taught.

For example, Qūshjī defines a right angle through the statement, "An angle is 'right' if it encloses four equal angles after its two sides are expanded". According to Sinān, Qūshjī states that this definition is preferable and better than the definitions of Shams al-Dīn al-Samarqandī (d. 1303) and Naṣīr al-Dīn al-Ṭūsī in *Ashkāl al-taʾsīs* and *al-Tadhkira fī ʿilm al-hay'a*. According to him, "It is one of the two equal angles that occur on either side of a line perpendicular to another line."[22]

In the passage in which he discusses the orbits of the upper and lower planets, Ghulām Sinān refers to al-Jurjānī's *Sharḥ al-Tadhkirah* and states that both the epicyclic and eccentric theories can be used in relation to the upper planets, whereas for the lower planets, only the epicyclic theory can be used. He says that Qūshjī said, "I saw these words in Quṭb al-Dīn al-Shīrāzī's handwritten marginal notes".[23]

19 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 80a-b.

20 Avicenna.

21 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 84a-b.

22 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 86a.

23 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 116b.

There are many references to the discussions between the teacher and his student in the work. According to Sinān's account, although his teacher generally agreed with him, he sometimes changed his original opinion as a result, but sometimes did not. For example, regarding the illustrated figures utilized in the section on moon and planet models, he recounts the discussion that took place in the class:

> "While reading this lesson, I told *ustādh* that these two shapes were really ugly, and that they did not conform either to reason (ʿ*aql*) nor to what had been transmitted (*manqūl*). So I instead pointed out a correction and told him how it should be. *Ustādh* thought for a while. Then he accepted what I said and [he replaced the shapes with the correct ones]. He said, 'This is how scrutiny (*muṭālaʿa*) and inference (*istikhrāj*) should be.'"[24]

The other two drawings given by Ghulām Sinān in the work are the corrected versions.

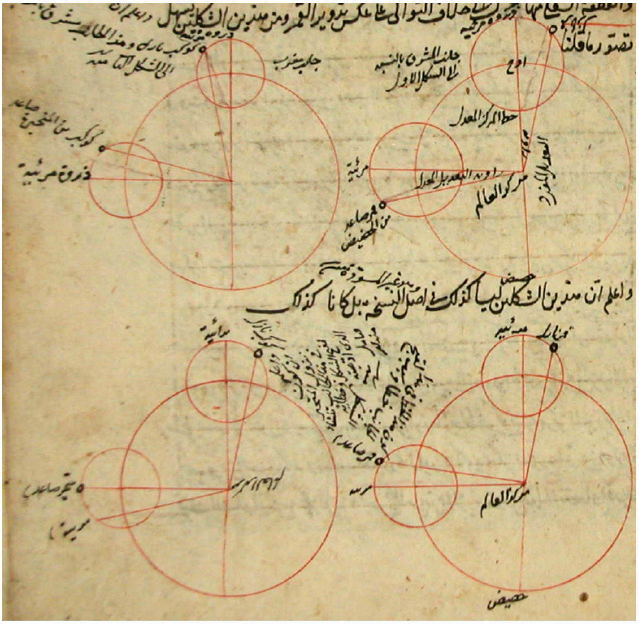

Figure 1. The correct and incorrect drawings mentioned by Ghulām Sinān in the previous passage, on the models of the moon and planets.[25]

24 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 126b.

25 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 126a.

In *al-Risāla al-Fatḥiyya*, the mean line of the planets is described as "a line extending from the center of the universe and parallel to a line extending from the epicycle center, or the point where the motion of the planet is uniform". In his commentary, Sinān describes how this topic was taught in class as follows:

> "The part 'or planet' [او الكوكب] was not in the copy read in class. When my teacher read it in class, I told him that according to the preferred view, the Sun has no epicycle, and therefore the description in question does not fit the mean shadow line for the Sun. I suggested that the expression should be as follows: ...passes through the epicycle center and terminates on the inclined sphere. On the Sun [in this case], it is a line extending from the world's center, parallel to the line extending from the center of the eccentric sphere to the center of the Sun. In the movable spheres, it is a line extending from the world's center and it is a line parallel to the line that extends from the center of the eccentric sphere to the epicycle center. However, although *ustādh* liked my idea, he changed the expression to what appears here. Then he wrote the phrase "or planet", and by this he meant the Sun. In this way, the expression of the definition became general while what he meant was specific."[26]

However, Sinān is of the opinion that this change is not sufficient:

> "The term 'planet' is not sufficient, because the motion of the spheres is not uniform around a point. We cannot use the term epicycle to include the Sun's body, because [the Sun's motion] just is similar to the epicycle in touching two surfaces on two points. Because this is difficult to understand and contrary to the terminology."[27]

Qūshjī states that the second circle, the circle of the equator on the plane of the horizon, and the third circle, the circle on the plane of the meridian circle, are in the middle of the inhabited area around the equator (وكلاهما في منتصف المعمورة بخط الاستواء). Ghulām Sinān states that this view is accepted as such in Qāḍīzāda al-Rūmī's commentary,[28] but there are differences in other sources. He points out that there is no such statement in his *tadhkira*s and commentaries. The author states that this feature is attributed only to the second circle in 'Ubayd Zāqānī's[29] (d. before 1370)

26 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 122b.

27 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 123a.

28 *Sharḥ al-Mulakhkhaṣ fī 'ilm al-hay'a*.

29 Khaja Niẓām al-Dīn Necm al-Dīn 'Ubayd Allāh Zāqānī al-Qazwīnī (d. before 772/1370). A Persian poet who also wrote a work of astronomy.

commentary on Sharaf al-Dīn Maḥmūd ibn Muḥammad ibn ʿUmar al-Jaghmīnī[30], (d. 1221?) and that Abū Muḥammad ʿAbd al-Jabbār al-Kharāqī's[31] (d. 1158) *al-Tabṣira*[32] contains explicit statements for the first circle and indirect statements for the second circle. Then, he conveys the dialogue between himself and his teacher Qūshjī on this subject in class:

> "There is some ambiguity in his [ʿAlī Qūshjī's] phrase "بخط الاستواء". Therefore, I asked *ustādh* to explain it. He said some things that caused more confusion and finally he said, '*Bi* here means *fī*. You are aware of the problem.'"[33]

In the section on the celestial orbs (*aflāk*), the author criticizes his teacher once more regarding the stellar parallax:

> "[The outermost celestial orb has three names.] The celestial orb that encompasses the other celestial orbs is called the 'Great Orb' (*falak al-aʿẓam*) because its diameter is larger than the diameter of the other celestial orbs, 'Atlas Orb' (*falak al-atlas*) because it does not have the embroidery of stars on it, that is, it is unpatterned like satin (*atlas*), and 'Orb of Orbs' (f*alak al-aflāk*) because it is not surrounded by any other celestial orb. In its void is the Orb of the Fixed Stars (*falak al-thawābit*). It is also called the 'Orb of the Zodiac' (*falak al-burūj*). It is considered the highest celestial orb because it is thought to have covered the greatest distance. All fixed stars except the seven moving bodies[34] are centered in this orb. That is, the diameter of the fixed stars that are not greater than it is equal to the thickness of this orb. [*Ustādh*] did not say the diameter of the largest of the fixed stars, because it is possible that the different fixed stars be equal in quantity. As al-Sharīf's commentary on Jaghmīnī[35] and ibn al-Qāḍī al-Rūmī[36] states, the bodies in this celestial orb are called fixed stars because either their second motions are very little, or their positions of proximity, distance, and alignment with respect to each other are always fixed, or the Ancients (*Qudamā*) did not sense their motion."[37]

30 *Sharḥ al-Jaghmīnī*.

31 Abū Muḥammad Bahāʾ al-Dīn ʿAbd al-Jabbār ibn ʿAbd al-Jabbār ibn Muḥammad ibn Thābit ibn Aḥmad al-Thābitī al-Kharāqī al-Marwazī (d. 553/1158).

32 *al-Tabṣira fī ʿilm al-hayʾa*.

33 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 141b.

34 Namely the Sun, Moon, Mercury, Venus, Venus, Mars, Jupiter and Saturn, whose positions relative to the stars have been known to change since antiquity.

35 *Sharḥ al-Mulakhkhaṣ fī ʿilm al-hayʾa*.

36 Qāḍīzāda al-Rūmī.

37 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 95a-b.

According to the passage above, there may be three reasons why stars are called fixed:

1. The second motion of the stars, that is, their motion relative to each other, may be very small and may not be detectable by observational instruments.

This motion, whose existence is expressed as a possibility, causes parallax. Therefore, stars cease to be "fixed". Notably, the sensitivity limit of the observation instruments of the period was greater than 1". The parallax of Proxima Centauri, the closest star to Earth after the Sun, is approximately 0.77". This is the upper limit for stellar parallax; the parallaxes of other stars are smaller than this. Therefore, it was not possible to determine stellar parallax in the pre-telescope era. The existence of stellar parallax, which was first measured by Thomas Henderson in 1833, is an undeniable possibility for the Samarqand school.

2. Their positions relative to each other may not be changing; so they may not really have parallax.

And,

3. The astronomers of the Ancients may not have been able to observe parallax in their observations due to the sensitivity of their observation instruments.

In fact, the first and third reasons are two complementary possibilities. The emphasis on "very little motion" in the first reason also includes the possibility that movement cannot be observed in the third reason.

The author quotes ʿAlī Qūshjī's opinion in the remainder of the text:

> "The third reason is problematic. Because, as explained in lengthy works, the Ancients attributed the fastest motion, i.e. daily motion, to the encompassing orb and denied the existence of Atlas Orb. How can it be correct for them to describe the encompassing orb as fixed? It is also very unlikely that it was the later school (*al-mutaʾakhkhirīn*) who did so. So the meaning becomes as follows: Since the Ancients did not perceive its peculiar motion, the later school called it fixed [stars]. Such a statement is not here taken into account."[38]

However, he does not agree with his teacher:

38 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 95b.

> "I wish this possibility were remote as he says. On the contrary, the first meaning to be understood from *Sharḥ al-Mawāqif* and *Sharḥ al-Tadhkirah* is that the third reason is specific to the later school. This is a beautiful explanation. If the Ancients were included among those who called them fixed [stars], there would be no meaning for the first reason to belong to them [the later school]. Then it would be natural to object to the first reason. However, *ustādh* did not object to it. It cannot be said that 'We adopt the distribution in these reasons; in our opinion, the first and third reasons belong to the later school, and the second reason is common to the Ancients and the later school. There is no harm in including the Ancients among those who call them fixed [stars].' Because we say: The statement in question does not harm our main purpose. This is the elimination of the *ustādh*'s objection. Because it [the statement] can also be obtained in this way.""[39]

On the subject of the Moon's orbs, we witness the process of a student examining the problem in detail and consulting with his teacher in the classical period:

> "A confusion arose regarding the determination of the universal celestial orb (*falak al-kullī*) of the Moon. The Moon's epicycle (*tadwīr*), inclined orb (*falak al-mā'il*), eccentric orb (*falak al-khārij al-markaz*), and lunar nodes orb (*jawzahar*) are considered to be the particular (*juz'ī*) celestial orbs. There is no way that the lunar nodes orb and the inclined orb can be considered universal. If the sum of these four orbs is considered as a single universal celestial orb, then the number of the Moon's orbs must be five. This contradicts the knowledge that the number of celestial orbs is 24, four of which belong to the Moon, and that the partial celestial orbs are between the two surfaces[40] of the universal celestial orb. I searched for the opinions of the leading scholars of the time on this issue, but I could not find anything to quench my thirst. Later, when I met *ustādh*, I presented it to him. He said, 'I was also confused about this issue, so I wrote about it in *Sharḥ al-Tajrīd*.' When I heard this from *ustādh*, I thought about it again and chose to accept their sum as the universal celestial orb."[41]

The author quotes ʿAli Qūshjī as saying that "the circumference of a circle is divided into 360 parts because it is the smallest number that is divisible without remainder by nine fractions except seven, which makes calculations easier, and the smallest number that is divisible without remainder by all digits is 1440" and then narrates the following narration: A Jew came to ʿAlī ibn Abū Ṭālib and asked him about the smallest number that is divisible into all digits without remainder. He replied that this

39 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 95b-96a.

40 Concave and convex.

41 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 94b-95a.

number is the number obtained by multiplying four by 360.[42] Although the result of the multiplication is 1440, the smallest number that fulfills this condition is not 1440, but 2520. Following the narration, Ghulām Sinān says that he thought about 1440, which he realized was incorrect, and that the real value should be 2520. The calculation he made to reach 2520 is 360 x 7. In order to verify the information he gave, he divides 2520 by all the digits and gives the results without remainders. At the beginning of the quotation from ʿAli Qūshjī, a note was written below the line "Some students also made this quotation. I did not hear it from him [ʿAli Qūshjī], because I was traveling at the time and was not there".

We learn a different version of the narration from a marginal note at the top of the page. According to this version, a Jew came to ʿAlī ibn Abū Ṭālib and asked him for the number in question. ʿAlī ibn Abū Ṭālib told him that this number would be obtained by multiplying the number of days of the week (7) by the number of days of the month (30) and then multiplying the result by 12, that is, the number of months. The result obtained was 2520, as it should be.

The marginal note mentioned above, like most of the marginal notes in the book, belongs to Riyāḍī ʿAlī Čelebī (d. 1588),[43] who served as a court astrologer. A follower of the Samarqand tradition, he read the commentaries on *al-Risāla al-Fatḥiyya* by Ghulām Sinān and Mīram Čelebī and made notes in the margins. The copy of *Fatḥ al-Fatḥiyya* that we use in our study also contains his record of seisin and notes. He also stated that he wrote a commentary on *al-Risāla al-Fatḥiyya* called *Miftāḥ al-Fatḥiyya*. However, this work is not extant.[44] If the interlinear note belongs to ʿAlī Čelebī, then he must have followed ʿAlī Qūshjī's lectures. In this case, the date of his death given in the sources becomes problematic. If the note in question does not belong to ʿAlī Čelebī, then the work must have passed through the hands of a person who was a student of ʿAlī Qūshjī in the same period as Ghulām Sinān.

At the end of the first chapter of the first book, there is a figure containing a schematic representation of the World. The drawing is the same as ʿAlī Qūshjī's, but with the difference that all the names of the 12th and 13th spheres are given.[45]

42 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 97a-b.

43 Menderes Velioğlu, "Müneccim Riyâzî Ali Çelebi'nin Hayatı, Telifâtı ve Muhallefâtı" (PhD diss., Istanbul University, 2023), 88.

44 Velioğlu, "Müneccim," 51.

45 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 97a.

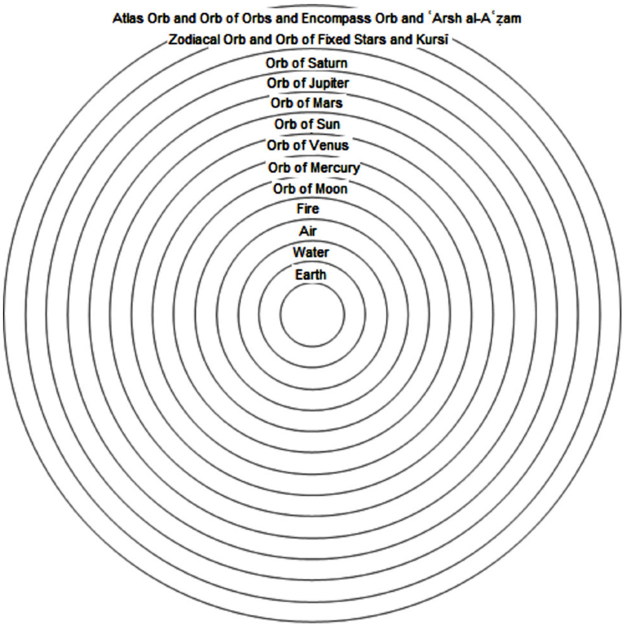

Figure 2. Cosmological structure of the world.[46]

The third chapter of the first book is about the eighth and ninth orbs. The eighth orb is responsible for the daily motion from east to west. According to ʿAlī Qūshjī, "the motion of this celestial orb lasts approximately one day." Ghulām Sinān explains in detail why his teacher used the term "approximately":

> "This celestial orb completes one revolution a little short of a solar day. When the Sun is aligned with a certain [star], that star rotates westward with the motion of the ninth orb. As the Sun follows the motion of the ninth orb, it moves eastward by its own motion. When the star returns to its initial position, it has completed one revolution; but the nychthemeron is not yet complete, because the Sun has not reached its position in alignment with the star, even though the star has reached the same place as the motion of the ninth orb. By its own motion, during the time the star returns to its initial position, it has traveled eastward in the zodiacal orb [ecliptic] by the length of an arc [1 degree]; when it reaches its initial position, the nychthemeron is complete. In sum, the day, whether mean or true, increases or decreases the time of the cycle, depending on the basis for calculation. This is the case for both inhabited and uninhabited places on the Earth."[47]

46 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 97a.

47 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 108b.

Throughout the work, Ghulām Sinān makes numerous references to al-Sayyid al-Sharīf al-Jurjānī, in addition to his teacher ʿAlī Qūshjī. His reading of *Sharḥ al-Tadhkirah* from his teacher plays a major role in this.[48] In addition to Sharḥ al-Tadhkirah, al-Jurjānī's *Sharḥ al-Mawāqif* and *Ḥāshiyat al-Tajrīd* stand out in terms of the number of times they are referenced. Other important names he cites include Naṣīr al-Dīn al-Ṭūsī, Qāḍīzāda al-Rūmī, and Niẓām al-Dīn al-Nīsābūrī (d. 1329?).

Ghulām Sinān analyzes the problem of whether the Earth is moving or not through the motion of the eighth celestial orb, which gives daily motion to the celestial bodies, and discusses the issue through the proofs of Naṣīr al-Dīn al-Tūsī and al-Jurjānī:

> "According to the author of *al-Tadhkirah* [Naṣīr al-Dīn al-Tūsī], it is not possible to attribute the first motion [the motion of the eighth orb] to the Earth. The reason for this is not that it is impossible for an object thrown into the air to fall to its initial position, as it is said, but that the object initially has a steep inclination. [If the Earth were rotating around its own axis], the object would undoubtedly make a circular motion. al-Sayyid al-Sharīf says that it would not be permissible to say that the circular motion is forced by something with a straight inclination. Of course, it is permissible for it to move in a circular motion when it is forced; for then we say that this motion is circular and that the forced motion has no permanence that would require the disrupt of existence."[49]

In the text, the immobility of the Earth is defended not with inferences based on Aristotelian natural philosophy and the theory of motion, but with observational evidence derived as an alternative. The Aristotelian argument that "an object thrown into the air falls to its initial position" is rejected and replaced by the inference that if the Earth moves in a circular motion (that is, its rotational motion), then the object thrown into the air must also make a circular motion.

After the evidence given in support of the view that the Earth is immobile, the issue continues with a discussion concerning which of the sciences the issue of the rotation of the Earth actually belongs to. The author cites the views of al-Jurjānī, who is in favor of discussing the issue within the natural sciences:

48 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 111a-b.

49 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 108b-109a.

"Someone might say that this issue is common between the natural and mathematical sciences, the difference being in terms of proof. If this issue is proven by a *limmī* proof (i.e. *burhān al-limmī*, propter quid), then it belongs to the natural sciences, not the mathematical sciences. That is why you see them avoiding *limmī* explanations in the mathematical sciences on issues held in common, such as the circularity of the Earth and the sky, and hold to things based on observation and mentality. If the issue is not held in common, it is proven with premises from the natural sciences."[50]

The he expresses his own opinion:

"We do not accept that this issue is held in common between the natural and mathematical sciences. This is because in the case of natural science, we say that the Earth does not have a circular motion in actual reality [whereas] in the case of astronomy we say that the Earth does not have a circular motion according to the senses. Indeed, this is what is said at the beginning of the second chapter of *al-Tadhkirah*. What is meant here by commonality is commonality in the subject matter."[51]

"As a result, the fact that [the body] initially has a straight [perpendicular] inclination certainly prevents it from moving circularly in actual reality, but it does not prevent it from moving circularly according to the senses. We know that whatever accords with reality [and not what happens to accord with the senses] is true, therefore, the subject belongs to the natural sciences, not to the mathematical sciences, because of the explanation based on the *limmī* proof."[52]

The author carefully avoids expressions that could be interpreted as an acceptance of the rotation of the Earth. The word "rotation" (*dawr*) is noteworthy in the second chapter of the third book, which deals with finding the ratio of the diameter of the Moon to the diameter of the shadow and the amounts in terms of the parts of the rotation (*dawr*). In order to avoid misunderstandings, Ghulām Sinān quotes ʿAlī Qūshjī's explanation in their lesson:

"*Ustādh* explained this position as follows: Let us put one leg of the compass at the center of the Earth and the other leg at the center of the Moon and turn it while it is at its minimum or maximum altitude on the meridian circle. Obviously, a circle is drawn from the point of view, and the [distance] of each side of this circle from the horizon is the altitude of the center of the Moon from the horizon, and this is the circle drawn. This is what is meant by rotation (*dawr*)."[53]

50 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 109a.

51 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 109a.

52 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 110a.

53 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 177b.

Ghulām Sinān is tracing a history of science by referring to historical measurements on some topics such as the obliquity of the ecliptic. The reference to al-Ṭūsī and al-Jurjānī, as well as to a lesser-known astronomer like Abū ʿAbd Allāh Muḥammad ibn Aḥmad al-Ḥāzimī in the text, gives the impression that his work was taught in class.

> "The value found by the Ancients was greater than the current value. Ptolemy found 23 degrees 51 minutes and 20 seconds. This value is the same as the result of Hipparchus, who came 265 years before him. Later, the Persians found 23 degrees 35 minutes according to the Coptic calendar 690 years later, during the reign of al-Ma'mūn, as a result of their observations. This value is the same as the value found by Benū Mūsā, who later made observations in Baghdad. This is what al-Sayyid al-Sharīf says in *Sharḥ al-Tadhkirah*. Although most of what they found was not more than 24 degrees and not less than 23 degrees and half of a degree and half of a tenth,[54] it is possible to think that what someone who is more recent in time found was smaller than what someone who is earlier in time found. al-Ṭūsī says, 'After writing *al-Tadhkirah*, I found [the greatest obliquity between the equator and the ecliptic] to be 23 degrees 30 minutes with new observations in Marāghah.' *Ustādh* says that in their observations they found the greatest obliquity to be 23 degrees 30 minutes and 17 seconds. We will talk about the way this was conveyed to *ustādh*. al-Sayyid al-Sharīf says in *Sharḥ al-Tadhkirah* that the source of this difference is not the motion [*mayl*] of the two planes towards one another, but the distortion in the rotation or alignment of the instruments during the passage of the meridian. Otherwise, the difference should have been on the same scale according to the time elapsed between the observations, but as we have shown, this is not the case. al-Khāzimī[55] found that the value he obtained as a result of his observations was the same as the value at the time of al-Ma'mūn, even though there were two Persian centuries between them. Abū Rayḥān[56] found it [the obliquity] to be greater than that found in al-Manṣūr's time, even though he came after the time of Yaḥyā ibn Manṣūr.[57] According to him [al-Khāzimī], Ptolemy's value was the same as that of Hipparchus in the aforementioned period.[58] During the reign of Ma'mūn, the value was found to be 16 minutes less; this is the distortion in the aforementioned period.[59] Accordingly, the decrease in every 43 years is one minute. al-Khāzimī should have found 5 minutes and 3 [seconds] less than the time found

54 23;35 degree.

55 Abū ʿAbd Allāh Muḥammad ibn Aḥmad al-Khāzimī al-Saʿīdī. The work used in the text is *Mukhtaṣar al-Majisṭī*.

56 Abū Rayḥān Muḥammad ibn Aḥmad al-Bīrūnī.

57 Abū ʿAlī Yaḥyā ibn Abī Manṣūr al-Munajjim (d. after 215/830).

58 284 is written interlinear. This value corresponds to the difference between the period in which the two astronomers lived.

59 695 is written interlinear. It refers to the time between two observations.

> in the period of al-Ma'mūn,[60] according to the time elapsed between the two.[61] When I was reading *Sharḥ al-Tadhkirah* from my teacher, my teacher quoted me as saying '5 minutes…' and said, 'his statement in *Sharḥ al-Tadhkirah* is not correct, as you know, it would have been correct if it had been said that it was close to 230 years; think about it carefully!" When I listened to *ustādh*, I thought about it for a while and I liked it very much. He left his answer for the next day. While examining the books, he said, 'What is said in the *Sharḥ*[62] is compatible with *Nihāyat al-idrāk,*[63] and what is written in *Hāmish* agrees with the 230 years given in *al-Tuḥfa al-shāhiyya*[64] and mentioned above."[65]

In various parts of the work, we see that Ghulām Sinān refers to the Samarqand school–which he inherited from his teacher–as the later school, and the Marāghah school and its predecessors as the Ancients. The passage where he explains the parallax is a good example of this.

For the definition of parallax, ʿAlī Qūshjī first gives a description of the real position, saying "What is meant by the real position is the end of a line that, emerging from the center of the Earth, passes through the center of the planet, and ends at the top of the orb." Then he explains the apparent position, stating "What is meant by the apparent position is the endpoint of a line that, emerging from the center of the Earth, is parallel to the line that extends from the viewpoint to the center of the planet, and ends on the greatest orb." Ghulām Sinān explains the matter as follows:

> "Since the extended line is parallel, it cannot be known that it does not pass through the center of the celestial body. When the celestial body is above the apparent (*ḥissī*) horizon, it is either below the line in question or on the line on the surface of the real horizon. It cannot be below both. When the celestial body rises, it is usually between the two horizons [apparent and real]. According to analogy and the interpretation of the apparent position, this is not the commonly accepted [definition]; the commonly accepted definition is that it is the end of a line emanating from the observer's position,

60 If the decrease in obliquity is 1 minute in 43 years, the time required for 5 minutes and 3 seconds is approximately 217 years. A decrease of approximately 5 minutes and 56 seconds occurs in 255 years.

61 255 is written interlinear. Accordingly, al-Khāzimī must have been alive around 1080.

62 *Sharḥ al-Tadhkirah*.

63 *Nihāyat al-idrāk fī dirāyat al-aflāk*. A work on theoretical astronomy that was completed by Quṭb al-Dīn al-Shīrāzī in 1281 while he was *qāḍī* of Sivas.

64 *al-Tuḥfa al-shāhiyya fī al-hay'a*. Also a work in theoretical astronomy by the same author, in the same period of time.

65 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 110b-111b.

as in *al-Tadhkirah*, or from the eye, as in *al-Mawāqif*.[66] Both statements refer to the surface of the Earth. The parallax arc obtained by ʿAlī Qūshjī's definition is larger than that according to the commonly accepted definition, as shown in the figure below. *Ustādh* abandoned the commonly accepted definition, choosing the one we have mentioned by al-Sayyid al-Sharīf. The apparent position is always closer to the horizon, as a mighty creation testifies."[67]

The last sentence shows that Ghulām Sinān thought like his teacher. As can be seen from the figure mentioned by Sinān, in the definition preferred by Qūshjī, the visible position is closer to the horizon. In the figure, al-Jurjānī and ʿAlī Qūshjī are described as the later school, while al-Ṭūsī and others are described as the Ancients.

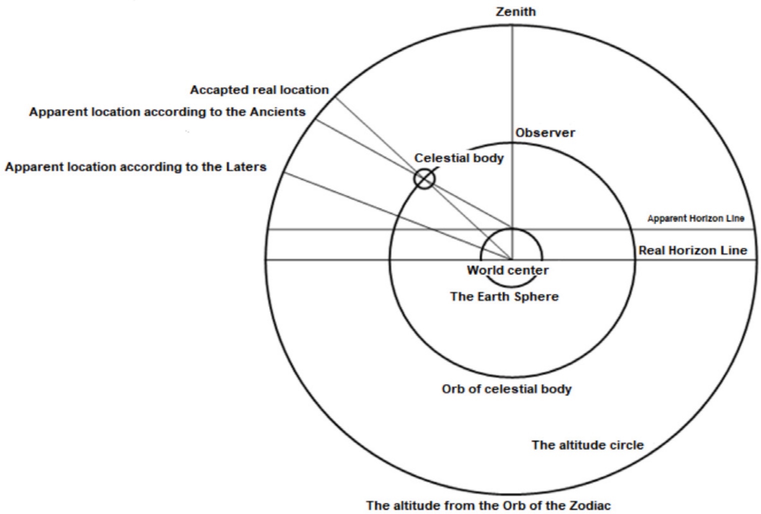

Figure 3. Parallax measurement according to the Ancients and the later school.[68]

However, in some areas, al-Ṭūsī is also considered to be among the later school. Therefore, it is understood that the distinction between old and new in the work is made based on whether the view put forward is different from the tradition or not.

66 *Sharḥ al-Mawāqif*.

67 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 136a-b.

68 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 136b.

An example to support this view is found in the section on the largest and smallest distances of the celestial orbs. After quoting ʿAlī Qūshjī's statement that "The closest distance of the Sun is 1152 and 18 minutes. This is the greatest distance of Venus." the author continues as follows:

> "This is because, as you know, the Sun's apogee is tangent to the surface of the parecliptic orb of Venus. This comparison is also valid for Mercury, but not for the Moon, because the orb (*jawzahar*) is centered between the perigee of Mercury and the apogee of the deferent. Thus, the smallest distance of Mercury is not the largest distance of the Moon. As *ustādh* says, [the smallest distance] is 4 degrees 40 minutes more than this, which is the width of the orb (*jawzahar*). However, Mawlānā Nizām al-Dīn[69] says, 'The scholars who seek the truth made the greatest distance of each planet the smallest distance of the planet above it. They could not agree on the radii of the planets and things that do not have magnitudes, and on the width of the Moon's orb, and so on, which we know.'"[70]

Sinān, who quotes his teacher as saying that the mean daily motion of the Sun is 59' 8", states that the length of the solar year is 365 ¼ days, as also stated in *Sharḥ al-Tadhkirah*. The value given by the author is quite rough. The author, who quotes Qāḍīzāda al-Rūmī, states that the length of the year is 20 split seconds longer than that of the Ancients who, like Ptolemy, accepted that the solar apogee is fixed.

> "As for the later school which argues that the apogee is moving, then according to them, the amount mentioned is the sum of the motions of the parecliptic and the eccentric orb; that is, it is not only the amount of motion of the eccentric orb; it is less than the amount of motion of the stars [the motion of the parecliptic orb is equal to the motion of the stars]. This is the reason why *ustādh* did not mention the split second. This motion is the motion of the apogee according to both views. According to Ptolemy, the position of the apogee moved 24.5 degrees towards the summer solstice. According to him, even if it is within the obliquity of the ecliptic, this position does not differ at all in its origin. According to the later school, its position varies according to the date. As a result of his new observation in Marāghah in the 650th year of the Yazdigird calendar, al-Ṭūsī determined that the Gemini had reached the position of 28° 6'51"."[71]

It can be seen that ʿAlī Qūshjī included the work done at the Samarqand Observatory and Ulugh Beg in his lectures.

69 Niẓām al-Dīn al-Nīsābūrī.

70 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 185a.

71 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 118b.

> "According to my statement at the end of the fourth chapter of the third book, the Sun is 167 times larger than the Earth. However, it is mentioned as 166 + ¼ + ⅛ in Jaghmīnī's commentaries, in *Sharḥ al-Tadhkirah*, and at the beginning of Surah Banī Isrā'īl [*al-Isrā'*] in Qāḍī's[72] *tafsīr*[73]. The value mentioned by *ustādh* may be based on new observations. Such disagreements are numerous in the book, especially in the sixth chapter of the first book, which discusses the diameters of the epicycles and the sizes between the centers, and at the end of the first part *ustādh* said, 'These and all other magnitudes have been obtained from our observations.'"[74]

The subject is revisited again in the rest of the text and is given with almost the same expressions. Ghulām Sinān, after quoting his teacher as saying, "When the diameters of the Earth and the Sun are cubed, it is understood that the Sun is 197 times the size of the Earth", continues as follows:

> "The calculations made by *ustādh* based on his observations require this. This value in question is given in *al-Tadhkirah* and its commentaries, and at the beginning of the Surah *Banī Isrā'īl* [*al-Isrā'*] in Qāḍī's *tafsīr* as 166 + ¼ + ⅛ times the size of the Earth. There are many such disagreements in *al-Risāla*, especially in the sixth chapter of the first book and at the end of the first part when discussing the sizes of epicycles and eccentrics. *Ustādh* said, 'This and all magnitudes are according to our observations.' Moreover, the volume of the Sun is 6644 times that of the Moon and the volume of the Earth is 39+ ¼ times that of the Moon."[75]

In the discussion of *zīj*, 'Alī Qūshjī says, "The majority of the *zīj* that have come down to us, almost all of them except *al-zīj al-muʿtabar,*[76] were prepared according to the Persian year," following which Ghulām Sinān relates an anecdote from the lecture, stating "*ustādh* said, 'This [*zīj*] was prepared during the reign of Sultan al-Sanjar and according to the opinion of the *munajjim*s, it uses the Hijri year like the *zīj-i* Ulugh Beg.'"[77]

In the section where the degrees of transit of the meridian of the stars and the degrees of rising and setting are discussed, 'Alī Qūshjī states:

72 Qāḍī al-Bayḍawi (d. 685/1286).

73 *Anwār al-Tanzīl wa Asrār al-Taʾwīl*.

74 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 155b.

75 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 184a-b.

76 *al-Zīj al-muʿtabar al-Sanjarī al-sulṭānī*. *Zîj* prepared by the 12th century Seljuk astronomer Abū al-Fatḥ 'Abd al-Raḥmān al-Khāzinī and dedicated to Sultan Sanjar.

77 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 161b.

> "When a line extends from the center of the World to the center of the star and terminates on the surface of the largest orb, if it terminates at the ecliptic, then its endpoint is the degree and position of the star. Otherwise, the closest of the two intersection points of the latitude circle passing through its endpoint is the degree of the star. Along the orbit of the zodiac [ecliptic], halfway along the declination circle bounded by the two poles of the World [equator], the point of intersection of the aforementioned line and the part passing through it is the transit degree of the star. If the star has no latitude, or if it does and the star is at one of the solstices, it will be the same as the degree of the star. In this case, the transit degree of the star will not lie between the poles of the ecliptic and the equator..."

Ghulām Sinān makes a note in this section, saying that "*Ustādh* said that the last restriction[78] was something invented by Sultan Ulugh Beg and that it was necessary."[79]

He begins the third book on the sizes and distances of the Earth and celestial bodies with a warning that the subject is beyond the limits of public comprehension:

> "The purpose of finding the distances and the sizes of the celestial bodies is to know the measurement of a single body like the Earth; because its measurement is the measurement of other celestial bodies, as *ustādh* says in *al-Risālah al-Muḥammadiyya*. The subjects of this book are far removed from the acceptance of the people. So for example, they are surprised when they hear that the distance between a celestial body and other celestial bodies and the Earth is of such leagues (*farsakh*)."[80]

Especially in the introduction at the beginning of the book, Ghulām Sinān frequently refers to his teacher's work on mathematics, called *al-Risāla al-Muḥammadiyya fī al-ḥisāb*, and to ʿUbayd Allāh, whom he calls the commentator of *al-Tadhkirah*. For example, he explains the meaning of *misāḥa* by quoting from his teacher's work, stating, "In *al-Risāla al-Muḥammadiyya*, *ustādh* says, '*Misāḥa* is the obtaining of the quantity of a part or all of the measured thing by means of a similar measured thing.'"[81]

The introduction of this book contains 10 propositions. The first of these is about the relationship between the diameter of a circle and its circumference, and reads "The circumference of every circle is $3\frac{1}{8}$ times its diameter. Thus, when the result of multiplying its diameter by 22 is divided by seven, its circumference is obtained. The result of its circumference multiplied by seven and divided by 22

78 That is, the statement "In this case, the transit degree of the star will not lie between the poles of the ecliptic and the equator".

79 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 164a.

80 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 171b-172a.

81 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 175b.

is its diameter." After this statement, Ghulām Sinān says, "The reference here is to a book in *al-Risāla al-Muḥammadiyya*." Then he quotes the relevant section in *al-Muḥammadiyya*.

> "If the diameter is known and the circumference is unknown, we multiply the diameter by twenty-two and divide the result by seven, in which case the amount of the diameter is [transformed into] the amount of the circumference. Conversely, if the circumference is known and the diameter is unknown, we multiply the circumference by seven and divide the result by twenty-two, in which case the amount of the circumference is [transformed into] the amount of the diameter. Mawlānā ʿUbayd Allāh, the commentator of *al-Tadhkirah*, says, 'Since the diameter is traditionally accepted as 120 parts, according to this rule the circumference becomes 377 1⁄7 parts.'"

However, ʿAlī Qūshjī objected to this calculation:

> "*Ustādh* said, 'According to this ratio, the diameter would be 114 1⁄6 degrees [parts], not 120 parts as mentioned at the beginning of the book.'"[82]

However, ʿAlī Qūshjī gives the value as 114 in *al-Risāla al-Fatḥiyya*:

> "As stated in the introduction of this book, the surface area of a complete segment of the sphere is equal to the circle whose radius is equal to the line extending from the pole of the segment to the circumference of the base, that is, the chord of the obliquity of the ecliptic. However, this is based on the fact that the diameter of the circle is 114 parts, not 120 parts."[83]

Ghulām Sinān is aware that the value of 114 1⁄6 that he attributes to his teacher in 172a-b will be questioned here. There is a difference of 1⁄6 between the value given by his teacher and the value he attributes to his teacher. He explains how he derived this difference as follows:

> "[120 parts] is well accepted and is the reason for the traditional view. I had previously quoted [this value] from Mawlānā ʿUbayd Allāh in the first proposition.[84] It is known that I increased the initial value [114 parts] by half of one tenth,[85] because one tenth of it[86] is [one divided by] twelve,[87] and half of that one tenth is [one divided by] six.[88] [Therefore the value becomes 114 1⁄6]."[89]

82 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 172a-b.

83 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 176b-177a.

84 The author refers to 172a-b.

85 Half of one tenth of a 1120 part.

86 1120x10=112

87 112

88 2x112=16

89 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 177a.

Immediately afterwards, we see the encouragement of the use of trigonometric functions instead of chords in astronomical calculations:

> "*Ustādh* noted the use of chords of magnitudes such as, for example, 20 degrees in tables and *zīj*, [and continued;] 'The diameter of the circle in terms of *dhirāʿ* would be 120 [parts], which is not what is stated in the first proposition. Indeed, we must subtract half of one tenth from twenty, which is one, so that the chord of the obliquity of the ecliptic becomes 19 degrees in terms of *dhirāʿ*, and the diameter of the circle becomes 114 [parts], similar to that mentioned above. Once you realize this, the following questions are easy to answer. In some *zīj*s, the quantity of the chord of the arc in degrees is obtained more than the quantity in degrees of this arc. This is due to sense and intellectual necessity, as it is said in al-Ḥimyarī's[90] drawing. This excess is due to the difference [between the values of] of the two *dhirāʿ*. When they are united [the same], there is no excess or equality in the reality of the matter.'"[91]

In the section examining the sizes of celestial bodies and orbs and their distances from the center of the World, the values given by ʿAlī Qūshjī are compared with the values in *al-Tadhkirah*. In the comparative examples given below, the first values belong to ʿAlī Qūshjī.

So for Qūshjī, "The distance of the Moon from the center of World is found by calculation as 39 parts [degrees] 55 minutes by calculation." Ghulām Sinān compares this with al-Ṭūsī's value, stating, "In *al-Tadhkirah*, the fraction [part] is a half and a quarter part."[92]

For Qūshjī, assuming the radius of the inclined sphere [of the Moon] is 60, the radius of its epicycle is 5 + ⅕ , whereas "In *al-Tadhkirah*, [the fractional part] is given as ¼."

For Qūshjī, the distance [eccentricity] between the two [the center of the Moon's deferent and the center of the World] is 10 parts 23 minutes [in the eccentrist]. In comparison, "In *al-Tadhkirah* it is 18 minutes. *Ustādh* said, 'This unit is smaller than the first unit, which is half the diameter of the Earth, and this action is called "transferring magnitudes from one unit to another", as mentioned in the eighth proposition.'"[93]

For Qūshjī, if we take the radius of the Earth as 1, then radius of the inclined sphere would be 59 parts 8 minutes and 11 seconds, whereas "There are no fractional parts in *al-Tadhkirah*."

90 Muḥammad ibn ʿAbd al-Munʿim al-Ḥimyarī. He is a Maghribī geographer.

91 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 177a.

92 45 minutes.

93 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 178b.

For Qūshjī, the radius of the epicycle is 5 degrees 7 minutes and 31 seconds, whereas "In *al-Tadhkirah*, it is 5 parts and ⅙."[94]

For Qūshjī, the eccentricity is 10 degrees 14 minutes and 2 seconds, whereas "In *al-Tadhkirah*, the fractional part is only 9 minutes."

For Qūshjī, assuming the radius of the Earth is 1, then the greatest distance of the Moon is 64 parts, 15 minutes and 42 seconds. In comparison, "In *al-Tadhkirah*, the fractional value is 1/3 of a part.[95] *Ustādh* said, 'This amount is actually less than the radius of the inclined sphere by the amount of the radius of the Moon's body, because this distance is relative to the center of the Moon.'"

For Qūshjī, the smallest distance [from the Earth to] the Moon is 33 degrees 32 minutes and 36 seconds. In comparison, "In *al-Tadhkirah*, the fractional part is only 36 minutes. In some copies it is 33 minutes. *Ustādh* said, 'This amount is actually more than the amount from the perigee of the deferent to the center of the World by the amount of the radius of the Moon's body, as we said above. Knowing the greatest and smallest distances of the Moon [to the Earth] is to know the thickness of the inclined sphere.'"

He continues, "According to this calculation, the average distance is 48 degrees 54 minutes and 9 seconds." Here, referring to ʿUbayd Allāh's work, Ghulām Sinān also gives the distance in terms of *farsakh,* stating "In his commentary on *al-Tadhkirah*, ʿUbayd Allāh gives the fractional part as only 51 minutes… thus [according to him] the greatest distance to the Moon is approximately 79472 *farsakh* and the smallest is approximately *42559* farsakh."[96]

One of the marginal notes left on the work is important as it is one of the first examples of how current knowledge produced in the West was transferred to Ottoman lands much faster than previously thought: In the section where the developed regions of the world are mentioned, *Munajjim Riyāḍī* ʿAlī Čelebī states in a marginal note that the Fortunate Isles were discovered by the Portuguese.[97] As mentioned earlier, ʿAlī Čelebī was a court astronomer who lived in the 16th century. This marginal note provides us with evidence that the Ottoman Ilmiye Class followed current developments.

A similar situation is encountered in *Sajanjal al-Aflāk fī Ghāyat al-Idrāk*, which was written in 1662 and is considered to be the first modern astronomy book written

94 5 degrees 10 minutes.

95 64 parts 20 minutes.

96 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 179a.

97 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 142a.

in Ottoman lands. In the introduction of the work, Tadhkiraji Kose Ibrāhīm Effendi gives a brief history of astronomy, focusing on Western astronomy. Among the names he mentions are Copernicus and Kepler, as well as Regiomontanus, Peuerbach, Christen Longomontanus and Philippe van Lansberge. The last two names mentioned are contemporaries of the author. Although the work is said in the literature to be a translation of Noel Durret's *zīj*, the drawings of the models of the Universe were taken from Andrea Argoli's Ephemerides of 1648.[98] This shows us that the Ottoman scholars had at least some of the works circulating in Europe at the time and used them.

There are various studies indicating that close interaction with Western sources increased during the reign of Grand Vizier Kūbrulizāda Fāḍil Ahmad Pasha (r. 1661-1676). Kūbrulizāda formed a circle of scholars working in various fields of science around him. Also during this period, there were students from non-Muslim subjects who went to Europe, especially to the University of Padova. One of them was Panagiotakis Nikousios, known as Panayiotis Effendi (d. 1673). Panayiotis Effendi, who studied astronomy and mathematics at the University of Padova, became one of Fāḍil Ahmad Pasha's close circle upon his return to Istanbul. According to the sources of the period, the two read and discussed Joan Blaeu's (d. 1673) *Atlas Maior*.[99] This work was later translated into Turkish by Abū Bakr ibn Bahrām al-Dimashqī (d. 1691). It is likely that Argoli's work was brought to Ottoman lands by Panagiotakis Nikousios, Argoli also being a graduate of the University of Padova.

Conclusion

ʿAlī Qūshjī's *al-Risāla al-Fatḥiyya* is one of the first theoretical astronomy works written in the Ottoman Empire. The work was taught as a textbook in madrasas and it was subject to at least two commentaries. It was also translated into Turkish with additions by Saydī ʿAlī Rảīs (d. 1562) under the title *Khulāṣat al-hay'a* and by Sayyid ʿAlī Pasha (d. 1846), the second head teacher of Muhandiskhāna-i Barrī-i Humāyūn, under the name *Mirʾāt-i ʿĀlam*. Of these, *Khulāṣat al-hay'a* is the first theoretical astron-

98 Pierre Ageron, "Note sur le dessin du système de Copernic dans le manuscrit Kandilli 403," *Osmanlı Bilimi Araştırmaları* 20, no. 2 (2019): 120-21.

99 M. Fatih Çalışır, "Sadrazam Köprülüzâde Fazıl Ahmed Paşa'nın hâmiliğindeki ilmî faaliyetler," in *XVIII. Türk Tarih Kongresi Kongreye Sunulan Bildiriler v. IV*, eds. S. Nurdan and M. Özler (Türk Tarih Kurumu Yayınları, 2022), 40. For Fāḍil Ahmad Pasha's relationship with scholarly circles see, M. Fatih Çalışır, "A Virtuous Grand Vizier: Politics And Patronage In The Ottoman Empire During The Grand Vizierate Of Fazıl Ahmed Pasha (1661-1676)" (PhD diss., Georgetown University, 2016).

omy book in Turkish. It can be understood from these studies how valuable *al-Risāla al-Fatḥiyya* was for the Ottoman scholars.

One of the two commentaries available, *Fatḥ al-Fatḥiyya*, is important in terms of showing how the Samarqand school was transmitted and received through the eyes of a student. While writing his work, Ghulām Sinān, who was educated by ʿAlī Qūshjī, mostly refers to the works and names read in class. The name al-Sayyid al-Sharīf al-Jurjānī is of particular note, both in terms of the sheer number of times it is referenced as well as the variety of works it is referenced in relation to. Other frequently cited names include Qāḍīzāda al-Rūmī, Naṣīr al-Dīn al-Ṭūsī, Quṭb al-Dīn al-Shīrāzī, and Niẓām al-Dīn al-Nīsābūrī.

It is noteworthy that there are few references to Ottoman scholars in the work. The names we have been able to identify are Hodjazāda Muṣliḥ al-Dīn Effendi and Jamāl al-Dīn Aqsarāyī. Of these, the references to Hodjazāda are usually criticisms against him rather than being used to explain the text. The paucity of references to Ottoman scholars can be explained by the fact that no theoretical astronomical work had yet been completed at a level that could fruitfully produce a commentary.

Although Ghulām Sinān was a student of ʿAlī Qūshjī, it cannot be said that he followed him blindly. From various parts of the work and the anecdotes he narrates from his lectures, we understand that the two disagreed on certain issues and that these were discussed in class. In his work, Sinān sometimes grants himself quite some esteem by stating that he corrected his teacher's mistakes and shortcomings, and sometimes even places himself above his teacher. According to Sinān, his teacher always agrees with him, and leverages his authority as a teacher to correct himself. However, some of these corrections do not always satisfy Sinān and he therefore continues to object to his teacher. This rather confrontational style can be considered quite daring for its time.

In the work, the classification of the Ancient thinkers versus the later school is something of a gray area. For instance, al-Ṭūsī is sometimes referred to as one of the Ancients and sometimes as one of the later authorities. However, names from the Samarqand school, such as ʿAlī Qūshjī and al-Jurjānī, are always classified as part of the later school. This classification can be interpreted as Ghulām Sinān view that the Samarqand school held views that could not be accepted within the classical astronomical circle.

The quotation from Niẓām al-Dīn al-Nīsābūrī at the end of the work represents a view shared by Ghulām Sinān and succinctly illustrates the role and position of astronomy in Islamic civilization:

"Mawlānā Niẓām al-Dīn says, 'There is no doubt that knowing the dimensions and sizes of the celestial bodies as they are is more exalted than being surrounded by the intellectual and human powers. These powers [intellectual and human] are immersed in the realm of nature. Their sensory powers have fallen into the pit of desires. The aim of this art [astronomy] is to know the Creator of all things and the heavens and to realize the helplessness of the human species. In reality, their [celestial bodies] Creator is known, but their quantity is unknown.'"[100]

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100 Ghulām Sinān, *Fatḥ al-Fatḥiyya*, 187b-188a.