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To my wife Masoumeh
who always made me passionate and hopeful,
and to our lovely kiddos, Reyhaneh and Amin.

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Table of Contents

Introduction	1
Chapter 1 ‘Āmilī’s life and career	5
1.1 The first Safavid century	5
1.2 Bahā’ al-Dīn ‘Āmilī: Life, education, and early career	8
1.3 ‘Āmilī’s father and the office of <i>shaykh al-islām</i>	14
1.4 ‘Āmilī’s patronage campaign -- a tale of four shahs	17
Appendix	27
A chronology of ‘Āmilī’s life and times	27
Chapter 2 Astral Sciences among the Safavids	34
2.1 Astrology in Safavid Culture	34
2.1.1 European Accounts by Missionaries, Merchants, and Ambassadors to Persia	38
2.2 Legitimizing the Astral Sciences among the Safavids	43
2.3 ‘Āmilī’s defense of astral sciences in <i>The Crescent Garden</i>	49
Chapter 3 The <i>Dissection of the Orbs</i> (<i>Tashrīḥ al-aflāk</i>)	64
3.1 Contents of the <i>Dissection</i>	66
3.2 Dedications and Patronage	80
3.3 Author’s <i>Gloss</i> and other commentaries on the <i>Dissection</i>	88
3.4 Conclusion	91
Chapter 4 ‘Āmilī’s <i>Gloss</i> on the <i>Dissection of the Orbs</i>	95
4.1 History of the text	95
4.2 Contents of the <i>Gloss</i>	97
4.2.1 The Definition of <i>‘ilm al-hay’a</i>	98
4.2.2 The nature and number of the orbs	99
4.2.3 The sphericity of the element water and the Earth	103
4.3 The Great Circles	108
4.4 The Total Obliquity and the end of the world	110
4.5 The Horizon Circle	115
4.6 Gloss on Chapter Two: On the configurations of the orbs	120

4.7	Gloss on Chapter Three: On the Motions	125
4.7.1	The Equation of the Sun	132
4.8	Conclusion	140
4.9	Appendix	143
Chapter 5 Shams al-Dīn ‘Alī Ḥusaynī Khalkhālī’s Commentary on ‘Āmilī’s <i>Dissection</i>		145
5.1	The Commentary tradition based on ‘Āmilī’s works	145
5.2	Shams al-Dīn Khalkhālī and the <i>Exposition of the Orbs</i>	157
5.3	Khalkhālī’s commentary and his readers in Agra	159
5.4	Features of the <i>Exposition</i>	162
5.5	The order of the Planets in the <i>Exposition</i>	167
5.6	Additions to the original text	170
5.7	Comments on the Orbs and Motions of the Planets	171
5.7.1	Commentary of Chapter two, on the structure of the orbs	171
5.7.2	A new definition for the Moon’s orbs	173
5.7.3	Commentary of Chapter three, on the motions	175
5.8	Concluding remarks	178
Chapter 6 Muḥammad-Kāẓim Tunikābunī’s Commentary on ‘Āmilī’s <i>Dissection</i>		179
6.1	Tunikābunī’s intellectual life	180
6.2	Seeking Patronage in India	182
6.3	Tunikābunī’s Works	184
6.4	Commentary on the <i>Dissection</i> : “The Rule of Perception”	186
6.4.1	The position and motion of the Earth	193
6.4.2	Non-Ptolemaic models of planetary motions	200
6.4.3	Planetary equations, objections to Kharaqī and others	203
6.5	Books and Authors cited in Khalkhālī’s <i>Exposition</i> and Tunikābunī’s <i>Rule</i>	206
6.6	Concluding remarks	213
Chapter 7 Conclusion		216
7.1	‘Āmilī’s works in Mughal India	216
7.2	The “Decline Thesis”	221
7.3	Two major arguments of the decline	224

7.4	‘Āmilī and his successors	227
7.5	Shams al-Dīn Khafī’s influence on Safavid astronomers	230
	Bibliography	233

List of figures

Fig. 3-1. The configuration (<i>hay'a</i>) of the total orbs redrawn from the <i>Dissection of the Orbs</i> . Each shell represents the parecliptic orb of the planet. In this configuration Venus and Mercury are lower or inferior planets being under the Sun, while Mars, Jupiter and Saturn are upper or superior planets. The whole cosmos is divided by the orb of Moon into the terrestrial and celestial regions. According to Aristotelian physics, no change occurs in the celestial region and all motions in that part of the universe are supposed to be uniform and perpetual...	69
Fig. 3-2. The orbs of the planets redrawn from the <i>Dissection of the Orbs</i> . The parecliptic is an orb concentric with the center of the universe. It carries the eccentric or deferent of the planets. In the model of the moon the outer orb, <i>jawzahar</i> , has the same function as the parecliptic, producing the motions of the nodes. In the model of Mercury, since Mercury has two perigees, another eccentric orb called the <i>dirigent</i> carries the deferent, which itself is carried by the parecliptic.	72
Fig. 3-3. Diagram for the starting moment of the false dawn redrawn from the <i>Dissection of the Orbs</i>	74
Fig. 4-1. If we assume that the fixed stars can be accommodated within the parecliptic orb of Saturn and they do not need to have a separate orb, then when Saturn is at the apogee (as shown here) it must not eclipse any of them for an observer on the Earth. But observations show that Saturn does eclipse some of them at its apogee, so the stars must be within another orb beyond the parecliptic orb of Saturn.	102
Fig. 4-2. <i>AHB</i> represents the surface of water on the Earth and if it is plane then the middle point <i>H</i> should always seen lower than other parts.	104
Fig. 4-3. Measuring the distances between heads and feet of two people standing on the Earth to show that the distance between the heads is always more than that between their feet.	105
Fig. 4-4. Measuring the time passed for people travelling with the speed of Sun on opposite directions.	107
Fig. 4-5. The Total Obliquity and the end of the world.....	113
Fig. 4-6. Different horizons discussed in the <i>Gloss on the Dissection</i> . Among the three horizons shown, only the True horizon is a great circle, and the other two are smaller circles parallel to it. The sizes of the Earth and observer are exaggerated to show the difference between the Apparent and the Shield horizon.	117
Fig. 4-7. The altitude of a given point <i>S</i> on the Ecliptic equator is the arc <i>SA</i> along the Altitude circle laid between the Ecliptic equator and the Horizon. The two arcs <i>AS</i> and <i>AP</i> define a horizontal coordinate system.....	119
Fig. 4-8. The orbs of the Sun	121
Fig. 4-9. Thickness of the complement orb and the eccentricity of the Sun.....	122
Fig. 4-10. Dawānī's second case for measuring the thickness of the complement orb.....	124
Fig. 4-11. Equation and anomaly of the Sun in the <i>Gloss on the Dissection</i>	133
Fig. 4-12. The equation of the Sun in the <i>Dissection</i>	135

Fig. 5-1. Khalkhālī' <i>Exposition</i> , University of Tehran, MS 1241, dated 1826. The text in black is the commentary. Phrases of 'Āmilī's text are overlined in red (on the left folio). In the margins the copy presents further scholia added later by Khalkhālī.....	149
Fig. 5-2. The parallax for the planet <i>S</i> as described in the <i>Exposition</i> . From <i>O</i> , the planet is viewed at point <i>B</i> , but from the center of the universe <i>E</i> , it is viewed at <i>A</i> . The angle represents the amount of parallax for <i>S</i> . Also, drawing <i>EC</i> parallel to <i>OB</i> , the parallax can be measure along the arc <i>AC</i> . From Euclid we know that opposite angles between parallel lines are equal. Hence angle <i>OSE</i> = <i>SEC</i> . It is evident that there is no parallax when <i>S</i> is at the observer's zenith.	168
Fig. 5-3. The orbs of the Moon, drawn based on the <i>Exposition</i> . The figure on the right shows that only the outer complement encloses and carries the Moon's deferent.	174
Fig. 6-1. <i>Qānūn al-idrāk</i> , MS P, fol. 62v.....	188
Fig. 6-2. <i>Qānūn al-idrāk</i> , MS P, fols. 3v-4r. Note the diagram in the marginal note at top left and many other notes from Tunikābunī added to his commentary by the scribe.	189
Fig. 6-3. The Tusi couple explained in the <i>Rule</i> . (MS P, fol. 70v). The diagram and the notes are quoted from Ṭūsī's <i>Tadhkira</i>	202
Fig. 6-4. Moon model using Tusi couple, redrawn based on the figure in the <i>Rule of Perception</i> (MS P, fol. 72r.).	203
Fig. 6-5. The equation of the Sun, redrawn from the <i>Rule of Perception</i> (MS P. fol. 76r).	205

List of Tables

Table 1-1. A Chronology of ‘Āmilī’s Life and Times.....	27
Table 3-1. Excerpts from the <i>Dissection</i> translated from Qūshjī’s <i>Risāla dar hay’at</i>	76
Table 3-2. A comparison of organization of topics between the <i>Mulakhkhaṣ</i> , <i>Riṣāla dar hay’at</i> and the <i>Dissection</i> . The other two books are compared against Qūshjī’s <i>Risāla</i> since it includes more topics and has the most detailed organization among all. Empty cells show missing sections in the <i>Dissection</i>	93
Table 3-3: The overall structure of the <i>Dissection</i> compared against the <i>Mulakhkhaṣ</i> and the <i>Risāla dar hay’at</i>	94
Table 4-1: Ṭūsī’s counting scheme for the orbs.....	100
Table 4-2: Circles and arcs defined in the <i>Dissection</i>	109
Table 4-3. Islamicate scholars who made attempts to solve problems of the Ptolemaic planetary models, based on three accounts recorded after the fifteenth century.	128
Table 4-4. Sixteen problems of the Ptolemaic planetary models.....	130
Table 5-1. Commentaries, super-commentaries, glosses, and translations of the <i>Dissection of the Orbs</i> (in alphabetical order by authors names). The ‘dates’ column represents either the composition date of the entry, if available, or the latest possible date based on the author’s or the dedicatee’s lives.	151
Table 5-2. Contents of the <i>Exposition</i> , based on MS Mashhad 8550	159
Table 5-3. Contents of the commentary on the orbs of the planets from the <i>Exposition</i>	172
Table 5-4. Contents of the commentary on the planetary motions from the <i>Exposition</i>	176
Table 5-5. Longitudinal motions of the planets based on Samarqand observations.....	177
Table 6-1. Six cases for the position and motion of a planet and the orb.....	192
Table 6-2. Books and authorities referred to by Khalkhālī and Tunikābunī	208

Abstract

This dissertation offers the first account of a scientific tradition in theoretical astronomy (*‘ilm al-hay’a*) initiated by Bahā’ al-Dīn al-‘Āmilī (1547-1621), a polymath and a chief jurisconsult in the Safavid monarchy (1501-1722) in Persia. ‘Āmilī’s campaign to acquire royal patronage, depended on multiple rededications of an introductory work on astronomy, *The Dissection of the Orbs* (*Tashrīḥ al-aflāk*), composed before 1576. The last shah to receive this dedication was ‘Abbās I (r. 1588-1629), who raised ‘Āmilī to the position of chief jurisconsult for the Safavid empire in 1001/1592-3. ‘Āmilī’s new position at the imperial court enabled him to legitimize astral sciences among the Safavids, for example, in *The Crescent Garden* (*al-Ḥadīqa al-hilāliyya*) completed in 1595. He also completed an extensive *Gloss* on the *Dissection* and began to train students in astronomy before 1599. The active research tradition in *‘ilm al-hay’a* founded by ‘Āmilī was continued by his disciples and subsequent scholars in Persia and Mughal India in commentaries that make use of the *Gloss* and the *Dissection*. ‘Āmilī and his commentators continued the scientific tradition of Marāgha and Samarqand. They differed from earlier scholars in accepting the work of another Safavid scholar, Shams al-Dīn Khafrī (d. after 1525), as the solution to the canonical list of problems in Ptolemaic astronomy, although there is evidence that ‘Āmilī proposed new models for the problematic cases of Mercury and the Moon. Original research material in this period appeared in the form of commentary and super-commentary literature on contemporary and previous authorities in astronomy. After describing the contents of the *Dissection* and the *Gloss*, I will introduce and discuss two commentaries on the *Dissection* by ‘Āmilī’s disciples; one by Shams al-Dīn ‘Alī Khalkhālī (fl. 1088/1599) written in India for the Mughal Emperor Akbar (r. 1556-1605), and the other by Muḥammad Kāzīm Tunikābunī (d. after 1033/1624) written in Persia for ‘Abbās I. Commentators on ‘Āmilī’s astronomical works did not

simply imitate him or previous Islamicate scholars; instead, they took the commentary style as a vehicle for manifesting their critical ideas and uncertainties concerning technical issues, besides showing their mastery of the literature of the discipline. Considering commentary literature as original research material, this dissertation emphasizes the necessity of a reformed attitude in understanding the intellectual productions of the Islamicate postclassical period (1200-1900) in its social and cultural context.

Introduction

In this dissertation I will give the first account of an active research tradition in theoretical astronomy, particularly in *‘ilm al-hay’a*, begun by Bahā’ al-Dīn ‘Āmilī (953-1030/1547-1621) the highest religious authority under ‘Abbās I (r. 158-1629), the most powerful of the Safavid shahs. ‘Āmilī’s first book in astronomy, *Tashrīḥ al-aflāk* (*The Dissection of the Orbs*, henceforth the *Dissection*), composed before 1576, was an introductory book on theoretical astronomy or *‘ilm al-hay’a*, and is mostly underestimated in the modern scholarship because of its short length and simple treatment of the technical topics. However, considering the broader social context of ‘Āmilī’s life and career, I will show how the *Dissection* initiated a research tradition in *‘ilm al-hay’a* and became the subject of numerous commentaries and super-commentaries in Safavid Persia and Mughal India. ‘Āmilī’s multiple dedications of the *Dissection* to four Safavid shahs played a major role not only in his intellectual and political advancement, but also in promoting the astral sciences among the court and public realms. This promotion of the astral sciences was continued by ‘Āmilī’s students and followers in Persia and India and appeared in the form of commentaries on his works. ‘Āmilī wrote other astronomical works including a *Gloss* on the *Dissection* (written before 1596) which I will describe in detail, and two super-commentaries on Jaghmīnī’s (fl. 13th century) *Mulakhkhaṣ fī hay’a al-basīṭa* (*An Epitome of Plain hay’a*, composed in 602-3/1205-6)¹, as well as Persian and Arabic works on the astrolabes and *qibla*. In the following chapter, I will provide some historical background, fill out ‘Āmilī’s biography and explain the role of the *Dissection* in ‘Āmilī’s campaign to gain patronage from a succession of Safavid shahs.

¹ Sally P. Ragep, *Jaghmīnī’s Mulakhkhaṣ: An Islamic Introduction to Ptolemaic Astronomy* (Springer, 2017), 20.

Introduction

‘Āmilī’s attempt to legitimize the astral sciences as licit methods for addressing religious issues manifests itself in the *al-Ḥadīqa al-hilāliyya* (*The Crescent Garden*, henceforth the *Crescent*), completed in 1595, a commentary on a prayer for the first sighting of the new moon. Chapter 2 first gives an overview of the status of astral sciences among the Safavids based on the chronicles of the early Safavid century and the European travelers’ accounts made during the reign of the last Safavid shahs. I go on to discuss *The Crescent Garden* and ‘Āmilī’s role in rehabilitating the discipline of *‘ilm al-hay’a* with his attempt to justify and endorse astrological practices in light of a new understanding of its causal relations to the earthly events.

A complete description of the contents of the *Dissection* is given in Chapter 3. I will show that the *Dissection* was a simple introductory book on *‘ilm al-hay’a* that lacked technical materials, but that it still made references to the reform tradition of Marāgha astronomers and their followers up to the early Safavid era, that aimed to solve the canonical problems of the *‘ilm al-hay’a*. Unlike other works in the genre, the *Dissection* presented a section on determining the *qibla* direction, which considering its multiple dedications to the Safavid shahs, promoted the astronomical methods of *‘ilm al-hay’a* in solving religious matters of courtly contention and daily use for the populace.

In Chapter 4, I will discuss the content of the *Gloss to the Dissection* (*Ḥāshiya tashrīḥ al-aflāk*), which ‘Āmilī made after he had been raised to the position of chief jurisconsult for the Safavid empire in 1001/1592-3. In the *Gloss* to he addressed more technical topics of *‘ilm al-hay’a*. One significant feature of the *Gloss* is ‘Āmilī’s introduction and classification of the canonical problems of the *‘ilm al-hay’a* about Ptolemaic models for the planetary motions, which Islamicate astronomers from the Marāgha period (13th century) to the early Safavid era attempted to solve. In ‘Āmilī’s view, Shams al-Dīn Khafrī (d. c. 1525), in his commentaries, solved the

Introduction

remaining of the sixteen difficulties that Marāgha astronomers like Naṣīr al-Dīn Ṭūsī (1201-1274) and his student Quṭb al-Dīn Shīrāzī (1236-1311) did not solve. In Chapter 4, I will present a short history of the treatment of these problems from the advent of the Safavids until ‘Āmilī’s time.

‘Āmilī’s disciples and subsequent scholars continued the intellectual tradition initiated by ‘Āmilī’s astronomical works, and his movement in rehabilitating the astral sciences among the Safavids, in the form of commentaries on his astronomical works. Chapter 5 and Chapter 6 will examine two of the commentaries written by ‘Āmilī’s students on the *Dissection*. Chapter 5 introduces Shams al-Dīn ‘Alī Khalkhālī’s *Exposition of the Orb*, which was made in India for the Mughal Emperor Akbar (r. 1556-1605). Khalkhālī changed the tone of parts of his commentary concerning religious issues to make it appeal to the Sunni audience of Mughal India. His commentary is evidence of how ‘Āmilī’s scientific works were transmitted into India. In Chapter 5, I will also discuss the nature of intellectual production of the Islamicate post-classical period (1200-1900) which appeared mostly in the guise of commentaries, super-commentaries, and glosses on previously established authorities in rational sciences. The commentary tradition on ‘Āmilī’s works should be viewed as an active scientific tradition in theoretical astronomy. In his commentary, Khalkhālī presented his disagreement with ‘Āmilī on some topics like comets and the nature of the sphere of Fire, and showed ongoing uncertainties on other issues like the order of the lower planets and the Sun.

Chapter 6 introduces Muḥammad Kāẓim Tunikābunī’s *Rule of Perception*, another commentary on the *Dissection* by one of his students which was written with ‘Āmilī’s initial encouragement. Tunikābunī dedicated his commentary to ‘Abbās I and completed the text in different places as will be discussed in Chapter 6. That chapter presents, for the first time, an

Introduction

account of Tunikābunī's intellectual life, scientific works, and his quest for patronage in Persia and India. Tunikābunī gave a more serious treatment than 'Āmilī of the non-Ptolemaic models for the planetary motions proposed by Marāgha astronomers. He explained the Tusi Couple and its application to solve the physical inconsistency of Ptolemy's orb model for the Moon. In Tunikābunī's commentary, certain natural philosophical topics gained more attention, such as the possible motion of the Earth, a topic 'Āmilī dealt with briefly in the *Dissection*, and with more details in the *Gloss*. In Chapter 6, I collate the sources used by Khalkhālī and Tunikābunī in their commentaries on 'Āmilī, and show their mastery of the major sources in the discipline of *'ilm al-hay'a* and their related mastery of philosophical, theological, and linguistic works of Islamicate culture. Following 'Āmilī, both Khalkhālī and Tunikābunī relied on Khafī for the final solutions to all remaining difficulties of Ptolemaic astronomy in the *'ilm al-hay'a* of the Islamicate astronomy.

In the Conclusion, I will draw redundant on all contents and major arguments of the dissertation. Certain additional topics will be addressed in the conclusion as further evidence of the importance of 'Āmilī's intellectual works and his foundation of an active scientific tradition, such as the transmission of his works to Mughal India and the influence on and reception by the Indian scholarly community. Because the greater part of the dissertation is based on primary sources that have not been examined before, in place of a review of the literature the Conclusion will comment on current literature in the light of the results of the dissertation. Using the arguments and evidence presented in this dissertation, I will evaluate the relevance of the “decline thesis” for Islamicate science in modern scholarship and discuss why it remained so long an accepted idea among historians of science.

Chapter 1

‘Āmilī’s life and career

1.1 The first Safavid century

In 1501 Shah Ismā‘īl I began to conquer the lands that Europeans called the Persian empire. He was assisted in this by a group of tribal warriors called the Qizilbāsh (named after their crimson headwear), who initially regarded Ismā‘īl as a messianic figure. In the next decade Ismā‘īl conquered almost all the territories of the former White Sheep (*Ak Koyonlu, Aq-qoyunlu*) federation, as well as land formerly controlled by the Ottoman Empire to the West, although the retaliation of Ottoman Sultan Selim I (‘the Grim’) led to the temporary loss of Tabriz and the more permanent loss of Kurdistan and Diyarbakir. After the death of Ismā‘īl I hostilities with the Ottomans continued, and the imperial capital was moved successively westward from Tabriz to Qazvin and finally to Isfahan.²

The Qizilbāsh abandoned their near worship of the shah after a crushing defeat by Ottoman forces at the battle of Chaldiran in 920/1514. However, Ismā‘īl I acted as both political and religious head of the new empire. From the beginning of his reign, he promulgated Twelver Shi’ism.³ Sunni officials and intellectuals were executed, forced to convert or to flee.⁴ Ismā‘īl I’s reign ended in strife between Qizilbāsh factions. When he died in 1524, his son Ṭahmāsb

² Percy Molesworth Sykes, *A History of Persia*, third edition (London: Macmillan and Co., limited, 1930), 2:162-63; H. R. Roemer, “The Safavid Period,” in *The Cambridge History of Iran*, ed. Peter Jackson and Laurence Lockhart, Reprint, vol. 6 (Cambridge: Cambridge University Press, 2006), 225.

³ Twelver Shi’ism is the largest alternative to Sunni Islam. Shi’a believe that, after the death of the Prophet, God provided an Imam as an infallible guide to the faith. The first Imam was the Prophet’s son-in-law ‘Alī, followed by his descendants, for twelve generations. The Twelfth Imam did not die, but was “occulted” (concealed by God) against a foretold return (*raj’a*), explaining the name of this variety of Islam. John Alden Williams (ed.) *Islam*. New York: Braziller, 1962, 224-6.

⁴ Tofigh Heidarzadeh, “Patronage, Networks and Migration: Turco-Persian Scholarly Exchanges in the 15th, 16th and 17th Centuries,” *Archives Internationales d’Histoire Des Sciences* 55, no. 155 (December 1, 2005): 419–34.

ascended the throne at the age of ten. He was protected by the most powerful Qizilbāsh leader, and reigned for 52 years.⁵

The new empire lacked Shia replacements for Sunni officials, and met the need by encouraging immigration of scholars from Shia regions elsewhere. The region of Jabal ‘Āmil, now in southern Lebanon, was an important source of Shia scholars, including ‘Āmilī’s father, Ḥusayn al-Ḥārithī (d. 1576), who brought his family, including the young Bahā’ al-Dīn, to Persia in 1554, in the middle of Ṭahmāsb’s reign.⁶ Shah Ṭahmāsb I restored unity and peace to the empire, despite continuing internal unrest and attacks from the Ottomans. He suppressed the rebellion of his brother Ikass Mirza (1574-8/ 954-5), and his successful defense against an invasion by the Ottoman sultan Suleiman the Magnificent was recorded by the English poet John Milton.⁷ Shah Ṭahmāsb negotiated a lasting peace with the Ottomans in 1555/962.

The reign of Shah Ismā‘īl II (r. 1576-78) was a short turbulent period of social and political unrest after the consolidation in Ṭahmāsb’s reign. As a young man he was imprisoned by his

⁵ Roemer, “The Safavid Period,” 233.

⁶ Rula Anis Jurdi, “Migration and Social Change: The ‘Ulama of Ottoman Jabal ‘Āmil in Safavid Iran, 1501-1736” (Ph.D. Dissertation, Connecticut, Yale University, 1998); Devin J. Stewart, “Notes on the Migration of ‘Āmilī Scholars to Safavid Iran,” *Journal of Near Eastern Studies* 55, no. 2 (1996): 81–103; “An Episode in the ‘Āmilī Migration to Safavid Iran: Husayn b. ‘Abd al-Samad al-‘Āmilī’s Travel Account,” *Iranian Studies* 39, no. 4 (2006): 481–508.

⁷ John Milton, *Paradise Lost*, X: lines 431-36:

As when the Tartar from his Russian foe,
By Astracan, over the snowy plains,
Retires, or Bactrian Sophi, from the horns
Of Turkish crescent, leaves all waste beyond
The realm of Aladule, in his retreat
to Tauris or Casbeen.

‘Aladule’ is Armenia and Ṭahmāsb is the ‘Bactrian Sophi’, while ‘Tauris’ and ‘Casbeen’ are Tabriz and Qazvin. Quoted and identified in Sykes, *A History of Persia*, 2:158, 165. See also, John Milton, *Paradise Lost*, ed. Philip Pullman (Oxford; New York: Oxford University Press, 2005), 297; Roemer, “The Safavid Period,” 241–44.

father Ṭahmāsb in the *Qahqaha* fortress in northwest Persia. He was kept there for nineteen years, six months and twenty-one days.⁸ While there the Shia heir came in to contact with Sunni scholars, especially Mīrzā Makhdūm Sharīfī (1544/5-1585), who played a decisive role in Ismā'īl's religious formation.⁹

Following Ṭahmāsb's death in 984/1576 the central government lost control. Upon receiving the news of Ṭahmāsb's death and the murder of his younger half-brother Heydar -- a contender for the crown--¹⁰ Ismā'īl left the *Qahqaha* fortress and was declared shah on 22 August 1578 in Qazvin.¹¹ In many respects Ismā'īl showed pro-Sunni inclinations. He appointed his former teacher Mīrzā Makhdūm Sharīfī as vizier, although he was a Sunni. He had several disagreements with the Shiite *ulamā'* of Qazvin and Qizilbāsh leaders on issues such as the uniquely Shia ceremony of cursing the first three caliphs, as well as the status of Friday prayers, and the inscriptions on imperial coins. All these actions by Ismā'īl spread suspicions that he had converted to Sunnism.¹² In 1577 Ismā'īl II died mysteriously,¹³ Mīrzā Makhdūm fled to the Ottoman Empire,¹⁴ and Ismā'īl's brother Khudābanda ascended the throne.

⁸ Iskandar Beg Munshī, *Tārīkh-e 'ālam-ārāy-e 'Abbāsī*, ed. Iraj Afshar, third edition (Tehran: Amir-Kabir, 2004), 1:199; Iskandar Beg Munshī, *The History of Shah 'Abbas the Great: Tārīkh-e 'Ālamārā-ye 'Abbāsī*, trans. Roger M. Savory, Persian Heritage Series 28 (Boulder, Colo: Westview Press, 1978), 1:294. For a brief account on the Safavid chronicles see: Sholeh A. Quinn, "The Historiography of Safavid Prefaces," in *Safavid Persia: The History and Politics of an Islamic Society*, ed. C. P. Melville and University of Cambridge, Pembroke Persian Papers 4 (London: New York: I.B. Tauris; Distributed by St. Martin's Press, 1996), 1–25. A detailed analysis is also provided in Sholeh Alysia Quinn, *Historical Writing During the Reign of Shah 'Abbas: Ideology, Imitation, and Legitimacy in Safavid Chronicles* (Salt Lake City: University of Utah Press, 2000).

⁹ Shohreh Gholosorkhi, "Ismail II and Mirza Makhdum Sharifi: An Interlude in Safavid History," *International Journal of Middle East Studies* 26, no. 3 (1994): 477–88.

¹⁰ Andrew J. Newman, *Safavid Iran: Rebirth of a Persian Empire* (London: Tauris, 2009), 41.

¹¹ Qāzī Aḥmad Qumī, *Khulāṣa al-tavārīkh*, ed. Ehsan Eshraghi (Tehran: University of Tehran Press, 1980), 2:618; Iskandar Beg Munshī, *Tārīkh-e 'ālam-ārāy-e 'Abbāsī*, 1:207; *The history of Shah 'Abbas*, 1:307.

¹² Iskandar Beg Munshī, *Tārīkh-e 'ālam-ārāy-e 'Abbāsī*, 1:214-17; *The history of Shah 'Abbas*, 1:319-25; Devin J. Stewart, "The Lost Biography of Baha' al-Din al-'Āmilī and the Reign of Shah Isma'īl II in Safavid Historiography," *Iranian Studies* 31, no. 2 (June 1, 1998): 180–86.

¹³ Iskandar Beg Munshī, *Tārīkh-e 'ālam-ārāy-e 'Abbāsī*, 1:218-219; *The history of Shah 'Abbas*, 1:325-27.

¹⁴ Gholosorkhi, "Ismail II and Mirza Makhdum Sharifi," 478, on the date of this see note 10.

Shah Muhammad Khudābanda (r. 1578-87) was not a successful ruler. He suffered from poor eyesight. His wife Mahd-e ‘Ulyā had the principal control of state affairs until she was assassinated by the Qizilbāsh in 1597, with the approval of the shah. There were several revolts during Khudābanda’s reign and Safavid neighbors took advantage of the disarray, making incursions into the country. Uzbeks invaded Khorasan in 1578 and the Ottomans seized some parts of Tabriz in 1585. An amīr who was appointed the ruler of Herat by Ismā‘īl II declared Khudābanda’s son ‘Abbās Mīrzā shah in 1581. Although Khudābanda advanced to Herat in the same year and the emir surrendered, ‘Abbas forced Khudābanda to abdicate and was enthroned in Qazvin in 1587.¹⁵ ‘Abbās became the most successful Safavid shah, as well as Bahā’ al-Dīn al-‘Āmilī’s most important patron.

1.2 Bahā’ al-Dīn ‘Āmilī: Life, education, and early career

Bahā’ al-Dīn Muḥammad al-‘Āmilī, known as Shaykh Bahā’ī¹⁶, became a prominent Shiite jurist and theologian, and a polymath in many fields of religious and secular sciences. He was born in late Dhil Ḥajja 953/February 1547 in Baalbek¹⁷ and lived his early childhood in the region of Jabal ‘Āmil, southern Lebanon. He usually introduced himself at the beginning of his writings as “Bahā’ al-Dīn al-‘Āmilī” or “Muḥammad, known as Bahā’ al-Dīn al-‘Āmilī.” In the present popular culture of Iran ‘Āmilī’s religious contribution and works, as well as his literary character manifested in his Persian poems, loom larger than his scientific and political role among the

¹⁵ Peter Jackson and Laurence Lockhart, eds., *The Cambridge History of Iran: The Timurid and Safavid Periods*, Reprint, vol. 6 (Cambridge: Cambridge Univ. Press, 2006), 253–61; Rudolph P. Matthee, “Safavid Dynasty,” in *Encyclopaedia Iranica*, 2008, <http://www.iranicaonline.org/articles/safavids>.

¹⁶ The name “Bahā’ī” is totally unrelated to the Baha’i sect that emerged in the nineteenth century and finally departed from Islam.

¹⁷ Yūsuf ibn Aḥmad al-Baḥrānī, *Lu’lu’ al-baḥrayn fī al-‘ijāzāt va-tarājum rijāl va-al-ḥadīth*, ed. Mohammad-Sadegh Bahr al-Oloum (Qum: Iran, n.d.), 22; Mīrzā Abdullāh Afandī Iṣfahānī, *Riyāḍ al-‘ulamā’ wa-ḥiyāḍ al-fuḍalā’*, ed. Ahmad Hosseini Eshkevari (Qum: Iran, 1980), 5:91.

Safavids. Later histories, including those written during the Qajar period (1789-1925) classified him as an occultist too, or particularly as a lettrist (a practitioner of lettrism or *‘ilm al-hūrūf*). However, as will be explained below, except for a few riddles of some literary or scientific importance, none of ‘Āmilī’s works include materials on the occult sciences. Neither did any contemporary chronicles introduce him as such.¹⁸ ‘Āmilī was a member of *‘ulamā*’ class and remained so for long in Persian history, but some reports reveal his inclination to Sufism and his frequenting of the Sufi communities. ‘Abbās who took serious measures in retarding any social movement against Twelver Shiism by the Sufis and controlling the relationship of *‘ulamā*’ with them, once found that ‘Āmilī visited Sufis and had conversations with them. ‘Abbās told ‘Āmilī that: “I have heard that a great scholar commingled with the poor and the vile in their cottages which is improper.” ‘Āmilī answered: “This is not true, for many are the times I spent in these places and it never happened that I encountered any such scholar there.”¹⁹

According to the chronicler and secretary at ‘Abbās I’s court, Iskandar Beg Munshī (969-c. 1043/1561–1633 or 1634), ‘Āmilī began studying sciences soon after his arrival in Persia, so that within a short while he made high achievements in religious and rational sciences and exceeded his peers in all arts.²⁰ Iskandar Beg maintained that he acquired all his religious knowledge including Quranic exegesis, Ḥadīth (tradition), jurisprudence, Arabic, and related subjects from his father. ‘Āmilī’s father, Ḥusayn, issued an *ijāza*²¹ to him and his younger brother ‘Abd al-

¹⁸ To know more about ‘Āmilī’s fame as an occultist in later note, for example: Matthew Melvin-Koushki, “Pseudo-Shaykh Bahā’ī on the Supreme Name, a Safavid-Qajar Lettrist Classic,” in *Light upon Light: Essays in Islamic Thought and History in Honor of Gerhard Bowering* (Brill, 2019), 256–90.

¹⁹ Rula Jurdi Abisaab, *Converting Persia: Religion and Power in the Safavid Empire*, International Library of Iranian Studies 1 (London; New York: I.B. Tauris, 2004), 68.

²⁰ Iskandar Beg Munshī, *Tārīkh-e ‘ālam-ārāy-e ‘Abbāsī*, 1:156; *The history of Shah ‘Abbas*, 1:248.

²¹ As indicated here an *ijāza* is a license to teach or transmit knowledge. Unlike western university degrees, which have a similar function, it is always issued by an individual to an individual. For the concept of *ijāza* see: Mesut Idriz, “From a Local Tradition to a Universal Practice: ‘Ijāzah’ as a Muslim Educational Tradition (With Special

Şamad in Mashhad on 2 Rajab 971/15 February 1564. Ḥusayn wrote the *ijāza* on the back of the extensive *ijāza* he had received from his own master Zayn al-Dīn (d. 955/1558), thus transmitting all his intellectual prerogatives to his sons. ‘Āmilī mentioned in the *Arba ‘ūn Ḥadīth* that the *ijāza* was given at their house.²² As the beginning of the *ijāza* reads, Ḥusayn taught his elder son both traditional (*naqlī*) and rational (‘*aqlī*) sciences that he had learned from Zayn al-Dīn and granted his son the transmission of all he had been granted previously.²³

‘Āmilī also studied theology and rational sciences under Mullā ‘Abd Allāh Bahābādī Yazdī (d. 981/1573–4).²⁴ Ḥasan Beg Rūmlū (d. c. 1578), the chronicler of Ṭahmāsb’s reign, presents Yazdī as a notable and a prominent scholar. His super-gloss on Jalāl-al-Dīn Dawānī’s (1426–1502)²⁵ gloss on Şa’d al-Dīn Taftāzānī’s (d. 1390) *Logic* (*Tahdhīb al-manṭiq*) became famous, along with Yazdī’s own gloss on the same work.²⁶ In some of his writings ‘Āmilī admitted that he had studied *Kullīyyāt al-qānūn* (lit. “The Generalities of the *Canon*,” in Latin translations *Colliget*), an epitome of Ibn Sīnā’s *Canon of Medicine*, and some other texts under Yazdī as well.²⁷ A copy of Shams al-Dīn Muḥammad in Maḥmūd Āmulī’s commentary on the *Golliget*,

Reference to a 19th Century Idrīs Fahmī b. Sālih’s ‘Ijāzah’ Issued in the Balkans and Its Annotated English Translation),” *Asian Journal of Social Science* 35, no. 1 (2007): 84–110; George Makdisi, *The Rise of Humanism in Classical Islam and the Christian West: With Special Reference to Scholasticism* (Edinburgh: Edinburgh University Press, 1990), 140; G. Vajda and I. Goldziher, “Idjāzah,” in *Encyclopaedia of Islam*, ed. B. Lewis et al. (Leiden: Brill, 1986).

²² Devin J. Stewart, “The First Shaykh al-Islām of the Safavid Capital Qazvin,” *Journal of the American Oriental Society* 116, no. 3 (1996): 393, n. 52.

²³ In his voluminous hadith collection, Muḥammad Bāqir Majlisī (1616–1698), whose father was ‘Āmilī’s disciple, preserved the texts of both Ḥusayn’s *ijāza* from Zayn al-Dīn and the *ijāza* granted to ‘Āmilī. ‘Āmilī’s *ijāza* was also recorded later by al-Işfahānī. Muḥammad Bāqir Majlisī, *Biḥār al-‘anvār al-jāmi‘a li-durar al-akhbār al-‘A’imma al-‘aṭhār* (Beirut: Lebanon: Dār Iḥyā’ al-Turāth al-‘Arabī, n.d.), 105:146–171, 189–90. Işfahānī, *Riyāḍ al-‘ulamā’*, 5:94–5.

²⁴ Iskandar Beg Munshī, *Tārīkh-e ‘ālam-ārāy-e ‘Abbāsī*, 1:156; *The history of Shah ‘Abbas*, 1:248.

²⁵ Andrew J. Newman, “Davānī, Jalāl-al-Dīn Moḥammad,” in *Encyclopaedia Iranica*, 1994.

²⁶ A similar description of Yazdī was recorded in 1078/1667–68 by Vāleh Işfahānī, who also reported Yazdī’s death in accordance with Rūmlū’s account in 981/1573–4 in “Arabistān” (Iraq). Ḥasan Beg Rūmlū, *Aḥsan al-tavārīkh*, ed. Abdolhossein Navai (Tehran, 1978), 3:1487; Muḥammad Yūsuf Vāleh Işfahānī and Hashem Mohaddeth, *Khulde Barīn* (Tehran, 1993), 443.

²⁷ Işfahānī, *Riyāḍ al-‘ulamā’*, 1:576.

completed on 15 Muḥarram 753/3 Mar 1352 and copied on 19 Šafar 754/26 Mar 1353, bears ‘Āmilī’s stamp and signature at the beginning and ending folios of the text.²⁸

According to Iskandar Beg, ‘Āmilī acquired his mathematical knowledge from Mullā ‘Alī Mudhahhib,²⁹ Mullā Afḍal Qā’inī, and other scholars for whom we lack specific dates, and studied medicine and Ibn Sīnā’s *Canon* under a well-known physician of the period, ‘Imād al-Dīn Maḥmūd Shīrāzī (d. c. 990/1582), from a prominent family of physicians of Shiraz.³⁰ Another of ‘Āmilī’s teachers in medicine, according to Vāleh Işfahānī (d. 1105-6/1694-5), was Šadrāy-i Gīlānī (11th century).³¹ When he was fifteen years old, in 969/1561-2, ‘Āmilī copied Qāḍīzāda’s commentary on the *Ashkāl al-ta’sīs* (*The Founding Figures*)³² of Shams al-Dīn Samarqandī (d. 1302).³³ The *Ashkāl al-ta’sīs* was a book on 35 propositions from Euclid’s *Elements* and Qāḍīzāda’s commentary, dedicated to Ulugh Beg in 814/1412, the same year he wrote a commentary on Jaghmīnī’s *Mulakhkhaṣ* for the emir, was a frequently read source during the Timurid and Safavid periods.³⁴ This extant copy in ‘Āmilī’s hand proves that the treatise was among the mathematical corpus he studied in Persia.

More than a hundred and eighty works have been attributed to ‘Āmilī.³⁵ He produced materials in almost all religious sciences including theology, Shiite law, creed, and hadith, and

²⁸ Muḥammad ibn Maḥmūd Āmulī, “Sharḥ kulliyāt al-qānūn” (British Library MS Or. 3654, March 26, 1353).

²⁹ He was referred to by ‘Āmilī’s disciples too. For details see Chapter 5.

³⁰ Emilie Savage-Smith, “‘Emād-al-Dīn Maḥmūd,” in *Encyclopaedia Iranica*, 1998; Cyril Elgood, *Safavid Medical Practice: Or, The Practice of Medicine, Surgery and Gynaecology in Persia Between 1500 A.D. and 1750 A.D.* (Luzac, 1970), 21–24.

³¹ Vāleh Işfahānī and Mohaddeth, *Khulde Barīn*, 435.

³² For another meaning of the title see: I. Fazlioğlu, “The Samarqand Mathematical-Astronomical School: A Basis for Ottoman Philosophy and Science,” *Journal for the History of Arabic Science* 14 (2008): 27–29.

³³ Šalāh al-Dīn Mūsā ibn Muḥammad Qāḍīzāda al-Rūmī and Shams al-Dīn Samarqandī, “Sharḥ ashkāl al-ta’sīs” (Tehran, Sepahsalar Library, MS 539, 1562).

³⁴ Fazlioğlu, “The Samarqand Mathematical-Astronomical School,” 19, 26, 29; Sonja Brentjes, “Euclid’s *Elements*, Courtly Patronage and Princely Education,” *Iranian Studies* 41, no. 4 (September 1, 2008): 442–43, 460.

³⁵ Nasrabadi recorded 104 authentic works and gave a list of 81 spurious and attributed works in his bibliography of ‘Āmilī: Sayyed Mohsen Naji-Nasrabadi, *Ketābshenāsiye Sheykh Bahā’ī* (Meshed: Islamic Research Foundation, 2008), 51–606, 609–56.

also composed several original works of poetry, mathematics, and astronomy in Arabic and Persian, as well as glosses and commentaries on previous authorities. His writings gained enormous attention and many commentaries and glosses have been written on them. Some of them are used as textbooks in seminaries and religious madrasas today. When he acquired a high position in state affairs by holding the office of *shaykh al-islām* for the imperial capital, he rose to such prominence that he became a leading figure in both religious and secular sciences.

The chronicles do not specify the subjects ‘Āmilī was teaching while in Qazvin in the last years of Ṭahmāsb’s reign and in Isfahan during the reigns of Ismā‘īl and Khudābanda. They only provide a general indication that he was teaching religious sciences. The sole report that shows he taught astronomy in that period refers to his return from his pilgrimage through Ottoman territory. In 991/1583 ‘Āmilī began a pilgrimage to Mecca and traveled through Ottoman territory in disguise. On the way back from Mecca to Isfahan in 992/1584, ‘Āmilī returned by Egyptian caravan first through Cairo and then Jerusalem. In Cairo he met Muḥammad al-Bakrī al-Ṣiddīqī (d. 993/1585), the leader of the Bakrī Sufi order, and composed a long poem in his praise. In Jerusalem ‘Āmilī met ‘Umar ibn Abī al-luṭf al-Maqdisī (d. 1003/1595), the Ḥanafī mufti of Jerusalem, with whom he exchanged poems after his return to Persia.³⁶ Raḍīy al-Dīn Muḥammad ibn Yūsuf ibn Abī al-Luṭf al-Maqdisī (d. 1028/1619), a relative of ‘Umar al-Maqdisī, met ‘Āmilī in Jerusalem and asked to study mathematical sciences including *hay’a* and geometry with him.³⁷ During his stay in Jerusalem, ‘Āmilī also met ‘Umar’s brother Muḥammad ibn Abī al-luṭf al-Maqdisī (ca. 941-992/ca. 1535-1585), the Shāfi‘ī mufti of Jerusalem and

³⁶ Bahā’ al-Dīn al-‘Āmilī, *al-Kashkūl* (Beirut: Lebanon: Mu‘assissat al-A‘lamī lil-Maṭbū‘āt, 1983), 67–69; Devin J. Stewart, “*Taqiyyah* as Performance: The Travels of Bahā’ al-Dīn al-‘Āmilī in the Ottoman Empire (991– 93/1583–85),” *Princeton papers in Near Eastern Studies* 4 (1996): 15.

³⁷ Muḥammad ibn Aḥmad al-Ṭāluwī al-Artaqī al-Dimashqī, *Sāniḥāt duma al-qaṣr fī muṭāriḥāt banī al-‘aṣr*, ed. Muḥammad Mursī al-Khulī (Beirut: Lebanon: ‘Ālam al-Kutub, 1983), 2:126-27. Stewart translated the passages on ‘Āmilī’s journey to Jerusalem from a manuscript copy of al-Ṭāluwī’s work. Stewart, “*Taqiyyah*,” 15–16.

received an *ijāza* from him.³⁸ In meeting with these scholars, as Steward noted, ‘Āmilī followed the same journey his father and Zayn al-Dīn had embarked on some years before. In 942-43/1535-37 his father and Zayn al-Dīn had traveled to Cairo and studied Quranic exegesis and jurisprudence with the father of Muḥammad al-Bakrī, then the leader of the Bakrī Sufi order. They also went to Jerusalem in 948/1542 and Zayn al-Dīn received an *ijāza* from Shams al-Dīn ibn Abī al-Luṭf al-Maqdisī.³⁹ Whatever ‘Āmilī’s aim was of going on this pilgrimage, either avoiding contentions with Mīr Ḥusayn (see below) or following his family intellectual legacy, the *ijāza* he received in Jerusalem would have had an influential role in his credentials, which would ultimately be effective in his future political and social promotion.

Some historians have argued that ‘Āmilī was made *shaykh al-islām* of Herat,⁴⁰ replacing his father after Ḥusayn’s death in Bahrain. Others, however, argued that ‘Āmilī’s younger brother ‘Abd al-Ṣamad became *shaykh al-islām* of Herat after his father’s death and ‘Āmilī replaced his father-in-law as *shaykh al-islām* of Iṣfahān when Shaykh ‘Alī Minshār died on 13 Rabī‘ I 984/10 June 1576 without an heir.⁴¹ This is supported by Iskandar Beg’s explicit report that after the death of Shaykh ‘Alī Minshār the position of *shaykh al-islām* was transferred to ‘Āmilī, and he became responsible for all religious and legal affairs of the whole community of Iṣfahān. When Ḥusayn left Herat for Qazvin in 983/1576 to get permission from the shah for the pilgrimage to Mecca, he requested permission for his son ‘Āmilī to accompany him, but Ṭahmāsb did not approve travel for ‘Āmilī and required him to stay in Qazvin and teach religious sciences.⁴² Ṭahmāsb died a few months later, on 15 Ṣafar 984/14 May 1576.

³⁸ Stewart, “*Taqiyyah*,” 16, 40–44.

³⁹ Stewart, 13–16.

⁴⁰ See e.g.: *ibid.*, 172; R. M. Savory et al., “Ṣafawids,” *Encyclopaedia of Islam, Second Edition*, 1995, 8: 779.

⁴¹ Iṣfahānī, *Riyāḍ al-‘ulamā’*, 4:284; Mohsen Amin, *A ‘yān al-Shī‘a*, ed. Hasan Amin (Beirut: Lebanon: Dār al-Ma‘ārif lil-Maṭbū‘āt, n.d.), 8:369; Devin J. Stewart, “A Biographical Notice on Bahā’ al-Dīn al-‘Āmilī (d. 1030/1621),” *Journal of the American Oriental Society* 111, no. 3 (1991): 569.

⁴² Iṣfahānī, *Riyāḍ al-‘ulamā’*, 2:120.

1.3 ‘Āmilī’s father and the office of *shaykh al-islām*

One of the most important state offices in Safavid Persia was *shaykh al-islām* (chief jurisconsult) of a city, a position with inseparable religious and legal responsibilities, appointed by the Shah. The *shaykh al-islām* of the capital had the greatest authority as he appointed other jurists as his deputies to the same position in provincial cities. The title *shaykh al-islām* first appeared toward the end of the fourth/tenth century in Khorasan (northeast of Iran) and was common until the early twentieth century mostly to distinguish prominent religious scholars. Although the title first bore honorific designations, in the Ottoman and Safavid Empires it transferred some crucial state affairs to religious authorities.⁴³ Before the position of *shaykh al-islām* was adopted by the Safavids, the most powerful office was the *ṣadārat*, whose holder the *ṣadr* was responsible for administering religious endowments, appointing or dismissing religious deputies in other cities as well as supervising education at the madrasas. A *shaykh al-islām* was administratively and financially dependent on the *ṣadr* or his deputies, but the *ṣadr* or his deputies did not have control on ‘*ulamā*’ in religious matters. Therefore, the various *shaykh al-islām* formed a distinct hierarchy from the *ṣadr* and became the foremost religious authority of the community.⁴⁴ In some contemporary sources the position of *shaykh al-islām* is defined as a title given by Safavid rulers to the most qualified Shiite jurist, to fulfill religious obligations as well as to gain more popular support.⁴⁵ I will explain more in section 2.2 that the responsibilities of the *shaykh al-islām* and a *ṣadr* have not always been distinctly defined and sometimes conflicts occurred between the two positions. Each *shaykh al-islām* was the supreme legal authority in his own city,

⁴³ J. H. Kramers, R. Bulliet, and R. C. Repp, “*Shaykh al-Islām*,” in *Encyclopaedia of Islam, Second Edition*, ed. C. E. Bosworth et al. (Leiden: Brill, 1997).

⁴⁴ Said Amir Arjomand, “The Mujtahid of the Age and the Mullā-Bāshi: An Intermediate Stage in the Institutionalization of Religious Authority in Shi’ite Iran,” in *Authority and Political Culture in Shi’ism*, ed. Said Amir Arjomand (State University of New York Press, 1988), 80–97.

⁴⁵ Stewart, “The First Shaykh al-Islām,” 403.

but in principle there was a hierarchy in these positions, determined by the importance of the city itself relative to others. The *shaykh al-islām* of the imperial capital under Ṭahmāsb was the highest in Safavid Persia – a position held by both ‘Āmilī, his father and their mutual rival Mīr Ḥusayn al-Karakī (d. 1001/1592-93).

The Shiite jurist who first held the office of *shaykh al-islām* in Qazvin was ‘Āmilī’s father.⁴⁶ Ḥusayn ibn ‘Abd al-Ṣamad al-Ḥārithī al-‘Āmilī brought his family to Persia during the third decade of the fifty-two-year reign of Ṭahmāsb I (1524-1576), and soon became a key figure in both state and religious affairs. According to al-Iṣfahānī, Ḥusayn first settled in Isfahan for three years, being occupied with teaching religious sciences, and then was introduced to Shah Ṭahmāsb by a fellow ‘Āmilī, Shaykh ‘Alī Minshār,⁴⁷ who was the *shaykh al-islām* of Isfahan. ‘Āmilī married Shaykh ‘Alī Minshār’s daughter, further strengthening the connection between the two families. Ḥusayn was invited to the court at the capital Qazvin by Shah Ṭahmāsb, and then was appointed *shaykh al-islām* of the capital. After holding the office in Qazvin for about seven years, Ṭahmāsb demoted him to *shaykh al-islām* of Mashhad in the north east of Persia and later sent him to the more important city of Herat, where he served as *shaykh al-islām* for eight years until he left Persia to perform the pilgrimage to Mecca in 983/1575.⁴⁸ Following the pilgrimage, Ḥusayn settled briefly in Bahrain and taught religious sciences until he died there on 8 Rabī‘ I 984/5 June 1576.⁴⁹

Ḥusayn al-Ḥārithī’s dismissal was rooted in frictions with other Shiite jurists on legal issues involving religion. His main adversary was Sayyid Ḥusayn ibn Ḥasan al-Karakī (d. 1001/1592-

⁴⁶ Stewart, 387.

⁴⁷ Alī ibn Muḥammad ibn Hilāl al-Karakī al-‘Āmilī known as Shaykh ‘Alī Minshār.

⁴⁸ Iṣfahānī, *Riyāḍ al-‘ulamā’*, 2:120-21. For details of Ḥusayn’s journey see: Stewart, “The First Shaykh al-Islām,” 394–95.

⁴⁹ Iṣfahānī, *Riyāḍ al-‘ulamā’*, 2:121; al-Baḥrānī, *Lu’lu’ al-baḥrayn fī al-‘ijāzāt va-tarājum rijāl va-al-ḥadīth*, 28.

93) mentioned as Mīr Ḥusayn al-Karakī in the chronicles.⁵⁰ Mīr Ḥusayn's maternal grandfather 'Alī ibn Ḥusayn ibn 'Abd al-'Ālī al-Karakī (ca. 870-940/1464-1534) known as *al-Muḥaqqiq al-thānī* (The Second Verifier)⁵¹ or *al-Muḥaqqiq al-Karakī*, was one of the most influential Shiite jurists who migrated to Persia in the reign of Shah Ismā'īl I. The elder Karakī was a leading legal authority of the early Safavid Empire under Ismā'īl and Ṭahmāsb; Ṭahmāsb honored him with the title *khātām al-mujtahidīn*, the Seal of the Jurisconsults,⁵² (a *mujtahid* is a high qualified jurist who had the authority to derive the law of *sharī'a* from the Quran and hadith, so that lay believers can emulate him in legal issues).⁵³ According to Iskandar Beg, the younger al-Karakī, Mīr Ḥusayn, migrated to Persia in the reign of Ṭahmāsb and held the office of *shaykh al-islām* of Ardabil. Afterwards, he came to the court in Qazvin and claimed to be a *mujtahid*⁵⁴ and also called himself the Seal of the *Mujtahids*.⁵⁵

Al-Muḥaqqiq al-Karakī and his grandson Mīr Ḥusayn belonged to the group of 'ulamā' opposing Ḥusayn al-Ḥārithī, his son Bahā' al-Dīn, and his master Zayn al-Dīn al-'Āmilī, in some religious legal issues.⁵⁶ The points of contention included the acceptability of Friday prayer,⁵⁷ the method of finding the *qibla* direction, and the status of Sunnis. When Ḥusayn al-Ḥārithī was appointed *shaykh al-islām* of Qazvin he convinced Ṭahmāsb to perform the Friday prayer after it

⁵⁰ The possible reasons for this dismissal is discussed in details in Stewart, "The First Shaykh al-Islām," 402–5.

⁵¹ Hossein Modarressi Tabataba'i, *An Introduction to Shī'ī Law: A Bibliographical Study* (London: Ithaca Press, 1984), 50; Andrew J. Newman, "The Myth of the Clerical Migration to Safawid Iran," *Die Welt Des Islams* 33, no. 1 (January 1, 1993): 78–80.

⁵² Said Amir Arjomand, "Two Decrees of Shāh Ṭahmāsp Concerning Statecraft and the Authority of Shaykh 'Alī al-Karakī," in *Authority and Political Culture in Shi'ism*, ed. Said Amir Arjomand (State University of New York Press, 1988), 250–62.

⁵³ J. Calmard, "Mudjtahid," in *Encyclopaedia of Islam*, ed. C. E. Bosworth et al. (Leiden: Brill, 1993).

⁵⁴ Iskandar Beg Munshī, *Tārīkh-e 'ālam-ārāy-e 'Abbāsī*, 1:145; Iskandar Beg Munshī, *The history of Shah 'Abbas*, 233.

⁵⁵ Iskandar Beg Munshī, *Tārīkh-e 'ālam-ārāy-e 'Abbāsī*, 2:458; *The history of Shah 'Abbas*, 631–32; Iṣfahānī, *Riyād al-'ulamā'*, 2:69.

⁵⁶ Stewart, "Notes on the Migration of 'Āmilī Scholars," esp. 97–99.

⁵⁷ Devin J. Stewart, "Polemics and Patronage in Safavid Iran: The Debate on Friday Prayer During the Reign of Shah Tahmasb," *Bulletin of the School of Oriental and African Studies* 72, no. 03 (October 2009): 425–57.

had been canceled for several years.⁵⁸ Mīr Ḥusayn, by contrast, believed that the Friday prayer should only be performed in the presence of a high qualified *mujtahid*. In 966/1559 in Ardabil, he wrote a treatise to Ṭahmāsb describing his view on the matter, while deeply criticizing the views of Ḥusayn al-Ḥārithī’s master Zayn al-Dīn,⁵⁹ known as *al-Shahīd al-Thānī* (the Second Martyr) who had been executed by Ottomans on 17 Rajab 965/5 May 1558. Ṭahmāsb finally appointed Mīr Ḥusayn *shaykh al-islām* of Qazvin replacing Ḥusayn al-Ḥārithī in 1564. Shortly after leaving Qazvin, Ḥusayn al-Ḥārithī wrote *The Necklace of Ḥusayn (al-‘Iqd al-ḥusaynī)* indirectly warning Ṭahmāsb against Mīr Ḥusayn and vehemently criticizing the latter’s views on the Friday prayer.⁶⁰ But it was too late. Mīr Ḥusayn held the office in Qazvin during the reigns of Ismā‘īl II and his successor Khudābanda, and into the early years of ‘Abbās I’s reign, until his death in 1001/1592-93 of plague.⁶¹ Mīr Ḥusayn al-Karakī’s success was not only the cause of Ḥusayn al-Ḥārithī’s downfall, it was also a major obstacle to his son’s career.

1.4 ‘Āmilī’s patronage campaign -- a tale of four shahs

Since the time his father was removed from the office of *shaykh al-islām* of Qazvin by Ṭahmāsb, ‘Āmilī faced a setback in his intellectual and political career. When he left his father in Herat to reside in Qazvin for education and teaching, succeeding his father and holding the office of *shaykh al-islām* was now an impossible dream. The *ijāza* Ḥusayn granted ‘Āmilī in 971/1564 in Mashhad, was probably aimed to provide him with enough credentials for both teaching and being accepted by the intellectual circles of highly qualified ‘*ulamā*’ in Qazvin. But even if the *ijāza* introduced ‘Āmilī’s qualifications as being a descendent from the intellectual chain of great

⁵⁸ Iṣfahānī, *Riyāḍ al-‘ulamā*, 2:120.

⁵⁹ Iṣfahānī, 2:66.

⁶⁰ For a detailed analysis of *al-‘Iqd al-ḥusaynī* see: Stewart, “The First Shaykh al-Islām,” 396–402.

⁶¹ Iskandar Beg Munshī, *Tārīkh-e ‘ālam-ārāy-e ‘Abbāsī*, 2:458; *The history of Shah ‘Abbās*, 631–32.

Shiite scholars like his father and Zayn al-Dīn, it would not suffice to gain a sustained status in state affairs and his association with the Safavid court. This would be more difficult for him with the presence of his adversary, Mīr Ḥusayn, in Qazvin who had caused his father’s removal from the office. Around the same time ‘Āmilī began a campaign to acquire Ṭahmāsb’s attention and get his patronage by dedicating books to him. He pursued the same plan in the reigns of the three subsequent shahs, Ismā‘īl II, Khudābanda, and ‘Abbās I. The first dedication with a date, a work on measuring water, the *al-Kuriya*, was dedicated to Ṭahmāsb, right at the time the shah denied ‘Āmilī permission to accompany his father on the pilgrimage. Another, and apparently more instrumental dedication, was the *Dissection of the Orbs* which will be discussed in Chapter 1, along with an assessment of the circumstances under which it was written.

The composition date of the *Dissection* was not mentioned by the author, but the dedications give us some clues. The extant copies show that the book was dedicated to four Safavid shahs. First it was dedicated to Ṭahmāsb (r. 1524-1576),⁶² then to his son Ismā‘īl II (r. 1576-1578)⁶³ whose reign only lasted a year and half, after that to Ismā‘īl’s brother and successor Muḥammad Khudābanda (r. 1578-1587),⁶⁴ and finally to the most powerful of the Safavid rulers ‘Abbās I (r. 1587–1629).⁶⁵ Comparing copies with the four dedications, no differences appear in the contents or structure. But based on some slight changes in the copies dedicated to Khudābanda and ‘Abbās I, especially the very last sentence, we can conclude that the author revised the text, so there are two versions of the book. Many other available copies have no dedicatory letter, and the introduction begins right after the epigraph. The oldest surviving copy of the *Dissection* made by ‘Abd al-Fattāḥ Mas‘ūd al-Sharīf for a certain al-Sayyid Sa‘īd, was dedicated to Khudābanda on

⁶² Bahā’ al-Dīn al-‘Āmilī, “Tashrīḥ al-aflāk” (Tehran, National Library, MS 19154, 1263 1847).

⁶³ MSS Berlin 5707, MS Parliament 6270 (Tehran), and MS Melli 2472-42 (Tehran) have Ismā‘īl as the dedicatee.

⁶⁴ Bahā’ al-Dīn al-‘Āmilī, “Tashrīḥ al-aflāk” (Tehran, Malek National Library and Museum, MS 3218, 986 1576).

⁶⁵ Bahā’ al-Dīn al-‘Āmilī, “Tashrīḥ al-aflāk” (Tehran, National Library, MS 31736, n.d.).

11 Rabi‘ II of 986/17 June of 1578, about four months after Khudābanda’s coronation in Qazvin.⁶⁶ As will be shown in the following, the *Dissection* was likely written towards the end of Ṭahmāsb’s reign, most probably sometime between 1567 and 1575 when ‘Āmilī’s father was serving as *shaykh al-islām* in Herat.

‘Āmilī’s career faced upheavals and suffered much in the last decade of Ṭahmāsb’s reign. As already explained, following a dispute between ‘Āmilī’s father and Mīr Ḥusayn al-Karakī, his father was dismissed from the office of *shaykh al-islām* by order of the shah after seven years of service in Qazvin, and sent to Mashhad to serve as *shaykh al-islām* there.⁶⁷ After a few years holding the office in Mashhad⁶⁸ Ṭahmāsb appointed ‘Āmilī’s father *shaykh al-islām* of Herat where he served about eight years until his departure from Persia in 983/1575. However, Ṭahmāsb required his heir Muḥammad Khudābanda to be present at Ḥusayn al-Ḥārithī’s lectures on every Friday prayer at the congregational mosque of Herat.⁶⁹

While his father lived in Herat, ‘Āmilī’s life in Qazvin was arduous. ‘Āmilī had accompanied his father to Mashhad and stayed with him a short while in Herat, but he probably returned to Qazvin for education, after he received the *ijāza* allowing him to transmit the texts and teach the sciences he had studied under his father on 2 Rajab 971/15 February 1564 in Mashhad. From Qazvin, ‘Āmilī wrote two poems to his father, one in 979/1571-72⁷⁰ and the other in 981/1573-74.⁷¹ In another long undated poem he described various features of Herat for a friend,

⁶⁶ al-‘Āmilī, “Tashrīḥ al-aflāk,” 986 1576. Khudābanda’s coronation was on 3 Dhul ḥajj 985/11 February 1578.

⁶⁷ Ḥusayn probably replaced *sayyid* Mīr Asad Allāh (d. 970/1562-63), the former *shaykh al-islām* of Mashhad and the superintendent (*mutavallī*) of the shrine of the eighth Imām. Since Ḥusayn was not a *sayyid* (a descendent from the Prophet), by tradition he could not hold the *mutavallī* office and served only as *shaykh al-islām*. Stewart, “The First Shaykh al-Islām,” 393.

⁶⁸ The date of his move to Mashhad and the duration of his stay there are not mentioned in the chronicles, but some historical evidence places him there in 971 when he issued two *ijāzas*, one to one of his disciples and the other to his sons. See Stewart, 393–94.

⁶⁹ Iṣfahānī, *Riyāḍ al-‘ulamā’*, 2:120.

⁷⁰ al-‘Āmilī, *al-Kashkūl*, 1983, 1:28.

⁷¹ al-‘Āmilī, 1:46.

presumably in Qazvin. In the last section of the poem ‘Āmilī lamented being removed from Herat and his loved ones, recalled delights he enjoyed there and expressed his desire to return.⁷² As mentioned earlier, ‘Āmilī was not permitted by Ṭahmāsb to accompany his father on the pilgrimage to Mecca. Most probably, his father’s aim in performing the pilgrimage was in part a peaceful strategy to leave Persia forever. In a letter written in Bahrain to ‘Āmilī, Ḥusayn al-Ḥārithī sheds light on his bitterness toward Persia and Ṭahmāsb. According to al-Iṣfahānī, the letter included this message for ‘Āmilī: “If you seek the mundane world, move to India. And if you desire the hereafter, then you ought to come to Bahrain. But if you desire neither this world nor the next world, stay in Persia.”⁷³

At the time he received the letter from Bahrain, we do not know whether ‘Āmilī was forbidden to leave Persia to join Ḥusayn, or whether he chose to stay there, but in the *al-Kuriya* written in Qazvin for Ṭahmāsb he recorded a depressing situation at that time. In 983/1576 he wrote an Arabic treatise on legal measures and volumes of water, which had religious purposes, for Ṭahmāsb. ‘Āmilī mentioned at the beginning that it had crossed his mind to write something on the topic (*fa-jāl bi-khāṭiri ‘an urattib maqālat^{an}*) in order to include proper methods of measuring on the basis of both legal criteria and geometrical demonstrations. He pointed out that he was writing it with a distracted mind due to suffering caused by exhaustion.⁷⁴ He was apparently not happy with the situation at that time, since he missed his father who was his mentor and patron.

The composition of *al-Kuriya* was not commissioned by Ṭahmāsb, who died shortly after its dedication to him. Afadandī al-Iṣfahānī reported that ‘Āmilī composed the treatise in Persian

⁷² al-‘Āmilī, 1:189-94.

⁷³ Iṣfahānī, *Riyāḍ al-‘ulamā*, 2:121.

⁷⁴ “*ma ‘a tashattūt al-bāl bi-muqāsāt ‘umūrⁱⁿ taḥduth fī al-ṭab ‘kalāl^{an}*,” Bahā’ al-Dīn al-‘Āmilī, “*al-Kuriya*” (Tehran, Parliament Library, MS 1231, 1036 1627), fl. 67v.

with the title *Tuḥfa* (*The Gift*), a copy of which al-Iṣfahānī himself saw in Astrābād (nowadays N. Iran) in the hand of a scholar of the region, but he added that ‘Āmilī had also written another treatise on the same subject in Arabic which was also dedicated to Ṭahmāsb.⁷⁵ A copy of the Arabic recension made on 1 Ṣafar 1002/17 October 1593 has the title *Kuriya* in the colophon and bears the date of composition in early Shawwāl 983/January 1576 in Qazvin,⁷⁶ which is very close to the time ‘Āmilī’s father left Persia.⁷⁷ A year later in Ṣafar 1003/October-November 1577 ‘Āmilī issued an *ijāza* to the scribe Muḥammad-Bāqir Ḥusaynī which is appended to that copy.⁷⁸ In another copy of *al-Kuriya* for Ṭahmāsb, dated late Ramaḍān 1036/June 1610 in Isfahan, the scribe mentioned the same composition date in the colophon, i.e. early Shawwāl 983, and wrote that he made it based on and collated with the author’s archetype.⁷⁹ At the end of another undated copy of *al-Kuriya* also dedicated to Ṭahmāsb, ‘Āmilī granted an *ijāza* to the scribe ‘Abd al-Karīm Tabrīzī.⁸⁰ Some copies of the Persian text, the *Tuḥfa*, mentions Ṭahmāsb’s son Khudābanda as the dedicatee⁸¹ and the title *Tuḥfa* in the introduction.⁸² Āqābuzurg Tehrānī (1876-1970), in his voluminous bio-bibliography of Shiite literature, recorded the composition date of the *Tuḥfa* as 985/1587⁸³, the same year in which Ṭahmāsb’s successor Ismā‘īl II died and Khudābanda succeeded the throne. Based on these accounts, ‘Āmilī should have changed the dedication of the *Tuḥfa* to Khudābanda as he did in the *Dissection*. As I will explain below, he

⁷⁵ Iṣfahānī, *Riyāḍ al-‘ulamā’*, 5:96.

⁷⁶ Bahā’ al-Dīn al-‘Āmilī, “al-Kuriya” (Mashhad, Astan Qods Razavi, MS 39517, 1002 1593).

⁷⁷ In order to perform the pilgrimage in Dhū al-Ḥajja/March of that year, Ḥusayn al-Ḥārithī must have attended the pilgrimage caravan in Damascus in Shawwāl. Stewart, “The First Shaykh al-Islām,” 394.

⁷⁸ Cited from: Mohammad-Kazem Rahmati, “Sālshomāre zendegī va ta’līfāte Sheykh Bahāyī,” *Jurisprudence & Law Quarterly Book Review* 1, no. 2 (June 22, 2015): 252.

⁷⁹ al-‘Āmilī, “al-Kuriya,” 1036 1627, fl. 71r.

⁸⁰ Bahā’ al-Dīn al-‘Āmilī, “al-Kuriya” (Tehran, National Library, MS 17594, n.d.).

⁸¹ Bahā’ al-Dīn al-‘Āmilī, “Tuḥfa” (Tehran, Parliament Library, MS 17445/10, n.d.); Moḥammad Ḥusayn Āqābuzurg Tehrānī, *al-Dharī‘a ‘ilā taṣānīf al-shī‘a*, ed. Aḥmad ibn Muḥammad Ḥusaynī (Beirut: Lebanon: Dār al-‘Aḍwā’, n.d.), 3:402, 17:288.

⁸² al-‘Āmilī, “Tuḥfa,” n.d., fl. 16v.

⁸³ Āqābuzurg Tehrānī, *al-Dharī‘a*, 23:321.

attempted to establish good relations with Ṭahmāsb’s successors, Ismā‘īl II and Khudābanda, and acquired their limited patronage and support.

Mīr Ḥusayn al-Karakī’s political and religious orientations played a significant role in the formation of ‘Āmilī’s career after the death of Ṭahmāsb. Unlike Mīr Ḥusayn, ‘Āmilī tried to maintain positive relations with Ismā‘īl and had an audience with him in early Ramaḍān 985/November 1577 in Qazvin. At that time ‘Āmilī was *shaykh al-islām* of Isfahan, replacing his father-in-law Shaykh ‘Alī Minshār. A source that gives complementary information on ‘Āmilī’s social and political status is a biography written by one of his students, al-Mawlā (or Mullā) Muẓaffar ‘Alī in Persian. The biography did not survive, but some excerpts of it have been preserved in Arabic translation or paraphrase by al-Iṣfahānī.⁸⁴ The preserved fragments do not tell much about ‘Āmilī himself and his career, but they include considerable discussion on the antagonism and contention between Mīr Ḥusayn and Ismā‘īl II on religious issues concerning inscriptions on the coins and the cursing of the first caliphs.⁸⁵ In Muẓaffar ‘Alī’s biography ‘Āmilī does not appear to be involved in the contentions between Ismā‘īl and Mīr Ḥusayn. Likewise, there are no indications of his involvement in the dispute recorded by Mīrzā Makhdūm.⁸⁶ However, as I will explain more in the next chapter, ‘Āmilī’s knowledge and his competence in sciences were recognized by the new shah.⁸⁷

‘Āmilī experienced similar situations during the reign of Khudābanda. There is little indication in the chronicles about this juncture of ‘Āmilī’s life before he became the foremost

⁸⁴ Iṣfahānī, *Riyāḍ al-‘ulamā’*, 2:119. This excerpts of ‘Āmilī’s biography in *Riyāḍ Al-‘Ulamā’* have been translated in the following works: Stewart, “The First Shaykh al-Islām,” 388–90; Stewart, “The Lost Biography of Baha’ al-Din al-‘Āmilī.”

⁸⁵ Iṣfahānī, *Riyāḍ al-‘ulamā’*, 2:72-75. Translation of some excerpts of the story is provided in Stewart, “The Lost Biography of Baha’ al-Din al-‘Āmilī,” 180–83.

⁸⁶ Stewart, “The First Shaykh al-Islām,” 189.

⁸⁷ Cf. Stewart, “The Lost Biography of Baha’ al-Din al-‘Āmilī,” 195.

jurist of the Safavid monarchy in the reign of ‘Abbās I.⁸⁸ In spite of the fact that tensions between Mīr Ḥusayn and Ismā‘īl ceased after Ismā‘īl’s death, ‘Āmilī’s disputes with Mīr Ḥusayn remained and the situation became aggravated. Stewart suggested that besides his father’s letter from Bahrain encouraging him to leave Persia, he went on the pilgrimage in 991/1583 as a way to avoid discord with Mīr Ḥusayn. ‘Āmilī’s record of his brief detention by the Ottomans in Āmid (now Diyarbakır) in 991/1583⁸⁹ refers to his discontent about having to leave Persia, against his will.⁹⁰ Moreover, if he had decided to leave Persia, the pilgrimage was an appropriate way to implement his plan. But, after visiting Mecca, he came back and was re-appointed *shaykh al-islām* of Isfahan. ‘Āmilī chose to stay in Persia, despite his father’s advice to leave and continued to seek preferment at the court.

Although ‘Āmilī remained *shaykh al-islām* of Isfahan, then an important provincial capital, under Khudābanda, he was quite unsatisfied by the general intellectual community at the time. As mentioned above, less than four months after the shah’s coronation ‘Āmilī rededicated the *Dissection* to Khudābanda and he wrote the *Tuhfa* for him most probably in the first year of his reign.⁹¹ But, in one of his writings which has no dedication, he expressed the tense situation he had under Khudābanda. In 990/1582-83 in Isfahan, ‘Āmilī completed his first short super-commentary (addendum: *ta’līq*, or *sharḥ*) on a topic in Qāḍīzāda al-Rūmī’s commentary on Jaghmīnī’s *al-Mulakhkhaṣ*, a work of *hay’a*.⁹² A remark, recorded in this work, presents a clear

⁸⁸ Stewart, “A Biographical Notice,” 568–69; Rahmati, “Sālshomāre zendegī va ta’līfāte Sheykh Bahāyī,” 248–50.

⁸⁹ A report on his travel is given in: Stewart, “*Taqīyyah*,” 8–19.

⁹⁰ Stewart, “The Lost Biography of Baha’ al-Din al-‘Āmilī,” 194.

⁹¹ Āqābuzurg mentioned the treatise with the title *Mīzān al-Maqādīr* (*Measuring the Magnitudes*). Āqābuzurg Tehrānī, *al-Dharī’a*, 23:321.

⁹² Bahā’ al-Dīn al-‘Āmilī, *Risālah fī taḍārīs al-’arḍ* (Tehran, 1894). There are two super-commentaries on Jaghmīnī’s *Mulakhkhaṣ* by ‘Āmilī. The first and the short one mentioned above is on the ratio of the height of the largest mountain to the diameter of the Earth. The second super-commentary which is much longer covers almost all topics in the *Mulakhkhaṣ* and is dedicated to ‘Abbās I (Ms Parliament 14738). Most of the manuscript copies of

picture of the time and demonstrates that, as Stewart argued, ‘Āmilī suffered much during the reign of Khudābanda. After specifying the topic and the purpose of the treatise, in a relatively long passage ‘Āmilī first described his personal depressed mood, and then explained the situation. He bitterly complained about the tension science and its advocates were experiencing, while ignorance and its companions were continually being venerated and gaining higher ranks. He declared that his mind was distracted and his heart broken. He lamented that the status of the companions of erudition (*ahl al-faḍl*) were being denigrated to the utmost degree, the market of science was stagnant (*sūq al-‘ilm fīh kāsid*) and its commodity corrupted (*wa-matā‘uh fāsid*), scientific books were ignored and obsolete (*wa-kutubuh mahjūra wa-zuburuh mastūra*), scientific ideas were contradictory (*wa-rāyātuh mun‘akisa*), and schools and learned gatherings were ineffective (*wa-madārisih bāṭila wa-majālisih ‘āṭila*). In short, the companions of ignorance were deriding the supporters and seekers of science.⁹³ ‘Āmilī did not specify any person or group in his complaint, but his rhetorical use of “the companions of the ignorance” indicates an existing antagonism with a group of scholars or ‘*ulamā*’ whose views ‘Āmilī opposed. The marginalization and torment experienced by the intellectual circle of ‘Āmilī, his fellows and disciples, could only have been caused by the powerful jurists and ‘*ulamā*’ who had already established firm associations with the court and controlled key positions and offices. Their leading member was Mīr Ḥusayn al-Karakī, who held the office of *shaykh al-islām* at the capital Qazvin until 1001/1592-93. Although ‘Āmilī failed to join the court, he retained his

the first super-commentary bear the title *Fī taḍārīs al-‘arḍ* (*On the Ripples of the Earth*). *Fī taḍārīs al-‘arḍ* was published together with Qāḍīzāda al-Rūmī’s commentary in Dhīl Ḥajja 1311/June 1894 in Tehran. Some recent studies, apparently, recorded the month of the publication date (p. 22) as the composition date while the author did not specify the month (Devin J. Stewart, “The Lost Biography of Baha’ al-Din al-‘Āmilī and the Reign of Shah Isma‘il II in Safavid Historiography,” *Iranian Studies* 31, no. 2 (June 1, 1998): 188; Mohammad-Kazem Rahmati, “Sālshomāre zendegī va ta’līfāte Sheykh Bahāyī,” *Jurisprudence & Law Quarterly Book Review* 1, no. 2 (June 22, 2015): 248).

⁹³ al-‘Āmilī, *Risālah fī taḍārīs al-‘arḍ*, 3.

position in Isfahan. Thus, his patronage campaign if not successful at the highest level, apparently enabled him to protect the status he had already gained until the abdication of Khudābanda in 1587.

‘Āmilī held the office of *shaykh al-islām* in Isfahan until 1001/1592-93, in the reign of ‘Abbās I, when he became the *shaykh al-islām* of the capital Qazvin, and thus acquired the highest religious authority in the Safavid Empire.⁹⁴ He dedicated his first book on *‘ilm al-hay’a*, *The Dissection of the Orbs* to ‘Abbās, which was the fourth rededication of the book. A preliminary indication of his new patronage status under ‘Abbās is his use as a diplomat. In 998/1590 he negotiated with the rebel Yūlī Beg, the governor of Isfahan, and brought him to the court, helping the shah consolidate his territory and ending a civil war.⁹⁵ ‘Āmilī proved his loyalty to the shah in another mission in 999/1591, after a previous failed attempt, ‘Abbās sent ‘Āmilī to negotiate with Khān Aḥmad Gīlānī (d. 1005/1596-97), the provincial governor of Gīlān (N. Iran) who had no male heirs. ‘Āmilī convinced the governor to marry his minor daughter to ‘Abbās’s son Ṣafī Mīrzā, firmly establishing his fealty to ‘Abbās.⁹⁶ While all this was going on ‘Āmilī probably continued to hold his former position in Isfahan by appointing a deputy, which was a normal practice at the time.⁹⁷ When ‘Abbās moved the capital to Isfahan in 1006/1597 he served there as *shaykh al-islām* until his death. It was during the reign of ‘Abbās that ‘Āmilī became a pre-eminent intellectual authority in the empire, contributing major works in theology and law. Also, during this period, he trained students in the rational sciences, including

⁹⁴ Stewart, “The Lost Biography of Baha’ al-Din al-‘Āmilī,” 193. For an analysis of ‘Āmilī’s multiple roles at the court of ‘Abbās I see: Rula Jurdi Abisaab, “The Ropes of Royal Tents: Shaykh Bahā’i and the Imperial Order of Shah ‘Abbās (996-1038/1587-1629),” in *Studies on Persianate Societies = Pizhuhish Dar Jvamea’ Farsi Zaban*, ed. Said Amir Arjomand (Tehran: Association for the Study of Persianate Societies, 2003), 29–56.

⁹⁵ Muḥammad ibn Hidāyat Allah Afushtayī Naṭanzī, *Noqāwat al-āthār fī dhikr al-akhyār*, ed. Ehsan Eshraghi, Second ed. (Tehran: Scientific and Cultural Publications Company, 1994), 334–35.

⁹⁶ Stewart, “The Lost Biography of Baha’ al-Din al-‘Āmilī,” 190–91.

⁹⁷ Stewart, 193.

Ch. 1: ‘Āmilī’s life and career

astronomy, and composed scientific works including the *Gloss* on the *Dissection*. We will consider the contents of these works in the sections that follow. ‘Āmilī died in Isfahan on 12 Shawwāl 1030/20 August 1621, but his body was moved to Mashhad and buried at his family house, next to the shrine of the eighth Shiite Imām.⁹⁸

⁹⁸ Iṣfahānī, *Riyāḍ al-‘ulamā’*, 5:97; al-Baḥrānī, *Lu’lu’ al-baḥrayn fī al-‘ijāzāt va-tarājum rijāl va-al-ḥadīth*, 22.

Appendix

A chronology of ‘Āmilī’s life and times

The following table presents major events in ‘Āmilī’s life and those of his father which were related to him and influences ‘Āmilī’s career directly. There are many more events in ‘Āmilī’s life and intellectual career, especially the more we know about the *ijāzas* he issued for his disciples and the copyists of his works.⁹⁹ However, I included here those that are related to the arguments and materials of this dissertation and added more events that I found in the primary and secondary sources. These events are compared against the major events of the Safavid court during ‘Āmilī’s life and service to the shahs, along with both Islamic Hijra dates and their Julian equivalents.

Table 1-1. A Chronology of ‘Āmilī’s Life and Times

Dates	Safavid Court Events	Bahā’ al-Dīn ‘Āmilī (953-1030/1547-1621)	Ḥusayn ibn ‘Abd al-Ṣamad (d. 984/1576)	Sayyid Ḥusayn ibn Ḥasan al- Karakī (1001/1592-93)
953/1547		27 Dhil Ḥajja 953/28 February 1547 --- Birth in Baalbek		
959/1522				959/1552 --- Arrived in Persia ¹⁰⁰
961/1554		961/1554 --- Migration of ‘Āmilī family to Persia		
961-63/ 1554-56			961-963/1554-1556 --- residence in Isfahan	

⁹⁹ Note: Rahmati, “Sālshomāre zendegī va ta’līfāte Sheykh Bahāyī”; Maḥmūd Malikī, “Ijāzāt al-Shaykh Bahā’ al-Dīn al-‘Āmilī,” *Kitāb al-shī’a* 7–8, no. 4 (2013): 216–314.

¹⁰⁰ Stewart, “The First Shaykh al-Islām,” 396.

Dates	Safavid Court Events	Bahā’ al-Dīn ‘Āmilī (953-1030/1547-1621)	Ḥusayn ibn ‘Abd al-Ṣamad (d. 984/1576)	Sayyid Ḥusayn ibn Ḥasan al-Karakī (1001/1592-93)
963-64/1556			963-964/1556 --- summoned by Ṭahmāsb to Qazvin	
963-70/1556-63			963-970/1556-63 --- <i>shaykh al-islām</i> of Qazvin	Ramaḍān 966/June 1559 --- In Ardabil dedicated his treatise on Friday prayer to Ṭahmāsb ¹⁰¹
969/1561-62		Copied Qāḍīzāda’s commentary on the <i>Ashkāl al-ta’sīs</i> of Shams al-Dīn Samarqandī (d. 1302), a book on 35 propositions from Euclid’s <i>Elements</i> . ¹⁰²		
970/1563			970/1563 --- Was dismissed from the office of <i>shaykh al-islām</i> of Qazvin	970/1563 --- Appointed the <i>shaykh al-islām</i> of Qazvin
970/1563			9 Rajab 970/4 March 1563 --- Completed his treatise <i>al-Iqd al-ḥusaynī</i> for Ṭahmāsb	
970-74/1563-67		on 2 Rajab 971/15 February 1564 --- acquired the <i>ijāza</i> from his father in Mashhad	970-974/1563-67 --- <i>shaykh al-islām</i> of Mashhad	970/1563 <i>Shaykh al-islām</i> of the capital Qazvin, until his death in 1001/1592-93
979-81/1571-74		979/1571-72 981/1573-74 --- In Qazvin composed poetry to his father	974-983/1567-75 --- <i>shaykh al-islām</i> of Herat	
983/1575		983/1575 --- Teaching in Qazvin	late 983/1575 --- Pilgrimage to Mecca	
		Dedicated the <i>Tuhfa</i> to Ṭahmāsb		

¹⁰¹ Stewart, 396.

¹⁰² Qāḍīzāda al-Rūmī and Samarqandī, “Sharḥ ashkāl al-ta’sīs.”

Ch. 1: ‘Āmilī’s life and career

Dates	Safavid Court Events	Bahā’ al-Dīn ‘Āmilī (953-1030/1547-1621)	Ḥusayn ibn ‘Abd al-Ṣamad (d. 984/1576)	Sayyid Ḥusayn ibn Ḥasan al- Karakī (1001/1592-93)
983/1576		early Shawwāl 983/ January 1576 in Qazvin --- Dedicated <i>al-Kurya</i> to Ṭahmāsb		
971-83/ 1564-76		Dedicated the <i>Tashrīḥ al-aflāk</i> (<i>Dissection of the Orbs</i>) to Ṭahmāsb		
984/1576	15 Ṣafar 984/14 May 1576 --- Ṭahmāsb died in Qazvin	984/1576 --- <i>shaykh al-islām</i> of Isfahan upon Shaykh ‘Alī Minshār’s death on 13 Rabī’ I/10 June	8 Rabī’ I 984/15 June 1576 --- died in Bahrain	Ṣafar 984/May 1576 --- In charge of washing Ṭahmāsb’s corpse for burial
984/1576	17 Rabī’ I 984/13 June 1576 --- Ismā‘īl’s coronation in Qazvin		984/1576 --- His younger son ‘Abd al-Ṣamad replaced him as <i>shaykh al-islām</i> of Herat	
985/1577	20 Sha‘bān 985 /12 November 1577 --- a comet appeared in the sky	23 Sha‘bān 985/1577 --- had an audience with Ismā‘īl in Qazvin and observed the comet		
985/1577		985/1577 --- dedicate the <i>Dissection of the Heavens</i> to Ismā‘īl		Ramaḍān 985/December 1577 --- In charge of washing Ismā‘īl II’s corpse for burial
985/1577	13 Ramaḍān 985/4 December 1577 --- Ismā‘īl died in Qazvin			

Dates	Safavid Court Events	Bahā’ al-Dīn ‘Āmilī (953-1030/1547-1621)	Ḥusayn ibn ‘Abd al-Ṣamad (d. 984/1576)	Sayyid Ḥusayn ibn Ḥasan al- Karakī (1001/1592-93)
985/1578	3 Dhil Ḥajja 985/11 February 1578 --- Khudābanda’s coronation in Qazvin			
986/1578		Before 11 Rabī‘ II 986/27 June 1578 --- Dedicated the <i>Dissection</i> to Khudābanda		
		985/1578 --- dedicated the <i>Tuhfa</i> to Khudābanda		
987/1579		Residence at the court of Tabriz for 11 months studying Fakhr al-Dīn al-Rāzī’s <i>Great Exegesis</i> on Quran (<i>Tafsīr al-kabīr</i> or the <i>Mafātīḥ al-ghayb</i>)		
990/1582- 83		990/1582-83 --- In Isfahan composed his first super- commentary on Jaghmīnī’s <i>al-</i> <i>Mulakhkhaṣ</i>		
991/1583		Dhul Ḥajja 991/December 1583 --- Performing the pilgrimage to Mecca		
992/1584		In late Ṣafar 992/March 1584 --- In Cairo		
992/1584		Jumādā I 992/May-June 1584 --- In Jerusalem received an <i>ijāza</i> from Muḥammad ibn Abī al-Luṭf al-Maqdisī the Shāfi‘ī <i>mufti</i> of Jerusalem ¹⁰³		
992/1584		992/1584 --- Met ‘Umar ibn Abī al-Luṭf al-Maqdisī, the Ḥanafī mufti of Jerusalem and the brother of Muḥammad ibn Abī al-Luṭf		
992/1584		992/1584 --- In Jerusalem taught astronomy and mathematics to Raḍīy al-Dīn al-Maqdisī (d. 1028/1619)		

¹⁰³ Stewart, “*Taqiyyah*,” 16.

Ch. 1: ‘Āmilī’s life and career

Dates	Safavid Court Events	Bahā’ al-Dīn ‘Āmilī (953-1030/1547-1621)	Ḥusayn ibn ‘Abd al-Ṣamad (d. 984/1576)	Sayyid Ḥusayn ibn Ḥasan al- Karakī (1001/1592-93)
993/1585		On 20 Ṣafar 993/21 February 1585 --- Composed some poem in Tabriz ¹⁰⁴		
993/1585		On 2 Ramaḍān 993/28 August 1585 --- In Isfahan, related <i>ḥadīth</i> to Sayyid Ḥusayn ibn Ḥaydar al-Karakī ¹⁰⁵		
996/1588	14 Dhil Qa‘da 996/25 September 1588 --- ‘Abbās’s accession to the throne in Qazvin			
998/1590		998/1590 Negotiates with the rebel Yūlī Beg in Isfahan to convince him to succumb to ‘Abbās		
1001/1592 -93				1001/1592-93 --- Died of Plague in Qazvin
1003/1595		Early Jumada II 1003/February 1595 --- Completed the commentary on the prayer, the <i>Ḥaḍīqah al-hilālīyah</i> (<i>The Crescent Garden</i>), in Kāzīmāyn		
1003/1595		after Jumada II 1003/February 1595 --- Began the <i>Ḥāshya</i> (<i>Gloss</i>) on the <i>Dissection</i>		
1006/1598	1006/1598 --- ‘Abbās moved the capital to Isfahan			
1007/1599		1599 --- Latest date for completing the <i>Gloss</i>		

¹⁰⁴ Stewart, 19; Bahā’ al-Dīn al-‘Āmilī, *al-Kashkūl*, ed. Sayyid Muḥammad Ḥusayn al-Mu‘allim (Qum: Iran, 2006), I:184.

¹⁰⁵ Stewart, “*Taqīyyah*,” 19.

Dates	Safavid Court Events	Bahā’ al-Dīn ‘Āmilī (953-1030/1547-1621)	Ḥusayn ibn ‘Abd al-Ṣamad (d. 984/1576)	Sayyid Ḥusayn ibn Ḥasan al- Karakī (1001/1592-93)
1008/1600		3 Rajab 1008/ 9 Jan 1600 --- In Mashhad ‘Āmilī issued the first <i>ijāza</i> to his disciple Tunikābunī ¹⁰⁶		
1008/1606		14 Dhū al-Ḥajja 1008/ 12 Apr 1606 --- In Marv (Khurasan) ‘Āmilī issued an <i>ijāza</i> for a certain al-Sayyid Ṭaqī al-Dīn Muḥammad indicating the student had studied under him the <i>Dissection</i> and the <i>Gloss</i> . ¹⁰⁷		
1010/1602		early Shawwāl 1010/ mid-Mar 1602 --- In Mashhad ‘Āmilī issued the second <i>ijāza</i> for Tunikābunī		
1011/1603		10-20 Shawwāl 1011/ mid-March 1603 --- ‘Āmilī issued the third <i>ijāza</i> for Tunikābunī		
1023/1614		23 Rajab 1023/ 19 Aug 1614 --- Near Tbilisi (Georgia), ‘Āmilī issued an <i>ijāza</i> for his disciple Jawād ibn Sa’d al- Kāzīmī (Fāḍil Jawād, d. 1655), including the <i>Dissection</i> , <i>Quintessence</i> , and the <i>Ṣafīḥa</i> on the astrolabe. ¹⁰⁸		
1026/1617		8 Dhū al-Qa‘da 1026/ 28 Oct 1617 --- ‘Āmilī issued an <i>ijāza</i> for al-Sayyid Badr al-Dīn al-Ḥusaynī al-‘Āmilī, including among other books the <i>Dissection</i> , the <i>Quintessence</i> , and his book on the astrolabe.		

¹⁰⁶ For Tunikābunī *ijāzas* see Chapter 5.

¹⁰⁷ Malikī, “Ijāzāt al-Shaykh Bahā’ al-Dīn al-‘Āmilī,” 281.

¹⁰⁸ Malikī, 238–39. Jawād al-Kāzīmī’s commentary on ‘Āmilī’s *Quintessence* became so popular in the Safavid period.

Ch. 1: ‘Āmilī’s life and career

Dates	Safavid Court Events	Bahā’ al-Dīn ‘Āmilī (953-1030/1547-1621)	Ḥusayn ibn ‘Abd al-Ṣamad (d. 984/1576)	Sayyid Ḥusayn ibn Ḥasan al- Karakī (1001/1592-93)
1030/1621		12 Shawwāl 1030/ 20 August 1621 --- Died in Isfahan and was buried in Mashhad		

Chapter 2

Astral Sciences among the Safavids

2.1 Astrology in Safavid Culture

Astrology was an essential component of the Safavid court culture. A common purpose of employing astrologers was making horoscopes for the royal family, the courtiers, and the notables. However, more critical matters at the highest level depended on astrologers' consultations. The shah would make all his decisions after getting consultations from the court astrologers. Astrological advice was not limited to administrative affairs; all defensive political and military actions, especially in response to a foreign threat, and strategies for proper maneuvers on a battlefield, would be made after prognostications by astrologers who always accompanied the troops. Many events would be postponed if the astrologers advised a later auspicious time, or some measurements would be taken to avoid and repel anticipated bad omens as impacts of the celestial configurations. The shah not only made major decisions based on astrological advice, like determining the time of a coronation, waging war, or starting a trip. He also consulted astrologers for minor events and almost all daily routines, like the best time for having a meal or whether to let the visitors have an audience with the shah.¹⁰⁹

¹⁰⁹ For this chapter I am relying on the Safavid chronicles, the reports in astrological and astronomical works, as well as travelogues of the European embassies, diplomats, merchants, and notables who traveled to Safavid Persia. There is no monograph on the enormous rise of astrological practices among the Safavids and their subjects. Note, however, Matthew Melvin-Koushki, "Early Modern Islamic Empire: New Forms of Religiopolitical Legitimacy," in *The Wiley Blackwell History of Islam* (Hoboken, NJ: Wiley-Blackwell, 2018), 353–75; "The Occult Sciences in Safavid Iran," in *The Empires of the Near East and India: Source Studies of the Safavid, Ottoman, and Mughal Literate Communities*, Illustrated edition (New York: Columbia University Press, 2019), 345–65; A. Azfar Moin, *The Millennial Sovereign: Sacred Kingship and Sainthood in Islam* (Columbia University Press, 2012).

Astrology was not only practiced in the realm of the court or the houses of notables and aristocrats. Almost everyone would follow astrologers' advice in every aspect of their ordinary life. The German secretary to the ambassador sent by Frederick III, Duke of Holstein, Adam Olearius (1599-1671), who was a mathematician and geographer, pointed out the prevalence of astrology among the Persian people and their preference of that to astronomy, so much that he described Persians as "extremely addicted to astrology"¹¹⁰ and that "they never undertake anything of consequence, but they first consult the *minatzim* [*munajjim*, lit. astronomer]." According to Olearius, who visited Persia during the reign of Šafī (r. 1629-1642), astrology was decisive in the daily lives of notables and aristocrats. Without consultation from the astrologers, they would not wear a new garment, take a bath or ride on a horse to embark on a trip.¹¹¹

The astrologer played the role of a consultant in matters like epidemics, disorder in government affairs, civil wars, natural phenomena like earthquakes, all assumed to be caused or influenced by the formation and positions of celestial bodies. Several examples of these events have been reported in the Safavid chronicles, but some show astrology's involvement in courtly decisions far beyond choosing auspicious times for some actions. Iskandar Beg, the scribe and chronicler at the court of 'Abbās I, reported in the notice of the year 1002/1593 that:

Astrologers had declared that the stars predicted the death this year of an eminent personage, probably in Iran, and the signs further indicated that this personage would be a royal one. In addition, their examination of the Shah's horoscope had revealed the quadrature of the two inauspicious planets (Mars and Saturn) in the ascendant, whereas the Shah's predominant star was at its nadir.

¹¹⁰ Adam Olearius, *The Voyages and Travells of the Ambassadors Sent by Frederick, Duke of Holstein, to the Great Duke of Muscovy and the King of Persia Begun in the Year M.DC.XXXIII. and Finish'd in M.DC.XXXIX: Containing a Compleat History of Muscovy, Tartary, Persia, and Other Adjacent Countries*, trans. John Davies (London, 1669), 253.

¹¹¹ Olearius, 252.

Mawlānā Jalāl al-Dīn Moḥammad Yazdī, who was the outstanding astrologer of his age, suggested to the Shah the following plan: during the three days when the influence of the conjunction and quadrature of the two inauspicious planets was at its height, the Shah should divest himself of his kingly status and raise to the throne some criminal under sentence of death. During those three days both military and civilians would give their allegiance to that man, so that the essential business of kingship might be discharged by him. At the end of the three days, the temporary monarch should be executed.

This plan was approved, and the lot fell on Ostād Yūsofī the quiver marker, whose heresy was more heinous than that of his fellows. Ostād Yūsofī was given the title of king, the crown was placed on his head, and he was clothed in gorgeous robes. ... Shah ‘Abbās spent these three days in the company of a handful of grooms and servants, and kept completely aloof from state affairs. ... At the end of the three days, Ostād Yūsofī was put to death, and by his stratagem the Shah avoided calamity.¹¹²

The astrologer in this report, Jalāl al-Dīn Muḥammad Yazdī, known as Mullā Jalāl Munajjim, was one of ‘Abbās’s court astrologers who always accompanied the shah even during travels and military campaigns. During ‘Abbās’s promenade from Isfahan to Mashhad (about 1000 kilometers), in 1010/1601 to visit and pledge homage to the shrine of the Eighth Shiite Imam, Mullā Jalāl accompanied him and was responsible for counting the days of the trip along with measuring the route distances between all stops and to the destination.¹¹³ He also wrote a history of the Safavids, including the last years of Ṭahmāsb’s reign and some years of ‘Abbās’s

¹¹² Translation by Savory in *The history of Shah ‘Abbas*, II: 648-49.

¹¹³ Iskandar Beg Munshī, *Tārīkh-e ‘ālam-ārāy-e ‘Abbāsī*, II:611. Also see: Caroline Mawer, “Shah ‘Abbās and the Pilgrimage to Mashhad,” *Iran* 49 (2011): 123–47.

reign until 1020/1611 that presented exact dates and time for the recorded events. In the *Tārīkh-e ‘Abbāsī* (*The Abbasi History*) Mullā Jalāl gave a short report about the same event with other details. He explained that after the appearance of a star which indicated the change and fall of the shah, he recommended that ‘Abbās appoint Ostād Yūsufī as the shah for three days to avoid the ill omen. According to Mullā Jalāl, on Thursday 7 Dhū al-Qa‘da 1001¹¹⁴/ 26 July 1593 Ostād Yūsufī was crowned the shah and after three days on Sunday 10 Dhū al-Qa‘da 1001/29 July 1593 was executed. On the same day, ‘Abbās ascended the throne for the second time.¹¹⁵ Mullā Jalāl served ‘Abbās for about thirty-four years and after his death in 1029/1620 his son Mullā Kamāl and his grandson Mullā Jalāl attended to the service of the shah and wrote two other histories.¹¹⁶

Iskandar Beg reported several other instances when Safavid shahs postponed their actions in order to let the astrologers determine a fortunate day and moment for it. For example, after the death of Ismā‘īl II (r. 1576-1578), on 1 Dū al-ḥajja 985/9 Feb 1578 shah Muḥammad Khudābanda moved toward the capital Qazvin to be crowned. Khudābanda and his retinue camped out of Qazvin on 11 February and waited for Mawlāna Afḍal Munajjim Qazwīnī (apparently the court astrologer) to determine the auspicious time, upon which Khudābanda and his elder son Ḥamza Mīrzā entered the capital.¹¹⁷ Iskandar Beg introduced several astronomers/astrologers practicing in different cities who are mostly unknown in the chronicles of the time or later histories. Other than serving the royal family, the courtiers and the governors or deputies in other provinces, astrologers had a close contact with common people and served as

¹¹⁴ Jalāl al-Dīn Yazdī recorded this event in the notice of the year 1001 and gave exact dates for other part of the story which makes it more reliable. However, Iskandar Beg included the same event in the year 1002.

¹¹⁵ Mullā Jalāl al-Dīn Muḥammad Yazdī, *Tārīkh-e ‘Abbāsī yā Rūznāme-ye Mullā Jalāl*, ed. Seifollah Vahidnya (Tehran: Vahid, 1967), 122.

¹¹⁶ Yazdī, 12–13.

¹¹⁷ Iskandar Beg Munshī, *Tārīkh-e ‘ālam-ārāy-e ‘Abbāsī*, I:225-226; *The history of Shah ‘Abbas*, I: 336-337.

a consultant to their community in different ways. In an earthquake that happened in 956/1549 in Qā' in (Khurasan, NE Iran), which according to Iskandar Beg caused the death of three thousand people, the local *qadi* (judge) who was an astrologer, Mawlānā Bāqī, had predicted the event on the same day based on celestial configurations, and warned the populace of the region in advance.¹¹⁸

2.1.1 European Accounts by Missionaries, Merchants, and Ambassadors to Persia

Similar reports about the popularity of the astronomical sciences among the Safavids are found in numerous travelogues of European missionaries, diplomats, and merchants who visited or lived in Persia during this period, especially during the reigns of the last three shahs, for which no Persian chronicle is found.¹¹⁹ Jean-Baptiste Chardin, later Sir John Chardin (1643-1713), who came to Persia during 'Abbās II's (r. 1642-1666) reign and stayed until 1088/1677, including some years of shah Sulaymān's reign (r. 1666-1694), wrote the most extensive report about the sciences and education in Persia of the time and dedicated a chapter of his voluminous travelogue to Persian astronomy and astrology.¹²⁰ Although Chardin seems unfamiliar with technical aspects of the discipline, he provided a lengthy report about all sorts of astronomical activities practiced in Persia. Besides talking about the background of Safavid astronomy, including primary sources and the *zījs*, Chardin gave a lengthy description of Persian calendars, ephemerides, and the standard instruments, especially astrolabes. Through a Capuchin friar, Chardin became acquainted with a Persian astronomer and instrument maker in Isfahan named

¹¹⁸ Iskandar Beg Munshī, *Tārīkh-e 'ālam-ārāy-e 'Abbāsī*, I:117.

¹¹⁹ Rudi Matthee, "The Safavid King Who Was Crowned Twice: The Enthronement of Safi Mirza as Shah Safi II in 1077/1666, and as Shah Sulayman in 1078/1668," in *Mapping Safavid Iran*, *Studia Culturae Islamicae* 105 (Tokyo: Research Institute for Languages and Cultures of Asia and Africa, 2015), 68.

¹²⁰ John Chardin, *Voyages du chevalier Chardin en Perse, et autres lieux de l'Orient, enrichis d'un grand nombre de belles figures en taille-douce, représentant les antiquités et les choses remarquables du pays*, Nouvelle édition (Paris: Le Normant, 1811), IV: 314-430.

Ākhūnd¹²¹ Muḥammad Amīn, from whom Chardin learned about Persian astronomy and their instruments. Chardin added that Muḥammad Amīn's father, Mullā Ḥasan-ʿAlī, was also an astronomer. Chardin described Persian astrolabes as the most accurate instruments in the world and far excelling those made by Europeans. Astrolabes and the Jacob's staff (called Ya'qūb's stick) were the most common instruments used in Persia. Other astronomical instruments like globes were rarely made and used.¹²²

Chardin believed that the sole purpose of Persians in studying astronomy and learning even geometry and arithmetic was to finally master astrology.¹²³ It is, however, evident that learning astrology would require a good knowledge of many of the other mathematical disciplines, as Chardin reported, but there were many other, either civil or scholarly, purposes for studying mathematics and astronomy. This report might be interpreted as a piece of evidence that people of the time were voracious in using astrology, as other witnesses testify. According to Chardin, numerous astrologers lived in Persia, and especially in the capital Isfahan "their numbers equated the number of stars."¹²⁴ Court astrologers would altogether receive, other than occasional expensive gifts from the shah, a considerable amount of money, about four million in the currency of the time (presumably in Liver) each year. He reported that in 1660 a court astrologer whose annual salary was 50000 Livres¹²⁵ asked ʿAbbās II for a raise which made the shah furious and ended in a reassessment of their salaries. When Chardin visited Persia during Sulaymān's reign, the chief astrologer (*munajjim-bāshī*) at the court was Mīrzā Shafīʿ. After Mīrzā Shafīʿ was affected by poor eyesight, the shah replaced him with his son for 50000 livers

¹²¹ An official title used for the clergy in the Safavid era, which today is used in vernacular Persian for the same people.

¹²² Chardin, *Voyages*, IV: 332-333, 337-338.

¹²³ Chardin, IV:314, 321.

¹²⁴ Chardin, IV:316.

¹²⁵ The livre was the French for "pound" and the currency of Kingdom of France until 1794. It was name of both the unit and coins.

annual salary.¹²⁶ Early Safavid histories do not mention the office of *munajjimbāshī*, but it was already an established position at the Ottoman court.¹²⁷ The office of *munajjimbāshī* might have been introduced later to the Safavid court. But it seemed that from early on, the position of *munajjimbāshī* was under the shah's personal control. Nicolas Sanson (1600-1667), a Jesuit missionary and a French cartographer who came to Persia during Suleymān's reign, gave descriptions of all courtly, administrative, military, and religious positions in Persia, including the *munajjimbāshī*. He explained that the *munajjimbāshī* was a skilled mathematician and astronomer always with the shah and that the shah consulted him on all major and minor affairs.¹²⁸ Other than the *munajjimbāshī*, there were always several astrologers present at the court, and one was always by the shah telling him the fortunate time for all decisions.¹²⁹ Making horoscopes for the courtiers, making prognostications, and making the annual calendar (*taqwīm*) and ephemerides for the shah were among the responsibilities of *munajjimbāshī*.

Another significant event in Safavid history involving astrology was the coronation of shah Suleymān (r. 1666-1694), who was crowned twice. In a separate book including the events of the first two years of shah Sulaymān's reign, Chardin reported the story of Suleymān's ascension and the struggles and disarray in the aftermath of the event, which resulted in a second coronation ceremony and changing the shah's name.¹³⁰ The coronation ceremony was held twice

¹²⁶ Chardin, *Voyages*, IV:317-318.

¹²⁷ For the practice of astrology at the Ottoman court and the office of *munajjimbāshī* see: Ahmet Tunç Şen, "Reading the Stars at the Ottoman Court: Bāyezīd II (r. 886/1481-918/1512) and His Celestial Interests," *Arabica* 64, no. 3-4 (2017): esp. 562, n. 11; J. H. Kramers, "Mūnedjdjīm Bāshī," in *Encyclopaedia of Islam, Second Edition*, Published Online (Brill, 2012), http://referenceworks.brillonline.com/entries/encyclopaedia-of-islam-2/munedjdjim-bashi-SIM_5512.

¹²⁸ Nicolas Sanson, *Voyage ou relation de l'état present du royaume de Perse* (Paris, 1695), 35-36, http://archive.org/details/bub_gb_EDX6Vabe4RQC.

¹²⁹ Chardin, *Voyages*, IV:319-320.

¹³⁰ Jean Chardin, *Le couronnement de Soleïmaan, troisième roy de Perse, et ce qui s'est passé de plus mémorable dans les deux premières années de son règne* (par Claude Barbin, au Palais, sur le Perron de la Ste Chapelle, 1671). A Persian translation made by 'Alīrezā Garūsī (d. 1289/1911), the major general (amīrtūman) of Naşer al-Dīn Shah Qajar (r. 1848-1896). *Sharḥ-e tājgozārī-ye Shāh Soleymān Şafavī va vaqāye' do sāl ba'd*, trans. 'Alīrezā Khān Garūsī (Tehran, n.d.).

because the Shah and his close companions were convinced that the wrong moment for the first coronation, determined by the astrologers, caused all the misfortunes, so another coronation by a better determination of time would make everything right. The same story, with different narrations, was reported by the French merchant Jean Tavernier (1605-1689) as a witness who made six voyages to Asia in four years,¹³¹ and Engelbert Kaempfer (1651-1716), the German naturalist and physician, who reached Isfahan in 1684. In 1712, Kaempfer published a Latin travelogue about his voyages through Russia, Persia, East Asia, and Japan.¹³²

In Safavid Persia, astronomy and astrology were not only practiced and learned through private apprenticeship but were parts of formal madrasa education. Elementary education, including reading and writing, began in a *maktab* (lit., place of writing), but other scientific disciplines were offered in madrasas, equivalent to European colleges in terms of the technical level. Adam Olearius (1599-1671), the German secretary to the ambassador sent by Frederick III, Duke of Holstein, who lived in Persia during 1635 and 1639, documented the disciplines taught at madrasas, although he believed that the sciences were not as perfect in Persia as they were in Europe. As he recorded, the most famous madrasas were in Shiraz, Ardebil, Mashhad, Tabriz, Qazvin, Qum, Rasht, and Shamakhi. These madrasas were under the control of *ṣadr*,¹³³ who took care of their allowances and maintenance. Madrasas' income came from the revenue of those provinces that were not supposed to pay taxes to the capital. The disciplines learned at madrasas were arithmetic, geometry, rhetoric ("eloquence"), poetry, natural and moral philosophy,

¹³¹ Jean-Baptiste Tavernier, *Les six voyages de Jean Baptiste Tavernier*, 2 vols. (Paris: G. Clousier, 1676); *The Six Voyages of John Baptista Tavernier* (London: Printed for R.L. and M.P., 1678).

¹³² Engelbert Kaempfer, *Amoenitatum Exoticarum Politico-Physico-Medicarum Fasciculi V: Quibus Continentur Variae Relationes, Observationes & Descriptiones Rerum Persicarum & Ulterioris Asiae: Multâ Attentione in Peregrinationibus per Universum Orientem Collectae* (Lemgoviae: Typis & impensis Henrici Wilhelmi Meyeri, aulae Lippiacae typographi, 1712).

¹³³ For a description of this position in Safavid administration see: Willem Floor, "The *ṣadr* or Head of the Safavid Religious Administration, Judiciary and Endowments and Other Members of the Religious Institution," *Zeitschrift der Deutschen Morgenländischen Gesellschaft* 150, no. 2 (2000): 461–500.

astronomy, astrology, law, and medicine. He also added that there were very few Persians who did not know how to read or write. Other than madrasas, several mosques in each area functioned as madrasas and offered education in the sciences.¹³⁴ Olearius emphasized the avid interest of Persian people in astronomy and astrology but reported that unlike Europeans, they did not use spheres or globes for observations and calculations.¹³⁵

Chardin's report about madrasas and education, visiting Persia after Olearius, confirms Olearius' account. Perhaps by the time Chardin reached Persia, the number of madrasas had grown because he recorded the existence of fifty-seven madrasas in Isfahan. Most of them by royal endowments and belonged to the shah.¹³⁶ Chardin wrote about madrasas in detail, including the expenses, revenue, instructors' positions, and the number of students lodging at the madrasa facility. Like Olearius, he mentioned that most of the mosques had a madrasa adjacent to their buildings and that there were madrasas in villages.¹³⁷ Chardin further reported that the shah would employ astrologers from Gunābād, a small town in Khurasan (NW Persia). He heard of a famous madrasa of astronomy in the region, which was a place for training children of wealthy families from all over the country.¹³⁸ Chardin's account about Gunābād is corroborated by the fact that there were several astrologers, native to that village who served earlier Safavid shahs. Mullā Muẓaffar Gunābādī was the chief astrologer of ʿAbbās I, whose sons and grandsons were also appointed court astrologers.

The Safavid courts' passion for astrology even in all minor decisions and daily routines grew increasingly in the reign of the last shahs, as documented by the European travelers. Certain

¹³⁴ Olearius, *The Voyages and Travells of the Ambassadors*, 247–48.

¹³⁵ Olearius, 252.

¹³⁶ Chardin, *Voyages*, IV:232.

¹³⁷ Chardin, IV:231.

¹³⁸ Chardin, IV:316–317.

chronicles, as introduced earlier, recorded the same attitude in the court culture of the earlier shahs, including Ṭahmāsb, Ismāʿīl II, Khudābanda, and ʿAbbās whom ʿĀmilī served during his lifetime. However, despite their avid interest in astrological prognostication and therefore support for that discipline, they did not always prove interested in the support of astronomy as a separate scientific field, especially in the matters that involved religion. ʿĀmilī, as I will explain in the following section, had a tremendous influence on justifying astronomy and *ʿilm al-hayʿa* in particular, as religiously accepted sciences among the Safavids.

2.2 Legitimizing the Astral Sciences among the Safavids

Early Safavid chronicles report some incidents that resulted in a conflict between astronomy and religion at the court. Participants in those disputes possessed the highest religious and political ranks of the Safavid state. As the office of *shaykh al-islām* in the early Safavid period was primarily held by jurists who had migrated from the Shiite regions of Lebanon, the position always competed with another religious authority, the office of *ṣadr*, which native Persian jurists and scholars always held, customarily *sayyids*. Before the Safavids, from the thirteen-century onward, under the Timurids and Aq-Qoyunlus the office of *ṣadr* was the highest religious position. The office of *ṣadārat* held by a *ṣadr* has always been completely Persian, and this was also true among the Safavids. A *ṣadr* was responsible for numerous tasks concerning religious duties, such as controlling the collection and distribution of the religious endowments, appointing the lower religious positions of provincial *ṣadrs* or *qāḍīs*. The *ṣadr* was also superintendent of the mosques and madrasas, and was responsible for appointing or dismissing madrasa teachers, and taking care of the students' education and welfare. The *ṣadr* normally made decisions about many religious matters. They both shared overlapping functions and responsibilities with the *shaykh al-islām* that resulted in disputes and conflicts.

The first jurist in the early Safavid history who apparently held the office of *shaykh al-islām* was ‘Alī ibn Ḥusayn ibn ‘Abd al-‘Ālī al-Karakī al-‘Āmilī (d. 940/1534), a native to the Shiite region of Lebanon who emigrated to Persia and who first served Ismā‘īl I and later attended the court of Ṭahmāsb I. Around 916/1511 Ismā‘īl recognized Karakī as the official jurist of the Safavids in Iraq. While serving Ṭahmāsb, in 939/1532 the shah issued a royal decree (*farmān*) declaring Karakī the “deputy of the [Hidden] Imam” (*nā’ib al-imām*) and the Seal of the Jurisconsults (*khatam al-mujtahidīn*), thus elevating his rank to the highest degree and obliging the shah himself to follow Karakī’s opinion in religious matters. Karakī became known as the Second Verifier (*muḥaqqiq thānī*) among other jurists.

Two *ṣadrs* serving Ṭahmāsb were dismissed from the position of *ṣadārat* by the shah after getting into a dispute with Karakī. In 935/1528-29, Amir Ni’matullāh al-Hillī, a former Iraqi student of Karakī, disagreed with some legal opinions such as the Friday prayer and was removed from his position by the shah. But a more contentious dispute occurred between Karakī and a Persian scholar, Ghyāth al-Dīn Manṣūr Dashtakī Shīrāzī (866-949/1461-1542), who first shared the office of *ṣadārat* with al-Hillī. Dashtakī was a prominent polymath who composed more than eighty works in theology, philosophy, mathematics, astronomy, and medicine.¹³⁹ He studied theology and philosophy under his father, Ṣadr al-Dīn Muḥammad (838-903/1452-1498), the theologian and philosopher who founded the famous madrasa of Shiraz and named it after his son “Manṣūriyya.” Dashtakī’s renowned book on astronomy *al-Safīr fī al-hay’a* was one of the important early Safavid works on simple *hay’a* (more about this in Chapter 4).

¹³⁹ Razieh Sadat Musavi, “Critical Edition, Translation and Commentary of the Second Chapter (*Maqāla*) of the First Purpose (*Maqṣad*) of Ghiyāth al-Dīn Manṣūr Dashtakī’s Treatise on *Qibla*” (Tehran, University of Tehran, 2015), 68–74.

Dashtakī's father Ṣadr al-Dīn was known for his several disputes with another fellow theologian in Shiraz, Jalāl al-Dīn Dawānī (d. 908/1502), in response to whom Dashtakī later wrote a theological work. After the death of Ṣadr al-Dīn, his son Ghyāth al-Dīn took the directorship of the Maṣūriyya and became a leading figure in sciences and philosophy in Shiraz. Among the younger Dashtakī's numerous disciples was the famous Muṣliḥ al-Dīn Lārī (c. 900/1494, d. 979/1572), trained in philosophy and astronomy, who migrated to India and dedicated a commentary on Qūshjī's *Persian hay'a* (*Risāla dar hay'a*) to the Mughal emperor Humāyūn who reigned from 1530 to 1540, and was restored to the throne with Safavid assistance in 1555-6. When Ismā'īl captured Shiraz in 909/1504, he exempted the Maṣūriyya madrasa from taxes.¹⁴⁰ During this time Ismā'īl I recognized Dashtakī's competence as well. Dashtakī shared the office of *ṣadr* first with Jamāl al-Dīn Astarābādī (d. 931/1524-25) but left the position after a while due to contentions with Astarābādī.¹⁴¹ Under Ṭahmāsb, he shared the position with for the second time in 936/1529-30, now with al-Hillī, until the latter was removed.¹⁴² Dashtakī also accompanied Ismā'īl on some of his military campaigns, once in 914/1509 when Ismā'īl captured Baghdad and another time in 927/1521 in Ismā'īl's camp at the foot of Mount Sahand (S. Tabriz) when the shah proposed that Dashtakī should reconstruct the Marāgha observatory.¹⁴³ The rebuilding of Marāgha never happened, and some chronicles kept silent about the event,¹⁴⁴ apparently because the shah ultimately refused to sponsor a project that would take thirty years to finish, equal to one astronomical cycle of Saturn.¹⁴⁵

¹⁴⁰ Reza Pourjavady, *Philosophy in Early Safavid Iran: Najm al-Dīn Maḥmūd al-Nayrīzī and His Writings* (Brill, 2011), 26.

¹⁴¹ Hasan Beg Rūmlū, *Aḥsan al-tavārīkh*, 248.

¹⁴² Hasan Beg Rūmlū, 307.

¹⁴³ Qumī, *Khulāṣa al-tavārīkh*, I:149.

¹⁴⁴ Andrew J. Newman, "Daštakī, Gīāth-Al-Dīn," in *Encyclopaedia Iranica*, n.d., <http://www.iranicaonline.org/articles/dastaki-amir-sayyed>.

¹⁴⁵ Hasan Beg Rūmlū, *Aḥsan al-tavārīkh*, 392; Qumī, *Khulāṣa al-tavārīkh*, I:296.

When Ṭahmāsb summoned Dashtakī to hold the office of *ṣadr*, Dashtakī opposed Karakī's opinion about *qibla* determination. Karakī had already appealed to the shah to change the *qibla* niches of the mosques in Persia as he found they deviated westward from those in Iraq. Karakī argued, quite implausibly, that the *qibla* of the Persian mosques must be aligned with the *qibla* of Iraq's mosque as he had earlier altered them in accordance with his legal opinion, based on traditional non-astronomical methods. Dashtakī, a well-versed mathematician and astronomer, disagreed and opposed the action, arguing that the matter of *qibla* must be addressed in the disciplines of astronomy and mathematics, of which Karakī had no knowledge. However, their controversy over the issue heightened to such an extent that they convened a dispute ceremony in the presence of Ṭahmāsb in 939/1532-33, which did not turn out in Dashtakī's favor. During the dispute, Ṭahmāsb sided with Karakī and dismissed Dashtakī from *ṣadārat*.¹⁴⁶ It was after Dashtakī's dismissal, in the same year, that Ṭahmāsb officially named Karakī the Seal of the Jurisconsults. Dashtakī later wrote a lengthy book on *qibla* in which he discussed all mathematical methods for determining the direction, besides including religious matters like the daily prayer times.¹⁴⁷

ʿĀmilī's career as *shaykh al-islām* under ʿAbbās I is involved in this history in several respects. As I explained earlier (section 1.2) ʿĀmilī's father Ḥusayn al-Ḥārithī was the first *shaykh al-islām* at Ṭahmāsb's court in Qazvin, but he was dismissed from the office after a dispute with Karakī's grandson, Mīr Ḥusayn. Ṭahmāsb appointed Mīr Ḥusayn *shaykh al-islām* after ʿĀmilī's father, and he held the position until the beginning of ʿAbbās' reign in 1001/1592-

¹⁴⁶ Iskandar Beg Munshī, *Tārīkh-e ʿālam-ārāy-e ʿAbbāsī*, I:144; Iṣfahānī, *Riyāḍ al-ʿulamāʾ*, III:453-455; Qumī, *Khulāṣa al-tavārīkh*, I:297.

¹⁴⁷ The mathematical/astronomical section of Dashtakī's work on *qibla*, has been edited and commentated upon in the following thesis: Musavi, "Critical Edition, Translation and Commentary of the Second Chapter (*Maqāla*) of the First Purpose (*Maqṣad*) of Ghiyāth al-Dīn Maṣṣūr Dashtakī's Treatise on *Qibla*." Musavi also discussed the dispute between Karakī and Dashtakī in greater detail (see pp. 62-67).

93. One dispute between the two was about the Friday prayer, like the dispute that caused al-Ḥillī to lose the *ṣadārat* position. Probably after leaving Qazvin for Mashhad and then Herat, ‘Āmilī’s father expressed his disagreement with Mīr Ḥusayn’s maternal grandfather ‘Alī al-Karakī who caused the dismissal of Dashtakī. In a treatise about *qibla*, *Fī qibla Khurāsān (On the qibla of Khurasan)*¹⁴⁸, Ḥusayn al-Ḥārithī presented a series of arguments rejecting Karakī’s opinion concerning *qibla*.

At the outset, Ḥusayn al-Ḥārithī mentioned the reason for the work as a response to Karakī. Karakī had heard from the previous ‘*ulamā*’ that the *qibla* of Persian Iraq (*Erāq-e Ajam*)¹⁴⁹ and Khurasan corresponds to the *qibla* of Iraq. But when Karakī visited Persian Iraq (*Erāq-e Ajam*) and Khurasan, he found the *qibla* of the mosques and the orientation of the graves deviated westward compared to the *qibla* of Arab Iraq. However, according to Ḥusayn al-Ḥārithī, Karakī misunderstood the opinion of the ‘*ulamā*’. By “the *qibla* of Iraq” they meant Eastern Iraq, not the Arab Iraq.¹⁵⁰ Ḥusayn al-Ḥārithī further explained that the disagreement on *qibla* in cities remote from Mecca occurs due to differences in opinion of those who are ignorant of ‘*ilm al-hay’a*’, while there is no disagreement concerning *qibla* among those who know ‘*ilm al-hay’a*’, which employs definite principles, like the principles of geometry and arithmetic.¹⁵¹ He also admitted that the *qibla* of some mosques in Khurasan deviated a bit from the proper direction, but such an error was seen in the *qibla* of other areas like the Levant as well, and did not mean that the *qibla* of Khurasan must be in accordance with the *qibla* of Iraq. He then reported that when the celebrated Sufi astronomer Quṭb al-Dīn Shīrāzī (1236-1311) visited the congregational mosque

¹⁴⁸ Afandī Iṣfahānī recorded a longer title for this work as the *Tuḥfa ahl al-īmān fī qibla ‘Irāq al-‘ajam wa-khurāsān (A Gift for the Believers on the qibla of Persian Iraq and Khurasan)*. Iṣfahānī, *Riyāḍ al-‘ulamā*, II:111.

¹⁴⁹ The name used to indicate the western portion of modern Persia in medieval period.

¹⁵⁰ Ḥusayn ibn ‘Abd al-Ṣamad al-Ḥārithī al-‘Āmilī, “Fī qibla Khurāsān” (Tehran, National Library, MS 1943, n.d.), fols. 54v-55r.

¹⁵¹ al-Ḥārithī al-‘Āmilī, fol. 56r.

of Damascus, he recognized a slight deviation in its *qibla* and, separately, that Shahīd al-Thānī had observed a slight deviation toward the south at the Shrine of first Shiite imam ‘Alī in Najaf.¹⁵²

Quoting his master and friend al-Shahīd al-Thānī (d. 966/1559), Ḥusayn al-Ḥārithī endorsed astronomical methods from *‘ilm al-hay’a* as legally justified ways for determining the *qibla* direction. Unlike Dashtakī, Ḥusayn al-Ḥārithī did not explain the technical details of astronomical methods other than giving rough determinations of *qibla* for multiple regions by comparing their latitude and longitude with those of Mecca. But he specified that he enumerated all reasonable results of *‘ilm al-hay’a* concerning *qibla* along with the traditional methods of the most accomplished jurists. Throughout the treatise, Ḥusayn al-Ḥārithī tried to present evidence to show that the opinions of the previous *‘ulamā’* were all in harmony with the principles of *‘ilm al-hay’a*, but he took a step further. Ḥusayn al-Ḥārithī declared *‘ilm al-hay’a* divine knowledge revealed to the ancient Prophet Idrīs, the third after Seth and before Noah, and Luqmān the Wise.¹⁵³ As I will explain below, ‘Āmilī’s also adopted this attitude toward justifying *‘ilm al-hay’a*.

The composition date of the *On the qibla of Khurasan* is not known, but perhaps it was written during the years Ḥusayn al-Ḥārithī served in Mashhad and then as *shaykh al-islām* in Herat. When holding the office of *shaykh al-islām* in Qazvin until demoted to Mashhad in 1564, he had enough power to oppose the opinion of Karakī’s whose legacy was highly esteemed by the Safavids, but Ḥusayn al-Ḥārithī’s good fortune did not last long, and he was replaced by Karakī’s grandson Mīr Ḥusayn in Qazvin. There is no mention in the sources about Mīr Ḥusayn’s knowledge of astronomy, especially regarding *qibla* determination, nor was any work

¹⁵² al-Ḥārithī al-‘Āmilī, fol. 57r.

¹⁵³ al-Ḥārithī al-‘Āmilī, fol. 56r.

recorded by him on the matter. Until the death of Mīr Ḥusayn, ‘Āmilī remained the *shaykh al-islām* of Isfahan under Ismā‘īl II and Khudābanda, a subordinate position to that held by his father’s adversary at the capital. None of the *shaykh al-islām* before ‘Āmilī, including his father, showed any interest in secular science. The first time the Safavid court embraced a religious scholar of the highest rank who knew mathematics and astronomy was when ‘Āmilī became *shaykh al-islām* of the whole of Safavid Persia under ‘Abbās I.

2.3 ‘Āmilī’s defense of astral sciences in *The Crescent Garden*

‘Āmilī made a series of attempts to justify the discipline of *‘ilm al-hay’a* among the Safavids, first at the court by dedicating books to four shahs, as I explained earlier, and then for a more popular audience in his commentary on the prayer, *al-Ḥadīqa al-hilāliyya*. ‘Āmilī’s first attempt was the dedication of the *Dissection* to Ṭahmāsb during the last years of his reign when he possessed no authority as an arbiter jurist on religious matters. In the *Dissection*, which will be introduced in Chapter 3, ‘Āmilī dedicated the final chapter to finding *qibla* first by the method of the Indian Circle and then by the astrolabe. In the *Dissection*, ‘Āmilī did not indicate any legal methods of finding the *qibla* suggested in Shiite jurisprudence. Some years later, while holding the office of *shaykh al-islām* under ‘Abbās, he expanded on the issue in three other works, in his *Gloss on the Dissection* (see Chapter 4 below) discussing astronomical methods, his book on Shiite jurisprudence *Ḥabl al-matīn* (*The Firm Rope...*) completed on 18 Shawwāl 1007/5 May 1599,¹⁵⁴ and in a short treatise on *qibla* made before 1018/1609.¹⁵⁵ ‘Āmilī’s comment on *qibla* in the *Gloss* primarily concerns the astronomical methods with a brief indication at the beginning

¹⁵⁴ Bahā’ al-Dīn al-‘Āmilī, *al-Ḥabl al-matīn fī ihkām aḥkām al-dīn*, ed. Balāsīm al-Mūsawī Ḥusaynī, 2 vols. (Mashhad: Majma’ al-Buḥūth al-Islāmīyah, 2003).

¹⁵⁵ Bahā’ al-Dīn al-‘Āmilī and Hadi al-Qabisi, “Jahat al-qibla,” *Mīqāt al-Ḥajj* 1, no. 7 (2000): 26–51.

about legal aspects of the problem. There he admitted that almost all Shiite jurists accepted the methods of *'ilm al-hay'a* for determining *qibla* bearing, especially the method of the Indian Circle. The jurists, according to him, were satisfied with a rough determination of *qibla* and never expected their followers to know *'ilm al-hay'a*. However, the astronomical methods were far more precise than the methods that jurists derived from the Islamic traditions. 'Āmilī invoked two reasons to show that astronomy is legally endorsed; first, because following the opinion of *hay'a* practitioners for *qibla* is less crucial than referring to philologists and grammarians in Quranic exegesis. Second, all the traditions that came down to us from the Shiite imams were used to find the *qibla* direction in Arab Iraq, and were of no use anywhere else.¹⁵⁶ In both the *Ḥabl al-matīn* and the treatise on *qibla* 'Āmilī contrasted his opinion with that of Karakī and followed the legal opinions of his father and al-Shahīd al-Thānī. There he also explained all six possible cases for finding *qibla*. In the *Ḥabl al-matīn* in a long section on *qibla*, 'Āmilī introduced two general methods of *hay'a* practitioners among legal matters pertaining to the subject¹⁵⁷ and defended the methods of *'ilm al-hay'a* as legally endorsed ways of addressing the issue.¹⁵⁸ Perhaps, considering the broader audience among religious students and educated people who wanted to know about legal matters, the *Ḥabl al-matīn* may have gained more success in disseminating 'Āmilī's opinions about astronomy and religion than the *Dissection* or the *Gloss*, which were of more benefit to specialists interested in *'ilm al-hay'a*.

In the four works introduced above, 'Āmilī established an application of astronomy in religious matters, the *qibla* determination, as a legally endorsed practice made by himself and other jurists. In addition, he dealt with astronomy and religion in a wider context, not limited to

¹⁵⁶ Bahā' al-Dīn al-'Āmilī, “Hāshiya Tashrīḥ al-aflāk” (Tehran, Parliament Library MS 6979, February 28, 1682), fol. 20r; “Hāshiya Tashrīḥ al-aflāk” (Tehran, Parliament Library, MS 16135, 1101 1689), fols. 22r-23r.

¹⁵⁷ al-'Āmilī, *al-Ḥabl al-matīn*, II:247-261.

¹⁵⁸ al-'Āmilī, II:242.

the problem of *qibla*, in his commentary on a collection of prayers by the fourth Shiite Imam Zayn al-‘Ābidīn (659-713). He began this commentary in Qazvin, and completed it in early Jumada II 1003/February 1595 in Kāzīmayn (Iraq). The only surviving part of the larger commentary titled *Ḥadā’iq al-ṣāliḥīn* (*Gardens for the Righteous [People]*),¹⁵⁹ is called *al-Ḥadīqa al-hilāliyya* (*The Crescent Garden*, henceforth the *Crescent*), on prayer forty-three for the first sighting of the new moon.¹⁶⁰ The Islamic lunar calendar is solely based on the new moon sighting to determine the beginning of each month, following the practice of the Bedouin pre-Islamic society of the Arabian Peninsula. The matter becomes more crucial for the three months of Ramadan, Shawwāl, and Dhū al-ḥajja, the first two marking the beginning and end of the fasting period, and the latter for performing the pilgrimage to Mecca.

The *Crescent* is extant in ‘Āmilī’s hand, bearing his signature and the dates mentioned above. The *Crescent* is not addressed to a notable or a courtier, but the completion date corresponds to the period that ‘Āmilī had been made the most potent jurist of the Safavid Persia under ‘Abbās I. The *Crescent* is remarkable in many respects. The prayer that ‘Āmilī commented upon is itself only one page long, but ‘Āmilī wrote more than sixty pages about it. His commentary presents, more than matters concerning just the prayer, ‘Āmilī’s opinion about astronomy and astrology as licit practices for Muslims, the latter with a reservation which I will explain later. As such works aimed at a more popular audience than those of astronomical books, ‘Āmilī tried to show, with evidence from Shiite tradition, that astronomy and particularly ‘*ilm al-hay’a*’ originated from the Prophets’ revealed knowledge and was practiced by them and the

¹⁵⁹ In the extant portion, however, ‘Āmilī referred to other chapters of the larger commentary which are yet to be found. Bahā’ al-Dīn al-‘Āmilī, *al-Ḥadīqah al-hilāliyyah: Sharḥ du ‘ā’ al-hilāl min al-Sahīfa al-Sajjādīyya*, ed. ‘Alī Mūsawī al-Khurāsānī, *Silsilat maṣādir Biḥār al-Anwār* (Qum: Iran: Mu’assasat Āl al-Bayt li-lḥyā’ al-Turāth, 1990), 93, 150–52.

¹⁶⁰ al-‘Āmilī, 65.

Shiite Imams. His defense of the discipline is paramount; no one in established orthodox Shiism in Persia, including ‘Āmilī’s fellow jurists, could resist astronomy and astrology that had been endorsed and practices by the Imams.

The technical details of the *Crescent* deserve a more extended analysis, but here I can highlight some crucial points of the book. The *Crescent* is in five sections: an introduction that presents basic definitions such as the meaning and nomenclature of a crescent among the Arabs and in Arabic lexicons, with criticism against al-Karakī, the Second Verifier, on the number of days at the beginning of each month during which the Moon should be called a crescent Moon. The introduction also deals with the importance of reciting prayers at the moment of Moon sighting. The moon sighting prayers were in two general categories, one specific to the month of Ramadan, and others made for all months in the Islamic lunar calendar. The last part of the introduction discusses some proofs and evidence for the sphericity of the Earth, which causes the Moon sighting not to be the same in different localities.¹⁶¹ The first actual commentary on the prayer comes in the second part of the *Crescent*. In his comments on the first sentence of the prayer, which calls the Moon a fast-moving servant of the God, ‘Āmilī dedicated a long section about the astronomy of the Moon to interpreting the phrases in that sentence.¹⁶² He first introduced the meaning of an orb (*falak*) and deemed possible mending and tearing of it. Next he covered the Moon’s mansions, its orbs and their motions with numerical values for each compared to other planets’ annual motions, and the two known irregularities of the Moon’s motions. Before concluding the section by further comments on the nature of orbs, ‘Āmilī raised objections against the famous theologians ‘Aḍud al-Dīn al-Ījī (1281-1355) and Jalāl al-Dīn

¹⁶¹ al-‘Āmilī, 65–80.

¹⁶² al-‘Āmilī, 81–93.

Dawānī (1426-1502) on the thickness of the complement orbs (detailed discussion about this in Chapter 3). On this Ḥamīdī referred to his long super-commentary on Jaghmīnī's *Mulakhkhaṣ*.

The third part comments on the middle portion of the prayer, which deals with the brightness and darkness of the Moon and its waxing and waning as signs of the Moon's obedience to God's providence. This part also covers the illumination of the Moon, eclipses, and the illumination of other planets by the Sun.¹⁶³ Ḥamīdī began this part with the literary and linguistic style of the prayer, but soon jumped to two standard definitions of the nature of light among Islamicate philosophers: light being an accident that occurred to material bodies or being itself a body. In one passing paragraph interpreting the prayer on the varying illumination of the Moon, Ḥamīdī asserted that the scholars of *'ilm al-hay'a*, i.e., astronomy, obtained their knowledge from the prophets, specifically from Seth (the third son of Adam and Eve) and from Idrīs (the third Prophet after Seth) who was called Hermes. Ḥamīdī did not mention his source on this but brought forward as testimony a verse in Quran (XIX:56) about which the exegeses purportedly claimed that astronomy was Idrīs' miracle (more about this below). Ḥamīdī further explained that a person familiar with "this noble science," i.e., astronomy, would admit that the prophets bestowed its principles since they are beyond human power. Without their inspiration, astronomers would not grasp all those principles through corporeal observations alone.¹⁶⁴

This section of the *Crescent* presents several technical topics about the Moon's illumination and eclipses. On the proofs that the Moon is illuminated by the Sun, Ḥamīdī defended Ibn al-Haytham's idea against al-Ījī and the Persian philosopher and logician al-Qazwīnī al-Kātibī (d. 1276). I have discussed this in detail in Chapter 4. One critical discussion regarding the nature of the Moon is about the uneven brightness of its surface, which puzzled Islamic scholars. It should

¹⁶³ al-Ḥamīdī, 94–124.

¹⁶⁴ al-Ḥamīdī, 106–7.

not concern us here, as it requires a separate discussion, but suffice to say that ‘Āmilī showed his awareness of and command of the topic here. He first stated that there were twelve opinions on this, and that he had explained all of them in another work, but here he discussed five of them from Ibn Sīnā, Ṭūsī, Shīrāzī, Neyshābūrī, Bīrjandī, and Khafrī (who will be introduced in the following chapters) along with his rejection of some and confirmation of some.¹⁶⁵ In the concluding section of this part, ‘Āmilī argued against Shīrāzī to show that other planets, like the Moon, are illuminated by the Sun, and do not have light of their own. He referred to one of his works, probably not surviving, in which he had provided an extensive discussion on this topic,¹⁶⁶ but he had dealt with the issue a bit further in his *Kashkūl (The Anthology)*.¹⁶⁷ These sections of the *Crescent* indicate the range of sources that ‘Āmilī drew upon and the typical arrangement of a commentary.

The fourth part of the *Crescent* is of more importance to our discussion here. It comments on a portion of the prayer asking God to bestow good fortunes, purity, health, safety, and comfort at the moment of the observed *Crescent*. As before, ‘Āmilī’s comments begin with some literary, theological, and ethical elaborations related to the prayer,¹⁶⁸ but in a supplementary section (*takmila*) he expands on astrological implications of the Moon in particular, and the influences of heavenly bodies on the terrestrial universe in general. ‘Āmilī classified knowledge of the Moon in three categories. The first category pertains to the orbs of the Moon, their arrangement, and their motions, as well as eclipses, and the irregular motions of the Moon’s inclined and epicycle orbs. The second category, considers the influence exerted by the Moon’s variation of brightness and light on earthly events. These include effects on the humidity of living bodies, the ebb and

¹⁶⁵ al-‘Āmilī, 118–21.

¹⁶⁶ al-‘Āmilī, 124.

¹⁶⁷ al-‘Āmilī, *al-Kashkūl*, 2006, I:150-156.

¹⁶⁸ al-‘Āmilī, *al-Ḥadīqah al-hilālīyyah*, 125–35.

flow of water, the critical moment of illnesses, and the growth of plants, and fruits growth, and so forth. The third section considers how the Moon influences things that are *sa‘d* (auspicious or fortunate) and things that are *naḥs* (inauspicious, unfortunate, or ill-fated), and all events for which the Moon is a sign of their occurrence. ‘Āmilī emphasized the inclusion of the third category in Islamic religious law, supported by three pieces of evidence from Shiite traditions (hadith).

According to Shiite hadith scholar Muḥammad ibn Ya‘qūb al-Kulaynī al-Rāzī (d. 329/940), in one tradition, the sixth Shiite Imam, Ja‘far al-Ṣādiq (d. 765), had warned the believers of harmful outcomes of traveling or having sexual relations while the Moon was in the scorpion constellation. In another tradition, the seventh Imam, Mūsā al-Kāẓim (d. 799), stated that a conception during a new Moon will result in miscarriage. And finally, ‘Āmilī quoted from the most authoritative Shiite jurist of the eleventh century, Abū Ja‘far al-Ṭūsī (d. 460/1067), that the Prophet avoided sexual relations with his wife during a lunar eclipse. Regardless of the authenticity of these traditions, ‘Āmilī’s attempt to prove astrology a legally endorsed discipline among the Shiites is apparent. But he did not accept it without reservation and set a criterion for valid and licit astrological practices. In ‘Āmilī’s viewpoint, astrology was not contradictory to religious conviction as long as the celestial phenomena are considered the signs of earthly events that have already been determined by God’s providence, just as physicians diagnose from patients’ pulse beats or fever to predict future bodily conditions or complications resulting from the illness. However, ‘Āmilī declared it prohibited to believe that celestial phenomena are causes for terrestrial events.¹⁶⁹ Here again, utilizing another Shiite tradition, ‘Āmilī emphasized that the Prophets were given the knowledge of future events. To offer certainty, astrological knowledge

¹⁶⁹ al-‘Āmilī, 139–40.

obtained by experience require abilities beyond human intellectual power.¹⁷⁰ To clarify this limitation, ‘Āmilī referred to Ibn Sīnā’s statement of the one criterion that would allow valid astrological prognostication. In the *Shifā* (*The Healing*), “Metaphysics,” Book X, Ch. 1, Ibn Sīnā stated that:

If it were possible for some human to know all the temporal events on Earth and in heaven, and their natures, he would comprehend the manner of all that will occur in the future. [But] this astrologer who professes astral [predictions] - in addition [to the fact] that his first positings and premises are not based on demonstration (although he may claim [for them] experiment or inspiration and may attempt poetic and rhetorical syllogism to establish them) - depends on [only] one genus of evidential indicators of the causes of generated things: namely, those that are in heaven. But he cannot guarantee for himself knowledge of all the states that are in heaven. And, [even] if he were to guarantee this for us and to fulfil [his promise], he would be unable to make us and himself know the existence of all of them in every [moment of] time, even if all were known to him with respect to their [kind of] action and nature.¹⁷¹

The problem with astrological prognostications, according to the above quote, is that they predict events based only on specific celestial configurations, which does not even guarantee a knowledge of all the heavens. Ibn Sīnā suggested that knowing future events might be possible if only one knew all that happened in the heavens and Earth altogether, something ‘Āmilī deemed impossible. Astrology, then could make judgements about the likely or possible course of the future but could not guarantee its predictions.

¹⁷⁰ al-‘Āmilī, 140–41.

¹⁷¹ Avicenna, *The Metaphysics of The Healing*, trans. Michael E. Marmura (Provo, UT: Brigham Young University, 2005), 363; Ibn Sīnā, *al-Shifā’: al-Ilāhiyyāt*, ed. Ibrāhīm Madkūr, 1960, 440.

To emphasize the endorsement of astrology in Shiite theology, ‘Āmilī concluded this section of the commentary with positive references to astrology from famous Shiite hadith scholars of the medieval period. One of them, known as Ibn Ṭāwūs (d. 1266), dedicated a book consisting of ten chapters to astrology, the *Faraj al-mahmūm fī ta’rīkh ‘ulamā’ al-nujūm* (*Comfort for the grieved concerning the history of the astrologers*).¹⁷² In the *Comfort*, Ibn Ṭāwūs provided a history of astrology and astrologers from the ancient Indians and Persians to medieval Muslim and non-Muslim ones, based on hadith traditions mostly related by the Shiite Imams, with little attention to the historical accounts. The first four chapters deliver discussions concerning the divine origin and legitimacy of astrology. Among the numerous traditions and accounts presented in the *Comfort*, ‘Āmilī focused on one which tells about an astrologer who predicted the return of the Hidden Imam. Ibn Ṭāwūs, claiming to have seen in a book about the nativities of the Imams (*Kitāb al-awṣiyā’*), related a story from one of the companions of the eleventh Imam who after the birth of the twelfth Imam (who became the Hidden Imam) met a Jewish scholar in Qum who was famous for his skills in astrology and calculation. The companion of the eleventh Imam told him about the birth time of a newborn (the future Hidden Imam) to get his horoscope. The Jewish astrologer first remarked that the child belonged to someone else, not the person who reached out to him, but then stated that the child would sometime govern the world from east to west until he brought justice to its corners, and that everyone will submit to his mandate.¹⁷³ There are significant indications in this peculiar story, regardless of its authenticity. First, it implies that the close companions of the Imams believed in astrological prognostications

¹⁷² The only printed version of the *Comfort* is undated and not a reliable edition. There is however, a study and English translation of chapters V-VIII of the book published as a PhD dissertation in 1987. Ibn Ṭāwūs, *Faraj al-mahmūm fī ta’rīkh ‘ulamā’ al-nujūm* (Qum: Iran, 1949); Zeina Matar, “The ‘Faraj al-Mahmūm’ of Ibn Ṭāwūs: A Thirteenth-Century Work on Astrology and Astrologers” (Ph.D., New York University, 1987).

¹⁷³ Ibn Ṭāwūs, *Faraj al-mahmūm fī ta’rīkh ‘ulamā’ al-nujūm*, 36–37; al-‘Āmilī, *al-Ḥadīqah al-hilālīyyah*, 142–43.

even obtained from non-Muslims; second, it was acceptable and possibly customary for notables of the imamate family to order horoscopes for their children. Perhaps, no other story would be more convincing to ‘Āmilī’s Persian audience and the Safavid court to justify the acceptability of astrology to Muslims with Shiite convictions.

The *Comfort* was a significant source for ‘Āmilī in this section of his commentary on the prayer. Ibn Ṭāwūs presented accounts indicating that astrologers had predicted the prophethood of Noah, Abraham, Moses, Jesus, and Muḥammad.¹⁷⁴ Based on a relatively long story about a dispute on the origins and nature of astrology that occurred between the Sixth Imam al-Ṣādiq and an Indian astrologer, recorded in a book entitled *al-Ihlīlaja*,¹⁷⁵ Ibn Ṭāwūs concluded that al-Ṣādiq did not reject astrology as a whole but determined the proper way of practicing it, which was through the knowledge God revealed to the prophets. He then reported that all accounts unanimously agreed that the Prophet Idris was the first to learn and practice astrology through revelation. This account was also reaffirmed by ‘Āmilī, as I mentioned earlier.¹⁷⁶ But this belief does not seem specific to ‘Āmilī and other jurists and hadith scholars of the previous centuries. A similar account about the origin of astronomy and astrology was made by an astronomer contemporary to ‘Āmilī in Europe. Following the request of the King of Denmark, Frederick II, and other notables, Tycho Brahe (1546-1601) was supposed to train Copenhagen students in mathematical disciplines through some lectures, which he delivered during 1574-75. In his oration of early September 1574 in the presence of the university community, Brahe mentioned the origin of astronomy in a genealogy from the Prophet Seth to Abraham, to Egyptians, then to Timocharis of Alexandria (c. 320–260 BC), Hipparchus, Ptolemy, Albategnius (al-Battānī, d.

¹⁷⁴ Ibn Ṭāwūs, *Faraj al-mahmūm fī ta’rīkh ‘ulamā’ al-nujūm*, 25–29.

¹⁷⁵ Ibn Ṭāwūs, 11–21.

¹⁷⁶ al-‘Āmilī, *al-Ḥadīqah al-hilālīyyah*, 106, 142.

929), Alfonso, and Copernicus.¹⁷⁷ Surprisingly, several figures in Tycho's account appear in Ibn Ṭāwūs as well, as attested and completed by 'Āmilī. Reporting on the *Rayḥān al-majālis wa-tuḥfa al-mu'ānis* by a certain Aḥmad al-Rukhajī, Ibn Ṭāwūs admitted that the most reliable wise men whose knowledge is uncontested among people began with Hermes Trismegistus (Hermes Thrice-Greatest, or in his wording *Hirmis al-muthallath bi-al-ḥikma*) on whom God had bestowed three fields of knowledge: astrology, medicine, and alchemy. Hermes, according to Ibn Ṭāwūs, was the Prophet Idris. Then came Hipparchus and Ptolemy, who he believed to be messengers of God, but their Greek names obscured the fact to the people. 'Āmilī completed this account by adding Seth to the genealogy.¹⁷⁸

Whatever these convoluted and sometimes confusing accounts about the origin of astrology tell us, Ibn Ṭāwūs and his successor and fellow religious scholar 'Āmilī both tried to show the legitimacy and legality of astrology, not unconditionally, but with a proper understanding of causality regarding celestial and terrestrial matters. For 'Āmilī, his commentary on the prayer pursued another purpose, justifying *'ilm al-hay'a* among the Safavid populace and courtiers as the only accepted method of addressing some religious issues like the determination of *qibla*. The astronomical and astrological discussions in the *Crescent* are unusual and unprecedented in Shiite literature. In the *Crescent*, 'Āmilī not only put a religious garment on *'ilm al-hay'a* and clarified the divine origins of astronomy and astrology, but determined the legally accepted methods for practicing astrology, without rejecting the discipline as a whole. 'Āmilī's views about astrology are also apparent through another celestial event that involved the Safavid court.

¹⁷⁷ J. R. Christianson and Tycho Brahe, "Tycho Brahe's German Treatise on the Comet of 1577: A Study in Science and Politics," *Isis* 70, no. 1 (March 1979): 111–12.

¹⁷⁸ al-'Āmilī, *al-Ḥadīqah al-hilālīyyah*, 106.

After fifteen months of the precarious reign of Ismā‘īl II with many cruel actions, including a massacre of Safavid princes and emirs, nothing less than a comet would jeopardize his monarchy. Despite his brutal behavior, Ismā‘īl showed interest and knowledge in arts and sciences, especially astrology, and patronized several projects.¹⁷⁹ Ismā‘īl entered Qazvin on 17 Rabī‘ I 984/14 Jun 1576,¹⁸⁰ but based on astrologers’ predictions, he postponed his coronation until the auspicious date 27 Jumāda I 984/22 Aug 1576.¹⁸¹ When the comet of 985/1577 appeared in the sky, Iskandar Beg reported that:

... a comet was seen under the sign of Sagittarius, and its tail was suspended in the midst of the western heavens. Since Ismā‘īl II had considerable knowledge of astrology, he was filled with apprehension, He consulted his astrologers daily and inquired of them what the comet portended. The astrologers gave a soothing answer, but Ismā‘īl reminded them that the appearance of a comet like this portended the downfall of a king. The astrologers then said that, because the tail of the comet appeared in the west, the bulk of its effect would be felt in the Ottoman empire and western lands. Although the assurances of the astrologers were of some comfort to him, the Shah was not entirely satisfied. And indeed, he had good reason to be alarmed, because the principles of astrology show that, whenever a comet appears in the house of a person’s ascendant star, that person will surely perish. Shah Ismā‘īl II was born under the constellation of Gemini. The star governing his horoscope was Mercury, and this comet had appeared in the house

¹⁷⁹ Iskandar Beg Munshī, *Tārīkh-e ‘ālam-ārāy-e ‘Abbāsī*, 1:217; *The history of Shah ‘Abbas*, 1:325; Newman, *Safavid Iran*, 47–48; Gholzorkhi, “Ismail II and Mirza Makhduṃ Sharifi,” 479. Contradictions between Muẓaffar ‘Alī’s account about Ismā‘īl and his reign with other chronicles and his manipulation of the event are discussed in: Stewart, “The Lost Biography of Baha’ al-Din al-‘Āmili,” 197–203.

¹⁸⁰ Qumī, *Khulāṣa al-tavārīkh*, 2:618-19.

¹⁸¹ In the course of his coronation, Ismā‘īl camped some days out of Qazvin waiting for the astrologer to find an auspicious moment for performing the coronation ceremony. Qumī, II:625-26.

of his ascendant star; but the astrologers misled him and prevented him from finding this out, and a few days later he died.¹⁸²

After this report, Iskandar Beg explained how Ismāʿīl died suspiciously on 13 Ramaḍān 985/24 Nov 1577, seemingly by an act of murder rather than a natural cause.¹⁸³

This comet appeared between 13 Nov 1577-26 Jan 1578¹⁸⁴/2 Ramaḍān-17 Dhu al-Qaʿda 985 and was observed by several astronomers like Tycho Brahe (1546-1601) in Denmark, Taqī al-Dīn Maʿrūf (1526-1585) in Istanbul, and others, and became known as the Great Comet of 1577 in modern scholarship. Brahe provided observational details and recorded its motion as three and a half degrees in twenty-four hours in the beginning but decreasing gradually until it eventually disappeared within a month.¹⁸⁵ One of the extensive commentaries on the *Dissection* completed on 10 Muḥarram 1083/28 Apr 1672, provides ʿĀmilī's description of the comet of 985/1577. The commentary entitled *Tafrīḥ al-idrāk fī tawḍīḥ tashrīḥ al-aflāk* (*Delight of Perception in Exposition of the Dissection of the Orbs*) was written by Ṣadr al-Dīn Muḥammad ibn Ṣādiq Ḥusaynī Qazvīnī for the governor of Qazvin, Zeynal Khān.¹⁸⁶ Shams al-Dīn ʿAlī Ḥusaynī Khalkhālī, ʿĀmilī's disciple, in addition to reporting ʿĀmilī's observation, specified his own observation of the phenomenon (see Chapter 5). Others of ʿĀmilī's commentators also reported the phenomenon from him. A few other reports of the comet in later Safavid chronicles added very little information to ʿĀmilī's account.¹⁸⁷

¹⁸² Iskandar Beg Munshī, *The history of Shah ʿAbbas*, 1:325; *Tārīkh-e ʿālam-ārāy-e ʿAbbāsī*, 1:217-18.

¹⁸³ Iskandar Beg Munshī, *The history of Shah ʿAbbas*, I:325-27.

¹⁸⁴ NASA, Jet Propulsion Laboratory, <https://ssd.jpl.nasa.gov/horizons.cgi#results>.

¹⁸⁵ Tofigh Heidarzadeh, *A History of Physical Theories of Comets, from Aristotle to Whipple*, Archimedes 19 (Dordrecht: Springer, 2008), 41; David A. Seargent, *The Greatest Comets in History: Broom Stars and Celestial Scimitars*, Astronomer's Universe (New York, NY: Springer, 2009), 104-9.

¹⁸⁶ Ṣadr al-Dīn Muḥammad Ḥusaynī Qazvīnī, "Tafrīḥ al-idrāk fī tawḍīḥ tashrīḥ al-aflāk" (Tehran, Parliament Library, MS 16135, 1101/1689); "Tafrīḥ al-idrāk fī tawḍīḥ tashrīḥ al-aflāk" (Tehran, Parliament Library, MS 6345, 1219/1805).

¹⁸⁷ Hasan Beg Rūmlū, *Aḥsan al-tavārīkh*, 645; Qumī, *Khulāṣa al-tavārīkh*, II:651; Afushtayī Naṭanzī, *Noqāwat al-āthār fī dhikr al-akhyār*, 61-62; Valī Qulī ibn Dāvūd Qulī Shāmlū, *Qīṣaṣ al-khāqānī*, ed. Sayyed Ḥasan Sādāt-Nāserī (Tehran, 1992), I:101.

Iskandar Beg did not specify any of the astrologers who consulted the Shah over the comet's influence. But 'Āmilī, in a long super-commentary on Jaghmīnī's *al-Mulakhkhaṣ fī al-hay'a al-basīṭa* (*An Epitome on Plain Hay'a*), reported his own meeting with the Shah, right after the comet appeared. According to 'Āmilī, during his stay in Qazvin in 1577, a comet appeared in the sky that resembled a peacock's tail moving at a speed similar to that of the diurnal motion. He did not provide further astronomical details but recorded the duration of its appearance as a month.¹⁸⁸ On the third night after the comet appeared, 'Āmilī had an audience with Ismā'īl, and the Shah explained his deep anxiety about the phenomenon and surmised that the comet indicated the end of his reign. In his advice to the Shah, 'Āmilī rejected the credibility of astrologers' interpretations of celestial events as causes of events on Earth but hoped that even if they were true, the comet's influence would be elsewhere than Persia. In his advice to the shah in 1577, then, 'Āmilī followed the same principles that he later presented in the *Crescent* in 1599; astrology cannot make causal claims, so there cannot be legitimate expectation that the appearance of a comet will cause the death of a king. In conclusion 'Āmilī reported that the Shah survived only a few days, and the bad omen he took for himself came true.¹⁸⁹

'Āmilī's dedication of the *Dissection* to a series of shahs, was not just an incentive for advertising his intellectual skills. He was also taking sides in an ongoing dispute with religious authorities who denied a role for astronomy in settling religious questions like the direction of the *qibla* and the visibility of the new Moon. He not only needed to promote himself, he also needed to promote the astral sciences. He achieved the first of these, in part, by writing and rededicating the *Dissection*, and the second by what he wrote in the *Crescent*, and elsewhere.

¹⁸⁸ Bahā' al-Dīn al-'Āmilī, "Ḥāshiya sharḥ Mulakhkhaṣ" (Tehran, Parliament Library, MS 14738, n.d.), fols. 72v-73r. 'Āmilī's meeting with the Shah was also reported by one of his commentators. Ḥusaynī Qazvīnī, "Tafrīḥ al-idrāk," 1101 1689, fol. 50r.

¹⁸⁹ al-'Āmilī, "Ḥāshiya sharḥ Mulakhkhaṣ," fols. 72v-73r.

Ch. 2: Astral Sciences among the Safavids

Astrology is handicapped without the best available astronomical methods. These he provided in the *Dissection*, and its sequel, the *Gloss*, which are the subjects of the next two chapters.

Chapter 3

The *Dissection of the Orbs* (*Tashrīḥ al-aflāk*)

This chapter is about one of the most popular books in astronomy in the Safavid period. Bahā' al-Dīn al-ʿĀmilī (1547-1621) composed several works in astronomy and mathematics which all became popular but among those the *Dissection of the Orbs* (*Tashrīḥ al-aflāk*) received enormous attention. Many contemporary and subsequent scholars of the following three centuries throughout Safavid Persia, Mughal India, and the Ottoman Empire copied, read and commented upon it. As late as 1857, the Ottoman scholar Sayyid ʿAbd Allāh Afandī Qūnavī published a commentary on the *Dissection* entitled *The Clarification of Perception about the Dissection of the Orbs* (*Tawḍīḥ al-idrāk ʿan tashrīḥ al-aflāk*).¹⁹⁰ Apart from numerous commentaries, super-commentaries, and glosses written on the *Dissection*, about two-hundred and fifty manuscript copies of the book were catalogued just in Iran.¹⁹¹ After wide circulation in manuscript, the *Dissection* appeared in print publication several times in Iran from 1275/1858-9 to 1319/1901-2, as well as in Calcutta in 1839 and 1882.¹⁹² The *Dissection* along with ʿĀmilī's book on mathematics, the *Khulāṣa al-ḥisāb* (*Quintessence of Arithmetic*), became standard textbooks and parts of the curricula in several madrasas in the following centuries.¹⁹³ The *Khulāṣa al-ḥisāb* is extant in 561 manuscript copies in Iran and was published several times in

¹⁹⁰ Robert G. Morrison, "The Reception of Early-Modern European Astronomy by Ottoman Religious Scholars," *Archivum Ottomanicum* 21 (2003): 189; Āqābuzurg Tehrānī, *al-Dharīʿa*, 4:186; ʿAbd al-Ḥusayn Amīnī, *al-Ghadīr fī al-kitāb va-al-sunnat va-al-adab* (Qum: Iran: al-Ghadir Center for Islamic Studies, n.d.), 11:348. Qūnavī's commentary was also published in Istanbul. Khānbābā Moshār, *Fehrest-e ketābhāy-e chāppīy-e arabī*, 1965, 225.

¹⁹¹ For a list of these copies see: Mostafā Derayati, ed., *Short Catalogue of Iranian Manuscripts* (Tehran, 2010), vol. 2, pp. 1191–98.

¹⁹² Printed editions of the *Dissection* were published in Iran in 1275/1858-9, 1279/1862-3, 1281/1864-5, 1291/1874-5, 1293/1876-7, 1316/1898-9, and 1319/1901-2. Moshār, *Fehrest-e ketābhāy-e chāppīy-e arabī*, cols. 185–6.

¹⁹³ For ʿĀmilī's scientific works which were used as textbooks in *madrasas* see: Gregg De Young, "The Khulāṣat al-Ḥisāb of Bahā' al-Dīn al-ʿĀmilī and the Dars-i Nizāmī in India," *Gaṇita Bhārati* 8 (1986): esp. 7; Sonja Brentjes, *Teaching and Learning the Sciences in Islamicate Societies* (S.l.: Brepols Publishers, 2017), 240–41.

Tehran, Tabriz, Calcutta, and Istanbul. More than seventy commentaries, glosses, and translations are known to have been made upon the *Khulāṣa al-ḥisāb*¹⁹⁴ and the book also appeared in German and French translations in 1843 and 1864 respectively.¹⁹⁵ Copies of ‘Āmilī’s works were transmitted to the Ottoman Empire by the physician Mūḥammad-Bāqir ibn ‘Imād al-Dīn Maḥmūd who also wrote commentaries on them.¹⁹⁶ ‘Āmilī studied medicine and particularly Ibn Sīnā’s *Canon* in Qazvin under Mūḥammad-Bāqir’s father ‘Imād al-Dīn Maḥmūd who was a well-known physician from a prominent family of physicians of Shiraz.¹⁹⁷

Numerous extant copies and printed editions of the *Dissection*, a simple and short text on theoretical astronomy, in addition to its popularity, sometimes inspired the assumption that the *Dissection* was a meager contribution to the genre and therefore showed a decline in astronomical science and education in the Safavid period.¹⁹⁸ In the following pages, my main effort is to address the question of why such a simple, short book should have received that enormous attention while other options in the same genre were available to the scholars and students of the time. As the evidence above shows, the *Dissection* was received by many

¹⁹⁴ Mostafa Derayati, *Union Catalogue of Iran Manuscripts (Fankha)* (Mashhad, 2014), 13:863-894.

¹⁹⁵ For a detailed analysis of Bahā’ al-Dīn’s works on mathematics see: Jalal Showqī, *Rīyāḍiyyāt Bahā’ Al-Dīn Al-‘Āmilī* (Aleppo, 1976) and Nader Rofagha, “An Investigation of the Mathematical and Pedagogical Contribution of Baha Al-Din Muhammad ibn Husayn Amili (Aka Sheikh Bahai), a Sixteenth Century Middle Eastern Teacher and Scholar” (Ph.D., Columbia University, 2006). ‘Āmilī famous work in mathematics, *Khulāṣa al-ḥisāb* (*The Quintessence of Arithmetics*) was widely circulated both in manuscript and printed editions. In the nineteenth century the *Quintessence* was translated into European languages two times: once into German along with an edition of the Arabic text and another in French with comments and notes. Mohammed Beha-eddin ben Alhossain aus Amul, *Essenz der Rechenkunst*, ed. Georg Heinrich Ferdinand Nesselmann (Berlin: Bei G. Reimer, 1843); Beha-eddin al Aamouli, *Kholāṣat al Hissāb, ou Quintessence du calcul*, trans. Aristide Marre (Rome: Imprimerie des sciences mathématiques et physiques, 1864).

¹⁹⁶ Ekmeleddin İhsanoğlu, ed., *Osmanlı Astronomi Literatürü Tarihi (History of Astronomy Literature During the Ottoman Period)*, Osmanlı bilim tarihi literatürü serisi (İstanbul: İslâm Tarih, Sanat ve Kültür Araştırma Merkezi, 1997), 336; Sonja Brentjes, “The Mathematical Sciences in the Safavid Empire: Questions and Perspectives,” in *Muslim Cultures in the Indo-Iranian World During the Early-Modern and Modern Periods*, ed. Denis Hermann and Fabrizio Speziale (Institut Français de Recherche en Iran, 2010), 335–36.

¹⁹⁷ Savage-Smith, “‘Imād-al-Dīn Maḥmūd”; Elgood, *Safavid Medical Practice*, 21–24.

¹⁹⁸ John W. Livingston, “Naṣir al-Dīn al-Tūsī’s *al-Tadhkirah*: A Category of Islamic Astronomical Literature,” *Centaurus* 17, no. 4 (December 1, 1973): 274; H. J. J. Winter, “Persian Science in Safavid Times,” in *The Cambridge History of Iran*, ed. Peter Jackson and Lawrence Lockhart (Cambridge: Cambridge University Press, 1986), 592.

subsequent scholars in the Safavid, Ottoman and Mughal Empires and that it was being used for teaching and learning astronomy from the seventeenth to the nineteenth centuries. The number of commentaries, super-commentaries, glosses, and translations of the *Dissection* in addition to multiple available printed editions of some of them provide solid evidence for the importance of the book and its author. A description of the contents of the *Dissection* will be followed by a comparison with two other popular works on simple *hay'a* prior to 'Āmilī to enable us better to classify the book in the genre of *'ilm al-hay'a*. Finally, I will discuss the socio-political status of 'Āmilī and his relations to the Safavid court during the reign of four shahs to answer the main question of this chapter.

3.1 Contents of the *Dissection*

The *Dissection* is an introductory treatise generally in *'ilm al-hay'a* (the science of the configurations),¹⁹⁹ particularly classified under the subcategory *al-hay'a basīṭa* (plain or simple *hay'a*) which aimed to give a general picture of the universe, both for the celestial and terrestrial realms, but was devoid of any mathematical or natural philosophical demonstrations. Likewise, the *Dissection* for instance does not provide geometrical or mathematical proofs for planetary

¹⁹⁹ For a recent study of *'ilm al-hay'a* see: Sally P. Ragep, *Jaghmīnī's Mulakhkhaṣ*, 27–65. For different definitions and interpretations of *'ilm al-hay'a* and possible explanations for its formation in Islamicate science see: David Pingree, “‘Ilm al-Hay’a,” in *Encyclopaedia of Islam, Second Edition*, vol. 3, 13 vols. (Leiden; London: Brill, 1986), 1135–38; Ḥasan ibn al-Ḥasan Ibn al-Haytham and Y. Tzvi Langermann, *Ibn al-Haytham's On the Configuration of the World* (New York & London: Garland, 1990), 25–34; F. Jamil Ragep, *Naṣīr al-Dīn al-Ṭūsī's Memoir on Astronomy (al-Tadhkira fī 'ilm al-hay'a)*, Sources in the History of Mathematics and Physical Sciences 12 (New York, NY: Springer New York, 1993), 29–36; George Saliba, “Astronomy and Astrology in Medieval Arabic Thought,” in *Les Doctrines de La Science de l'Antiquité à l'Age Classique*, ed. Roshdi Rashed and Joël Biard (Peeters, 1999), 131–64; George Saliba, “Islamic Astronomy in Context: Attacks on Astrology and the Rise of the Hay'a Tradition,” *Bulletin of the Royal Institute for Inter-Faith Studies* 4, no. 1 (Spring-Summer 2002): 25–46; F. Jamil Ragep, “Hay'a,” in *Encyclopaedia of the History of Science, Technology, and Medicine in Non-Western Cultures* (Springer, Dordrecht, 2008), 1061–62, https://doi.org/10.1007/978-1-4020-4425-0_8631.

models and its presentation through diagrams is one main part of the description it gives for planetary motions and orbs. The book is organized into seven parts as follows:

- The epigraph and the dedication
- Introduction: [the overall structure of the sublunary and superlunary universe] (Fig. 3-1)
- Chapter One: On the great and small circles and the well-known arcs
- Chapter Two: On the forms [*ṣuvar*] of the orbs of the seven planets (Fig. 3-2)
- Chapter Three: On the motions [of the orbs] and what pertains to them
- Chapter Four: On what pertains to the Earth and the differences of its localities
- Chapter Five: On dawn and dusk
- Epilogue (*khātima*): On deriving the meridian line and the *qibla* bearing by the method of the Indian circle

The *Dissection* begins with an epigraph including Quranic verses and veneration for the Prophet and his family.²⁰⁰ Afterwards, the author's name appears, followed by a general description of the purpose of composition and the title of the book.²⁰¹ 'Āmilī describes the *Dissection* as: “... a unique pearl, including the principles and cores of the art of *hay'a*, covering its important chapters and sections.”²⁰² This description implies that he did not intend to cover all topics of *hay'a* discussed in extensive works such as Naṣīr al-Dīn Ṭūsī's *Tadhkirah*²⁰³ or Qutb al-Dīn Shīrāzī's *al-Tuḥfa al-shāhiya fī 'ilm al-hay'a* (*The Royal Gift in the Science of Configuration*) and *al-Nihāya al-idrāk fī dirāya al-aflāk* (*The Limits of Perception in*

²⁰⁰ Hereafter, all reference to the contents are made to the earliest copy: al- 'Āmilī, “Tashrīḥ al-aflāk,” 986 1576, fols. 1v-2r.

²⁰¹ al- 'Āmilī, f. 2r.

²⁰² *hādhihī durratun yatīmatun iḥtawāt min fan al-hay'a 'alā 'uṣūlih wa-lubābih wa-inṭawat 'alā al-muhim min fuṣūlih wa-abwābih.* al- 'Āmilī, f. 2r.

هذه درة يتمية إحتوت من فن الهيئة على أصوله ولبابه وانطوت على المهم من فصوله وابوابه ...

²⁰³ Ragep, *Ṭūsī's Memoir*.

Understanding the Orbs).²⁰⁴ Then comes a dedicatory letter, followed by a sentence describing the structure of the book: an introduction, five chapters, and an epilogue. The introduction begins with matters of natural philosophy, including the composition of the cosmos, the nine total celestial orbs, and the sublunary universe which is made up of the four basic elemental shells of fire, air, water, and earth.²⁰⁵ The introduction ends with an illustration of the cosmos in the form of nested spherical orbs (Fig. 3-1).²⁰⁶ Chapter one provides definitions for small and great celestial circles. Ten “well-known” great circles like the ecliptic, horizon, and meridian are defined together with some small circles and other related matters of spherical astronomy.²⁰⁷ The only numerical value provided in this chapter is the obliquity of the ecliptic given as $23^{\circ} 30' 17''$ by reference to the Samarqand observations sponsored by Ulugh Beg (d. 1449).²⁰⁸

²⁰⁴ An outline of Tūsī's and Shīrāzī's works are given in Livingston, “Naṣir al-Dīn al-Tūsī's *al-Tadhkirah*.” Tūsī's *Tadhkira* is available in Ragep, *Tūsī's Memoir*. For a detailed analysis of Shīrāzī's astronomy see: Kaveh Niazi, *Qūṭb al-Dīn Shīrāzī and the Configuration of the Heavens: A Comparison of Texts and Models* (New York: Springer, 2013), 85–122.

²⁰⁵ al-ʿĀmilī, “Tashrīḥ al-aflāk,” 986 1576, ff. 2r-4v. ‘Total’ celestial spheres are defined by the nearest and furthest distances of the planets from the earth. They contain the partial spheres used to explain the detailed motions of the planets but may not display them. Total spheres are assumed to be contiguous or nesting, with no intervening space between them.

²⁰⁶ al-ʿĀmilī, f. 4v.

²⁰⁷ al-ʿĀmilī, 5r–9r.

²⁰⁸ Aydın Sayılı, *The Observatory in Islam and Its Place in the General History of the Observatory* (Türk Tarih Kurumu Basımevi, 1988), 260–89.

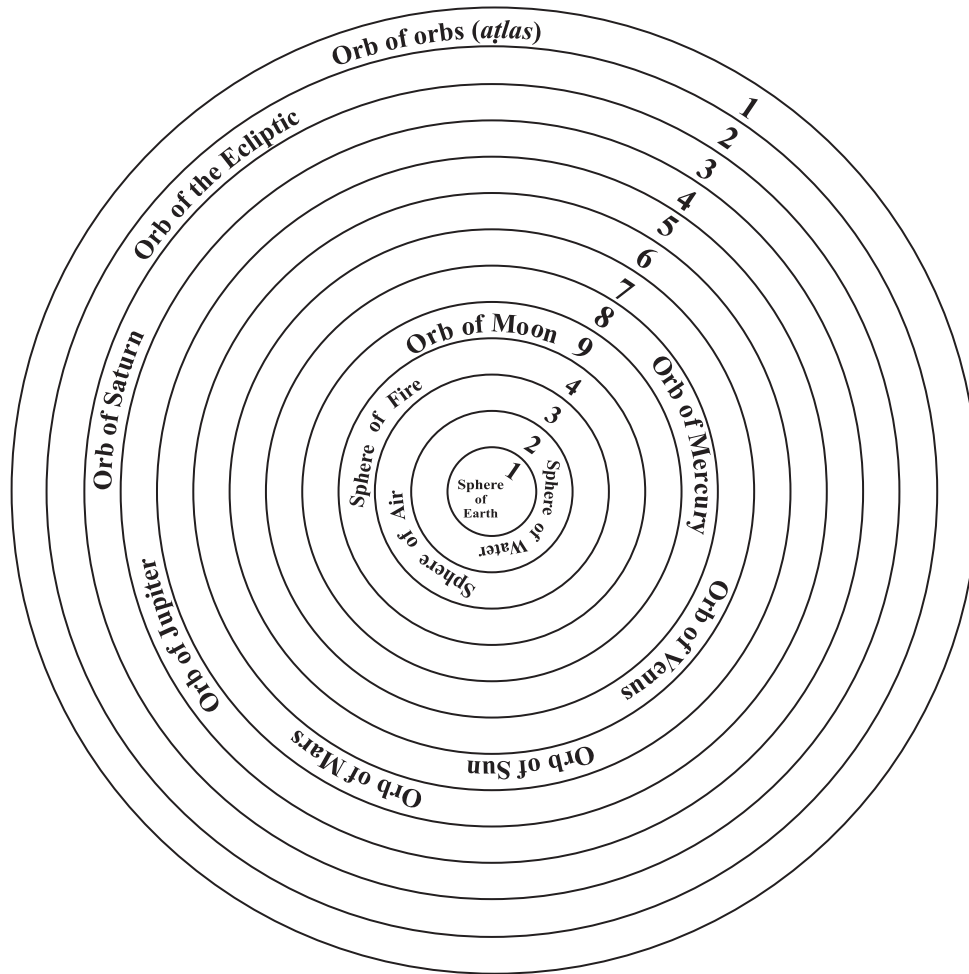


Fig. 3-1. The configuration (*hay'a*) of the total orbs redrawn from the *Dissection of the Orbs*. Each shell represents the parecliptic orb of the planet. In this configuration Venus and Mercury are lower or inferior planets being under the Sun, while Mars, Jupiter and Saturn are upper or superior planets. The whole cosmos is divided by the orb of Moon into the terrestrial and celestial regions. According to Aristotelian physics, no change occurs in the celestial region and all motions in that part of the universe are supposed to be uniform and perpetual.

The construction of the partial orbs of the seven planets along with four diagrams demonstrating the orbs of the Sun, Moon, Venus and the upper planets, and Mercury, are the materials of the second chapter including brief descriptions about their position and order (Fig.

3-2).²⁰⁹ The third chapter deals with the celestial motions, which is usually the most complicated part of *hay'a* books, but not in the *Dissection*. This chapter begins by discussing the rotation of the outermost orb, the ninth orb, and continues inward to the longitudinal motions of the planets above and below the Sun.²¹⁰ 'Āmilī did not include the latitudinal motions of the planets, which was the most complex topic regarding the planetary motions. About half of the chapter is dedicated to the motions of the Sun and the Moon, obviously for their practical use in everyday life and religious calendars. Among the planetary equations, the equation of the Sun is explained with a diagram. The origin of the phases of the Moon and of eclipses, accompanied by illustrations, form the concluding discussion of the third chapter.

In the section dealing with planetary models and motions, 'Āmilī briefly introduced the orbs of each planet along with their motions but abstained from giving more details about the mechanisms of the models. Similar to previous books such as Jaghmīnī's *Mulakhkhaṣ*, 'Āmilī's approach to discussing the orbs' structure is partly based on illustrations of the models. He presented a diagram for each planet showing structures and arrangements of physical orbs (see Fig. 3-2) but did not provide a detailed explanation for the motion of each orb. 'Āmilī's illustrations of the physical orbs is in line with the method applied by both Jaghmīnī and Qūshjī.

Although 'Āmilī did not fully discuss the problems of Ptolemaic astronomy or criticisms of it made by previous Islamicate astronomers, some indications in the text, and more in his *Gloss to the Dissection* (see Chapter 4), show that 'Āmilī, as well as his commentators, were aware of

²⁰⁹ al-'Āmilī, "Tashrīḥ al-aflāk," 986 1576, ff. 9r-10v. Although they were a standard feature of *hay'a*, partial orbs became generally used in European astronomy only after the publication of Georg Peurbach's *Theoricae novae planetarum* at Nuremberg in 1474. See Peter Barker, "The Reality of Peurbach's Orbs: Cosmological Continuity in Fifteenth and Sixteenth Century Astronomy," in *Change and Continuity in Early Modern Cosmology*, ed. Patrick J. Boner (Springer Netherlands, 2011), 7–32. Although by the time of Peurbach Islamicate astronomy had developed much more sophisticated partial orb models than those presented in the *Theoricae novae*, it makes an interesting point of contrast. Peurbach immediately explains the function of every partial orb he introduces. The *Dissection* does not, making it appear even more elementary.

²¹⁰ al-'Āmilī, "Tashrīḥ al-aflāk," 986 1576, ff. 11r-13v.

the critical tradition developed in the works of Marāgha astronomers. In the third chapter of the *Dissection* ‘Āmilī pointed to some problems of the Ptolemaic planetary models and indicated that his Islamic predecessors had proposed solutions to them.²¹¹ For example, he mentioned the non-uniform motion of the deferent orb of the Moon about its center and the equant problem of the upper planets and Venus²¹² and added that the description of those solutions would not be appropriate for a book the size of the *Dissection*.

²¹¹ Cf. George Saliba, *Islamic Science and the Making of the European Renaissance* (MIT Press, 2007), 115–16.

²¹² The equant is a hypothetical point eccentric to the centers of the orbs of the upper planets and Venus. These planets were assumed to move uniformly about the equant although it is not at the geometrical center of their carrying orbs. George Saliba, “Arabic Planetary Theories After the Eleventh Century AD,” in *Encyclopedia of the History of Arabic Science*, ed. Rushdī Rāshid and Régis Morelon, vol. 1 (London; New York: Routledge, 1996), 65–66. This part of the *Dissection* goes considerably beyond anything in the western astronomical tradition before Copernicus. It was problems like the equant, and the other issues mentioned here, that led to the development of sophisticated non-Ptolemaic orb models in the astronomical tradition preceding Bahā’ al-Dīn. See Saliba, *Islamic Science and the Making of the European Renaissance*.

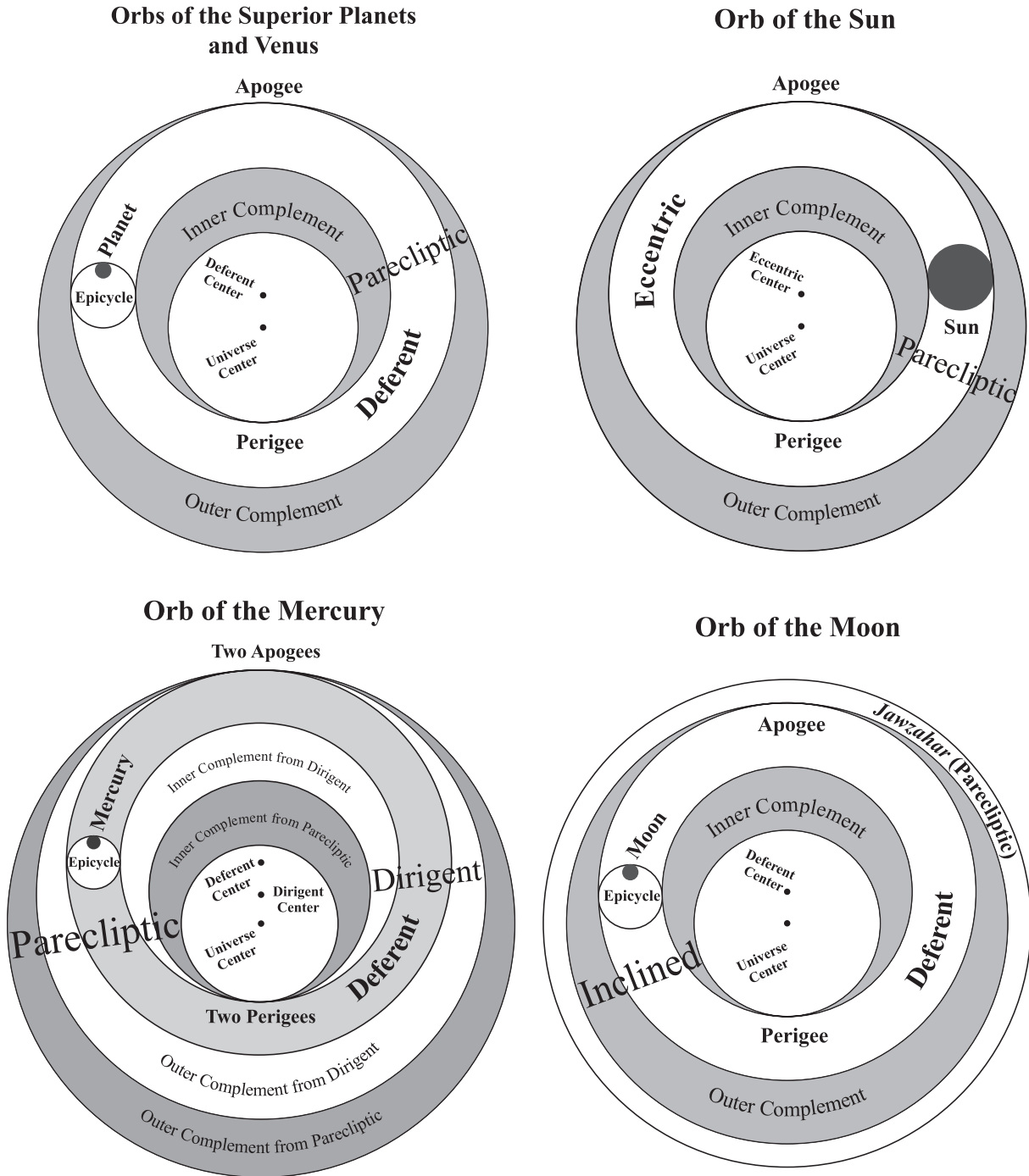


Fig. 3-2. The orbs of the planets redrawn from the *Dissection of the Orbs*. The parecliptic is an orb concentric with the center of the universe. It carries the eccentric or deferent of the planets. In the model of the moon the outer orb, *jawzahar*, has the same function as the parecliptic, producing the motions of the nodes. In the model of Mercury, since Mercury has two perigees, another eccentric orb called the *dirigent* carries the deferent, which itself is carried by the parecliptic.

The fourth chapter presents matters pertaining to the earth. It begins with defining the inhabited world and demarcating the climes, giving both numerical values and a demonstration by a diagram.²¹³ A table appears at the end of this chapter, providing the latitudes of the seven climes, the length of the longest day at the limits and middles of the climes, and the number of giant mountains and important cities specific to each clime.²¹⁴ Chapter five is a very short section on dawn and dusk. This chapter was of practical interests in determining some prayer times.²¹⁵ At the beginning the size of the Sun is mentioned to be $166 + \frac{1}{4}$ of $\frac{1}{8}$ times of the Earth. This value was quoted from Ṭūsī as ‘Āmilī noted in the *Gloss* but differing from what was recorded there as $166 + \frac{1}{4} + \frac{1}{8}$ ²¹⁶ in the *Dissection*. A diagram at the end of the chapter shows the position of the Sun in respect to the Earth at the starting moments of the false dawn (Fig. 3-3).

The last part of the *Dissection*, the ending (*khātima*) or epilogue, deals with finding the meridian line and the *qibla* direction of a given locality by two methods. One finds the *qibla* by the method of the “Indian Circle” (*al-dā’ira al-hindiyya*), a circle drawn on a flat horizontal surface with a gnomon fixed perpendicular to its center,²¹⁷ and the other by an astrolabe.²¹⁸

In the *Dissection* ‘Āmilī did not discuss legal issues of the *qibla*, but treated that topic in two of his other writings: once in his short undated treatise on *qibla*,²¹⁹ and the other, much longer than the former, in his extensive work on Shiite creed the *Ḥabl al-matīn*, completed on 18 Shawwāl 1007/4 May 1599 in Mashhad.²²⁰ Although, the main discussion in the *Ḥabl al-matīn* is

²¹³ al-‘Āmilī, “Tashrīḥ al-aflāk,” 986 1576, ff. 14r-16v.

²¹⁴ al-‘Āmilī, f. 17r.

²¹⁵ al-‘Āmilī, ff. 16v, 18r-18v.

²¹⁶ Ragep, *Ṭūsī’s Memoir*, 1: 327.

²¹⁷ al-‘Āmilī, “Tashrīḥ al-aflāk,” 986 1576, ff. 19r-20v.

²¹⁸ al-‘Āmilī, ff. 20v-22r.

²¹⁹ This treatise has been published in a modern edition with an introduction. Bahā’ al-Dīn al-‘Āmilī, “Jahat al-qibla,” ed. Hadi Hasan al-Qabisi al-Amili, *Turāthunā* 11, no. 1–2 (1996): 405–39.

²²⁰ al-‘Āmilī, *al-Ḥabl al-matīn*, 2: 227-59; Āqābuzurg Tehrānī, *al-Dharī’a*, 6:240-41.

on legal matters, a brief description of astronomical methods for determining the *qibla* bearing is quoted from Ṭūsī's *Tadhkira*.²²¹ In his *Gloss to the Dissection*, 'Āmilī expanded the discussion²²² and wrote that among several methods provided for determining the *qibla* bearing, the jurists only considered and explained the method of the Indian Circle.²²³

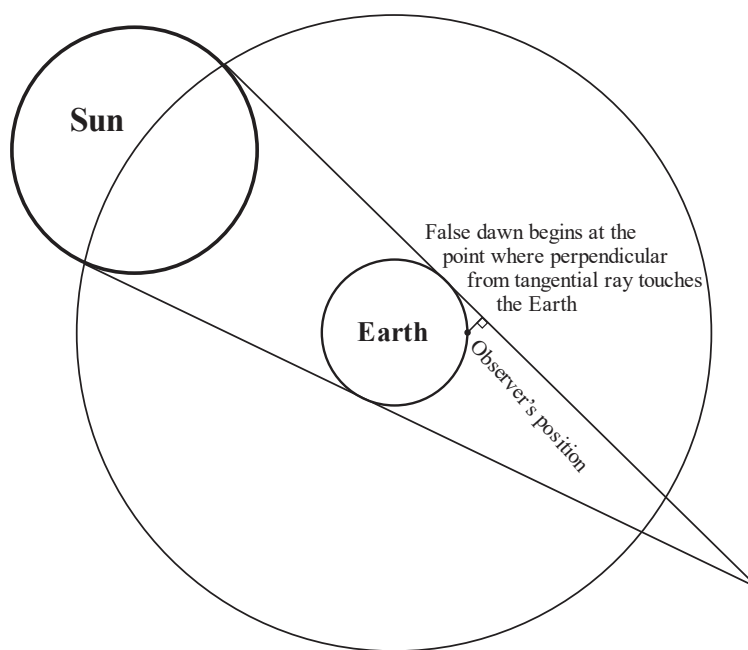


Fig. 3-3. Diagram for the starting moment of the false dawn redrawn from the *Dissection of the Orbs*.²²⁴

'Āmilī, however, did not compose the *Dissection* from scratch; he borrowed some materials from Qūshjī's (d. 1474) *Risāla*. A close comparison between the two texts shows that 'Āmilī not only made Arabic translations of some of Qūshjī's Persian sentences, but also summarized the content by dropping further explanations. His abridgment of the *Risāla* is very similar to an Arabic epitome of the text. The following table gives a few examples of 'Āmilī's translations and

²²¹ al-'Āmilī, *al-Ḥabl al-matīn*, 2:247-251. Cf. Ragep, *Ṭūsī's Memoir*, 1:309.

²²² al-'Āmilī, "Ḥāshiya (Gloss 1689)," ff. 20v-25r. Subsequently referred to as "Gloss."

²²³ al-'Āmilī, ff. 20v-21r.

²²⁴ Cf. Ragep, *Ṭūsī's Memoir*, 1:295-299.

summaries from Qūshjī, an excerpt of what is found on many pages of the *Dissection*. However, ‘Āmilī treated some topics in a completely different way than Qūshjī. For example, ‘Āmilī begins chapter five of the *Dissection*, corresponding to section eight of the book two in the *Risāla* (see

Table 3-2), with the relative sizes of the Sun and Earth then gives a different definition for the false dawn along with a diagram (Fig. 3-3) which are all absent in the *Risāla*.

Table 3-1. Excerpts from the *Dissection* translated from Qūshjī's *Risāla dar hay'at*

Qūshjī's <i>Risāla dar hay'at</i>	'Āmilī's <i>Dissection of the Orbs</i>
باب چهارم در هیأت افلاک کواکب هفتگانه که سیاره خوانند. آفتاب را دو فلک است هر دو متوازی السطحین، یکی را ممثل گویند مرکزش مرکز عالم بود و منطقه‌اش در سطح منطقه البروج و دیگری را خارج مرکز گویند و او در داخل ثخن این ممثل بود مرکزش نقطه‌ای بود غیر مرکز عالم لیکن منطقه‌اش در سطح منطقه البروج بود و سطح محدب او مماس محدب ممثل بود بر نقطه‌ای مشترک و آن را اوج گویند و مقعرش نیز مماس مقعر ممثل بود بر نقطه مشترک و آن را حسیض گویند. و لامحاله از ممثل بعد از افراز خارج مرکز دو کره مختلفه الثخن باقی ماند یکی محیط به خارج مرکز و دیگری محاط خارج مرکز و رقت حاوی از جانب اوج بود و غلظش از جانب حسیض و رقت و غلظ محوی بر عکس. و این دو کره را دو متمم گویند. و شمس جرمی بود کروی مُصمّت مرکوز در ثخن فلک خارج مرکز چنانچه سطح او مماس هر دو سطح خارج مرکز شود به دو نقطه.	الفصل الثاني في صور أفلاك السبع السيارة. فلک الشمس جرمٌ كروي متوازي السطحين مركزه مركز العالم ممثلاً بفلک البروج في المنطقة والقطبين وفي ثخنه آخر مثله خارج المركز يماس محدبه محدب الأول (و٩) على نقطة الأوج ومقعره مقعره على نقطة الحسیض. يفصل عنه بهتممين متدرجي الثخن إلى غاية هي ضعف ما بين المركزين. والشمس مركوزة في ثخن الخارج عند منتصف ما بين قطبيه مماسة لسطحيه على نقطتين.

Qūshjī's <i>Risāla dar hay'at</i>	'Āmilī's <i>Dissection of the Orbs</i>
Section four on the <i>hay'a</i> of the orbs of the seven stars which are called planets. The Sun has two orbs both with parallel surfaces, one called the parecliptic and its center is the center of the universe and its equator on the surface of the equator of the ecliptic, and the other called eccentric which is inside the thickness of this parecliptic. Its center is a point other than the center of the universe, but its equator is on the surface of the equator of the ecliptic. And its concave surface is tangent to the concave [surface] of the parecliptic at a common point called the apogee, and its convex [surface] is also tangent to the convex [surface] of the parecliptic at a common point called perigee. Indeed, after removing the eccentric from the parecliptic remain two spheres different in thicknesses, one circumscribing the eccentric and the other circumscribed in the eccentric. And the thinner part of the circumscribing one is adjacent to the apogee and its thicker part adjacent to the perigee, and vice versa for the thinner and thicker parts of the circumscribed. These two spheres are called complementary. And the Sun is a solid, spherical body centered in the thickness of the eccentric orb in such a way that its surface is tangent to both surfaces of that [the eccentric] at two points.	Chapter two on the illustrations of the orbs of the seven planets. The orb of the Sun is a spherical body with two parallel surfaces. Its center is the center of the universe, [and is] similar to the ecliptic having the same equator and poles. In its thickness there is another orb [which is] eccentric and similar to it whose convex [surface] touches the convex [surface] of the first at the apogee point and its concave [surface] touches the concave [surface] of it at the perigee point. Thus it [the eccentric] separates from that by two complementary [bodies] having gradual thickness to the amount of the double distance between the two centers [of the universe and the ecliptic]. And the Sun is centered in the thickness of the eccentric at the middle point between its [own] poles, tangent to its two surfaces at two points.
و هیأت فلک عطارد از هیأت افلاک کواکب چهارگانه به دو چیز تفاوت دارد. یکی آن که در عطارد فلکی که حامل در ثخن اوست آن را مُدیر گویند، مرکزش مرکز عالم نیست و منطقه‌اش در سطح منطقه البروج نی؛ بلکه با حامل در یک سطح‌اند.	وفلك عطارد كالعلوية أيضاً إلا أنّ مركز الفلك الحاوي لحامله وهو المدير غير مركز العالم ومنطقته ليست في سطح منطقة البروج (١٠و) بل مع منطقة الحامل في سطح واحد والمدير في ثخن ممثّل كالحامل في ثخنه. وهذه صور الأفلاك.

Qūshjī's <i>Risāla dar hay'at</i>	'Āmilī's <i>Dissection of the Orbs</i>
دوم آنکه عطارد را فلکی دگر است که مدیر در ثخن اوست به همان طریقه که حامل در ثخن مدیر است، یعنی محدب مماس محدب بر نقطه مشترکه و همچنین مقعر مماس مقعر. و مرکز عالم است و منطقه اش در سطح منطقه البروج است و این فلک را ممثل عطارد گویند. و لامحاله عطارد را دو اوج باشد یکی مشترک میان ممثل و مدیر و آن را اوج مدیر گویند و دیگری مشترک میان مدیر و حامل و آن را اوج حامل گویند. و دو حضيض به همین طریقه. و صورت افلاک به حسب تسطیح بر این گونه باشد.	
And the configuration of the orb of the Mercury differs from the configuration of the orbs of the four planets in two things. One is that for Mercury the orb which the deferent is in its thickness is called dirigent. Its [the dirigent's] center is not the center of the universe and its equator is not on the surface of the ecliptic equator; rather is on the same surface with the deferent. Second [difference is] that Mercury has another orb which the dirigent is in its thickness in likewise the deferent is in the thickness of the dirigent, i.e. the convex [surface] being tangent to the convex [surface] at the common point, and the concave [surface] tangent to the concave [surface]. And its center is the center of the universe and its equator on the surface of the ecliptic equator and this orb is called the parecliptic of Mercury. And indeed, Mercury has two apogees, one common between the parecliptic and the dirigent called the dirigent apogee, and the other common between the dirigent and the deferent called the deferent apogee. And likewise, [Mercury has] two perigees. And the illustration of the orbs considered on a plane surface is in this way.	And the orb of Mercury is also similar to the [orbs of] upper [planets] except for the center of the orb circumscribing its deferent orb, that is the dirigent, is other than the center of the universe and its [the dirigent's] equator is not on the surface of the ecliptic equator, rather it is on the same plane with the equator of the deferent. And the dirigent is in the thickness of the parecliptic like the deferent in its thickness. And these are the illustrations of the orbs.

Apart from the *Risāla* ‘Āmilī had other options at hand as a source for the *Dissection*. He wrote two super-commentaries on Jaghmīnī’s *al-Mulakhkhaṣ*, another simple book on *hay’a* which was also circulated in numerous copies.²²⁵ However, the *Risāla* and *Mulakhkhaṣ* share several similarities both in terms of organization and subject matter. They applied the general dichotomy of topics into celestial and terrestrial parts, accompanied with basic materials in the introduction. However, ‘Āmilī does not follow this organization in the *Dissection*, and instead is very selective on topics. We can say he condensed the book to the bare essentials of *hay’a*. The simple comparison presented in the

²²⁵ Sally P. Ragep, *Jaghmīnī’s Mulakhkhaṣ*, esp. 1-5, 284-291.

Table 3-2 better shows how the *Mulakhkhaṣ* and *Risāla* were organized, though a close reading of both reveals much more similarities in terms of contents.²²⁶

The above discussion clearly shows how simple the *Dissection* was and it was probably for this reason that the book appealed to a huge number of students and teachers as an introductory textbook on ‘ilm al-hay’a. However, this does not fully answer why it was preferred to other available simple books of the same genre and almost ended the use of previous similar works. The answer to this question needs other factors regarding the publication of the book, which are first the political and social circumstances under which ‘Āmilī decided to write the *Dissection*, and second, the author’s relations to the Safavid court and his powerful position of the chief jurisconsult of the whole empire. In addition, ‘Āmilī’s own *Gloss to the Dissection*, an attempt to make the book more appropriate for education, should be considered an effective step for initiating a new commentary tradition on the book.

3.2 Dedications and Patronage

‘Āmilī lived during the reigns of four Safavid shahs. His family migrated to Persia from Jabal ‘Āmil in southern Lebanon, then a region under the control of the Ottomans, in the reign of the second Safavid shah Ṭahmāsb I (r. 1524-76). ‘Āmilī’s father Ḥusayn ibn ‘Abd al-Ṣamad, then a qualified Shiite jurist, moved his family to Persia in 1554 when ‘Āmilī was only seven years old, in order to find an appropriate place for his religious career. Ḥusayn ibn ‘Abd al-Ṣamad soon attended the court of Ṭahmāsb I in Qazvin and became the first Safavid *shaykh al-islām* (chief

²²⁶ Except for the *Mulakhkhaṣ* the other two books do not have a modern edition, but a rough comparison regarding their lengths gives us some idea. The *Mulakhkhaṣ* is about 90 pages in the edited version, the *Risāla* is about 59 pages in a lithograph edition consisting of seventeen lines per page, and the oldest manuscript copy of the *Dissection* is in 41 pages having nine lines per page. ‘Āmilī’s own *Gloss to the Dissection* is also available in numerous copies. One of manuscript copies having 12 lines per page is 49 pages long. ‘Alī ibn Muḥammad Qūshjī, *Risāla dar hay’at* (Tehran, 1874); al-‘Āmilī, “Tashrīḥ al-aflāk,” 986 1576; al-‘Āmilī, “Ḥāshiya (Gloss 1689),” fols. 1r-25r.

jurisconsult) in the whole empire. Until ‘Abbās I (r. 1587-1626), the fourth Safavid shah, succeeded the throne and appointed ‘Āmilī to the same position his father had held, ‘Āmilī did not achieve a high political position. From the time Ṭahmāsb I (r. 1524-76) removed ‘Āmilī’s father from the office of *shaykh al-islām* of the capital Qazvin, ‘Āmilī faced setbacks in his career. He suffered much in the last decade of Ṭahmāsb’s reign. At the same time ‘Āmilī began a campaign to regain Ṭahmāsb’s favor and attract his patronage by dedicating books to him. He pursued the same plan in the reigns of the three subsequent shahs, Ismā‘īl II, Khudābanda, and ‘Abbās I. The first dedication to Ṭahmāsb, was the *Tuḥfa* (*The Gift*), a Persian work on measuring volumes of water for religious purposes in twelve chapters. The Arabic recension of the *Tuḥfa* entitled *al-Kuriya* and dated early Shawwāl 983/January 1576 in Qazvin was also dedicated to Ṭahmāsb, right at the time the shah denied ‘Āmilī permission to accompany his father on the pilgrimage to Mecca (see Introduction). A copy of the *Tuḥfa* kept in the Oriental Public Library at Bankipore mentions Ṭahmāsb as the dedicatee²²⁷ but other copies mention Ṭahmāsb’s son Khudābanda.²²⁸ The recorded composition date of the *Tuḥfa* is 985/1587,²²⁹ the same year in which Ṭahmāsb’s other son and successor Ismā‘īl II died and Khudābanda succeeded the throne. Based on these accounts, ‘Āmilī changed the dedication of the *Tuḥfa* from Ṭahmāsb to Khudābanda as he did in the *Dissection*.

Another, and apparently more effective dedication, was the *Dissection of the Orbs*. The composition date of the *Dissection* was not mentioned by the author, but the dedications give us some clues. The extant copies show that the book was dedicated to the four Safavid shahs

²²⁷ Maulavi Abul Muqtadir, *Catalogue of the Arabic and Persian Manuscripts in the Oriental Public Library at Bankipore*, vol. XVII (Calcutta, 1930), 173–74.

²²⁸ Bahā’ al-Dīn al-‘Āmilī, “*Tuḥfa*” (Tehran, Parliament Library, MS 1231, 1624); “*Tuḥfa*,” n.d.; Āqābuzurg Tehrānī, *al-Dharī‘a*, 3:402, 17:288.

²²⁹ Āqābuzurg Tehrānī, *al-Dharī‘a*, 23:321.

already mentioned. First it was dedicated to Ṭahmāsb I (r. 1524-1576),²³⁰ then to his son Ismā‘īl II (r. 1576-1578)²³¹ whose reign only lasted a year and half. After that it was rededicated to Ismā‘īl’s brother and successor Muḥammad Khudābanda (r. 1578-1587),²³² and finally to the most powerful of the Safavid shahs ‘Abbās I (r. 1587–1629).²³³ Comparing copies with the four dedications, no differences appear in the contents or structure of the book, except for two minor changes in the copies dedicated to ‘Abbās I. One is a sentence in finding the *qibla* by the method of the Indian circle that ‘Āmilī added a phrase to it in later copies, and the other is the very last sentence of the treatise which is absent in earlier copies but does not include any technical matter. The following sentences show the slight difference between the two versions:

Copies dedicated to Ṭahmāsb I and Ismā‘īl II	Copies dedicated to Khudābanda and ‘Abbās
وقد يقرب من التحقيق إن عمل في يوم يكون الشمس نصف نهار وفي المنقلب إتحد مدارها في حالتين. MS Parliament 6702, fol. 6v. MS Melli 19154, fol. 17v.	وقد يقرب من التحقيق إن عمل والشمس في المنقلب [20r] الصيفي أو قربه وإن عمل في يوم تكون الشمس نصف نهاره في المنقلب إتحد مدارها في حالتين. MS Malik 3128, fols. 19v-20r.
هذا ما غفلت عنه عوائق الزمان ولم يتنبه له طوارق الحدثان. MS Melli 19154, fol. 19v.	<i>Missing</i>

None of these minor changes proves that there are two versions of the *Dissection*, but they at least indicate that ‘Āmilī reviewed the book before dedicating it to ‘Abbās. Many other available copies have no dedicatory letter, and their introduction begins right after the epigraph. The oldest surviving copy of the *Dissection*, made by ‘Abd al-Fattāḥ Mas‘ūd al-Sharīf for a certain al-Sayyid Sa‘īd, was dedicated to Khudābanda on 11 Rabī‘ II of 986/17 June of 1578, about four months after Khudābanda’s coronation in Qazvin.²³⁴ The existing documentary evidence does not let me determine an exact date for the composition of the *Dissection*, but the *Dissection* must

²³⁰ Bahā’ al-Dīn Muḥammad al-‘Āmilī, “Tashrīḥ al-aflāk” (Tehran, National Library, MS 19154, 1263/1847).

²³¹ MSS Berlin 5707, MS Parliament 6270 (Tehran), and MS Melli 2472-42 (Tehran) have Ismā‘īl as the dedicatee.

²³² al-‘Āmilī, “Tashrīḥ al-aflāk,” 986 1576. Subsequently referred to “Dissection 1576.”

²³³ al-‘Āmilī, “Tashrīḥ al-aflāk,” n.d.

²³⁴ al-‘Āmilī, “Tashrīḥ al-aflāk,” 986 1576. Khudābanda’s coronation was on 3 Dhul ḥajj 985/11 February 1578.

have been written towards the end of Ṭahmāsb's reign, most probably sometime between 971/1564 and 983/1575 when 'Āmilī's father was serving as *shaykh al-islām* in Herat. On 2 Rajab 971/15 February 1564 in Mashhad (NE Iran), 'Āmilī's father issued an *ijāza*²³⁵ to him and his younger brother.²³⁶ Receiving an *ijāza* from a former high rank jurist was a crucial step in establishing the credibility of 'Āmilī and his competence in the sciences. It seems unlikely that 'Āmilī would have written either the *Tuhfa* or the *Dissection* before he acquired his first *ijāza* in 971/1564. He presumably dedicated both works to Ṭahmāsb sometime between 971/1564 and 983/1575-76, during his residence in Qazvin while his father was in Herat.

The *Dissection* was successively rededicated to subsequent rulers, yet no changes were made in the dedicatory letter in the different versions of the text: identical veneration and praises were written to Ṭahmāsb I, Ismā'īl II, Khudābanda, and 'Abbās I. However, among these dedications the one to Ismā'īl II is different in some regards. In contrast to the other three shahs who strongly supported Shi'ism and Shi'ite jurists, in many respects Ismā'īl showed pro-Sunni inclinations. He appointed his Sunni former teacher Mīrzā Makhdūm Sharīfī as the grand vizier, who after Ismā'īl's death fled to the Ottoman Empire.²³⁷ Ismā'īl had several disagreements with the Shiite *ulamā'* of Qazvin and Qizilbāsh leaders on issues such as the uniquely Shia ceremony of 'cursing the caliphs', as well as the status of Friday prayers, and the inscriptions on imperial coins. All these actions by Ismā'īl spread suspicions that he had converted to Sunnism.²³⁸ In spite of all these negative characteristics that Ismā'īl showed, 'Āmilī rededicated the *Dissection* to the

²³⁵ An *ijāza* is generally a license for teaching or transmitting scientific knowledge granted by a master to a disciple. For the definition and concept of *ijāza* see: Idriz, "From a Local Tradition to a Universal Practice"; Makdisi, *The Rise of Humanism in Classical Islam and the Christian West*, 140; Vajda and Goldziher, "Idjāzah." And for the role of *ijāza* in Islamic education see: Peter Barker, "The Social Structure of Islamic Science," *Journal of World Philosophies* 2, no. 2 (2017).

²³⁶ Stewart, "The First Shaykh al-Islām," 393, n. 52.

²³⁷ Gholsorkhi, "Ismail II and Mirza Makhdum Sharifi," 478, on the date of this see note 10.

²³⁸ Iskandar Beg Munshī, *Tārīkh-e 'ālam-ārāy-e 'Abbāsī*, 1:214-17; *The history of Shah 'Abbas*, 1:319-25; Stewart, "The Lost Biography of Baha' al-Din al-'Āmilī," 180-86.

shah and had an audience with him in Qazvin in early Ramaḍān 985/November 1577. Moreover, as will be discussed below ‘Āmilī’s knowledge and his competence in the sciences were also recognized by the new shah.

Ismā‘īl had interests and knowledge in arts and sciences, especially astrology, and patronized several projects.²³⁹ In the course of his coronation, Ismā‘īl camped some days out of Qazvin waiting for astrologers to find an auspicious moment for performing the coronation ceremony. Ismā‘īl entered Qazvin on 17 Rabī‘ I 984/14 June 1576,²⁴⁰ but based on astrologers’ predictions he postponed his coronation until the auspicious date 27 Jumāda I 984/22 August 1576.²⁴¹ In the last months of Ismā‘īl’s reign in 985/1577 a comet²⁴² appeared in the sky and the shah, who had knowledge of astrology,²⁴³ became anxious about the phenomenon. He summoned astronomers to consult about the comet’s influence on his fate. Ismā‘īl had already surmised the fall of his reign, but the astronomers gave him some comfort by concluding that since the tail of the comet pointed to the west, its major influence would be on the Ottomans and Europe.²⁴⁴ Iskandar Beg, who reported the event (see Chapter 2), did not specify the name of those astrologers who consulted the shah over the appearance of the comet, but ‘Āmilī, in his long super-commentary on Jaghmīnī’s *Mulakhkhaṣ*, reported his audience with Ismā‘īl II in the third night after the comet appeared. At the meeting, Ismā‘īl explained his deep anxiety about the phenomenon and

²³⁹ Iskandar Beg Munshī, *Tārīkh-e ‘ālam-ārāy-e ‘Abbāsī*, 1:217; *The history of Shah ‘Abbas*, 1:325; Newman, *Safavid Iran*, 47–48; Gholsorkhi, “Ismail II and Mirza Makhdum Sharifi,” 479.

²⁴⁰ Qumī, *Khulāṣa al-tavārīkh*, 2:618-19.

²⁴¹ Qumī, 2:625-26.

²⁴² This was the famous comet that appeared during 13 November 1577-26 January 1578/2 Ramaḍān-17 Dhu al-Qa‘da 985 observed by several astronomers like Tycho Brahe (1546-1601), Taqī al-Dīn Ma‘rūf (1526-1585) and others. Brahe provided observational details and recorded its motion as three and half degrees in twenty-four hours in the beginning, but decreasing gradually until it eventually disappeared within a month. Heidarzadeh, *A History of Physical Theories of Comets, from Aristotle to Whipple*, 41; Seargent, *The Greatest Comets in History*, 104–9. NASA, Jet Propulsion Laboratory, <https://ssd.jpl.nasa.gov/horizons.cgi#results>.

²⁴³ Qumī, *Khulāṣa al-tavārīkh*, 2:625.

²⁴⁴ Iskandar Beg Munshī, *Tārīkh-e ‘ālam-ārāy-e ‘Abbāsī*, 1:217-18; *The history of Shah ‘Abbas*, 1:325.

surmised that it indicated the decline of his reign. However, ‘Āmilī tried to give the shah some relief by arguing that astrologers’ interpretations are not reliable and even if they come true, we may hope the comet’s influence occurs somewhere else outside Persia (more about this in Chapter 2).

According to the chronicles, ‘Āmilī’s report about the comet of 1577 is the only record that tells us he met Ismā‘īl II in Qazvin.²⁴⁵ The sources do not tell us how long ‘Āmilī stayed in Qazvin, but since Ismā‘īl’s reign was short, he probably did not have many chances to have an audience with the shah, and so rededicated his book an astronomy, the *Dissection of the Orbs*, when Ismā‘īl summoned him about the comet (see Chapter 2). However, throughout Ismā‘īl II’s reign ‘Āmilī continued to serve as the *shaykh al-islām* of Isfahan, a position the shah controlled, and a further indication of his favor.

Throughout the reigns of Ismā‘īl II (r. 1576-78) and Khudābanda (r. 1578-87) ‘Āmilī continued to serve as the *shaykh al-islām* of Isfahan, a position the shah controlled and an indication of his favor. In 990/1582-83 in Isfahan, ‘Āmilī completed his first short super-commentary (addendum: *ta’līq*, or *sharḥ*) on Qāḍīzāda al-Rūmī’s commentary on Jaghmīnī’s *al-Mulakhkhaṣ*.²⁴⁶ In the introduction of the treatise ‘Āmilī described the intellectual milieu and his frustrations in several allegorical expressions. He lamented that the rank of the companions

²⁴⁵ Cf. Devin J. Stewart, “The Lost Biography of Baha’ al-Din al-‘Āmili and the Reign of Shah Isma‘il II in Safavid Historiography,” *Iranian Studies* 31, no. 2 (June 1, 1998): 189.

²⁴⁶ al-‘Āmilī, *Risālah fī taḍārīs al-‘arḍ*. There are two super-commentaries on Jaghmīnī’s *Mulakhkhaṣ* by ‘Āmilī. The first and the short one mentioned above is on the ratio of the height of the largest mountain to the diameter of the Earth, one of the topics discussed in the *Mulakhkhaṣ*. The second super-commentary which is longer covers almost all topics in the *Mulakhkhaṣ* and is dedicated to ‘Abbās I (Ms Parliament 14738). Most of the manuscript copies of the first super-commentary bear the title *Fī taḍārīs al-‘arḍ* (*On the Ripples of the Earth*). *Fī taḍārīs al-‘arḍ* was published together with Qāḍīzāda al-Rūmī’s commentary in Dhil Hajja 1311/June 1894 in Tehran. Some recent studies, apparently, recorded the month of the publication date (p. 22) as the composition date while the author did not specify the month (Devin J. Stewart, “The Lost Biography of Baha’ al-Din al-‘Āmili and the Reign of Shah Isma‘il II in Safavid Historiography,” *Iranian Studies* 31, no. 2 (June 1, 1998): 188; Mohammad-Kazem Rahmati, “Sālshomāre zendegī va ta’līfāte Sheykh Bahāyī,” *Jurisprudence & Law Quarterly Book Review* 1, no. 2 (June 22, 2015): 248).

of erudition (*ahl al-faḍl*) was being denigrated to the utmost degree, the market of science (*‘ilm*) was stagnant, and its commodity corrupted, scientific books were abandoned and obsolete, scientific ideas were contradictory, and schools and learned circles were ineffective. As he put it, the companions of ignorance were deriding the supporters and seekers of science.²⁴⁷ ‘Āmilī did not write anything about the origins of this situation, however, the torment and marginalization experienced by him, and probably by his fellows and disciples, could only have been caused by the powerful adversaries who had already established firm associations with the court and controlled key positions and offices. A prominent jurist, Mīr Ḥusayn al-Karakī, had a key role in the dismissal of ‘Āmilī’s father from his former office of *shaykh al-islām* at the court of Ṭahmāsb I (see Introduction).²⁴⁸ Mīr Ḥusayn turned Ṭahmāsb’s mind against ‘Āmilī’s father and finally replaced him as *shaykh al-islām* of the capital Qazvin until his death in 1001/1592-93. ‘Āmilī was obliged to stay in Qazvin while Ṭahmāsb had sent his father to the far eastern region of the Empire in Herat.

During the reigns of Ismā‘īl II and Khudābanda, although ‘Āmilī failed to join the court, he retained his position in Isfahan. At this time, ‘Āmilī did continue his dedications of scientific books to Safavid princes and courtiers. In extant manuscript copies of ‘Āmilī’s most important book on mathematics, the *Khulāṣa al-ḥisāb* (*Quintessence of Arithmetic*), three people appear as dedicatees. First, it was dedicated to Sulṭān Ḥasan, then to Sulṭān Ḥamza, and finally to ‘Abbās I. Sulṭān Ḥasan was the eldest among the sons of Khudābanda who was murdered in Tehran by Ismā‘īl II’s order. His three brothers together with their father had escaped the eliminations of

²⁴⁷ al-‘Āmilī, *Risālah fī taḍārīs al-‘arḍ*, 3.

لا يزال يرفع قدر الجاهلين ويخفض رتبة أهل الفضل إلى أسفل السافلين. سوق العلم فيه كاسد ومتاعه فاسد وكتبه مهجورة وزبره مستورة وآياته مندرسة وراياته منعكسة ومدارسه باطلة ومجالسه عاطلة وخادمه ذليل وناصره قليل لكن الجهل بضاعته نايقة وأعلامه خافضة ومواطنه مشهورة ومعاطنه محمودة ومنازله عامرة ومنازل غامرة وأصحابه مكرمون وأربابه معظمون ويسخرون من الفضل وأصحابه ويستهنؤون بالعلم وطلابه

²⁴⁸ Stewart, “The First Shaykh al-Islām,” esp. 394-96.

princes ordered by Ismā‘īl II.²⁴⁹ Less than two years after Khudābanda’s ascension, in 1579, a tribal alliance declared his eleven-year-old son Ḥamza (b. 1566-67) crown prince. He was older than Prince ‘Abbās but had the same mother Khayr al-Nisā’. This occurred shortly after Khayr al-Nisā’ was strangled in the Haram by conspiracy of some Qizilbash amirs.²⁵⁰ However, Ḥamza did not live long and his assassination in 994/1586 in a camp set up to confront Ottoman incursions, paved the way for Prince ‘Abbās to succeed Khudābanda.²⁵¹ The time of the first dedication is not known to us, but it must have been before 1579 that ‘Āmilī wrote the *Khulāṣa* for Sulṭān Ḥasan, and then rededicated it to Ḥamza and after Ḥamza’s death to ‘Abbās I.

‘Āmilī’s patronage campaign, if not successful at the highest level, apparently enabled him to protect the status he had already gained until the abdication of Khudābanda in 1587. ‘Āmilī held the office of *shaykh al-islām* in Isfahan until 1001/1592-93, in the reign of ‘Abbās I, when he became the *shaykh al-islām* of the capital Qazvin, and thus acquired the highest legal position in the Safavid Empire.²⁵² As I discussed in Chapter 1, a preliminary indication of his new patronage status under ‘Abbās is his use as a diplomat. During the reign of ‘Abbās I, ‘Āmilī became an intellectual authority in the empire, contributing major works in theology and law, as well as training students in the rational sciences and writing scientific works including the long super-commentary on Jaghmīnī’s *Mulakhkhaṣ* and the *Gloss* on the *Dissection*.

²⁴⁹ Roemer, “The Safavid Period,” 253.

²⁵⁰ Roemer, 255; Newman, *Safavid Iran*, 42.

²⁵¹ Roemer, “The Safavid Period,” 260–61; Newman, *Safavid Iran*, 43.

²⁵² Stewart, “The Lost Biography of Baha’ al-Din al-‘Āmilī,” 193. For an analysis of ‘Āmilī’s multiple roles at the court of ‘Abbās I see: Abisaab, “The Ropes of Royal Tents: Shaykh Bahā’i and the Imperial Order of Shah ‘Abbas (996-1038/1587-1629).”

3.3 Author's *Gloss* and other commentaries on the *Dissection*

About twenty years after composing the *Dissection*, no earlier than Jumada II 1003/February 1595, 'Āmilī completed a lengthy gloss to it (see Chapter 4). He added geometrical demonstrations and expanded many discussions, referring to earlier works and authors as well as raising objections to some of them. The *Gloss* is significantly longer than the *Dissection* and often exists in one binding either with the *Dissection* or with lengthy commentaries on it or other works of 'Āmilī.²⁵³ The *Gloss* sometimes appears as marginal notes to copies of the main text. In addition to circulation in manuscript the *Gloss* was also published separately in 1276/1859 in Tehran.²⁵⁴ The copyists of the *Gloss* did not mention the date it was made. Nor is there any indication in the text as to whether the *Gloss* had been made at different times or at one sitting. But, since 'Āmilī referred to some of his earlier compositions in the *Gloss* we can conclude that it was written after 1595 and completed not later than 1599 (see Chapter 4). The *Gloss* inspired numerous commentaries on the *Dissection*, all of which also incorporated the *Gloss* in their texts but discussed more topics or higher-level materials that 'Āmilī had not touched upon. Until early in the nineteenth century about forty-six commentaries and glosses were made upon the *Dissection* besides a translation into Persian and Ottoman Turkish in the Safavid, Ottoman, and Mughal empires (see Chapter 5). Āqābuzurg Tehrānī (Muḥammad Muḥsin, 1876-1970) and 'Abd al-Ḥusayn Amīnī (1902-1970) recorded many commentaries and glosses on the *Dissection* including the author's own.²⁵⁵ Most of the commentaries and glosses were made after the

²⁵³ See e.g. MSS Parliament 16135, 6345, and 3280.

²⁵⁴ Bahā' al-Dīn al-'Āmilī, *Ḥāshīya Tashrīḥ al-aflāk* (Tehran, 1859).

²⁵⁵ A recent study on 'Āmilī's works recorded these commentaries mostly from Āqābuzurg Tehrānī along with some anonymous ones. Najī-Nasrabadi, *Ketābshenāsīye Sheykh Bahā'ī*. Āqābuzurg Tehrānī, *al-Dharī'a*, 4:186-87, 13:146-49; Amīnī, *al-Ghadīr*, 11:348-49; Najī-Nasrabadi, *Ketābshenāsīye Sheykh Bahā'ī*, 187-202.

author's death in 1030/1621 and in later centuries and none is reported to predate 'Āmilī's own *Gloss*.

Some commentaries were made by 'Āmilī's disciples and some by later scholars in multiple locations. As shown in Chapter 5, there are commentaries written in Qazvin, Qum, Mashhad, Isfahan, Agra and Saharanpur (both in N. India), and Basra (Iraq) of which some were printed several times in Pakistan, Delhi, Qandahar, and Bengal. Two of the most extensive ones were made by the author's students during his lifetime, the first by Muḥammad-Kāẓim Tunikābunī in Dhil-Ḥajj 1007/June-July 1599 for 'Abbās I, and the other by Shams al-Dīn 'Alī ibn Muḥammad ibn 'Alī al-Ḥusaynī al-Khalkhālī at the end of Ṣafar 1008/10-11 September 1599 in Agra (India).²⁵⁶ A comparison between the commentary traditions upon the *Dissection* with those upon Jaghmīnī's *Mulakhkhaṣ* and Qūshjī's *Risāla dar hay'a* (*A Treatise on Hay'a*, in Persian, henceforth the *Risāla*) gives us better understanding of how 'Āmilī's work was received by scholars of the time.

Prior to the *Dissection* a work on simple *hay'a* which received numerous commentaries and super-commentaries was Jaghmīnī's *Mulakhkhaṣ*. There have been written no fewer than fifty-nine commentaries, glosses, and super-commentaries on the *Mulakhkhaṣ*, besides two translations, one into Turkish from a chapter of Bīrjandī's (d. 935/1528) super-commentary and another into Hebrew. Among these commentaries twenty-five were super-commentaries written on Qāḍīzāda's commentary including 'Āmilī's short super-commentary and Bīrjandī's. To this list we can add 'Āmilī's long super-commentary which was dedicated to 'Abbās I. There are two glosses written on Bīrjandī's super-commentaries, two super-commentaries on Sharīf al-Jurjānī's

²⁵⁶ Shams al-Dīn 'Alī ibn Muḥammad ibn 'Alī al-Ḥusaynī al-Khalkhālī, "Sharḥ Tashrīḥ al-aflāk" (University of Mashhad, Faculty of Theology, MS 323, 1038 1628); Āqābuzurg Tehrānī, *al-Dharī'a*, 13:147.

(d. 816/1413) and one on Kamāl al-Dīn Turkamānī's (d. 758/1357).²⁵⁷ According to this list, about fifteen commentaries, super-commentaries and glosses were made on the *Mulakhkhaṣ* after or around the same time that the *Dissection* and the *Gloss* appeared, including those whose authors also commented on 'Āmilī and those by 'Āmilī himself. The reception of Qūshjī's *Risāla dar hay'at* was much different from the other two books, the *Mulakhkhaṣ* and the *Dissection*. So far, we know about six commentaries written on the *Risāla*, one of them anonymous. The famous one which is extant in numerous copies was made by Muṣlih al-Dīn Lārī (c. 1510-1572) and dedicated to the Mughal emperor Humayun (r. 1530-1540 and 1555-56).²⁵⁸ Another commentary was written by Taqī al-Dīn Abū al-Khayr Muḥammad ibn Muḥammad Fārsī (10th/16th c.) who also wrote other works on the plane astrolabe, *qibla*, and astrology.²⁵⁹ In addition to the anonymous commentary, the other three were made by Ibrāhīm ibn Mālik Deylamī in 983/1575-76,²⁶⁰ Ḥabīb Allāh Tūysirkānī,²⁶¹ and Hibat Allāh Shāhmīr Ḥusaynī Shīrāzī.²⁶² We also know that the *Dissection* and 'Āmilī's work on mathematics were circulated as teaching textbooks in several madrasas until the late nineteenth century.²⁶³ By a rough comparison it becomes obvious that commentaries and glosses on the *Dissection* outnumber those on the other two books by Jaghmīnī and Qūshjī during and after 'Āmilī's time, although the two books themselves were still being copied in the Safavid period. The *Dissection* and the *Gloss* apparently replaced

²⁵⁷ S.P. Ragep provided a table of all these sixty-one items in Sally P. Ragep, *Jaghmīnī's Mulakhkhaṣ*, 284–91.

²⁵⁸ Derayati, *Fankha*, 20:206-210.

²⁵⁹ For his commentary on the *Risāla* I had access to two copies, MS Parliament 3792, and 6305 dated 27 Rabī' I 1096/21 Feb 1685 (for other copies see: Derayati, 20:211-212.). I have also seen his other works on astronomy and astrology in MS Parliament 6343.

²⁶⁰ The extant copy is MS Mashhad 5577. Derayati, 20:210.

²⁶¹ Derayati, 20:212-214.

²⁶² MS University of Tehran 833. Moḥammad-Taqī Dāneshpajhūh, *Fehrest-e ketābkhāneye Dāneshgāh-e Tehrān*, vol. 3 (Tehran, 1953), 3:919-20.

²⁶³ De Young, "The Khulāṣat al-Ḥisāb of Bahā' al-Dīn al-'Āmilī and the Dars-i Nizāmī in India."

previous books on simple *hay'a* and because of their author's political and religious status became so popular that they initiated a new commentary tradition among the scholars.

3.4 Conclusion

The circumstances under which 'Āmilī wrote the *Dissection* and multiple dedications of the book, show that the production of the *Dissection* was part of the author's attempt to gain patronage and join the court. The rededication of the *Dissection* was a constant strategy in 'Āmilī's patronage campaign through the reigns of the four shahs. This along with his rededications of his other scientific book, the *Khulāṣa al-ḥisāb*, to two of Khudābanda's sons and finally to 'Abbās I also reveals the scope of his attempt at gaining courtly patronage. The *Dissection* was also composed and dedicated in a period when 'Āmilī faced impediments in his intellectual and political career. While there were other textbooks and commentaries available for students of astronomy, like Jaghmīnī's *Mulakhkhaṣ* in Arabic or Qūshjī's *Risāla dar hay'at* in Persian, both extant in numerous copies at the time, the *Dissection* came into wide use after glosses and commentaries were available to supplement its limited presentation. But the commentaries and the extensive use of the *Dissection* in teaching were triggered by the appearance of the author's own *Gloss* on the text. However, there could be other reasons behind the wide circulation and reception of the *Dissection*, both related to the author's religious and political affiliation. Teachers and students of astronomy in the early seventeenth century began to copy and study the *Dissection* and comment on the book after 'Āmilī rose to power as the chief jurisconsult (*shaykh al-islām*) at the court of 'Abbās I the most powerful among the Safavid shahs. By this time 'Āmilī attained the highest religious authority in the whole Safavid Shiite monarchy, while the authors of the other two texts also available to students of astronomy, Jaghmīnī and Qūshjī, were both Sunni scholars and thus less appealing than a respected and

powerful Shiite jurist like ‘Āmilī. Although ‘Āmilī appropriated some technical contents from Qūshjī’s *Risāla dar hay’at* and translated and summarized them into Arabic in the *Dissection*, this was not considered an act of plagiarism at the time, otherwise the *Dissection* would not have been accepted as a patronage gift at the court of four shahs.

Patronage of sciences never disappeared in early modern Persia and always remained a salient feature of the Safavid court culture. ‘Āmilī’s multiple dedications of scientific works to the Safavid shahs, princes, and courtiers also corroborate this, although the courtly patronage of scholars was by no means limited to secular sciences. The wide reception of ‘Āmilī’s astronomy among students and teachers as well as numerous commentaries and super-commentaries made by his disciples and by scholars of the subsequent centuries throughout the Safavid, Ottoman, and Mughal empires refutes the decline thesis of sciences in early modern Islamicate societies.

Table 3-2. A comparison of organization of topics between the *Mulakhkhaṣ*, *Riṣāla dar hay'at* and the *Dissection*. The other two books are compared against Qūshjī's *Riṣāla* since it includes more topics and has the most detailed organization among all. Empty cells show missing sections in the *Dissection*.

	Qūshjī's <i>Risāla dar hay'at</i>	Jaghmīnī's <i>Mulakhkhaṣ</i>	‘Āmilī's <i>Dissection</i>
Introduction	Section 1: What pertains to geometrical [concepts]		
	Section 2: What belongs to natural philosophical [concepts]	On an Explanation of the Divisions of the Bodies in General Terms	Introduction [the overall structure of the sublunary and superlunary universe]
Book I: On the orbs and what belongs to them	Part 1: On the number of total orbs and their arrangement		
	Part 2: On the well-known circles	Book 1: On an Explanation of the Orbs and What Pertains to Them Chapter 3: On the Circles Chapter 4: On the Arcs	Chapter 1: On the great and small circles and the well-known arcs
	Part 3: On the motion and hay'a of the ninth and eighth orbs and a short note on the fixed stars	Chapter 2: On the Motions of the Orbs	Chapter 2: On the forms [ṣuvar] of the orbs of the seven planets
	Part 4: On the hay'a of the orbs of the seven stars which are called planets	Chapter 1: On the Configurations of the Orbs	
	Part 5: On the motions of the orbs of the planets	Chapter 2: On the Motions of the Orbs	Chapter 3: On the motions [of the orbs] and what pertains to them
	Part 6: On what occurs to the planets in four chapters Chapter 1: On what occurs to the planets in longitude	Chapter 5: On What Occurs to the Planets in Their Motions	
	Chapter 2: On what occurs to the planets in latitude		
	Chapter 3: On what occurs to the planets in longitude and latitude together		
	Chapter 4: On what occurs to the planets in their relative positions to each other		
	Book II: On the hay'a of the Earth and related topics	Part 1: On the hay'a of the Earth and the climes	On an Explanation of the Earth and What Pertains to It in Three Chapters Chapter 1: On the Inhabited Part of the Earth and Its Latitude, Its Longitude, and Its Division into the Climes
Part 2: On the characteristics of the Equator		Chapter 2: On the Characteristics of the Equator and Locations Having Latitude	
Part 3: On the characteristics of the Oblique Horizons in general			
Part 4: On the characteristic of each of the five types of the Oblique Horizons			

	Qūshjī's <i>Risāla dar hay'at</i>	Jaghmīnī's <i>Mulakhkhaṣ</i>	‘Āmilī's <i>Dissection</i>
	Part 5: On the characteristics of the locations whose latitudes is ninety degrees		Chapter 4: On what pertains to the Earth and the differences of its localities
	Part 6: On the co-ascensions of the Zodiacs		
	Part 7: On the degree of transit of a star and the degree of rising and setting	Chapter 3: Miscellaneous Items [1] Ascendant	
	Part 8: On the Dawn and Dusk		Chapter 5: On dawn and dusk
	Part 9: On the calendar of the year and month and its parts of the nychthemeron and hours	[5] On daytime, nighttime, hours, the year, and the month [6] The nychthemeron [7] the duration of daytime [8] the month	
	Part 10: On the shadow and what pertains to it	[2] The shadow	
	Part 11: On determining the meridian line and the <i>qibla</i> bearing	[3] On determining the meridian line and the equinox line [4] On determining the <i>qibla</i> bearing	Epilogue (<i>khātima</i>): On deriving the meridian line and the <i>qibla</i> bearing by the method of the Indian circle
Epilogue (<i>khātima</i>)	On the sizes and distances		

Table 3-3: The overall structure of the *Dissection* compared against the *Mulakhkhaṣ* and the *Risāla dar hay'at*

	Intro.	Book One			Book Two		Epilogue
<i>Mulakhkhaṣ</i>	*	Celestial topics			Earth topics		--
<i>Risāla dar hay'at</i>	*	Celestial topics			Earth topics		Sizes and distances
<i>Dissection</i>	*	Ch.1 Great and Small circles	Ch.2 The orbs of the planets	Ch. 3 The motions of the orbs	Ch.4 Earth and climes	Ch.5 Dawn and Dusk	Meridian and <i>qibla</i>

Chapter 4

‘Āmilī’s *Gloss* on the *Dissection of the Orbs*

4.1 History of the text

Twenty years after composing the *Dissection* and dedicating it to four Safavid shahs, ‘Āmilī wrote a lengthy gloss to it. In the *Gloss* he expanded many discussions and provided some of the topics with geometrical demonstrations. ‘Āmilī made references to earlier astronomical works and authors as well as raising objections to some of them. His comments vary in length; some appear in one or two sentences and some others occupy pages. The *Gloss* not only includes expansions to the *Dissection* but also contains new materials related to the topics discussed in the *Dissection*. It is significantly longer than the *Dissection* and often exists, as a separate work, in one binding either with the *Dissection* or with lengthy commentaries on it or other works of ‘Āmilī.²⁶⁴ The *Gloss* also sometimes appears as marginal notes to copies of the *Dissection* and sometimes it is partly incorporated to the main body of the text.²⁶⁵ In addition to circulation in manuscript the *Gloss* was also published separately in 1276/1859 in Tehran.²⁶⁶ The copyists of the *Gloss* did not mention the date it was made, but some copies of the *Gloss* begin with an introductory paragraph that explains the purpose of collecting all of ‘Āmilī’s comments in a single tract as “the marginal space in the copies of the book [the *Dissection*] did not suffice for the lengthy glosses, and because of that some comments were displaced from their proper positions and some were missed by the scribes.” This introduction also indicates that ‘Āmilī first

²⁶⁴ See e.g. MSS Parliament 16135, 6345, and 3280.

²⁶⁵ Bahā’ al-Dīn al-‘Āmilī, “Tashrīḥ Al-Aflāk” (British Library MS 23569, 1657).

²⁶⁶ al-‘Āmilī, *Ḥāshīya Tashrīḥ al-aflāk*.

wrote the *Gloss* in the margin of the main text of the *Dissection*,²⁶⁷ but does not tell when it was written or whether it was done by ‘Āmilī at one sitting or not. However, it is very likely that ‘Āmilī prepared the *Gloss* for students, as he taught the *Dissection* and the *Gloss* in Marv (NE Iran) to one of his disciples named Muḥammad and granted him an *ijāza* on 14 Dhil Ḥajj 1008/16 June 1600 allowing him to teach and transmit both texts.²⁶⁸

Although we do not know when ‘Āmilī began producing the *Gloss*, he provided some information in the *Gloss* which enables us to define an approximate time period for its completion. In the *Gloss* ‘Āmilī quoted from and cited some of his earlier compositions including:

1. His first super-commentary (*ta’līqā*, lit. annotation) on Qāḍīzāda al-Rūmī’s commentary on Jaghmīnī’s *al-Mulakhkhaṣ* written in Iṣfahān in 990/1582-83.²⁶⁹
2. *Ḥadīqah al-hilālīyah*, the only surviving section of his larger commentary the *Ḥadā’iq al-ṣāliḥīn*, on a collection of prayers by the fourth Shiite Imam Zayn al-‘Ābidīn. It was completed in Kāzīmāyn (Iraq) in early Jumada II 1003/February 1595 (more about this work in Chapter 2).²⁷⁰

According to the dates of these sources, ‘Āmilī completed the *Gloss* no earlier than Jumada II 1003/February 1595. Other documentary evidence gives us a date by which the *Gloss* must have been completed. One of ‘Āmilī’s disciples, Muḥammad-Kāzīm Tunikābunī (11th/16th century), made an extensive commentary on the *Dissection* entitled *Qānūn al-idrāk fī Tashrīḥ al-aflāk* (*The Rule of Perception in the Dissection of the Orbs*) and incorporated the author’s *Gloss*

²⁶⁷ al-‘Āmilī, “Hāshiya (Gloss 1682),” fol. 5v; “Hāshiya (Gloss 1689),” fol. 1r.

²⁶⁸ Ayatollah Marāshī Najafī Library, Qom, MS 17081; the text of the *ijāza* was published in the library catalogue: Mahmoud Marāshī, *Fehrest-e Noskhehāy-e Khattī-ye Ketābkhāne-ye Āyatollāh Mar’ashī Najafī*, vol. 43 (Qum: Iran, 2015), 234–35.

²⁶⁹ This super-commentary was published together with Qāḍīzāda al-Rūmī’s commentary in 1894 in Tehran. al-‘Āmilī, *Risālah fī taqārīs al-’arḍ*.

²⁷⁰ For a modern edition of this text see: al-‘Āmilī, *al-Ḥadīqah al-hilālīyyah*.

throughout his commentary. Tunikābunī completed the *Qānūn al-idrāk* at the end of Dhil-Ḥajj 1007/mid-July 1599 in Mashhad.²⁷¹ In the introduction Tunikābunī reported that ‘Āmilī had written a gloss to his own text and he was hesitant to write the commentary until ‘Āmilī encouraged him to do so.²⁷² Hence ‘Āmilī started the *Gloss* no earlier than 990/1582-83 and completed it after February 1595 and before the summer of 1007/1599, although Tunikābunī’s lengthy commentary would have taken several months to be accomplished. In any case, it is clear that ‘Āmilī wrote the *Gloss* at least twenty years after he composed the *Dissection*. ‘Āmilī also prepared some topics of the *Gloss* as a discussion with an interlocutor, for example warning that person to avoid holding the wrong side in a dispute. The interlocutor could be one of his disciples or an imaginary audience as this was a common style in many didactical writings. But the expressions he used in warnings and remarks like “and you know [that]” (*wa-’anta ta’lamu*),²⁷³ “and you are aware of” (*wa-’anta khabīrun bi*),²⁷⁴ “and be aware [that]” (*wa-’i’lam*),²⁷⁵ suggest that he was probably writing the *Gloss* for a real person.

4.2 Contents of the *Gloss*

‘Āmilī incorporated a large variety of materials into the *Gloss*. He mentioned nineteen Islamic philosophers, theologians, mathematicians, and astronomers from Ibn Sīnā (980-1037) and Bīrūnī (d. ca. 1050) to later scholars like Jalāl al-Dīn Dawānī (1426-1502)²⁷⁶ and Shams al-Dīn

²⁷¹ Muḥammad-Kāzīm Tunikābunī, “Qānūn al-idrāk fī tashrīḥ al-aflāk” (Tehran, Malek National Library and Museum, MS 3440, 1025 1616), f. 214r.

²⁷² Tunikābunī, f. 3r; Āqābuzurg Tehrānī, *al-Dharī’a*, 13:148.

²⁷³ al-‘Āmilī, “Ḥāshiya (Gloss 1689),” f. 4r.

²⁷⁴ al-‘Āmilī, ff. 8v, 10v.

²⁷⁵ al-‘Āmilī, ff. 8v, 9r, 22v.

²⁷⁶ Newman, “Davānī, Jalāl-al-Dīn Moḥammad.”

Khafīrī (d. after 1525).²⁷⁷ He also referred to Greek authors like Euclid, Hipparchus, and Ptolemy. Most of ‘Āmilī’s citations in the *Gloss* were to two of the leading astronomers associated with the Marāgha observatory, Naṣīr al-Dīn Ṭūsī (d. 1274) and Quṭb al-Dīn Shīrazī (d. 1311). More than anyone else ‘Āmilī referred to Ṭūsī, mostly from his *Tadhkira*, and from Shīrazī he cited *The Royal Gift (al-Tuhfa al-shāhiyya)*. He also cited his super-commentary on the *Tadhkira* and his gloss on Ṭūsī’s Persian work on astrolabes,²⁷⁸ which are yet to be found. Besides expanding the topics in the *Gloss*, ‘Āmilī gave further technical details for some and added geometrical demonstrations when needed.

It would be worth analyzing the whole contents of the *Gloss* to obtain a complete picture of its scope and knowing about ongoing debates in the discipline of ‘ilm al-hay’a from ‘Āmilī’s and his disciples’ point of view, but such lengthy discussion could not fit in the limited length of this chapter. So, to give some useful examples, in the following pages, I will explain the main discussions in the *Gloss* on the first three chapters of the *Dissection* dealing with the celestial part of ‘ilm al-hay’a. The other part of the *Dissection*, including chapters four and five and the epilogue, deals with some terrestrial topics of ‘ilm al-hay’a, presenting discussions about the Earth, the climes, and qibla.

4.2.1 The Definition of ‘ilm al-hay’a

The definition of ‘ilm al-hay’a is the first discussion in the *Gloss*. It reads, “Al-hay’a is a science in which the celestial [matters] are discussed with respect to quantity, quality, position, and movement, followed by that of the elements.” The definition denotes a general dichotomy in the

²⁷⁷ Glen M. Cooper, “Khafīrī: Shams Al-Dīn Muḥammad Ibn Aḥmad Al-Khafīrī Al-Kāshī,” in *The Biographical Encyclopedia of Astronomers* (Springer New York, 2007), 623–24, https://doi.org/10.1007/978-0-387-30400-7_754.

²⁷⁸ al-‘Āmilī, “Ḥāshiya (Gloss 1689),” f. 8r.

universe, as in Islamic theology and philosophy; all bodies (sing. *jism*) are either celestial (*falakiyya*) or elemental (*‘unṣuriyya*), therefore the subject of *‘ilm al-hay’a* includes both. ‘Āmilī explains every part of this definition afterward. He adds that by the ‘quantity’ we know the number of the orbs and observable stars, and the sizes and distances of the celestial bodies. Likewise, ‘quality’ indicates the status of celestial bodies in terms of their circular shape, luminosity or darkness, and so forth. ‘Position’ defines the relative positions of the bodies in relation to each other, like the inclination of a circle to another. ‘Movement’ defines the quantity of motion of celestial bodies and their directions, including direct motion, stations, and retrogradation, besides the discussion of their equations. The *Gloss* is organized in five sections, each one corresponding with one of the five chapters of the *Dissection*. The definition of *‘ilm al-hay’a* is the opening paragraph of the *Gloss* after which the comments about the Introduction of the *Dissection* begin.

4.2.2 The nature and number of the orbs

The introduction deals with natural philosophical matters regarding both the celestial and terrestrial parts of the universe. In his comment about the outermost orb, the “Orb of Orbs” or the *Primum mobile*, ‘Āmilī explains that the number of the total and partial orbs altogether as Ṭūsī recorded in his theological work *Tajrīd al-i‘tiqād* (*Abstraction of the Belief*) is 24²⁷⁹ and the outermost one encompasses the whole, but Qūshjī criticized Ṭūsī and counted them as 25.²⁸⁰ The following table shows the number of total and partial orbs for each planet which obviously

²⁷⁹ Naṣīr al-Dīn al-Ṭūsī and Jamāl al-Dīn Ḥasan al-Ḥillī, *Kashf al-murād fī sharḥ Tajrīd al-i‘tiqād* (Beirut: Lebanon: Mu‘assissat al-A‘lamī lil-Maṭbū‘āt, 1988), 135.

²⁸⁰ One of the most famous commentaries on Ṭūsī’s theology was written by Qūshjī known as “the new commentary” (*sharḥ jadīd*) against Shams al-Dīn Muḥammad Isfarāyīnī Beyhaqī’s (d. 1348) commentary on the same work known as “the former commentary” (*sharḥ qadīm*). Ali Sadrayi Khoye and Mahmoud Marashi, *Kitāb Shināsīy-e Tajrīd al-i‘tiqād* (Qum: Iran, 2003), 42.

including the *Primum mobile* is 24. This scheme is in accordance with that presented in the *Dissection* and what Ṭūsī explained in the *Tadhkira*.²⁸¹

Table 4-1: Ṭūsī’s counting scheme for the orbs

	Primum mobile	Ecliptic	Saturn	Jupiter	Mars	Sun	Venus	Mercury	Moon
Total orb	1	1	1 Parecliptic	1 Parecliptic	1 Parecliptic	1 Parecliptic	1 Parecliptic	1 Parecliptic	1 Parecliptic (<i>Jawzahar</i>)
Partial orbs			2 Deferent Epicycle	2 Deferent Epicycle	2 Deferent Epicycle	1 Eccentric	2 Deferent Epicycle	3 Dirigent Deferent Epicycle	3 Inclined Eccentric Epicycle

‘Āmilī argued that Qūshjī and his followers misunderstood Ṭūsī’s text, where Ṭūsī counted only those orbs enclosed in the outermost one. This, however, does not seem to be a sustained objection. ‘Āmilī notes that at the end of his commentary on Ṭūsī’s *Tajrīd*, Qūshjī also conjectured the same thing, that Ṭūsī might have been correct if he had counted only the enclosed orbs in the ninth orb. However, this does not seem to be the only reason for the discrepancy among the two accounts. According to ‘Āmilī the difference lies in the way Qūshjī counted the orbs of the Moon. Qūshjī argued that the *jawzahar* was not a total orb and so was not the parecliptic of the Moon. He believed that if the *jawzahar*, as Ṭūsī assumed, was parecliptic, the inclined orb of the Moon which was also concentric should be a total orb too. In contrast, Qūshjī counted four partial orbs for the Moon plus one total, that finally increases the total number to 25.²⁸² However, in the *Risāla* Qūshjī did not discuss the number of the orbs except for counting nine total orbs. ‘Āmilī continues the discussion by remarking that the practitioners of astronomy called the outermost orb “the starless,” but did not provide any proof for its not

²⁸¹ Ragep, *Ṭūsī’s Memoir*, I:109, 149, 151, 167, 179.

²⁸² ‘Alī ibn Muḥammad Qūshjī, *Sharḥ Tajrīd al-i’tiqād* (Tabriz, Iran, 1884), 188.

enclosing any star, since it is probable that there exist some tiny stars not perceptible by our senses, or some fixed stars not yet observed.

About the nature of an orb ‘Āmilī comments briefly that some defined the orb (*falak*) as an aethereal body having intellect (*nafs*) but not luminous, that revolves around the elemental world by command of its creator. The nomenclature of *falak*, ‘Āmilī believes, was because of its similarity with rolling wheels. He refers to Abū Rayḥān al-Bīrūnī (973-1048) for the terminology of *falak*. Bīrūnī reported that both the Arabs and Persians used similar methods for naming the sky (*samā*); the Arabs called it “*falak*” due to its resemblance to a rolling wheel with axis and poles and the Persians called it “*āsmān*” which is “*ās*,” meaning a mill, plus “*mān*” that indicates comparison.²⁸³

In the *Dissection* ‘Āmilī interpreted the eighth and ninth orbs as the Throne (*Kursī*) and Stool (*‘Arsh*) mentioned in the Quran, and in the *Gloss*, he adds more clarification. ‘Āmilī defines the Throne and the Stool respectively as the *aṭlas*, the starless orb, and the orb of the fixed stars. He explains that according to some traditions (sing. *ḥadīth*) the Stool was embedded in the Throne. To confirm this belief ‘Āmilī brings a witness from the Quran that says “His throne includes the heavens and the earth.”²⁸⁴ ‘Āmilī continues that the apparent meaning of the Quran indicates that there are only seven [total] orbs, the number of which becomes nine by adding the Throne and Stool, in accordance with the preference of those philosophers who counted nine. However, since they never provided a proof for that, one may conclude as Quṭb al-Dīn Shīrāzī did in his *al-Tuḥfa al-shāhiya*,²⁸⁵ that there are only seven orbs, bringing the stars and the zodiac within the parecliptic orb of Saturn. ‘Āmilī argues that Shīrāzī’s view holds true only if Saturn would never

²⁸³ Cf. Abū Reyḥān Bīrūnī, *al-Taḥfīm li-’awā’il ṣanā’a al-tanjīm*, ed. Jalal Homayī (Tehran, 1937), 56–58.

²⁸⁴ Quran II,255: وَسِعَ كُرْسِيُّهُ السَّمُوتَ وَالْأَرْضَ

²⁸⁵ Quṭb al-Dīn Shīrāzī, “*al-Tuḥfa al-shāhiya*” (British Library: Oriental Manuscripts, Add MS 23393, September 18, 1356), fol. 13v.

have eclipsed any of the fixed stars in its apogee, and if any star with significant magnitude does not exist above Saturn's apogee, otherwise it would be a gross violation of certainties and conventions of astronomy. Obviously, if Saturn eclipses a fixed star when in its apogee, something confirmed by observations, then the covered star must be beyond Saturn's parecliptic. This shows that the fixed stars are not accommodated within the parecliptic orb of Saturn (Fig. 4-1).

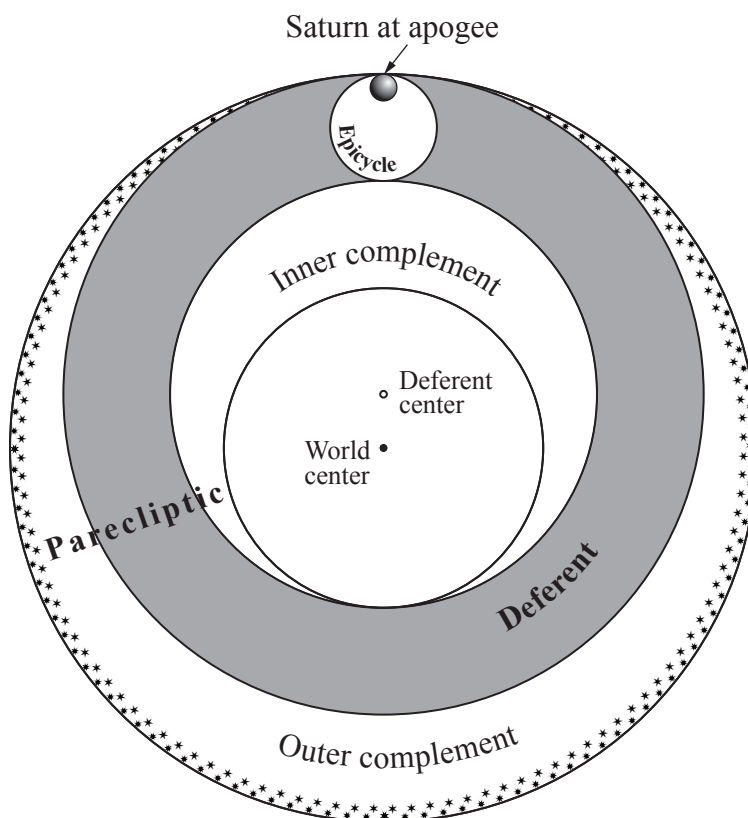


Fig. 4-1. If we assume that the fixed stars can be accommodated within the parecliptic orb of Saturn and they do not need to have a separate orb, then when Saturn is at the apogee (as shown here) it must not eclipse any of them for an observer on the Earth. But observations show that Saturn does eclipse some of them at its apogee, so the stars must be within another orb beyond the parecliptic orb of Saturn.

The meaning of a total orb, as 'Āmilī indicates, needs a lengthy discussion for which he refers us to his glosses on Ṭūsī's *Tadhkira*, yet to be discovered, but here he only comments on

Jalāl al-Dīn Dawānī’s definition in his commentary on Ṭūsī’s *Tajrīd*, which became known as the “the former commentary” (*sharḥ qadīm*) in comparison to that by Qūshjī. According to ‘Āmilī the best definition for a total orb is the one by which the status of each of the seven planets, or the fixed stars, or the primary motion is regulated. ‘Āmilī objects to Dawānī on the grounds that he considered only two orbs, as a result of being negligent about the meaning of ‘total orb’. But this was not Dawānī’s mistake, as ‘Āmilī points out, because Dawānī got the definition from Muḥammad ibn ‘Alī al-Munajjim al-Ḥimādhī (14th century), who wrote a commentary on Ṭūsī’s *Tadhkira* and who was accused of plagiarism by Shīrāzī.²⁸⁶

4.2.3 The sphericity of the element water and the Earth

In the definition of the sphere of water as one of the four terrestrial elements, in the *Dissection* ‘Āmilī pointed out that the surface of water everywhere is a section of a sphere and explained that this sphericity increases as the surface gets closer to the center of the Earth and reduces when it is further way. In the *Gloss* he provides a proof for the sphericity using *modus tollens* and argues as follows. First assume *AHB* is a water surface and is a plane (Fig. 4-2). Connect the sides of this surface to the center of the Earth *E*. In the isosceles triangle *ABE*, the perpendicular *h* is shorter than the sides *a* and *b* which means that the middle point of the water surface *H* must be always seen lower than the sides *A* and *B*, which is a contradiction. ‘Āmilī does not say more about how this proves that the surface of water is spherical. But if the Earth is a sphere, all points on its surface must have the same distance from its center, and in this demonstration the position of point *H* contradicts that. However, the demonstrations do prove that the surface of water is not plane, but how does it show that the surface is spherical? ‘Āmilī might have had in mind that the

²⁸⁶ Ragep, *Ṭūsī’s Memoir*, I:59-60.

demonstration is pretty obvious because it holds true for any two given points A and B on the surface of water.

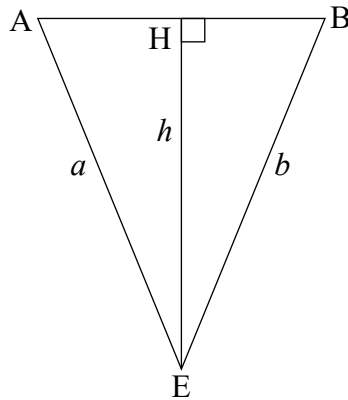


Fig. 4-2. AHB represents the surface of water on the Earth and if it is plane then the middle point H should always be seen lower than other parts.

Following this discussion of the Earth, 'Āmilī discusses some consequences of its sphericity. He argues the two persons standing on the Earth have their feet closer to each other than their heads and if they stand on opposite ends of a diameter the difference equals the sum of their heights. Also, if they stand one-sixth of the circumference away from each other, the difference equals to the height of one person. In fact, the last case holds true if we assume that the two persons have the same height compared to the radius of the Earth.

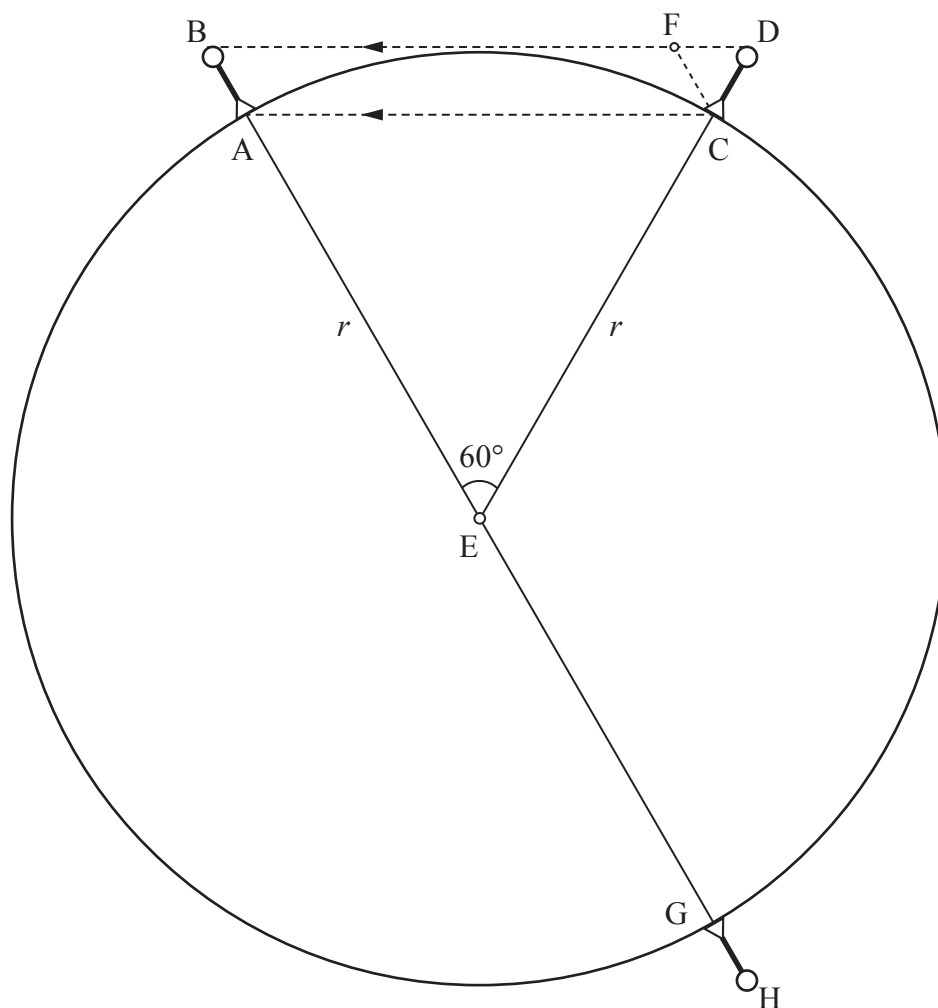


Fig. 4-3. Measuring the distances between heads and feet of two people standing on the Earth to show that the distance between the heads is always more than that between their feet.

If two persons stand diametrically on the earth at AB and GH the length difference between their feet and heads is $BH - AG = AB + GH$, the sum of their heights. But if they have the same height, $AB = CD$, and stand 60° away from each other, it can easily be shown that the difference equals one person's height. In Fig. 4-3 assume that they stand on the points A and C . The triangle ACE is equilateral with all sides the same as the radius of the Earth r , therefore the distance between the two persons' feet is $AC = r$. Obviously BD is the distance between their heads and is parallel to AC . If we draw CF parallel to EA then $BF = AC$ and DF is the difference between

the two lengths, i.e. $AC - BD = DF$. But the triangle CDF has all sides parallel to the sides of the triangle ACE then it is also equilateral. Therefore, $FD = CD$, and the difference between the distance between their feet and distance between their heads equals the height of one person.

Another consequence of the Earth’s sphericity is the time difference in different locations that ‘Āmilī briefly mentioned in the *Dissection*. As a result of this sphericity it is possible that a specific day for three people at different locations can be Friday, Thursday, and Saturday simultaneously. ‘Āmilī realized the ambiguity of his sentence in the *Dissection* and gave further explanation about it in the *Gloss* as follows. Consider three people P, W, E in a given location A on the Earth at the time when the Sun is crossing the meridian of that location at the point S_1 (Fig. 4-3). Assume that the Person P stays at the location, and persons W and E travel west and east respectively. Once the Sun makes one complete rotation around the Earth and crosses the meridian of the location A again, it has passed one day + night (nychthemeron), for the person P . But for the other two people that nychthemeron differs in length, as ‘Āmilī tries to explain in the *Gloss*.

For simplicity assume that the Sun is moving with the angular velocity of $\omega_S = \frac{2\pi}{T}$ in which $T = 24^h = 1$ nychthemeron. Therefore, by the same definition we have:

$$\begin{cases} \omega_S = \frac{2\pi}{T} \\ \omega_W = \frac{\theta_1}{t_1} \\ \omega_E = \frac{\theta_2}{t_2} \end{cases}$$

When the Sun completes one rotation and again crosses the meridian of the location A , the person W has travelled westward θ_1 degrees in time t_1 and the person E has travelled eastward θ_2 degrees in t_2 . The time elapsed for person W is less than a day + night from the viewpoint of

person P in 24 hours. For the person W one day + night occurs when the Sun is in S_1 . Then the length of one day + night for W is:

$$T_W = \frac{2\pi}{T} + \frac{\theta_1}{2\pi}$$

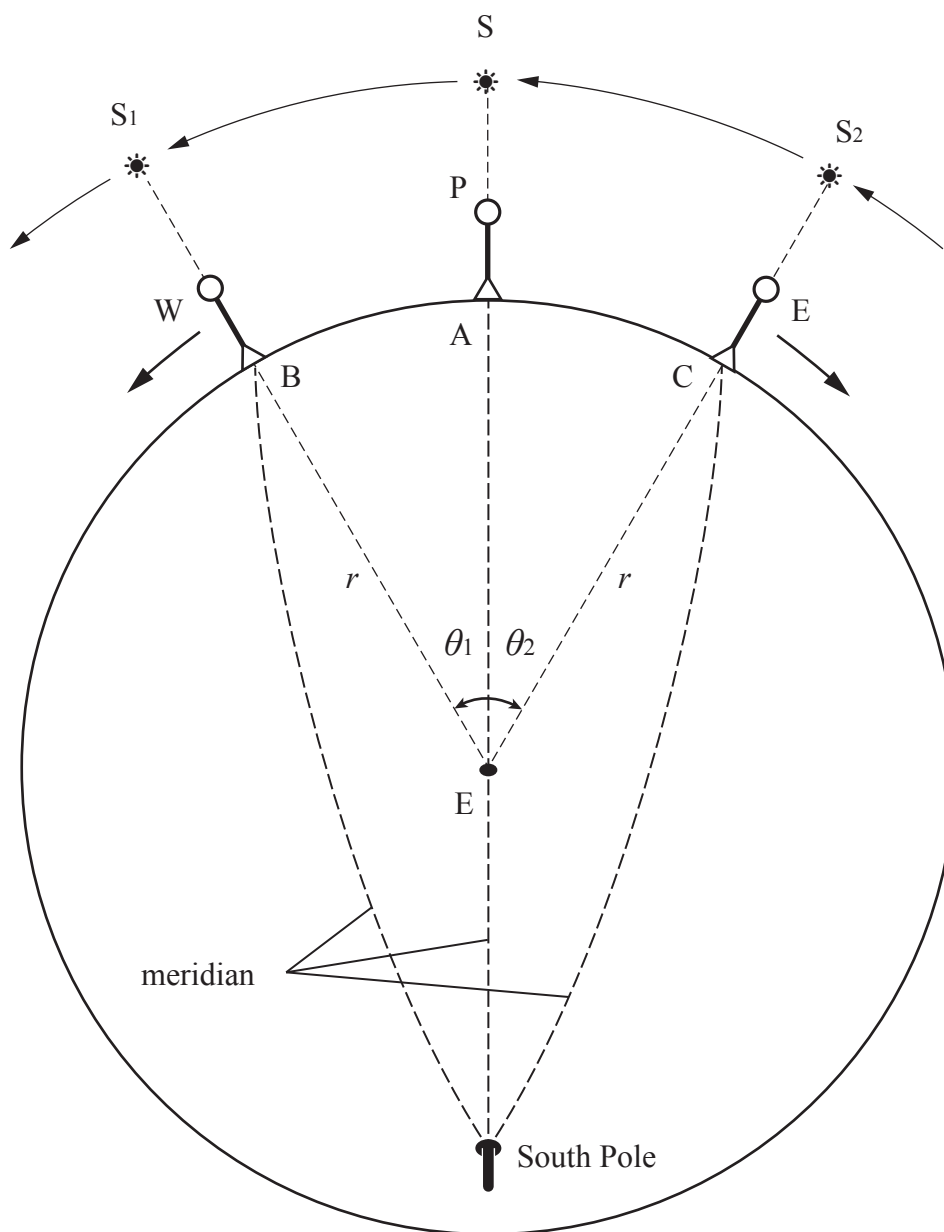


Fig. 4-4. Measuring the time passed for people travelling with the speed of Sun on opposite directions.

This is longer than the day + night for P , that is longer than 24 hours. And similarly, for the person E one day + night happens when the Sun is in S_2 , and this period is shorter than that for P . The length of one day + night for E is:

$$T_E = \frac{2\pi}{T} - \frac{\theta_1}{2\pi}$$

Here ‘Āmilī discusses another case when both people W and E travel with the speed of the Sun and complete one revolution but in opposite directions until they return to the location A . During this time for the person P a real nychthemeron has elapsed that equals $T = 24$ hours, but for the person E it has been two nychthemérons, not of equal lengths with that for P , and for the person W it is still the same time as when W departed the location A . Considering this case, if we go back to ‘Āmilī’s short sentence in the *Dissection*, we can conclude that if the given day at the location A was Thursday while the Sun was crossing its meridian, after one rotation of the Sun it becomes Friday for the Person P and Saturday for E , but it remains Thursday for W .

4.3 The Great Circles

The first chapter of the *Dissection* introduces ten great circles, both celestial and terrestrial, along with some other well-known arcs and small circles related to each of the great circles (Table 4-2). The *Dissection*’s first chapter is relatively longer than others, and ‘Āmilī also provided detailed comments on it in the *Gloss* which are much longer than the chapter itself in the *Dissection*. It seems that spherical astronomy was important for ‘Āmilī and his students, probably because of its benefits for practical needs like timekeeping and finding the *qibla* direction. It is not possible to discuss all topics and comments ‘Āmilī included in the *Dissection* about this chapter in the *Gloss*, but I will select and explain some which are more controversial including criticisms or comments on earlier astronomers.

Table 4-2: Circles and arcs defined in the *Dissection*

	Great circles	Small circles	Arcs
1	Equinoctial	Day-circles	
2	Ecliptic equator	Parallels of latitude	
3	Solstitial colure (passing through the four poles of the Equinoctial and Ecliptic)		Total obliquity (the maximum declination)
4	Declination circle		First declination; longitude
5	Latitude circle		Second declination; latitude; zodiacal signs
6	Horizon	Almucantars (parallels to the Horizon)	Ortive amplitude (rising amplitude); Occasive amplitude (setting amplitude) ²⁸⁷ ; arc of daylight; arc of night; equation of daylight; Wheel-like rotation [of the orb]; quern-like (spinning) rotation; slanted rotation;
7	Meridian		Depression line; local latitude and longitude;
8	Circle of the initial azimuth (prime vertical)		
9	Ecliptic meridian circle		The clime latitude of appearances
10	Circle of latitude		Azimuth line; azimuth arc

‘Āmilī began his comments on this chapter by introducing another great circle of more astrological purposes. The added circle was called the *Ufuq al-ḥādith* (Occurrence Horizon) which passes through the north and south poles and the center of a given celestial body or a point

²⁸⁷ For a short description of both terms see: W. Owen et al., *A New and Complete Dictionary of Arts and Sciences* (London: Printed for W. Owen, at Homer’s Head, in Fleet-Street, 1763), I:128. A more technical description is also found in: O. Neugebauer, *A History of Ancient Mathematical Astronomy*, vol. 1 (Springer-Verlag, 1975), I:37-39.

on the ecliptic. The poles of this great circle lie on the First Azimuth circle. Like the horizon, the Occurrence Horizon circle is constant for a given location on the Earth. ‘Āmilī explains that since only the astrologers discuss this circle, Shīrāzī in his *Tuḥfa al-shāhiyya* (*Royal Gift*) counted the well-known great circles in the ‘*ilm al-hay’*a to ten.²⁸⁸

4.4 The Total Obliquity and the end of the world

The comments about the third great circle, or Solstitial colure (the great circle passing through the four poles of the Equinoctial and Ecliptic), includes a religious discussion about the obliquity of the Ecliptic or the Total Obliquity (Fig. 4-5) which is measured along the Solstitial colure. In the *Dissection* ‘Āmilī only recorded the value of $\varepsilon = 23^\circ 30' 17''$ for the Total Obliquity but in the *Gloss*, he briefly explained the methods of calculating the value. The first method is to measure the altitude of the Sun over multiple days when crossing the meridian of the observer’s location to the south of the Equinoctial, then to subtract the minimum obtained value from the maximum and bisect the result to get the Total Obliquity. The second method is to measure the minimum altitudes of the Sun both north and south of the Horizon and take their complements from ninety degree; the average of the two new values is the Total Obliquity. However, ‘Āmilī clarifies that the explained methods only apply to the localities having a terrestrial latitude less or equal to the complement of the Total Obliquity, which is $\varphi = 90^\circ - 23^\circ 30' 17''$, and the method for other latitudes is lengthy and detailed, not appropriate for the *Gloss* to the short *Dissection*.²⁸⁹

²⁸⁸ For further explanation about the Occurrence Horizon see: Naṣīr al-Dīn Muḥammad ibn Muḥammad Ṭūsī, “Zīj-i Īlkhānī” (Vatican Library, MS Vat.pers.85, n.d.), fols. 126r-128r; Muḥammad ‘Alī al-Tahānuwī, *Kashshāf iṣṭilāḥāt al-funūn*, ed. Rafīq al-‘Ajam (Beirut: Lebanon: Maktaba Lubnān, 1996), I:240-241.

²⁸⁹ أما الطريق في بقية البقاع ففي تفصيلها طول لا يليق بحواشي هذا المختصر (fol. 8v).

Apart from giving the most recent value calculated for the Total Obliquity as $\varepsilon = 23^\circ 30' 17''$, ‘Āmilī compared different values measured in the past. According to him the Indian philosophers found it to be 24° assuming that their value is in accordance with Euclid. The last proposition in the book four of Euclid’s *Elements* shows how to inscribe a regular pentadecagon in a circle.²⁹⁰ Based on this proposition IV.6, the arc of the circle subtending the side of a regular pentadecagon is:

$$\frac{1}{15} \cdot 360^\circ = 24^\circ$$

and Indian philosophers considered the side of an inscribed regular pentadecagon to be the chord of the Total Obliquity. The next value given was from Ptolemy as $23^\circ 51'$ and the value calculated by the observations sponsored by the Abbasid caliph al-Ma’mūn (d. 833)²⁹¹ is mentioned to be slightly smaller than that by Ptolemy. ‘Āmilī emphasized that different observations never gave a value more than 24° or less than $23^\circ 30'$, but the decreasing trend in the values urged some people to think that either the Ecliptic or the Equinoctial is continually getting closer to the other circle, and at their coincidence the resurrection occurs. Some of them even went further to think that it was the Ecliptic that moves, otherwise there would be constant change in the position of the terrestrial equator and hence local latitudes on the Earth as well as the altitude of the poles, but all are contradicted by observations. Some others, according to ‘Āmilī, believed that it was possible for the Equinoctial to have a very slow motion so that none of those phenomena would be appreciable by our senses.

‘Āmilī rejected both views and in fact totally rejected the convergence of the two great circles. First, he mentioned that Ibn Sīnā argued in the *Shifā* (*The Book of Healing*) that the

²⁹⁰ Euclid, *The Thirteen Books of the Elements*, ed. Thomas L. Heath (Dover Publications, 1908), vol. 2, p. 110.

²⁹¹ Sayılı, *The Observatory in Islam*, 50–87.

discrepancy between the measured values was due to differences between the observational instruments. Second, by comparing values from the time of Hipparchus to those of the Samarqand observations (c. 1420-49), ‘Āmilī confirms Ibn Sīnā’s idea about the incompatibility of the instruments. Ptolemy calculated the same value Hipparchus had found about three centuries earlier; Abū Rayḥān al-Bīrūnī (d. 1048) found it two minutes larger than the value obtained earlier by Yaḥyā ibn Abī Maṣṣūr²⁹² (d. 830 Aleppo) the court astrologer of al-Ma’mūn,²⁹³ and the result of the Samarqand observations was 17" larger than Ṭūsī’s observation in Marāgha, ‘Āmilī concluded that “the absolute truth is the falsity of the idea of the continual convergence” and that no doubt remains that the discrepancy of obtained values was due to the observational instruments, either their construction, or their size and graduating to degrees and finer magnitudes, or the method of installing them.

²⁹² In the Gloss he is recorded as ‘Uthmān ibn Maṣṣūr which could be a misreading by the scribes or author himself.

²⁹³ Benno van Dalen, “Yaḥyā ibn Abī Maṣṣūr: Abū ‘Alī Yaḥyā ibn Abī Maṣṣūr al-Munajjim,” in *The Biographical Encyclopedia of Astronomers* (New York, NY: Springer New York, 2007), 1249–50.

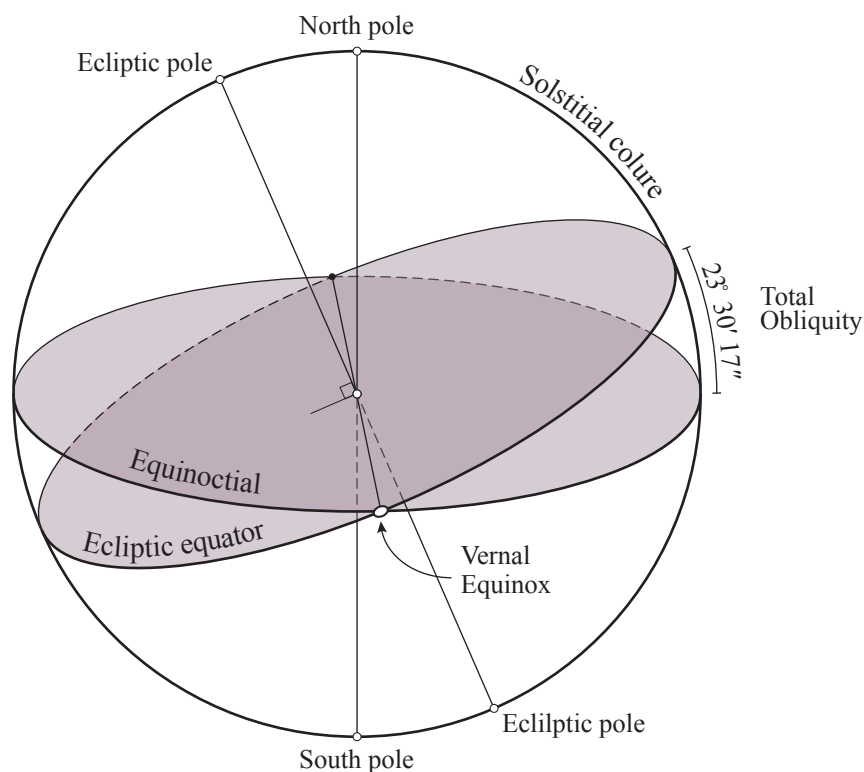


Fig. 4-5. The Total Obliquity and the end of the world

'Āmilī did not mention his source for this discussion, neither did he name anyone who believed in such a co-occurrence between the convergence of the two great circles and the Judgment Day. Both Ṭūsī and Shīrāzī pointed to the different results obtained for the Total Obliquity and reported that the maximum value ever recorded was 24° at the time of Euclid, but their minimum values differ. Ṭūsī gave the minimum as $23^\circ 23'$ ²⁹⁴ and Shīrāzī gave as $23^\circ 30'$. Ṭūsī did not give numbers other than the two extreme values and $23^\circ 35'$ as the value which most astronomers accepted, but he briefly explained eight possibilities as the consequences of such motion.²⁹⁵ In contrast, Shīrāzī discussed the matter in the *Nihāya al-idrāk fī dirāya al-aflāk* (*The Limit of Perception in Understanding the Orbs*) in more detail and compared multiple

²⁹⁴ Ragep, *Ṭūsī's Memoir*, I:121.

²⁹⁵ Ragep, I:121-123.

values, including those that ‘Āmilī also reported in the *Gloss*, to show that the Total Obliquity was not always decreasing.²⁹⁶ The discussion of varying numbers for the Total Obliquity is followed by the topic of trepidation by both authors. However, neither of the two Marāgha astronomers discussed the convictions of those who anticipated the end of the world from the decrease in the value for the Total Obliquity.

Another possible source for ‘Āmilī was Khafrī who discussed the subject in great detail in both his commentaries on Ṭūsī and Shīrāzī.²⁹⁷ Khafrī reported different values obtained for the total obliquity including the one measured at the Samarqand observatory. Apart from those reported by Shīrāzī, Khafrī named more observations done in the past by Islamicate astronomers, in his commentary on Ṭūsī completed on 4 Muḥarram 932/21 Oct 1525. Khafrī also mentioned the belief of those who assumed that the Equinoctial and the Ecliptic equator approach until at their second coincidence the Resurrection occurs. Khafrī added more to the story by quoting evidence from the Quran interpreted by believers as support for the coincidence conviction. Verse 30 of chapter XXI says: “Have not those who disbelieve known that the heavens and the earth were of one piece, and We parted and We made every living thing of water? Will they not then believe?”²⁹⁸ According to Khafrī, the “heavens” in the verse was interpreted as the Equinoctial and the “earth” as the Ecliptic equator, then the term *ratq* (from *rataqa* meaning to mend or to stitch, but here *ratq* means stitched together) denoted the coincident status of the two great circles and *fatq* (from *fataqa* meaning to rip) their separation. But Khafrī, in contrast to

²⁹⁶ Quṭb al-Dīn Shīrāzī, “Nihāya al-idrāk fī dirāyat al-aflāk” (British Library: Oriental Manuscripts, Add MS 7482, November 16, 1467), fols. 28r-28v. Another discussion concerning the variations in Obliquity was given by Shīrāzī’s disciple Nizām al-Dīn Nīsābūrī (d. 1329-30) in his commentary on Ṭūsī’s recension of the *Almagest*. Robert Morrison, *Islam and Science: The Intellectual Career of Nizām al-Dīn al-Nīsābūrī* (Routledge, 2007), 164–66.

²⁹⁷ Khafrī, Shams al-Dīn, “Muntahā al-idrāk fī murak al-aflāk” (Tehran, Parliament Library MS 6352, n.d.), fols. 33v-34v.

²⁹⁸ Muhammad Marmaduke Pickthall, trans., *The Holy Qur-’aan* (Lahore: Qudrat Ullah Co., 2011), 360.

«أَوَلَمْ يَرَ الَّذِينَ كَفَرُوا أَنَّ السَّمُوتِ وَالْأَرْضَ كَانَتَا رَتْقًا فَفَتَقْنَاهُمَا وَجَعَلْنَا مِنَ الْمَاءِ كُلَّ شَيْءٍ حَيٍّ أَفَلَا يُؤْمِنُونَ».

‘Āmilī, did not reject the whole idea of coincidence and the Resurrection, instead he wrote “God, Glory be to Him, knows better the truth.”²⁹⁹

4.5 The Horizon Circle

The discussion of horizon in the *Dissection* covers more pages than other circles. Its definition is accompanied with definitions of related small circles and some arcs. Comments on this topic in the *Gloss* also occupy a relatively long portion. The definition of horizon in the *Dissection* reads, “... it is an intermediary between the upper and lower halves [of the sky] and its poles are the zenith and nadir and [it] bisects the first [circle, i.e., Equinoctial] at the east and west points. The connecting [line] between the two is the equator line; and [the horizon bisects] the second [circle, i.e., Ecliptic equator] at the ascendant and descendent [points].”³⁰⁰ This definition is followed by definitions of the ortive and occasive amplitude arcs and almucantar parallel circles with their different positions with respect to the Equinoctial. The ending discussion of this topic is the introduction of the arc of daylight, the arc of night, and the equation of daylight.

‘Āmilī began his comments on the horizon circle by criticizing one of the famous commentators of Ṭūsī, Ḥasan ibn Muḥammad Nīsābūrī (d. 1329/30), known as Niẓām al-Dīn al-A‘raj, who studied astronomy under Quṭb al-Dīn Shīrāzī. Nīsābūrī completed his *Tawḍīḥ al-Tadhkira* (*Elucidation of the Tadhkira*) in mid-July 1311.³⁰¹ Ṭūsī’s definition of the horizon in the *Tadhkira* is short: “This is the great circle that divides the visible from the invisible on the celestial sphere. One of its poles is the zenith and the other is directly opposite if from below.”³⁰²

²⁹⁹ Shams al-Dīn Khafīrī, “al-Takmila fī sharḥ al-Tadhkira” (Tehran, National Library, MS 2337, December 1, 1682), fols. 92r-93v; “Muntahā,” fols. 34r-34v.

³⁰⁰ al-‘Āmilī, “Tashrīḥ al-aflāk,” 986 1576, fol. 6v.

³⁰¹ Robert Morrison, “Nīsābūrī: al-Ḥasan ibn Muḥammad ibn al-Ḥusayn Niẓām al-Dīn al-A‘raj al-Nīsābūrī,” in *The Biographical Encyclopedia of Astronomers* (New York, NY: Springer New York, 2007), 837–837, https://doi.org/10.1007/978-0-387-30400-7_1016.

³⁰² Ragep, *Ṭūsī’s Memoir*, I:116-117.

Nīsābūrī first defined the true horizon as a circle whose plane passes through the center of the Earth, therefore bisecting the body of the Earth, and then he added the definition of the apparent horizon, which is parallel to the former but tangent to the surface of the Earth. Both circles have the same poles, but the visible portion of the sky is always smaller in that portion divided by the apparent horizon. The difference between the two horizons amounts to the radius of the Earth, which compared to the sizes measured above the orb of the Sun is imperceptible, but it is perceptible compared to what is below the Sun, like its effect on parallax.³⁰³

‘Āmilī’s primary objection in this commentary is that while Ṭūsī classified the horizon as a great circle, Nīsābūrī mistakenly assumed Ṭūsī’s definition to be of the apparent and not the true horizon, which is smaller. For another corroborating witness to support Ṭūsī, ‘Āmilī referred to a commentator on the *Tadhkira* from the early Safavid period, ‘Abd al-‘Alī Birjandī (d. 1525/26) who confirmed ‘Āmilī’s interpretation. Birjandī’s commentary, completed in July-Aug 1507,³⁰⁴ was one ‘Āmilī liked, since he had taught the whole work to his disciple Tunikābunī and Tunikābunī later wrote a commentary on it. Birjandī defined three different horizons in his commentary (see Fig. 4.6): the True horizon, the Apparent horizon, and a third one called the Shield horizon (*ufuq al-tursī*) or the Perceptible horizon (*ufuq al-ḥissī*). ‘Āmilī also defined the Shield horizon in the *Gloss* and explained that neither the Apparent nor Shield horizon is a great circle, but they are parallels to the True horizon called almucantars. Another objection to Nīsābūrī, according to ‘Āmilī, was that it is not the apparent horizon that divides the visible from the invisible, instead it is the Shield horizon which makes the division. At the end ‘Āmilī brings his preferred definition of the true horizon as “The great circle to which the connecting line

³⁰³ Nizām al-Dīn al-A‘raj Nīsābūrī, “Tawḍīḥ al-Tadhkira” (British Library: Oriental Manuscripts, Add MS 7472, May 19, 1652), fols. 21r-21v.

³⁰⁴ Takanori Kusuba, “Birjandī: ‘Abd Al-‘Alī Ibn Muḥammad Ibn Ḥusayn Al-Birjandī,” in *The Biographical Encyclopedia of Astronomers* (New York, NY: Springer New York, 2007), 127.

between the zenith and nadir is perpendicular,” and refers the reader to his super-commentary on *Jaghmīnī* for further explanations.

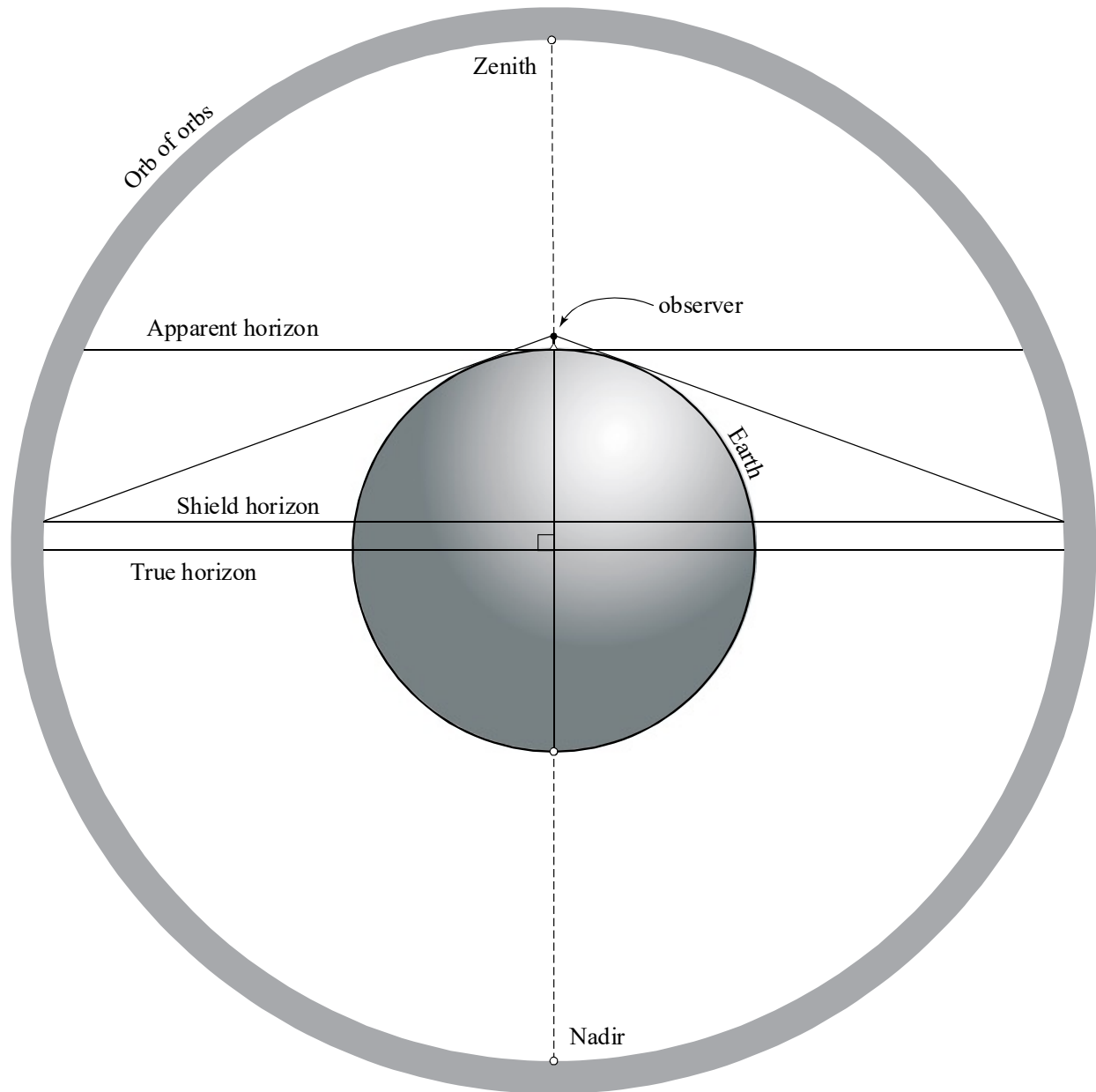


Fig. 4.6. Different horizons discussed in the *Gloss* on the *Dissection*. Among the three horizons shown, only the True horizon is a great circle, and the other two are smaller circles parallel to it. The sizes of the Earth and observer are exaggerated to show the difference between the Apparent and the Shield horizon.

The last great circle 'Āmilī discussed in the *Gloss* is the circle of altitude. This circle passes through a given point on the Ecliptic equator and the poles of the Horizon, so it is perpendicular to the Horizon like the Meridian circle. The altitude of the given point (S) on the Ecliptic equator, or the altitude of a star, is an arc (AS) measured along the circle of altitude between the Zenith point and its intersection with the Horizon (see Fig. 4-7). As 'Āmilī explains the altitude circle can coincide with several other great circles except for the Horizon. The altitude circle at the same time can coincide with five circles: the Solstitial colure, Declination circle, Latitude circle, Meridian, and the Ecliptic Meridian circle. Another magnitude related to point S is the shorter arc along the Horizon laid between the Altitude circle and the Circle of the initial azimuth (prime vertical), the great circle passing through the poles of Horizon and poles of Meridian. This is the azimuth arc of S . With the two arcs AS and AP , the altitude and the azimuth, we can also define a horizon coordinate system.

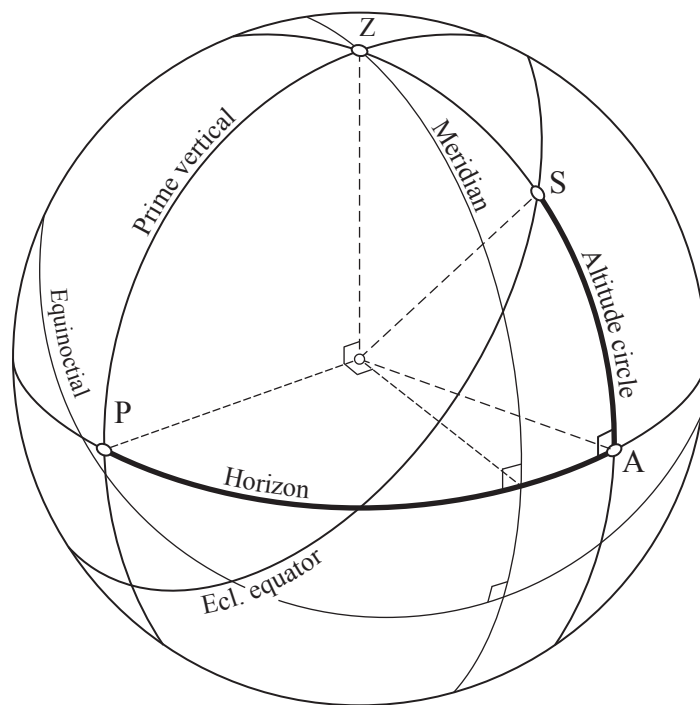


Fig. 4-7. The altitude of a given point *S* on the Ecliptic equator is the arc *SA* along the Altitude circle laid between the Ecliptic equator and the Horizon. The two arcs *AS* and *AP* define a horizontal coordinate system.

Here ‘Āmilī raised an objection against the theologian ‘Aḍud al-Dīn al-Ījī (1281-1355).³⁰⁵ In his *Kitāb al-Mawāqif fī ‘ilm al-kalām* (*The Book of Stations in Theology*), al-Ījī devoted a section of the Fourth Station to astronomy and the topics discussed in *‘ilm al-hay’a*. In his definition for the Altitude circle, he noticed that the altitude of a given star should be measured on the east, while the one which is measured on the west is called the “descent arc.”³⁰⁶ This specification was not necessary according to ‘Āmilī and the definition of the altitude arc does not depend on whether a star is east or west (rising or setting). However, ‘Āmilī did not blame al-Ījī for the

³⁰⁵ J. van Ess, “Al-Ījī,” in *Encyclopaedia of Islam*, ed. B. Lewis et al. (Leiden: Brill, 1986). On al-Ījī’s astronomical ideas see Abdelhamid I. Sabra, “Science and Philosophy in Medieval Islamic Theology: The Evidence of the Fourteenth Century,” *Zeitschrift für Geschichte der Arabisch-Islamischen Wissenschaften* 9 (1994): 32–39; Robert Morrison, “What Was the Purpose of Astronomy in Ījī’s *Kitāb al-Mawāqif fī ‘ilm al-kalām*?,” in *Politics, Patronage, and the Transmission of Knowledge in 13th-15th Century Tabriz* (Brill, 2013), 201–29..

³⁰⁶ ‘Aḍud al-Dīn ‘Abd al-Raḥmān al-Ījī, *al-Mawāqif fī ‘ilm al-kalām* (Beirut: ‘Ālam al-Kutub, n.d.), 207.

differentiation he made, instead ‘Āmilī believed that Ṭūsī first made such a distinction, but in a different context. In the *Tadhkira* (Book II, Ch. 1) Ṭūsī talked about the gradual ascent of rising points and their gradual descent and then their setting, after their arrival at a certain maximum altitude, and gave this as a reason for the sphericity of the heavens and the Earth.³⁰⁷ To ‘Āmilī, it was a convention in language to use descent or depression for falling motions, as Ṭūsī used it, not a convention in the science of astronomy, as al-Ījī implied, while descent or depression is defined for points and objects lying below the Horizon circle.

4.6 Gloss on Chapter Two: On the configurations of the orbs

A summary of this part of the *Dissection* was given in Chapter Two, and here I want to talk about what ‘Āmilī added in the *Gloss*. The second chapter of the *Dissections* is about the orbs of planets and first discusses the orbs of the Sun. According to ‘Āmilī’s definition the Sun has two orbs, one concentric with the Earth and the other once eccentric located within the thickness of the concentric orb. The body of the Sun is also located between the two spherical surfaces of the eccentric orb. The eccentric divides the concentric orb into two complements having gradual thickness (Fig. 4-8).

³⁰⁷ Ragep, *Ṭūsī’s Memoir*, I:103.

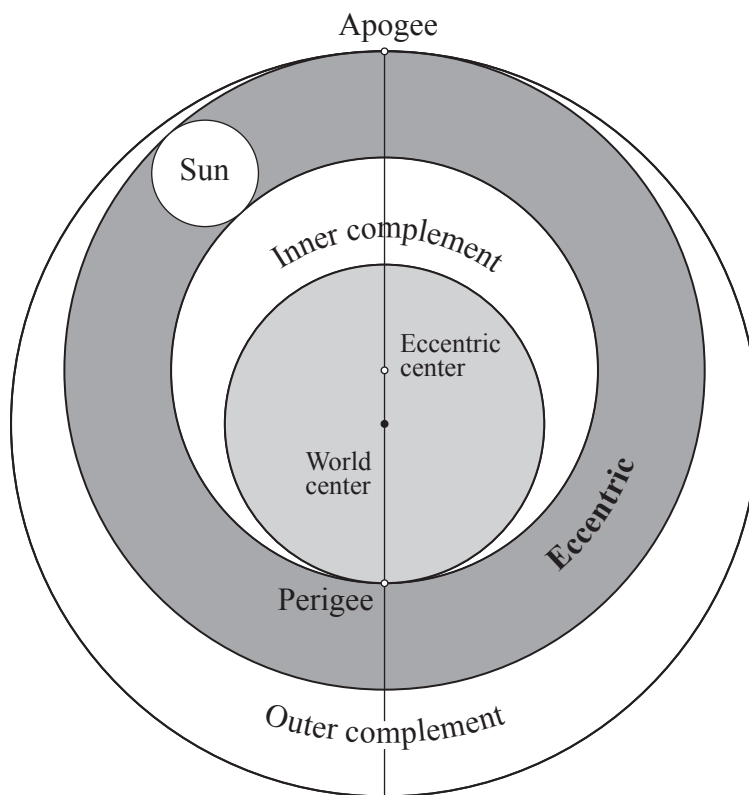


Fig. 4-8. The orbs of the Sun

Here 'Āmilī raised an objection against al-Ījī for his misunderstanding about the eccentricity of the Sun. The eccentricity of Sun is the distance between the Eccentric center and the World center (Fig. 4-8). In the *Mawāqif*, al-Ījī argued that the maximum thickness of each of the complementary orbs equals the eccentricity of the Sun,³⁰⁸ but 'Āmilī provided the following geometrical demonstration to show that the amount is double the eccentricity. Following 'Āmilī's demonstration, assume two circles *ABG* and *ADE* tangent at *A* (Fig. 4-9). *AE* is the diameter of the large circle *ABG*, and *AG* the diameter of the small circle. The distance between their centers is *ZH*. We want to show that $GE = 2ZH$.

³⁰⁸ al-Ījī, *Mawāqif*, 208.

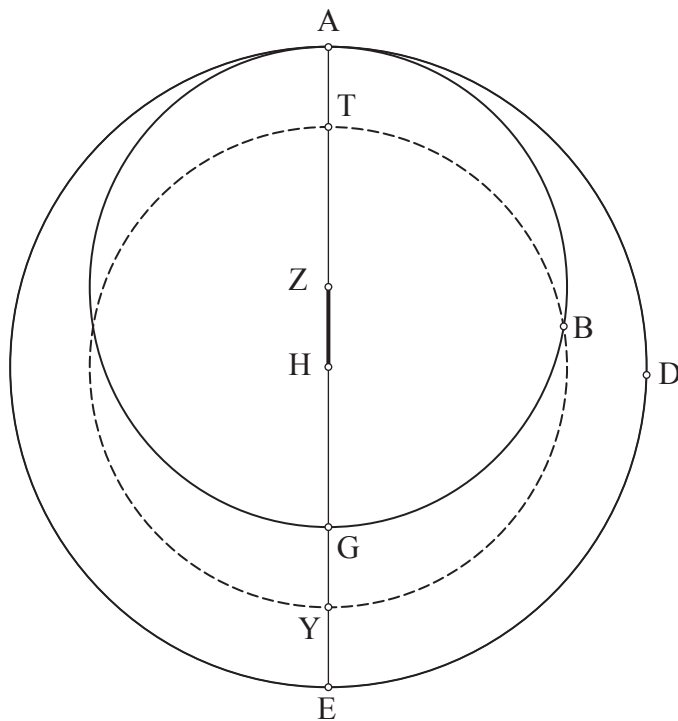


Fig. 4-9. Thickness of the complement orb and the eccentricity of the Sun

Let's draw another circle, equal to the small circle, by moving the small circle along the diameter of the large one, until its center coincides with the center of the large circle at H . Let's name the new circle TBY . It is obvious that any point on the circumference of TYB travelled the same distance that its center moved along. Then

$$AT = ZH = GY$$

since $AT = YE$ and $AT = ZH$ then

$$ZH = YE$$

and

$$GY = YE$$

therefore

$$GE = 2ZH$$

QED.

‘Āmilī regarded al-Ījī’s misunderstanding an obvious negligence, but more than that Jalāl al-Dīn Dawānī’s support for al-Ījī’s mistake astonished ‘Āmilī. ‘Āmilī wrote that Dawānī assumed al-Ījī’s argument true and Dawānī also vilified (*shanna* ‘a) anyone who vilified al-Ījī and then adduced three cases for that. According to ‘Āmilī, Dawānī’s cases which meant to support al-Ījī, were not all in accordance with al-Ījī ideas in the *Mawāqif*, and even some of them rejected Ījī.³⁰⁹ Here I show the falsity in each of the cases made by Dawānī.

Case 1: Consider both the eccentric and parecliptic orbs to be concentric. Then we move the eccentric along the apogee line until its circumference become tangent to the circumference of the parecliptic. Therefore, the circumference of the eccentric moves the same distance its center moves away from the center of the parecliptic.

In this case, Dawānī is using mobile geometry to prove his idea. He is correct about the fact that any given point on the circumference travels the same distance as the center of the circle does, but he missed an obvious point there. In Fig. 4-9 now consider that *TBY* and *ADE* represent the eccentric and parecliptic respectively. They are concentric at the initial moment as Dawānī assumed. Then move *TBY* along the apogee line until it touches the parecliptic *ADE* at point *A*. Obviously, points *T* and *Y* on circle *TBY* traveled the same distance as its center did, i.e. the distance *HZ*. So far Dawānī is right. But what he missed is the maximum thickness which is defined by the distance between points *G* and *E*. Once point *Y* moves up and coincides with point *G*, the maximum separation between *G* and *E* will be double the initial distance between *Y* and *E*.

³⁰⁹ al-‘Āmilī, “Ḥāshiya (Gloss 1682),” fols. 12v-13r; “Ḥāshiya (Gloss 1689),” fols. 10v-11r.

Case 2: Consider the eccentric coinciding with the parecliptic, then scale down the eccentric uniformly while keeping it tangent to the parecliptic at the apogee point. Therefore, to the same amount that the eccentric center is away from parecliptic center, so is the circumference of one circle distant from that of the other.

This case is a rough imagination about scaling circles that does not necessarily preserve the same distances for points on the circumference and center. As shown in Fig. 4-10, for each of the three small circles tangent with the parecliptic circle *ADE* at point *A*, Dawānī missed the same point as he did in the first case.

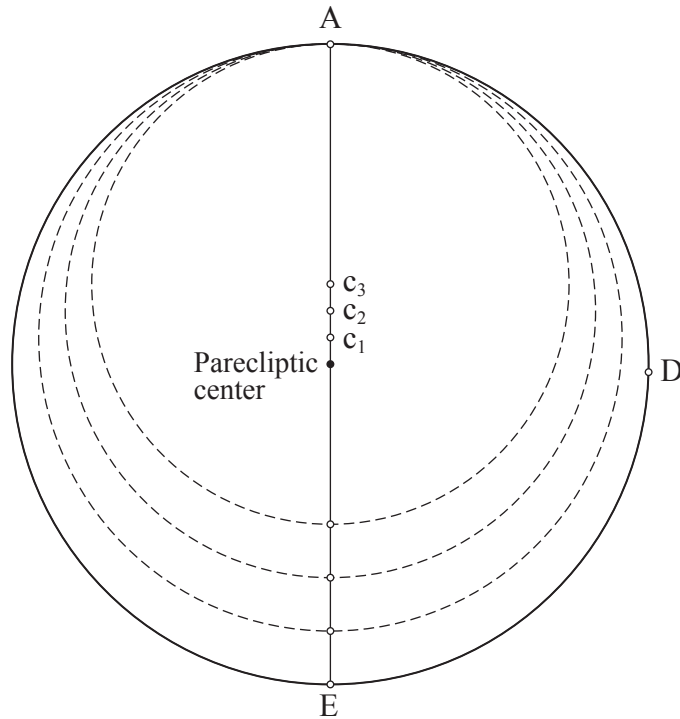


Fig. 4-10. Dawānī's second case for measuring the thickness of the complement orb

Case 3: The distance between the equators of the two orbs is the same as the distance between their centers.

This case is nothing else than repeating the first case with different wording. In fact, what Dawānī said was true in this case only if the considered orbs were of the same size and had equal diameters. The whole dispute is that for unequal orbs, as ‘Āmilī demonstrated, the maximum distance between the equators of the orbs (the circles in Fig. 4-10) is double the distance between their centers.

4.7 Gloss on Chapter Three: On the Motions

One of the interesting topics ‘Āmilī expanded in the *Gloss* was about the problems of Ptolemaic astronomy, particularly those related to the planetary models he proposed in the *Almagest*. There is a long history of how Islamicate astronomers dealt with those difficulties and came up with solutions to eliminate them. What matters more here for ‘Āmilī is a short history of the topic and the major technical problems which were, to him, finally solved by one of his predecessors from the sixteenth century. Before discussing what ‘Āmilī said in the *Gloss* about this crucial episode in Islamicate astronomy, I would like to examine and compare more accounts from the sixteenth century about the topic with a view to providing a perspective on the state of the matter from its practitioners’ viewpoint. The first account is given by Muṣliḥ al-Dīn Lārī (c. 900/1494, d. 979/1572) in his commentary on Qūshjī’s *Risāla dar hay’a*, introduced in the previous chapter. Lārī was born in Lār (S Iran) and studied under the famous astronomer Ghiyāth al-Dīn Maṣṣūr Dashtakī Shīrāzī (840-949/1416-1542) but wrote in multiple areas of knowledge like philosophy and astronomy. During the reign of Shah Ṭahmāsb I (r. 1524-1576), as Lārī indicated in one of his works, because of shah’s disfavor in supporting Sunni scholars,³¹⁰ he moved to India and attended the court of the Mughal emperor Humāyūn (r. 1508-1556) sometime during 1530-1556

³¹⁰ Reza Pourjavady, “Muṣliḥ al-Dīn al-Lārī and His *Samples of the Sciences*,” *Oriens* 42 (2014): 295.

and attained the office of *ṣadr*. After Humāyūn’s death he travelled to the Ottoman Empire and finally resided in Diyar Bakr where he was appointed the master of Hüsrev Pasha school and the Muftī (jurist). When in India Lārī wrote a Persian commentary on the *Risāla dar hay’a* for Humāyūn and there he gave the following brief history about the issue:

And the explanation of the discourse is that there are sixteen problems found with the rules of this art/discipline [astronomy]. Two of them belong to [the model of] the Moon, and [one] is the uniformity of the motion of the deferent center about the center of the universe and the other is the alignment of the epicycle radius towards the prosneusis point. And there are two problems with [the model of] each of the upper planets, one is the uniformity of deferent motion about the equant center and the other [is] the [rocking] motion of the diameter passing through the [epicycle] nodes. And there are four problems in each of the lower planets: uniformity of deferent motion toward [a point] other than its own center, the motion of the inclined [orb] due to the parecliptic, [rocking] motion of the diameter passing through the [epicycle] nodes, and the latitudinal slope (*wirāb*) and slant (*inḥirāf*).

For solving these [problems] nothing is clearly reported from the ancients and the verifier Ṭūsī in his commentary on [Ibn Sīnā’s] *Pointers [and Reminders]* had told that “it is reported from Aristotle that the number of orbs is about one hundred.” It is not unlikely that the report of this abundance would have been due to these problems. And from the moderns the first one who has intended to solve these problems is Abū ‘Ubayd Jūzjānī. He has a treatise explaining these [problems] at the beginning of which he says that “I asked the master (*shaykh*) Abū ‘Alī [Sīnā] the explanation of equant and the quality of the latitudinal twist (*iltewā’*), he said ‘I have found [the solution of] this after a great deal of difficulties and do not teach anyone [that]. You try

yourself; it might reveal to you as well.” And he [Juzjānī] proved a hundred and twenty spheres, but pondering on his modes, the falsity of all becomes apparent. After him Ibn Haytham of Egypt intended to solve some of these problems and that [his solution], as indicated in the *Tadhkira*, is not complete. After that the verifier Ṭūsī and Muḥyī al-Dīn Maghribī [intended to solve the problems], but neither gave a solution which suffices all problems without any flaws. And the scholar Shīrāzī made nine modes for solving the equant problem for Mercury and confessed the falsity of eight of them. He has explained the corruption of seven modes, and for the eighth mode has said that “I have not explained that for testing intellects.” And the ninth mode which he deemed satisfactory, is not even free of some deficiency.³¹¹

The same report also appears in an eighteenth-century source that introduces the Copernican system to the Persian readers in India. In a treatise, written in India, including an exposition of heliocentric astronomy, Abū Ṭālib Ḥusaynī Ṣafavī quoted the above excerpt from “the commentator of Qūshjī’s *Persian hay’a*” but did not indicate the commentator’s name.³¹² On this topic, however, there is another report prior to Lārī by his teacher Ghīyāth al-Dīn Dashtakī who told us about the problems of Ptolemaic models and their solutions in his book *al-Safīr fī al-hay’a* completed in 906/1500-1501.³¹³ Comparing Lārī’s report with those by Dashtakī and ‘Āmilī which I will discuss in what follows, we find it the most complete account in terms of the participants in the critical tradition developed in Islamicate astronomy (see Table 4-3).

³¹¹ For an edition of the Persian text see the Appendix to this chapter on page 142.

³¹² Abū Ṭālib Huseynī Ṣafavī and Hossein Masoumi Hamedani, “Resāle-ī dar ethbāt-e hey’at-e jadīd,” *Ma’āref* 2, no. 1 (July 1984): 162.

³¹³ Amir Mohammad Gamini and Fatima Keyghobadi, “Ghīyāth al-Dīn Manṣūr Dashtakī’s *al-Safīr fī al-hay’a*: An Abridged Treatise in ‘Hay’a’ of Safavid Period,” *Tārīkh-e Elm (The Iranian Journal for the History of Science)* 13, no. 1 (May 22, 2015): 115–31.

Table 4-3. Islamicate scholars who made attempts to solve problems of the Ptolemaic planetary models, based on three accounts recorded after the fifteenth century.

	Dashtakī (1416-1542)	Lārī (c. 1494-1579)	‘Āmilī (1547-1621)
1		Ibn Sīnā (d. 1037)	
2		Jūzjānī (d. 11 th century)	
3		Ibn al-Haytham (d. 1040)	
4	Naṣīr al-Dīn Ṭūsī	Naṣīr al-Dīn Ṭūsī (d. 1274)	Naṣīr al-Dīn Ṭūsī
5		Muḥyī al-Dīn Maghribī (d. 1283)	
6	Quṭb al-Dīn Shīrāzī	Quṭb al-Dīn Shīrāzī (d. 1311)	Quṭb al-Dīn Shīrāzī
7	<i>himself</i>		Shams al-Dīn Khafrī (d. after 1525)
8			<i>himself</i>

Lārī’s report, however, includes less technical details about the suggested solutions than the other two. The first actor in Lārī’s account is Jūzjānī, a disciple and younger colleague of Ibn Sīnā who attempted to solve some of the problems. Jūzjānī wrote a treatise on ‘*ilm al-hay’a*’ titled *kayfiyya tarkīb al-aflāk*, the complete text of which is missing today, but an epitome of the book is extant today under the title *Mulakhkhaṣ kayfiyya tarkīb al-aflāk* (*An Epitome of the Quality of the Structure of the Orbs*). The epitome was also preserved by Shīrāzī in his *Fa’alta fa-lā talum* (*You Committed That So Do Not Blame*).³¹⁴ The epitome includes Jūzjānī’s proposed models, he hoped to solve the equant problem for the upper planets and the same report Lārī gave about Jūzjānī asking from Ibn Sīnā is mentioned at the beginning of the text. But since Ibn Sīnā refused to let Jūzjānī know the solution he had found, or whether Ibn Sīnā just boasted about the issue

³¹⁴ George Saliba has edited and translated the *Epitome* in “Ibn Sīnā Abd Abū ‘Ubayd Al-Jūzjānī: The Problem of the Ptolemaic Equant,” *Journal for the History of Arabic Science* 4, no. 2 (1980): 376–403. Because of the lack diacritical marks in the manuscript copies, there are several other possible translations of this title including: “I did is so do not blame me.”

and had not really found any solution, Jūzjānī assumed himself the first who obtained those solutions.³¹⁵

Before comparing Dashtakī’s account with that of ‘Āmilī, I will introduce the description of the problems as ‘Āmilī mentioned in the *Gloss*. He classified the problems into the following six categories:³¹⁶

- 1- Uniform motion of the center of Moon’s epicycle, along its deferent orb, about the center of the universe not about the center of deferent;
- 2- Alignment of the diameter of the Moon’s epicycle towards a point (*prosneusis*) that differs from both the center of its deferent and the center of the universe; that point is distant south from the center of the universe by the same distance the center of the deferent has from the center of the universe.
- 3- Uniform motion of the five wandering planets (Upper and Lower planets) about the equant point instead of about the centers of their deferent orbs;
- 4- Motion of the apices of the epicycles of the wandering planets with different amounts in both directions (Latitudinal deviations);
- 5- Similar to the previous one for the epicycles of the lower planets (Latitudinal slant);
- 6- Motion in latitude of the deferent orbs of the lower planets in both directions.

Some of these problems pertain to multiple motions and bodies, so ‘Āmilī also gave the total number of them as sixteen as shown in Table 4-4.

³¹⁵ Saliba, 380, 400.

³¹⁶ al-‘Āmilī, “Hāshiya (Gloss 1689),” ff. 12r-12v. Ragep has also classified the sixteen problems explained by al-Ṭūsī in seven groups. Ragep, *Ṭūsī’s Memoir*, 50.

Table 4-4. Sixteen problems of the Ptolemaic planetary models

			<i>Upper Planets</i>		<i>Lower Planets</i>		
		Moon	Saturn	Jupiter	Mars	Venus	Mercury
I	Irregular motion of deferent	1					
II	Alignment of epicycle diameter toward the <i>prosneusis</i> point	2					
III	Uniform motion of epicycle center around the equant point		3	4	5	6	7
IV	Latitudinal deviation		8	9	10	11	12
V	Circular motion of epicyclic diameter (Latitudinal slant)					13	14
VI	Rocking motion of deferent diameter					15	16

Dashtakī’s account is different from Lārī’s but bears more similarities with that of ‘Āmilī. Dashtakī counted the problems of Ptolemaic models as sixteen and explained how Ṭūsī provided proper solutions to five of them and that Shīrāzī failed to give satisfactory solutions for the Moon’s model and the equant. A common report in all three accounts is Shīrāzī’s nine modes for the Mercury model, none of which was assumed effective by the three authors. According to Dashtakī, there remained eleven unsolved problems with the Ptolemaic models. Dashtakī referred readers to three of his works for his own solutions, but two of those are not extant today and the extant one includes only descriptions of alternative planetary models by Ṭūsī, Shīrāzī, and Mu’ayyid al-Dīn al-‘Urḍī (d. 1266).³¹⁷ Similar to Dashtakī’s account, in the *Gloss* ‘Āmilī explained that five problems, numbers, 1, 3, 4, 5, and 6, could be solved by the Ṭūsī couple and that Shīrāzī suggested nine models for problem number 7, and one for number 2. ‘Āmilī also added that Shīrāzī himself was satisfied with only one of his nine models for problem 7, as Lārī’s account tells us too, but ‘Āmilī did not count Shīrāzī’s models proper solutions and to him eleven unsolved problems remained. It is notable that remarks from Lārī’s account about the deficiency

³¹⁷ Gamini and Keyghobadi, “Ghīyāth al-Dīn Maṣṣūr Dashtakī’s *al-Safīr fī al-hay’a*,” 120.

of Shīrāzī’s solution for the Mercury model appear in the margin of almost all copies of the *Gloss* at this spot.

Among the three authors, Lārī is the one who assumed all previous attempts as unsuccessful solutions and according to him the state of affairs had not changed much by the time he wrote the commentary on Qūshjī. However, a key actor, according to ‘Āmilī and his commentators, who sealed the dossier of Ptolemaic problems was Shams al-Dīn al-Khafīrī (d. c. 1525) who “may God praise his attempt”³¹⁸ successfully solved all the remaining problems.³¹⁹ Khafīrī was a contemporary to Dashtakī and Lārī and was a resident of Shiraz where the other two lived for some time. In the *Gloss*, ‘Āmilī did not cite any of Khafīrī’s works, but it is obvious that his reference was to Khafīrī’s commentaries on Ṭūsī and Shīrāzī.³²⁰ ‘Āmilī also included himself in the same critical tradition saying that he had composed a single tract on solving two problems of the Moon and Mercury in two modes which “if they do not excel what others devised, [they] are not inferior to that.”³²¹ This work was later recorded as one of ‘Āmilī’s compositions under the title *Fī ḥall ishkālay ‘uṭārid wa-qamar*, by biobibliographers like Afandī Iṣfahānī (1656-1718) and Ḥurr al-‘Āmilī (d. 1693) but is currently lost.³²² I will discuss more about Khafīrī’s role in

³¹⁸ al-‘Āmilī, “Hāshiya (Gloss 1689),” f. 12v.

³¹⁹ This is an indication of how al-Khafīrī’s astronomical ideas influenced and were received by later generations. See: George Saliba, “A Sixteenth-Century Arabic Critique of Ptolemaic Astronomy: The Work of Shams al-Dīn al-Khafīrī,” *Journal for the History of Astronomy* 25 (February 1, 1994): 35–36.

³²⁰ Saliba, “A Sixteenth-Century Arabic Critique of Ptolemaic Astronomy.”

³²¹ al-‘Āmilī, “Hāshiya (Gloss 1689),” f. 12v-13r.

³²² Iṣfahānī, *Riyāḍ al-‘ulamā’*, 5:90; Muḥammad ibn al-Ḥasan al-Ḥurr al-‘Āmilī, *Amal al-‘āmil fī ‘ulamā’ jabal ‘āmil*, ed. Sayyid Aḥmad al-Ḥusaynī, Second Edition (Beirut: Lebanon: al-Wafā’, 1983), 1:156. The lost treatise was titled *Ḥall ishkālay uṭārid wa-qamar* (*Solution to the problems of the Mercury and the Moon*). Al-Iṣfahānī (d. 1130/1718) who usually recorded bibliographical information from actual copies he himself observed, included this title among ‘Āmilī’s works (Iṣfahānī, *Riyāḍ al-‘ulamā’*, 5:90.). It was also reported as one of Bahā’ al-

shaping subsequent thoughts about Ptolemaic problems among Persian astronomers, especially among ‘Āmilī’s disciples and a commentator, in Chapter 5 and Chapter 6.

4.7.1 The Equation of the Sun

On several occasions in the *Gloss* ‘Āmilī expanded topics for beginners who might not have enough knowledge to understand them as presented in the *Dissection*. One example was his proof for the nonuniform motion of the Sun and the equation of the Sun as observed from the Earth. Before dedicating pages providing a geometrical proof and demonstration for the equation of the Sun and showing that the Sun moves uniformly about the center of its eccentric orb not about the center of the universe,³²³ ‘Āmilī wrote that he has made the explanation in a way that a novice would not ignore it (‘*alā mā lā-yajūz lil-mubtadi’ jahlah*).³²⁴ Here I explain ‘Āmilī’s demonstration for the uniform motion of the Sun along its eccentric orb, which is observed to be nonuniform from the center of the universe.

In Fig. 4-11, consider that the circle *ABC* is the eccentric centered at *E*, and the circle *ADK* the precliptic centered at the center of the universe at *Z*, and *AD* the line passing through the apogee and perigee points. We want to show that the uniform motion of the Sun with respect to *E*, is nonuniform with respect to *Z*.

Proof: On circle *ABC* cut equal arcs *AB*, *BC* and connect *BZ* and *CZ*. Then produce *BZ* to *BH* then connect *AH* and *CH*. Therefore, *arc BAH* > *arc BCH* since the center of circle *ABC* lies in the larger section of *BAH*. Since

Dīn’s books by Ḥurr al-‘Āmilī (1033-1104/1624-1693) in his biobibliography of Shiite ‘ulamā’ of Jabal ‘Āmil. See al-Ḥurr al-‘Āmilī, *Amal al-‘āmil*, 1:156.

³²³ al-‘Āmilī, “Ḥāshiya (Gloss 1689),” ff. 13r-14v.

³²⁴ al-‘Āmilī, f. 13r.

$$\text{arc } AB = \text{arc } BC$$

then

$$\text{arc } AH > \text{arc } CH$$

then

$$AH > CH$$

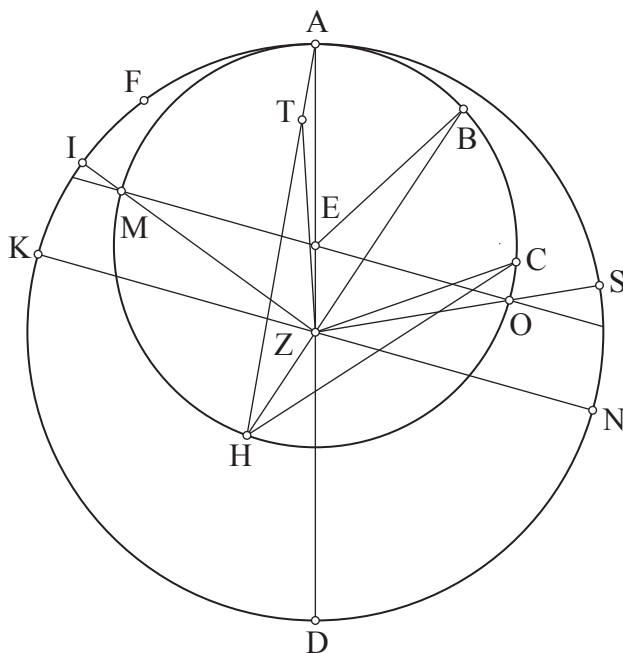


Fig. 4-11. Equation and anomaly of the Sun in the *Gloss* on the *Dissection*

On chord AH cut HT equal to CH , then connect ZT . Now in two triangles $\triangle THZ$, $\triangle CZH$ we have:

$$\Delta THZ, \quad \Delta CZH \begin{cases} CH = HT \\ HZ \text{ comm.} \\ C\hat{H}Z = Z\hat{H}T \end{cases}$$

therefore, according to *Elements* I:4³²⁵

³²⁵ This proposition is the first in the *Elements* about the equality of two triangles. It demonstrate that if two given triangles have two equal sides with equal angles contained by those equal sides, the triangles are equal. Euclid, *Elements*, I:247-248.

$$\triangle THZ = \triangle CZH$$

thus

$$H\hat{Z}T = H\hat{Z}C$$

Then for the exterior angles we have:

$$C\hat{Z}B = B\hat{Z}T$$

thus

$$C\hat{Z}B > B\hat{Z}A$$

Therefore, 'Āmilī concludes that for an observer at point Z , the center of the universe, $\text{arc } BC$ is seen greater than $\text{arc } AB$, which means that although the Sun traveled equal arcs on its eccentric orb, i.e. $\text{arc } AB = \text{arc } BC$, in equal intervals of time, and moves uniformly on the eccentric, from the center of the universe, it is seen that the Sun traveled a greater angular distance on $\text{arc } BC$ than the angular distance it traveled on $\text{arc } AB$ in the same amount of time. Moreover, the difference between the actual and observed values for $\text{arc } AB$, i.e. the difference between angles $A\hat{E}B$ and $B\hat{Z}E$, as 'Āmilī calculates, is $Z\hat{B}E$. If we connect BE (Fig. 4-11), according to *Elements* I:32³²⁶, the exterior angle $Z\hat{B}E$ in triangle $\triangle BEZ$ is the difference between the observed and true value:

$$A\hat{E}B = Z\hat{B}E + B\hat{Z}E \blacksquare$$

Afterwards, 'Āmilī gave more explanation about the equation of the Sun and expanded another topic he had dealt with in the *Dissection*. In the *Dissection*, 'Āmilī had introduced the equation of the Sun and pointed that among other planets, the Sun has the minimum number of equations, which is only one. The diagram in the *Dissection* (Fig. 4-12) that accompanies the definition of Sun's equation is simpler than the one in the *Gloss*.

³²⁶ Euclid, I:316-317.

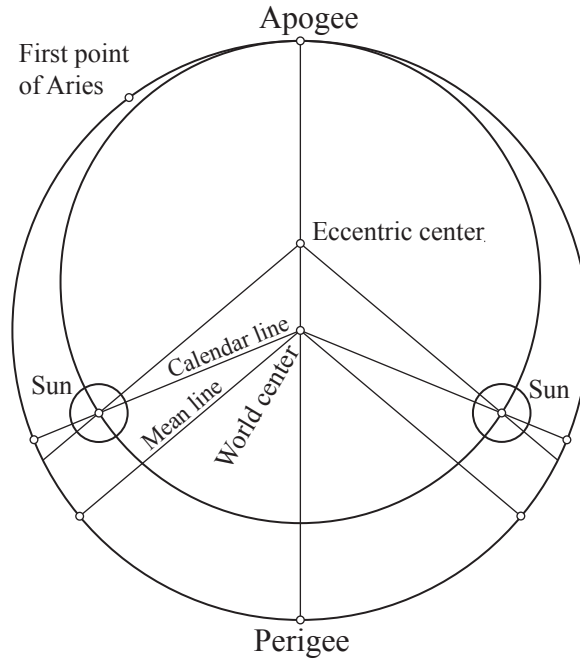


Fig. 4-12. The equation of the Sun in the *Dissection*

According to the *Dissection*, the equation of the Sun is an arc on its paraecliptic orb contained between two lines, the “true position line” (*taqwīm*) and the “mean position line” (*wasaf*). The true position line passes through the center of the world to the center of the Sun ending at the outermost orb, and the mean line passes through the center of the world to the outermost orb, but parallel to the line connecting the center of the eccentric orb and the center of the Sun. As 'Āmilī explains in the *Dissection*, the mean position of the Sun is defined by the arc on the paraecliptic between the first point of Aries and the endpoint of the mean on the paraecliptic. There he adds that in order to obtain the true position of the Sun, we should subtract the equation from the mean position when the Sun is descending on the eccentric orb, and add it to the mean position when the Sun is ascending. Therefore, the true position of the Sun is defined by an arc on the

Ecliptic orb that lies between the first point of Aries and the endpoint of the true position line, measured along the order of the zodiac signs.³²⁷

The *Gloss* gives more clarification on how to obtain the true position of the Sun in two modes of ascending and descending motions with respect to the apogee and perigee. Let’s assume that point *F* in Fig. 4-11 is the first point of Aries and that the Sun is centered at *M*. The mean line and true position line are *ZK* and *ZMI* respectively. Thus, the equation or anomaly of Sun is *arc IK* which is also defined by the angle $E\hat{M}Z$, the angle of anomaly, that equals the central angle $M\hat{Z}K$ subtending *arc IK*. In the descending half of the eccentric we have:

$$\text{true position} = \text{mean position} - \text{equation}$$

$$\therefore \text{arc FI} = \text{arc FK} - \text{arc IK}$$

Proof: The angle $E\hat{M}Z$ is the difference between the motion of the Sun with respect to the center of the eccentric (*E*) and to the center of the world (*Z*). The angle $E\hat{Z}M$ is the amount of the observed motion or the true position, and the external angel $A\hat{E}M$ is the amount of the uniform or mean motion. In the triangle $\triangle EZM$:

$$\hat{Z} = A\hat{E}M - E\hat{M}Z$$

$$\therefore \hat{Z} = A\hat{E}M - M\hat{Z}K$$

$$\therefore \hat{Z} = A\hat{E}M - \text{arc IK}$$

therefore

$$\text{true position} = \text{mean position} - \text{equation} \blacksquare$$

³²⁷ al-‘Āmilī, “Tashrīḥ al-aflāk,” 986 1576, fols. 12r-12v.

However, when the Sun is ascending on the eccentric, at O , the true position observed from Z is the angle $O\hat{Z}D$ that is the complement of the angle $O\hat{Z}E$ in the triangle $\triangle OZE$. The mean position is $O\hat{E}Z$ and we have:

$$O\hat{Z}D = 180^\circ - O\hat{Z}E = O\hat{E}Z + E\hat{O}Z.$$

Since

$$equation = E\hat{O}Z = O\hat{Z}N = arc\ SN$$

therefore, in the ascending half of the eccentric:

$$true\ position = mean\ position + equation \blacksquare$$

In the *Gloss*, the discussion about the motion of the Sun ends here and ‘Āmilī does not deal with the anomalies of the other planets, presumably because a matter of such complexity does not belong to this introductory text. But he expands on the topic of illumination and the eclipses of the two luminaries. The comments on the last topic in chapter three of the *Dissection* deal with the body of the Moon and eclipses including some interesting discussions which I will try to summarize here. This section consists of three discussions: first, the illumination of the Moon, its relative positions to the Sun in conjunctions, oppositions, and quadrature along with references to propositions in the Aristarchus of Samos’ (c. 310- c. 230) treatise *On the Sizes and Distances of the Sun and Moon*, and Euclid’s *Elements* and *Phenomena*; second, the formation and visibility of the eclipses and necessary conditions of them to occur; third, a short comment about the Earth reflecting the Sun’s rays and its possibly showing similar phases like the Moon.

‘Āmilī begins with the illumination of the Moon by Sun’s rays and rejects two objections by previous theologians who, according to ‘Āmilī, had misunderstood Ibn al-Haytham (d. 1040) and criticized him based on false grounds. ‘Āmilī does not mention any names and only refers to two

works, the *Ḥikma al-‘ayn* and the *Mawāqif*. The *Ḥikma al-‘ayn*,³²⁸ a book on metaphysics and natural philosophy, belongs to Najm al-Dīn al-Qazwīnī al-Kātibī (d. 1276),³²⁹ also known as Dabīrān, a Persian philosopher and logician who collaborated with Ṭūsī at the Marāgha observatory, and the *Mawāqif fī ‘ilm al-kalām*,³³⁰ a work on theology, was written by the famous theologian ‘Aḍud al-Dīn al-Ījī (d. 1355), who we have already mentioned.³³¹ Both scholars, as ‘Āmilī explains, attributed the false opinion to Ibn al-Haytham that what causes the Moon to exhibit different phases is that the Moon’s spherical body itself is self-luminous in one half and dark in the other. Therefore, by rotating around its axis it appears to us with different phases, and not because of reflecting the Sun’s rays. In the *Gloss*, ‘Āmilī refutes the idea and states that Ibn al-Haytham’s elevated rank in astronomy never lets him commit such mistakes. Then he recommends the reader to see details of his argument against Kātibī Qazwīnī and al-Ījī in the *Ḥadīqa al-hilāliyya* (see Chapter 2).

The last comment in this section is a remark concerning the illumination of the Earth by the Sun like that of the Moon. ‘Āmilī states that he is reporting the ideas from other scholars that the Moon receives the Sun’s rays because of the density of its surface and reflects them because of its shiny surface, so the same can apply to the Earth because of its density and shininess of its surface since it is mostly covered by water. Therefore, a person on the surface of the Moon

³²⁸ The only modern edition of al-Kātibī’s book available to me was a thesis including the edition of the Arabic text with a Turkish translation. However, an edition of Mīrak Bukhārī’s commentary on the *Ḥikma al-‘ayn* is also available. ‘Alī ibn ‘Umar Kātibī Qazwīnī and Šālih Aydin ibn ‘Abd al-Ḥamīd al-Turkī, “Ḥikma al-‘ayn” (University of Ankara, 2002), 75; Muḥammad ibn Mubārakshāh Mīrak Bukhārī and ‘Alī ibn ‘Umar Kātibī Qazwīnī, *Sharḥ Ḥikma al-‘ayn*, ed. Ja‘far Zahedi (Mashhad: Ferdowsi University of Mashhad Press, 1975), 527.

³²⁹ M. Mohaghegh, “Al-Kātibī,” in *Encyclopaedia of Islam, Second Edition*, vol. IV (Brill, 1997), 762.

³³⁰ al-Ījī, *Mawāqif*, 214. For further reading see: Morrison, “What Was the Purpose of Astronomy in Ījī’s *Kitāb al-Mawāqif fī ‘ilm al-kalām*?”

³³¹ Ess, “Al-Īdī.” On Ījī’s views about astronomy and validation of astronomers’ arguments see Sabra, “Science and philosophy in medieval Islamic theology,” 32–39. Particularly, about Ījī’s ideas on the nature of demonstrations astronomers proposed for the cause of Moon’s phases and eclipses see Morrison, “What Was the Purpose of Astronomy in Ījī’s *Kitāb al-Mawāqif fī ‘ilm al-kalām*?”

would see the same phases from the Earth and would assume that the Earth moves around the Moon as they observe crescents, full illumination of the Earth's disc, and eclipses during a month period. The only difference, as 'Āmilī explains, would be that when the full Moon appears to us, the Earth appears for the inhabitants of the Moon like a new Moon, and the other way round. Likewise, when there is a lunar eclipse for us, it is seen as a solar eclipse for the Moon and vice versa. At the end, 'Āmilī adds that although it is not possible to travel to the Moon, imagining this strengthens thoughts and sharpen minds. The hypothesis, as 'Āmilī indicated, was not his own, but he did not mention its source. However, he may have appropriated the idea, most probably, from one of Ṭūsī's Persian works on *hay'a*, the *Zubda al-hay'a*, that includes the same discussion.

The *Gloss* inspired numerous commentaries on the *Dissection*, all of which also incorporated the *Gloss* in their texts, but discussed more topics or higher level materials that 'Āmilī never touched upon. Most of the commentaries and glosses were made after the author's death in 1030/1621 and in later centuries. Āqābuzurg Tehrānī (Muḥammad Muḥsin, 1876-1970) and 'Abd al-Ḥusayn Amīnī (1902-1970) recorded many commentaries and glosses on the *Dissection* including the author's own.³³² No commentary in their records is reported to predate 'Āmilī's own *Gloss*. As noted above, in 1008/1600 'Āmilī granted an *ijāza* to a disciple after he taught him the *Dissection* and the *Gloss*. Before that, he also encouraged Tunikābunī to write his lengthy commentary *Qānūn al-Idrāk* on the book, as was noted in the introduction by Tunikābunī, and issued an *ijāza* in 1602 certifying the study of the *Dissection* and the *Gloss* as part of Tunikābunī's educational credentials. Some of the commentaries were made by 'Āmilī's disciples and some by later scholars up to the nineteenth century. Two of the most extensive ones

³³² Āqābuzurg Tehrānī, *al-Dharī'a*, 4:186-87, 13:146-49; Amīnī, *al-Ghadīr*, 11:348-49; Naji-Nasrabadi, *Ketābshenāsīye Sheykh Bahā'ī*, 187-202.

were made by the author’s students during his lifetime, the first by Tunikābūnī in Dhil-Ḥajj 1007/June-July 1599, as already mentioned, and the other by Shams al-Dīn ‘Alī ibn Muḥammad ibn ‘Alī al-Ḥusaynī al-Khalkhālī at the end of Ṣafar 1008/10-11 September 1599 in Agra (India).³³³ In the *Qānūn al-idrāk* ‘Āmilī’s sentences in the *Gloss* are distinguished by a red overline, which can be seen in extant copies.³³⁴ This technique was known as *sharḥ mazj* (interwoven commentary). In this type of commentary, instead of writing the explanatory sentences in the margin of the page or underneath the main text at the bottom of the page, the commentary includes the clauses of the original text among the explanatory sentences and distinguishes them by an overline. One of the copies of the *Qānūn al-idrāk* includes an *ijāza* Tunikābunī granted to the scribe, and in a marginal note he specified that phrases in red from the original text, i.e. the *Dissection*, which were differentiated from his commentary in black, and that ‘Āmilī’s *Gloss* should appear with a red overline.³³⁵

4.8 Conclusion

The *Gloss to the Dissection* by ‘Āmilī obviously contains material beyond the *Dissection*, and in several cases as explained above the *Gloss* expands the abridged topics of the original text. The widespread circulation of the *Dissection* besides its adoption as a textbook in astronomy (see Chapter 3) suggest that it became an ideal textbook on *hay’ā* for students at religious madrasas and appealed to a broad audience of med-level learners of the sciences. However, the use of the *Dissection* as a textbook was usually accompanied with the author’s *Gloss* and ‘Āmilī himself taught both texts to numerous of his disciples and granted some an *ijāza* for transmitting them.

³³³ al-Khalkhālī, “Sharḥ Tashrīḥ al-aflāk”; Āqābuzurg Tehrānī, *al-Dharī’a*, 13:147.

³³⁴ Tunikābunī, “Qānūn al-idrāk,” 1025 1616; Muḥammad-Kāẓim Tunikābunī, “Qānūn al-idrāk fī tashrīḥ al-aflāk” (Qum, Ayatollah Marashi Najafi Library, MS 4672, 1029H 1620); “Qānūn al-idrāk fī tashrīḥ al-aflāk” (Tehran, Parliament Library, MS 6262, 1032 1623).

³³⁵ Tunikābunī, “Qānūn al-idrāk,” 1029H 1620, f. 3r.

The purpose of the *Gloss* was twofold. It added necessary expansions to some topics benefitting those students who were interested to know more, and clarified the disputes between theologians on astronomical issues. The controversies 'Āmilī noted in the *Gloss* are all those topics of *'ilm al-hay'a* which most mattered for theology and religious scholars or were raised by theologians. The contents of the *Gloss* suggest that 'Āmilī's audience consisted mostly of theology students who might have come across some of those disputes in textbooks such as Ījī's *Mawāqif*, and its commentary by Jurjānī, or Ṭūsī's *Tajrīd al-i'tiqād* and its numerous commentators, among them Qūshjī and Dawānī. However, 'Āmilī's two super commentaries on Jaghmīnī's *Mulakhkhaṣ* addressed a broader audience as they discussed more technical matters of *'ilm al-hay'a*. On the other hand, the *Gloss* also presents amusing and entertaining materials like the proof about distances between feet and heads on the surface of the Earth and the imaginary traveler who would travel the circumference of the Earth in three days.

Although the *Gloss* does not itself contain new models in planetary theory, it informs its readers about previous attempts made by 'Āmilī's predecessors associated with Marāgha and Samarqand. In the *Gloss* 'Āmilī gave a complete report of all sixteen problems in Ptolemaic astronomy that Islamicate astronomers detected and endeavored to solve by proposing non-Ptolemaic models for planetary motions. Moreover, the *Gloss* mentions 'Āmilī's own book about new models for the Moon and Mercury, thus announcing that the critical tradition aimed at solving problems of Ptolemaic astronomy was still ongoing in the late sixteenth century. It is also notable that, in the *Gloss*, 'Āmilī places himself within this particular tradition in Islamicate astronomy, a project which according to him began by Naṣīr al-Dīn Ṭūsī and his disciple Shīrāzī and ended with the successful and final attempts of Shams al-Dīn Khafīrī. Unlike Lārī, 'Āmilī did not give a full report about all participants in the critical tradition, but 'Āmilī and his

commentators and successors, who wrote in Iran and Mughal India in the following two centuries optimistically viewed Khafrī as the savior of the tradition who essentially solved all remaining problems in Ptolemy’s planetary models and eliminated the difficulties. This topic will be fully discussed in Chapter 6.

4.9 Appendix

An excerpt from Lārī's commentary on Qūshjī's *Risāla dar hay'a* completed before 1556 in India, in which Lārī gave a brief account about what has been done by Islamicate astronomers to the problems of the Ptolemaic planetary models. The following text is edited based on two copies of the commentary, denoted in the critical apparatus by abbreviations **D** and **M**.

Ms. **D**: University of Tehran 9825, copied 1076/1666 in Constantinople

Ms. **M**: Parliament Library 5234, copied 1208/1794 in Mashhad.

[D 32r]... [M 81v] و تفصیل کلام آن که اشکالاتی که وارد می‌شود بر قواعد این فن شانزده است. دو از آن در قمر است و آن تشابه حرکت حامل است حول مرکز عالم و دیگر محاذات قطر نسبت به نقطه محاذات. و در هر یک از علویه دو^{۳۶} اشکال است یکی تشابه حرکت حامل نسبت به مرکز معدل المسیر و دگر حرکت قطر مارّ به ذروه و حضيض. و در هر یک از سفلیین چهار اشکال است تشابه حرکت حامل نسبت به غیر مرکز خود و حرکت مایل به جهت مُمَثِّل و حرکت قطر مارّ به ذروه و حضيض و عرض و راب و انحراف.

و در حل این از قدما به صریح چیزی منقول نیست و محقق طوسی در شرح اشارات آورده که از ارسطاطالیس منقول است که عدد افلاک به صد قریب است و دور نیست که قول به این کثرت بنا بر این اشکالات بوده باشد. و از متأخرین اول کسی که در صدد حل این اشکالات در آمده ابوعبید جوزجانی^{۳۷} است و او را رساله‌ای است در بیان این و در [M 82r] اول آن رساله می‌گوید که بیان معدل المسیر و کیفیت عرض التواء از شیخ ابوعلی پرسیدم گفت که من بعد از تعب بسیار این را یافته‌ام و کسی را تعلیم نمی‌کنم تو خود سعی کن که شاید بر تو هم ظاهر شود. و وی اثبات صد و بیست کره

^{۳۶} دو [سه (M)]

^{۳۷} جوزجانی [جرجانی (M)]

نموده لیکن بعد از تأمل در وجوه او عدم تمامی آن ظاهر می‌شود. و بعد از او ابن هیثم مصری در صدح حل بعضی از این اشکالات در آمده و آن نیز تمام نیست چنانچه در تذکرة به آن اشاره شده. بعد از آن محقق طوسی و محیی‌الدین مغربی و ایشان نیز حلی که وافی به جمیع اشکالات بی آن که خللی لازم آید نکرده‌اند. و علامه شیرازی در حل معدل المسیر عطارده وجه ذکر کرده و به فساد هشت وجه معترف شده و در هفت وجه فساد را ذکر کرده و در هشتم گفته که بنا بر امتحان اذهان ذکر نکرده‌ام. و وجه نهم را که مرضی دانسته هم خالی از قصوری نیست.

Chapter 5

Shams al-Dīn ‘Alī Ḥusaynī Khalkhālī’s Commentary on ‘Āmilī’s *Dissection*

5.1 The Commentary tradition based on ‘Āmilī’s works

Commentaries on ‘Āmilī’s scientific works appeared many times in the Safavid, Mughal, and Ottoman Empires. His works in mathematics and astronomy became textbooks in madrasas. Students of religious and secular sciences studied those texts frequently. His impact on education in Safavid Persia was undeniable; however, there is substantial evidence that he was also a scientific authority in Mughal India. As I showed in Chapter 3, ‘Āmilī’s *Dissection*, a short and elementary book on ‘ilm al-hay’a, initially appeared more as an attempt to make a patronage gift rather than to present an up-to-date textbook on astronomy. I also explained that the *Dissection*, beyond to the author’s primary purpose of the book, became the subject of more than forty commentaries, super-commentaries, and glosses over the subsequent three centuries, in multiple geographical locations from the Ottoman Empire to the Mughal empire in India. As I argued in that chapter, ‘Āmilī’s political and intellectual career ebbed and flowed, partly as a result of the career of his father as the first *shaykh al-islām* (the chief jurisconsult) of the Safavid dynasty. The *Dissection* began to attract the attention of scholars almost nineteen years after its publication, when the *Gloss* appeared and, at the same time, ‘Āmilī ascended to the most powerful religious position, the same one first held by his father, at the court of ‘Abbās I (r. 1588-1629). Once ‘Āmilī improved his political and religious status under the shah’s patronage, he obtained better opportunities for training students of both religious and secular sciences, a privileged situation in which his mathematical and astronomical works, including the *Dissection*

and the *Gloss* became widely read textbooks. In a relatively short time, 'Āmilī's students began to comment on his mathematical and astronomical works. Commentators on 'Āmilī's works had different motives and were of various social orientations. Among them were some religious scholars moderately interested in mathematics and astronomy for their use in religious law and everyday rituals. Such scholars made brief glosses on the *Dissection* that mainly incorporated 'Āmilī's *Gloss* to the book's main text, along with a few elaborations and comments, making occasional adjustments to the text that only suited their small circle of disciples. Some other commentators, however, were far more skilled. And commentators on 'Āmilī were not all from the Safavid Persia. During almost three centuries after 'Āmilī, people produced commentaries on him in Qazvin, Qum, Mashhad, Isfahan, Agra (N. India), Saharanpur (N. India), and Basra (Iraq). Some of these were printed, several times, in Pakistan, Delhi, Qandahar, and Bengal (see Table 5-1).

In the post-classical period of Islamicate intellectual history (1200-1900)³³⁸, most intellectual productions appeared in the form of commentaries, super-commentaries, glosses, and complements. This style of writing has been interpreted as a sign of scientific decline or demise in Islamicate culture. However, recent investigations have opened a completely new perspective on these texts and proposed new methods to treat and understand these post-classical textual productions. Dealing with commentaries and super-commentaries is usually a painstaking task, since they are mostly multi-layered texts with numerous direct and indirect quotations, and back and forth references to previously written contents. They easily confuse the reader and get them lost in determining which idea is whose. As a result, these texts need special scrutiny and patience to reveal the scope and purpose of their contents and situate them within the established

³³⁸ The term is not clearly defined in the recent scholarship, but there is a consensus about the period beginning after the twelfth century.

genres of the period. In a 1994 article, George Saliba introduced Shams al-Dīn Khafrī (d. c. 1525), an early Safavid astronomer, whose commentary on Ṭūsī's *Tadhkira* offered multiple new models for planetary motions which were meant to solve the remaining difficulties of the *'ilm al-hay'a*.³³⁹ Later Saliba discussed Ṭūsī's *Tadhkira* as an example of astronomical texts that inspired numerous commentaries. He also pointed to the misunderstanding the commentary literature as a factor in the mistaken doctrine of decline in post-classical Islamicate science, and suggested that the commentary tradition should be seen as the equivalent of modern research literature.³⁴⁰ In areas other than astronomy³⁴¹, there have recently been a few publications that examine commentaries in the medical and philosophical sciences. Asad Ahmed has examined an influential work on logic written in the late seventeenth century in India that became the subject of several commentaries up to the nineteenth century and provided a venue for philosophical disputes and the production of novel theories.³⁴² Nahyan Fancy, using the same approach, introduced the significance of the post-classical commentaries in Islamicate medicine. He has examined perhaps the most famous example of new research presented in a commentary, the work of Ibn al-Nafīs (d. 1288) whose commentary on Ibn Sīnā's *Canon of Medicine* presented, for the first time, the pulmonary transit of blood in the human body.³⁴³ All these authors have presented substantial evidence that commentary literature should be read as research literature and not be considered a symptom of decline. As a contribution to this new approach to studying

³³⁹ Saliba, "A Sixteenth-Century Arabic Critique of Ptolemaic Astronomy."

³⁴⁰ George Saliba, "Writing the History of Arabic Astronomy: Problems and Differing Perspectives," ed. F. J. Ragep and 'Abbās Sulaimān, *Journal of the American Oriental Society* 116, no. 4 (1996): 709–18, <https://doi.org/10.2307/605441>.

³⁴¹ There are still other works in modern scholarship on Islamicate astronomy that highlight the importance of commentaries after the twelve hundred. For example, see: Ragep, *Ṭūsī's Memoir*, esp. Ragep's introduction; Morrison, *Islam and Science*.

³⁴² Asad Q. Ahmed, "Post-Classical Philosophical Commentaries/Glosses: Innovation in the Margins," *Oriens* 41, no. 3/4 (2013): 317–48.

³⁴³ Nahyan Fancy, "Medical Commentaries: A Preliminary Examination of Ibn al-Nafīs's *Shurūḥ*, the *Mūjaz* and Subsequent Commentaries on the *Mūjaz*," *Oriens* 41, no. 3/4 (2013): 525–45.

the commentaries in the post-classical Islamic period, by a close examination of the two extensive and complicated commentaries, made by 'Āmilī's disciples on his *Dissection* I will highlight results similar to those in the work of Saliba, Ahmed and Fancy.

The commentaries on the *Dissection* served multiple purposes other than illuminating ambiguous parts of 'Āmilī's text. These commentaries provide a new vehicle for presenting the commentators' own ideas, criticisms, and disagreements with the author of the main text and other authorities in the discipline. Commentators do sometimes complement and correct previous works or make a judgment between the author of the main text and other authors of the same genre. Besides, commenting on earlier and contemporary authors, the commentaries on 'Āmilī's astronomy, offered an overview of the topic from ancient authorities like Ptolemy and his Islamicate successors until the time of the main text, showing how a particular theory had evolved over centuries. This single feature of the commentaries could be of some interest and use for the beginner and intermediate students who after reading some elementary textbooks on astronomy, such as the *Dissection*, would pursue higher level knowledge of 'ilm al-hay'a. Apart from the technical feature of the commentaries, they had a secondary function related to the social status of the authors. Scholars like Khalkhālī and Tunikābunī, whose commentaries on 'Āmilī I will introduce in this chapter and the one following, would have less chance of attracting attention in the scientific community without associating themselves to a well-known authority like 'Āmilī. In the Introduction, I have presented some evidence that 'Āmilī's works, both religious and secular, were not only known in Persia, but to the Indian audience of the Mughal Empire, as early as when they were produced. Commenting on such a high-profile authority, would bring greater chances for the commentators to be seen and considered serious scientific authors by their peers. In our cases, Khalkhālī and Tunikābunī both dedicated their

commentaries on the *Dissection* to the highest political authorities of their day, the former to the Mughal Emperor Akbar (r. 1556-1605), and the latter to Shah 'Abbās I (r. 1588-1629), most probably aiming to obtain the patronage of the ruler. However, this practice of dedication would not approach its highest goal without 'Āmilī's prestige in its background. This is especially true in the case of Tunikābunī who mentioned 'Āmilī's encouragement to write the commentary at the outset.

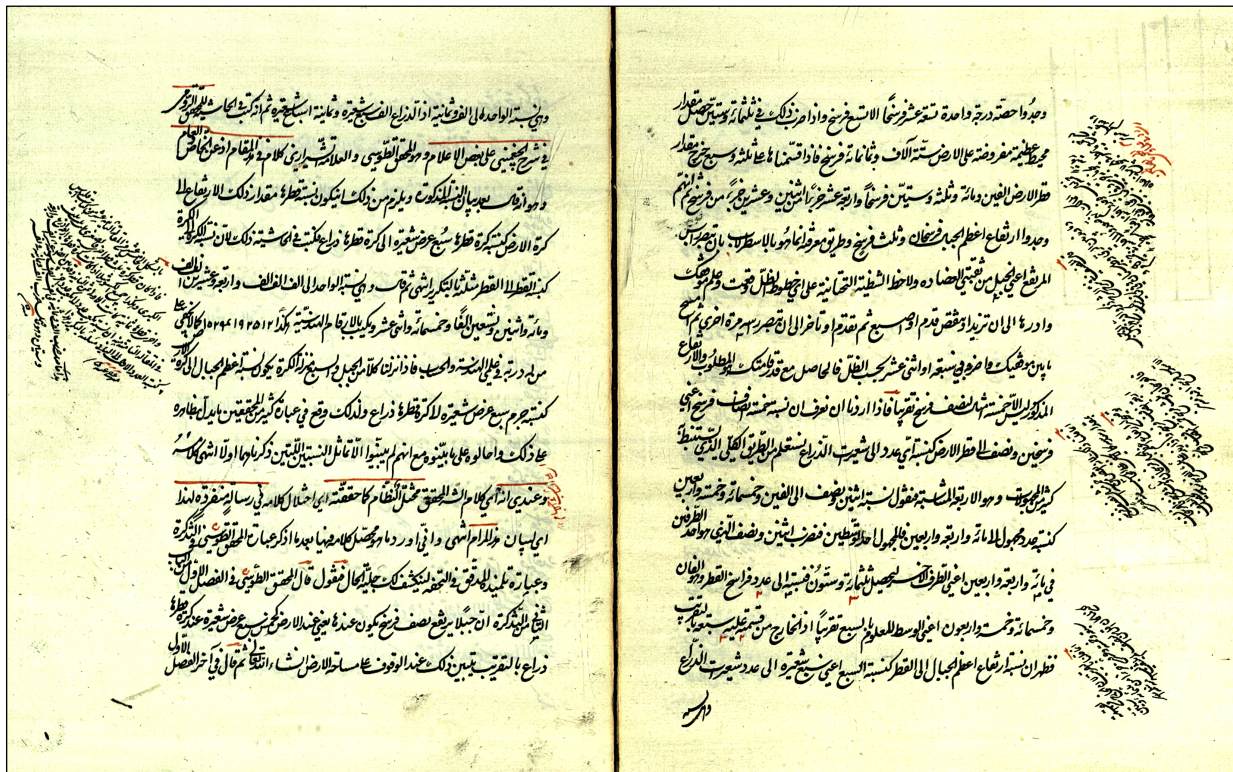


Fig. 5-1. Khalkhālī' *Exposition*, University of Tehran, MS 1241, dated 1826. The text in black is the commentary. Phrases of 'Āmilī's text are overlined in red (on the left folio). In the margins the copy presents further scholia added later by Khalkhālī.

The commentaries on the *Dissection* not only interwove (*mazi*) the author's *Gloss* with the main text but made a series of different types of comments on the whole work (see Fig. 5-1). These "critical commentaries," as I will call them, did not aim solely to expand, and explain the main text; they presented a different style of scientific composition that did not deal with the

topic from scratch but relied heavily on previous compositions and included the most up-to-date results. They presented the commentators' idea of the most appropriate way to treat the topic. I will discuss the sources used in Khalkhālī's and Tunikābunī's commentaries at the end of the following chapter to show how well the two commentators were familiar with the existing literature of astronomy, their predecessors and contemporary authors. There I have listed all authorities and sources that are mentioned in Khalkhālī's *Exposition* and Tunikābunī's *Rule*, along with the number of the appearance of the items in each commentary in Table 6-2.

In this chapter and the one following, I will examine two commentaries written by 'Āmilī's students, one written in Agra (India, in the state of Uttar Pradesh), the capital of Mughal emperors Akbar (r. 1556-1605), Jahāngīr (r. 1605-1627), and Shah Jahān (r. 1628-1658), by Shams al-Dīn 'Alī Ḥusaynī Khalkhālī, which was completed on 29 Ṣafar 1008/10 Sep 1599, during Akbar's reign. The other commentary was written in different places in Persia by Muḥammad-Kāzīm Tunikābunī, within the same year as the completion of Khalkhālī's. I begin with Khalkhālī's commentary, which was written in Agra and had features specific to the audience and culture of the place.

Below I provide an up-to-date list of all commentaries, super commentaries, and glosses written on the *Dissection*, in Table 5-1. I have made improvements to previous records by correcting some misattributions and adding previously unknown commentaries and translations which I have found. I also present some details about the printing dates and places of the commentaries.

Table 5-1. Commentaries, super-commentaries, glosses, and translations of the *Dissection of the Orbs* (in alphabetical order by authors names). The 'dates' column represents either the composition date of the entry, if available, or the latest possible date based on the author's or the dedicatee's lives.

	<i>Author, title</i>	<i>Sources and notes</i>	<i>dates</i>
1	Afandī al-Qūnawī, Sayyid 'Abd Allāh Shukrī Efendī ibn Sayyid 'Abd al-Karīm <i>Tawḍīḥ al-idrāk 'an Tashrīḥ al-aflāk</i>	Written in 1247/1857 and dedicated to the Ottoman Sultan 'Abd al-Majīd I (reign. 1839-61). ³⁴⁴	1857
2	Aḥmad ibn Muḥammad ibn Ḥasan Ḥurr al-Āmilī <i>Tawḍīḥ Tashrīḥ</i>	A copy is kept at King's College Library (Cambridge) and was made on 1 Dhū al-Ḥajja 1110/21 May 1699. ³⁴⁵ Another copy is dated 12 th /17-18 th century. ³⁴⁶ The commentator was a grandson of the famous Shiite scholar Ḥurr al-Āmilī (1033-1104/1624-1693). In Rabī' I 1055/Apr-May 1645 Ḥurr al-Āmilī copied Sharīf al-Jurjānī's (d. 816/1413) commentary on Jaghmīnī's <i>Mulakhkhaṣ</i> in Jaba' village (Palestine).	1699
3	Baḥrānī Qaṭifī (d. after 1241/1825, Muḥammad ibn 'Abd 'Alī Āl 'Abd al-Jabbār <i>Sharḥ Tashrīḥ al-aflāk</i>	Āqābuzurg, 13:148-49	1825
4	Al-Ḥuwayzī (d. c. 1103/1692), Faraj Allāh ibn Muḥammad ibn Darwīsh <i>Sharḥ Tashrīḥ al-aflāk</i>	Ḥur al-Āmilī, <i>Amal al-āmil fī 'ulamā' Jabal Āmil</i> , 2:215. Āqābuzurg, 4:187, 13:148.	1692
5	Pushdarī (or Bīshdarī), Ḥusayn ibn 'Abd Allāh ibn Muḥammad <i>Sharḥ Tashrīḥ al-aflāk</i>	Autograph written in 1267/1850-51, dedicated to Nāmiq Pāshā wālī (Governor) of Baghdad MS Princeton Garrett no. 4622Y, in 174 fols. ³⁴⁷	1851

³⁴⁴ Ekmeleddin İhsanoğlu, *Osmanlı astronomi literatürü tarihi (History of Astronomy Literature During the Ottoman Period)*, Osmanlı bilim tarihi literatürü serisi 1 (İstanbul: İslâm Tarih, Sanat ve Kültür Araştırma Merkezi, 1997), II:599; Morrison, "The Reception of Early-Modern European Astronomy by Ottoman Religious Scholars," 189.

³⁴⁵ Charles Rieu, *Catalogus codicum manuscriptorum orientalium qui in Museo britannico asservantur. Pars secunda, codices arabicos amplectens* (London, 1852), 244.

³⁴⁶ Naji-Nasrabadi, *Ketābshenāsīye Sheykh Bahā'ī*, 197.

³⁴⁷ For other copies see: İhsanoğlu, *Osmanlı astronomi*, II:689-690; Naji-Nasrabadi, *Ketābshenāsīye Sheykh Bahā'ī*, 199.

	<i>Author, title</i>	<i>Sources and notes</i>	<i>dates</i>
6	al-Jazā'irī, Faraj Allāh ibn Muḥammad ³⁴⁸ <i>Ma'ārij al-amlāk ilā Tashrīḥ al-aflāk</i>	Autograph, MS Parliament 6409, dated 23 Rabi' I 1065/21 Jan 1655, In Basra Presents numerical values for the planetary motions, including motions in latitude (fols. 48v-50r).	1655
7	Dihlawī, Muḥammad Rashīd al-Dīn Khān (d. 1833) <i>Sharḥ mūjaz li-kitāb Tashrīḥ al-aflāk</i>	Rahman recorded a Persian commentary by the same author, ³⁴⁹ but the manuscript copy at the British Library is in Arabic. ³⁵⁰	1833
8	'Aliyārī Tabrizī, 'Alī ibn 'Abd Allāh (d. 1327/1909) <i>Ḥāshīya Tashrīḥ al-aflāk</i>	Mentioned in his <i>Bahja al-'āmāl</i> , Āqābuzurg, 6:39.	1909
9	Fakhrīzāda Mūṣilī, Sayyid 'Abd Allāh <i>Tashrīḥ al-idrāk fī sharḥ Tashrīḥ al-aflāk</i>	Completed in 15 Shawwāl 1182/11 Feb 1769 Tehran Parliament Library, MS 16296, copied Sha'bān 1183/Nov-Dec 1769 from the autograph. Bibliothèque nationale de France, MS Arabe 6679. Fakhrīzāda also wrote a super-commentary on Qāḍīzāda's commentary on the <i>Mulakhkhaṣ</i> ³⁵¹ and a commentary on 'Āmilī's short Arabic treatise on the astrolabe, the <i>Ṣafīḥa</i> , in 22 Ṣafar 1149/11 June 1736 and entitled the work as <i>Sawānīḥ al-qarīḥa fī sharḥ al-Ṣafīḥa</i> . ³⁵²	1769
10	Faṭḥ Allāh, Faṭḥ- 'Alī ibn Isma'īl <i>Maṭla' al-mīzān</i>	MS Mashhad 9874, copied in 29 Sha'bān 1341/3 Apr 1923. ³⁵³	-
11	Al-Qāsānī al-Iṣfahānī, Ṣādiq al-Ṣabbāgh <i>Miṣbāḥ al-nāṣiriyya</i>	Āqābuzurg, 21:121.	-

³⁴⁸ Najī-Nasrabadi misattributed this commentary to Faraj Allāh ibn Muḥammad ibn Darwīsh al-Ḥuwayzī. *Ketābshenāsīye Sheykh Bahā'ī*, 195–96.

³⁴⁹ A. Rahman, *Science and Technology in Medieval India: A Bibliography of Source Materials in Sanskrit, Arabic and Persian* (New Delhi: Indian National Science Academy, 1982), 328.

³⁵⁰ Muḥammad Rashīd al-Dīn Khān Dihlawī, “Sharḥ mūjaz li-Kitāb Tashrīḥ al-aflāk” (British Library: Oriental Manuscripts, Delhi Arabic 1930, n.d.).

³⁵¹ Sally P. Ragep, *Jaghminī's Mulakhkhaṣ*, 289.

³⁵² İhsanoğlu, *Osmanlı astronomi*, 479–82.

³⁵³ Ahmad Golchin-Ma'ani, *Fehrest-e Kotob-e Khati-e Ketabkhaney-e Astan-e Quds-e Razavi*, vol. 8, 1971, 8:431; Najī-Nasrabadi, *Ketābshenāsīye Sheykh Bahā'ī*, 199–200.

	<i>Author, title</i>	<i>Sources and notes</i>	<i>dates</i>
12	Al-Sharmūṭī, Muḥammad ibn Sayyid Ḥāshim <i>Sharḥ Tashrīḥ al-aflāk</i>	Āqābuzurg, 13:149	
13	Al-Ḥaydarī, Faṣīḥ al-Dīn Ibrāhīm ibn Šibgha Allāl ibn Muḥammad ibn Asad ibn 'Ubayd Allāh ibn Šibgha Allāl (13 th /19 th century) <i>Fakk al-ishtibāk 'an ma 'ānī Tashrīḥ al-aflāk</i>	A commentary aimed to solve the problems of 'Āmilī's <i>Tashrīḥ al-aflāk</i> , written for the Ottoman Sultan 'Abd al-Majīd I (reign. 1839-61). ³⁵⁴	1861
14	Ḥusaynī Khalkhālī, Shams al-Dīn 'Alī ibn Muḥammad ibn 'Alī <i>Sharḥ Tashrīḥ al-aflāk</i>	Completed on Monday end of Šafar 1008/10 September 1599 in Agra, India.	1599
15	Ḥusaynī Ṭabāṭabā'ī, Muḥammad Ashraf ibn Ḥabīb Allāh Ḥasanī <i>Sharḥ Tashrīḥ al-aflāk</i> Author's disciple	Completed in Rabī' I 1049/18 Oct 1639 Āqābuzurg, 13:146. University of Tehran, MS 6254. ³⁵⁵	1639
16	Ilāhī Bukhsh [or Bakhsh] (19 th c.) <i>Sharḥ Tashrīḥ al-aflāk</i>	A commentary based on the book and 'Āmilī's <i>Gloss</i> studied under Rashīd al-Dīn Khān Šāhib. ³⁵⁶	1900
17	Kāshānī, Faḍl Allāh al-Thānī ibn Muḥammad-Sharīf <i>Sharḥ Tashrīḥ al-aflāk</i>	Began on 14 Jumāda I 1072/26 Dec 1661, completed on 25 Rajab 1072/6 Mar 1662 (MS Parliament 18096). ³⁵⁷	1662
18	Kāshānī, Muḥammad-'Alī ibn Muḥammad (d. 1294/1877) <i>Sharḥ Tashrīḥ al-aflāk</i>	Āqābuzurg, 13:148.	1877
19	Kāshānī, Murtaḍā ibn Muḥammad-Mu'min (d. 1083/1672-73) For a certain Rafī' al-Dīn Muḥammad	MS Ṭabāṭabā'ī (Shiraz) 1695/4, copied on 17 Rabī' I 1077/7 Sep 1666 in Isfahan at Shaykh Luṭf Allāh <i>madrassa</i> . ³⁵⁸	1666
20	Kāzīmī (d. 1065/1653), Jawād ibn Sa'd Allāh	Āqābuzurg, 13:146. 'Āmilī's disciple whose commentary on 'Āmilī's mathematics became widely read.	1653
21	Khalkhālī, Muḥammad-Šāliḥ ibn Muḥammad-Sa'id <i>Nihāya al-idrāk fī sharḥ Tashrīḥ al-aflāk</i>	University of Tehran MS 306, copied by Muḥammad-Sharīf in Muḥarram 1179/June-July 1765	-

³⁵⁴ İhsanoğlu, *Osmanlı astronomi*, II:599; Morrison, "The Reception of Early-Modern European Astronomy by Ottoman Religious Scholars," 189.

³⁵⁵ Derayati, *Fankha*, 19:296-97.

³⁵⁶ Rahman, *Science and Technology in Medieval India*, 315.

³⁵⁷ For more copies see: Derayati, *Fankha*, 19:297.

³⁵⁸ Derayati, 19:296.

	<i>Author, title</i>	<i>Sources and notes</i>	<i>dates</i>
22	Kirmānshāhī, 'Abbāsqulikhān Kalhur (d. 1273/1856-57)	Āqābuzurg, 4:186, 13:147.	1857
23	Lāhūrī Dihlawī, Imām al-Dīn ibn Luṭf Allāh al-Muhandis (d. 1732) <i>al-Taṣrīḥ fī sharḥ al-Tashrīḥ</i>	Composed in 1103/1691-92 Printed in Delhi in 1877 and 1894, in Qandahar in 1332/1913-14, and in Pakistan in 1980. ³⁵⁹	1692
24	Lārī al-Iṣṭahbānātī, Abū al-Ḥasan ibn Ismā'īl (d.1338/1920). <i>Sharḥ Tashrīḥ al-aflāk</i>	Printed in 1284/1867-68 in Iran. ³⁶⁰ Āqābuzurg, 4:186, 13:146	1868
25	Muḥammad Amīn ibn Sulaymān, Abū 'Abdallāh <i>Tarshīḥ al-idrāk fī sharḥ tashrīḥ al-aflāk</i>	Erzurum İl Halk Kütüphanesi, MS Hk 23869	-
26	Muḥammad Rashīd al-Dīn <i>Sharḥ Tashrīḥ al-aflāk</i>	An Arabic commentary written for Prince Raḍī al-Dīn 'Alī son of Jahāndār Shah (r. 1712-1713). ³⁶¹	1713
27	Naqawī Lakhinuwī, Muṣṭafā ibn Muḥammad-Ḥadī ibn Mahdī ibn Dildār (d. 1323/1905) <i>Hāshīya Tashrīḥ al-aflāk</i>	Āqābuzurg, 6:39, for information about the author see 4:166.	1905
28	Qazwīnī, Ṣadr al-Dīn Muḥammad ibn Muḥammad-Ṣādiq, <i>Tafrīḥ al-idrāk fī Tawḍīḥ Tashrīḥ al-aflāk</i>	Completed in Qazvin on 10 Muḥarram 1083/ 8 May 1672, for Zeynal Khān, the governor of Qazvin. It is a long commentary and discusses the Ptolemaic problems in detail, by reference to Khafīrī's works. Multiple copies of this commentary exist. Tehran, Parliament Library, MS 6345 and MS 16135. University of Tehran, MS 7052.	1672
29	Rashtī, Muḥammad-Riḍā ibn Muḥammad Ṣāliḥ <i>Tanqīḥ al-idrāk fī tawḍīḥ Tashrīḥ al-aflāk</i>	MS Princeton Islamic Manuscripts, New Series no. 157.	-

³⁵⁹ Imām al-Dīn ibn Luṭf Allāh Lāhūrī, *al-Taṣrīḥ fī sharḥ Tashrīḥ al-aflāk* (Dehlī, 1877); *al-Taṣrīḥ fī sharḥ al-Tashrīḥ*, Princeton University Arabic Collection; cn. 9100532.05. (Delhi: Maṭba'a al-Daf' al-Mujtabā'ī, 1894); *al-Taṣrīḥ fī sharḥ al-Tashrīḥ*, Facimile (Pakistan?, 1980); *al-Taṣrīḥ fī sharḥ al-Tashrīḥ* (Qandahār: Afghānistān, 1913).

³⁶⁰ Derayati, *Fankha*, 19:298.

³⁶¹ Maulavi Abdul Muqtadir, *Catalogue of the Arabic and Persian Manuscripts in the Oriental Public Library at Bankipore*, vol. XXII, 1937, 50.

	<i>Author, title</i>	<i>Sources and notes</i>	<i>dates</i>
30	Şafawī Ḥusayn-Ābādī, Ibrāhīm ibn Ḥaydar <i>Tarshīḥ al-idrāk fī sharḥ Tashrīḥ al-aflāk</i>	MS Marashi 737 dated 29 Şafar 1241/1 Oct 1825.	-
31	Sahāranpūrī, 'Işmat-Allāh ibn A'zam ibn 'Abd al-Rasūl (d. 1100/1698) <i>Bāb Tashrīḥ al-aflāk</i>	Completed in Saharanpur (North India) on 22 Ramaḍān 1087/16 Nov 1676. The autograph copy is available in the Oriental Public Library at Bankipore, MS. 2458. ³⁶² Edited and published once on 19 Şafar 1265/2 Jan 1849 in Lucknow based on the autograph ³⁶³ and another time in Delhi in 1904. ³⁶⁴ Āqābuzurg, 13:146.	1676
32	Shūshtarī, Nūr Allāh ibn Sharīf al-Dīn (956-1019/1549-1610)	Āqābuzurg, 13:149 Nūr Allāh also wrote a Persian commentary on Jaghmīnī's <i>Mulakhkhaş</i> . ³⁶⁵	1610
33	Ṭabāṭabā'ī, Sayyid 'Alī-Ḥaydar <i>Sharḥ Tashrīḥ al-aflāk</i>	Printed once in 1300/1883 in Calcutta ³⁶⁶ , and another time in Bengal at Maṭba'a Maẓhar al-'Ajā'ib library.	1883
34	Tunikābūnī, Muḥammad ibn Sulaymān (1234-1302/1818-1885) <i>Ḥāshīya Tashrīḥ al-aflāk</i>	Mentioned in his <i>Qiṣaṣ al-'ulamā'</i> . Āqābuzurg, <i>al-Dharī'a</i> , 6:39 and 13:147.	1885
35	Tunikābūnī, Muḥammad Kāẓim ibn 'Abd al-'Alī <i>Qānūn al-idrāk fī sharḥ Tashrīḥ al-aflāk</i>	Written in Qum, Qazvin, and Mashhad, and completed late Dhū al-Ḥajja 1007/ Mid-July 1599 for a complete description of this, see Chapter 6.	1599
36	Tunikābūnī, Muḥammad-Şādiq <i>Sharḥ Tashrīḥ al-aflāk</i>	Āqābuzurg, 4:186, 13:147	-
37	Urūmī (Urūmajī), Ḥasan ibn Muḥammad-Walī <i>Sharḥ Tashrīḥ al-aflāk</i>	Dedicated to Muḥammad Shah Qajar (r. 1834-1848). ³⁶⁷ Āqābuzurg, 4:186, 13:146.	1848
38	Anonymous	Completed in 1082/1671-72 MS Goharshad (Mashhad) 1027. Naji-Nasrabadi, 196.	1672

³⁶² Maulavi Abdul Muqtadir, XXII:49.³⁶³ 'Işmat Allāh al-Sahāranpūrī, *Bāb Tashrīḥ al-aflāk*, ed. Muḥammad Ma'shūq 'alī (Lucknow: Maṭba'a Ja'fariyya, 1849).³⁶⁴ 'Işmat Allāh al-Sahāranpūrī, *Bāb Tashrīḥ al-aflāk* (Delhi: Maṭba' al-Mujtabā'ī, 1904).³⁶⁵ Sally P. Ragep, *Jaghmīnī's Mulakhkhaş*, 291.³⁶⁶ Naji-Nasrabadi, *Ketābshenāsiye Sheykh Bahā'ī*, 198.³⁶⁷ Derayati, *Fankha*, 19:297-98; Naji-Nasrabadi, *Ketābshenāsiye Sheykh Bahā'ī*, 198.

	<i>Author, title</i>	<i>Sources and notes</i>	<i>dates</i>
39	Anonymous <i>Ḥāshīya Tashrīḥ al-aflāk</i>	MS Parliament 17638, 3 Dhū al-Qa‘da 1349/22 Mar 1931 in Sulaymaniyah by Muḥammad Zayn al-Dīn al-‘Uthmānī. Includes a table with numerical values for the planetary motions (p. 32). Also bears scholia from Ibn Qaradāqī.	-
40	Anonymous	University of Isfahan, MS 96, dated 1044/1634-35 Naji-Nasrabadi, 193.	-
41	Anonymous	Contemporary with ‘Āmilī. MS Mashhad 5571, Catalogue, 8:210.	-
42	Anonymous	University of Tehran, Theology Department MS 356 , 13 th century	-
43	Anonymous	Manuscript copy made in 1327/1909. ³⁶⁸	-
44	Anonymous	MS Marashi 5920 ³⁶⁹	-
45	Anonymous	A copy kept at Ayat Allāh Najafī library in Isfahan. ³⁷⁰	-

Persian and Turkish translations			
46	Anonymous <i>Tarjumah-i Tashrīḥ al-aflāk</i> , a Persian translation, and commentary.	1- Oriental Public Library at Bankipore, MS 1053, dated 4 Sha‘bān 1244/28 Jan 1829, copied by Muḥammad-Bāqir. ³⁷¹ 2- Maulana Azad Library, Aligarh, Call no. AH 117/10. ³⁷²	1829
47	Kuyucaklı Mehmet Atıf <i>Teshil ül-idrak Terceme-i Taṣrīḥ al-aflāk</i> , a commentary in Ottoman Turkish.	MS Princeton Garrett no. 1794Y. The copy was corrected by the author on 11th of Jumāda II 1251/22 Sep 1835, 107 folios. ³⁷³	1835

³⁶⁸ Naji-Nasrabadi, *Ketābshenāsīye Sheykh Bahā’ī*, 199.

³⁶⁹ Naji-Nasrabadi, 200–201.

³⁷⁰ Naji-Nasrabadi, 201.

³⁷¹ Maulavi Abdul Muqtadir, *Catalogue of the Arabic and Persian Manuscripts in the Oriental Public Library at Bankipore*, vol. XI, 1927, 67.

³⁷² The library handlist catalogued the author/translator as Mawlawī Ismā‘īl.

³⁷³ For other copies see İhsanoğlu, *Osmanlı astronomi*, II:589-590.

5.2 Shams al-Dīn Khalkhālī and the *Exposition of the Orbs*

About Shams al-Dīn 'Alī ibn Muḥammad ibn 'Alī Ḥusaynī Khalkhālī, we know very little. There is not much biographical information on him in the contemporary sources except for a short notice by Afandī Iṣfahānī (1656-1718) which tells us that Khalkhālī was “a man of virtue, a knowledgeable scholar of 'Āmilī's students.”³⁷⁴ Afandī Iṣfahānī only included one of Khalkhālī's works in his short report, a commentary on 'Āmilī's *Khulāṣa al-ḥisāb* (*Quintessence of Mathematics*).³⁷⁵ This work was completed during 'Āmilī's lifetime and Afandī Iṣfahānī saw a copy in Bārfurūsh (today Bābol city in Mazandaran Province, N. Iran). Khalkhālī's commentary on the *Khulāṣa* does not include a date or place of composition, but according to its concluding sentences, it must have been written while he resided outside Persia. At the end of the commentary, Khalkhālī complained about his distress at being remote from his homeland, his brothers, friends, and companions, and prayed for God to bestow the days of reunion on him.³⁷⁶ However, the reason for Khalkhālī's move to India, most probably toward the end of Akbar's reign, is not known, nor there is any indication about this migration in the chronicles. But as he desired to return to Persia, he might have travelled there to fulfill a mission at the court of Akbar or to pursue patronage in India as many others did in the same period.³⁷⁷ His commentary on the *Dissection* tells a bit more about his residency in Agra. So far, I have identified five copies of this commentary, two in Iran and three in India, as follows:

³⁷⁴ Iṣfahānī, *Riyāḍ al-'ulamā'*, III:440, VII:88.

³⁷⁵ The commentary exists in several copies in Iran. Derayati, *Short Catalogue of Iranian Manuscripts*, VI:662-663. Also see MS Arab SM4286. Houghton Library, Harvard University and Islamic Manuscripts, Garrett no. 808Y at Princeton University Library.

³⁷⁶ Shams al-Dīn 'Alī ibn Muḥammad ibn 'Alī Ḥusaynī Khalkhālī, “Sharḥ Khulāṣa al-ḥisāb” (Tehran, Malik Library, MS, 1105 1694), fol. 221v; “Sharḥ Khulāṣa al-ḥisāb” (Tehran, Parliament Library MS 6767, 1191 1777); “Sharḥ Khulāṣa al-ḥisāb” (Harvard University, Houghton Library MS Arab SM4286, 1840), fols. 196r-196v.

³⁷⁷ For the migrations of Iranians to India in the seventeenth century see: Sanjay Subrahmanyam, “Iranians Abroad: Intra-Asian Elite Migration and Early Modern State Formation,” *The Journal of Asian Studies* 51, no. 2 (1992): 340–63.

- 1- **MS Mashhad:** Mashhad University, Department of Theology, MS 8550, copied by Muḥammad-Ṣādiq Ḥussaynī in Dhū al-Qa‘da 1038/June-July 1629.
- 2- **MS Tehran:** University of Tehran, MS 1241, copied by a certain ‘Abd Allāh ibn Najm al-Dīn “known as Khalīfa,” on 4 Shawwāl 1241/30 Apr 1826, in the “city of Aḥmadshāhī,” which would be Qandahar, the capital of Ahmad Shah Durrānī (d. 1772) the founder of Durrānī Empire.
- 3- **MS Patna:** Khuda Bakhsh Oriental Public Library, Patna, India, MS 2472, not dated. The codex includes two items: the commentary on the *Dissection* is on fols. 1-84, and the second item is Khalkhālī's commentary on ‘Āmilī's *Khulāṣa*, fols. 85-186.
- 4- **MS Aligarh:** Maulana Azad Library, Aligarh Muslim University, MS AH 995/77, not dated, incomplete.
- 5- **MS Hyderabad:** Aṣifiyya Library, MS 137 (Mathematics handlist).

Out of the copies introduced here, only MS Patna has the introduction of the text, which includes ‘Āmilī's complete name and the title of the *Dissection*, the commentator's name, the title of the commentary, which is recorded as *Tawḍīḥ al-aflāk (Exposition of the Orbs, henceforth the Exposition)*,³⁷⁸ and the person to whom the commentary is addressed. The name of the dedicatee is not given in the manuscript, and a lacuna is left instead (probably to be written in a different color). But in the surviving introduction Khalkhālī says that he wrote the commentary for the “Sultān ibn Sultān ibn Sultān” and praised the Sultan as “the propagator of the strong religion of Aḥmad [the Prophet], the rectifier of the true law of Muḥammad.”³⁷⁹ From the date of composition and the description and list of virtues of the dedicatee, he must have been the third Mughal Emperor Akbar (r. 1556-1605).

³⁷⁸ I only had access to a few of the beginning and ending folios of this copy. It had several scribal errors in transcribing the text. In some instances, the scribe confused Arabic *ḥā* (ح) or *jīm* (ج) with ‘*ayn*’ (ع), for example he wrote مروع الدين which must be مروج الدين. The title of the work is recorded as “T-w-ḍ-‘ al-aflāk” (fol. 2v) which should be *Tawḍīḥ al-aflāk*.

³⁷⁹ MS Patna, fol. 2v.

5.3 Khalkhālī's commentary and his readers in Agra

The *Exposition* has several specific features that I will briefly explain now, a few of which I will discuss in more detail later in the chapter. Khalkhālī's commentary is remarkable in several ways. It not only comments on 'Āmilī's text but takes a rather critical attitude toward him. Contrary to 'Āmilī's theoretical approach in the *Dissection* and the *Gloss*, which is typical for *hay'a* books, except for the ending part that deals with finding the meridian and *qibla* for a given locality, Khalkhālī presented more practical materials compared to other topics. For example, he discussed the method of parallax used for determining the order of the planets and expanded the discussion of the great circles far beyond what 'Āmilī had given. As will be discussed below, Khalkhālī also added higher-level topics to his work with underlying mathematical and astronomical discussions, such as different anomalies of the Moon. A concise table of contents will be helpful here to give an overall view about the organization and extent of comments on each topic Khalkhālī presented in the *Exposition*.

Table 5-2. Contents of the *Exposition*, based on MS Mashhad 8550

<i>Folios</i>	<i>Topics</i>
1v-60r	Introduction: Mathematical and natural philosophical topics; the total orb structure of the universe
60v-88v	Chapter One: On the great and small celestial and terrestrial circles
88v-99v	Chapter Two: On the forms [<i>ṣuvar</i>] of the total and partial orbs of the seven planets
99v-124v	Chapter Three: On the motions of the total and partial orbs and what pertains to them
125r-140v	Chapter Four: On what pertains to the Earth and the differences in its localities from dividing it into climes, features of each of the equatorial and oblique horizons, and so forth.
140v-144v	Chapter Five: On dawn and dusk
145r-155v	Epilogue: On deriving the meridian line, the eastern and western lines, and the <i>qibla</i> bearing by the method of the Indian circle

The topics in the *Exposition* at first may seem an ordinary way of expanding elementary materials by adding more details from other books on *hay'a*, which, after all, does not show original ideas by the commentator. But Khalkhālī's book does not fit this pattern for several reasons. The arrangement of the materials in his commentary suggests an intentional plan to produce a separate coherent composition on *hay'a*. On the one hand, he follows the general structure of the *Dissection* and incorporates materials from 'Āmilī's other works like the *Gloss* and his super-commentaries on Jaghmīnī. On the other hand, he presents a deeper historical background for astronomical theories by comparing old and new findings, along with providing the most up-to-date values from observations made at Samarqand. Unlike some other commentaries on the *Dissection*, such as the one by Tunikābunī, which I will discuss in the next chapter, the *Exposition* does not incorporate the entire *Gloss* into the commentary; it takes a selective approach. A later commentator like Sāhārānpūrī (fl. 1674-75), who lived in Saharanpur (W India, state of Uttar Pradesh), criticized Khalkhālī for not including all of 'Āmilī's text in his commentary, which he added in his own.³⁸⁰

Among all the characteristics of the *Exposition*, one looms large in terms of the cultural milieu of Agra and distinguishes Khalkhālī's commentary from those written around the same time in Persia. Although a Shiite student trained under 'Āmilī, then the *shaykh al-islām* of the Safavid capital and the leading jurist of the empire, in his commentary Khalkhālī minimized almost all elements present in the *Dissection* and the *Gloss* that would reveal the Shiite orientation of 'Āmilī or of Khalkhālī himself. In the *Gloss* and his commentary on the Prayer for the Crescent Moon, which I discussed in Chapter 4, 'Āmilī raised objections against some very renowned Sunni theologians like Ījī, Kātibī, and Dawānī, and demonstrated their

³⁸⁰ al-Sāhārānpūrī, *Bāb Tashrīḥ al-aflāk*, 1849, 3.

misunderstandings or false arguments about several of astronomical issues. 'Āmilī's criticism of those people was not simply a result of his religious orientation; they had all made false claims about the astronomical topics under discussion. But in the *Exposition*, Khalkhālī only pointed out these criticisms in passing. Khalkhālī's action can be understood as a recognized practice of dissimulation on religious matters (*taqiyya*, dissimulation). His master 'Āmilī had also practiced *taqiyya* in a different way in the Ottoman territories to conceal his Shiite identity when coming back to Persia from the pilgrimage to Mecca.³⁸¹ Khalkhālī would have taken the same precautions, most probably for two reasons. First, the Mughal Emperor to whom the commentary is dedicated was nominally Sunni; second, audience and readers in Agra at the turn of the sixteenth century were largely Sunni. At the beginning of the commentary, while arguing that the meaning and philological roots of the word "Allāh" are of Syriac origin, Khalkhālī praised two earlier Sunni religious authorities, Abū Ḥāmid al-Ghazālī (d. 1111) and Fakhr al-Dīn al-Rāzī (1150-1210) as the "two magnanimous imams".³⁸²

That Khalkhālī is concealing his Shiite identity and minimizing related elements in the *Exposition* becomes more apparent in the commentary on the *Epilogue*. Here topics include the determination of the meridian line and *qibla* direction, which normally entail issues and disputes from Islamic legal law. In the *Gloss*, 'Āmilī discussed this topic, which is the concluding topic of the *Dissection*, relying solely on Shiite law and the ideas from Shiite jurists, and interpreted the opinions from Shiite Imams about the matter as being said only to determine the *qibla* of places in Iraq.³⁸³ In contrast, Khalkhālī explained the ideas of the Sunni schools of Hanafī, Shafiite, and

³⁸¹ Stewart, "Taqiyyah."

³⁸² MS Mashhad, fols. 2v-3v. In this chapter all my references to the *Exposition* will be to MS Mashhad, which is the earliest known copy of the text. However, my copy of this codex is missing some folios, either missing from the original codex or skipped in photography, in which case I will refer to MS Tehran for the missing folios.

³⁸³ al-'Āmilī, "Ḥāshiya (Gloss 1682)," fols. 20r-21r.; "Ḥāshiya (Gloss 1689)," fols. 22r-25r.

Maliki law accompanied by a short notice on the Twelver Shiite opinion, in an additional discussion about the timing of the afternoon (‘*aṣr*’) prayer to be determined by the shadow length cast by a gnomon.³⁸⁴ Moreover, in determining the *qibla* direction, Khalkhālī pointed that there were two general interpretations among the jurists of the meaning of *Ka‘ba*. One took it to indicate the name of the city of Mecca and all the space above it up to the heavens, but the other just indicated the building in the city that housed the *Ka‘ba*. Khalkhālī made it clear that ‘Āmilī preferred the first meaning, which is commonly accepted by all Islamic jurists.³⁸⁵

5.4 Features of the *Exposition*

Khalkhālī provided several introductory topics needed to understand ‘*ilm al-hay’a*’ better, which were absent in the *Dissection* and the *Gloss*. In the *Exposition*, Khalkhālī introduces concepts required for learning ‘*ilm al-hay’a*’ but not necessarily its standard components. He does so by expanding the definition ‘Āmilī had given for the ‘*ilm al-hay’a*’ in the *Gloss*. Here I should quote the complete definition to show how Khalkhālī used it as the basis for the introduction of the commentary.

Hay’a is a science in which everything celestial is discussed with respect to quantity, quality, position, and movement, and the [terrestrial] elements [are discussed] in accordance [with them]. The celestial means the total and partial orbs along with what is fixed in them and what is necessary in and about them to regulate their behaviors. And by quantity, what the discrete [magnitude] includes, like the number of the orbs and observed stars, and what the continuous [magnitude] includes, like examining magnitudes for the study of the [celestial] bodies. And by quality, what

³⁸⁴ MS Mashhad, fol. 146v

³⁸⁵ MS Mashhad, fol. 149r.

includes roundness, illuminations, darkness, and the like. And by position, the resulting configurations in comparison to each other in terms of closeness, remoteness, highness, lowness, and circles being either perpendicular or inclined to one another and similar things. And by motion, the magnitude of the celestial bodies, their directions, and what results from them regarding the stations, forward motion, and retrogression, and the study of equations, and so on. It is obvious that the distribution of these characteristics is assumptive, and that our expression “and the [terrestrial] elements [are discussed] in accordance [with them]” was to explicitly exclude the topics of natural philosophy even though they [those topics] would be implicitly left out by the first conditions [above]. However, it would even suffice if it is said that *hay'a* is a science in which the orbs are discussed in principle, and the elements in accordance [with them].

Khalkhālī expanded the topics included in this definition and provided each with further discussion. He gave four different definitions for *'ilm* (knowledge): first, the mathematical bodies (*jism al-ta'limī*), second, the definition of celestial and terrestrial bodies (sing. *jism*), third, that the majority of natural philosophers assumed the existence of a soul in every celestial body, and fourth, that the inclusion of terrestrial compound bodies (*murakkaba*) in the subject of *'ilm al-hay'a* was to show their distinction from the simple bodies (*basīṭa*) of the heavens, not to discuss the nature of the known three natures of minerals and vegetative and animal bodies on the Earth which are assumed to come into existence by the influence of the heavens. Here he noted that the heavens as fathers and terrestrial elements as mothers gave birth to these natures, but that meteorological phenomena like the clouds, rain, thunder, and shooting stars, are brought

forth from the terrestrial elements but “without temperament.”³⁸⁶ Khalkhālī had already explained the opinion of most natural philosophers and brought testimony from Ibn Sīnā's *Shifā* (*Healing*) and *Ishārāt wa-tanbīhāt* (*Pointers and Reminders*) that all planets have separate souls which never die and move them in circular motions.³⁸⁷

Other than expanding the definition of the discipline, Khalkhālī added a section consisting of some principles from mathematics and natural philosophy helpful for learning *‘ilm al-hay’a*.³⁸⁸ This section begins with the logical method of defining two major types of principles (*mabādī*) in a branch of knowledge, here concerning *‘ilm al-hay’a*. These are imagination (*taṣawwur*) and attestation (*taṣdīq*), the latter being divided into common notions (*‘ulūm muta‘arifa*) and axioms (*uṣūl mawḍū‘a*). Following the general definitions, Khalkhālī states that the attestation principles of *‘ilm al-hay’a* are from natural philosophy and geometry. He then defines geometrical concepts such as the geometrical surfaces and shapes, angles, geometrical solids, trigonometric magnitudes of sine, chord, and verse-sine of an arc. Finally, he defines concepts related to spherical geometry by references to Theodosius' *Spherics* and Autolycus's *Moving Sphere*. Of the natural philosophical concepts, he defines different types of bodies, simple and compound, elemental and celestial, besides the uniform motion of the celestial bodies.

The place of comets in the universe is another discussion that Khalkhālī comments on by referring to Shīrāzī, Qūshjī, and ‘Āmilī. If the motions of the celestial bodies are perpetually connected to them and never separate from them, then the motion in the definition of *‘ilm al-hay’a*, given by ‘Āmilī, must apply to the motion of the sphere of Fire in the sublunary universe

³⁸⁶ MS Mashhad, fol. 8v.

³⁸⁷ MS Mashhad, fol. 7v.

³⁸⁸ MS Mashhad, fols. 19v-25v.

too. Khalkhālī believes that the sphere of Fire moves in conformity to the Inclined or Complementary orb of the Moon³⁸⁹, and its motion is perpetual. This means that the sphere of Fire should also exhibit the daily motion of the sky. But the motion of comets is sometimes in the opposite direction of the diurnal motion. Therefore, deciding the place of the comets, whether in the Fire sphere or below that, would be a crucial matter to solve this issue. In order to solve the problem, Khalkhālī quotes from 'Āmilī's super-commentary on Jaghmīnī's *Mulakhkhaṣ* where 'Āmilī had given reports of two comets, one observed by Qūshjī and the other one by 'Āmilī himself. The first one was the comet reported by Qūshjī in his commentary on Ṭūsī's theology (*Tajrīd al-i 'tiqād*) that appeared in the sky close to the constellation Corona Borealis in 837/1433. According to Qūshjī, the comet appeared when the Sun was in the zodiac sign of Libra (Sep 23-Oct 22). It rose and set every day along with the constellation and never separated from it, but after a while, it began to have a slow proper motion of its own between east and north until its body and light gradually diminished after about eight months. From this observation, Qūshjī concluded that "this is an obvious reason [in favor of the idea] that the sphere of Fire moves by the diurnal motion."³⁹⁰ The second was the comet of 985/1577 that 'Āmilī had observed while he met Ismā'īl II (r. 1576-1578) at the court in Qazvin (more has been said about this in Chapter 2). Khalkhālī quoted 'Āmilī's text from the super-commentary on Jaghmīnī's *Mulakhkhaṣ* and noted that he had also observed the same comet but did not specify where he resided then.³⁹¹

According to 'Āmilī, Shīrāzī first in his *Nihāya al-idrāk fī dirāya al-aflāk* (*The Ultimate Perception in Understanding the Orbs*), completed in Dec 1281, and late in the *Tuḥfa al-Shāhiya fī 'ilm al-hay'a* (*The Royal Gift on the 'ilm al-hay'a*), completed in Aug 1285, declared that the

³⁸⁹ Cf. Ragep, *Ṭūsī's Memoir*, I:106-107.

³⁹⁰ Qūshjī, *Sharḥ Tajrīd al-i 'tiqād*, 194.

³⁹¹ MS Mashhad, fol. 11v.

sphere of Fire does not move in conformity with the orb of the Moon because of comets' irregular motions. Shīrāzī concluded that there existed a separate soul responsible for a comets' ascending and descending motions; otherwise, they would have always moved parallel to the celestial equator. Qūshjī rejected Shīrāzī's idea that the sphere of Fire does not move in conformity with the Moon's orb and argued that like other planets comets have daily motion parallel to the celestial equator and proper motion that places them, once in a while, above or below the equator. Although, like Shīrāzī, Qūshjī considered a separate soul responsible for the proper motion of the comets but specified that it does not prove that the sphere of Fire moves unparallel to the daily rotation of the heavens.³⁹²

‘Āmilī attempted to defend Shīrāzī against Qūshjī. ‘Āmilī first argued that in Shīrāzī's view the motion of a comet requires the motion of the sphere of Fire. This is true whether assuming a separate soul for the comet or not, which according to Qūshjī is responsible for the proper motion. So perhaps motions corresponding to or opposing the motion along the celestial equator issue from a single soul attached to the sphere of Fire. But Shīrāzī denies that the sphere of Fire moves in conformity with the motion of the celestial equator. Therefore, ‘Āmilī argues that there is no reason to assume a proper motion for the comets, which could result from the motion of the sphere of Fire. Moreover, Qūshjī's own observations, as ‘Āmilī reported, on the one hand attest that such a slow motion of the comet over eight months would not be well perceived by our senses, and the opposing motion of the comet could be its stationary status. On the other, the apparent rising and setting of the comet of 837/1433 simultaneously with the rising and setting of Corona Borealis, as Qūshjī observed, does not prove that the comet did not deviate from the diurnal motion. Despite ‘Āmilī's attempt to defend Shīrāzī, Khalkhālī disagreed with his

³⁹² This objection is in Qūshjī's text but not attributed to anyone. Qūshjī, *Sharḥ Tajrīd al-i 'tiqād*, 194.

conclusions. Khalkhālī argued that these phenomena are very unlikely to happen and if they were as 'Āmilī claimed, Qūshjī would have already discovered them by the aid of observational instruments or other methods.³⁹³

5.5 The order of the Planets in the *Exposition*

The order of the planets was a controversial issue in Islamicate astronomy and astrology that Khalkhālī discussed and expressed as an existing uncertainty, especially about the place of Venus in the Ptolemaic system. One simple and general method for identifying the order of the planets, starting from the closest to the farthest, was through eclipses. The planet that eclipses another planet must be below the eclipsed one. But as Khalkhālī pointed out, this method did not work well for the planets close to the Sun because of the effect of the Sun's rays on sighting them, known as heliacal rising and setting. The brightest object in the sky after the Sun and the Moon, Venus, brought ambiguity among astronomers concerning its position in the heavens. Although Islamicate astronomers almost unanimously believed Venus to reside below the Sun, some prominent figures like Shīrāzī and 'Urḍī placed her above the Sun. A more reliable method of determining the order of the planets, as Khalkhālī explained, was by the parallax effect. Parallax occurs when the apparent position of a celestial body observed from a point on the surface of the Earth differs from its real position observed from the center of the Earth. In Fig. 5-2, the angle is the amount of parallax for viewed at the same time from the Earth's center *E* and observed by the observer *O* on the Earth's surface. Khalkhālī added that by drawing *EC* parallel to *OB*, the parallax could be measure on the starry vault along the arc *AC*. He further explained that the larger the parallax closer the planet is to us, therefore for two celestial bodies,

³⁹³ Mashhad, fol. 13v-14r.

the one that exhibits a larger parallax is closer than the other. In the case of Mars and the Sun, the Sun is closer to us because Mars has no measurable parallax. Khalkhālī introduced an instrument used for measuring parallax (*dāt al-shu 'batayn*), which is similar to the *triquetrum* or the “parallactic instrument” Ptolemy used in the *Almagest*.³⁹⁴

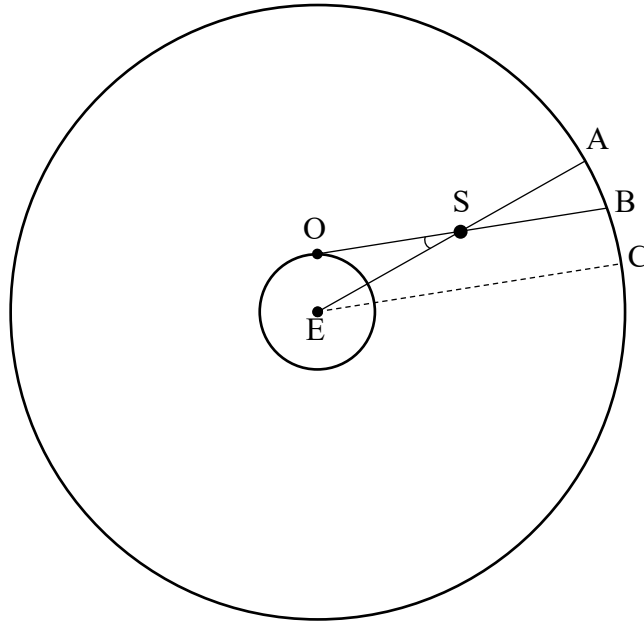


Fig. 5-2. The parallax for the planet *S* as described in the *Exposition*.
From *O*, the planet is viewed at point *B*, but from the center of the universe *E*, it is viewed at *A*. The angle represents the amount of parallax for *S*. Also, drawing *EC* parallel to *OB*, the parallax can be measure along the arc *AC*. From Euclid we know that opposite angles between parallel lines are equal. Hence angle $OSE = SEC$. It is evident that there is no parallax when *S* is at the observer's zenith.

However, the problem of ordering the planets had other practical difficulties. Khalkhālī noted that even the method of parallax would not respond well in the case of Venus and Mercury in most localities due to their small maximum elongations from the Sun of 45° and about 27° respectively. The parallax instrument is to be installed coincident with the surface of the meridian circle of the locality, but Venus and Mercury, while transiting over the meridian line,

³⁹⁴ Claudius Ptolemy, *Ptolemy's Almagest*, trans. Gerald J. Toomer (Duckworth, 1984), 244–46.

are hardly visible due to Sun's rays. Therefore, he concludes that the place of the Sun, being in the middle of the planets above Venus and Mercury, was deemed elegant by ancients like Ptolemy and modern astronomers and was not determined by scientific methods or observations. Rather it was determined based on an accepted rule concerning the motion of the planets.

According to the rule of planetary velocities, the planet that seems to move slower is farther than the one which seems to move faster. Khalkhālī remarked that this rule applies well for comparing two lower planets or upper planets but not for comparing two of different types. So, in the case of Venus and Mercury, since the Sun seems to move slower than both, it is assumed to be above them. But he objects to the generality of the rule, which does not work as well, for instance, for Mars and the Moon, and also objects that the apparent slowness of further planets is because of the larger size of their paths, not their actual velocity. By the example of the Moon and Mars, he explains that the Moon, which is assumed to be the fastest of the planets, moving 1445 parasangs in one nychthemeron, is not faster than Mars, which in reality moves 114917 parasangs in the same period of time, but along a much larger path.³⁹⁵

The introductory section on arranging the planetary orbs accompanied with an explanation of the difficulties of each method is followed by a historical account that reflects the ideas of Khalkhālī's predecessors. Khalkhālī goes on to report observations of the transit of Venus in front of the Sun by those who confirmed the rule of planetary velocities. The first one was Ibn Sīnā, who observed Venus and Mercury as two "birthmarks" on the disc of the Sun, and took it as evidence for placing them below the Sun. The second was Ṭūsī, who in his *Recension of the Almagest* (*Tahrīr al-majisṭī*) reported that Šālīḥ ibn Muḥammad al-Baghdādī, in his book *Majisṭī* reported two other people who observed the transit of Venus in different places twenty years

³⁹⁵ MS Mashhad, fols. 30v-31r.

apart.³⁹⁶ Third, Shīrāzī's *Ultimate Perception* (*Nihāya al-idrāk*) reported Ibn Bājjā's (Avempace in Latin, c. 1085 – 1138) observation of Venus and Mercury appearing like birthmarks on the Sun's disc. Before concluding this section, Khalkhālī brings an objection by 'Āmilī, especially against Shīrāzī who believed the planets are luminous themselves and not illuminated by the Sun. 'Āmilī's objection was that if Venus and Mercury are luminous, they should not be seen as dark spots in front of the Sun. In the end, Khalkhālī restates that Shīrāzī and 'Urḍī, based on their calculations of sizes and distances, placed the orb of Venus above the orb of the Sun.³⁹⁷

However, his concern about the issue is obvious in one of his own earlier marginal notes, which apparently belongs to a discussion in the following folios. In that marginal comment, he cast doubt on the reliability of the method of sizes and distances for ordering the planets and emphasized that it has always been a controversial issue among astronomers in that no standard system was agreed upon; therefore, the ancients placed Venus below the orb of the Sun, but Shīrāzī placed it above the Sun. After all, Khalkhālī concludes that this is still an unsolved issue in astronomy.³⁹⁸

5.6 Additions to the original text

In addition to materials Khalkhālī added when he felt the need for more explanations, he added specific sections to the text distinguished by headings like “sequel” (*tadhnīb*) or “supplement” (*takmila*), which further expanded the topic or discussed more aspects of the problem at hand. The first of these types of addition, which is brief, appears as a sequel at the end of chapter one concerning the general features of the ten great celestial and terrestrial circles.³⁹⁹ The second

³⁹⁶ Baghdādī reported observation made by Abū 'Imrān in Baghdad and Muḥammad ibn Abī Bakr al-Ḥakīm in “Farsīn, a region in Qūlak.”

³⁹⁷ MS Mashhad

³⁹⁸ MS Mashhad, fol. 29v.

³⁹⁹ MS Mashhad, fols. 88r-88v

sequel is at the end of chapter two, presenting the planetary sectors (*niṭāqāt*) for eccentrics and epicycles with diagrams.⁴⁰⁰ He later refers back to this section in his comments on the epicyclic proper motion of the planets.⁴⁰¹ The last of these types of comments is a longer complementary section (*takmila*) about the anomalies and equations of the planets other than the Sun, which ʿĀmilī discussed in the *Dissection* and later with a more detailed demonstration in the *Gloss*.⁴⁰²

5.7 Comments on the Orbs and Motions of the Planets

Khalkhālī's comments on the two chapters of the *Dissection* concerning the orbs and motion of the planets go beyond the scope of both the *Dissection* and the *Gloss*, to the extent they are aimed at intermediate students of astronomy. I have made a table of contents individually for each section to give a snapshot of the material Khalkhālī presented (see Table 5-3 and Table 5-4). At the beginning of Chapter three the longitudinal motion gets Khalkhālī's special attention, as he dedicates a relatively long portion of the *Exposition* to it (see Table 5-2).

Khalkhālī wrote this section so that it could stand on its own as an independent introduction of the basic concepts of the orbs and their motions, including the observational reasons for defining multiple partial orbs and motions for each planet. He goes on to more complicated concepts like the anomalies of the motions, which require calculating equations to record the proper motion of each planet

5.7.1 Commentary of Chapter two, on the structure of the orbs

In the commentary on chapter two of the *Dissection*, Khalkhālī's focus is on the reasons behind the orb schemes of the planets and explaining why a particular model is proposed for a planet.

⁴⁰⁰ MS Mashhad, fols. 97r-99r

⁴⁰¹ MS Mashhad, fol. 103v-104r.

⁴⁰² MS Mashhad, fols. 112v-116v.

For instance, for the orbs of the Sun, he first explains the necessity of having an eccentric orb. Observational facts reveal the Sun's non-uniform motions, speeding up close to the perigee, and slowing down around the apogee. He then shows how the two models of an eccentric orb, and a concentric orb carrying an epicycle are equivalent if a certain criterion applies.⁴⁰³ Finally, Khalkhālī restates the idea of previous Islamicate astronomers that Ptolemy's reason for preferring the eccentric model for the Sun over the epicycle model was the simplicity of the former since the eccentric model requires tracking one motion and one circuit (*madār*) while the epicycle model requires two motions and two circuits.

Table 5-3. Contents of the commentary on the orbs of the planets from the *Exposition*

1	The reasons that prove there are multiple orbs
2	The reason for apparent variation in planetary motions and the solution of the eccentric and epicycle models
3	The equivalency of the eccentric and epicycle models for the Sun and the planets
4	Why Ptolemy preferred the eccentric model for the Sun over the epicycle model
5	The complementary orbs
	'Āmilī's proof that rejects al-Ījī's and Dawānī's misconceptions about the thickness of the complementary orbs
6	Orbs of the upper planets and Venus
7	Orbs of the Moon
	Complementary orbs of the Moon
8	Orbs of Mercury
9	A sequel on the planetary sectors

⁴⁰³ In order to have two compatible models that return the same result, the following relation must hold:

$$\frac{\text{Eccentricity (World Ctr. to Ecc. Ctr.)}}{\text{Ecc. radius}} = \frac{\text{Epicycle's radius}}{\text{Deferent's radius}}$$

5.7.2 A new definition for the Moon's orbs

Khalkhālī's presentation of the orbs of the planets follows the standard Ptolemaic models accepted by his Islamic predecessors, but in some cases, suggests a finer interpretation or a better design. The commonly accepted Moon model, presented in the *Dissection* too, consisted of multiple orbs (Fig. 5-3), from outer to the inner being *jawzahar* (the parecliptic, moving the head and tail of dragon), the inclined orb, the deferent, and the epicycle. Two of them, the *jawzahar* and inclined orb, which consists of the inner and outer complements, are concentric with the center of the world. Two others are the eccentric deferent carrying the epicycle, which carries the Moon, and the epicycle itself. In contrast to 'Āmilī's *Dissection* that had defined the Inclined orb, which is inclined to the zodiacal equator, as the one that encloses the Moon's deferent orb,⁴⁰⁴ Khalkhālī gives the complement orbs somewhat separate characteristics and emphasizes that it is not the Inclined orb which enclose the Moon's deferent orb; instead, the outer complement encloses the deferent orb.⁴⁰⁵ This definition implies that while part of the Inclined orb, the outer complement, encloses the deferent, the deferent itself encloses part of the Inclined orb, that is, the inner complementary orb.

⁴⁰⁴ al-'Āmilī, "Tashrīḥ al-aflāk," 986 1576, fol. 10r.

⁴⁰⁵ MS Mashhad, fol. 95v.

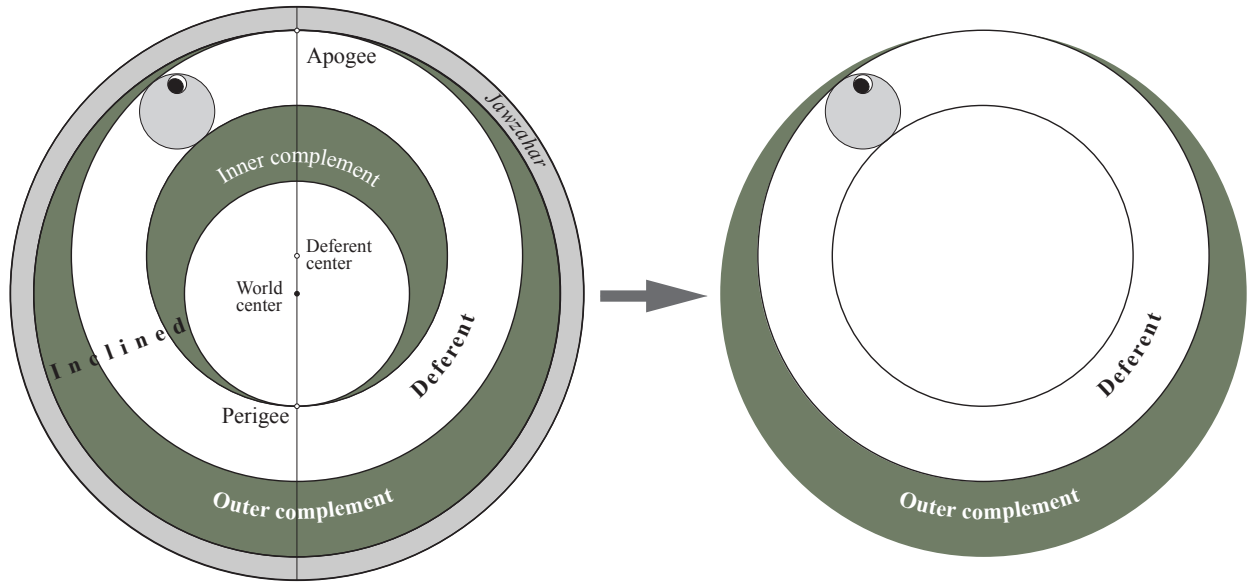


Fig. 5-3. The orbs of the Moon, drawn based on the *Exposition*. The figure on the right shows that only the outer complement encloses and carries the Moon's deferent.

Khalkhālī's definition of the Moon's orbs, seems to correspond better to visual perception of them. According to Fig. 5-3, the deferent splits the Inclined orb into two complements that have no physical contact with each other. Rather, part of the Inclined orb — the inner complementary orb. — is enclosed in the deferent. In other words, the Inclined orb is made of two completely isolated parts. This configuration is in contradiction with the accepted definition of the orb (*falak*) in Islamic astronomy and natural philosophy. The planetary orbs, in the first place, are simple bodies, and second, have spherical shapes, each bounded by two parallel spherical surfaces.⁴⁰⁶ A simple body cannot have two separated parts, as Khalkhālī showed was the case for the Moon's Inclined orb. An indication by Khalkhālī informs us that 'Āmilī was also aware of this inconsistency in the definition of the orb. 'Āmilī's simple definition for the Moon's Inclined orb in the *Dissection* should not lead us to assume that he was unaware of the issue at

⁴⁰⁶ Ragep, *Tūsī's Memoir*, I:98-99; Sally P. Ragep, *Jaghmīnī's Mulakhkhaṣ*, 90-91.

hand, as Khalkhālī later attested. To address the problem of the complementary orbs as separate orbs, according to Khalkhālī, 'Āmilī modified the definition of the orb in his long super-commentary on Jaghmīnī's *Mulakhkhaṣ*⁴⁰⁷ by saying that “the most accurate statement I can make is that the orb is a body which revolves around the elemental universe, either having a uniform thickness and enclosing the elemental universe or having a non-uniform thickness or not enclosing the elemental universe.”⁴⁰⁸ Khalkhālī goes on to say that “I swear that this is the best definition proposed by the practitioners so far.”⁴⁰⁹ Obviously, the first part of 'Āmilī's definition covers the parecliptic and eccentric orbs, while the second part includes in the definition the complementary orbs, which do not have uniform thicknesses and the epicycles which do not enclose the terrestrial world. The issue of the complementary orb is the same for the model of other planets, but in Islamicate astronomy, the complementary orbs were never identified as independent simple bodies, and were never double counted in the total number of the planetary orbs.

5.7.3 Commentary of Chapter three, on the motions

This part of the *Exposition* deals with the general topic of the planetary motions, but at the same time includes multiple discussions, some describing the overall structure of the orbs, some others defining the motions specific to each planet. For a better presentation of the materials, I have made a table of contents (see Table 5-4).

⁴⁰⁷ The two extant copies of the super-commentary that I identified so far are both incomplete and do not include this discussion in full.

⁴⁰⁸ MS Mashhad, fols. 17v-18r.

⁴⁰⁹ MS Mashhad, fol. 18r.

Table 5-4. Contents of the commentary on the planetary motions from the *Exposition*

1	The motion of the Ninth orb, the <i>primum mobile</i>
2	The motions of the eighth orb
	The precession of the equinoxes, ancient and modern values
3	The mean motions of the planets with numerical values from Samarqand observations
4	Difficulties of Ptolemy's models and the non-uniform motions of the planets
5	The proper motions of the planets' epicycles with numerical values from Samarqand observations
6	Direct motions, stations, and retrogradations of the wandering planets
7	Equations of the planets
	Why the equation is needed
	Equation of the Sun with an expansion on 'Āmilī's geometrical proof in the <i>Gloss</i>
	Supplement on the equations of other planets
	Longitudinal motion, true position, mean motions
	Three different equations/anomalies in the case of the Moon and the wandering planets
	Three equations of the Moon and the <i>prosneusis</i> point
8	Phases of the Moon and eclipses

In chapter three of the *Exposition*, the first value Khalkhālī reports for the precession of the equinoxes is the rate of 1° per 70 solar years, referring to Ibn A'lam (d. 985), Ṭūsī, and the Samarqand observations as the modern values. Afterward, Khalkhālī explains that among the ancients, Aristotle was not aware of the slow eastward motion of the fixed stars. Hipparchus first discovered it but did not find the value, and after him, Ptolemy assigned the rate of 1° per 100 solar years. This short historical background is followed by the presentation of motions of the partial orbs of the planets, including numerical values for them, as shown in Table 5-5.

Table 5-5. Longitudinal motions of the planets
based on Samarqand observations

	Mean motion (eccentric or deferent)	Epicyclic proper motion
Sun	0; 59' 8''	-
Venus	0; 59' 8''	0; 36' 59''
Mercury	1°; 58' 16''	3°; 6' 24''
Saturn	0; 2'	0; 57' 8''
Jupiter	0; 4' 59''	0; 54' 9''
Mar	0; 31' 27''	0; 27' 419''
Moon	24°; 22' 53''	13°; 3' 54''

Unlike Tunikābunī, who spent a section of his commentary on the difficulties of Ptolemaic planetary models and Islamicate solutions to them, Khalkhālī treats the topic only in passing, with a description of each problem and references to works of Ṭūsī, Shīrāzī, and Khafīrī. As I also discussed in Chapter 2, as with other of 'Āmilī's commentators, Khalkhālī considered the final solutions of the Ptolemaic problems to have been presented in the *Utmost Perception* (*Ghāya al-idrāk*) by Khafīrī. Instead, Khalkhālī expanded the topic of the anomalies of the planets and their true and mean positions. In a complementary (*takmila*) section,⁴¹⁰ he described all types of anomalies and the equations of the planets with illustrations and further discussions for the Moon's three equations. The commentary on chapter three of the *Dissection* ends with a lengthy discussion on the illumination of Moon's body, the first visibility of the lunar crescent, and eclipses in greater detail than the *Dissection*.

⁴¹⁰ MS Mashhad, fols. 112v-116v.

5.8 Concluding remarks

The *Exposition* made several improvements to 'Āmilī's astronomy, using the *Gloss* and 'Āmilī's super-commentaries on the *Mulakhkhaṣ*. Although Khalkhālī did not discuss in detail the non-Ptolemaic models for the planetary motions, but pointed to Khafrī's work, presented in his commentaries on Ṭūsī and Shīrāzī, as the final solution to all the remaining difficulties of Ptolemy's models. Khalkhālī's desired audience for the *Exposition on the Orbs* was an intermediate level student of astronomy, including the religious students who learned the *'ilm al-hay'a* for practical religious purposes like finding the daily prayer times, determining the beginning of the lunar months, and finding the *qibla* direction. Khalkhālī wrote the *Exposition* for the Mughal Emperor Akbar, in Agra where the dominant community consisted of Sunni Muslims, a factor that explains his attitude in discussing legal matters in accordance with the Sunni sharia law. There are few extant copies of Khalkhālī's commentary, but there is evidence that his work was known and received by Indian scholars as it was commented upon later in 1674-75. I have discussed the transmission of 'Āmilī's works to Mughal India in the Introduction, but as a quick note regarding Khalkhālī's role in that process, we should consider the production of the *Exposition* in Agra for the Emperor, was a way of introducing 'Āmilī's scientific works to the Indian community.

Chapter 6

Muḥammad-Kāẓim Tunikābunī's Commentary on 'Āmilī's *Dissection*

A disciple of 'Āmilī and a commentator of the *Dissection*, Tunikābunī authored books and tracts on astronomy, mathematics, philosophy, and theology, most of which are in the style of commentaries or responses to previous and contemporary scholars. At the end of his commentary on the *Dissection*, he recorded his full name as Muḥammad Kāẓim ibn 'Abd al-'Alī al-Āmulī, originated from Shīrum (*al-shīrumī aṣl^{an}*), born in Tunikābun (*al-tunikābunī mawlid^{an}*).⁴¹¹ From the last expression, it is evident that he was born in Tonekābon, a county in the north of Iran on the southern coast of the Caspian Sea. The other expression, *al-shīrumī aṣl^{an}*, shows his tribal origin. A marginal note on the end of a copy of his commentary on the *Dissection*, apparently from Tunikābunī, explains that “Shīrmeh” or “Shīromeh” was the title of a clan that resided in the city of Amol, a large county in Mazandaran Province off the seacoast, on the east of his birthplace. This also shows why he picked the *nisba* “Āmulī” for himself. There is no information in the chronicles about Tunikābunī's birth or death date, but an indication in his super-commentary on Bīrjandī's commentary on Ṭūsī's *Tadhkira*, shows that he was born in 985/1577-78. At the beginning of the super-commentary, he explained that he had a rough life until he turned forty.⁴¹² The super-commentary was completed in 1025/1616 in Mashhad.⁴¹³ It is

⁴¹¹ Tunikābunī, “Qānūn al-idrāk,” 1032 1623, fol. 139r; “Qānūn al-idrāk,” 1025 1616, fol. 214r; “Qānūn al-idrāk,” 1029H 1620, fol. 93r.

⁴¹² “Innī mundhu mā nasha 'tu ilā 'an dakhaltu 'arba'in, ...”. Muḥammad-Kāẓim Tunikābunī and Niẓām al-Dīn 'Abd al-'Alī ibn Muḥammad Bīrjandī, “Ḥāshya sharḥ Tadhkira” (Tehran, Parliament Library MS 4391, September 11, 1624), fol. 5r.

⁴¹³ The colophon of the manuscript copy reads as “1024/1615,” for the composition date, but in the text while explaining different ideas about the motion of Sun's apogee, Tunikābunī mentioned that he was writing in 1025/1616. Tunikābunī and Bīrjandī, fol. 188r.

not known where Tunikābunī met 'Āmilī, but probably they first met in Qazvin, before 1598 when 'Abbās I moved the capital from Qazvin to Isfahan. In his commentary on 'Āmilī's *Dissection* (more about this below), completed in 1007/1599 in Mashhad, Tunikābunī specified his place of residence in Qazvin⁴¹⁴, which shows that he might have started writing the commentary there but later moved to Mashhad where he finished the book.

6.1 Tunikābunī's intellectual life

There is not much known to us about Tunikābunī's early education, but he received three *ijāzas* from 'Āmilī, all extant in 'Āmilī's hand, which tell us more about his higher education. He received the first *ijāza* on 3 Rajab 1008/9 Jan 1600 and the second on early Shawwāl 1010/mid-Mar 1602, both in Mashhad. The third *ijāza* was issued during 10-20 Shawwāl 1011/mid-March 1603 but did not indicate the place.⁴¹⁵ The first *ijāza*, is a short note which granted Tunikābunī the transmission of a book on hadith from Zayn al-Dīn al-'Āmilī (d. 966/1559), 'Āmilī and 'Āmilī's father, and all other authorities in the chain of transmission mentioned in that extensive *ijāza*. The third *ijāza* also includes one book which Tunikābunī studied a considerable part of under 'Āmilī, the *al-Fihrist (The Catalogue)*⁴¹⁶ of al-Shaykh al-Ṭūsī (385-460/995-1067), one of the main authorities in Shiite hadith and jurisprudence.

The second *ijāza*, issued in 1010, is longer than the other two and specifies the topics and books Tunikābunī learned under 'Āmilī. The titles can be divided into four main categories: (1) hadith and Quranic exegeses; (2) mathematics and astronomy; (3) theology and jurisprudence; (4) Arabic literature. In the mathematics and astronomy section, 'Āmilī certified that Tunikābunī

⁴¹⁴ Tunikābunī, "Qānūn al-idrāk," 1032 1623, fol. 51v.

⁴¹⁵ Muḥammad al-Samāmī al-Ḥā'irī, "Ijāzatā al-Shaykh al-Bahā'ī lil-Tunikābunī," *Turāthunā* 2, no. 1 (1986): 172–82; Malikī, "Ijāzāt al-Shaykh Bahā' al-Dīn al-'Āmilī," 279–81.

⁴¹⁶ The *al-Fihrist* presents a list of works by Shiite scholars.

learned the following books under him: Neyshābūrī's (Nīsābūrī) commentary on Ṭūsī's *Tadhkira*, parts of Ṭūsī's recension of Euclid's *Elements*, 'Āmilī's *Quintessence of Arithmetic*, *Dissection* and the *Gloss*, and a treatise on the astrolabe, which could be either the one by 'Āmilī or Ṭūsī. Other parts of the *ijāza* present more titles in religious sciences, from previous scholars, both Sunni and Shiite, and from 'Āmilī's compositions as well. A significant feature of this *ijāza*, compared to the other two, is that 'Āmilī granted Tunikābunī all books and topics his father Ḥusayn ibn 'Abd al-Ṣamad had granted 'Āmilī in the extensive *ijāza* issued in Mashhad in 971/1564, after Ṭahmāsb I had dismissed Ḥusayn ibn 'Abd al-Ṣamad from the office of *shaykh al-islām* at the then Safavid Capital Qazvin. This *ijāza* should have made a tremendous change in Tunikābunī's intellectual career. By then 'Āmilī had become the most powerful and accepted religious authority in Safavid Persia, and by the *ijāza* Tunikābunī obtained all the credentials he needed to be a certified scholar in both religious and mathematical sciences.

Tunikābunī also trained students in astronomy. In a copy of his commentary on the *Dissection*, Tunikābunī issued an *ijāza* for the scribe (see **MS MR** below). The copy is dated mid-Ramadan 1029/4 Aug 1620 and was made by Malik 'Izz al-Dīn Muḥammad Ashraf. At the beginning of this copy (fol. 2r), Tunikābunī wrote an *ijāza* in his hand, for Malik 'Izz al-Dīn, certifying that the scribe had studied the commentary under him for a while, and granted him the transmission of what he learned from Tunikābunī to whoever Malik 'Izz al-Dīn would find competent and enthusiastic for the topic. Tunikābunī wrote and signed the *ijāza* in 1030/1621 in Mashhad at the shrine of the Eighth Imam, and it bears the Malik 'Izz al-Dīn's signature on the bottom right of the folio too.

It is reported that Tunikābunī entered into several disputes with the Safavid philosopher Sayyid Muḥammad Bāqir Astarābādī (d. 1040/1631) known as MīrDamād.⁴¹⁷ MīrDamād was a famous and revered philosopher who was also called the Third Teacher (*mu'allim al-thālith*) after Aristotle and al-Fārābī and considered a key founder of the philosophical school of Isfahan. He was the master of perhaps the most famous Safavid philosopher Mulla Ṣadrā (d. 1640). As a close friend and companion to 'Āmilī and a former student of 'Āmilī's father Ḥusayn ibn 'Abd al-Ṣamad, MīrDamād had collaborated and corresponded with 'Āmilī and his disciples like Tunikābunī. Like 'Āmilī, MīrDamād also served 'Abbās I.⁴¹⁸

6.2 Seeking Patronage in India

Tunikābunī wrote one of his *Unmūzaj al-'ulūm* (*Samples of Sciences*), a compendium of sciences in two versions, one containing ten topics, the other containing twelve topics by the title *al-Ithnā 'ashariyya* (*The Twelve Topics*). He wrote *The Twelve Topics* for shah 'Abbās I in 1015/1606-7 in Mashhad, and made another version, lacking two topics of jurisprudence and hadith, retitled to *al-Ashara al-kāmila* (*The Complete Ten Topics*) and dedicated to Amir 'Abd al-Raḥīm Khān-i Khānān (946-1036/1556-1627). 'Abd al-Raḥīm Khān was a noble at the court of Mughal emperors Akbar (r. 1556-1605) and Jahangir (r. 1605-1627), who was interested in Persian poetry and widely patronized Persian scholars. 'Abd al-Raḥīm was known for his couplets in poetry, and a collection of astrological verses in Sanskrit and Persian entitled *Kheṭa-kautukam* is attributed to him.⁴¹⁹

⁴¹⁷ He received the title "MīrDāmād" because he was the son in law of the senior jurist 'Alī ibn al-Husayn ibn 'Abd al-'Ālī al-Karakī (d. 940/1534) known as *al-Muḥaqqiq al-thānī* (The Second Verifier) who served two Safavid shahs, Ismā'īl I and his son Ṭahmāsb I.

⁴¹⁸ For MīrDāmād's career under 'Abbās and his relationship with 'Āmilī, see: Abisaab, *Converting Persia*, 71–79.

⁴¹⁹ Corinne Lefèvre, "The Court of 'Abd-ur-Raḥīm Khān-i Khānān as a Bridge between Iranian and Indian Cultural Traditions," in *Culture and Circulation: Literature in Motion in Early Modern India* (Brill, 2014), 75–106.

I could not locate any extant copy of the *Samples*, but according to Afandī Iṣfahānī (1066-1130/1656-1718), in the *Samples* Tunikābunī disputed many ideas of MīrDāmād and denounced some of his arguments in different areas of knowledge. Afandī Iṣfahānī reported that he had seen the two versions of the *Samples*, one in Ray and another in Herat, and reported that Tunikābunī summarized his name in *al-Ashara al-kāmila* to “‘Abd al-Kāzīm ibn ‘Abd al-‘Alī al-Tunikābunī” and dropped the topics of religious law and hadith in the shorter version, to make it appealing to the dedicatee and the Sunni audience of Mughal India. However, Afandī Iṣfahānī doubted the precedence of either version but explained the action as very common among the scholars of the time, such as Muḥammad ibn Ḥasan Shirwānī (d. 1098/1687) who lived in Najaf (Iraq, “Arḍ al-Ghurā”) when shah Suleymān (r. 1666-1694) commissioned him to write some works.⁴²⁰

Based on Tunikābunī's activities during the reign of ‘Abbās I (r. 1587-1629), we may conclude that he made the shorter recension of the *Samples*, *al-Ashara al-kāmila*, after 1629. Tunikābunī dedicated his commentary on the *Dissection* for ‘Abbās in Mashhad in 1599, however, as I will show later, he wrote the commentary in three places but completed it in Mashhad. Later in 1615 in Mashhad, Tunikābunī completed his super-commentary on Bīrjandī's commentary on Ṭūsī's *Tadhkira* for ‘Abbās I, and in 1618 he wrote a short treatise *al-Shubha al-taḥra* (*The Leap into Obscurity*) in Mashhad. An *ijāza* Tunikābunī issued for the scribe of his commentary on the *Dissection* (see below), places him in 1030/1621 in Mashhad, the same year that ‘Āmilī died.

Also, the **MS P** and the unique copy of his super-commentary on the *Tadhkira* (both discussed below), completed in 1033/1624, both contain numerous scholia from Tunikābunī

⁴²⁰ Iṣfahānī, *Riyāḍ al-‘ulamā’*, III:161-162. Shirwānī also wrote *Fī kā’ināt al-jaww* (*On the Meteorological Phenomena*) for ‘Abbās II (r. 1642-1666). Muḥammad ibn Ḥasan Shirwānī, “Fī kā’ināt al-jaww (*On the Meteorological Phenomena*)” (Tehran, Parliament Library MS 208812, n.d.).

signed by expressions that indicate he was alive then.⁴²¹ So it is reasonable to say that at least until 1624 Tunikābunī lived in Mashhad and still had 'Abbās' support. In addition, it seems very unlikely that Tunikābunī would have left Persia before the death of his powerful patron 'Abbās I in 1629, or before 'Āmilī's death in 1621. Now, there are two possibilities based on these accounts: either Tunikābunī left Persia after 1629, if ever, and sought patronage in India by attending the court of Amir 'Abd al-Raḥīm Khān-i Khānān in Deccan, which the Khān had been assigned to by Emperor Akbar in 1593; or after 1629 Tunikābunī was looking for a good patron in India and ambitiously wrote the shorter version of the *Samples* for the Khān before his departure, but never left Persia.

6.3 Tunikābunī's Works

There are mathematical and religious works by Tunikābunī of various lengths. Some exceed two hundred folios, and others occupy a few pages. Below is a list of his extant works:

- 1- *Qānūn al-idrāk fī tashrīḥ al-aflāk* (*The Rule of Perception in the Dissection of the Orbs*), introduced in detail in the following pages.
- 2- A super-commentary on Bīrjandī's commentary on Ṭūsī's *Tadhkira* for 'Abbās I, completed in 1025/1616 in Mashhad. The unique extant copy, in 226 folios, was completed in 8 Dhūl Ḥajja 1033/11 Sep 1624 by Muḥammad-'Alī ibn Maḥmūd Tabrīzī.⁴²² The copy contains some scholia from Tunikābunī that indicate he was alive then.

⁴²¹ **MS P** contains scholia, all signed “dāma baqāh” (may his life last long), and the super-commentary includes some scholia signed “minhu sallamah Allāh ta'ālā” (may the exalted God protect him) or “dāma zilluh al-'ālī” (may his elevated shadow last long).

⁴²² Tunikābunī and Bīrjandī, “Ḥāshya sharḥ Tadhkira.” Tabrīzī, probably, had a close connection with Tunikābunī and learned from him. Tabrīzī copied about 61 works by 'Āmilī, 'Āmilī's father, and a few other Safavid scholars, during the years 1030-1044 at two madrasas, the Razmsāriya in Qazvin and Shaykh Luṭf Allāh in Isfaha (Tehran, Parliament Library, MS 1231).

- 3- *Risāla fī imtedād al-ẓill* (*A Treatise on the Extension of the Shadow*).
- 4- *Shubha al-ṭafra* (*The Obscurity of Leap*) on the problem of the *cornicular* or horn-like angle in geometry related to Euclid's *Elements*, III, prop. 16, extant in autograph, completed in 1027/1618 in Mashhad.
- 5- *Risāla fī ẓill miqyās mansūb 'alā saṭḥ al-uḥuq* (*On the Shadow of the Gnomon on the Plane of the Horizon*).
- 6- *Al-Ithnā 'ashariyya* (*The Twelve Topics*) or the *Unmūzaj al-'ulūm* (*Samples of Sciences*), a compendium of sciences in twelve topics:
 - 1) Quranic exegesis, 2) theology, 3) jurisprudence, 4) hadith, 5) Arabic, 6) logic
 - 7) philosophy, 8) *hay'a* (theoretical astronomy), 9) metaphysics
 - 10) natural philosophy, 11) geometry, 12) arithmetic.
- 7- A Gloss on Fakhr al-Rāzī's *Maḥṣūl fī 'ilm al-uṣūl al-fiqh* (*Attainment of Principles of Jurisprudence*).⁴²³
- 8- *al-Wāsita wa 'anwā' uhā* (*The Intermediary and its Types*), in logic, poetry, and so forth.
- 9- *al-Abḥath al-tis' fī al-amr bi-l-ma'rūf wa-al-nahy 'an al-munkar* (*Nine Discourses on Committing Right and Forbidding Wrong*).
- 10- *Hāshia sharḥ Hikma al-'ayn*: A super-commentary on the *Hikma al-'ayn* of Najm al-Dīn Kātibī Qazwīnī (d. 675/1276) in theology, completed on 18 Rajab 1014/19 Nov 1605 in Mashhad.
- 11- *al-Lawḥ al-mahfūz* (*The Preserved Tablet*), a Persian exegesis on the Quran.
- 12- *Mas'ala al-ṣudūr* (*The Problem of Emanation*).

⁴²³ Iṣfahānī, *Riyāḍ al-'ulamā'*, III:161-162.

6.4 Commentary on the *Dissection*: “The Rule of Perception”

Most of the commentaries and glosses on the *Dissection* were written after the appearance of ‘Āmilī’s *Gloss*, and many others after his death in 1030/1621 or in later centuries. Āqābuzurg and Amīnī (1902-1970) recorded many commentaries and glosses on the *Dissection* including the *Gloss*.⁴²⁴ No commentary in their records is reported to predate ‘Āmilī’s *Gloss*, the completion of which took place during his early years of service to ‘Abbās I, as I showed in Chapter 4.

At the end of Dhil-Ḥajj 1007/mid-July 1599 in Mashhad, Tunikābunī completed his extensive commentary on the *Dissection*⁴²⁵ entitled *Qānūn al-idrāk fī tashrīḥ al-aflāk* (*The Rule of Perception in the Dissection of the Orbs*, henceforth, the *Rule*) and incorporated the author’s *Gloss* throughout his commentary. Tunikābunī had wanted to write the commentary long before, but only encouragement from ‘Āmilī made its completion possible. At the beginning of the *Rule*, Tunikābunī explained that he had desired to collect and record some of ‘Āmilī’s knowledge until his attention was drawn to *‘ilm al-hay’a* and he decided to write a commentary on the *Dissection*. Then he described the *Dissection* as a concise and inclusive work on *‘ilm al-hay’a* and ‘Āmilī’s *Gloss* as a strong complement to the earlier text, which needed further elucidation and demonstrations. However, as Tunikābunī further explained, he fell into an awkward mood and felt so miserable for a while that the job faded away into oblivion until a signal from ‘Āmilī gave him enough encouragement to begin the commentary.⁴²⁶ There are four copies of the *Rule*, three

⁴²⁴ Āqābuzurg Tehrānī, *al-Dharī’a*, 4:186-87, 13:146-49; Amīnī, *al-Ghadīr*, 11:348-49; Naji-Nasrabadi, *Ketābshenāsīye Sheykh Bahā’ī*, 187–202.

⁴²⁵ Tunikābunī, “Qānūn al-idrāk,” 1032 1623, fol. 139r.

⁴²⁶ Tunikābunī, “Qānūn al-idrāk,” 1029H 1620, fols. 3r-3v.

of them extant in Iran and one at the British Library, all were written during Tunikābunī's lifetime.

1. **MS P:** MS 6262, at the Parliament Library in Tehran, dated Ramadan 1032/June-July 1623, in Mashhad, anonymous scribe, fols. 1v-139r.
2. **MS MR:** MS 4672, at Ayatollah Marashi Najafi Library in Qum, dated mid-Ramadan 1029/4 Aug 1620, copied by Malik 'Izz al-Dīn Muḥammad Ashraf, fols. 2v-93r.
The beginning of this copy (fol. 2r) includes Tunikābunī's *ijāza* for the scribe (see above).
3. **MS ML:** MS 3440/1, at Malek National Library and Museum in Tehran, dated Dhū al-Qa'da 1025/ Nov 1616, copied by Malikī ibn Uways Sarkānī, fols. 1v-108r.
4. **MS BL:** MS Or 11857, at the British Library, dated 8 Rajab 1033/ 16 April 1624, copied by Muḥammad Sa'īd ibn Ḥājī Muḥammad al-Gīlānī, fols. 1r-160r.

Tunikābunī's commentary is very well-organized based on the contents of both the *Dissection* and the *Gloss*. Tunikābunī incorporated both texts by the method of interwoven commentary (*sharḥ mazj*, see Fig. 6-1). This presents phrases of the original work in the commentary by interweaving them into the commentator's sentences so that the final product is a consistent and consolidated composition.

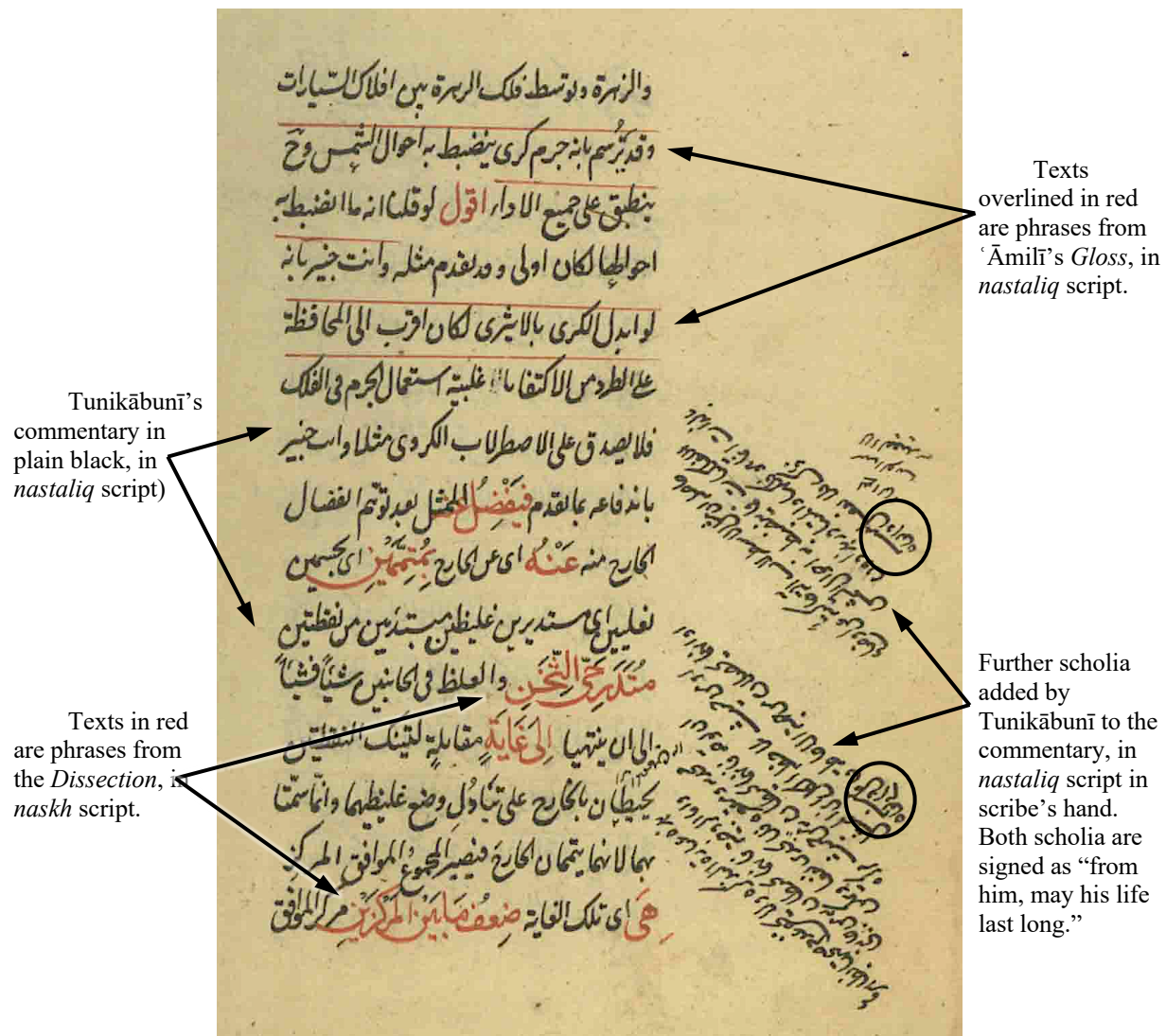


Fig. 6-1. *Qānūn al-idrāk*, MS P, fol. 62v.

As shown in see Fig. 6-1, if we take out all *naskh* scripts in red and put them together, we can remake the entire text of the *Dissection*, and the same goes for the *Gloss* if we put together all overlined phrases in *nastaliq* script. Tunikābunī's comments, however, are not all in the main text of the commentary. He later added much more to his commentary as marginal notes, all signed at the end by the statement “from him, may his life last long” (*minhu, dāma baqāh*), which shows that the notes were made by Tunikābunī and written down by his disciples or possibly dictated to him. The marginal notes, as presented in Fig. 6-2, go beyond the main

commentary in terms of content and level, sometimes including drawings as well. Among the existing copies of the *Rule*, **MS P** and **MS BL** have more marginal comments, probably because they were made after the other copies, but comparing these two, **MS P** presents many more marginal notes than **MS BL**. A few folios from the beginning are missing in **MS P**, but in the following pages all my references to the *Rule* are made to **MS P**, unless there is additional information in other copies that is missing in that manuscript.



Fig. 6-2. *Qānūn al-idrāk*, MS P, fols. 3v-4r. Note the diagram in the marginal note at top left and many other notes from Tunikābunī added to his commentary by the scribe.

Tunikābunī presented additional preliminary material before commenting on the text of the *Dissection* and *Gloss*. He added three short sections at the beginning under *maqāla* (discourse), on the topics of geometry, natural philosophy, and metaphysics, with several drawings and marginal notes.⁴²⁷ The purpose of these sections seems to present concepts of each topic necessary for understanding the rest of the commentary. The first discourse, on geometrical topics, defines: point, surface, solids, angle, sine, cosine, tangent, cotangent, chord, circle, sphere, and regular cone, in its first part. Part two is on certain problems in spherical geometry, providing six theorems from Theodosius' *Sphaerica*. The second discourse explains what belongs to natural philosophy, that is motions, natural and compulsory. The third discourse explains what belongs to metaphysics: the absurdity of vacuum, the necessity of a single mover for one simple motion, and that celestial bodies never become detached or condensed, neither grow nor diminish, tear nor mend.

After these additional introductions, Tunikābunī began commenting on 'Āmilī's texts, starting with the definition of the *'ilm al-hay'a*. He expanded on 'Āmilī's definition and made complementary and critical discussions referring to Ṭūsī, Khafri, Neyshābūrī (Nīsābūrī), and Ibn Sīnā. Like Khalkhālī's commentary, which I described in the previous chapter, Tunikābunī preferred 'Āmilī's definition of the orb (*falak*) as a comprehensive one which included the complement orbs with non-uniform thicknesses as well. Tunikābunī's general approach in the introduction, which covers topics of natural philosophy and the total orbs, was commenting on 'Āmilī's text with much more scrutiny and expansion, by bringing into the discussion alternative opinions of previous astronomers, philosophers, and theologians. In many cases, he made corrections to 'Āmilī's ideas or opened further aspects of the discussion to give a complete

⁴²⁷ MS P, fols. 3r-6v.

picture of the ongoing disputes about the topics. Here, I will discuss some examples of how Tunikābunī commented upon the first chapter of the *Dissection*.

Tunikābunī discussed the nature of an orb and its relation to the enclosed planet by adding references to 'Āmilī's commentary on prayer, *Ḥadīqa al-hilāliyya* (*The Crescent Garden*), and Fakhr al-Dīn al-Rāzī's (544–606/1149–1210) *Mabāḥith al-mashriqiyya*, a philosophical work on natural philosophy and metaphysics. At the beginning of the *Dissection*, 'Āmilī quoted two phrases from Qur'an which talk about *falak*. In XXI:33 it says: "And He it is Who created the night and the day, and the sun and the moon; they float, each in a *falak*," and in XXXVI: 40 it says: "It is not for the sun to overtake the Moon, nor doth the night outstrip the day. They float each in a *falak*."⁴²⁸ The first part of the first verse talks about the creation of night and day, the Sun and the Moon, while the final phrase tells us about the motions of the Sun and the Moon. In the *Dissection*, 'Āmilī used this phrase for the motions of all seven planets.⁴²⁹ There is a long discussion on the meaning of *falak* and this phrase in the exegeses of the Qur'an. Rāzī also wrote extensively on it.⁴³⁰ In the *Gloss*, as I discussed in Chapter 4, on the meaning of *falak*, 'Āmilī quoted from Bīrūnī who said that both the Arabs and Persians took the same approach to naming the sky (*samā*); the Arabs called it *falak* due to its resemblance to a rolling wheel with axis and poles, and the Persians called it "āsmān" which is a combination of "ās," meaning a mill, and "mān" that indicates a comparison.⁴³¹ Bīrūnī describes the geometrical shape of the orbs but does not tell us about their physical nature. What seemed problematic in the Quranic phrase "they float, each in a *falak*"⁴³² was the meaning of "floating," since all practitioners of the *ilm al-*

⁴²⁸ Here I am quoting M. Pickthall's translation but replaced "orbit" in his translation with *falak*.

⁴²⁹ al-'Āmilī, "Tashrīḥ al-aflāk," 986 1576, fol. 3v.

⁴³⁰ Fakhr al-Dīn al-Rāzī, *al-Tafsīr al-kabīr (Maḥāṭib al-ghayb)* (Beirut: Lebanon: Dār al-Fikr, 1981), XXII:161-168.

⁴³¹ Cf. Bīrūnī, *al-Taḥfīm li-'awā'il ṣanā'a al-tanjīm*, 56–58.

⁴³² «كُلٌّ فِي فَلَكٍ يَسْبَحُونَ»

hay'a, including Ṭūsī, believed in solid physical orbs that do not tear. To solve this inconsistency between scripture and astronomy, in the *Crescent Garden* 'Āmilī rejected this tenet of *'ilm al-hay'a*, by resorting to another event in the early Islamic history, the corporeal Ascension of the Prophet to the heavens and beyond. 'Āmilī concluded that based on this event, philosophers' proof for the impossibility of perforation in the orbs is untenable.⁴³³ In the commentary, Tunikābunī included this idea but in a short marginal note added more precision based on Rāzī's *Mabāḥith*. In his *Great Exegesis*, Rāzī also rejected the philosophers and astronomers who assumed that planets were fixed in moving orbs; instead, he attributed motions to the planets by floating within their fixed orbs.⁴³⁴ Following the same understanding of the Quranic phrase, Tunikābunī presented six cases for the motion of the planet and the orb.

Table 6-1. Six cases for the position and motion of a planet and the orb

Cases	Planet	Orb
1	moving	stationary
2	moving	moving, parallel to the planet's motion
3	moving	moving, not parallel to the planet's motion
4	moving with the same motion of the orb	moving
5	moving with a different motion from the orb	moving
6	stationary (in the orb)	moving

Tunikābunī stated that the Ascension hadith refutes four of the cases, but not cases 2 and 4 (see Table 6-1). For cases 2 and 4 to hold, he made a further criterion that all moments of motion and

⁴³³ al-'Āmilī, *al-Ḥadīqah al-hilālīyyah*, 84.

⁴³⁴ al-Rāzī, *al-Tafsīr al-kabīr (Maḥāṭib al-ghayb)*, XXVI:168.

stationary positions for both the planet and the orb must occur at the same time. Obviously, he like 'Āmilī did not follow the classic understanding of the physical orbs in *'ilm al-hay'a*, and his comments cast doubt on the real nature of the celestial bodies.

6.4.1 The position and motion of the Earth

'Āmilī's definition of the Earth in the *Dissection* created some ambiguity about whether the Earth is moving or stationary. Throughout the *Dissection*, 'Āmilī followed standard Ptolemaic astronomy, which assumed the Earth to be stationary at the center of the world.⁴³⁵ But the following statement in the *Dissection* led to a bit of controversy for his commentators:

Then, there is the sphere of Earth, whose center of heaviness is the center of the world and holds to it. Its [Earth's] motion depends on the movement of a heaviness on it, and no evidence has been offered to disprove its [Earth's] slow motion in place.⁴³⁶

In the *Gloss*, 'Āmilī did not say anything further about this slow motion he considered to be possible for the Earth, except for a short phrase saying that “Its motion is the opposite direction of the motion of the heavy [object].” He added more to this section by explaining that if the sphere is homogeneous, then its geometrical center coincides with its center of heaviness and that the motion of all heavy objects is toward the Earth's center, in all directions, along straight lines perpendicular to its surface. Then he presented the example of the distances of heads and feet of two people standing on the surface of the Earth, described in Chapter 4. In the *Rule*, in addition to presenting a different geometrical proof for the heads and feet example, Tunikābunī

⁴³⁵ Some recent scholars, based on this statement by 'Āmilī, concluded that he anticipated the Earth's rotation in the sixteenth century. See: Behnaz Hashemipour, “'Āmilī: Bahā' al-Dīn Muḥammad ibn Ḥusayn al-'Āmilī,” in *The Biographical Encyclopedia of Astronomers*, ed. Thomas Hockey et al. (Springer New York, 2007), 42–43, https://doi.org/10.1007/978-0-387-30400-7_45.

⁴³⁶ al-'Āmilī, “Tashrīḥ al-aflāk,” 986 1576, fols. 4r-4v.

ثم كرة الأرض، ومركز ثقلها مركز العالم ويلزم حركتها / بتحريك ثقلها عليها ولم يقم دليل على بطلان تحريكها حركة وضعيتها بطيئة.

wrote eight pages about the position and motion of the Earth, to comment on the above short expression from the *Dissection*.⁴³⁷ This slow motion seems to be a displacing motion of the Earth's center to the center of the world upon the motion of a heavy object on the surface of the Earth. A heavy object on one side will disrupt the Earth's homogeneousness, and therefore its geometrical center would not coincide with its center of heaviness. As a result, the natural motion of all heavy objects toward the center of the world requires the Earth's center of heaviness to move to that point, in the opposite direction that the heavy object is laid on it. This can be one interpretation of 'Āmilī's expression, but in his comments on the topic, Tunikābunī considered the Earth's rotation as one of 'Āmilī's points.

Tunikābunī discussed different types of evidence to reject two possibilities, the displacing motion, and the rotation of the Earth. For the first motion, he first made an objection to Shīrāzī's *Tuhfa* that the center of the Earth's sphere coincides with the center of its heaviness but presented thought experiments and examinations to reject the displacing motion. In a marginal note, he pointed out that Shīrāzī's claim is true only if the Earth is surrounded with a regular amount of water everywhere. But according to the practitioners of *hay'a*, including Shīrāzī, water has a horseshoe shape on one side of the Earth. However, even in this case the center of the Earth's sphere coincides with the center of its heaviness, as Tunikābunī clarified, provided that the Earth and water maintain such an equilibrium in the volume that both form a single uniform sphere, something that according to Tunikābunī, Shīrāzī did not admit. In the commentary, Tunikābunī provided another argument against the first motion, arguing that if the Earth had a slow motion, the ascending and descending times of a stone thrown upward would differ, but the examination (*imtiḥān*) provides evidence against it.

⁴³⁷ MS P, fols. 22r-25v.

For the second motion, the Earth's rotation, Tunikābunī presented a long series of arguments and evidence to show why in the *Dissection*, 'Āmilī wrote: "...and no evidence has been offered to disprove its [Earth's] slow motion in place." In the text and a marginal note, he first explained the reason why some ancients (probably Aristarchus of Samos) attributed motions to the Earth. The purpose, as he put it, was to offer a solution for the physical problem of attributing two motions at different directions at the same time to celestial bodies, i.e., the rapid daily motion from east to west and the proper slow motion eastward. And because there were several slow (proper) motions, and it was impossible to assign them all to the Earth, they attributed only the daily motion to the Earth.⁴³⁸ Following this comment, Tunikābunī reviewed four arguments against the rotation of the Earth but pointed out a problem with each. If we consider that the Earth rotates, then:

1. A flying bird and shot arrow must be seen faster in the direction of Earth's rotation and slower in the opposite direction.
2. A projectile thrown upward in the air must not land at the same place it departed the Earth but must land on the west of the initial position.
3. The projectile going upward must not trace a straight line [when descending], since at its stationary status at the highest elevation, the Earth rotates eastward.
4. The clouds and birds must not either be seen stationary in the air or be seen traveling eastward because none can keep up with the rapid eastward motion of the Earth.

Considering the Earth's circumference to be 24000 miles, each point on it travels 1000 miles each hour in a nychthemeron. No moving object on the Earth even moves at such a speed as 100 miles in a tenth of an hour. Therefore, the Earth always moves faster eastward than any object.

Here Tunikābunī brings objections that some made to these arguments, but he clarifies the problems of each counterargument. Some people argued that the Earth rotates in conformity to

⁴³⁸ MS P, fol. 23v.

the surrounding air, and so do flying objects, like the conformity of the sphere of Fire with the orb of the Moon, which causes comets to move. So, they would not be left behind by the Earth's rotation.

Tunikābunī denied any conformity between the sphere of Fire and the orb of the Moon, arguing that the motion of comets is not always parallel to the motion of the orb of the Moon and sometimes goes north-south. The motion of the comets and its relevance to a possible motion of the Earth has been a matter of dispute between the astronomers of Marāgha and their commentators.⁴³⁹ Some of those argument appear in Tunikābunī's commentary as well. As I discussed in the previous chapter, Khalkhālī also discussed the motion of the comets by comparing ideas of Ṭūsī, Shīrāzī, and Qūshjī, besides commenting on and finally disagreeing with 'Āmilī. However, the cometary motion was one, among several others, of the Tunikābunī's arguments to reject the Earth's motion. According to Tunikābunī, even if we accept that there is a conformity between the sphere of Fire and the orb of the Moon, such a conformity does not exist in terrestrial matters. Consider two stones, one large and one small, thrown in one direction, along the meridian line. The air must move the large stone less than the small; otherwise, the large must fall on the west side of the small one, which is not the case. And if we do not accept that the air moves the large stone more and admit that the air moves the objects regardless of their sizes, then it requires that both the large and small stones move at the same speed as the Earth's rotation, which never happens. On the other hand, even if we admit that the air moves the large stone more, the difference between the two movements is so small that it is hardly perceptible. There is no one among the practitioners of experience/experiment (*aṣḥāb al-tajriba*)

⁴³⁹ A detailed study on the cometary motions used for accepting or denying the motion of the Earth, both in the Islamicate and premodern European astronomy, is found in F. Jamil Ragep, "Ṭūsī and Copernicus: The Earth's Motion in Context," *Science in Context* 14, no. 1 & 2 (June 2001): 145–63.

who can measure that difference in the cases that the stones are too huge or so tiny. Tunikābunī concludes that, because none of the arguments adduced against the motion of the Earth is without any flaw, in the *Dissection* 'Āmilī stated that "...and no evidence has been offered to disprove its [Earth's] slow motion in place."

A significant point in Tunikābunī's approach in reassessing the argument against the Earth's rotation is that he did not rely on thought experiments in his counterarguments, but empirical observations. In the example of the large and small stone, especially, he explained that the experiment could not be performed in many cases that involve a huge or a tiny stone; therefore, no conclusion can be made from this experiment, and the problem remains open.

There remained another famous and strong argument that Tunikābunī tried to debunk at the end of this section. From ancient times, Aristotelians argued that since all parts of the Earth have the principle of rectilinear motion,⁴⁴⁰ so does the Earth as a whole, and therefore it is constrained from moving with circular motion "naturally" (*bi al-ṭabʿ*).⁴⁴¹ Tunikābunī added that this argument does not suffice at all,⁴⁴² and in a marginal note, presented three reasons to support his idea.⁴⁴³ He wrote that, first, the fact that the Earth does not rotate by nature does not deny the possibility of its motion by compulsion. Second, this argument is natural philosophical, not mathematical, and its advocates, like Shīrāzī (in the *Tuhfa*) and Neyshābūrī, refrain from giving a mathematical argument. Third, the Earth's parts having a principle of direct motion does not require the Earth as a whole to have the same motion; rather, it is possible for the Earth to have a principle of circular motion.⁴⁴⁴ The discussion of the Earth moving to the orb of the Moon and

⁴⁴⁰ ذات مبدأ ميل مستقيم

⁴⁴¹ The same expression was used by Ṭūsī. Ragep, *Ṭūsī's Memoir*, I:170.

⁴⁴² «لا يسمن ولا يغني من جوع» from Quran, XXX:7.

⁴⁴³ MS P, fols. 25r.

⁴⁴⁴ ذات مبدأ ميل مستدير

returning to its present position because of the tendency of all its parts does not solve anything. Khalkhālī attributed this idea to Ṭūsī⁴⁴⁵ which in fact belongs to Bīrjandī. In response to the idea that the Earth could have the principle of rectilinear motion, Bīrjandī gave the thought experiment that if the Earth moves to the concave surface of the Moon's orb, all its parts will descend to the center of the world, either being separated or attached to it.⁴⁴⁶ Apparently, Tunikābunī is arguing against Bīrjandī without mentioning his name. More elaboration on this matter by Bīrjandī got Tunikābunī's attention as well as 'Āmilī's.⁴⁴⁷ Tunikābunī quoted Bīrjandī's idea from 'Āmilī's super-commentary on Jaghmīnī:

The truth is what the master of our master,⁴⁴⁸ Bīrjandī the verifier (*muḥaqqiq*), said in his commentary on the *Tadhkira* that it is not true to attributed to the ancient philosophers such an opinion, which is refuted by observing the motion of an ant on a millstone.⁴⁴⁹ Rather it is apparent that there were two reasons that caused them to do so. First, they saw all the orbs moving by the daily motion but realized that ascribing the daily motion of all to the outermost orb is not free from any issue because the outermost orb is not attached to all of the orbs but only one of them. Second, by assuming such, there was no need for the outermost orb, and therefore, one less orb was required.⁴⁵⁰

⁴⁴⁵ Shams al-Dīn 'Alī ibn Muḥammad ibn 'Alī Ḥusaynī Khalkhālī, "Sharḥ Tashrīḥ al-aflāk" (University of Mashhad, Department of Theology, MS 323, 1038 1629), fol. 16r.

⁴⁴⁶ Nizām al-Dīn 'Abd al-'Alī Bīrjandī, "Sharḥ al-Tadhkira" (MS Arab SM4285. Houghton Library, Harvard University, n.d.), fol. 37v.

⁴⁴⁷ Earlier I noted that Tunikābunī studied Bīrjandī's commentary on the *Tadhkira* under 'Āmilī and received an *ijāza* for that. Tunikābunī also wrote a super-commentary on Bīrjandī's commentary.

⁴⁴⁸ A marginal note here names 'Āmilī's master as 'Alī al-Mudhahhib al-Hirawī (), who was also referred to by Khalkhālī in the *Exposition* (see the first section of this chapter). Al-Hirawī was also called Mīr 'Alī or Mīr Jān. He was a Persian calligrapher and artist but no work on astronomy by him has survived. The same expression "the master of our master" is used by 'Āmilī in the *Crescent Garden* and this note in the *Role*, clarifies that al-Hirawī had studied under Bīrjandī and taught 'Āmilī too. al-'Āmilī, *al-Ḥadīqah al-hilālīyyah*, 123.

⁴⁴⁹ This expression was used by Rāzī to show that the ant moves while the millstone rotates at the opposite direction. al-Rāzī, *al-Tafsīr al-kabīr (Maḥāṭib al-ghayb)*, XXII:166.

⁴⁵⁰ MS P, vol. 25r.

The opinion attributed to ancient philosophers in this quote is the one that Tunikābunī earlier explained as the reason for assuming the Earth's rotation, the problem of ascribing two motions in opposite directions to celestial bodies. Bīrjandī believed that this could not be the reason for the ancients to present the idea of Earth's rotation, and he explained it, as quoted above, in his commentary on Ṭūsī. However, Tunikābunī's rejection immediately follows this quote and concludes this topic in the *Rule*. Tunikābunī borrowed the idea from Rāzī's *Mabāḥith* that the movement caused by the outermost orb results from a strong soul or intelligence attached to it that moves whatever is inside it, but not by direct physical contact.

The topic of the Earth's position and motion attracted special attention in Tunikābunī. Unlike Khalkhālī, who presented natural philosophical arguments against the motion of the Earth, Tunikābunī's attitude reflects an obvious uncertainty about the issue in the seventeenth century. The practitioners of *'ilm al-hay'a* had assumed the Earth's stationary position at the center of the world for a long time, and almost no serious doubt had been expressed about the matter in Islamicate astronomy. But Tunikābunī's detailed review of the arguments and his objections to them in a relatively long section of the *Rule* implies that none of the arguments provided by his predecessors were convincing enough to prevent someone from thinking about the Earth's motion. He even explained the impossibility of performing some experiments to reject the rotation of the Earth, although no one, as he admitted, had presented an experiment to prove the Earth was stationary. Tunikābunī's conclusion at the end of the topic, which seems to talk to a disciple, restates that the topic needs a much longer conversation to properly deal with and leaves the question open for further debate.

6.4.2 Non-Ptolemaic models of planetary motions

In the commentary on chapters two and three of the *Dissection* dealing with the structure and motions of the orbs, respectively, Tunikābunī included several discussions, which concern both the Ptolemaic definitions and models and not-Ptolemaic techniques devised by his Islamicate predecessors. The commentary begins with the definition of the two principles in planetary models, the eccentric and the epicycle models, with necessary conditions for the equality of both principles. For the partial orbs of the planets, Tunikābunī explained the reason for each model and why astronomers assumed a specific number of orbs for each planet, to be technically based on the number of irregularities of motion that each planet exhibits. Tunikābunī introduced the function of various orbs, like the deferent, the Inclined orb and *Jawzahar* of the Moon, and the dirigent (from Latin *dirigere*: to direct or conduct, Arabic *mudīr*) of Mercury, pointing to the differences of each planet's model and the reason behind their nomenclature. For instance, Tunikābunī explained that the Inclined orb of the Moon was so named because of its inclination to the Ecliptic. He added that the equator of the inclined orb and the ecliptic intersect each other at two nodes, also called *jawzahar* from Persian *gezahr*, literally meaning endpoints of a snake, the head and tail. This nomenclature seems to be the reason why the nodes are also called the head and tail of the dragon. Likewise, the outermost orb of the Moon, which carries the two nodes, was named *Jawzahar* after that.

In chapter three of the *Dissection*, which concerns planetary motions, Tunikābunī dedicated a long portion of the *Rule*⁴⁵¹ to presenting more numerical values and introducing the Tusi couple as a key for solving the *prosneusis* problem of the Moon and the equant problem for the outer planets and Venus. He summarized the sixteen difficulties of the Ptolemaic models and,

⁴⁵¹ MS P, fols. 67v-92r.

like 'Āmilī and Khalkhālī, stated that Ṭūsī and his disciple Shīrāzī solved a few of the problems while Khafī solved the remaining ones by applying eighty-five orbs, in his commentaries on Ṭūsī and Shīrāzī. Tunikābunī also noted from 'Āmilī's *Gloss* that 'Āmilī had introduced other solutions for the Moon and Mercury in a single treatise, but he did not explain further if he had seen that work of 'Āmilī or not. However, Tunikābunī's interest in presenting non-Ptolemaic models and alternative solutions does not end here. He dealt with the topic in a more systematic way than that in the *Gloss*. First, he introduced three criteria for the uniform circular motion that all celestial orbs must have, that is (1) maintaining the same distance from the center of motion at all times; (2) for orbs being carried by another orb, like an epicycle by the deferent, having the same distance from the center of the larger or carrying orb and also, (3) keeping a diameter always pointed to the center of the larger or carrying orb. The motion of the deferent of the Moon and the eccentrics of the other five planets, as modeled by Ptolemy, violated some or all of these conditions. In the discussion of the equant as the main problem of Ptolemy's model for Venus and the upper planets, Tunikābunī explained that although the epicycle's center is assumed to move uniformly around the imaginary equant point, it does not maintain the same distance from the equant, so it does not hold to the second criterion above. Tunikābunī introduced the Tusi couple as one solution to some of the problems and explained its application in a new model for the motion of the Moon proposed by Ṭūsī and modified by Shīrāzī. This was not the only application of the Tusi couple introduced in the *Rule*; Tunikābunī earlier stated the use of the mechanism for modeling the trepidation motion.⁴⁵²

⁴⁵² MS P, fol. 37v.

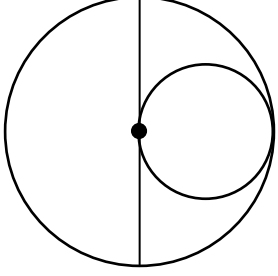
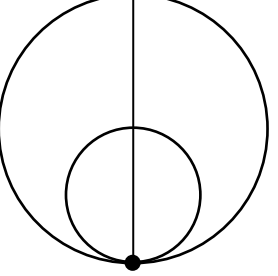
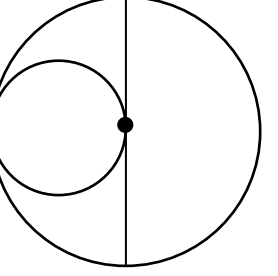
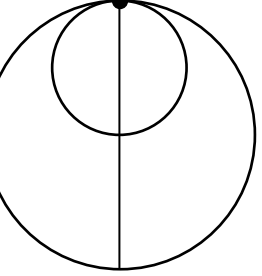
The positions once the small circle rotates one and half a circles, and the larger rotates three quarters of a circle. The position of the larger completing one rotation is the same as figure one.	The positions once the small circle completes one rotation and the larger rotates half a circle.	The positions once the small circle rotates half a circle and the larger rotates a quarter circle.	Position of the two circles at the beginning. The small circle rotates clockwise, while the large one rotates counterclockwise.
			
[4]	[3]	[2]	[1]

Fig. 6-3. The Tusi couple explained in the *Rule*. (MS P, fol. 70v). The diagram and the notes are quoted from Tūsī's *Tadhkira*.

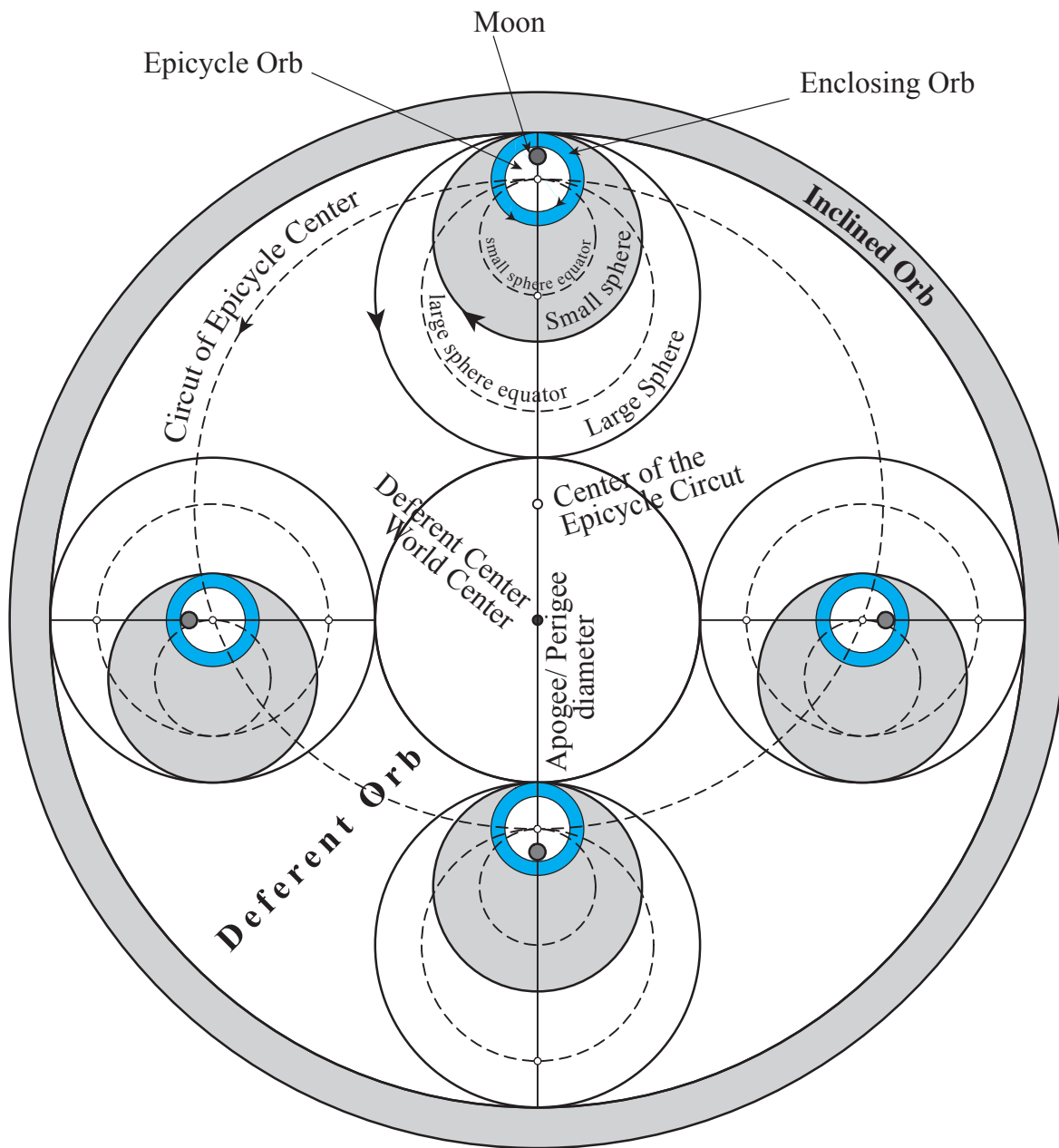


Fig. 6-4. Moon model using Tusi couple, redrawn based on the figure in the *Rule of Perception* (MS P, fol. 72r.)

6.4.3 Planetary equations, objections to Kharaqī and others

In the *Dissection*, ‘Āmilī discussed the equation of the Sun and in the *Gloss*, he presented a mathematical demonstration for the equation (see Chapter 4). Compared to other planets, the Sun

has only one equation or anomaly. The number of equations for all planets amounts to 20, as Tunikābunī stated, one for the Sun, four for the Moon, and three for each of the other five planets. The equation of the Sun is the angular difference between Sun's true position and its position according to its mean uniform motion around the Ecliptic, or the difference between the motion of the Sun on its eccentric orb and what is observed from the Earth. 'Āmilī, among other things, spent pages of the *Gloss* on this topic and called it necessary for all beginners of astronomy. Tunikābunī also discussed the equation of the Sun in detail but pointed to 'Abd al-Jabbār Kharaqī's (1084–1158) *Tabṣīra fī al-hay'a* where, according to Tunikābunī, he mistakenly stated that the equation angle is measured from the center of the disk of Sun. In his *Tabṣīrā*, Kharaqī defined the correct arc of the Ecliptic for the Sun's equation but made a mistake in defining the corresponding angle by putting the angle at the center of the disk of the Sun.⁴⁵³ As Tunikābunī explains it must actually be measured at the center of the world, by the angle $A\hat{C}B$ in Fig. 6-5.

According to Fig. 6-5, the equation angle $A\hat{C}B$ equals the angle $A\hat{Z}D$ when the mean line CB is parallel to ED . The Sun travels equal arcs in equal times on the Eccentric orb, but its motion is measured along the Ecliptic with respect to the center C . So, as Tunikābunī explained, the equation arc is measured on the Ecliptic, which is the *arc* AB subtending the equation angle $A\hat{C}B$ not the *arc* AD . Obviously, the angle $A\hat{Z}D$ is not equal to *arc* AD on the Ecliptic. Therefore, the mean motion of the Sun, the mathematically calculated position of the Sun, is marked by the line CB on the Ecliptic and that differs from the Sun's true position by the amount

⁴⁵³ 'Abd al-Jabbār Kharaqī, "al-Tabṣira fī al-hay'a" (University of Tehran, MS 5399, December 23, 1665), fols. 14r-14v; "al-Tabṣira fī al-hay'a" (Tehran, Parliament Library MS 3936, March 25, 1653), fols. 13r-13v.

of *arc AB* (Note that on Fig. 6-5, the eccentricity *EC* is exaggerated for visual presentation, while it should be much smaller than shown on the image.)⁴⁵⁴

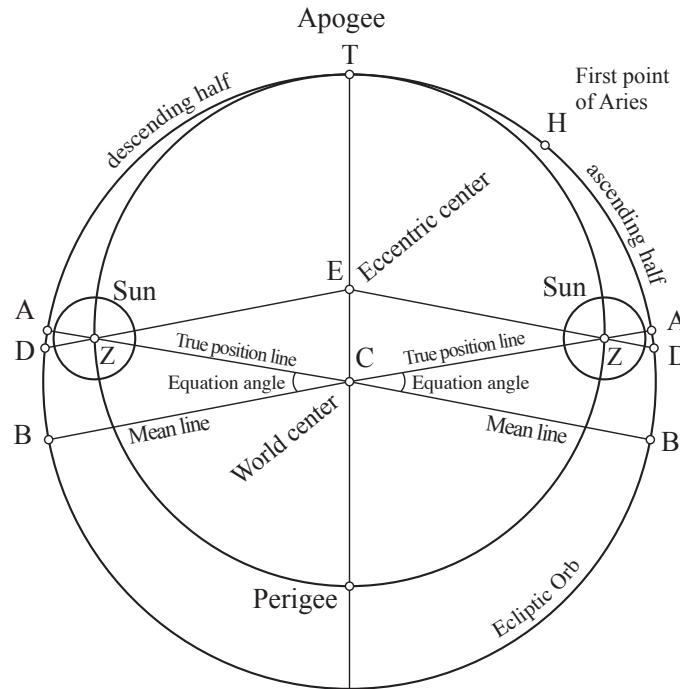


Fig. 6-5. The equation of the Sun, redrawn from the *Rule of Perception* (MS P. fol. 76r).

In fact, it was not only Kharaqī who made a mistake in determining the equation of the Sun. A few other prominent astronomers, according to Mu'ayyid al-Dīn al-'Urḍī's (d. 1266) report in his *Kitāb al-hay'a*, had the same misunderstanding of the mean position of the Sun. Besides mentioning Kharaqī, 'Urḍī pointed to Kūshyār ibn Labbān al-Jīlī (Gīlānī, d. early 11th century) and Zarqālī (d. 1100) who gave false definitions for either the mean motion, the equation, or the true position of the Sun. After defining the concepts, 'Urḍī explained that al-Jīlī and Kharaqī got the true position right but went wrong in defining the mean motion of the Sun. Kharaqī also made a mistake in defining the equation arc, which according to the figure above, he assumed to

⁴⁵⁴ The Ptolemaic value for Sun's eccentric was $2; 29\frac{1}{2}^P$ when the eccentric radius is 60^P , which means the eccentric's radius *TE* should be about 24 times longer than the eccentricity *CE*. Ptolemy, *Almagest*, 155.

be *arc AD*.⁴⁵⁵ We should add Jaghmīnī to this list, although contemporary to 'Urḍī, who apparently was not aware of Jaghmīnī's book. In the *Mulakhkhaṣ*, Jaghmīnī made a mistake in defining the mean motion of the Sun to be an arc on the Ecliptic traced by the Eccentric's extended radius (*ED* in Fig. 6-5) not the center of the world. As a result, Jaghmīnī went wrong in defining the equation arc too⁴⁵⁶ and in his commentary on the *Mulakhkhaṣ* Qāḍizāda pointed to Jaghmīnī's mistake and gave the correct definitions.⁴⁵⁷

6.5 Books and Authors cited in Khalkhālī's *Exposition* and Tunikābunī's *Rule*

As the initial phases of developing the *'ilm al-hay'a* appeared in the 4th/10th century, an early author in the genre would normally have very few sources in hand or would have just started off with the Greek astronomical legacy. But, as the *'ilm al-hay'a* further developed from simple works in its early stages to lengthy and complicated compositions with a highly critical attitude toward Ptolemaic astronomy, such as the products of the Marāgha associates, writing about the topic demanded far more mastery of the extant works. Islamicate astronomers of the thirteenth and fourteenth centuries created a series of complex works on *hay'a*, which matured this branch of science and formed a new tradition for the subsequent scholars to follow. These complex works became the subject of numerous commentaries or super-commentaries by contemporary and subsequent scholars. As a result, Safavid authors and astronomers faced such a huge literature in *'ilm al-hay'a* that developing any new and different idea in astronomy required an overwhelming command over the existing literature. This attitude is obvious in commentaries on

⁴⁵⁵ Mu'ayyad al-Dīn al-'Urḍī, *The Astronomical Work of Mu'ayyad al-Dīn al-'Urḍī: A Thirteenth Century Reform of Ptolemaic Astronomy*, Kitāb al-Hay'ah, ed. George Saliba, 7th ed., Silsilat tārīkh al-'ulūm 'inda al-'Arab 2 (Bayrūt: Markaz Dirāsāt al-Wahdah al-'Arabīyah, 1990), 81–82.

⁴⁵⁶ Sally P. Ragep, *Jaghmīnī's Mulakhkhaṣ*, 117.

⁴⁵⁷ Ṣalāh al-Dīn Mūsā ibn Muḥammad Qāḍizāda al-Rūmī, *Sharḥ Chaghmīnī*, Lithograph edition, 1869, 63–64; *Kitāb Sharḥ Chaghmīnī*, Lithograph edition (Tehran, 1894), 72–73, http://dlib.ical.ir/faces/search/bibliographic/biblioFullView.jspx?_afPfm=-lvyquiyfn.

‘Āmilī's astronomy. One feature of Khalkhālī's and Tunikābunī's commentaries, in this regard, is their use of numerous scholarly works by his predecessors in multiple fields, which shows his mastery not only over the Islamicate astronomical literature and traditions but his awareness of ancient Greek mathematical and astronomical works. The following list presents all authors and books Khalkhālī and Tunikābunī referred to in their commentaries on the *Dissection*. Items are chronologically grouped from ancient Greek scholars to Islamicate philosophers, astronomers, mathematicians, theologians, and philologists in alphabetical order.

Table 6-2. Books and authorities referred to by Khalkhālī and Tunikābunī⁴⁵⁸

Sources and authorities	Khalkhālī's <i>Exposition</i>	number of citations	Tunikābunī's <i>Rule</i>	number of citations
<i>Ancient Greek Sources</i>				
▪ Plato (d. 348 BC)			✓	1
▪ Aristotle (384-322 BC)	✓	1		
▪ Autolycus of Pitane (c. 360- c. 290 BC) ○ <i>On the Moving Sphere</i>	✓	3		
▪ Aristarchus of Samos (c. 310- c. 230 BC) ○ <i>On the Sizes and Distance</i>	✓	2	✓	1
▪ Euclid (3 rd century BC) ○ <i>Elements</i> (Ṭūsī's recension)	✓	6	✓	7
○ <i>Optics</i> (Ṭūsī's recension)	✓	2	✓	2
▪ Hipparchus (d. c. 120 BC)	✓	2	✓	2
▪ Theodosius of Bithynia (d. c. 100 BC) ○ <i>Sphaerica</i> (Ṭūsī's recension)	✓	13	✓	2
○ <i>On the Days and Nights</i> (Ṭūsī's recension)	✓	1		
○ <i>On Habitations</i> (Ṭūsī's recension)	✓	1		
▪ Ptolemy (d. 160) ○ <i>Almagest</i>	✓	5 1	✓ ✓	5 2
○ <i>Geography</i>				1
<i>Islamic Sources</i>				
Astronomers and Mathematicians				
Before Marāgha				
▪ Al-Kindī, Ya'qūb b. Ishāq (c. 800-870)	✓			
▪ Farghānī, b. Kathīr (d. 861)		1	✓	1
▪ Al-Khāzin, Abū Ja'far (d. 971) ○ observations			✓	1
▪ Ibn al-A'lam (d. 985)	✓	2	✓	2
▪ Ṣūfī, 'Abd al-Raḥmān (903-986) ○ <i>Book of the Fixed Stars</i> (<i>Ṣuwar al-kawākib</i>)	✓	2	✓	2

⁴⁵⁸ The number in front of the entries count the appearances of that entry in each commentary. When the book is not specified by Khalkhālī or Tunikābunī, the number is given to the author.

Sources and authorities	Khalkhālī's <i>Exposition</i>	number of citations	Tunikābunī's <i>Rule</i>	number of citations
- Ibn al-Haytham, al-Ḥasan (956-1040) <i>Optics (al-Manāẓir)</i>	✓	1	✓	1
Bīrūnī, Abū Rayhān (973-1050)	✓	1		
- Kharaqī, 'Ab al-Jabbār (1084-1158) <i>al-Tabṣira fī 'ilm al-hay'a</i> (<i>Enlightenment on the Science of hay'a</i>)	✓	1	✓	1
- Jaghminī, Maḥmūd ibn Muḥammad (fl. 13th century) - An Epitome of Plain hay'a (<i>Al-Mulakhkhaṣ fī al-hay'a al-basīṭa</i>)	✓		✓	
Marāgha (13 th -14 th century)				
- Kātibī Qazwīnī, Najm al-Dīn (d. 675/1276) - Tunikābunī's commentary on Qazwīnī's <i>Ḥikma al-'ayn</i>			✓	1
al-Maghribī, Muḥyī al-Dīn (d. 1283)	✓	1		
- Ṭūsī, Naṣīr al-Dīn (1201-1274) <i>Memoir (Tadhkira)</i> <i>Recension of the Almagest (Taḥrīr al-majisī)</i> - Marāgha observations	✓ ✓ ✓	1 6 1	✓ ✓	11
- al-'Urḍī, Mu'ayyid al-Dīn (d. 1266) <i>Kitāb al-hay'a (The Book on hay'a)</i>	✓	1		
- Shīrāzī, Quṭb al-Dīn (d. 1311) <i>The Ultimate Perception (Nihāya al-idrāk)</i> <i>Tuhfa al-shāhīya (The Royal Gift)</i> <i>Ikhtiyārāt Muzaḥḥarī</i> (in Persian)	✓ ✓ 	2 6 11	✓ ✓ ✓	3 16 1
- Neyshābūrī, Nizām al-Dīn al-A'raj (Nīsābūrī, d. 1330) - Commentary on Ṭūsī's <i>Tadhkira</i>			✓ ✓	3 5
- al-Ḥimādī, Muḥammad al-Munajjim (14th century) - Commentary on Ṭūsī's <i>Tadhkira</i>	✓	1	✓	1
Samarqand (after 14 th century)				
Kāshānī, Ghiyāth al-Dīn Jamshīd (or al-Kāshī, d. 1429)	✓	1		

Sources and authorities	Khalkhālī's <i>Exposition</i>	number of citations	Tunikābunī's <i>Rule</i>	number of citations
○ <i>Sullam al-samā'</i> (<i>The Ladder of the Sky</i>)			✓	1
▪ Qāḍīzāda al-Rūmī (d. after 1440) ○ Commentary on Jaghmīnī's <i>Mulakhkhaṣ</i>	✓		✓	
▪ Qūshjī, 'Alā al-Dīn (d. 1474) ○ Commentary on Ṭūsī's theology (<i>Sharḥ tajrīd al-i 'tiqād</i>)	✓	1	✓	1
▪ Ulugh Beg (1394-1449) ○ Samarqand observations	✓	4		
▪ Sharīf al-Jurjānī (d. 816/1413) ○ Commentary on Ṭūsī's <i>Tadhkira</i>			✓	1
Safavid era				
▪ Khafīrī, Shams al-Dīn (d. c. 1525) ○ <i>Muntahā al-idrāk</i> (<i>The Utmost Perception</i>) ○ <i>al-Takmila fī sharḥ al-Tadhkira</i>	✓	1	✓	3 3
▪ Bīrjandī, 'Abd al-'Alī (d. 1525-26) ○ Super commentary on Jaghmīnī's <i>Mulakhkhaṣ</i> (<i>Ḥāshiya sharḥ Chaghmīnī</i>) ○ <i>Sizes and Distances</i> (also <i>Masālik wa-mamālik</i>) ○ Commentary on Ṭūsī's <i>Tadhkira</i>	✓ ✓	1 4 1	✓ ✓	3 5 1
▪ Dashtakī, Ṣadr al-Dīn Muḥammad (1425- 1498)			✓	1
▪ Dashtakī, Qiyāth al-Dīn Manṣūr (1416-1542)			✓	1
▪ 'Āmilī, Bahā' al-Dīn (1547-1621) ○ <i>Gloss on the Dissection</i> (<i>Ḥāshiya tashrīḥ al-aflāk</i>) ○ <i>On the Ripples of the Earth</i> (<i>Fī taḍārīs al-arḍ</i>) ○ Super-commentary on Jaghmīnī's <i>Mulakhkhaṣ</i> (<i>Sharḥ sharḥ Chaghmīnī</i>) ○ <i>On the problems of Mercury and the Moon</i> (<i>Fī ishkālay 'uṭārid wa-qamar</i>)	✓ ✓	8 2 9	✓ ✓	1 1 1

Sources and authorities	Khalkhālī's <i>Exposition</i>	number of citations	Tunikābunī's <i>Rule</i>	number of citations
○ On the illumination of the celestial bodies (<i>Anwār al-kawākib</i>) ○ <i>The Crescent Garden</i> (<i>Al-ḥadīqa al-hilāliyya</i>) ○ <i>Ḥabl al-matīn fī iḥkām aḥkām al-Dīn</i> (Shī'a law)	✓	1	✓	3
○ <i>Ḥabl al-matīn fī iḥkām aḥkām al-Dīn</i> (Shī'a law)			✓	1
▪ Tunikābunī ○ Quranic exegesis			✓	1
Philosophers, Jurists, and Theologians				
▪ Mālīk ibn Anas (711–795)	✓	1		
▪ Abū Ḥanīfa al-Nu'mān b. Thābit (d. 767)	✓	1		
▪ al-Shāfi'ī, Muhammad ibn Idrīs (767–820)	✓	1		
▪ Ibn Sīnā (980–1037) ○ <i>Healing</i> (<i>Shifā'</i>) ○ <i>Pointers and Reminders</i> (<i>Ishārāt wa-al-tanbīāt</i>)	✓ ✓	1 1	✓	3
▪ al-Ṭūsī, Abū Ja'far Muḥammad b. Ḥasan (995–1067, shaykh al-tā'ifa)			✓	1
▪ al-Rāzī, Fakhr al-Dīn (1150–1210) ○ <i>The Great Commentary</i> (<i>al-Taḥsīl al-kabīr</i>) [on the Quran] or the <i>Keys to the Unknown</i> (<i>Mafātīḥ al-ghayb</i>) ○ <i>Mabāḥith al-mashriqiyya</i>	✓	2	✓	1
▪ Suhrawardī, Shihab al-Dīn (1154–1191) ○ <i>Ḥikma al-ishrāq</i> ○ <i>Hayākil al-nūr</i> (<i>The Temples of Light</i>)	✓	1	✓	1
▪ Ibn 'Arabī (1165–1240) ○ <i>Futūḥāt al-Makkiyya</i> (<i>The Meccan Revelations</i>)			✓	1
▪ Jamāl ad-Dīn al-Ḥasan al-Ḥillī (d. 1325)			✓	1
▪ al-'Āmilī al-Jizzīnī, Muḥammad b. Makkī (1334–1383), known as “The First Martyr”			✓	1
▪ Ījī, 'Aḍud al-Dīn (d. 1355–56)				

Sources and authorities	Khalkhālī's <i>Exposition</i>	number of citations	Tunikābunī's <i>Rule</i>	number of citations
○ <i>Al-Mawāqif fī 'ilm al-kalām</i> (The Stations in Theology)			✓	2
▪ Taftāzānī, Sa'd al-Dīn (1322-1390)			✓	1
▪ Dawānī, Jalāl al-Dīn (1426-1502) ○ Super-commentary on Ṭūsī's theology (<i>Ḥāshiya sharḥ tajrīd</i>)	✓	1		2
▪ al-ʿAmilī al-Jubāʿī, Zayn al-Dīn (1506-1559), known as “The Second Martyr”			✓	1
▪ al-Karakī al-ʿĀmilī, ʿAbd al-ʿĀlī (d. 1534)			✓	2
Other scholars				
▪ al-Jawharī, Ismāʿīl ibn Ḥammād (d. c. 1008) ○ <i>The Correct Language</i> (<i>al-Ṣiḥāḥ fī al-luḡa</i>)	✓	2	✓	1
▪ Jamāl Qarshī, Muḥammad b. ʿUmar (d. c. 1310) ○ <i>al-Ṣurāḥ min al-ṣiḥāḥ</i>			✓	1
▪ al-Samʿānī, Abū Sa'd (1113-1166) ○ The Biographical Dictionary (<i>al-Ansāb</i>)	✓	1		
▪ Muṭarrazī, Abū al-Faṭḥ (1141-1213)	✓	1		
▪ Qazwīnī, Zakariyā ibn Muḥammad (1203-1283) ○ <i>The Wonders of Creatures</i> (<i>Ajāʾib al-makhlūqāt wa-gharāʾib al-mawjūdāt</i>)	✓	1		
▪ Fīrūzābādī, Majd al-Dīn Muḥammad (1329-1414) ○ <i>The Encompassing Dictionary</i> (<i>al-Qāmūs al-Muḥīṭ</i>)	✓	1	✓	1
▪ Hirawī, Mīr ʿAlī (d. 1544), a Persian calligrapher.	✓	1		
▪ Yazdī, Mullā ʿAbd Allāh Bahābādī (d. 1573-74) ʿĀmilī's master in logic.			✓	1

6.6 Concluding remarks

In this and the previous chapter I have introduced, for the first time, two important and extensive commentaries by 'Āmilī's disciples. A complete picture of the commentary tradition on 'Āmilī's *Dissection* requires a detailed examination of these two important examples, if not all the commentaries presented in the previous chapter. These commentaries share some features in style and content and differ in some others. A common feature of almost all the commentaries on the *Dissection* is the incorporation of the *Gloss* into the commentary while also consulting other astronomical works by 'Āmilī like his super-commentaries on Jaghmīnī's *Mulakhkhaṣ*. Many of the extensive commentaries, like the *Exposition* and the *Rule*, consulted numerous previous books and authors from the Islamicate scientific tradition, mostly those which developed in regions close to or in Persia. The mastery of Islamicate scientific literature is apparent in the works of Safavid scholars and 'Āmilī's commentators. The legacy of Marāgha and Samarqand loom large in the astronomical literature of the Safavid period, besides the influence of earlier authorities from Greek and Islamic science and philosophy (see Table 6-2). 'Āmilī's commentators were completely aware of the reform in Ptolemaic astronomy by the Marāgha associates and their followers in Persia and Samarqand, but the attempts from other regions, like those by Ibn al-Shāṭir, are absent in the Safavid astronomical literature. One reason for this lack of awareness could be due to the long-lasting political conflicts between the Safavids and Ottomans.

We have evidence that 'Āmilī produced different planetary models, but we do not yet know if anybody else produced new models. The number of citations to previous authorities in Khalkhālī's and Tunikābunī's commentaries (Table 6-2) shows more reliance on Marāgha scholars than other authors. This reliance was not a simple imitation of those authorities. The

references to the previous astronomers also include cases in which 'Āmilī's commentators disagreed with people like Ṭūsī, Shīrāzī, or Qāḍīzāda, and complemented or improved their ideas by taking a critical approach. 'Āmilī and his commentators in astronomy recognized and understood the alternative solutions to Ptolemy's planetary models that had been devised by their predecessors in Marāgha and elsewhere. They classified and explained those solutions in their commentaries but did not feel the need to contribute to the same reform tradition. This might seem a weakness in Safavid astronomy due to the incompetency of its authors and practitioners. However, this does not seem to be the case since many of 'Āmilī's commentators fully understood the non-Ptolemaic models, and 'Āmilī himself proposed some alternatives in the cases of the Moon and Mercury, the text of which is yet to be found. The reason for the unwillingness to produce new non-Ptolemaic models lies in what Safavid astronomers received as the astronomical literature of the time and the tradition to which they found themselves heirs. As I explained in the Introduction, Safavid astronomers found all the sixteen difficulties of Ptolemaic astronomy to have been solved by previous scholars, some by Ṭūsī and his colleagues at Marāgha and the remaining ones by one Safavid astronomer, Shams al-Dīn Khafīrī (d. after 1525). 'Āmilī's *Gloss*, and the commentaries by Khalkhālī and Tunikābunī, all referred to Khafīrī's solutions to the outstanding problems as final. The texts introduced in Chapter 5 and Chapter 6, and some briefly noted in the list of commentaries presented in the previous chapter, relied on Khafīrī's alternative models for the motions of the planets, still in a geocentric arrangement, as ultimate solutions to the physical problems of Ptolemy's system, which in the end made a harmony between geometrical models and Aristotelian physics governing the planetary motions. 'Āmilī discussed the problems and introduced the alternative attempts in his *Gloss* (see Chapter 3), and his commentators, like Tunikābunī, and Ḥusaynī Qazwīnī (fl. 1672),

went into further technical aspects of the solutions. Other practical matters also gained the special attention of Safavid astronomers, like the methods for finding the meridian and the *qibla* direction (more about his in Chapter 2), both obviously of great importance for daily religious practices.

‘Āmilī’s commentators, as well as ‘Āmilī himself, showed more concern about natural philosophical topics of the *‘ilm al-hay’a* than earlier writers. Despite the satisfaction with Khafīrī’s solutions for the planetary motions, there were ongoing debates about physical problems of the world, like the place and nature of the sphere of Fire as the fourth terrestrial element, the motion of the earth, the place and nature of the comets, the order of the orbs of Sun and Venus, and the illumination of the planets. In the case of Tunikābunī these discussions introduce a new reliance on empirical observations compared to the thought experiments of earlier writers. Thus, although they contain no new planetary models, these commentaries deserve to be classified as contributions to an ongoing research literature.

Chapter 7

Conclusion

7.1 ‘Āmilī’s works in Mughal India

‘Āmilī’s works became known in Mughal India shortly after their publication. His scientific books became textbooks of elementary and intermediate levels in mathematics and astronomy to the Mughal audience and at the madrasas.⁴⁵⁹ A manuscript collection of his works produced in the Deccan and Golconda during 1026-1056/1616-1646 contains forty of ‘Āmilī’s works. The opening folio of the collection bears a note specifying that it was made for a Royal library. Some of ‘Āmilī’s works were transmitted to Mughal India by his disciples. One connection to India was made by ‘Āmilī’s disciple Shams al-Dīn Khalkhālī (see Chapter 5), who wrote a commentary on the *Dissection* in Agra for Emperor Akbar (r. 1556-1605) in 1599. A prominent feature of Khalkhālī’s commentary is that he modifies the last chapter of ‘Āmilī’s *Dissection*, concerning the determination of *qibla*, which involves religious legal matters, to appeal to the Sunni audience of Mughal India. Khalkhālī most probably made his commentary on ‘Āmilī’s *Khulāṣa al-ḥisāb* (*Quintessence of Arithmetic*) in India as well (see Chapter 5). According to Khalkhālī’s commentary on the *Dissection*, *The Exposition of the Orbs*, he must have taken with himself to India a series of books including ‘Āmilī’s *Dissection*, the *Gloss on the Dissection*, and both super-commentaries ‘Āmilī wrote on Jaghmīnī’s *Mulakhkhaṣ*. Another link between ‘Āmilī and Mughal India was made by his disciple Muḥammad ibn ‘Alī ibn Khātūn al-‘Āmilī (d. second half of 17th century). Ibn Khātūn migrated to India and attended the court of Muḥammad Qutbshah (r. 1612-1625), the sixth ruler of the Qutb Shahi dynasty (918-1098/1518-1687) in

⁴⁵⁹ De Young, “The Khulāṣat al-Ḥisāb of Bahā’ al-Dīn al-‘Āmilī and the Dars-i Nizāmī in India.”

Golconda (Eastern Deccan). Ibn Khātūn was once recorded as a nephew (sister's son) to 'Āmilī. The eighteenth-century Indian literary figure known as Azād Bilgrāmī (1704-1786), in his bibliography *Ma'āthir Dakkan (The Notable Works of Deccan)*, gave a detailed account about Ibn Khātūn, including his intellectual and political career. Bilgrāmī considered Ibn Khātūn a nephew of 'Āmilī; however, Afandī Iṣfahānī, a contemporary of Ibn Khātūn, did not mention that family relationship in his notice of Ibn Khātūn.⁴⁶⁰ Ibn Khātūn attained the office of Royal Secretary (*munshī al-mulk*) at Muḥammad Qutbshah's court and made for the sultan a Persian translation and commentary of 'Āmilī's *Arba'īn (Forty Hadith)*, which became known as the *Qutbshahi Translation (Tarjume-ye qutbshāhiyya)*. He also wrote a commentary on 'Āmilī's Persian work on religious rituals requested by 'Abbās I and named after him *Jāmi' 'Abbāsī (The 'Abbāsī Compendium)*.⁴⁶¹ In Golconda, Ibn Khātūn was favored by the scholarly community. He delivered lectures every day at the madrasa, taught religious and mathematical sciences, and held discussion circles with the region's scholars. Before the death of Muḥammad Qutbshah in 1625, Ibn Khātūn returned to Persia as the ambassador of the Qutbshah ruler to 'Abbās I. During his visit to Persia, he met 'Āmilī again and showed him his translation and commentary of the *Arba'īn*. In Shawwāl 1022/Nov-Dec 1613 'Āmilī wrote him an encomium and praised his scholarly and literary skills. Ibn Khātūn returned to India in 1029/1620 and attended the court of Muḥammad's successor 'Abdullāh Qutbshah (r. 1625-1672). Under the new ruler, and perhaps because of good relations between the Safavid and Qutbshahi courts, Ibn Khātūn enjoyed even higher ranks. Abdullah bestowed upon him the office of Grand Vizier (*ṣadr a'ẓam*) and granted him the government of his territory in 1038/1628.

⁴⁶⁰ Iṣfahānī, *Riḡāḍ al-'ulamā'*, V:134-135. Cf. Abisaab, *Converting Persia*, 61.

⁴⁶¹ Iṣfahānī, *Riḡāḍ al-'ulamā'*, V:135.

Other than the direct connections I introduced above, there is evidence that multiple generations of Indian scholars received ‘Āmilī’s mathematical and astronomical works. ‘Iṣmat-Allāh ibn A‘ẓam Sahāranpūrī (fl. 1674-1750) completed a commentary on the *Dissection* in Saharanpur on 16 Nov 1676. In addition to manuscript copies it was edited and printed once on 2 Jan 1849 in Lucknow, based on the autograph, and again in Delhi in 1904. In the introduction, Sahāranpūrī explains that he had seen the commentary by ‘Āmilī’s disciple Khalkhālī but criticized him for not thoroughly explaining all sentences and expressions of the original text, so he decided to write a new commentary to improve on Khalkhālī. He also explained that he incorporated ‘Āmilī’s *Gloss* into his commentary and adopted a moderate method between the old method of commentating and the modern method of integration (*damj*) or interweaving (*mazj*) commentaries for which recent scholars showed a great deal of passion. Sahāranpūrī began his commentary in 1675 and called it *Bāb Tashrīḥ al-aflāk* (*The Gate to the Dissection of the Orbs*).⁴⁶² Like Khalkhālī, he also made a commentary on ‘Āmilī’s *Quintessence of Arithmetic*, (*Khulāṣa al-ḥisāb*), entitled *Anwār Khulāṣa al-ḥisāb*, completed on 27 Dhū al-Ḥajja 1086/3 Mar 1676, and two separate commentaries on Naṣīr al-Dīn Ṭūsī’s *Taḥrīr al-majisṭī* (*Recension of the Almagest*), both in Arabic.⁴⁶³

A family famous for their intellectual productions made several translations and commentaries on ‘Āmilī’s works. The descendants of Ustād Aḥmad al-Mi‘mār, the chief architect of the Taj Mahal commissioned by the Mughal emperor Shah Jahan and completed in 1648, commented on ‘Āmilī. The son of Ustād Aḥmad, Luṭf Allāh al-Muhandis (lit. the geometer, also can be astronomer or mathematician in general) wrote an abridged Persian

⁴⁶² al-Sahāranpūrī, *Bāb Tashrīḥ al-aflāk*, 1849, 4.

⁴⁶³ Āqābuzurg Tehrānī, *al-Dharī‘a*, 3:36; M. Hidāyat Ḥusain, *Catalogue of the Arabic Manuscripts in the Būhār Library*, vol. II (Calcutta: Imperial Library, 1923), 381; Rahman, *Science and Technology in Medieval India*, 316–17.

translation of ‘Āmilī’s *Quintessence of Arithmetic* (*Khulāṣa al-ḥisāb*). Luṭf Allāh wrote the book at the request of one Mīr Sayyid Muḥammad Sa‘īd ibn Mīr Muḥammad Yaḥyā under the title *Muntakhab* (lit. *Selected*) in 1092/1681.⁴⁶⁴ In his mathematical commentary, Luṭf Allāh introduced himself and his father Ustād Aḥmad al-Mi‘mār. A manuscript copy of Luṭf Allāh’s commentary on ‘Āmilī also includes marginal notes signed as “Khalkhālī.”⁴⁶⁵ Also, Luṭf Allāh wrote two other works on astronomy in Persian, an almanac entitled *Taqwīm-e Luṭfī* and a translation and commentary of ‘Abd al-Raḥmān Ṣūfī’s (903–986) star catalog the *Ṣuwar al-Kawākib*.⁴⁶⁶

Luṭf Allāh’s son Imām al-Dīn (d. c. 1732) completed a commentary on the *Dissection* in 1691-92 called *al-Taṣrīḥ fī sharḥ al-tashrīḥ*. His commentary was printed in Delhi in 1877 and 1894, and 1913 in Qandahar. He also wrote a super-commentary on ‘Āmilī’s *Quintessence of Arithmetic*. Imām al-Dīn wrote more than 25 works on several fields of knowledge. He wrote a super-commentary on Qāḍīzāda’s commentary on the *Mulakḥkhaṣ*, a gloss on Qūshj’s *Risāla dar hay’at*, a super-commentary on ‘Āmilī’s mathematics, *Quintessence of Arithmetic* (*Khulāṣa al-ḥisāb*).⁴⁶⁷ In the *al-Taṣrīḥ* Lāhūrī refers to some works of his father, Luṭf Allāh al-Muhandīs.⁴⁶⁸ Imām al-Dīn commented on his father’s Persian abridgment of ‘Āmilī’s *Quintessence of Arithmetic*.

Further documents show that Lāhūris were primarily involved in mathematics and astronomy. Imām al-Dīn’s brother, Khayr Allāh ibn Luṭf Allāh, wrote some books on astronomy

⁴⁶⁴ Hermann Ethé, *Catalogue of Persian Manuscripts in the Library of the India Office*, vol. 1 (Oxford Printed for the India Office by H. Hart, 1903), col. 1229; Maulavi Abul Muqtadir, *Catalogue of the Arabic and Persian Manuscripts in the Oriental Public Library at Bankipore*, XVII:171–72.

⁴⁶⁵ Luṭf Allāh ibn Aḥmad al-Muhandīs al-Lahūrī, “Sharḥ Khulāṣa al-ḥisāb” (British Library: Oriental Manuscripts, IO Islamic 1362, n.d.), fols. 8v, 9v, 10r.

⁴⁶⁶ Rahman, *Science and Technology in Medieval India*, 324–25.

⁴⁶⁷ Sally P. Ragep, *Jaghmīnī’s Mulakḥkhaṣ*, 288; Rahman, *Science and Technology in Medieval India*, 316.

⁴⁶⁸ Lāhūrī, *al-Taṣrīḥ fī sharḥ al-Tashrīḥ*, 1913, 69.

including a Persian translation of Naṣīr al-Dīn Ṭūsī's *Tahrīr al-majisī* (*Recension of the Almagest*) entitled *Taqrīb al-tahrīr*. The translation begins with a preface by his son Muḥammad-ʿAlī al-Riyāḍī (lit. the Mathematician), which is followed by Khayr Allāh's preface. In his preface, Muḥammad-ʿAlī reported that his father had also written a commentary on Ṭūsī's recension of Euclid's *Elements*, entitle *Taqrīr al-tahrīr*, after which he translated the *Tahrīr al-majisī*. Muḥammad-ʿAlī adds that he edited the translation, which remained for a long time as a draft. Khayr Allāh's preface tells that he did the translation with the aid of his master ʿAbd al-ʿAlī Bīrjandī's (d. 1526) commentary on Ṭūsī's book. The translation was dedicated to Muḥammad Shah (r. 1719-1748), and Khayr Allāh mentioned that he completed the first draft in the third decade of Muḥammad Shah's reign, which would be sometime between 1739 and 1748.⁴⁶⁹

Khayr Allāh's son Muḥammad-ʿAlī al-Riyāḍī wrote the *Sullam al-idrāk fī hay'a al-aflāk* (*The Ladder of Perception in the Configuration of the Orbs*) in Arabic, an epitome on theoretical astronomy which according to the author integrated both Ṭūsī's *Tadhkira* and Qūshjī's *Risāla dar hay'at* to provide a text of moderate level of complexity.⁴⁷⁰ Al-Riyāḍī also wrote the *Muqaddima al-taqwīn*, a work on almanacs.⁴⁷¹ Al-Riyāḍī also wrote the *Introduction to Calendars (Muqaddima al-taqwīn)*, a work on almanacs copied by his son Zayn al-ʿĀbidīn.⁴⁷² His grandson, Mīrzā Gulībeg Munajjim son of Mīrzā Zayn al-ʿĀbidīn, composed a Persian astronomical table called *The Indian Zij (Zīj-i Hindī)*.⁴⁷³

⁴⁶⁹ Maulavi Abdul Muqtadir, *Catalogue of the Arabic and Persian Manuscripts in the Oriental Public Library at Bankipore*, 1927, XI:70–71. For other copies of the translation and other works by Khayr Allāh see Rahman, *Science and Technology in Medieval India*, 285.

⁴⁷⁰ Muḥammad-ʿAlī ibn Khayr Allāh al-Riyāḍī, “Sullam al-idrāk fī hay'a al-aflāk” (British Library: Oriental Manuscripts, Delhi Arabic 1927, September 25, 1185).

⁴⁷¹ Rahman, *Science and Technology in Medieval India*, 325.

⁴⁷² Rahman, 325.

⁴⁷³ Rahman, 333.

Sayyid ‘Alī-Ḥaydar Ṭabāṭabā’ī (early 18th century) made another commentary on ‘Āmilī’s *Dissection* in India. Ṭabāṭabā’ī’s commentary was printed once in 1300/1883 in Calcutta, and another time in Bengal at Maṭba‘a Maẓhar al-‘Ajā’ib library.⁴⁷⁴ The commentator was a grandson of the famous Shiite scholar Ḥurr al-‘Āmilī (1033-1104/1624-1693). Ḥurr al-‘Āmilī composed a rhymed version (*manẓūma*) of Shams al-Dīn Samarqandī’s (d. 1302) *Ashkāl al-ta’sīs*, a treatise on 35 propositions of Euclid’s *Elements*, completed on the last day of Jumādā II, 1056/2 Aug 1646.⁴⁷⁵ In Rabī‘ I 1055/Apr-May 1645 he copied Sharīf al-Jurjānī’s (d. 816/1413) commentary on Jaghmīnī’s *Mulakhkhaṣ* in Jaba‘ village (Palestine).⁴⁷⁶

To summarize, ‘Āmilī’s astronomical and mathematical works were well known in India from his lifetime until the nineteenth century. The interest in his work was so great that printed editions of commentaries on the *Dissection* appeared in 1849, 1877, 1883, 1894, 1904 and 1913. Five generations of Lahuris contributed to the mathematical sciences, with at least two generations specifically writing about ‘Āmilī. Knowledge of his works extended from the Deccan throughout the whole Mughal empire.

7.2 The “Decline Thesis”

Now I would like to make an evaluation of the “decline thesis” in the historiography of Islamicate science in light of my findings in this dissertation. A so-called “classical narrative” of Islamicate science frames Muslim scientific practices in three phases, as the beginning or rise, the golden age, and the decline. The beginning of Islamicate science has not been of so much dispute among historians. It occurred roughly in the eighth century with massive translations of

⁴⁷⁴ Naji-Nasrabadi, *Ketābshenāsīye Sheykh Bahā’ī*, 198.

⁴⁷⁵ For an edition and translation into English of Ḥurr al-‘Āmilī’s work see: Gregg De Young, “An Arabic Introduction to Euclidean Geometry in Didactic Verse,” *SCIAMVS: Sources and Commentaries in Exact Sciences* 17 (2016): 161–215.

⁴⁷⁶ Sayyid Sharīf al-Jurjānī, “Sharḥ al-Mulakhkhaṣ” (Tehran, Malek National Library and Museum, MS 652, 1645).

non-Arabic sources, mostly from Greek and Syriac, but also Persian and Sanskrit. However, in the recent scholarship, there is an ongoing dispute about the other two phases of the classical narrative, the “golden age”, and the “decline.” A simple version of this narrative describes a “golden age” of Islamicate science, in which many scientific and philosophical works were produced, and new ideas were proposed that were not present in earlier traditions. But the period of productivity did not last very long, and there was a moment that Muslims ceased to pursue science. The proposed dates for this decline vary from the eleventh to the fourteenth century. It is worth considering some famous quotes by recent historians of science about the decline. Edward Grant (d. 2020) marked the year 1500 as the beginning of the decline era of Islamicate science:

In Islam, until approximately 1500, mathematics, astronomy, geometric optics, and medicine were more highly developed than in the West. Indeed, the West learned these subjects from translations of Arabic treatises into Latin. But science was not institutionalized in Islamic society.⁴⁷⁷

He further claimed the rejection of sciences by the religious authorities to be the major cause of the decline:

Over some four or five centuries, many scholars in Islamic society, including those who were Christians and Jews, absorbed Greek science and natural philosophy and added much to them. Nevertheless, the theologians and religious leaders who were the guardians of orthodoxy in Islamic society did not warmly receive these disciplines.⁴⁷⁸

In his book first published in 1993 and printed with revisions for the third time in 2017, Toby Huff admitted to the advancement of the “Arabic science,” though using a label that

⁴⁷⁷ Edward Grant, *The Foundations of Modern Science in the Middle Ages: Their Religious, Institutional, and Intellectual Contexts*, Cambridge History of Science (Cambridge; New York: Cambridge University Press, 1996), 168, also see 176.

⁴⁷⁸ Grant, 177.

inspires confusion, which surpassed Europe and China from the eighth to the fourteenth century.

But by claiming a “sudden rise and precipitous decline”⁴⁷⁹ it concluded that:

In short, driven by both curiosity and religious motives, the Arab-Muslim world from the eighth to the fourteenth century achieved significant heights of scientific advance, but thereafter (and perhaps as early as the 12th century) went into decline and even retrogression. This did not happen uniformly across all fields, but in general scientific advance was on the wane.⁴⁸⁰

Finally, H. Floris Cohen who presented an extended version of his rise and decline theory as an “upswing” and “downturn,” previously in 1994 and 2010,⁴⁸¹ in a later publication of 2015 summarized it as follows:

The rise and decline of nature knowledge in Islamic civilization, then, follow roughly the same pre-modern pattern as with the Greeks. In both cases the downturn following the Golden Age is sudden and steep, and distinguished by a few individual late-comers of remarkable ingenuity. Except that in the Islamic world these late-comers are firmly anchored in three episodes of regional revival: Persia under the Mongols [Ṭūsī]; the eastern Mediterranean under the Ottoman Turks [Qūshjī]; and Andalusia under the Berbers [Ibn Rushd (Averroes)].⁴⁸²

⁴⁷⁹ Toby E. Huff, *The Rise of Early Modern Science: Islam, China, and the West*, Third edition (Cambridge: Cambridge University Press, 2017), 53–55.

⁴⁸⁰ Huff, 60. See also his *Intellectual Curiosity and the Scientific Revolution: A Global Perspective* (Cambridge ; New York: Cambridge University Press, 2011), 115–42.

⁴⁸¹ H. Floris Cohen, *The Scientific Revolution: A Historiographical Inquiry* (Chicago: Chicago University Press, 1994), 384–409; *How Modern Science Came Into the World: Four Civilizations, One 17th-Century Breakthrough* (Amsterdam University Press, 2010), 53–74.

⁴⁸² H. Floris Cohen, *The Rise of Modern Science Explained* (Cambridge University Press, 2015), 72.

7.3 Two major arguments of the decline

All three authors accept the classical narrative of Islamicate science. Among them, Grant has declared the latest date for the decline, to have begun by 1500. However, there are certain differences between these authors about the causes of the decline. Grant viewed Islamic religious orthodoxy as inimical to the secular sciences that caused the downfall of most natural and philosophical inquiries by Muslims. Huff dates the decline from the twelfth century and points to the alleged antagonism of religion to science, and the lack of Western institutions like universities, as reasons for the decline. Cohen recognizes that, for example, the two most important astronomical observatories were built after the date set by Huff – Marāgha in Persia around 1270 and Samarkand around 1420. He therefore places the decline after the 1449 assassination of Ulugh Beg, the patron of the Samarkand observatory, and attributes the decline to the lack of new patrons after his death.

Sonja Brentjes has evaluated and rejected the same arguments as proposed by previous generations and current scholars of Islamic studies, including Ignaz Goldziher (1850-1921), George Makdisi (1920-2002), and Yahya Michot (b. 1952). In her research, Brentjes presents counterevidence from different Islamic societies before 1500.⁴⁸³ We can summarize the major arguments in favor of the decline thesis and its causes into two general areas: first, Islamic orthodoxy resisted scientific and philosophical inquiries, a result of which would be the exclusion of non-religious sciences from madrasas as George Makdisi claimed.⁴⁸⁴ But the sciences were not excluded from madrasas, as Brentjes has recently shown at length.⁴⁸⁵ Similarly, in Chapter 2,

⁴⁸³ Sonja Brentjes, “The Prison of Categories—‘Decline’ and Its Company,” in *Islamic Philosophy, Science, Culture, and Religion. Studies in Honor of Dimitri Gutas*, Islamic Philosophy, Theology and Science (Brill, 2011), esp. 138-149.

⁴⁸⁴ George Makdisi, *The Rise of Colleges: Institutions of Learning in Islam and The West* (Edinburgh University Press, 1981), 10.

⁴⁸⁵ Brentjes, *Teaching and Learning the Sciences in Islamicate Societies*.

while discussing the status of astral sciences among the Safavids, I have presented several examples from Safavid sources and European travelers' accounts that madrasas offered education in mathematics and astronomy.

A famous example of rejecting sciences by religious orthodoxy, always prevalent in the decline arguments, is Ghazālī's (d. 1111) refutation of philosopher's method, mostly their theory of natural causation. Ghazālī's attitude toward philosophers is claimed to have made the initial step in the downfall of philosophy and science in the Islamic intellectual history. For our purpose here, there is no need to review this claim. Ghazālī was indeed an influential religious figure in Islamic history, but a close examination of his arguments against philosophers shows the absurdity of this idea.⁴⁸⁶ It is correct to say that some famous Islamic jurists and hadith scholars have opposed secular sciences, like Ibn al-Jawzī (d. 1201), Shahrāzūrī (d. 1245), al-Dhahabī (d. 1348), and Ibn Taymiyya (d. 1328)⁴⁸⁷. But as I have discussed throughout this dissertation, many other jurists and hadith scholars, at the same time and in later periods, have contributed to the sciences. Some achieved mastery in those non-religious disciplines, to name a few, Naṣīr al-Dīn Ṭūsī (d. 1247), Sharīf al-Jurjānī (d. 1414), Nizām al-Dīn al-A'raj al-Neyshābūrī (d. 1330), Shams al-Dīn Khafrī (d. after 1525), as well as 'Āmilī and some of his students and successors. The religious writings of both Ṭūsī and 'Āmilī are still read today. For the other major argument, the disappearance of royal patronage of non-religious sciences, I will discuss and summarize the findings of this dissertation below.

⁴⁸⁶ Ghazālī's attack on philosophers is formulated in his most famous work the *Incoherence of the Philosophers* (*Tahāfut al-falāsifa*) written in 488/1095, and later repeated in his autobiography the *Deliverer from Error* (*Al-Munqidh min al-dalāl*) completed around 500/1106. A detailed account on Ghazālī's attitude toward philosophical inquires can be found in: Sabra, "Science and philosophy in medieval Islamic theology," esp. 26-32.

⁴⁸⁷ Brentjes, "The Prison of Categories—'Decline' and Its Company," 138.

The classical narrative has recently been challenged by several scholars. In 2007 George Saliba presented extensive evidence that disproves the arguments in favor of the classical narrative.⁴⁸⁸ But the decline thesis survived for a very long time in modern scholarship, as an accepted theory by some high-profile authors. The enduring acceptance of the decline thesis was a result of multiple presumptions in understanding history of science in the Islamic societies. A major one would be the historiography that views Islamicate science as a universal category that applies to all Islamic societies of all time. Considering the early modern period, when there existed at least three major Islamic empires, the Ottomans, the closest to the west, the Safavids in Persia, and the Mughals in the Indian subcontinent, there was hardly a unified and homogeneous Islamic culture that could be defined for these states. Especially at the beginning of the sixteenth century, two of them, the Safavids and Mughals, were nascent governments with newly defined religious and political ideologies.

The Safavids took a radical step by introducing Shiism as the official religious denomination in Persia, besides consolidating the land after a long-time suffering fragmentation under feudal rulers. This huge transformation not only changed the political agenda of Persia but ordered a new culturally contracted system of education which gradually became dominated by Shiite scholars, including those who migrated from the Levant during the reign of Ismā'īl I (r. 1501-1524) and Ṭahmāsb (r. 1524-1576). When 'Āmilī gained an office at the imperial court and enjoyed the shah's patronage, he set a new religious and culturally accepted definition to promote the astral sciences. He endorsed the method of *'ilm al-hay'a*, theoretical astronomy, as licit for addressing religious issues. 'Āmilī rejected astrological prognostication of primary causes for earthly events, but at the same time endorsed its predictive capability to anticipate

⁴⁸⁸ Saliba, *Islamic Science and the Making of the European Renaissance*, esp. 1-3, 20-25.

future events and declared it legitimate science which had been practiced by the Shiite Imams. The 'Āmilī research tradition described in this dissertation is a *prima facie* counterexample to the decline thesis in at least three respects: it shows the existence of ongoing scientific work after the period of the alleged decline; it shows that religion and science were not necessarily antagonistic in the Islamicate world, but could be mutually supportive, and practiced by the same scholars; and it shows that patronage of sciences like astronomy did not end abruptly with the death of Ulugh Beg and the closing of the Samarkand observatory in the middle 1400s.

Here I am suggesting that the decline thesis should be rejected for several different reasons. Some of its arguments and causation theories, such as the antagonism of science and religion or the loss of patronage in the post-classical period must be rejected. Plenty of counterexamples have been presented in this dissertation and in many other modern studies. More importantly, a different attitude should be taken toward examining the status of sciences in early modern Islamic societies, that considers the cultural and political structure of those societies as key factors in the evaluation of their scientific agenda and activity. In the case of the Safavid Persia, especially during the first half its ruling period, the cultural and political shift is so huge that it impacted all areas of intellectual inquires. An example of this revolutionary change under the first two Safavid shahs, Ismā'īl and Ṭahmāsb, was replacing the Sunni scholars who held administrative positions and directed madrasas until the early sixteenth century with Shiite '*ulamā*'.

7.4 'Āmilī and his successors

Safavid scholars inherited the scientific legacy of two major dynasties, the Ilkhanate and the Timurids who collectively ruled over Persia from the middle of the thirteenth century to the beginning of the Safavids in 1501. The most prestigious institute of astronomy under the

Ilkhanate was the Marāgha observatory sponsored by the ruler Hulegu Khan (r. 1256-1265) and run by the Persian polymath Naṣīr al-Dīn Ṭūsī. Ṭūsī and his colleagues at Marāgha developed a reform in astronomy, especially in *‘ilm al-hay’a*, which succeeded in solving some difficulties of the discipline and opened a new horizon for subsequent generations. This was continued by astronomers of the Timurid era who worked at the Samarqand observatory patronized by Ulugh Beg, who was a mathematician and astronomer himself. After the huge social and political change brought forth by the Safavids, fearing persecution by Ismā‘īl I’s (r. 1501-1524) anti-Sunni campaign, many intellectuals, including those in charge of running madrasas throughout the country, migrated from Persia to the neighboring Ottoman and Mughal Empires. The Shiite jurists under Ismā‘īl and Ṭahmāsb who served their shahs as replacement to Sunni officials, showed little interest, if any, in non-religious sciences. Some like ‘Alī ibn Ḥusayn ibn ‘Abd al-‘Ālī al-Karakī (d. 940/1534), the *shaykh al-islām* under Ismā‘īl I and Ṭahmāsb, even opposed astronomical methods for solving religious matters like determining the *qibla* direction.

The situation, however, has changed enormously after ‘Āmilī took the office of *shaykh al-islām* (the chief jurisconsult) around 1593, as well as among his successors. ‘Āmilī, who was well trained in mathematics and astronomy now obtained the highest religious rank in the Safavid dynasty. ‘Āmilī’s support of astral sciences became apparent in his publications, first in the *Tashrīḥ al-aflāk* (*The Dissection of the Orbs*), which he dedicated to four successive shahs, a way of inspiring their interest and support, besides an attempt at obtaining courtly patronage. Although ‘Āmilī showed his interpretation and endorsement of astrology, as I discussed in Chapter 2, he only wrote works on theoretical astronomy, *‘ilm al-hay’a*, and the astrolabes. He bolstered his support for astronomical education by producing two super-commentaries on Jaghmīnī’s *Mulakhkhaṣ fī hay’a al-basīṭa* (*An Epitome of Plain hay’a*), one for ‘Abbās, and a

Gloss to the Dissection after he had been raised to the chief jurisconsult position. He taught the *Dissection* and the *Gloss* to his disciples and encouraged them to write commentaries on his works. Numerous commentaries on the *Dissection* were made after the appearance of the *Gloss*, all of which incorporated the *Gloss* as well. The *Dissection*, although an introductory work on ‘ilm al-hay’a, together with the *Gloss* could serve elementary and intermediate enthusiasts of astronomy, especially students of religious sciences, to a satisfactory extent. The *Gloss* not only provided technical materials that the *Dissection* lacked but presented an overview of the development of ‘ilm al-hay’a by reviewing key steps of the Marāgha reform and its continuation until the early Safavid period.

The consequences of ‘Āmilī’s attempts at directing courtly patronage in favor of sciences became evident during ‘Abbās reign, when the shah and his grand vizier, Ḥātām Beg Urdubādī (in office 1591-1610) commissioned books on astronomy to be made by ‘Āmilī and other scholars. This patronage of science by the Safavid court, to which his successors contributed, continued after ‘Āmilī’s death. Muḥammad Kāẓim Tunikābunī, one of ‘Āmilī’s students, wrote his commentary on the *Dissection* for ‘Abbās (see Chapter 6). Another of ‘Āmilī’s students, Qāḍī ibn Kāshif al-Dīn Muḥammad Yazdī (d. 1075/1664-65) who succeeded him in holding the office of *shaykh al-islām* under ‘Abbās I, wrote medical and astronomical works in Persian for the Safavid shahs. Yazdī’s father, Kāshif al-Dīn Muḥammad, was ‘Abbās’ court physicians and wrote Persian books on astronomy. Among several books Yazdī wrote by request of ‘Abbās was a Persian book on ‘ilm al-hay’a which was entitled *Tuḥfa-e ‘Abbāsiye* (*The Gift for ‘Abbās*). Yazdī’s *Tuḥfa* consisted of three topics: on the order of the planets Venus, Mercury, and the Sun; on the sphericity of the heavens and orbs; on the sphericity of the Earth. In the *Tuḥfa*, Yazdī also

introduced an instrument of his invention for measuring parallax.⁴⁸⁹ Many scholars contributed to the scientific tradition founded by ‘Āmilī, including generations of scholars in Mughal India. As I discussed in Chapter 5, Shams al-Dīn ‘Alī Khalkhālī wrote his commentary on the *Dissection* for the Mughal emperor Akbar (r. 1556-1605).

7.5 Shams al-Dīn Khafrī’s influence on Safavid astronomers

A remarkable feature of ‘Āmilī’s works on *‘ilm al-hay’a* as well as of his commentators, is the role of the early Safavid astronomer Shams al-Dīn Khafrī in providing canonical solutions to the problems of the discipline. ‘Āmilī had introduced sixteen difficulties of the Ptolemaic astronomy that the practitioners of *‘ilm al-hay’a* from the Marāgha period had strived to solve by proposing alternative models for the planetary motions. Khafrī was one of the latest ones that contributed to that reform tradition and devised new models in his commentaries on Naṣīr al-Dīn Ṭūsī (d. 1274) and Quṭb al-Dīn Shīrāzī (d. 1311). To ‘Āmilī and his commentators, Khafrī’s solutions were final and closed the case of sixteen canonical difficulties of the *‘ilm al-hay’a*. Khalkhālī and Tunikābunī attested this in their commentaries and referred their audience to Khafrī the culmination of that tradition. Safavid astronomers were completely aware of the reforms in *‘ilm al-hay’a* descending from Marāgha and through Samarkand; they introduced the technical details of them in their commentary works. Model building did not cease completely. ‘Āmilī pointed to his attempt at devising new models for problems of Mercury and the Moon, a copy of which is yet to be found. However, it seems that Safavid astronomers never felt the need of a serious engagement in addressing the problems solved by Khafrī. ‘Āmilī could have been the first scholar after Khafrī who drew attention to Khafrī’s tremendous role in the development of *‘ilm*

⁴⁸⁹ Qāḍī ibn Kāshif al-Dīn Muḥammad Yazdī, “Tuḥfay-e ‘Abbāsyē” (Mashhad, Astan Qods Razavi, MS 12223, December 26, 1647).

al-hay'a. The same attitude is absent in some earlier works, which indicates Khafri's contemporaries might not have seen the same impact by him. One student of Ghiyāth al-Dīn Maṣṣūr Dashtakī (840-949/1416-1542, see Chapter 2 for more about Dashtakī's career) who reported on Islamic attempts at reforming Ptolemaic astronomy was Muṣliḥ al-Dīn Lārī (c. 900/1494, d. 979/1572, more about him in Chapter 4). Fearing Ṭahmāsb I's disfavor of Sunni scholars and his move toward their elimination, Lārī left Persia forever and moved to India and attended the court of the Mughal emperor Humāyūn (r. 1508-1556) sometime between 1530 and 1556. At the Mughal court Lārī attained the office of *ṣadr* but after Humāyūn's death he moved to the Ottoman Empire and died there. In his commentary on Qūshjī's Persian *Treatise on Hay'a*, Lārī reported all the attempts from Ibn Sīnā's time to his day at suggesting alternative models for the difficulties of *'ilm al-hay'a*, but both he and his master Dashtakī, both contemporaries to Khafri, considered Quṭb al-Dīn Shīrāzī the last but not the successful participant in the reform.⁴⁹⁰

A comprehensive view of what topics of *'ilm al-hay'a*, Safavid astronomers showed more interest in, needs exhaustive research on the existing unpublished literature from that period, most of which has yet to be examined. However, what we can tell about 'Āmilī's commentators is that they criticized and refined ideas in fundamental topics of natural philosophy that comprised a significant part of the *hay'a* works. As I have discussed in Chapter 5, most of scientific productions in early modern Islamic history took the form of commentaries and super-commentaries. These productions should not be considered a slavish imitation of the past authorities or a mere explanation on obscure topics. There were certain debates and disputes on scientific matters that ran through the commentaries and involved contribution of many scholars.

⁴⁹⁰ Lārī's disregard for Khafri's commentaries on Ṭūsī and Shīrāzī and his new planetary models is puzzling as he was considered to have studied mathematics under Khafri. Pourjavady, "Muṣliḥ al-Dīn al-Lārī and His *Samples of the Sciences*," 294, 304.

Chapter 5 and Chapter 6 examined two of the commentaries on ‘Āmilī’s astronomy. Khalkhālī and Tunikābunī, who studied, among other things, astronomy and mathematics under ‘Āmilī. They show a mastery of the existing literature on *‘ilm al-hay’a*, including Greek (through Arabic translations and recensions) and Islamicate works from the tenth century onward. They found themselves in a matured discipline that existed in numerous complicated works but still with many unresolved debates on fundamental topics. ‘Āmilī’s students presented their disagreements with him as well as with other authorities, within the same tradition, on certain topics of *‘ilm al-hay’a* such as the nature of the sphere of Fire and the comets, the order of the lower planets and the Sun, and the possible motion of the Earth. The same attitude was continued by subsequent scholars. The contents of Yazdī’s *Tuhfa*, introduced above, is another evidence of the same ongoing disputes and controversies that ‘Āmilī’s commentators aimed to address. Thus, although ‘Āmilī and those who followed saw Khafīrī’s work as the endpoint for building planetary models, their original contributions to questions of natural philosophy within the tradition of *‘ilm al-hay’a* are more than sufficient to establish their work as part of a continuing and active research tradition.

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