NAZARİYAT

ʿAlī Qūshjī on the Earth's Motion and Bīrjandī's Critique

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Abstract: In his commentary on Naṣīr al-Dīn al-Ṭūsī's *Tajrīd al-iʿtiqād*, ʿAlī Qūshjī (d. 879/1474) took several radical positions. One notable argument was his insistence that astronomy did not need Aristotelian natural philosophy. Because of this stance, in conjunction with his agreement with Ṭūsī that there were no valid empirical proofs for the Earth's state of rest, Qūshjī concluded that "nothing fallacious follows" from the assumption of a rotating Earth. In the following generation, ʿAbd al-ʿAlī al-Bīrjandī (fl. 913/1507) was intent on refuting Qūshjī, both regarding the rejection of Aristotelian natural philosophy and the unprovability of the Earth's state of rest. To do this, Bīrjandī, in his commentary on Ṭūsī's *al-Tadhkira fī ʿilm al-hayʾa*, presents a vigorous defense of the need for Aristotelian natural philosophy and metaphysics for the practitioners of astronomy. In so doing, he affirms Ṭūsī's position that one could justifiably prove the Earth's immobility using natural philosophy since empirical proofs were lacking. Bīrjandī's extended discussion is quite cogent and contains a number of interesting ideas, including the proposal of what can arguably be called "circular inertia" if the Earth were indeed rotating.

Keywords: Qūshjī, Ṭūsī, Bīrjandī, Shīrāzī, *hayʾa*, natural philosophy, Earth's motion, *innī*/*limmī*

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Introduction

ʿAlī Qūshjī (d. 879/1474) took a number of radical positions in his commentary on Naṣīr al-Dīn al-Ṭūsī's *Tajrīd al-iʿtiqād*.[1] Among these was his insistence that astronomy did not need Aristotelian natural philosophy; that instead its underlying premises should be based on mathematics and observation, with other premises determined by what is appropriate for the discipline. Qūshjī recognized that not all premises were provable, and he accepted a certain degree of tentativeness within the discipline. Nevertheless, when something could not be definitively demonstrated within the confines of astronomy itself, he was unwilling, unlike his predecessors, to resort to natural philosophy, which would make astronomy subalternate to philosophy.[2]

The most famous example of this stance concerned the Earth's possible rotation. In a passage from his *al-Tadhkira fī ʿilm al-hayʾa*, a passage that would become the starting point for any number of extensive glosses, Ṭūsī rejected Ptolemy's observational evidence for the Earth's immobility. In his view, the Earth could be rotating, but we would be unaware of it, since the air and whatever was in it could conform in speed and direction to that rotation. In rejecting observational evidence, Ṭūsī saw no alternative but to resort to a natural philosophical proof for the Earth's state of rest, thus accepting that astronomy could not be wholly independent from philosophy.[3]

Ṭūsī's erstwhile student and colleague Quṭb al-Dīn al-Shīrāzī (d. 710/1311) thought he had an empirical solution to this dilemma. He proposed an observational test, namely the throwing of two rocks of different sizes into the air. According to him, the rotation of the air would affect the two rocks differently; thus, they should fall in different locations if Ṭūsī's "conformity" suggestion were actually true. Since we don't observe such a difference in the falling of rocks of different sizes, we have thus

1 The work is also called *Tajrīd al-ʿaqāʾid*, for example, in the edition by ʿAbbās Sulaymān (Alexandria: Dār al-Maʿrifa al-Jāmiʿiyya, 1996).

2 An account of Qūshjī's position as well as the text and translation of the relevant passage from his commentary on the *Tajrīd* can be found in F. Jamil Ragep, "Freeing Astronomy from Philosophy: An Aspect of Islamic Influence on Science," *Osiris* 16 (2001): 49–71. https://islamsci.mcgill.ca/Jamil/TUBA-978-625-8352-02-3.pdf#page=38.

3 For Ṭūsī's text and a translation, see F. J. Ragep, *Naṣīr al-Dīn al-Ṭūsī's Memoir on Astronomy* (*al-Tadhkira fī ʿilm al-hayʾa*), 2 vols. (New York: Springer-Verlag, 1993), 1: 106–7. For a discussion, see ibid., 2: 383–88. https://escholarship.mcgill.ca/concern/books/gx41mn69v.

proven that the Earth must be at rest without resorting to natural philosophy. Or thus according to Shīrāzī.[4]

The history of the reactions to both Ṭūsī's and Shīrāzī's positions, as well as a possible connection to Copernicus, carries considerable interest.[5] But here I wish to focus on ʿAlī Qūshjī's response to his predecessors' positions on this critical question as put forth in his *Sharḥ al-tajrīd*. I shall then turn to ʿAbd al-ʿAlī al-Bīrjandī's (fl. 913/1507) counter-response to Qūshjī that can be found in his commentary on Ṭūsī's *Tadhkira*. The texts and translations for both authors can be found in the appendices below.[6]

Qūshjī on the Rotation of the Earth

Qūshjī's treatment of the question of the Earth's rotation is far from straightforward; in fact, at first glance one might conclude that he contradicts himself in a number of places. To understand his strategy, one needs to take into account the kind of argumentative structure that one often finds in commentaries. Part of this consists of recounting the positions of one's predecessors, often without attribution; as such, an unknowing reader might easily conclude that these are the positions of the current author. My assumption is that most authors, including Qūshjī, expected that their readers knew the provenance of the arguments; there was no need to provide an attribution.

Qūshjī's discussion of the Earth's possible rotation occurs in Part 2 of the Second Intention (*maqṣad*) of Ṭūsī's *Tajrīd,* which deals with bodies (*ajsām*). Ṭūsī is, to say the least, pithy; in the main he only presents the bare essentials, which perhaps was

4 Shīrāzī's discussion of the Earth's motion can be found in his *Nihāyat al-idrāk fī dirāyat al-aflāk*, Book II, Chapter 1, Part 4, and in his *al-Tuḥfa al-shāhiyya*, Book II, Chapter 4. For the text and translation of these passages and a discussion, see Sally P. Ragep and F. Jamil Ragep, "Shīrāzī's Attitude Toward Philosophy: Some Preliminary Observations," forthcoming in a volume edited by Mustakim Arıcı, Asiye Aykıt, and Hasan Umut.

5 For details, see F. J. Ragep, "Ṭūsī and Copernicus: The Earth's Motion in Context," *Science in Context* 14, nos. 1-2 (2001): 145–63. https://islamsci.mcgill.ca/Jamil/TUBA-978-625-8352-02-3.pdf#page=296.

6 Some caveats: This paper is far from an exhaustive study of Qūshjī's positions on astronomical premises and the rotation of the Earth. That would need a much more thorough examination of his writings, including the commentary on Ṭūsī's *Tajrīd*. Furthermore, a study of the reactions to Qūshjī would require a major research project. Not only would one need to study all of Qūshjī's writings in detail, one should also undertake a study of commentaries and glosses on his works. Just to give an idea of what that might entail: the Post-classical Islamic Philosophy Database Infrastructure (PIPDI) project lists five commentaries on Qūshjī's commentary on the *Tajrīd*, for which there are 17 glosses/supercommentaries: https://islamsci.mcgill.ca/RASI/docs/pipdi.htm#dd34.

the work's attraction when Qūshjī decided to provide an extensive commentary. For example, for fire Ṭūsī just gives its properties. It is hot, dry, transparent, and moves by adherence (*bi-al-tabaʿiyya*). It is this latter that, as we shall see, has relevance for the question of the Earth's rotation.

Qūshjī begins his gloss by noting that the motion of the level of fire is indicated by the motion of comets. According to this view, which Ṭūsī mentioned in the *Tadhkira* and Aristotle in the *Meteorology*, the upper atmosphere, i.e., the level of fire, moves with the daily motion of the celestial orb.[7] Since comets were held to be formed in the level of fire, their daily motion was the evidence for the upper atmosphere's "adherence" to the orb's daily rotation. This was disputed by Quṭb al-Dīn al-Shīrāzī, who held that comets, though they sometimes moved with a motion parallel to the celestial equator, had a variety of other motions that indicated that they did not strictly adhere to the orb's rotation.[8]

Qūshjī is at pains to dispute Shīrāzī, most notably by providing a remarkably detailed account of a comet that Qūshjī began observing in 837/September 1433.[9] His conclusion is that comets are no different than planets; although they have their own proper motions, they also participate in the daily motion as he was able to observe over an eight-month period.

In moving on to the possible motion of the Earth, which comes a bit later in the commentary, Qūshjī provides the standard arguments against the Earth's motion. He quickly dispenses with the two suggestions that the Earth might be moving away from or moving toward the middle of the Universe. He then turns to the possibility that the Earth is rotating about the center. The first set of arguments against this are empirical ones, some of which one finds in Ptolemy's *Almagest*.[10] These mostly concern all the unobserved phenomena that would occur were the Earth rotating. He then brings up Ṭūsī's conformity argument that is meant to undermine the empirical arguments. This is followed by Shīrāzī's argument based on the two thrown rocks of differing sizes that is meant to counter Ṭūsī.

7 For Ṭūsī, see Ragep, *Ṭūsī's Memoir*, 1: 106–7 and 2: 383–85; for Aristotle, see *Meteorology* I.vii, esp. 344a5–23.

8 *Tuḥfa*, Bk. II, Ch. 4. I have been unable to find this argument in the *Nihāyat*.

9 This comet was also seen and recorded in Europe and in East Asia. For a detailed account of what is known of this comet, but not including Qūshjī's observation, see Gary W. Kronk, *Cometography: A Catalog of Comets, Volume 1: Ancient–1799* (Cambridge: Cambridge University Press, 1999), 267–69.

10 Ptolemy, *Ptolemy's Almagest*, trans. and annot. G. J. Toomer (Princeton, NJ: Princeton University Press, 1998), 43–45.

Throughout this discussion, the unwary reader might think that Qūshjī is agreeing with several of the arguments against the Earth's motion. He writes, for example, that the impossibility of the Earth moving with circularity, which instead has a principle of rectilinear inclination, "has been established." But this is an argument based on natural philosophy, which earlier in the commentary he said is not needed in astronomy. Likewise, Qūshjī seems to be agreeing with Shīrāzī when he writes that "we say" the two rocks counter Ṭūsī's conformity argument.

What Qūshjī has done is quote other authors and their claims without arguing against them, indeed seeming to agree with them. But his position emerges forcefully in the final paragraph of this section. First, he says that what has been claimed to be established, namely the impossibility of circular motion for a body (like the Earth) that has a rectilinear inclination, has not in fact been established. Second, he dismisses Shīrāzī's argument by saying that Ṭūsī's conformity applies to whatever is in the air, whatever its size, thus undermining the two-rock argument.

Where does this leave Qūshjī? Remarkably, but in a way consistent with his more general views, he states that none of the proposed arguments against a rotating Earth leads to either observational or logical falsehoods. One might well imagine that assuming a non-moving Earth falls into his "indefinite" (*taraddad*) category of astronomical premises.[11] In any event, Qūshjī did not take the next step and advocate *for* a moving Earth. However, as I have argued, it is not far-fetched to believe that Copernicus was aware of this centuries-long discussion in the Islamic world and perhaps even Qūshjī's position.[12]

The Response of ʿAbd al-ʿAlī al-Bīrjandī[13]

Early in his commentary on Ṭūsī's *Tadhkira*, Bīrjandī dismisses ʿAlī Qūshjī's proposal of an astronomy free of natural philosophy and metaphysics.[14] Ṭūsī had stated in

11 Ragep, "Freeing Astronomy," 70–71.

12 Ragep, "Ṭūsī and Copernicus," passim.

13 Bīrjandī was a student of Manṣūr al-Kāshī, the son of Muʿīn al-Dīn al-Kāshī, both father and son likely having been on the staff of the Samarqand Observatory. Thus, Bīrjandī can be considered a legacy member of the Samarqand scientific establishment. His commentary on Ṭūsī's *Tadhkira*, called *Sharḥ al-Tadhkira*, was completed in 913/1507 and is an extensive, *ad litteram* commentary that contains a wealth of information and is particularly useful for understanding the history of Islamic astronomy.

14 See appendix for the text and translation. Robert Morrison has written that "Bīrjandī chose not to

his introductory remarks that "Those principles [of astronomy] that need proof are demonstrated in three sciences: metaphysics, geometry, and natural philosophy."[15] In his gloss on "natural philosophy" (*ṭabīʿiyyāt*), Bīrjandī lists the eight different subsections making up natural philosophy and then gives what appears to be a quote from "one of the eminences (*afāḍil*)," whom he does not name. But both manuscripts I used for the edition below have a marginal note identifying the person as ʿAlī Qūshjī. And the passage, though more a paraphrase than a direct quotation, leaves no doubt that this is taken from Qūshjī's commentary on Ṭūsī's *Tajrīd*.[16] After the paraphrase, Bīrjandī rejects Qūshjī's claim, saying that removing natural philosophy and metaphysics from astronomy is "impossible … as will become clear in the discussions of this book."

One of these discussions is the question of the Earth's motion, something, as mentioned, that Ṭūsī claimed could not be settled empirically but instead needed a natural philosophy proof. As far as I can tell, Bīrjandī does not deal explicitly with Qūshjī's remarks from the commentary on the *Tajrīd*, but I think there can be little doubt that his extended commentary on the Earth's motion is in response to Qūshjī.

Bīrjandī's discussion formally follows Ṭūsī's critique in the *Tadhkira* of the standard empirical arguments for the Earth's immobility (II.1[6]) and his "conformity" argument. In the appendix is a preliminary edition and translation of Bīrjandī's commentary on II.1[6] and the related passage II.1[8]. It is a fulsome exposition of previous discussions and an attempt to deal with a variety of issues associated with Ṭūsī's passages. Here are the main points that Bīrjandī makes:

1) Bīrjandī agrees with Ṭūsī's conclusion that proving the Earth's immobility needs a natural philosophy proof. This proof is a *limmī* (*propter quid*) proof that establishes the cause (or the why [*limā*]) of a proposition. Thus, the Earth does not move because something with rectilinear inclination cannot move by nature with circular motion.

defend premises borrowed from physics as convictions or firm beliefs." ("Cosmography, Cosmology, and *Kalām* from Samarqand to Istanbul," *Intellectual History of the Islamicate World* 9 (2021): 308–37 at 333.) But at least in the passages in the appendix, Bīrjandī strongly defends the use in astronomy of premises from both physics and metaphysics; indeed, *contra* Qūshjī, Bīrjandī sees them as essential. Morrison's point is that Bīrjandī is less explicit than someone like Mīrim Çelebī in engaging with the theologians on cosmological questions. But given the massive size of Bīrjandī's commentary, I would prefer to postpone judgement.

15 Ragep, *Ṭūsī's Memoir*, Introduction [2], 1: 90–91.

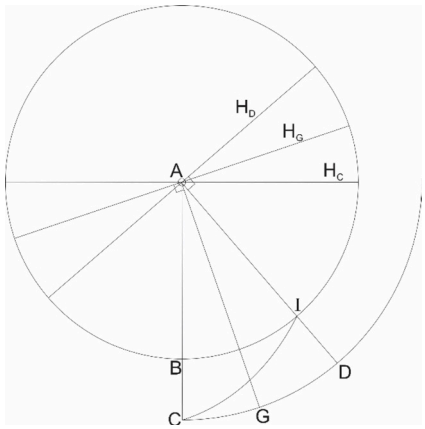
16 For Qūshjī's original text, see Ragep, "Freeing Astronomy," 66–71.

2) According to Bīrjandī, the *limmī* proof that Ṭūsī provides is incomplete, since he only proves the impossibility of the Earth moving *naturally* with a circular motion. Rather, Bīrjandī asserts that there are other possibilities, such as circular motion by force, by volition, or by accident. Bīrjandī then goes on to claim that the first two are refuted in philosophy (*ḥikma*), whereas the third possibility [by accident] is obviously not true. Here, Bīrjandī may be responding to Shīrāzī, who, in both the *Nihāyat* and the *Tuḥfa*, raised the possibility that the Earth might be moving by force with a circular motion.

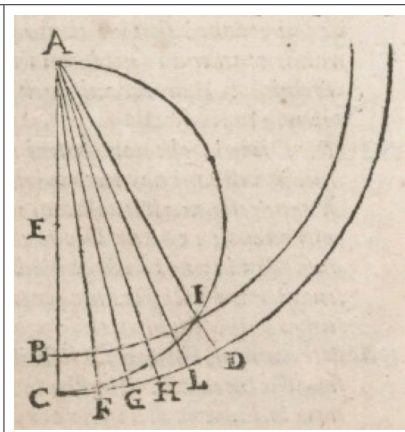
3) In order to confirm the necessity of natural philosophical proofs for the Earth's immobility, Bīrjandī must discredit not only the empirical tests that Ṭūsī brings up but others he is aware of, in particular the more serious challenge by Shīrāzī through the two-rock test. It is worth noting that Bīrjandī does not consider the criticisms of Shīrāzī in the commentaries by Niẓām al-Dīn al-Nīsābūrī (d. 730/1329-30) and al-Sayyid al-Sharīf al-Jurjānī (d. 816/1413) as sufficient to undermine the two-rock test. In each case, Bīrjandī interprets their positions to be such that the air moves in conformity with the Earth, but the rocks do not; instead, they are being moved forcibly by the air. If that were so, Shīrāzī's two-rock test would stand.

Bīrjandī instead offers a different way to counter Shīrāzī; this involves assuming that both the large and the small rocks thrown into the air along the meridian will descend on a line that is perpendicular to the horizon plane at the point of tangency between the Earth's sphere and the horizon plane. The point of tangency moves with the Earth's rotation, thus providing a point of reference for any object in the air, which also participates in this rotational motion. This remarkable position is similar to the "circular inertia" proposed by Galileo in his *Dialogue Concerning the Two Chief World Systems*. To see this, we reproduce below Galileo's illustration of his proposal and juxtapose it with our reconstruction based on Bīrjandī's brief explanation.[17] For both, an object in the air at C will fall to Earth (BAI, with center at A) along a moving straight line, going from CA to DA, which is always perpendicular to the moving horizon (shown in the Bīrjandī reconstruction as going from H_C to H_D).

17 The reconstruction of Bīrjandī's proposal follows the lettering and orientation in the original Italian publication of Galileo's *Dialogue*. The horizon planes are drawn in accordance with Ṭūsī's definition in the *Tadhkira* (1: 116–17): "This is the great circle that divides the visible from the invisible on the celestial sphere"; thus, its center is the World center, here marked as A. For the purposes of the falling body, Bīrjandī needs to refer to the "visible" horizon, which is parallel to the "true" horizon.



Reconstruction of Bīrjandī's proposal for a falling body.



Galileo Galilei, *Dialogo di Galileo Galilei* ..., p. 159. Courtesy of Library of Congress, Rare Book and Special Collections Division.

Clearly there are many differences in the presentation and the motivation of the two scholars. Galileo was attempting to provide a plausible way to explain the motion of a falling body with the Earth in motion. He also wished to show how one could use simple circular motion as an alternative to what was perceived to be the acceleration of a falling body. Bīrjandī, who is committed to an immobile Earth, is obviously not motivated by a need to justify the Earth's rotation; he simply is trying to counter Shīrāzī's two-rock argument. Nevertheless, Bīrjandī's proposal bears a striking similarity to Galileo's. Both depend on analyzing the fall of any body (assuming it is not being acted upon by the air or other forces) by tracking it along the arc of a circle parallel with the Earth. Since the reference point of that arc (in the illustrations, moving from C to D) moves with a circular motion that is equal to that of the Earth's rotation and would continue forever unless acted upon, it has been called "circular inertia." This is fundamental for Galileo's physics but plays no further role for Bīrjandī. On the other hand, it is interesting that Bīrjandī has mathematized the motion of a falling body in such a way that it has become idealized, something that is conceivable in thought but not dependent on actual physical bodies subject to other physical forces as is the case with Ṭūsī's "conformity" of objects in the air or Shīrāzī's two rocks. This idealization of the physical world would, of course, become a hallmark of early modern physics, and not just with Galileo.[18]

18 For Galileo's proposal, see Galileo Galilei, *Dialogue Concerning the Two Chief World Systems—Ptol-*

4) In the comment to the final paragraph of this chapter (II.1[8]), Bīrjandī provides a helpful discussion of the term "proof" (*burhān*) and its synonyms. The main focus is on the difference between *innī* and *limmī* proofs, which allows him to reiterate his agreement with Ṭūsī that they may share a subject and predicate but prove different things.[19] *Innī* proofs convey that something is the case, but they cannot convey the "certainty of judgement," which means that it is true in an absolute sense. The reason is that *innī* proofs are based on observations that can only be true for the moment of observation. Usually there is no problem since an astronomer can be content with his *innī* proof, which will not be in conflict with the *limmī* proof from natural philosophy. But there are exceptions; the lack of circular motion of the Earth and the coinciding of the Earth's center of gravity with the center of the World are two cases that an astronomer cannot prove with an *innī* proof and therefore must depend on natural philosophy. Although he does not refer to "one of the eminences," it is clear that this is an argument directed at Qūshjī.

Conclusion

ʿAlī Qūshjī's challenge to the standard view of astronomy, that among its premises were ones from natural philosophy and metaphysics, did not go unchallenged.[20] Bīrjandī, representing a member of the generation that came after the demise of the Samarqand Observatory and Madrasa, clearly felt the need to provide an extensive answer to Qūshjī. Qūshjī's views were even challenged by his grandson, Mīrim Čelebī (1475–1525).[21] Qūshjī's ideas must have continued to be debated inasmuch as they are

emaic and Copernican, trans. Stillman Drake, 2nd ed. (Berkeley/Los Angeles: University of California Press, 1967), 164–66: "… if we consider the matter carefully, the [falling] body really moves in nothing other than a simple circular motion, just as when it rested on the tower it moved with a simple circular motion" (p. 166). For an overview and analysis of Galileo's "circular inertia," see John Henry, "Hobbes, Galileo, and the Physics of Simple Circular Motions," *Hobbes Studies* 29 (2016): 9–38, esp. 13–20.

19 For more on *innī* and *limmī* proofs as well as disciplinary boundary conditions in astronomy, see Ragep, *Ṭūsī's Memoir*, 1: 38–41, 2: 386–88.

20 I have not, however, found a response by Bīrjandī's contemporary al-Khafrī, at least not in his supercommentary on Ṭūsī's *Tadhkira* entitled *al-Takmila fī sharḥ al-Tadhkira*.

21 İhsan Fazlıoğlu, "Mīram Čelebī," in *The Biographical Encyclopedia of Astronomers*, edited by Thomas Hockey et al. (New York: Springer, 2007), 788–89. https://islamsci.mcgill.ca/RASI/BEA/Miram_Celebi_BEA.htm. See now the more extensive discussion by Morrison in his "Cosmography, Cosmology, and *Kalām*," 321–26.

presented in Tahānawī's thesaurus of technical terms, *Kashshāf iṣṭilāḥāt al-funūn*, dated 1158/1745, under the listing for *hay'a*.[22]

One might argue that Qūshjī was ahead of his time, but perhaps a better way to understand the reaction to his ideas was that the Ptolemaic astronomical system, and its strong connection to Aristotelian natural philosophy and metaphysics, was so entrenched within the intellectual world of Islam that it was very difficult to overcome. Even its opponents, such as the theologians (*mutakallim*s) ʿAḍud al-Dīn al-Ījī (d. 756/1355) and Saʿd al-Dīn al-Taftāzānī (d. 793/1390)[23], would be criticized for their opposition to Ptolemaic astronomy by none other than al-Sharīf al-Jurjānī, who not only wrote a commentary on Ṭūsī *Tadhkira* but also a widely disseminated and well-studied commentary on Ījī's *Mawāqif*.[24] By making the Ptolemaic system a means of glorifying God, Jurjānī, Bīrjandī, and others, even when holding Ashʿarite views that went against the deterministic doctrines of the philosophers, strengthened the hold not only of Ptolemaic astronomy but also its underpinnings in Aristotelian natural philosophy and metaphysics.[25]

There is another point we can make here. The opposition to the subalternation of astronomy to physics and metaphysics, whether coming from the different perspectives of an Ījī, a Taftāzānī, or a Qūshjī, remained trapped within the confines of the *content* of the Aristotelian/Ptolemaic paradigm. It was all well and good for Taftāzānī to claim that rectilinear motion in the heavens might be possible, or for Qūshjī to remark that the Earth's motion was as yet unsettled, but that is not the same as

22 Muḥammad Aʿlā b. ʿAlī al-Tahānawī, *Kashshāf iṣṭilāḥāt al-funūn: A Dictionary of the Technical Terms Used in the Sciences of the Musalmans*, eds. Mawlawies Mohammad Wajih, Abd al-Haqq, and Gholam Kadir under the superintendence of A. Sprenger and W. Nassau Lees, 2 vols. (Calcutta: W. N. Lees' Press, 1862), vol. 1, 48–49.

23 On Taftāzānī's opposition to astronomy's theoretical claims, in particular the subalternation of astronomy to physics and metaphysics, see Morrison, "Cosmography, Cosmology, and *Kalām*," 311–21.

24 A. I. Sabra, "Science and Philosophy in Medieval Islamic Theology: The Evidence of the Fourteenth Century," *Zeitschrift für Geschichte der Arabisch-Islamischen Wissenschaften* 9 (1994): 1–42, esp. 34–41.

25 Moiz Hasan has put the situation well: "[Jurjānī] remains largely faithful to the commentary tradition of *Tadhkira* by *granting* the principles, which he would have seen as required (and rightly so) in order to proceed with the task of cosmography; on the other hand, he reflects his Ashʿarite view of science by pointing to the contingency of the principles, thereby preserving the possibility that on these issues (pertaining to the physical considerations of astronomy) the reality can be otherwise, if God so desires" (Moiz Hasan, "Foundations of Science in the Post-Classical Islamic Era: The Philosophical, Historical, and Historiographical Significance of Sayyid al-Sharīf al-Jurjānī's (d. 1413) Project" [PhD diss., University of Notre Dame, April 17, 2017], 386).

acting on those claims. Taftāzānī or other skeptical Ashʿarīs did not develop a new astronomy based on rectilinear motion, and Qūshjī's astronomical works adopted the main assumptions of Ptolemaic astronomy.[26]

In comparison, the situation among Latin astronomers was quite different.[27] As Olaf Pedersen has remarked:

> The *Corpus astronomicum* [the body of medieval Latin astronomical texts] was a mathematical collection illustrating the development of the teaching of theoretical astronomy without dealing with cosmological problems [...] There is no doubt that the compilers regarded themselves as mathematicians doing planetary theory without caring much about the physical structure of the world.[28]

Pedersen goes on to say: "On the other hand, cosmology was from the very beginning part and parcel of Mediaeval philosophy." However, the two traditions of astronomy and cosmology generally remained separated both in the curriculum and, apparently, conceptually. This, of course, began to change in the fifteenth century, but it is curious that Georg Peurbach's *Theoricae novae planetarum* (published in 1472) does not have a natural philosophy introduction that might have provided a philosophical justification for his solid-orb models.[29]

I would contend that the entrenched nature of the Ptolemaic paradigm—seen as being undergirded by Aristotelian/Avicennian natural philosophy and metaphysics by both proponents and opponents—was a major reason Qūshjī's position could not find a receptive audience within an Islamic context. Perhaps the lesson here is that it would prove easier to move beyond the strong connection between astronomy and philosophy in cultural areas in which that paradigm was not so deeply embedded.[30]

26 On Qūshjī's astronomy, see Hasan Umut, "Theoretical Astronomy in the Early Modern Ottoman Empire: ʿAlī al-Qūshjī's *Al-Risāla al-Fatḥiyya*" (PhD diss., McGill University, 2020), which in addition to an extensive study contains an edition and translation of Qūshjī's *Al-Risāla al-Fatḥiyya*.

27 For a more extensive discussion of the following points, see F. Jamil Ragep, "The Genius of Nicholas Copernicus: An Islamic Perspective," in the 46th volume of *Studia Copernicana* (Turnhout, Belgium: Brepols, forthcoming).

28 Olaf Pedersen, "The *Corpus Astronomicum* and the Traditions of Medieval Latin Astronomy: A Tentative Interpretation," in *Colloquia Copernicana*, iii, eds. Owen Gingerich and Jerzy Dobrzycki (Wrocław: Ossolineum, 1975), 57–96 at 82.

29 E. J. Aiton, "Peurbach's *Theoricae novae planetarum*: A Translation with Commentary," *Osiris*, 2nd Series, 3 (1987): 4–43.

30 A similar point is made by S. P. Ragep in her "Fifteenth-Century Astronomy in the Islamic World," in *Before Copernicus: The Cultures and Contexts of Scientific Learning in the Fifteenth Century*, eds. Rivka Feldhay and F. Jamil Ragep (Montreal: McGill-Queen's University Press, 2017), 143–60 at 158.

Appendices

The following appendices contain texts and translations for three of the documents discussed above. I make no claim that these are critical editions; these are meant to be serviceable texts and translations that convey the meanings of the authors. There were few (if any) significant variants, and translation was relatively straightforward. There is always the possibility that Qūshjī and Bīrjandī made authorial emendations, but I have not been able to detect them in the witnesses I used.

Passages from Ṭūsī's *Tajrīd* and *Tadhkira* are enclosed in curly brackets: {}. Qūshjī's and Bīrjandī's texts then follow. In the translations, parentheses are used when providing the Arabic original. Square brackets are used for clarification.

Text and Apparatus Conventions

Text Conventions

For the Arabic texts, the following conventions have been used:

1. Orthography has been modernized, in particular for *hamza*s, *alif maksūra*s, and dagger *alif*s.
2. The dotting of ي follows the rules used by printers in Syria and Lebanon.
3. *Tanwīn* is generally added (but not on feminine *tā'* endings).
4. *Shadda*s have been supplied (except for sun letters and *nisba*s).
5. Short vowels have been provided sparingly as aids to the reader and/or to avoid ambiguity.

Apparatus Conventions

[	Separates reading in edition from any variant
:	Separates variant and manuscript *sigla*
+	Added in
–	Missing from
=	Indicates another variant
(...)	Editor's comments
طا	مطموس، غير مقروء، إلخ (smudged, unreadable, etc.)
فا	فوق السطر في (above the line in)
ها	في الهامش في (in the margin in)

APPENDIX I (text)

Qūshjī's Commentary on Ṭūsī's *Tajrīd al-iʿtiqād*
Al-Maqṣid al-thānī, al-Faṣl al-thānī (*Fī al-ajsām*)
[Second Intention, Part 2 (On Bodies)]

I have used three witnesses to establish the text:
1) Istanbul, Süleymaniye Library, Çorlulu Ali Pasha MS 305: چ
Copied in 896/1490 by ʿAlī ibn Ḥusayn ibn ʿAlī al-Yazdī in Cairo.
2) Istanbul, Süleymaniye Library, Laleli MS 2275: ل
Copied in 988/1580 by ʿAbd Allāh ibn al-Ḥusayn. Note that the copy is fully vowelled.
3) Tehran, ca. 1890 lithograph?: ط
https://iiif.lib.harvard.edu/manifests/view/drs:50460298$1i

(چ: ص٢٤٦؛ ط: ص١٩٣؛ ل: ١٩٥آ) {فالنار ... متحرّكة[١] بالتبعية}

لحركة[٢] الفلك بدلالة حركة (ط: ص ١٩٤) ذوات الأذناب[٣] فإنّه قد ظهر في سنة سبع وثلاثين وثمانمائة هجرية[٤] والشمس في أوائل الميزان ذات[٥] ذنب تقرُب[٦] الإكليل الشمالي كانت تطلع وتغرب[٧] معه لا تفارقه ثمّ بعد مدّة ظهر أنّ لها حركة خاصّة بطيئة[٨] فيما بين المشرق والشمال وكانت يصغر[٩] جرمها[١٠] ويضعف ضوءها بالتدريج حتّى انمحت بعد ثمانية أشهر تقريباً وقد بعدت[١١] عن الإكليل في الجهة المذكورة قَيد رُمْحٍ[١٢] وفيما شاهدنا دلالة ظاهرة على أنّ كرة الأثير[١٣] تتحرّك[١٤] بالحركة اليومية

١ متحرّكة] متحرك: چ.
٢ لحركة] يُحَرِّكُهُ: ل.
٣ الأذناب] الأَذْنَابِ: ل.
٤ هجرية] تحربه(؟): چ.
٥ ذات] ذَوَاتُ: ل.
٦ تقرُب] بقرب: ط.
٧ وتغرب] وبغيب: چ.
٨ بطيئة] +من: چ.
٩ يصغر] يَصْفَرُّ: ل.
١٠ جرمها] جِرْمُهمَا: ل.
١١ بعدت] تَعَدَّتْ: ل.
١٢ قَيد رُمْحٍ] قيدرمح: چ = قدررمح: ط = قِيد رُمْحٍ: ل.
١٣ الأثير] الاثر: چ.
١٤ تتحرّك] يتحرك: چ = يَتَحَرَّكُ: ل

وما قيل من أنّه لو كان كذلك[١٥] لكانت حركة ذوات الأذناب على موازاة[١٦] المعدّل لكنّها ليست كذلك[١٧] بل تارة إلى الشمال من المعدّل وتارة إلى الجنوب منه أقول ليس بشيء لأنّها على ما شاهدنا إنّما تتحرّك[١٨] كذلك[١٩] بحركتها الخاصّة وجميع الكواكب كذلك[٢٠] يتحرّك[٢١] [٢٢] بالحركة[٢٣] اليومية مع أنّ لها حركات خاصّة تارة إلى الشمال من المعدّل وتارة إلى الجنوب منه

والاستدلال بأنّ السطح المقعّر لفلك القمر مكان للنار[٢٤] فإذا تحرّك ذلك بحركة فلك القمر تحرّك[٢٥] المتمكّن فيه بالعرض كحركة جالس[٢٦] السفينة يتحرّك بحركة مكانه باطل[٢٧] وإلاّ لزم أن يتحرّك سائر العناصر أيضاً والتشبيه بجالس[٢٨] السفينة وهمٌ لأنّ ذلك في الحركة المستقيمة وكلامنا في المستديرة

(چ: ص ٢٤٧؛ ط: ص ١٩٤؛ ل: ١٩٦آ) {والأرض ... ساكنة في الوسط}

أمّا أنّها في وسط العالم أي مركز حجمها منطبق على مركز العالم فلانخساف القمر في مقاطراته[٢٩] الحقيقية للشمس وامّا أنّها ساكنة فلأنّها[٣٠] لو تحرّكت فإمّا أن تتحرّك[٣١] عن الوسط

١٥ كذلك] كك: ط.
١٦ موازاة] مُوَاذَاتِ: ل.
١٧ كذلك] كك: ط.
١٨ تتحرّك] يَتَحَرَّكُ: ل.
١٩ كذلك] كك: ط.
٢٠ كذلك] كك: ط.
٢١ يتحرّك] تتحرّك: ط.
٢٢ كذلك بحركتها الخاصّة وجميع الكواكب كذلك يتحرّك] هال.
٢٣ بالحركة] بحركه: چ.
٢٤ للنار] النّار: ط.
٢٥ تحرّك] يحرك: چ.
٢٦ كحركة جالس] كَجَالِسِ: ل.
٢٧ باطل] بط: ط، ل.
٢٨ بجالس] بحابس: چ.
٢٩ مقاطراته] مقاطراتها: چ.
٣٠ فلأنّها] فلانّه: ط.
٣١ تتحرّك] يَتَحَرَّكَ: ل.

(ط: ص ١٩٥) أو إلى الوسط أو على الوسط فإن كان الأوّل أو الثاني[٣٢] لزم[٣٣] عدم انخساف القمر في مقاطراته الحقيقية للشمس والتالي باطل[٣٤]

وإن كان الثالث لزم أن يتحرّك بالاستدارة ما فيه مبدأ ميل مستقيم وقد ثبت امتناعه وأيضاً لزم[٣٥] أن يُرى حركة[٣٦] المرمي إلى جهة حركتها أبطأ من حركة ذلك المرمي بعينه بتلك القوة بعينها إذا رُمي[٣٧] إلى خلاف جهتها وذلك إذا كان حركة المرمي أسرع من حركتها وأمّا إذا تساويا لزم أن لا يحسّ[٣٨] بحركة المرمي إذا توافقتا في الجهة ويحسّ بحركة سريعة له إذا تخالفتا وإذا كان حركته أبطأ من حركتها لزم أن يحسّ[٣٩] حركة المرمي إلى خلاف جهة[٤٠] رمي إليها فإذا[٤١] فرض شخصان متساويان في القوة قد[٤٢] رميا حجرين متساويين[٤٣] أحدهما إلى جهة حركتها والآخر[٤٤] إلى خلافها لزم أن يرى حركتا[٤٥] الحجرين (ج: ص ٢٤٨) كليهما إلى جهة واحدة مختلفين[٤٦] بالسرعة والبطء والتوالي بأسرها باطلة[٤٧]

فإن قيل ما ذكرتم إنّما يلزم لو لم يشايعها[٤٨] (ل: ١٩٦ب) الهواء في حركتها كما يشايع الأثير[٤٩] الفلك قلنا لزم حينئذ[٥٠] أن لا يقع الحجران المختلفان في الصغر والكبر المرميان في الهواء من[٥١] سمت

٣٢ أو الثاني] وَالثَانِيَ: ل.
٣٣ لزم] يلزم: ط.
٣٤ باطل] بط: ط، ل.
٣٥ لزم] يلزم: ط.
٣٦ حركة] حركته: ج.
٣٧ رُمي] رَمَى: ل.
٣٨ يحسّ] نحسّ: ط.
٣٩ يحسّ] نحسّ: ط.
٤٠ جهة] +ما: ط.
٤١ فإذا] وَاذَا: ل.
٤٢ قد] وقد: ط.
٤٣ إلى خلاف جهة رمي إليها فإذا فرض شخصان متساويان في القوة قد رميا حجرين متساويين] ها ج.
٤٤ والآخر] وَالْأَخْرَى: ل.
٤٥ حركتا] حركة: ط.
٤٦ مختلفين] مخلتفتين: ج، ط.
٤٧ باطلة] بط: ط.
٤٨ يشايعها] تشايعها: ط.
٤٩ الأثير] الاثر: ج.
٥٠ حينئذ] ح: ج، ط، ل.
٥١ من] فِي: ل.

خطّ[٥٢] واحد على الأرض كخطّ[٥٣] من خطوط أنصاف النهار على ذلك الخطّ لأنّ تحريك الهواء للكبير[٥٤] يكون أقلّ من تحريكه[٥٥] للصغير فظهر بطلان ما ذهب إليه قوم من الأوائل من أنّ للأرض حركة[٥٦] وضعية من المغرب إلى المشرق وإنّما ذهبوا إلى هذا القول لأنّهم لمّا[٥٧] رأوا[٥٨] للكواكب حركات بطيئة إلى المشرق وحركة[٥٩] سريعة إلى المغرب واستحال عندهم كون الجسم الواحد متحرّكاً[٦٠] دفعة إلى جهتين ولم يعلموا أنّ ذلك جائز إذا كانت إحداهما بالعرض[٦١] ولم يمكنهم إسناد الحركات البطيئة إلى الأرض لاختلافها فأسندوا الحركة السريعة اليومية إليها وزعموا أنّها المتحرّكة[٦٢] بهذه[٦٣] الحركة وبسببها ترى[٦٤] الكواكب طالعة[٦٥] وغاربة كما أنّ السفينة في الماء متحرّكة والشطّ ساكن وإن كنّا نتخيّل حركة الشطّ إلى الجانب المضادّ للجانب الذي إليه[٦٦] يتحرّك السفينة

والجواب عن الوجه الأوّل أنّه لم يثبت امتناع الحركة المستديرة على ما فيه مبدأ ميل مستقيم وعن الثاني[٦٧] أنّ المراد بمشايعة الهواء هي مشايعته مع جميع ما فيه حجراً كان أو غيره صغيراً كان أو كبيراً وحينئذ[٦٨] لا يلزم شيء من المفاسد

٥٢ خطّ] الخط: چ.
٥٣ كخطّ] ـل.
٥٤ للكبير] للكثير: چ.
٥٥ تحريكه] تحريك: چ.
٥٦ للأرض حركة] الارض متحرّكة بحركة: ط = لِلأرْضِ مُحرِّكَةً بِحَرَكَةٍ: ل.
٥٧ لمّا] ـچ.
٥٨ رأوا] راو: ط.
٥٩ وحركة] وحركات: چ.
٦٠ متحرّكاً] متحرّكة: ط.
٦١ بالعرض] بالفرض: چ.
٦٢ المتحرّكة] متحرّكة: ط.
٦٣ بهذه] هذه: چ.
٦٤ ترى] يُرَى: ل.
٦٥ طالعة] طايعة(؟): چ.
٦٦ إليه] ـچ.
٦٧ الثاني] ـچ.
٦٨ وحينئذ] وح: چ = وَح: ط، ل.

APPENDIX I (translation)

Qūshjī's Commentary on Ṭūsī's *Tajrīd al-iʿtiqād*

{Fire … moves by adherence}

to the motion of the orb by the indication of the motion of the comets. For in the year 837 of the Hijra, the Sun being in the beginning part of Libra, there appeared a comet near Corona Borealis that rose and set with it, not departing from it. Then after a certain time, it appeared that it had a slow proper motion between the east and north. Gradually its body became smaller[1] and its brightness waned until it was extinguished after approximately eight months, it having become distant from the Corona in the stated direction by the length of one spear.[2] In what we witnessed, there was a clear indication that the aethereal sphere moves with the daily motion.

[As to] what is said, namely that were that to be the case, then the motion of comets would be in parallel with the equinoctial, but this is not so; rather, [they] are sometimes [moving] northward from the equinoctial and sometimes southward from it. I say [in response]: there is nothing to this because, according to what we have witnessed, it moves as such by its proper motion, and all the planets move in such a way with the daily motion despite having proper motions, sometimes northward away from the equinoctial and sometimes southward from it.

The argument (*istidlāl*) for the concave surface of the Moon's orb being the [inherent] place for fire, so that when [the fire] moves with the motion of the Moon's orb, that which is located in it will move by accident, just as the motion of someone sitting in a ship moves with the motion of his place, is invalid; otherwise, it would follow that the other elements would move as well. The comparison with someone sitting on a ship is fanciful, since that is by linear motion [whereby] our discussion concerns circular [motion].

1 MS L has "became yellowish [pale?]" (*yaṣfarru* vs. *yaṣghuru*).

2 A "spear-length" (*rumḥ*) was often used in connection with comets. There is uncertainty regarding its measure, but Paul Kunitzsch makes a plausible case that it is about 14 degrees. See his "Postscript" to W. S. Rada, "A Catalogue of Medieval Arabic and Islamic Observations of Comets During the Period AD 700–1600," *Zeitschrift für Geschichte der Arabisch-Islamischen Wissenschaften* 13 (1999–2000): 71–91 at 91. I owe this reference to Sajjad Nikfahm-Khubravan, who also helped me understand the passage.

{The Earth … is at rest in the middle}

As for it being in the middle of the World, i.e., the center of its volume is coincident with the center of the World, [this is shown] by the eclipse of the Moon at its true oppositions to the Sun. As for its being at rest: if it were to move, it would either move away from the middle, or toward the middle, or about the middle. If it were the first or second, it would require the absence of an eclipse of the Moon at its true oppositions to the Sun, and what follows is false.

If it were the third, it would require that which has in it a principle of rectilinear inclination to move with circularity; but its impossibility has been established.[3] Furthermore, it would require that the motion of a projectile in the direction of [the Earth's] motion would be seen to be slower than the motion of that same projectile were it to be thrown with that same force opposite the direction of [the Earth's motion]. This would be the case were the motion of the projectile faster than [the Earth's] motion. If they were equal, it would require that the motion of the projectile not be perceived if they agree in direction. A fast motion for [the projectile] would be perceived were they to differ [in direction]. Were the motion [of the projectile] slower than [the Earth's] motion, then it would require that the motion of the projectile be perceived to be opposite the direction in which it was thrown. If we then assumed two individuals of equal strength who threw two equal rocks, one of them in the direction of the [Earth's] motion and the other opposite [the Earth's motion], it follows that the motion of each of the two rocks would be in a single direction [but] differing in speed [lit., fastness and slowness]. In their entirety, the consequences are false.

If one were to say: but what you have stated would follow if the air did not conform (*yushāyiʿu*) to [the Earth] with its motion, just as the aether (*athīr*, i.e., fire) conforms to the orb. We say: thereupon it follows that two rocks differing in size that were thrown into the air from along the same line on the Earth, such as one of the meridian lines, would not fall on that line because the air's moving of the larger [rock] would be less than its moving of the smaller.[4] The falsity then becomes appar-

3 This impossibility may at first seem to be Qūshjī's position, but he is simply reporting the standard view from natural philosophy; he makes it clear in the final paragraph below that such a position "has not been established." We should recall that earlier in *Sharḥ al-Tajrīd* Qūshjī rejected the use of such natural philosophical propositions in astronomy; see Ragep, "Freeing Astronomy," 65–71.

4 This argument is from Quṭb al-Dīn al-Shīrāzī. See his *Nihāyat*, Bk. II, Ch. 1, Pt. 4, and his *Tuḥfa*, Bk. II, Ch. 4. For the text and translation of these passages and a discussion, see Ragep and Ragep, "Shīrāzī's Attitude Toward Philosophy."

ent of what a certain group among the Ancients held, namely that the Earth has a motion in place (*waḍʿiyya*) from west to east. They only held to this position because: [a] when they saw that the planets had a slow motion to the east and a fast motion to the west, and [b] they did not allow for a single body to move simultaneously in two directions, not knowing that that was possible if one of them were by accidental [motion], and [c] not being able to attribute the slow motions to the Earth because of their diversity, they then attributed the fast daily motion to [the Earth]. They claimed that it [i.e., the Earth] was the one moving with this motion, and on account of it the stars (*al-kawākib*) are seen rising and setting. Similarly, a ship is moving in the water and the shore is at rest, even though we are imagining the shore moving toward the side opposite the side toward which the ship is moving.[5]

The response to the first way [to disprove the Earth's rotation] is that the impossibility of circular motion for that which has in it a principle of rectilinear inclination has not been established. To the second [way] is that what is intended by the conformity (*mushāyaʿa*) of the air is its conformity with everything that is in it, whether it be a rock or something else, whether it be a small one or a large one. Hence, nothing fallacious follows [from the assumption of a rotating Earth].

5 This report of how some "Ancients" came to believe in a rotating Earth may be found in Shīrāzī's *Nihāyat* and *Tuḥfa* in the passages cited in the previous footnote.

APPENDIX II (text)

Bīrjandī on Qūshjī (*Sharḥ al-Tadhkira*, Preface)
Two witnesses have been used to establish the text:

1) London, British Library MS Or 13060: ب
Copied in 1097/1686 by Muḥammad Yūsuf ibn Muḥammad ʿAlī ibn ʿAbd al-Raḥmān in Qum. http://www.qdl.qa/en/archive/81055/vdc_100030796164.0x000001

2) Cambridge, Harvard College Library, Houghton MS Arabic 4285: ه
Copy date has been erased; copied by Darwīsh ʿAlī ibn Yūsuf al-Ṭāliqānī.
https://curiosity.lib.harvard.edu/islamic-heritage-project/catalog/40-990115386310203941

[ب: ١١ب؛ ه: ٧آ] {والطبيعيات}

وهي علم يبحث فيه عن أحوال الجسم الطبيعي من حيث يتحرّك ويسكن وإنّما جمعها إشارة إلى أقسامها الثمانية المشهورة وهي مباحث الأمور التي تعمّ[١] الأجسام كالهيولى والصورة والطبيعة[٢] والحركة والسكون ونحو ذلك ومباحث الأركان التي هي السموات والعناصر وهي علم السماء والعالم ومباحث الكون والفساد ومباحث الآثار العلوية ومباحث المعادن ومباحث النبات[٣] ومباحث الحيوان ومباحث النفوس الإنسانية[٤]

وقال بعض الأفاضل المذكور في الهيئة بعضه مقدّمات هندسية وبعضه حدسية كالحكم بأنّ نور القمر مستفاد من الشمس وبعضه ما يحكم به العقل بحسب[٥] الأخذ بالأليق كالحكم بتوسّط الشمس بين السيّارة وبانّه لا فضل[٦] في الفلكيات وبعضه ما يذكر على سبيل التردّد كإسناد حركات الشمس إلى أصل الخارج أو أصل التدوير وليس شيء منها من المقدّمات الطبيعية والإلٰهية وتصدير المصنّفين كتبهم بها إنّما هو لمتابعة الفلاسفة لا على (ب: ١٢آ) سبيل الوجوب بل يمكن إثباته من غير ابتناء عليها

وفيه بحث لأنّ كثيراً من مسائل هذا الفنّ مبنية على بساطة الفلكيات وامتناع الخرق وغير ذلك ممّا يتوقّف على العلمين والانحصار فيما ذكره [ه: ٧ب] ممنوع كما سيظهر ذلك في مباحث هذا الكتاب

١ تعمّ] يعم: ه.
٢ والطبيعة] –ب.
٣ النبات] النباتات: ب.
٤ الإنسانية] –ب.
٥ بحسب] يجب: ه.
٦ فضل] فصل: ب.

APPENDIX II (translation)

Bīrjandī on Qūshjī (*Sharḥ al-Tadhkira*, Preface)

{Natural philosophy (*ṭabīʿiyyāt*)}

It is a science in which one studies the circumstances of the natural body in so far as it moves and is at rest. It [i.e., *ṭabīʿiyyāt*] being plural is an indication of its eight well-known parts, which are: [1] studies of matters that are common to bodies, such as matter, form, nature, motion, rest and so forth; [2] studies of the bases, which are the celestial regions and the elements, this being the science of "The Sky and the World" [i.e., *On the Heavens*]; [3] studies of "Generation and Corruption"; [4] studies of atmospheric phenomena; [5] studies of minerals; [6] studies of plants; [7] studies of animals; [8] studies of the human psyches.

One of the eminences[1] has said: Some things stated in astronomy (*hayʾa*) are geometrical premises; some [premises] are suppositions (*ḥadsiyya*), such as the determination that the light of the Moon is derived from the Sun; some [premises] are what is determined by the mind in accordance with the apprehension of what is most suitable, such as the determination that the Sun is in the middle of the planets and that there is no useless part in the celestial region; and some [premises] are stated as undetermined, such as basing motions of the Sun on an eccentric model or an epicyclic model. There is nothing [among these premises] that are natural philosophical or theological premises. Authors introducing their books with them is, rather, by following the philosophers, not according to what is necessary. It is indeed possible to establish [this science] without basing it upon them.

This needs further examination, because many of the problems of this discipline are based upon the simplicity of the celestial region, the impossibility of piercing [the orbs], and so on, which are based upon the two sciences [i.e., natural philosophy and theology/metaphysics]. The restriction in what he [i.e., Qūshjī] has stated is impossible, as will become clear in the discussions of this book.

1 Both manuscripts have marginal notes indicating that the "eminence" in question is ʿAlī Qūshjī. The citation is a paraphrase of what one finds in Qūshjī's *Sharḥ al-Tajrīd*; see Ragep, "Freeing Astronomy," 66–71.

APPENDIX III (text)

Bīrjandī (*Sharḥ al-Tadhkira*), on *Tadhkira*, II. 1[6, 8]
(For Manuscripts, see Appendix II.)

II.1[6] [ب: ٥٩آ؛ ه: ١٣٧آ] {وثبات جميع ما ذكرنا من الدلائل يدلّ[١] على ثبات[٢] تلك الأجرام على الهيئة المذكورة}

يعني أنّ ثبات الدلائل المذكورة على ما دلّت عليه تجارب الحكماء بالأرصاد وغيرها يدلّ[٣] على أنّ تلك الأجرام من الفلكيات والأرض والماء ثابتة دائماً على الهيئة المذكورة وهذه الدلائل[٤] ظنّية لا يقينية حتّى يردّ أنّ ثبات هذه الدلائل لا يفيد إلّا أنّ هذه الأجرام وقت الإحساس بها كذلك وامّا أنّها أبداً كذلك فلا يستفاد منها

{ولا يمكن إسناد الحركة الأولى إلى الأرض}

اعلم أنّ مذهب[٥] الحقّ أنّ الأرض ساكنة لا حركة لها أينية ولا وضعية وقيل إنّها هابطة دائماً بدون السماء لثقلها[٦] وقيل إنّها صاعدة دائماً بدون السماء ويبطل الأوّل لحوق المدرة المرمية إلى فوق إلى الأرض وعدم تصاغر الكواكب كلّ يوم بحسب الحسّ إذ لو كان كما زعموا لما لحقها المدرة المذكورة[٧] لأنّ الأثقل أسرع والسريع لا يدرك الأسرع ولازداد صغر الكواكب يوماً فيوماً بسبب البعد ويبطل الثاني عدم ازدياد الكواكب حسّاً كلّ يوم لمثل ما ذكرنا ويبطلهما معاً ما مرّ من الدلائل الدالّة [ب: ٥٩ب] على أنّ الأرض في وسط الكلّ عند المركز وما تقرّر في كتب الحكمة

١ يدلّ] –ه.
٢ ثبات] اثبات: ه.
٣ يدلّ] تدل: ب.
٤ الدلائل] الدلالة: ه.
٥ مذهب] المذهب: ب.
٦ لثقلها] –ه.
٧ المذكورة] –ب.

من الدلائل الدالّة[٨] على تناهي الأبعاد التي يتصوّر حركة الجسم فيها فهذان الوجهان هما المعتمد عليهما في إبطال القولين أحدهما إنّي والآخر لمّي والوجوه المذكورة أوّلاً لا ينتهض فيها[٩] إذا فرض الهبوط أو الصعود في غاية البطء وقيل إنّها والسماء هابطتان بقدر واحد وقيل صاعدتان أيضاً بقدر واحد ويبطلهما أنّه لو كان الأمر كذلك لكانت المسافة التي يقطعها الحجر المرمي إلى فوق في صعوده أكثر من التي[١٠] يقطعها في نزوله على الثاني لارتفاع سطح الأرض زمان صعود الحجر وبالعكس على الأوّل والامتحان يكذبه كذا ذكره العلّامة

ونخدشه[١١] أنّه لو[١٢] كان الصعود أو الهبوط بطيئاً لم يمكن التفرقة بين الزمانين حتّى يعلم بالامتحان بطلانه فالوجه أن يحال بيان بطلانهما على الطبيعيات بأن يقال[١٣] هذان القولان مستلزمان لحركة الجسم في الخلاء وللحركة المستقيمة فيما فيه مبدأ ميل مستدير وقد تبيّن استحالتهما في الطبيعيات ولم يلتفت المصنّف[١٤] إلى هذه الأقوال لضعفها

وذهب بعض القدماء إلى أنّها متحرّكة حركة وضعية من المغرب إلى المشرق بمقدار الحركة اليومية وطلوع الكواكب وغروبها وارتفاعاتها[١٥] إنّما هي بهذه الحركة إذ لا شكّ أنّ الأرض إذا تحرّكت نحو المشرق مقداراً ظهر لساكنيها ما كانت محتجبة بحدبتها من الكواكب في المشرق واحتجبت عنهم بحدبتها ما كانت ظاهرة منها في المغرب وبمقدار ما تتحرّك[١٦] يزداد ارتفاع[١٧] الأولى وانحطاط الثانية إلى أن يبلغ [ه: ٣٧ب] دائرة نصف النهار إيّاهما ثم ينعكس الأمر إلى

٨ الدالّة] –ب.
٩ فيها] فيما: ب، ه.
١٠ التي] الذي: ب.
١١ ونخدشه] ويخدشه: ب = يخدسه: ه.
١٢ لو] ان: ه.
١٣ يقال] –ه.
١٤ المصنّف] المص: ب، ه.
١٥ وارتفاعاتها] وارتفاعها: ب.
١٦ تتحرّك] يتحرك: ب، ه.
١٧ ارتفاع] +~~ارتفاع~~: ب.

أن تحتجب[١٨] الأولى وتظهر[١٩] الثانية وإذا فرضت[٢٠] حركة الأرض ينبغي أن تفرض[٢١] مشايعة الماء لها أيضاً وإلّا لم يبق القدر المنكشف من الأرض على حاله والظاهر أنّ الباعث لهم على ذلك أمران أحدهما أنّهم رأوا الأفلاك كلّها متحرّكة بالحركة اليومية وإسناد حركاتها بأسرها إلى الفلك الأعظم الذي لم يلاصق إلّا أحدها لا يخلو[٢٢] عن بعد وثانيهما أنّه على هذا التقدير لا يحتاج إلى الفلك [ب: ٦٠آ] الأعظم فتقلّ[٢٣] الأجرام بذلك وليس الباعث لهم على ذلك هو أنّهم اعتقدوا استحالة تحرّك الجسم الواحد كالكوكب دفعة إلى جهتين كما ذكره العلّامة وتبعه الشارحون فإنه لا استحالة في كونهما بالعرض أو كون[٢٤] إحداهما بالذات والأخرى بالعرض ومثل ذلك مشاهد محسوس في تحرّك النملة على الرحى مخالفاً لحركته وإنكاره مكابرة ولا ينبغي أن يظنّ بالحكماء الأقدمين مثل هذا الظنّ

وهذا القول باطل عند الجمهور لكنّهم أبطلوه بوجهين غير مرضيين عند المصنّف[٢٥] فأشار إليهما بقوله

{لا لِما قيل من أنّ ذلك يوجب أن لا يقع} الحجر {المرمي في الهواء} بالاستقامة[٢٦] {على موضعه الأوّل بل يجب أن يقع في الجانب الغربي منه}

هذا هو الوجه الأوّل وإنّما وجب ذلك لأنّ الأرض في مدّة حركة الحجر المرمي الصاعدة والهابطة قد تحرّكت مقداراً إلى جانب المشرق فلا يقع الحجر المرمي إلى فوق على الاستقامة على موضعه الأوّل والتجربة بخلافه

١٨ تحتجب] يحتجب: ب، ه.
١٩ وتظهر] ويظهر: ب، ه.
٢٠ فرضت] فرض: ه.
٢١ تفرض] يفرض: ب، ه.
٢٢ لا يخلو] لا يح: ب = لا يخ: ه.
٢٣ فتقلّ] فثقل: ب = فمقل: ه.
٢٤ كون] كان: ب.
٢٥ المصنّف] المص: ب، ه.
٢٦ في الهواء بالاستقامة] بالاستقامة في الهواء: ه.

{أو يوجب أن} تكون[٢٧] {الحركة لما انفصل منها كالسهم والطائر إلى جهة حركتها أبطأ وإلى خلافها أسرع}

مع أنّهما متساويان في الواقع وهذا هو الوجه الثاني وحاصله أن المتحرّك إلى جهة المشرق التي هي جهة حركة الأرض يفارق موضعه الأوّل تفضل حركته على حركتها والمتحرّك إلى خلافها يفارقه بمجموع الحركتين فبالضرورة[٢٨] تُرى[٢٩] حركة الأوّل أبطأ من حركة الثاني[٣٠] وذلك خلاف الواقع هكذا قالوا وفيه نظر لأنّه لا يوجد في المتحرّكات السفلية ما يقاوم حركته الحركة اليومية فضلاً عن أن يفضل عليها فإنّ تلك الحركة تتمّ[٣١] في أربع وعشرين ساعة تقريباً ومجموع الدور ثلاثمائة وستّون درجة فحصّة ساعة واحدة خمس عشرة درجة وهي من محيط عظيمة مفروضة على الأرض ألف ميل كما يجيء في مساحة الأرض فهي تتحرّك[٣٢] في دقيقة واحدة ستّة عشر ميلًا وثُلثي[٣٣] ميل وهذا في خطّ الاستواء وأمّا في أوّل الإقليم الثاني فحصّة ساعة واحدة من الأرض تسعمائة وستّة وثلاثون ميلاً كما مرّ فتتحرّك [ب: ٦٠ب] في دقيقة واحدة خمسة عشر ميلاً وثلاثة أخماس ميل وفي سائر الأقاليم يكون أقلّ من هذا لكنّ لا يبلغ إلى حدّ يقاومه المتحرّكات السفلية إلا في المواضع القريبة من[٣٤] القطب وهي ليست بمسكونة وللمناقشة فيه مجال والأظهر أن يقال يوجب أن لا يُرى متحرّك نحو المشرق[٣٥] أصلًا كما ذكره العلّامة في التحفة والنهاية

وحمل بعضهم عبارة المتن على أنّ المعنى يوجب أن تكون[٣٦] حركة المتحرّك إلى المشرق في الواقع أبطأ لكنّ إلى جهة[٣٧] المغرب فإنّه وإن كان متوجّهاً إلى المشرق[٣٨] لكن بسبب التخلّف[٣٩]

٢٧ تكون] يكون: ب، ه.
٢٨ فبالضرورة] فبالض: ب.
٢٩ تُرى] يري: ب.
٣٠ الثاني] الثانيه: ب.
٣١ تتمّ] يتم: ب، ه.
٣٢ تتحرّك] يتحرك: ب، ه.
٣٣ وثُلثي] وثلثين: ه.
٣٤ من] طا ه.
٣٥ المشرق] الشرق: ه.
٣٦ تكون] يكون: ب، ه.
٣٧ إلى جهة] +الى ~~جهة~~: ب.
٣٨ المشرق] الشرق: ه.
٣٩ التخلّف] التخالف: ه.

يصير إلى المغرب[٤٠] أقرب فتكون[٤١] الحركة البطيئة والسريعة له[٤٢] كلتاهما إلى جهة المغرب[٤٣] والحركة السريعة مركّبة من الحركتين والبطيئة هي بمقدار تخلّف[٤٤] حركة المتحرّك [ه: ١٣٨آ] عن الحركة اليومية وأقول لا يبعد أن يقال هذا الوجه إشارة إلى بطلان ما ذهب إليه البعض من أن الحركة اليومية بعضها للسماء وبعضها للأرض وذلك لأنّ الحركة المستندة إلى الأرض يحتمل حينئذ[٤٥] أن تكون[٤٦] أسرع من جميع المتحرّكات السفلية ويحتمل أن لا تكون[٤٧] كذلك بل تكون[٤٨] حركة بعض المتحرّكات السفلية أسرع منها[٤٩] فالوجه الأوّل إشارة إلى بطلان الاحتمال الأوّل وبطلان إسناد الحركة بتمامها إلى الأرض والوجه الثاني إشارة إلى بطلان الاحتمال الثاني فلا حاجة إلى صرف كلام المتن عن ظاهره فتأمّل

{فإنّ المتّصل بها من الهواء يمكن أن يشايعها بما يتّصل بها (!)[٥٠]}

هذا تزييف للوجهين المذكورين والمعنى أنّ الهواء المتّصل بالأرض يمكن أن يشايع الأرض مع ما يتّصل بالهواء من الحجر والسهم والطائر وغيرها فيكون للمتّصل بالهواء حركتان إحداهما عرضية بتبعية[٥١] الهواء والأخرى ليست بالتبعية[٥٢] فبمقدار ما تتحرّك[٥٣] الأرض يتحرّك المتّصل بالهواء بالعرض ولا يفارق المتّصل بالهواء عن محاذاة أجزائها إلّا بالحركة الخاصّة به كجالس

٤٠ المغرب] العرب: ه.
٤١ فتكون] فيكون: ب، ه.
٤٢ له] –ب.
٤٣ المغرب] الغرب: ب، ه.
٤٤ تخلّف] تخالف(؟): ه.
٤٥ يحتمل حينئذ] ح يحتمل: ب = يحتمل ح: ه.
٤٦ تكون] يكون: ب، ه.
٤٧ تكون] يكون: ب، ه.
٤٨ تكون] يكون: ه.
٤٩ منها] –ب.
٥٠ بها] به: ب، ه. (الظاهر أنّ هذا خطأ في المتن وصحّحه الشارح.)
٥١ بتبعية] تبعة: ه.
٥٢ بالتبعية] بالتبعيّة: ه.
٥٣ تتحرّك] يتحرك: ب، ه.

السفينة إذا تحرّك فيها بنفسه فلا يلزم في الحجر المرمي إلى فوق بالاستقامة أن يزول عن محاذاة موضعه الأوّل ولا في السهم والطائر أن تختلف حركتاهما الذاتيتان إلى جهتي[٥٤] [ب: ٦١آ] الشرق والغرب وبهذا يندفع ما قيل لو صحّت المشايعة لوجب إحساسنا بحركة الهواء وأن لا ترى[٥٥] السحاب ولا الرياح متحرّكة نحو المغرب[٥٦] وامتنع حركتنا إلى المغرب[٥٧] فإنّه إنّما يلزم لو لم تتحرّك[٥٨] بمثل تلك الحركة أيضاً

واعترض عليه العلّامة بأنّ مشايعة الهواء يستلزم أن لا يقع الحجران المختلفان بالصغر والكبر المرميان إلى فوق من سمت خطّ نصف النهار مثلاً على ذلك الخطّ بل يقع الكبير[٥٩] في الغربي من الصغير لأنّ تحريك الهواء للكبير أقلّ من تحريكه للصغير وأجاب عنه المحقّق الشريف بأنّه لا تفاوت بين تحريكهما في الحركة العرضية إذ هي بمقدار الحركة الذاتية سواء كان المتحرّك بالعرض صغيراً أو كبيراً بل التفاوت بينهما إنّما هو في الحركة القسرية وأجاب الشارح الفاضل بأنّ المفروض هو المشايعة مع ما يتّصل بالهواء سواء كان صغيراً أو كبيراً فيصير معنى كلامه لو كان الهواء بما فيه كبيراً كان أو صغيراً متحرّكاً بمقدار[٦٠] حركة الأرض لزم اختلاف وقوع الحجرين وهل هذا إلّا تدافع وبأنّ التفاوت بين تحريك الهواء للكبير[٦١] وبين تحريكه للصغير مما لا يحسّ به ولا يدرك ذلك بالتجربة فإنّ الكبير لو ثقُل[٦٢] جداً تعذّرت تجربته أو تعسّرت[٦٣] والصغير لو صغُر جداً تشوّشت حركته في الهواء فلم تتيسّر[٦٤] التجربة المستدعية لظهور التفاوت

٥٤ جهتي] جهة: ه.
٥٥ ترى] يرى: ه.
٥٦ المغرب] الغرب: ب.
٥٧ المغرب] الغرب: ب.
٥٨ تتحرّك] يتحرك: ب، ه.
٥٩ الكبير] الكبر: ه.
٦٠ بمقدار] بقدر: ه.
٦١ للكبير] الكبير: ب.
٦٢ ثقُل] نفل: ه.
٦٣ أو تعسّرت] –ب.
٦٤ تتيسّر] يتيسر: ب = سسر: ه.

وفي الكلّ نظر أمّا في الأوّل فلأنّ المتحرّك[٦٥] بالعرض على ما فسّره[٦٦] المصنّف[٦٧] في الباب الأوّل هو أن يكون كجزء من المحرّك[٦٨] أو كان المحرّك مكاناً له بالطبع والحجر ليس كجزء من الهواء إذ لا يمتنع حركة الهواء بدون حركة الحجر والهواء ليس[٦٩] مكاناً طبيعياً له فحركة الحجر لو تحقّقت على الوجه المذكور لكانت بالقسر ولا يمتنع أن يكون المتحرّك بالعرض محرّكاً لغيره بالقسر كجالس السفينة إذا حرّك غيره بالقسر ولمّا كان القاسر موجوداً دائماً لدام[٧٠] تلك الحركة بدوامه[٧١] وإذا كانت حركة الحجر بالقسر يلزم ما ذكره العلّامة بلا ريب وأمّا في الثاني فلأنّ حاصل كلام المعترض أنّ حركة الحجر لا يكون [ه: ٣٨ب] بالمشايعة بل بسبب تحريك الهواء له إذ مشايعة الهواء للأرض إنّما هي بسبب لزوم مقعّر الهواء لكرة [ب: ٦١ب] الأرض ومثل هذا غير واقع للحجر بالنسبة إلى الهواء فلا تكون[٧٢] حركته[٧٣] بالمشايعة وحينئذ[٧٤] [لا؟] يلزم ما ذكره المعترض[٧٥] ويندفع التدافع وأمّا في الثالث فلأنّ الحجر الذي يكون مَنّاً مثلاً ممّا لا تتشوّش[٧٦] حركته في الهواء والذي يكون خمسة أمنان[٧٧] مثلاً ممّا لا[٧٨] يتعذّر[٧٩] تحريكه فيمكن التجربة وإدراك التفاوت وهذا ظاهر[٨٠]

٦٥ المتحرّك] +با: ه.
٦٦ فسّره] فسرها: ه.
٦٧ المصنّف] المص: ب، ه.
٦٨ المحرّك] المتحرك: ب.
٦٩ ليس] +~~ه~~: ب = ليست: ه.
٧٠ لدام] لدوام: ه.
٧١ ولمّا كان القاسر موجوداً دائمًا لدام تلك الحركة بدوامه] ها ب (مع رمز «ص»).
٧٢ تكون] يكون: ب، ه.
٧٣ حركته] +~~لا~~: ب.
٧٤ وحينئذ] ح: ب، ه.
٧٥ المعترض] المعرض: ه.
٧٦ تتشوّش] يتشوش: ب = سوس: ه.
٧٧ أمنان] أمناء: ب.
٧٨ لا] –ه.
٧٩ يتعذّر] يتغير: ه.
٨٠ ظاهر] ظ: ه.

ويمكن أن يندفع[٨١] اعتراض العلّامة بأنّ الحجر الصغير أو الكبير ينزل إلى[٨٢] الأرض على مسامتة خطّ يكون عموداً على سطح الأفق وذلك مشاهد بالتجربة وهذا العمود خارج من نقطة مماسة كرة الأرض بسطح الأفق الحسّي وهذه النقطة متحرّكة بحركة الأرض فلهذا[٨٣] لا يختلف موقعا[٨٤] الحجرين فتامّل[٨٥]

{كما يشايع الأثير الفلك بدلالة حركات ذوات الأذناب بحركته}

أي بحركة الفلك والمراد بالأثير كرة النار وبالفلك فلك القمر ثمّ إنّها قد تتحرّك[٨٦] على موازاة معدّل النهار أيضاً وهي ليست بمراده ههنا على ما زعم الشارح الفاضل[٨٧] لأنّ حركاتها على هذا الوجه ليست بمشايعة الفلك حينئذ[٨٨] بل بمشايعة الهواء المتحرّك بمشايعة الأرض إذ المفروض أنّ الحركة اليومية للأرض لا للفلك بل نقول إنّها على هذا التقدير إنّما ترى[٨٩] متحرّكة بالحركة اليومية بسبب التخلّف[٩٠] كسائر الكواكب لا بمشايعة شيء أصلًا ويمكن أن يكون مراده أنّ الهواء متحرّك[٩١] بمشايعة الأرض على هذا القول كما أنّ النار متحرّكة بمشايعة الفلك الأعظم على ما ذهب إليه جماعة لا يقال إنّ قياس مشايعة الهواء للأرض على مشايعة النار للفلك غير مستقيم لأنّ الفلك محيط بكرة النار والأرض ليست محيطة بكرة الهواء لأنّا نقول لو سلّم ذلك فلا تأثير للإحاطة في المشايعة وإنّما المؤثّر فيها هو كون سطح أحد الجسمين مكاناً طبيعياً للآخر

٨١ يندفع] يدفع: ب.
٨٢ إلى] على: ب.
٨٣ فلهذا] فلذا: ه.
٨٤ موقعا] موقعاً: ه.
٨٥ فتامّل] –ب.
٨٦ تتحرّك] يتحرك: ب، ه.
٨٧ الفاضل] فا ب (مع رمز «ص»).
٨٨ حينئذ] ح: ب، ه.
٨٩ يرى] يري: ب.
٩٠ متحرّكة بالحركة اليومية بسبب التخلّف] متحركة بالتخلف: ه.
٩١ متحرّك] متحركه: ب.

إمّا تامّاً أو غير تامّ ولا شكّ أنّ سطح[٩٢] الأرض والماء مكان طبيعي غير تامّ للهواء وكذا مقعّر الفلك للنار فلا إشكال فإن قيل إنّ حركاتها ليست بالمشايعة بل بنفوس تتعلّق[٩٣] بها وتحرّكها[٩٤] تارة من المشرق إلى المغرب وبالعكس [ب: ٦٢آ] وأخرى من الشمال إلى[٩٥] الجنوب وبالعكس قلنا هذا الكلام[٩٦] على السند فإنّ قوله كما يشايع سند للمنع المتقدّم وتساويهما غير معلوم فلا يضّر فإنّ إبطال السند الغير المساوي لا يجدي نفعاً على ما تقرّر عند النظّار

{بل لكونها ذات مبدأ[٩٧] ميل مستقيم فيمتنع أن تتحرّك[٩٨] على الاستدارة بالطبع}

يعني عدم إمكان استناد الحركة اليومية إلى الأرض إنّما هو[٩٩] لكونها ذات مبدأ ميل مستقيم بالطبع كما يشاهد من حال[١٠٠] أجزائها المنفصلة عنها فيمتنع أن تتحرّك[١٠١] على الاستدارة[١٠٢] بالطبع كما مرّ في المقدّمات والمراد بالطبع مبدأ حركة المتحرّك بنفسه على نهج واحد واعترض عليه بأنّ الميل المستقيم في أجزائها المنفصلة عنها لا في جملتها فيجوز أن يكون جملتها من حيث هي ذات مبدأ ميل مستدير وأجيب بأنّه لو نقل الأرض إلى مقعّر[١٠٣] فلك القمر مثلاً فلا شكّ أنّ كلّ جزء منها يميل إلى مركز العالم سواء كان منفصلاً عنها أو لا على ما هو مقتضي الثقل[١٠٤] المطلق ويلزم منه أن يميل المجموع إليه أيضاً فمبدأ الميل المستقيم ثابت في جملتها أيضاً

٩٢ سطح] +~~الماء~~: ب.
٩٣ تتعلّق] يتعلق: ب.
٩٤ وتحرّكها] وتحريكها: ب.
٩٥ إلى] او: ه.
٩٦ الكلام] كلام: ب.
٩٧ مبدأ] ها ب (مع رمز «ص»).
٩٨ تتحرّك] يتحرك: ب، ه.
٩٩ هو] –ب.
١٠٠ حال] –ه.
١٠١ تتحرّك] يتحرك: ب، ه.
١٠٢ على الاستدارة] بالاستدارة: ب.
١٠٣ مقعّر] فا ب (مع رمز «ص»).
١٠٤ الثقل] النقل: ه.

ولا يخفى أنّ مجرّد ما ذكره[١٠٥] المصنّف[١٠٦] لا يثبت المطلوب[١٠٧] إذ امتناع تحرّكها على الاستدارة بالطبع لا يستلزم عدم تحرّكها على الاستدارة بنوع آخر والبيان التامّ أن يقال إنّ هذه الحركة لو فرضت وقوعها [ه: ٣٩آ] فهي ليست طبيعية لما ذكر المصنّف[١٠٨] ولا إرادية لأنهّا إنّما تكون[١٠٩] بنفس تعلّقت بها وتعلّق النفس بالعناصر لا يكون إلّا بعد التركيب ولا قسرية لأنّ هذه الحركة أزلية عندهم ومثل هذا لا يمكن صدورها من قاسر وكلاهما ممّا برهن عليه في الحكمة ولا عَرَضية وهو ظاهر فهي لا تتحرّك[١١٠] حركة مستديرة أصلًا قال صاحب التحفة إنّما لم يبطل الأوائل حركة الأرض على الاستدارة بأنّها ذات ميل مستقيم لأنّ البيان على هذه الوجه فلسفي طبيعي لا تعليمي وهم يتحاشون عن استعمال غيره في مطالبهم ولهذا تمسّكوا[١١١] في إثبات استدارة البسائط بالأمور[١١٢] المبنية على الرصد والاعتبار لا إلى ما تمسّك به الطبيعي من أنّ غير [ب: ٦٢ب] الكرة من الأشكال يقتضي اختلاف الأجزاء

واعترض عليه بأنّ الحكمة الطبيعية من مبادئ الهيئة كما تقدّم فلا بعُد في أن يثبت مسئلة الهيئة بالمقدّمات المبنية في الطبيعيات والجواب أنّ هذا إذا لم يكن المسئلة مشتركة بين الحكمة الطبيعية والهيئة[١١٣] وأمّا[١١٤] إذا كانت مشتركة كما نحن فيه فالاختلاف حينئذ[١١٥] ينبغي أن يكون بحسب البرهان فإذا[١١٦] ثبت بالبرهان[١١٧] اللمّي كانت مسئلة طبيعية وإذا ثبت بالبرهان الإنّي كانت تعليمية كما سيجيء بيانه عن قريب

١٠٥ ذكره] ذكر: ه.
١٠٦ المصنّف] المص: ب، ه.
١٠٧ المطلوب] المط: ب.
١٠٨ المصنّف] المص: ب، ه.
١٠٩ تكون] يكون: ب، ه.
١١٠ تتحرّك] يتحرك: ب، ه.
١١١ تمسّكوا] تمسكو: ب.
١١٢ بالأمور] الى الامور: ه.
١١٣ الحكمة الطبيعية والهيئة] الهيئه والحكمه الطبيعيه: ب.
١١٤ وأمّا] اما: ه.
١١٥ حينئذ] ح: ب، ه.
١١٦ فإذا] واذا: ه.
١١٧ بالبرهان] بالبرها: ب.

II.1[8]

[ب: ٦٤ب؛ ه: ٤٠ب] {وهذه الأدلّة إنّية تُفيد[١١٨] الوقوع والتي تُفيد وجوب الوقوع من اللمّيات ما يذكر في كتاب السماء والعالم من العلم الطبيعي}

اعلم أنّ الحدّ الأوسط في البرهان علّة لحصول التصديق بالحكم الذي هو المطلوب[١١٩] وإلاّ لم يكن برهاناً عليه فإن كان مع ذلك أيضاً علّة لثبوت ذلك الحكم في الخارج يسمّى برهان لمٍّ وإلّا فبرهان إنٍّ فإن كان الأوسط في برهان الإنّ (؟) معلولاً [ب: ٦٥آ] لثبوت ذلك[١٢٠] الحكم في الخارج يسمّى[١٢١] دليلًا وإلاّ لا يخصّ باسم كذا ذكره المصنّف[١٢٢] في شرح الإشارات وإنّما سمّيا بلمٍّ وإنٍّ لأنّ اللمّية هي العلّية والإنّية هي الثبوت مأخوذتين من لِمَ الدالّة على العلّية وإنّ الدالّة على الثبوت فبرهان اللمّ يفيد علّة الحكم ذهناً وخارجاً وبرهان الإنّ لا يفيدها إلّا ذهناً وقد يطلق الدليل مرادفاً للبرهان وأعمّ منه أيضاً مرادفاً للحجّة والمراد بالدليل في كلام المتن هو ما يرادف البرهان[١٢٣]

ثم إنّ موضوع العلمين إذا كان شيئاً واحداً مختلفاً بحسب قيدين مختلفين فقد[١٢٤] يتّحد بعض مسائلهما بالمحمول والموضوع ويختلف بالبرهان كما فيما نحن فيه فإنّ أجرام[١٢٥] العالم من حيثية موضوعه[١٢٦] للهيئة ومن حيثية أخرى موضوعه للسماء والعالم من الطبيعي كما مرّ[١٢٧] فلذا اشتركت[١٢٨] مسائل هذا الفصل بين العلمين لكنّ الأعراض المشاهدة من هذه الأجرام التي هي الحدود الوسطى في براهين هذا الفصل توجب التصديق تكون هذه الأجرام على الهيئة المذكورة

١١٨ تُفيد] يفيد: ه.
١١٩ المطلوب] المط: ب.
١٢٠ ذلك] –ه.
١٢١ يسمّى] +~~برهان لمّ~~: ب.
١٢٢ المصنّف] المص: ب، ه.
١٢٣ البرهان] +الى المنبهه(؟): ه.
١٢٤ فقد] وقد: ه.
١٢٥ أجرام] أجزاء: ب.
١٢٦ موضوعه] موضوعة: ب.
١٢٧ كما مرّ] فا ب (مع رمز «ص»).
١٢٨ اشتركت] اشترك: ب، ه.

وقت المشاهدة من غير أن تفيد ثبوت الحكم في نفس الأمر ما دام ذات الموضوع موجوداً وما يفيدهما معاً هو المذكور في كتاب السماء والعالم كما يقال كلّ فلك بسيط وكلّ بسيط لا يقتضي شكلاً مختلفاً بل مستديراً فالبراهين المذكورة في السماء والعالم هي اللمّيات والمذكورة ههنا هي الإنّيات وهذا على سبيل التغليب فإنّ برهان عدم تحرّك الأرض على الاستدارة[١٢٩] على ما ذكره المصنّف[١٣٠] لمّي وكذا برهان انطباق مركز ثقل الأرض على مركز العالم كما لا يخفى

١٢٩ الاستدارة] استدارة: ب.

١٣٠ المصنّف] المص: ب، ه.

APPENDIX III (translation)

Bīrjandī (*Sharḥ al-Tadhkira*), on *Tadhkira*, II.1[6,8]

II.1[6]

{The reliability of all the evidence we have adduced establishes that these bodies are according to the stated configuration (*hay'a*)},

meaning that the reliability of the stated proofs according to what testing by scientists (*al-ḥukamā'*) through observations and otherwise has shown proves (*yadullu*) that those bodies, namely the celestial orbs, the Earth, and water, are permanently established according to the stated configuration. These proofs are suppositional (*ẓannī*), not certain, such that one [might] counter that establishing these proofs only conveys that these bodies are as such at the time they are perceived. That they are always as such is not derivable from them.

{It is not possible to attribute the primary motion to the Earth.}

One should know that the true doctrine is that the Earth is at rest without motion, neither from place to place (*aynıyya*) nor in place (*waḍ'iyya*). It is claimed that it is permanently falling beneath the sky on account of its heaviness. And it is claimed that it is permanently rising beneath the sky. The first is refuted by the catching up to the Earth of an earthen clod thrown upwards and the absence of any diminishing of the stars each day according to the senses. For were it as they claimed, the above-mentioned earthen clod would not catch up to the [Earth] because that which is heavier is faster and something going fast cannot catch up to something going faster; [also] the size of the stars would increasingly diminish day by day on account of distance. The second is refuted by the absence each day of a sensible increasing [in size] of the stars, similar to what we have [already] stated. Both of them are refuted by what has been previously mentioned, namely, the proofs that indicate that the Earth is in the middle of the Universe at the center, and what is confirmed in philosophy books, namely the proofs that indicate the finite distances in which one can conceive the motion of a body. These are the two methods that are relied upon to refute the two claims: one of them is *innī*, and the other is *limmī*.[1] The first mentioned meth-

1 I.e, a *quia* (knowledge of the fact) proof and a *propter quid* (knowledge of the reasoned fact) proof. The terms will be explained more fully below.

od cannot be pursued if the falling and rising are assumed to be extremely slow. It is claimed that [the Earth] and the sky are falling with the same amount; and it is also claimed that both are rising with the same amount. The two are refuted in that were the matter as such, then the distance that a rock thrown upwards would traverse in its rising would be greater than what it would traverse during its fall, according to the second [claim], on account of the ascent of the Earth's surface during the rising of the rock; the opposite [would occur] according to the first [claim]. Testing disproves it.[2] Thus said the Most Learned (*al-ʿallāma*).[3]

We undercut this in that were the rising and falling to be slow, one could not distinguish between the two time intervals in order to determine its falsity through testing. So the [correct] method is to refer their refutation to natural philosophy, in that one says these two claims require the motion of the body in a void and rectilinear motion for what has a principle of circular inclination. And their impossibility is shown in natural philosophy. The Author (*al-muṣannif*)[4] did not take these claims into consideration because of their weakness.

Some of the Ancients held that [the Earth] moved with an in-place motion from west to east in the amount of the daily motion. The rising and setting of the stars and their ascents were actually due to this motion, since there is no doubt that the Earth, if it moved toward the east a certain amount, [then] stars in the east that had been hidden by its curvature would appear to its inhabitants, and those that had been visible in the west would be hidden from them by its curvature. By [then] moving a certain amount, the altitude of the first [stars] would increase and the second would decrease in altitude until they reach the meridian circle for the two of them. The situation would then reverse, until the first [stars] become hidden and the second are visible. If one assumes the motion of the Earth, one should assume the conformity (*mushāyaʿa*) of the water to [the Earth] as well. Otherwise, the amount of the

2 On the concept of testing (*imtiḥān*) in Islamic astronomy, see F. Jamil Ragep, "Islamic Reactions to Ptolemy's Imprecisions," in *Ptolemy in Perspective*, ed. Alexander Jones, 121–34 (Dordrecht; New York: Springer-Verlag, 2010).

3 "Most Learned (*al-ʿallāma*)" was the honorific title for Quṭb al-Dīn al-Shīrāzī. In his references to Shīrāzī and Nīsābūrī, Bīrjandī generally provides paraphrases rather than direct quotations. Shīrāzī's discussion of the Earth's motion can be found in his *Nihāyat*, Bk. II, Ch. 1, Pt. 4, and in his *Tuḥfa*, Bk. II, Ch. 4. Bīrjandī in his criticism is focused on Shīrāzī's empirical arguments and the possibility of testing. As will be clear, Bīrjandī is keen on undercutting any attempt to provide empirical arguments against the Earth's motion and instead wishes to follow Ṭūsī in only depending on natural philosophy.

4 The Author, of course, is the author of the base text, i.e., Naṣīr al-Dīn al-Ṭūsī.

Earth that is uncovered would not remain in its same situation. It is apparent that what compelled them to this were two things: one of them is that they saw all the orbs moving with the daily motion, and the attributing of its motion in its entirety to the great orb, which only was contiguous with one of the [orbs], was not without oddity. The second of them was that according to this determination, one does not need the great orb, and thereby the number of bodies would decrease. [But] what compelled them to that [position] was not that they thought it was impossible for one body, such as a planet, to move in two directions at once, as the Most Learned stated and with the commentators following him.[5] For it is not impossible for [the two directions] to be by accidental [motion] or for one of them to be by intrinsic and the other by accidental [motion]. Something similar is what an observer perceives in the motion of an ant on a millstone that is moving opposite its motion. To deny it is stubbornness; it is not necessary to think the ancient scientists had this notion.

This claim [regarding the rotation of the Earth] is false according to the majority of people; however, they have refuted it in two ways, which are not accepted by the Author. He points to these two by saying:

{This is not, however, because of what has been maintained, namely that this would cause a} rock {thrown} straight {up in the air not to fall to its original position but instead it would necessarily fall to the west of it.}

This is the first way, and this would be necessitated because the Earth, during the period of motion of the thrown rock ascending and descending, will have moved a certain amount toward the east, so the rock thrown straight up will not fall to its original position. Testing (*tajriba*)[6] contradicts this.

{Or that this would cause the motion of whatever leaves the [Earth], such as an arrow or a bird, in the direction of the [Earth's] motion to be slower, while in the direction opposite to it to be faster},

whereas in reality they are equal. This is the second way; the upshot of it is that

5 The discussion referred to here is in Shīrāzī's *Nihāyat*, Bk. II, Ch. 1, Pt. 4, and in his *Tuḥfa*, Bk. II, Ch. 4. As Bīrjandī notes, Shīrāzī's passage about the Ancients can be found in Nīsābūrī's commentary; it is also in Jurjānī's commentary and Khafrī's supercommentary on Jurjānī. These commentaries follow the *Tadhkira*, so the passages are in II.1[6].

6 Bīrjandī uses both *imtiḥān* and *tajriba* in the sense of testing. Both words (or derivatives) had been used to translate the Greek *πεῖρα* in the *Almagest*; see Ragep, "Islamic Reactions," 131.

something moving toward the east, which is the direction of motion of the Earth, in leaving its initial position its motion will be what remains [after subtracting] the [Earth's] motion. Something moving opposite the [Earth] will depart [from its initial position] with the sum of the two motions. So necessarily the motion of the first will be seen to be slower than the motion of the second, which contradicts reality. So this is what they have maintained. This needs further examination, since there is nothing in things moving in the lower region that would resist their moving with the daily motion in addition to what would be in excess to it [i.e., the daily motion]. For that motion is completed in about 24 hours, and the entire rotation is 360 degrees. So the portion of one hour is 15 degrees, which from the circumference of a given great [circle] on the Earth is 1000 miles, as will be forthcoming in [the chapter on] the measure of the Earth. So it will move in one minute 16⅔ miles, this being at the equator. At the beginning of the second clime, the portion of one hour from the Earth is 936 miles as aforementioned. So it will move in one minute 15⅗ miles. In the rest of the climes, it will be less than this but will not reach an extent that things moving in the lower region could withstand except in the locations near the pole, which are not inhabited. So, there is room for debate on it. The surest thing to say is that necessarily one would not see a moving object toward the east at all, as the Most Learned stated in the *Tuḥfa* and the *Nihāyat*.[7]

Some [someone?] have interpreted the phrase in the base text such that the meaning requires the motion of the moving object to the east to be in actuality slower but toward the west. Even though it is directed to the east, however, on account of lagging behind, it comes to be closer to the west. Thus each of its slower and faster motions will be toward the west: the faster motion being composed of the two motions and the slower being in the amount of lag in the motion of the moving object from the daily motion. I say: it is not far-fetched to say that this way is an indication of the falsity of what some have held, namely that part of the daily motion belongs to the sky and part of it belongs to the Earth. That is because the motion based on the Earth might thereupon be faster than all the moving objects in the lower region [or] might not be so; indeed, the motion of some of the moving objects in the lower region [might] be faster than [the Earth]. The first manner [that Ṭūsī presents] indi-

7 Cf. Abū Rayḥān al-Bīrūnī (d. ca. 1050 CE), who also provided a mathematical calculation of the consequences of the Earth's rotation, which convinced him that it must be at rest (*Al-Qānūn al-Masʿūdī*, 3 vols [Hyderabad: Dāʾirat al-maʿārif al-ʿUthmāniyya (Osmania Oriental Publications Bureau), 1954–1956], 1: 51–53).

cates the refutation of the first possibility [that the Earth is faster than the moving objects] [in addition to that manner's] refutation of basing the motion in its entirety on the Earth. The second manner [that Ṭūsī presents][8] indicates the refutation of the second possibility [that some moving objects are faster than the Earth]. So there is no need to divert the words of the base text from what is obvious. So reflect [on this].

{For the part of the air adjacent to the [Earth] could conceivably conform to the [Earth's motion] along with whatever is joined to it.}

This is the falsification of the two previous manners [of argumentation]. The meaning is that the air that is contiguous with the Earth could possibly conform to the Earth along with what is in contact with the air, such as a rock, an arrow, a bird, and so forth. So that which is in contact with the air has two motions: one of them is accidental, following along with the air; the other is not by following [the air]. So in the amount the Earth moves, that which is in contact with the air will move accidentally. That which is in contact with the air will not depart from alignment with the part of the [Earth to which it is aligned] except by its own proper motion, such as someone sitting on a ship when he moves in it on his own. So there is no necessity for a rock thrown straight up to cease being aligned with its original place. Nor would the intrinsic motion of an arrow or a bird diverge toward the east or west. To this, one [might] refute what was said [by saying] that were conformity correct, we would necessarily sense the motion of the air, and that neither clouds nor winds would be seen moving toward the west. And our motion toward the west would be impossible. However, this would only follow were they not also to move with that same motion.

The Most Learned objected to him [or it?] in that the conformity of the air necessitates that two rocks differing in size that are thrown [straight] up from along the meridian line, for example, will not both fall on that line but rather the larger will fall to the west of the smaller. This is because the moving by the air of the larger is less than its moving of the smaller.[9] The Righteous Sharīf[10] responded to him in that there would be no difference in [the air's] moving of them in accidental motion, since it is

8 Bīrjandī means by the "second manner" the argument cited by Ṭūsī that the Earth's motion would cause a difference in speed depending on the direction of the moving object.

9 Shīrāzī's objection based on the two rocks occurs in both the *Nihāyat* (Bk. II, Ch. 1, Pt. 4) and in the *Tuḥfa* (Bk. II, Ch. 4).

10 I.e., al-Sayyid al-Sharīf al-Jurjānī. The response to Shīrāzī occurs in Jurjānī's *Sharḥ al-Tadhkira;* as a commentary on Ṭūsī's *Tadhkira*, the response is in II.1[6].

in the amount of its intrinsic motion, whether the object moved accidentally be small or large. Rather, a difference between them would instead only be with forced motion. The Eminent Commentator[11] responded that what is assumed is conformity [to the Earth] with what is in contact with the air, whether it be small or large. So the meaning of [Shīrāzī's] statement becomes: Were the air with what is in it, whether large or small, moving in the amount of the motion of the Earth, this would necessitate the difference in the falling of the two rocks. But isn't this just a contradiction? [The Eminent Commentator's response continues, saying] that the difference between the air's moving of the larger and moving of the smaller is something that is insensible and cannot be perceived by testing. The larger, were it to be very heavy, would be impossible or difficult to test. The motion of the smaller, were it to be very small, would become disordered in the air, so the required test to show a difference would not be easy.

For all of this [one needs further] examination. As for the first, since motion by accident, according to what the Author explained in Book I, is to be part of the mover or the mover is its natural place, [but] the rock is not a part of the air, since the air's motion is not prevented without the motion of the rock, and the air is not a natural place for [the rock]. So the motion of the rock, were it to be confirmed according to the stated method, would be by force; and there is nothing preventing an object moving accidentally from moving something else by force, such as someone seated on a ship when he moves something else by force. When the force is present permanently, that motion will be permanent due to its permanence. And if the motion of the rock is by force, then what the Most Learned stated will be necessary without a doubt. As for the second, because what results from the statement of the opponent is that the motion of the rock will not be by conformity but rather on account of the air moving it, since the conformity of the air to the Earth is just on account of the necessity of the concavity of the air to the Earth's sphere, while something similar to this does not occur for the rock in relation to the air, thus its motion is not by conformity. Thereupon what the opponent has stated will [not?][12] follow, and the contradiction

11 I.e., Niẓām al-Dīn al-Nīsābūrī. The objection to Shīrāzī is in Nīsābūrī's *Tawḍīḥ al-Tadhkira*, which again, as a commentary, follows Ṭūsī's text in II.1[6].

12 A negative particle would seem necessary here to make sense of the argument, but none of the manuscripts I consulted have it. In any event, it is clear that Bīrjandī is seeking to refute the objections that had been raised against Shīrāzī's two-rock proof. In the case of both Jurjānī (first argument) and Nīsābūrī (second argument), Bīrjandī is pointing out that for both commentators the rocks are not "in conformity" with the Earth, which then undercuts both their arguments. Since Bīrjandī's refutation of Nīsabūri is not entirely clear, I here present Nīsābūrī's entire argu-

is contradicted. As for the third, because the rock, which, say, [weighs] a *manna*,[13] is something whose motion would not become disordered in the air, and something that is, say, five *manna*s would not be difficult to move, so testing would be possible and the perception of difference. This is clear.

It is possible to counter the objection of the Most Learned in that the small or large rock will fall to the ground along the length of a line perpendicular to the plane of the horizon, which [line] is observed by testing. This perpendicular extends from the tangent point of the Earth's sphere with the plane of the visible horizon. This point would move with the motion of the Earth, so that the falling place of the two rocks would not differ. So reflect [on this].

{Just as the aether conforms to the orb as evidenced by the comets, which move with its motion}

i.e., with the motion of the orb. What is intended by "aether" is the sphere of fire and by "orb" the Moon's orb. Then [the sphere of fire] might move parallel with the equinoctial as well. It [i.e., the sphere of fire] is not intended here by the [Author]

ment against Shīrāzī from his *Tawḍīḥ al-Tadhkira* along with a translation (following the *Tadhkira*: II.1[6]). It somewhat, but not entirely, clarifies Bīrjandī's claim that Nīsābūrī's position compels him to accept that the rock is moved by the air and not by "conformity":

قلنا لا نسلّم أنّ تحريك الهواء للكبير أقلّ لأنّ المشايعة المتنازع فيها إنّما هي المشايعة مع ما يتّصل بالهواء من السهم أو الطائر أو الحجر أو غير ذلك عظمت تلك الأشياء أو صغرت ليلزم تحرّكها بقدر حركة الهواء بل الأرض فيصير معنى كلامه لو كان الهواء بما فيه عظيماً أو صغيراً متحركاً بقدر حركة الأرض لزم اختلاف وقوع الحجرين وهل هذا إلّا تناقض بيّن

We [i.e., Nīsābūrī] say: We do not accept that the moving of the large [rock] by the air is less, inasmuch as the contested [concept] of conformity is conformity along with whatever is joined to it such as an arrow, a bird, a rock or something else, irrespective of being large or small, so that its motion is in the amount of the motion of the air, or rather the Earth. So the meaning of [Shīrāzī's] statement becomes: Were the air with what is in it, whether large or small, moving in the amount of the motion of the Earth, this would necessitate the difference in the falling of the two rocks. But isn't this just a contradiction?

13 A *mann* (or *mannā*) is usually said to be two *raṭl*s, but beyond that is a wide divergence of possibilities for this unit of weight. The most prevalent amount in the premodern period was 260 dirhams, which comes to about 0.83 kilograms for the smaller rock and 4.15 kilograms (=5 *manna*s) for the larger one. Both amounts seem reasonable in the context of Bīrjandī's argument. For an in-depth discussion of *mannā*, see Mahmood Fakhoury and Salahuddin Khawwam, *Encyclopedia of Arab and Islamic Units of Measurement with Their Modern Equivalents* (*Mawsūʿat waḥadāt al-qiyās al-ʿarabiyya wa-al-islāmiyya*) (Beirut: Librairie du Liban, 2002), 429–35.

to be what was claimed by the Eminent Commentator, [namely that] its motions in this manner are thereupon not by conformity with the orb but rather by conformity to the air that moves in conformity to the Earth, since what is assumed is that the daily motion is to the Earth, not to the orb. Rather, this is because we say [against the Eminent Commentator] that according to this supposition [of a moving Earth], it [i.e., the sphere of fire] would be seen to move instead with the daily motion on account of remaining behind just as the rest of the stars, not due to any conformity whatsoever. It is possible that his intention is that the air moves by conformity with the Earth, according to this doctrine, just as the fire moves by conformity with the great orb, according to what a certain group has maintained. One should not say that the conformity of the air to the Earth being analogous to the conformity of fire to the orb is not correct, inasmuch as the orb encompasses the sphere of fire, whereas the Earth does not encompass the sphere of air. This is because we say that were that to be accepted [i.e., the conformity hypothesis], then there would be no effect of encompassing for conformity; rather, what is efficacious [for conformity] is the surface of one of the two bodies being a natural place for the other, either completely or not completely. There is no doubt that the surface of the Earth and water is an incomplete natural place for air. Similarly for the concavity of the orb for fire. So there is no problem. If one were to say that their [i.e., the comets'] motions are not by conformity but by souls that are connected to them, and they move them sometimes from east to west and vice versa, and other times from north to south and vice versa, we say that this statement [by Ṭūsī?] is by way of being supportive; so his statement "just as it conforms" is support for the previous negation. [Since] their similarity is unknown, there is no harm. For falsification of a support for something not similar [to it] does not provide any benefit according to those who have considered the matter.

{Rather, it is on account of the [Earth] having a principle of rectilinear inclination that it is precluded from moving naturally with a circular motion.}

This means that the impossibility of attributing the daily motion to the Earth is rather because it has a principle of rectilinear inclination by nature, as is evidenced from the situation of its parts that are separated from it. So it is precluded from moving naturally with circularity as previously stated in the introductory parts. What is intended by "by nature" is a principle of motion of an object on its own in a single way

[monoformly].[14] This has been objected to in that the rectilinear inclination is in its separated parts, not in its totality. So it is permissible that its totality is such that it has a principle of circular inclination. The response is that were the Earth to move to the concavity of the Moon's orb, for example, there is no doubt that every part of it would incline to the center of the World, whether it be separate from it or not, according to what is required by unrestricted heaviness. So it follows from it that the entirety inclines to it as well. So the principle of rectilinear inclination is also fixed in its totality.

It is obvious that what the Author has stated does not establish as such what is required, since the impossibility of [the Earth] moving naturally with circularity does not entail not moving with circularity in some other way. A complete proof is to say that this motion, were its occurrence to be assumed, would not be natural according to what the Author stated. Nor would it be by volition, since it [then] would instead be by a soul that is attached to it, but the attachment of a soul to the elements cannot occur except after compounding. Nor by force, because this motion is, according to them, eternal, [whereas] this kind [of motion] could not emanate from action by force. Each of these two are among the things demonstrated in philosophy (*ḥikma*). Nor by accidental [motion], which is obvious. Thus [the Earth] does not move with circular motion at all. The author of the *Tuḥfa* has said: the Ancients did not, however, refute the circular motion of the Earth on the basis of it having a rectilinear inclination, because the proof in this manner is natural philosophical, not mathematical (*ta'līmī*). They avoided using something other than [mathematics] in their pursuits. For this [reason], they stuck to matters based on observation and critical testing (*i'tibār*) for establishing the circularity of the simple [bodies]. [They did not use] what pertains to natural philosophy, such as something not spherical in shape entails a variability in [its] parts.

This was objected to in that natural philosophy is among the principles of astronomy (*hay'a*) as previously mentioned. It is not farfetched to establish an issue in astronomy with premises based on natural philosophy. The answer is that this is the case if the issue is not in common between natural philosophy and astronomy. If it is common, as is the matter before us, the difference thereupon is necessarily according to the proof. If it is established by a *limmī* proof, then it is a natural philosophical issue. If it is established by an *innī* proof, it is mathematical as will soon be explained.

14 This notion of "in a single way" is stated by Ṭūsī in *Tadhkira*, I.2[2]. See Ragep, *Ṭūsī's Memoir*, 1: 100–1; for a discussion, see ibid., 1: 44–46.

II.1[8]

{The above proofs are *inniyya*, which convey existence (*wuqūʿ*); those which convey the necessity of that existence are *limmiyyāt* proofs and are given in the book *The Sky and the World* [i.e., *De caelo*] of the science of Natural Philosophy.}

One should know that the middle term of a demonstration is the cause for obtaining affirmation of the judgement that is required; otherwise, it is not a demonstration of it. Then if it, in addition, is also the cause for establishing that judgement externally, it is called a *limm* demonstration; otherwise an *inn* demonstration. If the middle in the *inn* demonstration is causal for establishing that judgement externally, it is called a proof (*dalīl*); otherwise, it is not specifically designated with a name. The Author stated it thusly in [his] commentary on *Pointers* (*Sharḥ al-ishārāt*).[15] They were called *limm* and *inn* because *al-limmiyya* is causal reason and *al-inniyya* is establishing. The two are taken from *lima*, which indicates cause, and *inn*, which indicates establishing. So the *limm* demonstration conveys the reason/cause of the judgement both mentally and externally; the *inn* demonstration does not convey except mentally.[16] *Dalīl* [proof] may be designated as a synonym for *burhān* [demonstration], being more general than [*burhān*]; it is also synonymous with *ḥujja* [argument]. What is intended by *dalīl* in the words of the base text is what is synonymous with *burhān*.

Then if the subject of the two sciences is the same, it will differ on account of two different stipulations. Some of their issues will have a common predicate and subject but will differ in proof, as is the case before us: the bodies of the World from the point of view of its subject in astronomy, and from another point of view of its subject in *The Sky and the World* from natural philosophy, as stated previously. Therefore, the issues of this chapter are shared between the two sciences; however, the accidents that are observed from these bodies that are the middle terms of the demonstrations of this chapter necessitate affirmation (*taṣdiq*). These bodies are in the stated configuration at the time of observation [but] without conveying the certainty of the judgement as

15 This is Ṭūsī's commentary on Ibn Sīnā's *al-Ishārāt wa-al-tanbīhāt*.

16 This seems to contradict the earlier statement that an *inn* demonstration can establish a judgement externally. There are no variants in the manuscripts I have examined, so I am at a loss to understand the seeming contradiction. Note that at the beginning of the commentary on II.1[6], as also later in this paragraph, Bīrjandī raises the possibility of distinguishing between proofs that establish that something is permanently the case [*limmī* proofs] and ones that establish that bodies "are as such at the time they are perceived" [*innī* proofs]. But in either case, one would seem to establish some aspect of externality.

"the fact of the matter" (*nafs al-amr*) as long as the subject itself exists.[17] What conveys both together is what is stated in the book *The Sky and the World,* such as one says: every orb is a simple [body], and every simple [body] does not entail a varying shape but one that is circular. So the demonstrations that are stated in *The Sky and the World* are *limmiyyāt*, [while] the ones stated here are *inniyyāt*. This is for the most part. For the demonstration of the lack of circular motion of the Earth is, according to what was stated by the Author, *limmī.* Likewise for the demonstration of the coinciding of the center of gravity of the Earth with the center of the World, as is obvious.

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17 The concept of *nafs al-amr* is complex and varies among authors. Bīrjandī seems to be advocating the idea that a *limmī* proof can provide the certainty of judgement that is the hallmark of *nafs al-amr*. For a pioneering examination of the concept, see İhsan Fazlıoğlu, "Between Reality and Mentality—Fifteenth Century Mathematics and Natural Philosophy Reconsidered," *Nazariyat* 1.1 (2014): 1–39.

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