

***Al-Zij al-Jadīd* as an Instrument for Timekeeping in Fifteenth-Century Cairo: The Materiality of Bodleian MS Arch. Seld. A 30**

Introduction

In this article I discuss an early fifteenth-century manuscript known as Ibn al-Shāṭir's *Kitāb al-zīj al-jadīd* (The new tables for timekeeping).¹ Ibn al-Shāṭir (d. ca. 777/1375) was a fourteenth-century astronomer and *muwaqqit* (Islamic timekeeper) of the Umayyad mosque of Damascus. His “new *zīj*” has always been presented as a typical example of its genre, that is: a work containing the data needed to “solve all the standard problems” in timekeeping, written down by an astronomer.² However, I will show that a different perspective on this work, which takes into account its materiality and considers this an aspect which is not at all distinct from its content, provides us with interesting insights into the meaning of the text in early fifteenth-century timekeeping in Cairo.

I will first introduce *Al-zīj al-jadīd* and summarize the way in which the work has previously been presented in academic literature. Thereafter, I will show how such presentation presupposes a strict distinction between the ideal content of the text and its material use and appearance—a view which has led earlier scholars to discuss this work's content without paying attention to its materiality. Then I will question this strict distinction between content and material carrier, drawing on the insights of philosopher Bernd Frohmann and of historian of science Karine Chemla, among others.³ In the third and last part of this article, I will provide an alternative way to look at this text, by considering it as a discursive artifact of the practice of timekeeping in early fifteenth-century Cairo. Here I will show how this work functioned as an astronomical instrument but also as both a didactical and a social instrument.

¹Alī ibn Ibrāhīm Ibn al-Shāṭir, “Kitāb al-zīj al-jadīd,” Bodleian MS Arch. Seld. A 30.

²E. S. Kennedy, “A Survey of Islamic Astronomical Tables,” *Transactions of the American Philosophical Society* 46, no. 2 (1956): 125.

³Bernd Frohmann, *Deflating Information: From Science Studies to Documentation* (Toronto, 2004); Karine Chemla, ed., *History of Science, History of Text*, Boston Studies in the Philosophy of Science 238 (Dordrecht, 2004).



Previous Research: *Kitāb al-Zīj al-Jadīd* as a Container of Information

Previous research on Ibn al-Shāṭir's *Kitāb al-zīj al-jadīd* is either part of research on the person of Ibn al-Shāṭir as an astronomer or of research on the genre of the *zīj* in general. A *zīj* consists of several sorts of tables that are either directly or indirectly used in the practice of timekeeping. For instance, this particular *zīj* provides information on the specific dates for holidays and the different calendars used, but also contains a chapter on calculating the sine (*al-jayb*), versed sine (*al-sahm*), and tangent (*al-zill*) for different angles. Furthermore, this text also provides information that would nowadays be categorized as astrological,⁴ such as a chapter on the “projection of rays” (*maṭāriḥ al-shu'ā'āt*)⁵ by which a planet was considered to influence other planets.⁶

Studies on *Zījes*

Previous research on the genre of the *zīj*⁷ treats *zījes* from the ninth until the sixteenth century in an area ranging from the Iberian peninsula in the West to India in the East as one continuous whole. These studies do not make any substantial mention of the differently structured societies and political systems in which these texts circulated. Instead, they focus on what they consider to be the essential characteristics of the genre. Kennedy describes “the *zīj*” as follows:

A *zīj* consists essentially of the numerical tables and accompanying explanation sufficient to enable the practising astronomer, or astrologer, to solve all the standard problems of his profession, i.e. to measure time and to compute planetary and stellar positions, appearance, and eclipses. ...The tables themselves, as the end results of theory and observation, can be used to reconstruct the

⁴It is problematic to use the astronomy/astrology dichotomy for practices concerning the science of the stars in this period. Both terms do not fully agree with the categories historical actors used. However, because this is not the main issue addressed in this article, I use the terms here for the sake of brevity.

⁵*Maṭrah al-shu'ā'* refers to the doctrine according to which “the Sun, Moon and planets cast seven rays of astrological significance to particular points of the ecliptic, the ‘aspects’ (*nazar*, pl. *anzār*).” Benno Van Dalen, “An Introduction to the Mathematics of Islamic Astronomy and Astrology” (unpublished paper), 1–32. I thank Dr. Van Dalen for sharing this unpublished work with me.

⁶Ibn al-Shāṭir, “*Kitāb al-zīj*,” fol. 134b.

⁷Kennedy, “Survey of Islamic Astronomical Tables,” 123–77; David A. King and Julio Samsó, “Astronomical Handbooks and Tables from the Islamic World (750–1900): An Interim Report,” *Suḥayl: International Journal for the History of the Exact and Natural Sciences in Islamic Civilization* 2 (2001): 9–105.



underlying geometric models as well as the mathematical devices utilized to give numerical expression to the models.⁸

We find more or less the same definition in King and Samso's study, where these authors state that the purpose of a *zīj* was

[t]o provide astronomers with all that they needed in the way of theory and tables for such tasks as calculating the positions (longitudes and latitudes) of the Sun, moon and five naked-eye planets and of the time of day or night from solar or stellar altitudes.⁹

Both the studies of Kennedy and of King and Samso offer an overview of the subjects generally present in *zījes*. In the margins of this overview they acknowledge that there were some differences in content in different areas and different periods, but they do not elaborate on this remark. Neither do they take into account the different intellectual contexts in which these texts were used. In their focus on these *zījes* as one rather static and well delineated genre, they assume that the practice of using a *zīj*, which is the practice of timekeeping and a part of astronomy, is a universal and immutable discipline that consists in a definite quantity of predefined problems that have to be solved in a predefined manner. The values in the tables may shift, but the tables themselves and the problems that can be solved with these tables are considered to be fixed independently of their concrete circumstances. If a specific *zīj* is mentioned in these studies, its tables are not reproduced. Instead, parts of them are converted to contemporary mathematical notation. This translation to contemporary notation can be seen as being motivated by a certain perspective on science. Several levels of abstraction can be seen at work in the writings of these scholars: they abstract from the specific use and function of the manuscript in the period under investigation, they abstract the tables from the rest of the manuscript as being its central content, and finally they abstract from the concrete materiality of the tables as written in the manuscript by translating them into modern notation. In secondary research, the translation of ancient text into present day mathematical notation has been criticized as distorting our understanding of science and mathematics in the past, first in the history of mathematics, and more recently in the history of science.¹⁰

⁸Kennedy, "Survey of Islamic Astronomical Tables," 123.

⁹King and Samso, "Astronomical Handbooks and Tables," 15.

¹⁰Writing on the history of mechanics, Bertoloni Meli for example writes that "Over the last few decades, however, historians of mathematics have produced innovative and historically sensitive works that have changed our understanding of the discipline and its methods. Only comparatively recently has the practice of translating seventeenth-century works into modern notation become unacceptable, for example. We are therefore in a much better position than previous historians in having this new and sophisticated literature at our disposal" (Domenico Bertoloni



As I will elaborate further in the second part of this article, the text of *Al-zīj al-jadīd* is presented as a mere container or a conveyor of factual information. Thus the study of *zījes* fits in a wider tradition of the history of science in the Islamicate world where the tendency towards the historical contextualization of scientific practices was not as strong as was the case for the history of science in Europe.¹¹

Of course, there are some important exceptions to this rule. It would be unfair to neglect important publications like those of A. I. Sabra, which, from the eighties on, questioned the narrative of studying scientific practices without regard to their contexts. In his seminal article “The Appropriation and Subsequent Naturalization of Greek Science in Medieval Islam: A Preliminary Statement”¹² Sabra questions what he calls the “kinematic account” of the transmission of science, according to which knowledge can be transmitted from one society or culture to another without being affected by this transmission. Without contextualization, Sabra argues, this account of knowledge transmission leads to reductionism and precursorism. Two later works inspired and influenced by Sabra’s writings are Kaveh Niazi’s *Quṭb al-Dīn Shīrāzī and the Configuration of the Heavens*, in which the author situates the work of astronomer Quṭb al-Dīn al-Shīrāzī in the Persian tradition of astrology in service of the Ilkhanid leader,¹³ and Nahyan Fancy’s *Science and Religion in Mamluk Egypt: Ibn al-Nafis, Pulmonary Transit and Bodily Resurrection*,¹⁴ in which the author places his work in the tradition of Sabra by the title of the first chapter: “Towards a Contextualist Approach.”¹⁵ However impor-

Meli, *Thinking with Objects: The Transformation of Mechanics in the Seventeenth Century* [Baltimore, 2006], 9). For a general discussion of the problematic nature of translating to contemporary notation in the history of mathematics, and a view of the history of mathematics which has some affinity with the material approach outlined in this paper, see: Jacqueline Stedall, *The History of Mathematics: A Very Short Introduction* (Oxford, 2012), 32–48; 107–12.

¹¹E.g., John Henry, *The Scientific Revolution and the Origins of Modern Science* (London, 2008); Steven Shapin, “Placing the View from Nowhere: Historical and Sociological Problems in the Location of Science,” *Transactions of the Institute of British Geographers* 1, no. 23 (1998): 5–12; David Livingstone, *Putting Science in Its Place* (Chicago, 2003); Mario Biagioli, *Galileo Courtier: The Practice of Science in the Culture of Absolutism* (Chicago and London, 1993). These studies, among others, explicitly engage with the internalism-externalism debate in the history of science, favoring the latter over the former in different gradations and for different reasons. These debates were mostly (though not entirely—cf. notes 13, 14, 15, 16, 17) absent in contemporary history of science in Islamicate societies.

¹²A. I. Sabra, “The Appropriation and Subsequent Naturalization of Greek Science in Medieval Islam: A Preliminary Statement,” *History of Science* 25 (1987): 223–43.

¹³Kaveh Niazi, *Quṭb al-Dīn Shīrāzī and the Configuration of the Heavens: A Comparison of Texts and Models* (Berkeley, 2014).

¹⁴Nahyan Fancy, *Science and Religion in Mamluk Egypt: Ibn Al-Nafis, Pulmonary Transit and Bodily Resurrection* (New York, 2013).

¹⁵*Ibid.*, 1–15.



tant such publications are, they are relatively few. Studies on *zījes* still bear witness to a linear vision of progress through history that sees science as a universal project independent of its historical context.¹⁶

Studies on Ibn al-Shāṭir

When science is considered to be independent of its context, the authors of scientific texts tend to be presented as geniuses or inventors rather than as human citizens part of society. This is no less true for studies on Ibn al-Shāṭir. The most important study focusing on Ibn al-Shāṭir as a scholar was conducted by Edward Kennedy and Imad Ghanem.¹⁷ In studies on the person of Ibn al-Shāṭir, *Al-zīj al-jadīd* is discussed on the basis of this specific manuscript. However, studies that focus on Ibn al-Shāṭir generally do not consider the *Zīj* to be one of the most interesting texts he wrote. Instead, they consider it to be the practical appendix to his theoretical work on planetary theory. This strict distinction between theory and practice, and the corresponding hierarchy, can be seen as a product of the same kind of idealism that I will argue is at play in the idealist opposition between content and material carrier. I will discuss this further in the next section of this article.

The Materiality of Texts: Beyond the Content-Carrier Dichotomy

Earlier Studies: Idealism and the Content-Carrier Dichotomy

Idealism

By studying this text as just another one of the *zījes* written in the Islamicate world between the ninth and the sixteenth centuries, we downplay its particularities: the people who wrote and used it, the context of the practices in which it was used. In other words, the particular nature of the material manuscript and the context in which it was used is not considered to be of direct relevance for an understanding of the scientific treatise. As such, studies thus bear witness

¹⁶Sonja Brentjes makes the interesting remark that one of the reasons for this is that most research on the subject was carried out by academics with a background in philology or mathematics who had a supplementary interest or education in oriental studies. They felt, she states, “deeply attached to the style of Otto Neugebauer which concentrated on identifying the scientific contents while ignoring most of its context.” Sonja Brentjes, “Between Doubts and Certainties: On the Place of History of Science in Islamic Societies within the Field of History of Science,” *NTM International Journal of History & Ethics of Natural Sciences, Technology & Medicine* 11 (2003): 65–79.

¹⁷E. S. Kennedy and Imad Ghanem, eds., *The Life & Work of Ibn al-Shāṭir, an Arab Astronomer of the Fourteenth Century* (Aleppo, 1976).



to a view of science as one universal project untouched by local conditions and their specific material characteristics. In these studies the history of science is framed as essentially a history of the development of abstract theories and concepts. Therefore, I will call this approach an idealist view of scientific knowledge. Such an approach would not be a problem if we accept that scientific knowledge is not affected by the time and place in which it developed. Science is treated as a universal project untouched by local conditions. If scientific knowledge bears the marks of circumstances and if results differ from place to place, this must mean that there is something wrong and that someone has made a mistake. Science is considered to be a collective term for a set of universal ideas that are discovered, an immaterial conceptual field that represents the natural world in its theories. From this point of view, it is no problem that the contextual particularities of the *zījes* have not been covered, because they simply do not matter.

In recent decades, however, this view has been widely questioned in research on the history of science.¹⁸ By studying the concrete historical circumstances in which, and the particular people by whom, science was practiced, several studies have stated that the history of science is not a mere history of theories and concepts but a history of scientists and their practices. These practices are embodied and recreated in the work of real people who are situated in a specific society and whose activities depend on specific instruments and materials. If we acknowledge this, then the idealist view sketched above becomes problematic and can at best provide a very impoverished understanding of scientific practices in the past.¹⁹ Thus stated, the wide generalizations and the absence of contextualization in the works on *zījes* written by Kennedy, King, and Samsó are symptomatic of an idealist view of scientific knowledge.

Text: The Content-Carrier Dichotomy

This idealist view of scientific knowledge is tied to a corresponding dichotomy between scientific knowledge and scientific texts. If scientific knowledge is universal, immaterial, and independent of its context, then scientific texts are particular, material instances of these universal ideas. This is reflected in the divide between the content and carrier of a text, where the content is universal science and the paper and ink are the particular, local carriers of it. Thus, ideas are writ-

¹⁸Although not as much in the discipline of the history of science in Islamicate societies as it is the case in the history of science in Europe and America. (See also note 11.)

¹⁹E.g., Henry, *The Scientific Revolution*; Shapin, "Placing the View from Nowhere"; Livingstone, *Putting Science in Its Place*. Or specifically for the Islamicate world: A. I. Sabra, "Situating Arabic Science: Locality versus Essence," *Isis* 87 (1996): 654–70; Sonja Brentjes, "The Prison of Categories: 'Decline' and Its Company," in *Islamic Philosophy, Science, Culture, and Religion: Studies in Honor of Dimitri Gutas*, ed. David Reisman and Felicitas Opwis (Leiden, 2011), 131–56.



ten down on material carriers by people in social contexts, but their epistemological content is considered to be clearly distinguishable from the material and social uses of their writers and material carriers. Texts are the dead material that contain ideal content or information.²⁰ The distinction between the material aspect of a text (“the container”) and its ideal discursive content (“the information”) is not only present in studies of the history of science, it is a dichotomy anchored deeply and firmly in any research on textual sources. In spite of its naturalness to us, this dichotomy leads to a lot of problems, which has led several voices in recent research to reject it and to look at texts in a different way. One of those voices is Karine Chemla, a historian of science who states that the problems with this distinction are manifold. First, a satisfactory, all-embracing, and unique definition of the “content” of a text can never be given. Interpretation always depends on who is reading or writing the text and in which circumstances. The meaning of a text, she states, always depends on its particular use and is not contained in an invariable ideal content. Furthermore, texts are always written in the process of carrying out intellectual activities: writing is a constitutive part of these activities and an essential condition for the research done.²¹ As such, texts are “*discursive artifacts*”: documented statements that come from somewhere and have certain agendas rather than being mere containers or conveyors of facts, of epistemic content or propositions. Frohmann states that when we shift our focus from conceiving science as cognitive processes to a view that takes into account labor processes or practices, this reveals scientific work as a construction of localized assemblages of things, persons, devices, social relations, and discursive objects.²² For similar reasons, Chemla rejects the presupposition that “once concepts, results or theories have been obtained by other ways, in an immaterial space, they are merely transcribed in a textual form that remains indifferent to them.”²³ In contrast to this she argues that texts are artifacts, elaborated in the course of the practice to which they belonged.²⁴ Thus Chemla’s view of texts corresponds to a tradition of scholars who reject the idea of (scientific) knowledge as an immaterial collection of theories that represent the natural world, and instead argue that it is

²⁰Frohmann, *Deflating Information*, 13.

²¹Chemla, *History of Science*, viii–ix.

²²Frohmann, *Deflating Information*, 100. Frohmann draws on insights from Bruno Latour’s work on actor-network theory. Latour uses the term “assemblages” to denote networks that are held together by a limited amount of heterogeneous forms of ordering (actants or actor-networks) that provisionally assemble, without there being any larger overall order. Latour has a view of knowledge and materiality similar to the studies discussed here. However, I cannot go into the details of how this relates to actor-network theory within the limits of this article. Bruno Latour, *Reassembling the Social: An Introduction to Actor-Network-Theory* (Oxford, 2005), 1–17.

²³Chemla, *History of Science*, viii.

²⁴Ibid.



always embodied. Knowledge is not something that can be possessed by a human being or a material bearer, but it is rather the process by which human beings interact with material reality.²⁵ A text is a material tool rather than a container of immaterial ideas.

Implications of This View on the Study of *Al-Zīj al-Jadīd*

If we acknowledge that texts are more than mere containers of epistemic content and pay attention to the hitherto neglected “complex circuits in which documents travel and their equally complex and varied effects,”²⁶ then several features of *Al-zīj al-jadīd* need to be studied more thoroughly than has been done in earlier research. In this article, I will use the following two sources to discuss the use of the text. On the one hand I will look at paratextual traces on the manuscript itself, which provide evidence of its use, and on the other hand I will look at biographical dictionaries for information about the scholars among whom this text circulated. Previous studies have not taken these paratexts nor these biographical dictionaries into account because of their focus on the technical content. However, when we acknowledge that a text always acquires meaning within a specific practice, paratextual and intertextual material provides us with crucial information on the meaning of the text. The front page of this *zīj*, for example, contains notes about its writer and copyist as well as the people who possessed and used it. In the biographical dictionary of Shams al-Dīn Muḥammad al-Sakhāwī (d. 902/1497), the author refers to the copyist mentioned on this front page. If we consider texts as parts of the practices in which they were used, then we have to take a look at other genres of texts that were part of those practices in everyday life too. The study of dictionaries that refer to scientific texts and their writers is therefore a prerequisite for the understanding of the practice of timekeeping rather than a gratuitous appendix to the more serious study of the scientific texts. Moreover, as Stephen Humphreys and Michael Chamberlain have argued, biographical dictionaries provide a very interesting source of information if they are not used in a vacuum, as a source for information on one specific individual.²⁷ Chamberlain even argued that these sources do not merely provide us with a description of the writer’s context and interpretation of history, but enable us to understand what their writers considered “the useful” past, that is “a past that was intended to secure their futures.”²⁸

²⁵Livingstone, *Putting Science in Its Place*, 17–20; Frohmann, *Deflating Information*, 11.

²⁶Frohmann, *Deflating Information*, 11.

²⁷R. Stephen Humphreys, *Islamic History: A Framework for Inquiry*, rev. ed. (London and New York, 2009), 191–92.

²⁸Michael Chamberlain, *Knowledge and Social Practice in Medieval Damascus, 1190–1350*, Cambridge Studies in Islamic Civilization (Cambridge, 2002), 19–20.



In the next section of this article I will show how, when we take both the paratextual and the intertextual source material into account, this text can be seen not just as an astronomical, but also as a didactical and a social instrument in the context of fifteenth-century timekeeping in Cairo.

Material Approach: *Al-Zīj al-Jadīd* as an Instrument

The *Zīj* as an Astronomical Instrument

As a work containing tables for timekeeping, the context in which *Al-zīj al-jadīd* circulated was that of Islamic timekeepers/astronomers. Previous studies only reference this by acknowledging Ibn al-Shāṭir as the author of the text. As was mentioned in the first part of this article, his social background has not been studied. Ibn al-Shāṭir is, however, not the only—and maybe not even the most important—scholar connected to this work. On the front page of this text, Ibn al-Shāṭir is indeed mentioned as the author, but he must have already been dead at the time the manuscript was written. Further notes on the front page of the manuscript reveal that this work was actually possessed and used by a certain ‘Abd al-‘Azīz al-Wafā’ī (d. ca. 875/1471). A first note says “*malaka hādhā al-zīj al-[ms corrupt] ‘Abd al-‘Azīz al-Wafā’ī al-muwaqqit [ms corrupt]*” (The [...] *muwaqqit* ‘Abd al-‘Azīz al-Wafā’ī owned this [...] *zīj*). On the first page of the introduction this is repeated in the same handwriting in a marginal note reading “*hādhā khaṭṭ al-Wafā’ī*” (this is the handwriting of al-Wafā’ī), alongside the note “*naqalat hādhihi al-nuskah min musawwadat ‘Alā’ al-Dīn*” (This version is transmitted from the draft text²⁹ of ‘Alā’ al-Dīn),³⁰ ‘Alā’ al-Dīn referring to Ibn al-Shāṭir. Al-Wafā’ī was a well-known astronomer and *muwaqqit* who lived in fifteenth-century Cairo shortly after the death of Ibn al-Shāṭir in 777/1375. A more extensive note on the title page of the manuscript tells us more about the scholarly network this scholar and *zīj* were part of:

*Ra’aytu bi-khaṭṭ al-‘alāmah Shams al-Dīn Muḥammad Ibn Abī al-Faḥ al-Ṣūfī ‘alā zuhr kitāb ta’līfihī wa-huwa bi-khaṭṭihī mā ṣawwartuhu, nazartu fī zīj li-Ibn al-Shāṭir samāhu Nihāyat al-ghāyāt fī al-‘māl al-falakīyāt wa-wasamahu bi-khidmat al-maqarr al-Sayfī Tankīz kāfil al-mamlakah al-shāmīyah.*³¹

²⁹I follow Adam Gacek’s vademecum for Arabic manuscripts in translating *musawwadah* as a draft. A *musawwadah* or draft is a first version of the text that the writer has not yet finished and/or authorized, in contrast to a fair copy or *mubayyadah* that has been authorized by the author. Adam Gacek, *Arabic Manuscripts: A Vademecum for Readers* (Leiden/Boston, 2009), 15, 94.

³⁰Ibn al-Shāṭir, “Kitāb al-zīj,” fol. 1b.

³¹Ibid., fol. 1a.



(I [i.e., al-Wafāʿī] saw in the handwriting of the very learned Shams al-Dīn Muḥammad Ibn Abī al-Faṭḥ al-Ṣūfī on the back of the book of his own composition, that was in his own handwriting, [a note] that I am copying here: I [i.e., Shams al-Dīn Abī al-Faṭḥ al-Ṣūfī] examined a *zīj* by Ibn al-Shāṭir, which he entitled *Nihāyat al-ghāyāt fī al-aʿmāl al-falakīyāt* and which he marked as in the service of the noble al-Sayfī Tankīz, viceroy of the Syrian realm.)

Thus, the front pages provide us with very straightforward information about the use and circulation of this text. The scholar who used this manuscript was a certain ʿAbd al-ʿAzīz al-Wafāʿī, a *muwaqqit* who lived and worked in Cairo.³² Al-Wafāʿī relied on the writings of Shams al-Dīn Muḥammad Ibn Abī al-Faṭḥ al-Ṣūfī (d. ca. 899/1494), another famous fifteenth-century timekeeper/astronomer, on an earlier *zīj* written by Ibn al-Shāṭir titled *Nihāyat al-ghāyāt fī al-aʿmāl al-falakīyāt*, of which no manuscript is known to have survived. As such, the use and meaning of this text cannot be considered merely as a collection of calculated data resulting from the theoretical works of Ibn al-Shāṭir, as it was not used in the context of fourteenth-century Damascus but rather in fifteenth-century Cairo. (Fig. 1)

The biographical dictionary *Al-dawʿ al-lāmiʿ fī aʿyān al-qarn al-tāsiʿ* of these scholars' contemporary, al-Sakhāwī, who also lived in Cairo, provides us with further information on the names of the timekeepers mentioned here. They were neither unimportant nor unknown among their contemporaries, and their social network can be reconstructed as shown in Figure 2. Shams al-Dīn Abū ʿAbd Allāh Muḥammad Ibn Abī al-Faṭḥ al-Ṣūfī (d. ca. 899/1494) was a timekeeper who was well known among his contemporary scholars. He also wrote a famous *zīj* himself, titled *Zīj al-Ṣūfī*, which is a recension for Egypt of the Timurid *zīj* compiled for Ulugh Beg.³³ ʿAbd al-ʿAzīz al-Wafāʿī was a student of another well-known and important timekeeper, Shihāb al-Dīn Abū al-ʿAbbās Aḥmad ibn Rajab ibn Taybughā Ibn al-Majdī (d. 850/1447). The latter was a student of Sibṭ al-Maridānī, who was in turn a student of Ibn al-Shāṭir himself.³⁴

³²David A. King, *In Synchrony with the Heavens: Studies in Astronomical Timekeeping and Instrumentation in Medieval Islamic Civilization*, vol. 1, *The Call of the Muezzin* (Leiden/Boston, 2014), 136; Muḥammad ibn ʿAbd al-Raḥmān al-Sakhāwī, “ʿAbd Al-Azīz ibn Muḥammad ibn Muḥammad al-Wafāʿī al-ʿIzz Abū al-Faḍl wa-Abū al-Fawāʿid,” no. 539, *Al-dawʿ al-lāmiʿ li-ahl al-qarn al-tāsiʿ* (Beirut, 2004), 2:348.

³³İhsan Fazlıoğlu, “Ibn Abī al-Faṭḥ al-Ṣūfī: Shams al-Dīn Abū ʿAbd Allāh Muḥammad Ibn Abī al-Faṭḥ al-Ṣūfī,” in *The Biographical Encyclopedia of Astronomers*, ed. Thomas Hockey (New York, 2007), 547.

³⁴François Charette, “Ibn al-Majdī: Shihāb al-Dīn Abū al-ʿAbbās Aḥmad Ibn Rajab Ibn Taybughā al-Majdī al-Shāfiʿī,” in *The Biographical Encyclopedia of Astronomers*, 561–62.



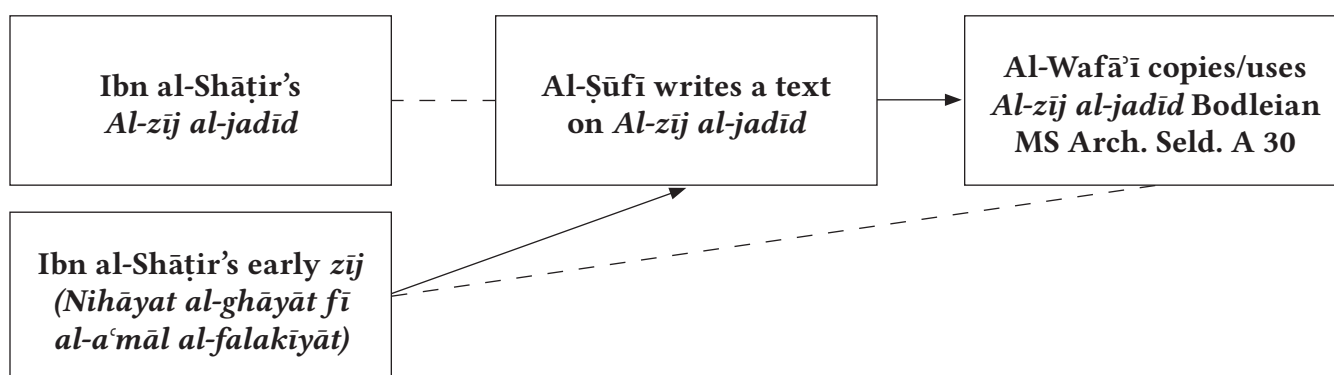


Figure 1. Scholars related to the transmission of this manuscript as mentioned in the marginal notes.

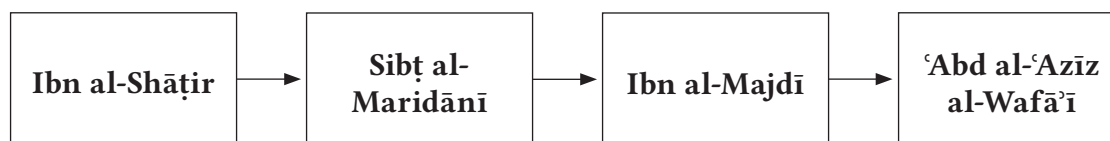


Figure 2. Scholars related to the possessor/user of the manuscript.

Al-Wafāʿī was a *muwaqqit* who manufactured and owned a lot of instruments³⁵ and who wrote several didactical works on the use of instruments. Al-Sakhāwī mentions the *muwaqqits* Ibn al-Majdī and Nūr al-Dīn al-Naqqāsh (d. ca. mid-ninth/fifteenth century) as the two teachers with whom al-Wafāʿī studied *ʿilm al-mīqāt*. Both of them were also instrument makers.³⁶ When we consider the *zīj* among those instruments and treatises on instruments, the question arises to what extent these texts can be studied as the discursive counterpart of the astronomical instruments these scholars made. On a related note, all the *muwaqqits* mentioned, including Ibn al-Shāṭir himself, had a background in or close relations to families of craftsmen.³⁷

According to al-Sakhāwī, al-Wafāʿī had lodgings in the Muʿayyadīyah mosque, where he worked as a *muwaqqit*.³⁸ As Michael Chamberlain pointed out in his

³⁵We know he owned a lot of instruments because his name was engraved on several surviving instruments and because he wrote texts on the use of these instruments. King, *In Synchrony with the Heavens*, 94–100.

³⁶Al-Sakhāwī, “Al-Wafāʿī,” 348. Ekmeleddin Ihsanoglu and Boris Rosenfeld, *Mathematicians, Astronomers and Other Scholars of Islamic Civilisation and Their Works (7th–19th C.)* (Istanbul, 2003).

³⁷Ṣalāḥ al-Dīn Khalīl ibn Aybak al-Ṣafadī, “Alāʾ al-Dīn Ibn al-Shāṭir,” no. 270, *Kitāb al-wāfī bi-al-wafāyāt* (Wiesbaden, 1962), 20:301–7. Charette, “Ibn al-Majdī,” 561–62.

³⁸Al-Sakhāwī, “Al-Wafāʿī,” 348.



study on Damascus, holding a *manṣab* or an office in a religious institution, thus being paid via the *waqf* system, was a widespread practice that nonetheless suffered a great deal of criticism from certain groups of scholars. In particular, the use of the lodging facilities of such an institution was considered below the standards of a good scholar by several scholarly families.³⁹ Scholars from wealthy scholarly families generally did not live in religious institutions, even if they worked in them.⁴⁰ The indirect support from the political elite was seen as a corrupting influence on their intellectual work. Some scholars working in religious institutions even enjoyed direct support from the political elite, like Ibn al-Majdī, one of al-Wafāʿī's teachers, who was appointed *muwaqqit* and head of the teachers at the Jānibakīyah madrasah directly by Sultan al-Ashraf Barsbāy.⁴¹

In an earlier study I have linked the ambiguous attitude towards the *manṣab* of the *muwaqqit* in particular to the fact that many of the *muwaqqits* had grown up in artisans' families or at least had several artisans in the networks of people around them.⁴² Konrad Hirschler describes how the fourteenth-century Mamluk Sultanate witnessed a growing upward social mobility. I consider the people who held the function of *muwaqqit* and came from families or networks of artisans as exemplary for this process.⁴³ *Muwaqqits* often built their own instruments and wrote didactical treatises on their use.⁴⁴ Al-Wafāʿī fits perfectly into this pattern. While we do not know anything about his social background, it seems reasonable to assume that he was not part of a very wealthy scholarly family, as he used the lodgings of the Muʿayyadīyah. Moreover, none of his family members are mentioned as well-known scholars in al-Sakhāwī's entry on him.⁴⁵

³⁹Chamberlain, *Knowledge and Social Practice*, 69–90.

⁴⁰Ibid., 67.

⁴¹Al-Sakhāwī, "Al-Wafāʿī," 348. Sonja Brentjes, "Shams al-Dīn al-Sakhāwī on *Muwaqqits*, *Muʾadhdhins*, and the Teachers of Various Astronomical Disciplines in Mamluk Cities in the Fifteenth Century," in *A Shared Legacy: Islamic Science East and West*, ed. Emilia Calvo, Merce Comes, and Rius Monica (Barcelona, 2008), 133.

⁴²Fien De Block, "De Muwaqqit in 14de Eeuws Syrië En Egypte: Tussen Religieus Geleerde En Wetenschapper?" *De Handelingen* 69 (2016): 210–11.

⁴³Konrad Hirschler, *The Written Word in the Medieval Arabic Lands: A Social and Cultural History of Reading Practices* (Edinburgh, 2012), 22–25.

⁴⁴One of these didactical works on instruments is for example studied by François Charette in his work *Mathematical Instrumentation in Fourteenth-Century Egypt and Syria*. However, a lot of work remains to be done on this topic. All the *muwaqqits* mentioned in this paper have for example also written didactical treatises on instruments. A thorough study of the materiality of these sources and their use in relation to the non-discursive astronomical instruments used in this period would provide us with interesting insights on the practice of timekeeping. François Charette, *Mathematical Instrumentation in Fourteenth-Century Egypt and Syria* (Leiden, 2003).

⁴⁵Al-Sakhāwī, "Al-Wafāʿī," 348.



The *Zīj* as a Didactical Instrument

Closely related to this is al-Wafā'ī's role in the educational network of early fifteenth-century Cairo. Al-Sakhāwī mentions that al-Wafā'ī became the *muwaqqit* not only of the Mu'ayyadiyah mosque, but also of the mosque of al-Maridānī and of the Azhar mosque.⁴⁶ Many of the works al-Wafā'ī wrote are didactical treatises on the use of astronomical instruments. Thus, to fully understand this *zīj*, I argue that we also have to study it as a didactical tool, a sort of exemplar for students of *'ilm al-mīqāt*. When we look at the work in this way, several interesting features stand out. First, in every chapter al-Wafā'ī explains how to calculate certain unknown values on the basis of every other possible known value. The recurrent structure of his argument is "If you know [this value], then add/multiply [that second value] to/with this to arrive at a third value, but if you know this third value already then subtract/divide the second value from/by this value to arrive at the first one." Moreover, as Sonja Brentjes has pointed out, biographical dictionaries of these periods reveal that most of the *muwaqqits* in this period also worked as a teacher or *mudarris*.⁴⁷

When we consider this work as a didactical tool, the fact that the values of its tables are calculated for Damascus and not for Cairo in particular could be interpreted as a way of teaching timekeeping students how to recalculate these values for their own locations.⁴⁸ The values in the work were calculated for a terrestrial latitude of 33°30', which is equivalent to the latitude of Damascus. The ascension tables (the tables of the rising times) in the work are all calculated on the basis of this value.⁴⁹ Whereas it was not unusual that *zīj*es calculated for other latitudes were used in new places, because an astronomer can always recalculate the data for another location, looking at them as didactical tools may help us to get a better understanding of the meaning of these sources.

The *Zīj* as a Social Instrument

Furthermore, I also argue that this *zīj* was used as a social instrument; that is, as a text with which certain scholars acquainted themselves in order to gain status and authority in society. According to al-Sakhāwī, al-Wafā'ī not only worked in

⁴⁶Ibid.

⁴⁷Brentjes, "Al-Sakhāwī on *Muwaqqits*," 129–50.

⁴⁸Kennedy states that the tables in this manuscript "have been computed on the basis of observations taken in Damascus, not in Cairo, as reported in some sources." Kennedy, "Survey of Islamic Astronomical Tables," 123–77. This is confirmed by a marginal note on the title page of the manuscript in which it is indicated that the observations for this work have been carried out in Damascus (Ibn al-Shāṭir, "Kitāb al-zīj," fol. 1a).

⁴⁹Kennedy, "Survey of Islamic Astronomical Tables," 163.



the Mu'ayyadiyah as a *muwaqqit*, but he also lodged there.⁵⁰ Criticism of scholars who were paid via *waqfs* or housed in religious institutions was mentioned above and is relevant in this context as well. The use of the *zīj* as a social instrument can be linked to the process of upward social mobility discussed above.⁵¹ For a scholar from an artisans' background, to have copied and possess a *zīj* may have provided him with social status and authority within the scholarly elite.

Another thing which appears relevant in this context is the extensive line of scholars that are quoted at the beginning of the work as predecessors in the field. In the introduction, several well-known scholars are mentioned, among them al-Majritī, Ibn al-Walīd al-Maghribī, Ibn al-Haytham, Naṣīr al-Dīn al-Ṭūsī, al-Mu'ayyad al-ʿUrdī, al-Quṭb al-Shīrāzī, and Ibn Shukr al-Maghribī.⁵² There is no reference to any of these scholars' works; only their names are mentioned, making Ibn al-Shāṭir the terminus of this chain of knowledge transmission. Al-Wafāʿī, who used the manuscript, is added in the margin as a later inheritor of this text.

In this way the linear transmission of knowledge from one scholar to another, without attention to the different contexts that we find in the studies of Kennedy and King, is instigated by the author of the work himself: he wants to give the reader the impression that this work is part of a great tradition and to benefit from its honor and status to ameliorate his own position and status in society. This must be understood within the context of what we know about educational practices in Mamluk Cairo. Jonathan Berkey's work on this subject has highlighted how education in the Mamluk Sultanate was based on individuals, on a personal relationship between teacher and student, rather than on institutions. By studying with a certain teacher and receiving an *ijāzah* or diploma from him, part of the authority and status of the teacher was transmitted to the scholar.⁵³ If we look at the scheme of transmission of the manuscript, taking into account this transmission of authority, then the use of a fourteenth-century manual whose writer had already earned his position in society is a logical choice for augmenting one's own authority and status in society.

Conclusion

In this article I discussed an early fifteenth-century manuscript of Ibn al-Shāṭir's *Kitāb al-zīj al-jadīd*.⁵⁴ While this manuscript has always been presented as one of

⁵⁰ Al-Sakhāwī, "Al-Wafāʿī," 348.

⁵¹ Hirschler, *The Written Word*, 22–25.

⁵² Ibn al-Shāṭir, "Kitāb al-zīj," fol. 2a.

⁵³ Jonathan P. Berkey, *The Transmission of Knowledge in Medieval Cairo: A Social History of Islamic Education*, Princeton Legacy Library (Princeton, 1992), 20–25.

⁵⁴ Ibn al-Shāṭir, "Kitāb al-zīj."



the many extant *zīj*es in the Islamic world and has thus been conceived as a container of data needed to solve standard problems in timekeeping, I have argued that a material approach to this text provides us with interesting insights into its use and meaning. Instead of a collection of data written down by a *muwaqqit* in fourteenth-century Damascus, a material approach reveals the way this text functioned as an important tool in fifteenth-century Cairo, where it was used and transmitted among a network of reputable scholars with a background in artisans' families. If we look at the text as a discursive artifact, with attention to its background, use, and role in specific practices in society, then it proves to have been actively used as an instrument in astronomical but also in didactic and social practices. Looking at the *zīj* in this way makes it clear that the transmission of scientific texts like this consisted of more than the passive reception of the invariable content of a text. It is rather a discursive act, a practice. This is not only the case for this text, but for all scientific texts from this period. Therefore, studying these sources as *actively (re)used* material parts of practices, rather than invariable and passive theoretical standard works *resulting from* practices, will open new avenues for research on timekeeping and allow interesting new insights into not only how a tradition of timekeeping was maintained but also into how it changed throughout this period.



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DOI: [10.6082/1aqn-6g50](https://doi.org/10.6082/1aqn-6g50). (<https://doi.org/10.6082/1aqn-6g50>)

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