CORRECTING PTOLEMY AND ARISTOTLE

IBN AL-ṢALĀḤ ON MISTAKES IN THE *ALMAGEST*, *ON THE HEAVENS*, AND *POSTERIOR ANALYTICS*

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Abstract. The polymath Ibn al-Ṣalāḥ (d. 1154 CE) is known for a number of comparatively small treatises on specific aspects of ancient Greek mathematical and philosophical works. He devotes many of his works to greater or smaller errors that he found in the works by Euclid, Ptolemy, and Aristotle. The aim of the present paper, which focuses on three treatises on Ptolemy and Aristotle, is to describe Ibn al-Ṣalāḥ's method and aim in these works. I argue that his treatises on the *Almagest*, *On the Heavens*, and *Posterior Analytics* follow a similar structure and that there is much value for modern research resulting from the bibliographical details provided by Ibn al-Ṣalāḥ. To give but just one example, Ibn al-Ṣalāḥ attests to the existence of a so far unknown Arabic translation of Aristotle's *Posterior Analytics*. In this way, this paper is the first to establish Ibn al-Ṣalāḥ's research profile: his works tell us which sources were available to scholars active in Baghdad and Damascus in the 12th century CE and how he tried to resolve contradictions from the different versions of authoritative texts. Thus, this paper enhances our knowledge of the Graeco-Arabic transmission of scientific and philosophical texts.

Résumé. Le savant Ibn al-Ṣalāḥ (m. 1154) est connu pour ses petits traités portant sur des questions particulières d'ouvrages mathématiques et philosophiques grecs. Il consacre plusieurs de ses travaux aux erreurs, plus ou moins importantes, qu'il trouve dans les travaux d'Euclide, de Ptolémée et d'Aristote. Le but de cet article, qui se concentre sur trois traités de Ptolémée et d'Aristote, est de décrire la méthode d'Ibn al-Ṣalāḥ et les objectifs qu'il poursuit dans les traités en question. Je suggère que ses traités sur l'*Almageste*, le *Traité du ciel* et les *Seconds analytiques* suivent une structure semblable et qu'ils sont d'une grande valeur pour la recherche moderne en raison des éléments bibliographiques fournis par Ibn al-Ṣalāḥ. Pour ne citer qu'un exemple, Ibn al-Ṣalāḥ atteste de l'existence d'une traduction arabe des *Seconds analytiques* d'Aristote inconnue jusqu'ici. Cet article établit ainsi pour la première fois le profil de savant d'Ibn al-Ṣalāḥ : ses travaux nous disent quelles sources étaient disponibles aux savants actifs à Bagdad et Damas au XIIᵉ siècle et comment il a tenté de résoudre les contradictions entre les différentes versions des textes faisant autorité. Cet article offre donc une contribution à notre connaissance de la transmission gréco-arabe des textes scientifiques et philosophiques.

1. INTRODUCTION

Of Ibn al-Ṣalāḥ's life, we only have some basic information. His full name was Abū l-Futūḥ Aḥmad ibn Muḥammad ibn al-Sarī (sometimes in older literature: al-Surā) Naǧm al-Dīn. After living in Baghdad, Mardīn, and also Marāġa at an unknown point, he later in his life moved to Damascus where he died around 1154 CE. Curiously, we have nearly no evidence from medieval biographers concerning his scholarly output, except for al-Qifṭī's general account that Ibn al-Ṣalāḥ worked on logic, mathematics, and medicine and wrote "commentaries" (ḥawāšī) of remarkable quality. In addition, Ibn Abī Uṣaybiʿa provides a list of just two works.[1] Of these two works, only one is extant, namely a critical assessment of the fourth figure of the syllogism ascribed to Galen, which was edited and translated by Nicholas Rescher.[2] There are, neverthe-less, in total at least 17 works by Ibn al-Ṣalāḥ extant today, all of them identified through their ascription to Ibn al-Ṣalāḥ in the manuscript tradition.[3] This means that it is quite possible that more works ascribed to him will appear in the future through the discovery and description of further manuscripts.

[1] For his life and works, see al-Qifṭī, *Taʾrīḫ al-ḥukamāʾ*, ed. Julius Lippert (Leipzig: Dieterichsche Verlagsbuchhandlung, 1903), p. 428:7-18; Ibn Abī Uṣaybiʿa, *ʿUyūn al-anbāʾ fī ṭabaqāt al-aṭibbāʾ*, ed. August Müller, 2 vol. (Cairo: al-Maṭbaʿa al-Wahbiyya, 1882; repr. Frankfurt, 1995), here vol. 2, p. 167:1-2; Heinrich Suter, *Die Mathe-matiker und Astronomen der Araber und ihre Werke* (Leipzig: Teubner, 1900), p. 120; Carl Brockelmann, *Geschichte der arabischen Litteratur. Erster Supplementband* (Leiden: Brill, 1937), p. 857; and Paul Kunitzsch's foreword in Ibn al-Ṣalāḥ, *Zur Kritik der Koordinatenüberlieferung im Sternkatalog des Almagest*, ed. and tr. Paul Kunitzsch (Göttingen: Vandenhoeck & Ruprecht, 1975), p. 13-14. His stay in Marāġa is testified by his own note of an observation he did there, unfortunately without providing a date, see Richard Lorch, "Ibn al-Ṣalāḥ's Treatise on Projection: a Pre-liminary Survey," in Menso Folkerts and Richard Lorch (eds.), *Sic itur ad astra. Studien zur Geschichte der Mathematik und Naturwissenschaften* (Wiesbaden: Har-rassowitz, 2000), p. 401-408, here p. 401.

[2] See Nicholas Rescher, *Galen and the Syllogism* (Hertford: University of Pittsburgh Press, 1966).

[3] For lists of his works, see Max Krause, "Stambuler Handschriften islamischer Math-ematiker," *Quellen und Studien zur Geschichte der Mathematik, Astronomie und Physik*, 3 (1936), p. 485-487; Boris A. Rosenfeld and Ekmelleddin İhsanoğlu, *Math-ematicians, Astronomers, and other Scholars of Islamic Civilization and their Works (7th-19th c.)* (Istanbul: Research Center for Islamic History, Art and Culture, 2003), p. 177-178; and most recently Johannes Thomann, "Al-Fārābīs Kommentar zum Al-magest in sekundärer Überlieferung bei Ibn aṣ-Ṣalāḥ. Ein vorläufiger Bericht," *Asi-atische Studien – Études asiatiques*, 69 (2015), p. 99-113, here p. 101-102. Johannes Thomann's list, which contains 16 treatises, lacks Ibn al-Ṣalāḥ's treatise on Aristo-tle's *Posterior Analytics* that I discuss in the present study.

Just such a discovery was made by Johannes Thomann, who confirmed that a manuscript in Mašhad, Iran, contains Ibn al-Ṣalāḥ's critique of a part of al-Fārābī's commentary on Ptolemy's *Almagest*.[4] As evidence for the ascription of the treatise to Ibn al-Ṣalāḥ (in addition to the name "Aḥmad ibn Muḥammad ibn Sarī" found in the beginning), Thomann writes that the "critical character of this treatise" fits to the other works ascribed to Ibn al-Ṣalāḥ.[5] Indeed, as Thomann points out,[6] Ibn al-Ṣalāḥ often attacks specific arguments from the mathematical, astronomical, and philosophical works by *the* Greek authorities *par excellence*, namely Euclid's *Elements*, Ptolemy's *Almagest*, and Aristotle's *On the Heavens* and *Posterior Analytics*, and their later Greek and Arabic commentators. Thomann is certainly right in assigning a "critical character" to Ibn al-Ṣalāḥ's extant corpus, in general. Further elaborating on this brief remark, the present paper aims at an investigation of Ibn al-Ṣalāḥ's scientific method and goal in his writings on mistakes or dubious passages that he found in those works. In the present paper, I focus on his two treatises on short passages from Aristotle's *On the Heavens* and *Posterior Analytics* and his more extensive work on the star catalogue from Books VII and VIII of the *Almagest*. I will argue that Ibn al-Ṣalāḥ follows a similar method in these three treatises, the most interesting part of which is a philological and bibliographical study: Ibn al-Ṣalāḥ is not content just to point out the main mistakes which led him to write this treatise in the first place, but also wishes to trace the origin of these mistakes. Since in the case of the *On the Heavens*, *Posterior Analytics*, and *Almagest* he deals with Arabic translations of originally Greek versions, sometimes through a Syriac mediator, he suspects that mistakes have entered the Arabic versions in the translation process and he thus engages in a comparison of the different versions available to him. This makes Ibn al-Ṣalāḥ an extremely important source for modern research on the Arabic translations of Greek works.[7] However, he does not even stop his investigation at that point, but further turns the readers' at-

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[4] See Thomann, "Al-Fārābīs Kommentar."

[5] Thomann, "Al-Fārābīs Kommentar," p. 104.

[6] Thomann, "Al-Fārābīs Kommentar," p. 101.

[7] In this way, his works have already been used, for example, by Paul Kunitzsch for the Arabic *Almagest*, see Paul Kunitzsch, *Der Almagest. Die Syntaxis Mathematica des Claudius Ptolemäus in arabisch-lateinischer Überlieferung* (Wiesbaden: Harrassowitz, 1974), p. 22-24, and by Gerhard Endress for the Arabic *On the Heavens*, see Gerhard Endress, "Ibn al-Ṭayyib's Arabic Version and Commentary of Aristotle's *On the Heavens*," *Studia graeco-arabica*, 7 (2017), p. 213-275, here p. 215-216 and 226-229.

tention to the way in which commentators before him, both Greek and Arabic, dealt with the problematic passages he attempts to correct. In this way, Ibn al-Ṣalāḥ directs his criticism also to towering figures in the history of philosophy and science, such as Themistius, Avicenna, Yaḥyā Ibn ʿAdī, al-Ṣūfī, and al-Bīrūnī, to name just a few. The present study investigates the similarities and differences concerning Ibn al-Ṣalāḥ's method and motive of these three treatises, with special emphasis on the way in which he expresses his critique and on his reasons for correcting these apparently minor flaws in the first place. The same results might also pertain to the (at least) five treatises that deal with Euclid's *Elements*. Since my focus in the present study lies on Ibn al-Ṣalāḥ's Aristotelian and Ptolemaic works, these still await future research.[8]

2. IBN AL-ṢALĀḤ ON THE *ALMAGEST*

The present study takes Ibn al-Ṣalāḥ's treatise on Ptolemy's star catalogue as the starting point because it is well accessible through Paul Kunitzsch's careful edition and German translation and thus offers a straightforward first impression of Ibn al-Ṣalāḥ's method in dealing with ancient authorities.[9] This work is extant through the following witnesses, all of which have been used by Kunitzsch:

• Istanbul, Topkapı Sarayı Müzesi, Ahmet III 3455, f. 82v-86v and 76r-v;
• Manisa, İl Halk Kütüphanesi (Genel), 1706, f. 211r-223v;
• Oxford, Bodleian Library, Thurston 3, f. 95r-99v;
• Oxford, Bodleian Library, Marsh 720, 177r-193v (directly copied from Thurston 3).

The treatise carries the following long title: "On the Reason for the Mistakes and Misspellings Occurring in the Tables of Book VII and VIII of the *Almagest* and on the Correction of What can be Corrected of Them."

Before I discuss the highly interesting introduction of this treatise, it

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[8] Only one of these has already been edited and translated, see Gregg de Young, "Ibn al-Sarī on *ex aequali* Ratios: His Critique of Ibn al-Haytham and His Attempt to Improve the Parallelism between Books V and VII of Euclid's *Elements*," *Zeitschrift für Geschichte der Arabisch-Islamischen Wissenschaften*, 9 (1994), p. 99-152. For another list of Ibn al-Ṣalāḥ's treatises on Euclid, see Fuat Sezgin, *Geschichte des arabischen Schrifttums. Band V. Mathematik bis ca. 430 H.* (Leiden: Brill, 1974), p. 110.

[9] Ibn al-Ṣalāḥ, *Zur Kritik der Koordinatenüberlieferung*. For descriptions of the manuscripts, see Ibn al-Ṣalāḥ, *Zur Kritik der Koordinatenüberlieferung*, p. 27-33.

is important to stress that the extant versions are not the original one by Ibn al-Ṣalāḥ himself. Instead, we only have an abridged version by Quṭb al-Dīn al-Šīrāzī as is reported in the colophon of three of the four witnesses (the exception being Genel 1706; nevertheless, the main text is, generally speaking, not different):

> This is the end of what we have found of the discussion by Aḥmad ibn Muḥammad ibn al-Sarī on the fixed stars in his own hand. Maḥmūd ibn Masʿūd ibn al-Muṣliḥ al-Mutaṭabbib al-Šīrāzī, being God's creature in the greatest need of Him, may God let his works prosper, wrote these notes (*fawāʾid*) ascribed to Aḥmad ibn Muḥammad ibn al-Sarī and, for the sake of avoiding great length, he abridged [Ibn al-Ṣalāḥ's] expressions (*iḫtaṣara alfāẓa-hū*). Now, this should be known and fair-minded people [may] accept the excuse.[10]

Unfortunately, al-Šīrāzī does not specify which passages or arguments of the treatise he shortened or whether he omitted a specific part altogether. At present, we are not in a position to reconstruct Ibn al-Ṣalāḥ's original version. Nevertheless, it seems probable that al-Šīrāzī did not change too much in the introduction because it is still very exhaustive. It constitutes roughly a third of the entire extant text and it strictly follows a coherent train of thought leading to the detailed discussion of mistaken star positions. Al-Šīrāzī states in the colophon cited above that he copied his abridgment directly from an autograph by Ibn al-Ṣalāḥ. Therefore, even if al-Šīrāzī did abridge a couple of passages there, one can still be confident that this is an accurate report of Ibn al-Ṣalāḥ's argument.

There is yet another important thing to learn from al-Šīrāzī's role in the transmission of the text. As already outlined by Max Krause in his description of Ahmet III 3455, most of it was written by al-Šīrāzī himself.[11] Another link to al-Šīrāzī is the other important witness Thurston 3. This was copied from a disciple of al-Šīrāzī named Suhrāb ibn Amīr al-Ḥāǧǧ in two different periods, the second being 1276-1277 CE when he was working with al-Šīrāzī in Anatolia.[12] When we take into account that Marsh 720 was directly copied from Thurston 3, it is evident that our present knowledge of Ibn al-Ṣalāḥ's treatise is heavily dependent on the value that al-Šīrāzī saw in this work for his own research activities.

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[10] Ibn al-Ṣalāḥ, *Zur Kritik der Koordinatenüberlieferung*, p. 130:11-14; see Kunitzsch's German translation on p. 76.

[11] Krause, "Stambuler Handschriften," p. 484, 486, 496-497, 516-517, and Kunitzsch's summary in Ibn al-Ṣalāḥ, *Zur Kritik der Koordinatenüberlieferung*, p. 28.

[12] See José Bellver's description of Thurston 3 online at https://ptolemaeus.badw.de/ms/672 (last consulted 18th February 2022).

Despite the lack of attention devoted to Ibn al-Ṣalāḥ by medieval biographers, this fact nicely testifies the later influence of Ibn al-Ṣalāḥ's work on al-Šīrāzī and his direct environment, most importantly the school around the observatory in Marāġa.

Ibn al-Ṣalāḥ starts his treatise by presenting the main problem that he encountered while reading Ptolemy's star catalogue in Books VII and VIII of the *Almagest*:

> When I looked at (*lammā taʾammaltu*) the tables in which the positions of the fixed stars in longitude and latitude and direction [i.e. southern or northern hemisphere] are determined and to which size and constellation they belong, I have seen there an obvious defect that mere sensation confirms, not to speak of observation. This is not the case [only] in some of the translations of this work [i.e. the *Almagest*] or in works derived from it such as astronomical tables or similar books on the constellations, but in all of them. In some of them, they [i.e. the fixed stars] are found with a certain value and in another [work] with a contradicting [value]. One does not know which of them is correct or whether both are wrong.[13]

The main problem pointed out by Ibn al-Ṣalāḥ consists, first, of wrong coordinates for the positions of the fixed stars that he found not only in some versions of the *Almagest* or later astronomical works, but in the entire Ptolemaic tradition, and second of divergences between different texts concerning these coordinates so that it remains unclear which source should be trusted. Although he might exaggerate at this point, Ibn al-Ṣalāḥ was apparently amazed by the fact that one did not even need to do thorough observations in order to notice some of these errors. This finding just by itself would be a sufficient reason for an astronomer like Ibn al-Ṣalāḥ to write a work on these flaws. However, he adds a reason why these mistakes are not only relevant for mathematicians and astronomers, but for all natural philosophers, as well:

> I have noticed (*wa-raʾaytu*) that this kind of mistake undermines the *principles* (*uṣūl*) of this science and [also] its [own] *branches* (*furūʿ*).
>
> As to its *principles*, this is obvious for to its principles belongs what Aristotle demonstrated in *On the Heavens*, namely that these stars were observed in past periods, and no change was ever seen in any aspect of their states.[14] Likewise, Ptolemy points out in more than one passage of his *Almagest* that change is entirely excluded from this substance.[15] For someone

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[13] Ibn al-Ṣalāḥ, *Zur Kritik der Koordinatenüberlieferung*, p. 158:6-10; see Kunitzsch's translation on p. 35.

[14] See for example *On the Heavens* I.3, 270b11-16, and II.1, 284a2-12.

[15] As Ibn al-Ṣalāḥ rightly points out, there are a couple of remarks on the unchanging nature of the heavens and aether, see for example Claudius Ptolemy, *Syntaxis mathematica*, ed. Johan L. Heiberg, 2 vol. (Leipzig: Teubner, 1898-1903), here I.1,

contesting this doctrine (ʿilm) like John Philoponus, among others, [such mistakes allow him] to say that they in fact changed or even that some of them vanished entirely, because there are among them some for which a certain position on the celestial sphere is determined, whereas we actually do not see them there, at all. […]

[This is followed by a couple of examples for wrong positions, in which no star can actually be found.]

[p. 157:3] Thus, it is [possible] for the opponent to say that they faded away and perished like the fading of the trace called comet. […]

[This is followed by some examples for a variation in magnitude.]

[p. 157:9] Thus, it is [possible] for the contester to say that they receive [the process of] fading and that they are in it, for they were at the time of the determination in some magnitude and now they are in the state of diminishing, and thus their affair is obvious and they will be annihilated.

As for the [fact] that [this mistake] invalidates the *branches* of this science, this happens as it belongs to its branches that all of the fixed stars are in one sphere (kura). The demonstration for that is [as follows]: what is observed of them belongs to stars (kawākib) that are in a straight line or in a triangle or in a square in previous observation and that are then in the same way in his time, and that the same [is true] in the case of their other figures that are found to preserve one order, as Ptolemy demonstrates in [Book] VII of the *Almagest* through his observations and a comparison of them to previous observations.[16] This is why they are called "fixed." The contester [might] say that they are not in one sphere and do not preserve [one] order. He [might] demonstrate this in the same way as Ptolemy did, saying that the position (tabt), which Ptolemy laid down for the planets in longitude and latitude, testifies the soundness of what we have explained concerning the change (iḥtilāl) of these stars. For if we draw stars with the position that [Ptolemy] drew, they form (waqaʿa ʿalā) a certain figure. Now, they can be found in the heavens by eyesight in a figure different to that

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vol. 1, p. 6:9-11; I.3, vol. 1, p. 10:16-19 and 13:21 – 14:16; XIII.2, vol. 2, p. 532:12 – 534:6. Most importantly, he might have in mind a passage from the first chapter of Book VII, which basically is the introduction to the star catalogue that is under discussion in his treatise: "First, then, no change has taken place in the relative positions of the stars even up to the present time. On the contrary, the configurations observed in Hipparchus's time are seen to be absolutely identical now too. This is true not only of the positions of the stars in the zodiac relative to each other, or of the stars outside the zodiac relative to other stars outside the zodiac […]; but it is also true of the positions of stars in the zodiac relative to those outside it, even those at considerable distances. This can easily be seen by anyone who is willing to make an inspection of the matter and examine, in the spirit of love of truth, whether present phenomena agree with those recorded for Hipparchus' time." (Ptolemy, *Syntaxis*, VII.1, vol. 2, p. 3:12 – 4:2, tr. by Gerald J. Toomer in Claudius Ptolemy, *Ptolemy's Almagest*, tr. and comm. Gerald J. Toomer (Princeton: Princeton University Press, 1998), p. 321-322.)

[16] See again the citation from *Almagest*, VII.1 in the previous footnote.

one. This would be a proof for their lack of preserving the distances. […]

[This is followed by some examples for such different figures in the Arabic and Syriac versions.]

[p. 156:7] When we noticed (*fa-lammā raʾaynā*) that this is the extent belonging to this mistake of nullifying and undermining this science, we spent some time to investigate and examine (*natafattiš*) the books of the ancients and of the moderns concerning this science so that we might find someone improving (*aṣlaḥa*) that. We did not find in these books anything at all, but we found them giving [even] more confusion to the researcher.[17]

As Ibn al-Ṣalāḥ points out, the danger that could arise from such mistakes for the science of astronomy is twofold. First, there is the threat to the "principles" (*uṣūl*) of this science, which has been established by both Aristotle in the *On the Heavens* and Ptolemy in his *Almagest*, namely that there is no change whatsoever in the celestial realm. Second, one of the consequences ("branches," *furūᶜ*, which corresponds to the literal meaning of *uṣūl* as "roots") of this absence of any change is that the outermost stars are, as opposed to the "wandering" planets, fixed in one sphere and simply rotate together with the motion of the outermost sphere carrying them. In this way, they do not change their positions relative to each other and always form the same constellations. Ibn al-Ṣalāḥ already provides a number of examples for these threatening mistakes here in the introduction:

• If one cannot find a star in the location given in the star table, one could assume that the star vanished, just like comets and meteors seem to fade away.

• If the observed magnitude is less than what is ascribed to them in the star table, this could mean that they are in the process of vanishing.

• If the stars do not preserve the same relative positions to each other and thus change their constellations, this would mean that the so-called "fixed" stars are in fact not "fixed" in one single sphere, but carried by a multitude of spheres.

Why, however, would these thoughts have the capacity to "nullify and undermine this science," i.e. astronomy? In order to answer this question, one must keep in mind the strong and fruitful relationship between the observed celestial phenomena of immutable star constellations and even the regular revolutions of the – at least on first sight – irregular planetary motions as observed in a longer period of time on the one hand and the very influential Peripatetic theories of natural philosophy concerning the fifth element and its everlastingness on the other hand. Ibn

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[17] Ibn al-Ṣalāḥ, *Zur Kritik der Koordinatenüberlieferung*, p. 158:11 – 156:9; compare Kunitzsch's translation on p. 35-38.

al-Ṣalāḥ refers to the observed stability of astronomical observations as expressed both in the *On the Heavens* and the *Almagest*. Aristotle, in fact, refers to previous observations in Chapter I.3, where he establishes that there is a first body, devoid of any change and consisting of aether, a special element that differs from the sublunar elements with respect to the fact that it allows the everlasting nature of its body. In Chapter II.1, on the other hand, he sums up the arguments for the eternity of the world and refers to the beliefs of more ancient traditions in the divinity, immortality, and everlastingness of the celestial realm.[18] This means that Aristotle uses ancient beliefs and especially previous observations as additional arguments for at least two of his most important cosmological theories, namely the existence of aether and the eternity of the world. Although Ptolemy does not address the latter issue, he adopts at least the theory of the fifth, unchanging element. On the one hand, this nicely fits with the fact that his own observations are in agreement with the ones carried out for example by Hipparchus. On the other hand, this theory provides a rationale for Ptolemy's agenda in the *Almagest*, namely to construct regular mathematical models for the apparently irregular planetary motions: if one assumes that also the celestial realm consists of the sublunar elements, which are doomed to constant generation and corruption, one is led to the belief that also the planets and stars will, at a certain point, change their nature. Then, their motions would be, in fact, not really regular for a longer period and astronomical models would lose much of their accuracy and predictive value for the future. This is the view for which Ibn al-Ṣalāḥ refers to John Philoponus, who was famous for attacking Aristotle's theory of aether and the eternity of the world in the Arabic tradition through his two works against Aristotle and Proclus.[19] In this way, astronomy and natural philosophy are therefore not only closely related with, but also dependent on each other, and this works in both directions. As Ibn al-Ṣalāḥ's usage of "principles"

[18] See n. 14.

[19] The work against Proclus is extant in full, see John Philoponus, *De aeternitate mundi contra Proclum*, ed. Hugo Rabe (Leipzig: Teubner, 1899). The fragments of the lost work against Aristotle were gathered and discussed by Christian Wildberg, see John Philoponus, *Against Aristotle on the Eternity of the World*, tr. Christian Wildberg (London: Duckworth, 1987). In fact, Philoponus complains in another work, his *De opificio mundi* (which was not translated into Arabic), that the astronomers constantly disagree with each other. Although he acknowledges that Ptolemy came close to a convincing theory, there might be a connection with this critique of earlier and contemporary astronomical theories and his denial of an unchanging celestial substance. See John Philoponus, *De opificio mundi*, ed. Walther Reichardt (Leipzig: Teubner, 1897), III.3, p. 113:15 – 116:17.

suggests, he adopts the view that astronomy needs to take its "principles" from natural philosophy, the most important of these principles being the unchanging nature of the aethereal realm. This view was also upheld by other important Islamic philosophers such as al-Fārābī before him and Naṣīr al-Dīn al-Ṭūsī after him.[20] On the other hand, astronomical observations themselves offer strong empirical evidence for a part of Peripatetic natural philosophy, namely the absence of any change in the heavens and the eternity of the world. This strong link between astronomy and natural philosophy, therefore, is the reason why inaccurate star positions are so dangerous not only for astronomers, but also for philosophers, which is exactly the point that Ibn al-Ṣalāḥ is trying to make here in the introduction in order to explain why the following investigation is necessary.

In his attempt to find the reason for those mistakes concerning the star positions, he first turns to more recent Arabic works, namely al-Ṣūfī's *Book on Constellations* and al-Bīrūnī's *Al-qānūn al-masʿūdī*. To put it briefly: he is satisfied by neither al-Ṣūfī's nor al-Bīrūnī's remarks. According to Ibn al-Ṣalāḥ, al-Ṣūfī makes two major mistakes when he addresses the divergences concerning the star positions. In some cases, al-Ṣūfī does not attempt to give a proper explanation of how these divergences came about. This opens up the possibility of an actual change in the heavens, which is exactly the sort of reasoning Ibn al-Ṣalāḥ wants to avoid. In other cases, al-Ṣūfī identifies mistakes by the copyists as the origin of the divergences. To this, Ibn al-Ṣalāḥ replies as follows:

> For some of them [i.e. the mistakes], when he wants to mention the reason, he says that it is due to a mistake of the copyist, just like he says in the beginning of his book on the fifth star of Virgo and the 23rd and 24th star of Sagittarius that the copyist might have made a mistake on their size: whereas they were of the fourth size in the original [version], [the copyist] shortened the *dāl* which then became a *bāʾ* so that they came to be believed as being of the second size. [Al-Ṣūfī] did not understand that this mistake, if it came from the copyist, could not be found in the various translations and also in the other, non-Arabic languages. Even if the *dāl* and the *bāʾ* are close with regard to the Arabic, they are not close in Greek and Syriac.[21]

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[20] For al-Fārābī, see Damien Janos, "Al-Fārābī on the Method of Astronomy," *Early Science and Medicine*, 15 (2010), p. 237-265, here p. 255-256; for al-Ṭūsī, see Jamil Ragep's edition of al-Ṭūsī's *Taḏkira* in al-Ṭūsī, *Memoir on Astronomy (Al-tadhkira fī ʿilm al-hayʾa)*, ed. and tr. F. Jamil Ragep, 2 vol. (New York: Springer, 1993), here vol. I, p. 91:10-18.

[21] Ibn al-Ṣalāḥ, *Zur Kritik der Koordinatenüberlieferung*, p. 156:14-20; compare Kunitzsch's translation on p. 38.

This brief remark illustrates the careful attitude Ibn al-Ṣalāḥ devotes to his own research. He could have been happy with blaming the copyists, since this would explain the apparent divergences of the star positions in a – from the point of view of natural philosophy – harmless way. (Which modern Arabist working with manuscripts has never been tempted to blame the copyist in order to explain a problematic passage?) Instead, he points out that this reasoning is mistaken in two respects, namely that (a) this does not explain why this mistake occurs in all different Arabic versions, and (b) it should not occur also in non-Arabic versions such as the Syriac one (as we will see below, Ibn al-Ṣalāḥ apparently only made use of the Syriac and not the Greek version in his comparison of the different versions). This is an example of Ibn al-Ṣalāḥ's serious engagement with the different versions of the text, which makes his text such a valuable source.

Ibn al-Ṣalāḥ is also not satisfied by al-Bīrūnī's remarks. He complains that al-Bīrūnī claims to have corrected these faulty coordinates, but in the end Ibn al-Ṣalāḥ notes that this is, in fact, not the case.[22] As he concludes that no one of his predecessors corrected these mistakes, Ibn al-Ṣalāḥ turns to the different Arabic versions that were available to him. Although this is not the place to discuss the different Arabic versions of the *Almagest*,[23] I cite his report on these different versions because we will see similar reports in the two other treatises that I discuss in this article:

> When we gave up on finding that in any treatise, we investigated about the cause of the mistake that occurs in these treatises in different translations (*nuqūl*) and languages. In fact, of the *Almagest* five versions (*nusaḥ*) are extant, in different languages and translations. Among them are a Syriac version, which was translated from Greek; a second version in the translation of al-Ḥasan ibn Qurayš for [the Caliph] al-Maʾmūn from Greek into Arabic; a third version in the translation of al-Ḥaǧǧāǧ ibn Yusuf ibn Maṭar and Hiliya ibn Sarǧūn also for [the caliph] al-Maʾmūn from Greek into Ara-

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[22] See Ibn al-Ṣalāḥ, *Zur Kritik der Koordinatenüberlieferung*, p. 156:26 – 155:10; compare Kunitzsch's translation on p. 39-40.

[23] For previous assessments of this passage, see Kunitzsch, *Der Almagest*, p. 22-24; more recently Dirk Grupe, "Thābit ibn Qurra's Version of the *Almagest* and Its Reception in Arabic Astronomical Commentaries (based on the presentation held at the Warburg Institute, London, 5th November 2015)," in David Juste, Benno van Dalen, Dag Nikolaus Hasse and Charles Burnett (eds.), *Ptolemy's Science of the Stars in the Middle Ages* (Turnhout: Brepols, 2020), p. 139-157, here p. 139-140; and Johannes Thomann, "The Oldest Translation of the *Almagest* Made for al-Maʾmūn by al-Ḥasan ibn Quraysh: A Text Fragment in Ibn al-Ṣalāḥ's Critique on al-Fārābī's Commentary," ibid., p. 117-138, here p. 126-128.

bic; a fourth version in the translation of Isḥāq ibn Ḥunayn for Abū l-Ṣaqr ibn Bulbul from Greek into Arabic, which is the archetype of Isḥāq and his autograph; a fifth version in the redaction of Ṯābit ibn Qurra for this version by Isḥāq ibn Ḥunayn for Abū l-Ṣaqr ibn Bulbul, [this redaction] corresponding to Isḥāq's version except for the notes that [are found] in the margins of Isḥāq's version, like the doubt,[24] for they are not existent in Ṯābit's version. All of these versions are different and defective. I saw that in them there are, concerning the stars, aspects on which they agree with one number and [still] are defective, or [aspects] in which they are differing, either all or most of them, and are also defective, and [aspects] in which some of them are defective and others correct. Thus, I inquired about the reason [for that] and I saw that informing about its reason is the strongest [way] for the verification and that this method is a road for anyone who seeks a correction, not only in this field (*maʿnā*), but also in all the other fields translated from Greek into Syriac or Arabic.[25]

From this overview, we learn that Ibn al-Ṣalāḥ at least had basic knowledge of Syriac and, whenever possible, included the Syriac version in his investigations of different versions of a text. In addition, he either had no access to the Greek version of the *Almagest*, in particular, or he even did not have an intimate knowledge of Greek. As we will see in the case of the next two treatises, he never refers to the Greek texts. In any case, it is remarkable that he claims that the method that he is going to pursue in this treatise on the star positions in the *Almagest* can be transferred to other investigations of texts that were translated from Greek into Syriac and/or Arabic. As a more general note, it remains here to point out that Ibn al-Ṣalāḥ is very well informed about the history of the different versions of the *Almagest*. In fact, his information is even more accurate than the one given in Ibn al-Nadīm's *Fihrist*.[26]

Before we turn to the other two treatises in order to see whether he indeed follows a similar method there, it might be useful to summarize the main sources that Ibn al-Ṣalāḥ identifies for the observed divergences. He divides them into three main categories ("I noticed that the cause for this mistake are three things," *fa-raʾaytu anna sabab hāḏā l-ġalaṭ ṯalāṯa ašyāʾ*):

• Scribal errors, as already pointed out by al-Ṣūfī. As briefly explained above, Ibn al-Ṣalāḥ criticizes that this cannot be the only source

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[24] I.e. doubts concerning variant readings in the different versions, see Kunitzsch's note in Ibn al-Ṣalāḥ, *Zur Kritik der Koordinatenüberlieferung*, p. 40, and Kunitzsch, *Der Almagest*, p. 22-24.

[25] Ibn al-Ṣalāḥ, *Zur Kritik der Koordinatenüberlieferung*, p. 155:11-25; compare Kunitzsch's translation on p. 40-41.

[26] For a comparison, see again Kunitzsch, *Der Almagest*, p. 17-24.

for the observed textual problems, as some of them appear in all the different versions.

- Different notation systems for distinguishing between integers and fractional numbers in Greek, Syriac, and Arabic.
- Letters that look similar to each other in Greek but signify different values. Ibn al-Ṣalāḥ uses the Greek A and Δ as example.[27]

With the exception of the first, these sources of mistakes relate mostly to mathematical texts, because it is easier to distinguish similar letters in words than in single numerical values. The method that he intends to establish consists of a thorough comparison of different versions of the text and the assessment of previous commentators, although this last point does not yield any important result in the case of Ptolemy's star catalogue. Thus, he concludes the introduction with the following general statement:

> I noticed (*wa-raʾaytu*) that I leave behind a method for the lovers of truth in this [field], [a method] which they can follow. In fact, Aristotle says in the beginning of his *Metaphysics* (*fī-mā baᶜd al-ṭabīᶜa*): "We should not [only] thank someone who says much about the truth, but also someone who says little about it."[28]

With this citation from Aristotle's *Metaphysics*, Ibn al-Ṣalāḥ tries to provide his method with a stronger authority. The citation itself is also of some interest, since it shows that Ibn al-Ṣalāḥ used the Arabic translation of this work by Usṭāṯ.[29] One should keep in mind the mere fact that Ibn al-Ṣalāḥ ends his introduction with a citation from Aristotle, for this is also something we will see in one of the following treatises. Because this treatise on Ptolemy's star catalogue is well-researched and the details are interesting most importantly for historians of astronomy, there is no need to go into the details of that treatise here.

Before I turn to Ibn al-Ṣalāḥ's treatises on Aristotle's *On the Heavens* and *Posterior Analytics*, it remains to say that there are two other commentaries by Ibn al-Ṣalāḥ on problems in Ptolemy's *Almagest*. The first is a very small note on Ptolemy's account of the planetary retrogradations in Book XII of the *Almagest* (*Al-maᶜnā ḏakara-hū Baṭlamyūs fī l-bāb al-ṯānī min al-maqāla al-ṯāniya ᶜašar*). This treatise has not yet

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[27] See Ibn al-Ṣalāḥ, *Zur Kritik der Koordinatenüberlieferung*, p. 155:25 – 152:7, the cited sentence being on p. 155:25-26; compare Kunitzsch's translation on p. 41-44.

[28] Ibn al-Ṣalāḥ, *Zur Kritik der Koordinatenüberlieferung*, p. 151:11-13; compare Kunitzsch's translation on p. 46. The citation stems from *Metaph.* II.1, 993b11-13.

[29] See Kunitzsch's note in Ibn al-Ṣalāḥ, *Zur Kritik der Koordinatenüberlieferung*, p. 46 n. 40.

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been subject of modern research, at least to my knowledge, and is extant through three manuscript witnesses.[30] Unfortunately, it does not contain anything of importance for the present investigation, because it is merely a brief comment on Ptolemy's method and not one of Ibn al-Ṣalāḥ's critical assessments. Instead, one should turn to yet another Ptolemaic work by Ibn al-Ṣalāḥ, namely his critique of a certain argument that he found in al-Fārābī's commentary on *Almagest* V.17 (or rather V.19 in the Greek version). He tells us that while he was reading al-Fārābī's commentary, he noticed an error in this chapter. Therefore, he wrote this treatise in which he first cites the corresponding passage from the *Almagest* and then provides lengthy citations from al-Fārābī's commentary, accompanied by his explanations.[31] In this way, this treatise is strikingly similar not only to the work on Ptolemy's star catalogue, in which he deals critically with the works of his predecessors, but also to the treatises that I discuss in the following, as in these cases he responds directly to one specific mistake.

3. IBN AL-ṢALĀḤ ON A MISTAKE IN *ON THE HEAVENS*

In contrast to Ibn al-Ṣalāḥ's treatise on Ptolemy's star catalogue, the other two treatises that I want to discuss here in detail survived in their original form and not in a later recension. The first of these is extant through two witnesses:

• Istanbul, Süleymaniye Kütüphanesi, Ayasofya 4830, f. 129r-139v (abbreviated as "AS 4830" in the notes);
• Istanbul, Süleymaniye Kütüphanesi, Ayasofya 4845, f. 8v-19r (abbreviated as "AS 4845" in the notes).

The full title is again quite long: "On the Proof of the Mistake Occurring in an Argument (*maʿnā*) Mentioned in Book III of Aristotle's *On the Heavens* and in all Commentaries and Notes[32] in which an Explanation of this Argument is Given." It has been edited and translated into Turkish by Mubahat Türker Küyel on the basis of the first of these two witnesses.[33] Both manuscripts contain the same collection of seven trea-

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[30] See MS Oxford, Bodleian Library, Thurston 3, f. 94v; MS Istanbul, Topkapı Sarayı Müzesi, Ahmet III 3455, f. 82r; MS Istanbul, Topkapı Sarayı Müzesi, Hazine 455, f. 116r-117r.

[31] I rely on the synopsis by Johannes Thomann, see Thomann, "Al-Fārābīs Kommentar," p. 104-109.

[32] Reading with AS 4830, f. 129r:4 *taʿālīq*.

[33] See Mubahat Türker Küyel, "İbnüʾş-Ṣalāḥʾın *De coelo* ve onun Şerhleri hakkındaki Tenkitleri," *Araştırma*, 2 (1964), p. 1-79.

tises by Ibn al-Ṣalāḥ, among them also his note on Aristotle's *Posterior Analytics* that will be discussed below.[34] The first obviously older copy is dated to July-August 1229 AD, and the copyist claims to have it copied from a "correct copy" (*nusḫa ṣaḥīḥa*) in Damascus, which is where Ibn al-Ṣalāḥ died roughly 70 years before.[35] The value of the second, much later witness lies in the fact that there is a small number of damaged words in the older manuscript and that these gaps can be filled through this second witness.

This treatise takes its departure from a geometrical argument in *On the Heavens* III.8, where Aristotle claims in the course of the argument that – among the regular three-dimensional bodies – not only cubes, but also pyramids fill the space without leaving interstices, although this is wrong in the latter case.[36] In this chapter, Aristotle attempts to provide counterarguments for the Platonic theory that the simple bodies consist of elementary regular planes. His main point is that not all of the regular bodies fill space without creating empty space. As a matter of fact, Ibn al-Ṣalāḥ explains the context of Chapter III.8 in the introduction of his treatise:

> When my investigation of the unfolding of Book III of Aristotle's *On the Heavens* arrived at the passage in which [Aristotle] replies to those that assign a shape to the elements and [claims] that not all of the plane figures are filling [the space without leaving void interstices] nor do all corporeal bodies and that those of the regular (*mutasāwiya mutašābiha*) plane figures which fill a plane are only three figures and those of the corporeal figures that fill the space (*faḍāʾ*) are only two figures, I devoted an investigation to that [point]. Then, I noticed (*fa-raʾaytu*) that what fills [space] among the plane figures is what he mentioned, and as for what fills [space] among the corporeal figures, it is only one figure. Thus, I refused to acknowledge that the Philosopher would argue (*yakūn ḏahaba*) like that, even if he were

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[34] Sezgin, and Rosenfeld & İhsanoğlu, list yet another manuscript that supposedly contains the same collection of seven treatises on Euclid, Galen, and Aristotle, namely MS Istanbul, Millet, Feyzullah 1366, see Sezgin, *Geschichte des arabischen Schrifttums V*, p. 110, and Rosenfeld & İhsanoğlu, *Mathematicians, Astronomers*, p. 177-178. Unfortunately, I was not able to confirm that: the scans I received of this manuscript do not show any sign of a work by Ibn al-Ṣalāḥ. I thank Ali Fikri Yavuz for his help concerning the Istanbul manuscripts.

[35] AS 4830, f. 160v:21-22.

[36] *On the Heavens* III.8, 306b3-8. For an introduction into the problem, see Thomas L. Heath, *Mathematics in Aristotle* (Oxford University Press, 1949), p. 177-178. Ian Mueller discussed the problem and how later thinkers including Ibn al-Ṣalāḥ dealt with it, see Ian Mueller, "Space-filling Pyramids from Aristotle to Jan Brozek," *Revue philosophique de la France et de l'étranger*, 143 (2018), p. 159-180, here p. 165-168; for his summary of Ibn al-Ṣalāḥ's objection, see esp. p. 165-167.

asleep, especially [as] there is an even stronger [claim] (*ablaġ*) concerning what he wishes to oppose. For it is his intention to show that not all regular (*al-mutasāqiyat al-qawāᶜid al-mutašābiha*) solid figures fill the space[37] and that these figures are not infinite as in the case of plane figures, I mean that it is possible that figures of equal sides and angles are taken or drawn in a circle infinitely, the first of them being the triangle, and so on (*wa-halluma ǧarran*).

As for the regular (*al-mutasāwiyat al-qawāᶜid al-mutašābiha*) corporeal figures, it is not possible that they are taken or drawn in a sphere infinitely, but this is possible rather only for five figures. These are: [First,] the figure that has four bases of regular triangles with regular sides and angles, which Plato in his *Timaeus* ascribes to fire; second, the figure that has eight bases of regular triangles with regular sides and angles, which Plato ascribes to air; third, the one that has twenty bases of triangles in the aforementioned state, which Plato ascribes to water; fourth, the one that has six bases of squares, namely the cube, which Plato ascribes to earth[38]; fifth, the one that has twelve bases of regular pentagons with regular sides and angles, which Plato ascribes to the celestial sphere (*falak*). Plato describes these five figures, as already said, in the *Timaeus*, breaking them into planes.[39] Through correcting that in which Plato was obscure, a group of the ancients explained [it], such as Galen in Book VIII of *The Opinions of Hippocrates and Plato*,[40] while others showed the invalidity of that, such as Aristotle in this and other treatises and a group of commentators who commented on his treatises.

As for showing how to construct them and for establishing the true demonstration and showing the relation of their sides to the diameter of a sphere in rational and irrational [numbers], and as for the fact that they are indeed only five figures, this has been shown by Euclid in the five figures towards the end of Book XIII. He ends the treatise with his proof that these are the only five [figures], so that[41] one [could] assume that it is his aim in the entire work that it is only [about] these five figures.

Thus, it is obvious that if Aristotle had shown that it is only one of these five figures that fills [space], this would have been a stronger [claim] (*ablaġ*) than showing that only two figures fill [space].[42]

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[37] Reading with AS 4830, f. 129r:12 *tašġal al-furǧa*.

[38] Reading with AS 4830, f. 129r:20 *al-arḍ*.

[39] See *Timaeus*, 54d3-56c7. For the Arabic rendition of Galen's synopsis of the *Timaeus*, see Galen, *Compendium Timaei Platonis aliorumque dialogorum synopsis quae extant fragmenta*, ed. Paul Kraus and Richard Walzer (London: Warburg Institute, 1951), p. 15:1-5.

[40] Ibn al-Ṣalāḥ apparently refers to Chapter 2, in which Galen summarizes Plato's theory of elements in the context of human constitutions and the source for diseases. See Galen, *On the Doctrines of Hippocrates and Plato*, ed. and tr. Phillip de Lacy, 3 vol. (Berlin: Akademie-Verlag, 1980-1984), here vol. 2, p. 494:26 – 498:16.

[41] Reading with AS 4830, f. 129v:6 *ḥattā*.

In the introductory words of his treatise, Ibn al-Ṣalāḥ describes his astonishment that he found a very basic mistake in *On the Heavens*. He is right in pointing out that this mistake even runs against Aristotle's agenda, namely to show that there is only a small number of regular bodies that fill space. For this reason, it would have served Aristotle's argument well that there is, in fact, only *one* regular body filling space and not even a second one beside that. Ibn al-Ṣalāḥ proceeds by describing Plato's account of regular bodies that correspond to the simple elements (fire, air, water, earth) and to the celestial sphere. This leads him to briefly summarize that this teaching from the *Timaeus* was already attacked by some ancient commentators (one of them obviously Aristotle) and defended by others, for whom he names Galen as an example.

Through Ibn al-Ṣalāḥ's reference to Euclid's *Elements*, we learn two things. First, he thinks that it is one of Euclid's most important goals to demonstrate that there are only five regular bodies because this is shown in the last proposition of the *Elements*.[43] Second, he obviously considers Euclid as the main authority on geometrical matters and thus concludes that Aristotle, in asserting that two solid bodies fill space, went beyond things that are established in geometry. Judging from Ibn al-Ṣalāḥ's extant works, we should be inclined to the view that he was mostly interested in the mathematical sciences, most importantly geometry and astronomy. It is, therefore, no surprise that he addresses a geometrical problem from *On the Heavens* and not a physical or metaphysical one. Nevertheless, it is remarkable to see how well-read Ibn al-Ṣalāḥ was in philosophical works, which becomes apparent through his references to Plato's *Timaeus* and other ancient commentaries on it. In the next section, in which Ibn al-Ṣalāḥ lays out the different sources he consulted in order to find a solution to the encountered problem, we learn even more about his familiarity with ancient and more recent commentaries:

> When I refused to acknowledge that (*fa-lammā ankartu ḏālika*), I thought that this might rather be a mistake by the translator (*mutarǧim*) of this treatise, namely Yaḥyā ibn al-Biṭrīq. So I investigated it in the translation (*naql*) of Abū ᶜAlī ᶜĪsā ibn Zurᶜa for this treatise from Syriac into Arabic. I found that the passage was the same, and likewise in the translation (*naql*) of Abū l-Faraǧ ᶜAbdallāh ibn al-Ṭayyib from Syriac into Arabic. Then I looked into the commentaries, especially those by the Greeks, because they report the sense of the man in this treatise. As is known, for this treatise none of the old commentaries are extant except for

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[42] Türker Küyel, "İbnüᵓṣ-Ṣalaḥᵓın De Coelo," p. 53:7 – 54:17.

[43] See Euclid, *The Thirteen Books of the Elements*, tr. Thomas L. Heath, 3 vol. (Cambridge University Press, 1908), here vol. 3, p. 507-508.

the commentary[44] by Themistius, which is complete, and some part from Book I of the commentary (*šarḥ*) by Alexander [of Aphrodisias]. When we investigated this [passage] in the commentary by Themistius, we saw that it indeed provides a commentary of the passage and shows that the fire parts (*al-nāriyyāt*) fill the space in two ways. These ways are not true, but they are false on the basis of geometrical principles. Then, we sought to find this statement in the abridgment (*iḫtiṣār*) by Nicolaus [Damascenus] for this treatise, but did not find him tackling the passage, at all.[45] Next, we looked at the commentaries of recent [scholars] and their appendices, and we found by Abū ʿAlī ibn Zurʿa questions posed to Yaḥyā ibn ʿAdī on this meaning, namely: "Why is the space of the corporeal [bodies] only filled by two figures?" and so forth of what is appended to the discussion by Themistius in the commentary of that passage. Yaḥyā ibn ʿAdī replied to him on this point by replies completely remote from the truth. Likewise, we found that Abū Sahl al-Masīḥī in his abridgment (*iḫtiṣār*) of this treatise deviated entirely from the meaning, insofar as he drops the five figures and replaces them with planes enclosing them. We [also] investigated this meaning in the commentary by Abū l-Faraǧ ibn al-Ṭayyib and we saw him there reflecting (*yuḥawwim*) on the argument by Aristotle and blending it with other things of his, building on the mistake mentioned in the commentary by Themistius and in the text (*faṣṣ*). In another commentary by this Abū l-Faraǧ, lacking the mentioning of the text of the argument by Aristotle, he mentions this mistake according to the way which he [already] mentioned in his greater commentary (*šarḥ akbar*). I happened to hear that there were comments on (*taʿālīq*) this treatise by Abū Naṣr al-Fārābī, which he dictated to[46] Ibrāhīm Ibn ʿAdī the author. Thus, I looked for it in the City of Peace [i.e. Baghdad] but could not find it. Then, I got it from Damascus and investigated the passage, but did not find him tackling it, at all, nor commenting anything upon it.[47]

As in the case of Ibn al-Ṣalāḥ's treatise on Ptolemy's star catalogue, this passage has already been used in modern research, namely by Gerhard Endress, as a source for the Arabic translations of *On the Heavens*.[48] In light of Endress' detailed analysis of the different versions of

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[44] Reading with AS 4830, f. 129v:13 *šarḥ*.

[45] For a different translation of this sentence, see H. J. Drossaart Lulofs, *Nicolaus Damascenus. On the Philosophy of Aristotle* (Leiden: Brill, 1969, 2nd edition), p. 173.

[46] Adopting the translation by Endress, see Endress, "Ibn al-Ṭayyib's Arabic Version," p. 227.

[47] Türker Küyel, "İbnüʾṣ-Ṣalaḥʾın De Coelo," p. 54:18 – 55:17.

[48] See Endress, "Ibn al-Ṭayyib's Arabic Version," and esp. p. 226-227 for a previous translation of this passage. See also Elisa Coda, "Reconstructing the Text of Themistius' Paraphrase of the *On the Heavens*. The Hebrew and Latin versions on the three meanings of the term Heaven," *Studia graeco-arabica*, 4 (2014), p. 1-15, here p. 5

the Arabic *On the Heavens*, there is no need to go into any detail here
again. It can simply be summarized that Ibn al-Ṣalāḥ had access to three
Arabic versions, namely by Ibn al-Biṭrīq, Ibn al-Zurᶜa, and Ibn al-Ṭayyib,
all three of which were translated from Syriac. Later, he provides the
short excerpt from *On the Heavens* in all three different versions in or-
der to show that all of them share the same mistake.[49]

As for the ancient commentaries, he states that he had access to the
first book from Alexander's commentary. This was the only part trans-
lated into Arabic and, therefore, not relevant for the present discussion
on Book III.[50] In contrast, Themistius' commentary will be a very impor-
tant source for Ibn al-Ṣalāḥ in this treatise. He briefly points out that
he is not convinced by Themistius' explanation of the passage in ques-
tion. In fact, he finds even more points in Themistius' commentary that
he criticizes. This is probably the reason why he decides to include the
entire commentary on Chapter III.8, which is an important source for
modern research, as the Arabic translation of this commentary is lost to
us.[51] There will be more to say about Ibn al-Ṣalāḥ's usage and criticism
of Themistius. For now, Ibn al-Ṣalāḥ continues his list of sources with a
reference to an abridgmet of *On the Heavens* by Nicolaus of Damascus,
who, as Ibn al-Ṣalāḥ complains, does not offer a fruitful discussion of the
passage.[52]

Ibn al-Ṣalāḥ proceeds with Arabic commentaries and first refers to
questions by Ibn Zurᶜa posed to Yaḥyā Ibn ᶜAdī. However, he states that
the replies by Ibn ᶜAdī are worthless. It seems that he wants to show
this fact by appending a paraphrase of the question and answer towards
the end of his treatise. This citation is the only extant source of these
questions, and it shows that Ibn al-Ṣalāḥ, who spent the first part of his
life in Baghdad, was well acquainted with the philosophical tradition in
Baghdad roughly two centuries before him.[53] In addition, if we jump to
the last source he mentions in his survey, we learn that he tried to get his

[49] See Türker Küyel, "İbnü᾽ş-Ṣalaḥ᾽ın De Coelo," p. 57:1-23.

[50] See F. E. Peters, *Aristoteles Arabus. The Oriental Translations and Commentaries
on the Aristotelian Corpus* (Leiden: Brill, 1968), p. 35-36.

[51] On Themistius' commentary on the *On the Heavens* and its Arabic, Hebrew and
Latin translations, see for example Coda, "Reconstructing the Text."

[52] As described by H. J. Drossaart Lulofs, who edited the fragments of Nicolaus' *On the
Philosophy of Aristotle*, there is none but one small fragment extant on Book III of
On the Heavens, which interestingly enough stems from the same chapter III.8. See
Lulofs, *Nicolaus Damascenus*, p. 88, 165-166, and esp. p. 171-173 for the reference
to Ibn al-Ṣalāḥ.

[53] See Gerhard Endress, *The Works of Yaḥyā ibn ᶜAdī. An Analytical Inventory* (Wies-
baden: Reichert, 1977), p. 63-64.

hands on al-Fārābī's comments (*taᶜālīq*), but that he was not able to find them in Baghdad and only afterwards received them from Damascus. This seems to suggest that he wrote this treatise while he was still in Baghdad, where he could also find the questions by Ibn Zurᶜa.[54] These notes by al-Fārābī, which were apparently hard to access already in Ibn al-Ṣalāḥ's time, are unfortunately lost today.[55]

Before we take a closer look at Ibn al-Ṣalāḥ's discussion of Themistius and the exchange between Yaḥyā ibn ᶜAdī and Ibn Zurᶜa, it remains to quickly sort the references to the two other authors. The first, namely Abū Sahl al-Masīḥī, authored an abridgment of *On the Heavens* that is extant in a single witness (MS Leiden, Acad. 44). This manuscript, which contains in addition four other works by Abū Sahl, is accessible through the facsimile edition published by Fuat Sezgin.[56] Ibn al-Ṣalāḥ quickly dismisses Abū Sahl's discussion, because in his view Abū Sahl only talks about planes and not solid bodies. In fact, in the version that is extant to us Abū Sahl has little to say on the present issue:

> There is no figure that fills its space without another figure except for the triangle and squares for plain (*mabsūṭa*) surfaces and for surfaces that surround bodies (*aǧsām*) and hexagons can fill the plain (*basīṭ*) surface and pentagons the surface of the body (*ǧism*).[57] Thus, an element can only be composed of triangular and square parts.[58]

Abū Sahl follows in this passage Aristotle's argument, that there are not enough regular figures that fill space to ascribe one to each of the five elements. Ibn al-Ṣalāḥ's critique seems unfair. It is true that Abū Sahl does not refer to the regular bodies mentioned by Aristotle explicitly, namely the pyramid and the cube. Nevertheless, he refers to these solid bodies when he speaks about bodies that are made up by surfaces of triangles and squares. Ibn al-Ṣalāḥ may have just quickly went through

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[54] Nevertheless, it is hard to give a more accurate date of the composition of this work. As noted in the beginning, Ibn al-Ṣalāḥ died around 1154 CE. In addition, we know that he spent some time in Mardīn at the court of Timurtaš ibn al-Ġāzī (reigned 1122-1154 CE) before moving to Damascus. This means that he did not leave Baghdad before 1122 CE.

[55] For some possible traces, see Moritz Steinschneider, *Al-Farabi (Alpharabius), des arabischen Philosophen Leben und Schriften* (St.-Pétersbourg, 1869), p. 138.

[56] See Abū Sahl al-Masīḥī, *Five Books on Cosmology, Physics, and Medicine. Facsimile edition by Fuat Sezgin, reproduced from MS Royal Academy 44, Leiden* (Frankfurt a. Main: Institute for the History of Arabic-Islamic Science, 2011); the abridgment of *On the Heavens* can be found on p. 139-245 (Hindu-Arabic pagination).

[57] The pentagon is not mentioned by Aristotle in *On the Heavens* III.8. It seems to be a wrong addition by Abū Sahl himself.

[58] Abū Sahl al-Masīḥī, *Five Books*, p. 217:13 – 218:2 (Hindu-Arabic pagination).

the text, searching it for a mention of pyramids or cubes, and since these are not mentioned by name he came to the conclusion that Abū Sahl considered only the two-dimensional aspect of Aristotle's argument. Be that as it may, it is certainly true that also Abū Sahl does not note the problem identified by Ibn al-Ṣalāḥ.

Finally, Ibn al-Ṣalāḥ's reference to two commentaries by Abū l-Faraǧ ibn Ṭayyib, one of the Arabic translators of *On the Heavens*, is quite interesting. There are only some fragments extant of these commentaries, which are discussed in much detail by Gerhard Endress.[59] At this point, Ibn al-Ṣalāḥ apparently criticizes that Abū l-Faraǧ also follows Aristotle. Since the extant fragments do not contain the passage in question, one cannot check what Ibn al-Ṣalāḥ exactly means by his complain that Abū l-Faraǧ was "reflecting on the argument by Aristotle and blending it with other things of his." Nevertheless, it is very interesting to see that Ibn al-Ṣalah does not only refer simply to two commentaries, but rather describes their outlook and their differences, namely that Abū l-Faraǧ wrote a "greater commentary" that included the Aristotelian lemmata and a second apparently shorter one without these lemmata. Thus, we see here again Ibn al-Ṣalāḥ's exact description of his sources which is the reason why Ibn al-Ṣalāḥ is such a valuable witness for us, especially in cases in which we only have fragments or dispersed testimonies of a work.

This list of earlier commentaries on *On the Heavens* is much more extensive than the one we have previously seen in Ibn al-Ṣalāḥ's treatises on Ptolemy's star catalogue. There, Ibn al-Ṣalāḥ had only included two references, namely to al-Ṣūfī and al-Bīrūnī. In this light, the detailed list of commentaries both by Greek and Arabic authors is even more striking. It seems that Ibn al-Ṣalāḥ is eager to point out that he is supposedly the first author to notice that error in Aristotle's text. This was different in the case for the diverging star positions, as he admits that al-Ṣūfī and al-Bīrūnī have noticed (at least some of) those errors, but did not offer a final solution. In the context of the mistake from *On the Heavens* III.8, Ibn al-Ṣalāḥ now wants to put an emphasis on the point that no one before him has even noticed that the mentioning of the pyramid is a basic mistake.

When Ibn al-Ṣalāḥ comes to the conclusion that this mistake was indeed already present in the Greek text by Aristotle, he obviously feels the need to excuse the fact that he is in opposition with Aristotle.

> I thus saw it is necessary [to present the truth] not just for myself, but for

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[59] See Endress, "Ibn al-Ṭayyib's Arabic Version," p. 255-275.

anyone who [merely] imitates Aristotle, because such one is not concerned
with presenting the truth and is not interested in what he believes to be
a mistake, despite that with which Aristotle is concerned in Book I of his
Nicomachean Ethics when he replies to what Plato said about the topic of
the forms as follows:[60]

> "As for the universal good, it seems that it would be best to investigate
> it and look how it is said, even if the investigation on that belongs to the
> things[61] difficult for us because some of our friends have adopted [the doc-
> trine of] the forms and believe in them. Nevertheless, we see that it is best to
> preserve the truth and to abandon a particular saying of ours in its support,
> if we need to do that. This would be so if we were not inclined towards phi-
> losophy (*falsafa*). So how is it when we prefer [philosophy] and prioritize[62]
> it? Therefore,[63] if we had two friends, who actually are different and one of
> them is the truth, it is necessary to prefer the truth."[64]

Through this famous quote from Aristotle's *Nicomachean Ethics*, Ibn
al-Ṣalāḥ highlights that also Aristotle upheld the view that the philoso-
pher must follow the truth, even though it sometimes means to be in
conflict with previous authorities. One should read this apologetic ac-
count and the Aristotelian quote together with the citation from Aristo-
tle's *Metaphysics* II.1 that we encountered in Ibn al-Ṣalāḥ's treatise on
Ptolemy's star catalogue. The topic of this brief sentence is the "truth,"
as well: he quotes Aristotle in order to show that the kind of treatises he
writes, namely works that "only" correct some mistakes, are still valu-
able as they are also helpful for approximating the truth. Ibn al-Ṣalāḥ
wishes to provide his treatises with an Aristotelian background or justi-
fication, although (a) they do not offer a complete philosophical theory,
and (b) they are sometimes in contradiction with ancient authorities,
most importantly Aristotle himself.

That being said, Ibn al-Ṣalāḥ explains the agenda for the following
main part of his treatise:

> Thus, we here start presenting the truth, even though a contrast with
> the one [i.e. Aristotle] who guides and leads us to it becomes apparent from
> that. We establish first the text of Aristotle's argument on that, including

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[60] The following citation stems from *Nicomachean Ethics* I.6, 1096a11-17; cf. the edited
Arabic version in Aristotle, *The Arabic Version of the Nicomachean Ethics*, ed. Anna
A. Akasoy and Alexander Fidora (Leiden, Boston: Brill, 2005), p. 125:1-5.

[61] Reading with AS 4830, f. 130r:17 *mimmā* (as confirmed in Aristotle, *The Arabic
Version*, p. 125:2).

[62] Aristotle, *The Arabic Version*, p. 125:4, has *nuqarribu-hā* instead of *nuqaddimu-hā*
(AS 4830, f. 130r:19).

[63] AS 4830, f. 130r:19 reads *wa-ḏālika anna-hū*; Aristotle, *The Arabic Version*, p. 125:4
has *wa-ḏālika annā*.

[64] Türker Küyel, "İbnüʾṣ-Ṣalaḥʾın De Coelo," p. 56:3-12.

the difference of the translations, and [next] the text of Themistius' argument in his commentary for this passage (*maʿnā*). Since in the translation of this commentary in the expression of Abū Bišr Mattā from the Syriac and the revision by Yaḥyā ibn ʿAdī, there is much struggle (*takalluf*) and departure from the way [things] are said in Arabic (*ḫurūǧ ʿan maḏhab al-ʿarab fī l-kalām*), we mention after every chapter of it something by which we understand it, being in opposition to it afterwards, reporting on the comments of the recent scholars and their additions to the discussion of Themistius and what departs [there] from the truth, as well, and establishing which incoherences it contains. Then at the end of the discussion (*amr*), we prove that it is not possible that there is among the five figures something by which the space can be filled except for the cube, so that no one might think (*kay-mā yaḏunn ḏānn*) that Aristotle's argument is about two figures, one of them the cube and the other not the fiery, but the aerial figure, for example, or another remaining from the five figures, although this is [what] the scribes and translators identify as "fire."[65]

Immediately after this citation, Ibn al-Ṣalāḥ provides the passage in question from *On the Heavens* III.8 in all three Arabic versions available to him. He had already stated in the beginning of his treatise that he found the same mistake in all three versions, which is why he does not need to say more on these translations and instead directly proceeds with Themistius' commentary. One might wonder why he even includes all three citations. The first, obvious reason is that he intends to show that all three versions indeed contain the mistake, namely that the pyramid, which is associated with fire, can fill space as well and not only cubes. There seems to be another reason in addition to that why he includes full citations of this passage. As he explains at the end of the above cited description of his agenda, he is worried that someone might claim that Aristotle did not, in fact, argue specifically that the figure of fire, i.e. the pyramid, fills space, but that some other figure does that. For this purpose, one could suggest that an Arabic copyist changed any other figure to "pyramid" by mistake. Ibn al-Ṣalāḥ points to two ways of refuting such a suggestion. First, he will indeed spend some time at the end of his treatise to argue that the cube is, in fact, the *only* of the five regular bodies filling space.[66] Second, however, the fact that all three versions have "pyramid" (*birāmīsā*, *fūrāmīdis*, or *fūrāmidis*) is a textual indication that the pyramid did not enter the Arabic texts *after* the translation. As further proof, Ibn al-Ṣalāḥ writes that also either the scribes or the translators associated the pyramid with the figure of

[65] Türker Küyel, "İbnüʾş-Ṣalaḥʾın De Coelo," p. 56:12-23

[66] For this set of arguments, see Türker Küyel, "İbnüʾş-Ṣalaḥʾın De Coelo," p. 72:16 – 79:6.

fire, which is a reference to the marginal notes that are still included in the text of Ibn al-Ṣalāḥ's treatise extant to us today. In two of the three translations, namely the versions by Yaḥyā ibn al-Biṭrīq and by ᶜĪsā ibn Isḥāq Ibn Zurᶜa, the marginal notes read "i.e. the [figure of] fire" (*yaᶜnī l-nārī*). This means that Ibn al-Ṣalāḥ copied the marginal annotations from the versions available to him into his own treatise, retaining them as marginal notes, and that he was not certain whether they were added by the translators themselves or by later scribes.[67] We get here another example for Ibn al-Ṣalāḥ's interest in the history of the texts and his careful presentation of the sources available to him.

Ibn al-Ṣalāḥ then devotes the largest part of the treatise (roughly 13 out of 26 pages in the edition by Türker Küyel) to Themistius' commentary, which he cites literally and comments in detail.[68] Some of his comments are merely more detailed accounts of what Themistius means. This owes to the problems of the Arabic rendition of a Greek text to which Ibn al-Ṣalāḥ already refers in the passage cited above. In this way, he acknowledges that some of the dubious points one might notice concerning Themistius' commentary might be caused by the translation process and not by Themistius himself. This is nicely illustrated by one comment by Ibn al-Ṣalāḥ, in which he refers to a gloss "either by the translator or by the revisor." While the glossator tries to make sense out of the Arabic text of Themistius' commentary as it stands, Ibn al-Ṣalāḥ thinks that the confusion is caused by a mistake in the Arabic translation and suggests to change the text.[69] Later, Ibn al-Ṣalāḥ again refers to a gloss either by the translator or by the revisor. While he dismisses the content of this gloss as not pertaining to the question at hand, it is nevertheless important to highlight that Ibn al-Ṣalāḥ identifies the translator of Themistius' commentary with Abū Bišr Mattā and the revisor with Yaḥyā Ibn ᶜAdī and that he had an exemplar at hand with glosses that he traced back to the Baghdad school.[70]

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[67] The Aristotelian citations can be found at Türker Küyel, "İbnüʾṣ-Ṣalaḥʾın De Coelo," p. 56:25 – 57:23. For the marginal notes, which are not printed in the edition, see the outer margin in AS 4830, f. 130v. For the connection of the Greek word *pyramis* with *pyr*, i.e. "fire," see the note by Paul Kraus and Richard Walzer in Galen, *Compendium Timaei Platonis*, p. 15, note to line 3 (Hindu-Arabic pagination). I owe this reference to Lulofs, *Nicolaus Damascenus*, p. 166.

[68] For the extant Latin version, see Themistius, *In libros Aristotelis On the Heavens paraphrasis. Hebraice et latine*, ed. Samuel Landauer (Berlin: Reimer, 1902), p. 197:34 – 199:34.

[69] See Türker Küyel, "İbnüʾṣ-Ṣalaḥʾın De Coelo," p. 63:19 – 64:9.

[70] See Türker Küyel, "İbnüʾṣ-Ṣalaḥʾın De Coelo," p. 68:7-13. For the importance of Ibn al-Ṣalāḥ's testimony for our knowledge of the Arabic translation of Themistius' com-

At least the first of these two instances illustrates that Ibn al-Ṣalāḥ is not entirely dismissive of Themistius' arguments. Especially in the beginning, he approves of them and restricts himself to more detailed explanations. This positive attitude towards Themistius changes drastically in the course of Ibn al-Ṣalāḥ's comments. The reader gets a first idea of his overall critical assessment of Themistius' commentary in the introduction, when Ibn al-Ṣalāḥ points to the possibility that later commentators added the mistake on the pyramid in the text and not Aristotle himself. As an example, he describes a passage on the lunar eclipse in *On the Heavens* II.14 (297b24-31). Whereas Aristotle's text is free from any mistake, Ibn al-Ṣalāḥ points out that one finds an astronomically absurd statement in Themistius' commentary.[71] As for the mistake in *On the Heavens* III.8, Ibn al-Ṣalāḥ reacts with severe criticism to Themistius' attempt to explain that pyramids can fill space and that Aristotle's statement is correct. To put a long story short, he disproves Themistius' arguments by taking recourse to much material from Books X and XIII of Euclid's *Elements*.[72] His excessive use of Euclidean material is no surprise given that five of his extant treatises deal specifically with the *Elements*.[73]

Before he concludes his treatise with the general proof that only one of the five solid bodies fills space, he paraphrases the reply by Yaḥyā Ibn ʿAdī to a question posed by Ibn Zurʿa. Although Ibn al-Ṣalāḥ dismisses Yaḥyā Ibn ʿAdī's reply because he thinks that it does not add anything to the solution of the problem at hand, this is a valuable testimony: both of the interlocutors were part of the translation process of the Arabic *On the Heavens*. Ibn al-Ṣalāḥ provides us with the only direct evidence of Ibn Zurʿa's translation of *On the Heavens*, while he also testifies that Yaḥyā Ibn ʿAdī revised the Arabic translation of Themistius' commentary. Whereas Ibn al-Ṣalāḥ cites the initial question in full, he only paraphrases the reply. In fact, this report only covers roughly a page in Türker Küyel's edition, before Ibn al-Ṣalāḥ then closes his treatise with the proof promised before, namely that only one of the five regular bodies fills space. Unfortunately, he does not inform us in detail how many questions and answers by the two interlocutors were collected and

mentary, see already Coda, "Reconstructing the Text," p. 5, and Endress, "Ibn al-Ṭayyib's Arabic Version," p. 228-229.

[71] See Türker Küyel, "İbnüʾṣ-Ṣalaḥʾın De Coelo," p. 55:18 – 56:2.

[72] For brief summaries, see Türker Küyel, "İbnüʾṣ-Ṣalaḥʾın De Coelo," p. 19-30, and Mueller, "Space-filling Pyramids," p. 165-168.

[73] See again Thomann's list in Thomann, "Al-Fārābīs Kommentar," p. 101-102.

whether this exchange dealt only with *On the Heavens* or other Aristotelian works, as well. He only notes that there are further questions following this one, which he decided to omit because they have no connection to the issue at stake.[74]

Although his references to this question and reply by Ibn Zurᶜa and Yaḥyā Ibn ᶜAdī are kept briefly, it is remarkable that he devotes such a detailed discussion to Themistius' commentary. It is clear that Ibn al-Ṣalāḥ chose to write this treatise not solely on the basis of the mistake in Aristotle's text. Rather, he can use it as a starting point of a much more exhaustive discussion. First, this includes to point out the wrong treatment this issue received also in the commentary tradition, and second, the correct way to solve it, of which he thinks he is the first to achieve that. One can see something similar in the next treatise under discussion, which deals with Aristotle's *Posterior Analytics*.

4. IBN AL-ṢALĀḤ ON TWO CHAPTERS FROM THE *POSTERIOR ANALYTICS*

The last of Ibn al-Ṣalāḥ's treatises that I want to discuss here is the one that received least attention in modern research. Like the previous one on Aristotle's *On the Heavens*, this one is extant in the two witnesses in Istanbul:

- Istanbul, Süleymaniye Kütüphanesi, Ayasofya 4830, f. 158v-160v;
- Istanbul, Süleymaniye Kütüphanesi, Ayasofya 4845, f. 40v-43r.

Mubahat Türker Küyel edited also this treatise and translated it into Turkish, again on the basis of the first of these two witnesses.[75] The full title is: "Commentary on the Chapter at the End of Book II of Aristotle's *Posterior Analytics* and Correction of a Mistake in it."

This treatise differs significantly from the previous two, namely insofar as Ibn al-Ṣalāḥ does not begin with a long introduction. Instead, he directly jumps into the passage from *Posterior Analytics* II.17 (99a17-20):

> Aristotle says at the end of Book II of his treatise *Posterior Analytics* in the translation by Abū Bišr Mattā ibn Yūnus al-Qunnāʾī: "As for the case that the cause, the thing of which it is the cause, and the thing for which it is the cause are related to each other (*lāzima baᶜḍu-hā baᶜḍan*), the situation regarding it is the following: If you take the thing of which it is the cause, in particular, it is wider (*akṯar*). An example of this are the outer angles that

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are equal to four right angles: they are wider (*azyad*) than what belongs to the triangle and the square. As for the case if you take them together, then they are equal. For [it is] all of the things [marginal note: 'i.e. the figures'] the four outer angles of which are equal to four right angles. Then, the middle term is in the same way."[76]

First, he informs us again of the exact source, namely the translation by Abū Bišr Mattā, and indeed his citation closely corresponds to the extant version of this translation.[77] One cannot say that Ibn al-Ṣalāḥ is particularly interested in the wider context of Aristotle's argument here. He quickly explains what Aristotle supposedly means with "the cause," "the thing of which it is the cause," and "the thing for which it is the cause," namely the middle term, the predicate term, and the subject term in a syllogism. Next, however, he continues with the geometrical example to which Aristotle refers twice in the cited passage, namely the observation that the sum of the outer angles of any regular figure is always 360°. In the following longer passage, Ibn al-Ṣalāḥ gives a double proof for this theorem. The first proof shows this theorem to be true for the examples of a triangle, a square, and a pentagon. Ibn al-Ṣalāḥ adds a second proof to that, through which he proves it in a "general way" (*ṭarīq kullī*). The proof is pretty straightforward and builds upon the division of any regular figure into triangles, the angles of each of which are 180° in sum.[78]

Following these two proofs, Ibn al-Ṣalāḥ shows that Aristotle chose the example well and that it indeed illustrates what Aristotle wanted to show in this passage. Only afterwards, he finally comes to speak about the error that he found in the Arabic text of the *Posterior Analytics* and which he has not even briefly mentioned before:

> As for his statement that "for it is all of the things[79] the four outer angles of which are equal to four right angles," this is a mistake by the translator. It ought to read as follows: "For it is all of the things the outer angles of which are equal to four right angles," without specifying by saying "the four outer angles," because the outer angles of a pentagon are five and equal to four right angles, and the outer angles of a hexagon are six and equal to four right angles, and likewise for any other figure to infinity, when the outer angles become more. How many they [might] be, they are [still] equal

[76] Türker Küyel, "İbn uş-Salah comme exemple," p. 21:5-11.

[77] Cf. Badawī's edition in Aristotle, *Manṭiq Arisṭū*, vol. 2, p. 459:8 – 460:1; see also MS Paris, BnF arabe 2346, f. 239r:4-10.

[78] See Türker Küyel, "İbn uş-Salah comme exemple," p. 22:6 – 23:17. For a modern summary and reconstruction, see Heath, *Mathematics in Aristotle*, p. 62-64.

[79] Marginal note: "i.e. the figures."

to four right angles. Thus, there is no sense for his specification of "four." This is a nonsensical error in the translation.[80]

The error that Ibn al-Ṣalāḥ points out in the text is in fact a rather minor one, namely that in the second mentioning of Aristotle's example a superfluous instance of "four" made its way into the text. Especially in comparison to the previously discussed treatises, however, it seems rather strange that Ibn al-Ṣalāḥ ascribes this mistake so quickly to the "translator" (*mutarǧim*). When one thinks of the way in which Ibn al-Ṣalāḥ first compared various earlier commentaries and works in the case of the divergences he found in Ptolemy's star catalogue and of the mistake in Aristotle's *On the Heavens*, it is very surprising that we do not find any trace of a similar strategy here in this respect. First, he does not say whether he tried to access different copies of the same Arabic version by Abū Bišr Mattā in order to exclude a scribal error. It may well be the case that he in fact did do that, although one would expect that he would have let his readers know about such attempts, as he did in the other two treatises. Judging from our modern point of view, he might be right in excluding a scribal error, as the same mistake is indeed also included in the famous witness for the Arabic *Posterior Analytics*, namely the manuscript Paris, BnF arabe 2346 (f. 239r:9). We nowadays also have the Greek version underlying the Arabic translation, in which this mistake is not present.[81] It nevertheless remains odd that Ibn al-Ṣalāḥ, who has cautiously noted down each one of his steps in tracing the origin of certain errors in the previously discussed treatises, now jumps to this conclusion without even mentioning any other possibility. Especially in light of the fact that he wondered so lengthy about the reason why someone such as Aristotle wrote that pyramids can fill space without leaving void interstices, it is not clear why he does not even hint at the possibility that here it was Aristotle's mistake in the first place, as well.

At this point, the reference to the explanation preceding the point of

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[80] Türker Küyel, "Ïbn uş-Salah comme exemple," p. 24:5-12.

[81] In the following, I will compare the Arabic texts of the *Posterior Analytics* in Ibn al-Ṣalāḥ's treatise to other extant versions, for example Gerard of Cremona's Latin translation, for which he relied not only on Abū Bišr Mattā's Arabic translation, but also on a second translation that is a revision of Abū Bišr Mattā's text. Here, it is noteworthy that Gerard's rendition does not include this mistake of adding "four" to the text. See Aristotle, *Aristoteles Latinus. IV.3. Analytica Posteriora Gerardo Cremonensi interprete*, ed. Lorenzo Minio-Paluello (Brussels, Paris: Desclée de Brouwer, 1954), p. 94:7-8. If we rule out the possibility that it was a scribal error (following Ibn al-Ṣalāḥ), either this mistake was already corrected by the anonymous reviser (perhaps an otherwise unknown figure with the name Marāyā) or Gerard noticed it and omitted "four."

critique is of some help. As just explained, Ibn al-Ṣalāḥ describes there the way in which this geometrical example helps Aristotle in making the desired point, which is slightly different from the case of the mistake from his *On the Heavens*, in the context of which he replied to a Platonic theory. In addition, this geometrical example was a well-known theorem. This means that if the mistake goes back to Aristotle himself, it must have indeed been a slip. Perhaps Ibn al-Ṣalāḥ supposed that Aristotle would not commit such an easy mistake, especially since he needs the example to concern precisely not only a figure with four outer angles, but with any number of outer angles to make the argument work. When we think about Aristotle's example in this way, it seems indeed more likely – from the point of view of Ibn al-Ṣalāḥ – that the mistake made its way into the text in the course of the translation.

Another explanation possibly is that Ibn al-Ṣalāḥ had access to yet another Arabic version. This is suggested by Ibn al-Ṣalāḥ himself in the second part of this treatise where he describes that Aristotle used the same geometrical example not only this one time in Chapter II.17, but also before in Chapter I.24 (85b27-86a5). The main bulk of this second part is devoted to a critical assessment of Avicenna's engagement with this example from *Posterior Analytics* I.24 in two of his works. I will briefly summarize this discussion below. More important, however, is the passage with which Ibn al-Ṣalāḥ finishes his treatise. This is a citation from another translation, which he calls the "old translation," and contains this first allusion to the same geometrical example from Chapter I.24:

> This section can be found in Aristotle's *Posterior Analytics* in the old translation in a correct way.[82] We report the section [here] in this translation. Aristotle says: "There [marginal note: 'namely at the universal'] one comes to an end in the search for the why. Then we think to know, if there is no other thing except that which either comes to be (*kāʾin*) or is (*huwa*). The completeness and the end is the most final end (*aḫīr*), which is according to that state. An example is this: 'Why does someone come?' Then we say: 'To take money; and this for what is his duty; and this so that he is not unjust.' When we say that [and] when it [cannot] be likewise [the case] because of something else and not from another thing, but from this [only], we say that we came to the completeness, which is and comes to be. It is then most appropriate that we know why he came. If this is like that for all causes and for [the things] from which the what [comes about], and if it is thus most appropriate that we know likewise for all [things] that are causes, as well,

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[82] The reading of the last word of this sentence is not without difficulty. For my translation, I read *muġawwidan* with some hesitance.

similar to that from which it is, then ultimately it is thus appropriate that we know if nothing else remains which is the cause for that. Thus, when we know that the outer [angles] are equal to four angles [marginal note: 'namely right angles'] and that the triangle is an isosceles, it remains also [to say] why the triangle is an isosceles. This is because it is a triangle, and this is a figure with rectilinear lines. Therefore, if[83] there is no other thing, it happens to become most appropriate that we know the universal and then also in a universal way. Therefore, the universal is better."[84]

This citation is of particular interest as it may indicate the existence of a hitherto unknown Arabic translation of Aristotle's *Posterior Analytics*.[85] The translation by Abū Bišr Mattā, which Ibn al-Ṣalāḥ had cited for his reference to *Posterior Analytics* II.17, is well-known through the medieval bibliographical literature, through the extant manuscript tradition as well as through the modern edition by ʿAbd al-Raḥmān Badawī.[86] There are also traces of another translation that must be understood as a revision of Abū Bišr Mattā's translation. This version has been used together with Abū Bišr Mattā's translation by Gerard of Cremona for his Latin translation and by Averroes in Book I of his *Long Commentary* as well as in his *Middle Commentary* on the *Posterior Analytics*. In addition, there are two marginal notes in MS Paris, BnF arabe 2346 that refer to a version by an unidentified "Marāyā." These two brief notes do not suffice to make a statement about the relation of this "Marāyā" to the revised version used by Gerard and Averroes.[87]

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[83] Reading *iḏā* instead of *iḏan*, which is suggested in AS 4830, f. 160v:18.

[84] Türker Küyel, "İbn uṣ-Salah comme exemple," p. 26:17 – 27:10.

[85] For the brief remarks by Türker Küyel on this translation, see Türker Küyel, "İbn uṣ-Salah comme exemple," p. 6.

[86] For the references to and summaries of the entries in Ibn al-Nadīm, al-Qifṭī and Ḥāǧǧi Ḫalīfa as well as the extant manuscripts see Moritz Steinschneider, *Die arabischen Übersetzungen aus dem Griechischen* (Leipzig: Harrassowitz, 1897), p. 43; Brockelmann, *GAL Suppl I*, p. 370; and Peters, *Aristoteles Arabus*, p. 17-20. For Badawī's edition, see Aristotle, *Manṭiq Arisṭū*, ed. ʿAbd al-Raḥmān Badawī, 3 vol., (Cairo: Maktabat Dār al-kutub al-miṣriyya, 1948-1952), here vol. 2, p. 309-465; for critical remarks on this edition, see Richard Walzer, "New Light on the Arabic Translations of Aristotle," *Oriens*, 6 (1953), p. 91-142, here esp. p. 134-141.

[87] For previous comparisons between the two versions with reference to Abū Bišr Mattā's translation, to Averroes and to Gerard, see the introduction by Lorenzo Minio-Paluello in Aristotle, *Aristoteles Latinus. Analytica Posteriora*, p. XV-XXVII, Walzer, "New Light," p. 130-131, and Helmut Gätje and Gregor Schoeler, "Averroes' Schriften zur Logik. Der arabische Text der *Zweiten Analytiken* im *Großen Kommentar* des Averroes," *Zeitschrift der Deutschen Morgenländischen Gesellschaft*, 130 (1980), p. 557-585, here p. 567-585. More recently, Riccardo Strobino has casted light on Avicenna's reception of the two versions, see Riccardo Strobino, "Avicenna's Use of the Arabic Translations of the Posterior Analytics and the Ancient Commentary

How does the version that is cited here by Ibn al-Ṣalāḥ fit into that story? A first sign that it may have been yet another version, independent from the previously known ones, is the fact that Ibn al-Ṣalāḥ refers to it as an "old translation." Unfortunately, he does not provide any further information about his source. For a better comparison, here is again his description of the different translations of *On the Heavens*:

> When I refused to acknowledge that (*fa-lammā ankartu ḏālika*), I thought that this might rather be a mistake by the translator (*mutarǧim*) of this treatise, namely Yaḥyā ibn al-Biṭrīq. So I investigated it in the translation (*naql*) of Abū ʿAlī ʿĪsā ibn Zurʿa for this treatise from Syriac into Arabic. I found that the passage was the same, and likewise in the translation (*naql*) of Abū l-Faraǧ ʿAbdallāh ibn al-Ṭayyib from Syriac into Arabic.[88]

Ibn al-Ṣalāḥ does not only always give the name of the translator, but also from which language the respective translation has been made. Such an account is entirely missing from his description of this mysterious alternative translation of the *Posterior Analytics*. Despite our lack of any further knowledge about the source, one can compare the citation to the corresponding passages in the version by Abū Bišr Mattā, in Averroes' lemmata from his *Long Commentary*,[89] and in Gerard's Latin translation. As already mentioned, both Averroes and Gerard have made use not only of Abū Bišr Mattā's translation, but also of the revised version. This means that a comparison between these sources can bring to light whether the translation cited by Ibn al-Ṣalāḥ could be the same as the second translation, of which we only know that it was a revised version of Abū Bišr Mattā's translation and that it has been used by Averroes and Gerard. Against this thesis speaks Ibn al-Ṣalāḥ's report since he calls it, supposedly in comparison to Abū Bišr Mattā's translation, the "old" translation. The following comparison will further strengthen the other possibility, namely that we indeed have here a citation from a version completely independent from the two translations already known.

For this comparison, I present here the Arabic texts of both versions, namely by Abū Bišr Mattā and the one that is cited by Ibn al-Ṣalāḥ, together with the Latin texts of Gerard's translation and Averroes' *lemma*

Tradition," *Oriens*, 40 (2012), p. 355-389. I benefitted greatly from this last article, which contains references to the most important sources.

[88] See again Türker Küyel, "İbnüʾṣ-Ṣalaḥʾın De Coelo," p. 54:18-21.

[89] In the *Middle Commentary*, the passage in question is paraphrased by Averroes in a way that it cannot serve for the purpose of a comparison between the three versions. Cf. Averroes, *Šarḥ al-Burhān li-Arisṭū wa-talḫīṣ al-Burhān*, ed. ʿAbd al-Raḥmān Badawī (Kuwait, 1984), p. 103:23 – 104:4.

from his *Long Commentary*. As for the latter, the extant Arabic version does not reach the passage in question; most unfortunately, it breaks off at the end of (what is nowadays) Chapter I.23 and therefore directly before the passage in question.[90] This is why we need to rely on the two Latin translations from the 16th century that are included in Junta's edition for Chapter I.24. I confine myself to the second half of the cited passage, in which the example of the outer angles of regular figures is described, because it is here that one can see the differences most clearly (and, in fact, this is also the passage in which Ibn al-Ṣalāḥ is so interested).

Text I) tr. by Abū Bišr Mattā (ed. Badawī):

فإن كان الأمر في سائر العلل وفي لم الشيء يجري على هذا المثال وكان في جميع العلل التي هي على هذا النحو علل على أنّها نحو ماذا هكذا تعلم خاصّة فإذًا في تلك الأخر أيضًا الباقية حينئذ يعلم أكثر متى لم يوجد هذا من أجل شيء آخر. فمتى علمنا أنّ الزوايا الخارجة مساوية لأربع قوائم من قبل أنّه متساوي الساقين فذلك ناقص. ولماذا هو بما هو متساوي الساقين؟ فيقال إنّه من أجل أنّه مثلّث وهذا من أجل أنّه شكل مستقيم الخطوط. وإن كان هذا ولا يوجد حينئذ شيء آخر هو من أجله فحينئذ نعلم أكثر والكلّي أيضًا فحينئذ نعلمه. فالكلّي إذًا أفضل.[91]

Text II) "old translation" (cited by Ibn al-Ṣalāḥ, ed. Türker Küyel):

وإذا كان مثل ذلك في جميع العلل وفي التي لمكان ماذا وكنّا أن نعلم هكذا في جميع التي هي علل هكذا مثل الذي لكمانه فإنّا في الأخر إذن حينئذ أحرى أن نعلم إذا لم يبق شيء آخر هو علّة لهذا فإنّا إذا علمنا أنّ الخارجة مساوية لزوايا أربع يعني القوائم[92] وأنّ المثلّث متساوي الساقين يبقى أيضًا لم المثلّث المتساوي الساقين وهو لأنّه مثلّث وذلك شكل مستقيم الخطوط فإذا لم يبق شيء آخر هذا حينئذ أحرى أن نعلم الكلّي وحينئذ أيضًا بنوع كلّي فالكلّي إذًا أجود.[93]

Text III) tr. by Gerard of Cremona (ed. Minio-Paluello):

Cum ergo res, in reliquis causis apud interrogationem per quare, currat secundum hunc modum, *et scientia currat secundum hunc modum in causis que sunt cause secundum semitam finis, tunc in causis reliquis cadit scientia iterum secundum verificationem quando cadit scientia per causam verificatam. Et iterum si scimus quod* anguli trianguli extrinseci *sunt equales quatuor rectis, et est causa in hoc quia scimus illud esse trianguli duorum equalium crurium,* est scientia nostra diminuta; *quod est quia nos redimus et querimus et dicimus: "quare quando duorum equalium crurium est* cum

[90] See Gätje, Schoeler, "Averroes' Schriften," p. 569-570.
[91] Aristotle, *Manṭiq Arisṭū*, vol. 2, p. 388:16 – 389:8.
[92] *Yaʿnī l-qawāʾim*: marginal addition.
[93] Türker Küyel, "İbn uṣ-Salah comme exemple," p. 27:4-10.

hac proprietate*?" tunc* dicitur *"quoniam est triangulus;"* et "quare quando est triangulus?"*, et* dicitur *"quoniam est figura rectilinea." Et quando cadit responsio cum hac causa, non invenitur causa alia esse illius super propter quam; tunc cadit scientia vera de hac re. Et hec causa ultima, per quam scitur illud, est universale; ergo scientia per universale est melior.*[94]

Texts IVa+b) *lemma* in Averroes' *Long Commentary* (ed. Junta):

(tr. by Abraham de Balmes) *et quando reliquarum causarum dispositio apud sua quesita, cur sit,* hoc gressu procedit*, et scientia causarum, que sunt ut finis causae, hoc modo procedit: de aliis itaque causis occurrit etiam scientia secundum veritatem, quando incidit scientia verae causae. Ac etiam si sciverimus quod* trigoni exteriores anguli *sint quatuor rectis equales:* et causa qua nos habeamus hanc scientiam fuerit*, quia si trigonus isocheles,* sit nostra scientia imperfecta*:* nos enim redimus, et quaerimus*: et cur isocheles fuit* huiusmodi*?* Et dicetur*, quia est trigonus: et* cur dum trigonus est*;* et dicetur *quia figura rectilinea sit: et dum haec causa occurrit non invenitur alia causa, qua haec fuerit: et apud hanc incidit vera huius rei scientia: et hec ultima causa, qua haec sit, est ipsa universalis: igitur, scientia itaque de universali est potior.*[95]

(tr. by Johannes Franciscus Burana) *cum dispositio in reliquis causis de quesitis propter quod* procedet hunc in modum*: et scientia procedet hoc pacto in causis, que sunt causae per modum finis: in reliquis igitur causis cadet scientia consimiliter et secundum veritatem: cum ceciderit scientia in causis veris. Consimiliter etiam si sciverimus, quod* anguli trianguli extrinseci *sunt equales quatuor rectis,* et fuerit causa in eo*, quod scimus hoc, esse triagulum equicrurem:* scientia utique nostra erit diminuta*: et hoc,* quoniam nos redibimus, et interrogabimus*: propter quod equicrus est cum* hac dispositione*? Et* dicetur *quoniam est triangulus: et* propter quod est triangulus? *Quoniam est figura rectilinea: cumque deciderit responsio in hanc causam, non invenietur causa alia propter quam sit haec causa, et ad hoc cadet scientia vera in hanc causam: et haec causa ultima, per quam scitur hoc, est universalis: scientia igitur per universale est melior.*[96]

The most glaring divergences between these versions can be divided into two categories. First, there are differences solely between the old version cited by Ibn al-Ṣalāḥ (Text II) on the one hand and all other versions on the other hand: see tab. 1.

In all of these examples, one can clearly see that the translation cited

[94] Aristotle, *Aristoteles Latinus. Analytica Posteriora*, p. 51:11-26.

[95] Aristotle, *Aristotelis opera cum Averrois commentariis. Vol. I. Part. 2a* (Venice: apud Iunctas, 1562; repr. Frankfurt am Main: Minerva, 1962), here p. 351v:16-40 (left column entitled "Abram").

[96] Aristotle, *Aristotelis opera cum Averrois commentariis. I.2a*, p. 351v:17-40 (right column entitled "Burana"). I thank Colette Dufossé for her help with the Latin transcriptions.

TAB. 1

Text I	Text II	Text III	Text IVa	Text IVb
yaǧrī ᶜalā hāḏā l-miṯāl	[missing]	*currat secundum hunc modum*	*hoc gressu procedit*	*procedet hunc in modum*
min qibal anna-hū	*wa-anna*	*et est causa in hoc quia scimus*	*et causa qua nos habeamus hanc scientiam fuerit*	*et fuerit causa in eo*
fa-ḏālika nāqiṣ	[missing]	*est scientia nostra diminuta*	*sit nostra scientia imperfecta*	*scientia utique nostra erit diminuta*
fa-yuqālu	[missing]	*tunc dicitur*	*et dicetur*	*et dicetur*

by Ibn al-Ṣalāḥ (Text II) lacks certain aspects of the text that can however be found in each one of the other sources. In addition, Texts III, IVa and IVb have the addition of *scientia* in comparison to Abū Bišr Mattā's translation (Text I). This could already indicate that Gerard's translation and Averroes' *lemma* depend on an addition, perhaps by the anonymous revisor of Abū Bišr Mattā's translation. This, in fact, is the second category of divergences between these versions. There are some instances, in which the Latin texts apparently do not correspond to Text II (as in tab. 1) and neither to Text I: see tab. 2

The most obvious divergences in tab. 2 are the longer additions in Texts III, IVa and IVb. These additions, which do not have a basis in the Greek text, obviously serve the function to structure the example more coherently in the following way: "then it is said / asked: why *x*; to this, it is said: because *y*." Both in Abū Bišr Mattā's translation as well as in Ibn al-Ṣalāḥ's citation (Texts I and II) these structural elements appear only rudimentary, although one can see in the last example of tab. 1 that also Abū Bišr Mattā's version (Text I) has one additional of these elements in comparison to the version cited by Ibn al-Ṣalāḥ (Text II). For this instance, then, one can clearly see again that this short addition is present in the other three versions (Texts III, IVa and IVb).

This comparison is only possible for the short passage of which we have Ibn al-Ṣalāḥ's citation, so the textual basis could be better. Never-

TAB. 2

Text I	Text II	Text III	Text IVa	Text IVb
al-zawāyā al-ḫāriǧa	*al-ḫāriǧa*	*anguli triranguli extrinsici*	*trigoni exteriores anguli*	*anguli trianguli extrinseci*
[missing]	[missing]	*quod est quia nos redimus et querimus et dicimus*	*nos enim redimus, et quaerimus*	*quoniam nos redibimus, et interro-gabimus*
wa-li-māḏā huwa bi-mā huwa mutasāwī l-sāqayn	*yabqā ayḍan li-ma l-muṯallaṯ al-mutasāwī l-sāqayn*	*quare quando duorum equalium crurium est cum hac proprietate*	*et cur isocheles fuit huiusmodi*	*propter quod equicrus est cum hac dispositione*
[missing]	[missing]	*quare quando est triangulus*	*cur dum trigonus est*	*propter quod est triangulus*
[missing]	[missing]	*et dicetur*	*et dicetur*	[missing]

theless, it clearly shows two things. First, there are even in this short paragraph many textual elements that do not appear in Ibn al-Ṣalāḥ's citation, but do so in Abū Bišr Mattā's translation and in the texts by Gerard and Averroes, which have been shown by previous scholarship to be based on Abū Bišr Mattā's translation as well as on the second revised version (tab. 1). Second, there are also divergences between Abū Bišr Mattā's version on the one hand and Gerard's and Averroes' versions on the other hand (tab. 2). The fact that these larger additions appear equally in all the three witnesses of Gerard's and Averroes' versions suggest that these probably go back to the second known Arabic translation. Interestingly, these additions also lack analogous counterparts in the version cited by Ibn al-Ṣalāḥ, which strongly suggests that this version cited by Ibn al-Ṣalāḥ is not only distinct from the one by Abū Bišr Mattā (which is obvious on the basis of the different Arabic texts), but also from this anonymous revision to which we only have indirect access on the basis of Gerard and Averroes.

The fact that this version does not correspond to the version revised

from Abu Bišr Mattā's text nicely conforms to the fact that Ibn al-Ṣalāḥ calls it "the old translation." The designation "old" (*qadīm*) surely must be understood in relative terms, namely that it precedes the one by Abū Bišr Mattā that he had cited in the beginning of his treatise. The only references in the medieval bibliographers to versions of the *Posterior Analytics* previous to the one by Abū Bišr Mattā are to two Syriac translations, namely the complete one by Isḥāq ibn Ḥunayn, which was the exemplar of Abū Bišr Mattā's translation into Arabic, and a partial one by his father Ḥunayn ibn Isḥāq.[97] But there is no sign that this truncated version also made its way into Arabic.

In fact, the question whether we deal here with a complete or just a partial translation could relate to the question why Ibn al-Ṣalāḥ does not refer to this "old" translation already before in the context of the mistake he found in Abū Bišr Mattā's version of *Posterior Analytics* II.17. After all, this was his first idea when he encountered the error in *On the Heavens* III.8: he compared the three different translations that were available to him in order to find out whether they all share the same mistake or whether it can only be found in some of them. The fact that Ibn al-Ṣalāḥ now quickly ascribes the mistake in *Posterior Analytics* II.17 to the translator, namely Abū Bišr Mattā, could suggest that he was able to compare Abū Bišr Mattā's to this other, "old" translation. This seems rather unlikely, however, given his silence on such a comparison. Again, one should consider his other treatises, in which Ibn al-Ṣalāḥ documents meticulously his own method. It seems, therefore, more likely to assume that he did not have access to this "old" translation for Chapter II.17. Given that this citation by Ibn al-Ṣalāḥ is the only reference known so far, we cannot know for sure at the present state whether the "old" translation was only a partial one from the outset or whether it was complete, but only parts of it made their way up to Ibn al-Ṣalāḥ. The meager information on this translation that we receive from Ibn al-Ṣalāḥ, who is usually well-informed about his sources, fits to the fact that such an earlier version of the Arabic *Posterior Analytics* is not mentioned in any bibliographical work.

In sum, there is not much we learn about this version, with the very important exception, however, that the citation by Ibn al-Ṣalāḥ does not correspond to any of the known versions of the *Posterior Analytics*, either in Arabic or in its Latin translation by Gerard. There may or may not be a connection to the otherwise unknown "Marāyā;" this version

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[97] See Ibn al-Nadīm, *Kitāb al-fihrist*, ed. Gustav Flügel, 2 vol. (Leipzig: Vogel, 1871-1872), here vol. 1, p. 249:11-12.

may have been a complete translation or just a partial one; it may have been made from Syriac or even directly from Greek. Nevertheless, Ibn al-Ṣalāḥ provides us with a fragment of a hitherto unknown Arabic version of the *Posterior Analytics*, which supposedly predates the one made by Abū Bišr Mattā. Thus, there seems to have existed at least three Arabic versions of the *Posterior Analytics*, namely the famous one by Abū Bišr Mattā, a revision of that, and a third one predating these two versions (of these latter two, one may be connected to Marāyā).

While the citation from *Posterior Analytics* I.24 might be the most interesting aspect of Ibn al-Ṣalāḥ's short treatise for the historian of philosophy, the second part of it deals mostly with the way in which Avicenna uses this example in two of his works. Before I conclude my discussion of Ibn al-Ṣalāḥ's method in these three treatises, I summarize his critical engagement with Avicenna concerning the *Posterior Analytics*. As he writes in the beginning of this second part, Avicenna refers to the example of the outer angles of regular figures only in his comparison of the universal and the particular demonstration, which is the topic of *Posterior Analytics* I.24, and not in his discussion of Chapter II.17:

> Avicenna mentions this example, when he talks about the *Posterior Analytics* in his treatise entitled *Al-šifāʾ* and in his treatise entitled *Al-awsaṭ al-ǧurǧānī* and makes a mistake about it in both treatises. He makes the example particular, namely when he wants to confront (*yuḥāḏī*) Aristotle's argument in the *Posterior Analytics* on the superiority, about which he talks in Book I, namely that the universal proof is superior to the particular. For Aristotle mentions this example in two places of his treatise, the first in Book I in the chapter[98] we [just] mentioned here, and the second in Book II in the passage that we have presented[99] in the translation of Abū Bišr. As for Avicenna, may God have mercy upon him, he mentions the example concerning the aforementioned [passage] from Book I and makes it particular and omits it from Book II alone. We report the chapter with the text of both [passages] by Avicenna in his two works.[100]

These references do not pose major difficulties or surprises for the modern reader because both works are extant. Ibn al-Ṣalāḥ adds full citations of the passages in question from both treatises.[101] In both

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[98] Reading *fī al-šakl* with AS 4845, f. 42r:16, which is illegible in AS 4830, f. 159v:23.

[99] I am not certain about the reading of the following word, which is written as *ḥ-d-y-ā* in both manuscripts. Türker Küyel's edition reads *ḥadīṯan*.

[100] Türker Küyel, "Ïbn uṣ-Salah comme exemple," p. 24:13 – 25:3.

[101] These citations conform mostly with the text that can be found in the modern editions. See Türker Küyel, "Ïbn uṣ-Salah comme exemple," p. 25:4 – 26:10; cf. Avicenna, "Al-burhān," in *Al-šifāʾ. Al-manṭiq*, vol. 3, part 5, ed. Ibrāhīm Madkūr (Cairo: Dār al-Kitāb al-ʿArabī li-l-Ṭibāʿa wa-l-Našr, 1956), p. 51-484, here p. 240:15 – 241:9 for

texts, Avicenna follows closely the structure of Aristotle's argument and gives the same two examples for the investigation of the ultimate cause, namely the example of the debtor and the one of the outer angles of a regular figure. Ibn al-Ṣalāḥ points out that Avicenna does not apply the second example correctly. His point of criticism is here, however, different from the mistake of the translator he found in Abū Bišr Mattā's translation of Chapter II.17 of the *Posterior Analytics*. Avicenna fails to formulate the example of the outer angles in a universal way in his paraphrase of Chapter I.24. As Ibn al-Ṣalāḥ had described in his explanation of this geometrical argument, the universal demonstration entails that the outer angles of *any* figure with regular lines are equal to four right angles. Instead, Avicenna stops his investigation at the level of the triangle and fails to point out that the ultimate cause for the sum of the outer angles is not the fact that the figure is a triangle with three sides, but that the sides are straight, regardless of whether it is a triangle, a square, a pentagon, or any other regular figure:

> This is what Avicenna explains in these two treatises. On account of what we have previously said in the commentary of the preceding section it is known that [the claim] is not universal, namely "that it is a figure that is circumscribed by three straight lines," and the *why* does not stop at this reply. However, the [following] is universal, namely "that it is a perfect (*muṭlaq*) figure that is circumscribed by straight lines, may it be a triangle, a square, a pentagon, or any other figure with straight lines." If it is replied by that, the *why* stops because there is nothing universal above that, more general than it for its reason [why] the outer angles are equal to four right angles.[102]

I have pointed out some differences between Ibn al-Ṣalāḥ's two treatises on the *Almagest* and *On the Heavens* on the one hand and this third work on the *Posterior Analytics*. We have seen that these first treatises included proper introductions in which Ibn al-Ṣalāḥ explains how he encountered the problem under discussion as well as exhaustive overviews of the various sources he was able to consult. This last treatise on the *Posterior Analytics* turns out to be rather concise in comparison. Instead of an introduction, Ibn al-Ṣalāḥ directly jumps into the Aristotelian text and in the following only refers to Avicenna as an additional source. Despite such differences, this way of citing and criticizing Avicenna is closer to the method especially in his treatise concerning *On the Heavens*. Ibn

the passage in *Al-šifāʾ* and Avicenna, *Al-muḫtaṣar al-awsaṭ fī l-manṭiq*, ed. Seyyed Mahmoud Yousofsani (Tehran: Iranian Institute of Philosophy, 2017), p. 301:4-12 for *Al-awsaṭ al-ǧurǧānī*. There is only one lacuna in Ibn al-Ṣalāḥ's version of the Avicenna's *Al-awsaṭ*, which can be filled with the modern edition.
[102] Türker Küyel, "İbn uṣ-Salah comme exemple," p. 26:11-17.

al-Ṣalāḥ uses here the opportunity to point out Avicenna's wrong use of this example, for which he has discovered a mistake in the Arabic translation by Abū Bišr Mattā. Given the lengthy citations not only from one, but from two of Avicenna's works, it seems that the correction of Avicenna's mistake has at least the same importance for Ibn al-Ṣalāḥ as the one in the Arabic version of Aristotle. Interestingly, this can already be seen in Ibn al-Ṣalāḥ's presentation of the geometrical proof of this example. As I described above, he presents both the "particular" demonstration as well as the "general" demonstration in order to show that this example, in fact, applies to any regular figure and not only those that are mentioned by Aristotle. This "universal" demonstration does not only help him for his argument on the mistranslation by Abū Bišr Mattā, but also for showing that Avicenna wrongly made use of the Aristotelian example. Therefore, we find here the same motivation to write this short treatise as for the other two treatises. The major bulk of his treatise on *On the Heavens* is not concerned primarily with the Aristotelian text, but rather with the entire citation from Themistius' commentary and a critical assessment of it. Even more so, he adds a paraphrase of the exchange between Yaḥyā Ibn ᶜAdī and Ibn Zurᶜa and takes his time to refute Yaḥyā Ibn ᶜAdī's explanations in detail. His interest not only lies on the identification and removal of mistakes he finds in the Aristotelian texts, but equally also on later commentaries. In this respect, one can compare the two treatises on *On the Heavens* and *Posterior Analytics* with each other. As in the case of his treatise on *On the Heavens*, Ibn al-Ṣalāḥ equally first points at the problem in the Aristotelian text, but then spends a considerable part of his treatise with lengthy citations to the two Avicennean works. He is thus able to show that the geometrical example in question is not only faulty in his transmission from Greek to Arabic, but also caused some problems for later authors, in this case even for Avicenna. This focus on how certain issues pervaded philosophical and scientific works from Aristotle up to his own time in different languages is the most remarkable feature of Ibn al-Ṣalāḥ's method.

5. CONCLUSION
AND COMPARISON TO OTHER TREATISES BY IBN AL-ṢALĀḤ

Ibn al-Ṣalāḥ's treatises on Ptolemy and Aristotle share very interesting and important characteristics. The works discussed in this article are not only devoted to some mistakes in the primary sources available to Ibn al-Ṣalāḥ. Of course, the starting points of every treatise are errors

in the Arabic versions, which go back either to the translation process or (as in the case of *On the Heavens*) to Aristotle himself. It is nevertheless the most important feature of Ibn al-Ṣalāḥ's method that he points not only to these primary texts, but tries to show that the Greek and Arabic commentary tradition copies the same errors again and again or even introduces new problems as in the case of Themistius' commentary on the *On the Heavens* and of Avicenna's logical part of the *Kitāb al-šifāʾ*. This was surely a decisive motive for Ibn al-Ṣalāḥ to write these treatises, namely the fact that some mistakes are repeated from the time of Aristotle and Ptolemy through their commentators up to the 12th century CE. For the modern historian, these enumerations of and partial citations from the different textual versions available in 12th century Baghdad and Damascus are incredibly valuable witnesses. For Ibn al-Ṣalāḥ, they serve as the main reason to write his treatises in the first place, as he would not need to do so if the late ancient Greek commentators had discussed these problems in much detail or if wrong translation had been corrected before by Arabic authors.

The shared methodology in Ibn al-Ṣalāḥ's treatises can also easily be seen in his writing style. In the introduction of his work on Ptolemy's star catalogue, he describes the first steps of his research in the following way:

• Finding the mistake: *lammā taʾammaltu* […] *raʾaytu* […] ("When I read […] I saw […]");

• Investigation of other sources: *fa-lammā raʾaynā* […] *baqīnā zamānan* […] ("When we saw […] we spent some time […]");

• Comparison of translations: *wa-lammā yaʾisnā* […] *baḥaṯnā* ("When we gave up […] we investigated […]");

• Starting one's own investigation: *wa-lammā raʾaytu* […] *qaṣadtu ilā* […] ("When I saw […] I turned to […]").[103]

This can be compared to the style in which Ibn al-Ṣalāḥ describes similar steps in his treatise on *On the Heavens* III.8:

• Finding the mistake: *qad kuntu lammā intahā bī l-naẓar* […] *anʿamtu l-naẓar* […] *fa-raʾaytu* […] ("When my investigation arrived at […] I devoted the investigation […]. Then, I noticed […]");

• Comparison of translations: *fa-lammā ankartu* […] *tawahhamtu* […] *fa-naẓartu-hū* […] *fa-raʾaytu* […] ("When I refused to acknowledge […] I thought […]. So, I investigated it […] I found that […]");

• Investigation of other sources: *fa-lammā naẓarnā* […] *raʾaynā-hu*

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[103] Ibn al-Ṣalāḥ, *Zur Kritik der Koordinatenüberlieferung*, p. 152:8-9; 155:11; 156:7-8; 158:6-7.

[…] ("When we investigated […] we saw that […]");
- Starting one's own investigation: *wa-lammā yaʾistu*[104] […] *raʾaytu iḏan* […] ("When I gave up […] I thus saw […]").[105]

These two treatises on Ptolemy and Aristotle are, therefore, very close to each other not only in their general outline, but also on a stylistic level. In fact, these two aspects are mutually dependent. On the one hand, the similar structure of the texts naturally leads to a similar wording. On the other hand, Ibn al-Ṣalāḥ probably chose to use the terminology throughout his works deliberately in order to highlight the fact that he follows the same methodology throughout his works. This point deserves further attention especially in light of his statement already cited above from his treatise on Ptolemy's star catalogue:

> I noticed (*wa-raʾaytu*) that I leave behind a method for the lovers of truth in this [field], [a method] which they can follow.[106]

This means that Ibn al-Ṣalāḥ is convinced that his own method should be applied to any philosophical investigation. By structuring his texts along the same way with the same terminology he leaves a clear example for his successors.

Accordingly, we can take Johannes Thomann's assertion that Ibn al-Ṣalāḥ's works share a general "critical character" even further. One can easily extend such a comparison to other treatises by Ibn al-Ṣalāḥ. I have already briefly mentioned his treatise on the so-called "fourth figure" that was ascribed to Galen. Ibn al-Ṣalāḥ opens this logical treatise with a short introduction, the first part of which is a description of the Arabic tradition of the "fourth figure."[107] He refers to Avicenna's *Kitāb al-šifāʾ*, to the commentary on the *Prior Analytics* by Abū l-Faraǧ ibn al-Ṭayyib, to al-Saraḫsī's epitome on the same work, to al-Kindī's rejection of the fourth figure, and lastly to a work by al-Fārābī not available to him.[108] The conclusion of this enumeration is that these authors do not consider the fourth figure as an important or even necessary instrument in logic. In the second part of his introduction, Ibn al-Ṣalāḥ first states that he did not find any discussion of the fourth figure either in Aristotle, Alexander, Porphyry, or even Galen himself. He admits that

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[104] Reading with AS 4830 f. 130r:5 *yaʾistu* instead of *y-b-b-t*.

[105] Türker Küyel, "Ïbnüʾş-Şalaḥʾın De Coelo," p. 53:8, 12-13; 54:18-20; 55:18; 56:3.

[106] Ibn al-Ṣalāḥ, *Zur Kritik der Koordinatenüberlieferung*, p. 151:11-12.

[107] For the entire introduction which I summarize in the following, see Rescher, *Galen and the Syllogism*, p. 76:1 – 77:2 (Arabic text) and p. 52-54 (English translation).

[108] There is an interesting parallel to al-Fārābī's comments on *On the Heavens* that Ibn al-Ṣalāḥ was not able to access in Baghdad. See above p. 218. Apparently, it was difficult to get hands on some of al-Fārābī's works even in 12th-century Baghdad.

he did not have access to all of Galen's logical writings, albeit that he says he knew their titles through Ibn al-Nadīm's *Fihrist*. The most important motive to write his treatise, however, is not Galen's supposed authorship, but yet again some errors in the presentation of the fourth figure in a treatise by a Christian author called "*Dinḥā l-qaṣṣ*." Because he found this treatise defective for a number of reasons, he decided to study the fourth figure in detail and to provide a proper explanation in this treatise. This is, therefore, the same kind of introduction with which we are now so familiar through his works on Ptolemy and Aristotle. The introduction includes a list of sources available to him, both Arabic and originally Greek, and the observation of certain mistakes that need to be corrected. Furthermore, there are again similarities in his terminology to structure the different steps of his investigation:

- List of Arabic sources: *in-nā waǧadnā* […] ("We have found […]");
- Finding the mistake: *fa-lammā taʾammalnā-hā waǧadnā-hā* […] ("When we read it, we found that it […]");
- Starting one's own investigation: *fa-lammā raʾaynā ḏālika baḥaṯnā* […] ("When we saw that, we investigated […]").[109]

These parallel expressions again illustrate Ibn al-Ṣalāḥ's general method in his treatises. As described above, most of his works still await critical editions and translations. Without diving too deeply into these unedited works, one can also point at least to two further treatises for comparison. Richard Lorch already provided a brief summary of his treatise "On the Projection of the Surface of the Sphere." This work, again, starts with an introduction in which Ibn al-Ṣalāḥ provides an overview of previous works on this topic, namely by Ptolemy, Pappus, Ḥabaš al-Ḥāsib, al-Farġānī, al-Bīrūnī, and Kūšyār ibn Labbān. He then goes on to say that some of these works focus too much on the theory, while others only contain the practical aspect of the construction of an astrolabe. As Richard Lorch describes, he spends some time setting out especially the shortcomings in al-Farġānī's treatise. This highly critical assessment of these earlier sources has led him to write his own treatise.[110] The parallelism between this introduction and the method of his other treatises is obvious. In contrast, one of his works on Euclid's *Elements* looks rather different at first sight. This work on Books V and VII is extant under the following title: "Reply by Aḥmad ibn Muḥammad ibn al-Sarī [Ibn al-Ṣalāḥ] on the Demonstration of a Question Appended to Book VII of Euclid's Elements and the Rest of What the Discussion

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[109] Rescher, *Galen and the Syllogism*, p. 76:4, 25, 27.
[110] I rely on the summary in Lorch, "Ibn al-Ṣalāḥ's Treatise on Projection," p. 402-403.

on this [Point] Brings with it." It is not comparable to the other treatises discussed so far because it is a reply to an unknown correspondent. It is, therefore, only natural that the style of this treatise is different from that of the other treatises, since Ibn al-Ṣalāḥ directs his explanations to his interlocutor. Nevertheless, the main part of this treatise deals not with Euclid, but with explanations given by Ibn al-Hayṯam and al-Anṭākī on the *Elements*. The main point of criticism, therefore, is again not the primary source, but the way in which later commentators dealt with it.[111] It may well be that the original question, which is not extant, already referred to Ibn al-Hayṯam and al-Anṭākī, so one cannot be sure whether Ibn al-Ṣalāḥ chose to discuss their explanations or whether his interlocutor already asked about them. Despite this *caveat*, his criticism of the way in which Arabic authors dealt with Euclid reflects again his main interest and motive in writing his works. As just seen in detail and repeated many times, Ibn al-Ṣalāḥ similarly deals with al-Ṣūfī and al-Bīrūnī in the case of Ptolemy's star catalogue, with Ibn Zurᶜa and Yaḥyā ibn ᶜAdī in the case of *On the Heavens* III.8, and with Avicenna in the case of *Posterior Analytics* I.24. I have also pointed out some aspects in which his treatise on the *Posterior Analytics* is different from the other works. Nevertheless, this critical engagement with ancient Greek authorities and their later commentators forms the basis of Ibn al-Ṣalāḥ's entire *œuvre*, and one can observe the same stylistic characteristics in many of his treatises, by which he structures this criticism in the same way.

It is reasonable to compare Ibn al-Ṣalāḥ's treatises to the literary tradition of *šukūk* ("doubts"). Famous examples of this tradition are Abū Bakr al-Rāzī's "Doubts about Galen" and Ibn al-Hayṯam's "Doubts about Ptolemy."[112] These works are much more extensive than the comparatively short treatises by Ibn al-Ṣalāḥ that I have discussed here. Whereas Ibn al-Ṣalāḥ takes only one particular mistake as the starting point for each treatise, al-Rāzī and Ibn al-Hayṯam wrote extensive works in which they present a huge variety of dubious arguments by Galen and Ptolemy. Despite this difference in the overall extent of their works, all three authors have similar motives. This becomes especially evident in the case of al-Rāzī's "Doubts about Galen." In the

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[111] I rely on the introduction in de Young, "Ibn al-Sarī on ex aequali Ratios," p. 99-106, which is followed by an edition and English translation of this text.

[112] For the former, see Abū Bakr al-Rāzī, *Doutes sur Galien*, ed. and tr. Pauline Koetschet (De Gruyter, 2019); for the latter, Ibn al-Hayṯam, *Al-šukūk ᶜalā Baṭlamiyūs*, ed. ᶜAbd al-Ḥamīd Ṣabra and Nabīl al-Šahābī (Cairo: Dār al-kutub, 1971).

introduction, al-Rāzī justifies a treatise in which he criticizes such an eminent philosopher as Galen. He emphasizes the high esteem in which he holds Galen. Nevertheless, one should not blindly follow previous authorities but only follow the truth. As an illustration of this goal, he provides a paraphrase of the same Aristotelian passage from the *Nicomachean Ethics* that also Ibn al-Ṣalāḥ cited literally in his treatise on *On the Heavens* III.8.[113] Similarly, Ibn al-Hayṯam opens his "Doubts about Ptolemy" with the statement that "the truth is sought for itself," followed by a longer proclamation that the one who seeks the truth should critically engage with the works of the ancients.[114] Ibn al-Hayṯam proceeds with a description of how he encountered certain dubious passages. It is worth citing this passage as the wording of this description is reminiscent of the treatises by Ibn al-Ṣalāḥ discussed here:

> When we looked (*wa-lammā naẓarnā*) into the books of the man famous for his excellence, versatile in mathematical concepts, well-received in the true sciences, I mean Claudius Ptolemy, we found (*waǧadnā*) in them much knowledge, abundant ideas, much of benefit and of great use. When we opposed and analyzed these ideas and when we pursued justice for him and justice for the truth from him, we found (*waǧadnā*) in them doubtful places, ugly words, and contradictory concepts, except that they were small beside those places where he was correct. Then, we saw (*fa-raʾaynā*) that in restraint [from pointing out] these errors there is suppression of the truth, transgression and injustice to him who examines his books after us in our concealing these [faults] from him. We found (*wa-waǧadnā*) it best to mention these places, to expose them to him who labors afterwards, to remedy their imperfections and to correct their meanings, in every way possible in order to bring about their truths.[115]

The similarities between Ibn al-Hayṯam and Ibn al-Ṣalāḥ are striking. In fact, Ibn al-Hayṯam tells the story of the origin of his work exactly as Ibn al-Ṣalāḥ will do roughly one century later: they study a specific work, find among many true things an error or a number of dubious arguments, and thus find it necessary to compile a treatise explaining the error(s). In addition, al-Rāzī, Ibn al-Hayṯam, and Ibn al-Ṣalāḥ are connected by their generally positive attitude towards the ancient au-

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[113] For the paraphrase in al-Rāzī's "Doubts about Galen," see al-Rāzī, *Doutes sur Galien*, p. 4:10-11.

[114] See Ibn al-Hayṯam, *Al-šukūk*, p. 3:6 – 4:6, tr. by Don L. Voss in Ibn al-Hayṯam, "Doubts Concerning Ptolemy. Tr. and comm. by Don L. Voss" (doctoral thesis, University of Chicago, 1985), p. 22.

[115] Ibn al-Hayṯam, *Al-šukūk*, p. 4:7-16, tr. by Voss in Ibn al-Hayṯam, "Doubts," p. 23-24, modified.

thorities. We have seen above that also Ibn al-Ṣalāḥ first struggled to accept that the great Aristotle could commit such a basic error as he does in *On the Heavens* III.8, which on the other hand means that Ibn al-Ṣalāḥ accepts that Aristotle hits the truth in most cases. Despite the difference that the works by al-Rāzī and Ibn al-Hayṯam provide a more extensive list of errors in the respective primary sources and that Ibn al-Ṣalāḥ most often takes its starting point from just one mistake, all of these three authors share the aim of freeing ancient authoritative works of philosophy and astronomy from a limited number of imprecisions and mistakes. Ibn al-Ṣalāḥ was familiar with at least one exemplar of the *šukūk*-tradition, for he refers in two of his works to Ibn al-Hayṯam's "On the Resolution of Doubts of Euclid's Elements,"[116] and it is reasonable to assume that he knew Ibn al-Hayṯam's "Doubts about Ptolemy" given his interest in astronomy. However, Ibn al-Ṣalāḥ's treatises show a unique feature that distinguishes them from the best-known treatises of the *šukūk*-tradition. Neither Ibn al-Hayṯam nor al-Rāzī undertake such a philological study as Ibn al-Ṣalāḥ, by which he not only points to the doubtful passages, but even tries to find a cause for the occurrence of these errors. One can think of such an enterprise as a further step in comparison to the works by al-Rāzī and Ibn al-Hayṯam. Ibn al-Ṣalāḥ tries to free Aristotle and Ptolemy from the errors one can find in the versions of their works available at his time by pointing out that they did not commit these mistakes in the first place, but that the origin of them can be found in the transmission of the texts. While he is successful in the case of Ptolemy's star catalogue and Aristotle's *Posterior Analytics* II.17, he cannot prove such a later insertion of this error in the case of *On the Heavens* III.8.

The present investigation has shown sufficiently how modern historians of philosophy and science can make use of Ibn al-Ṣalāḥ's lists and citations from the sources that were available to him. I have also briefly pointed to the fact that we owe some of the evidence in the manuscript tradition to Quṭb al-Dīn al-Šīrāzī, who apparently compiled an abridged version of Ibn al-Ṣalāḥ's text on Ptolemy's star catalogue. Although the interlocutor from his treatise on Euclid's *Elements*, Books V and VII is unknown, we still learn that people addressed questions to Ibn al-Ṣalāḥ, which illustrates the respect that he received already during his lifetime. In this way, one must understand al-Qifṭī's assertion that Ibn

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[116] See de Young, "Ibn al-Sarī on ex aequali Ratios," and AS 4830, f. 146r-149v. See item numbers 3 and 13 in Thomann's list in Thomann, "Al-Fārābīs Kommentar," p. 101-102.

al-Ṣalāḥ was famous for his commentaries "of utmost quality" (*fī ġāyat al-ǧūda*).[117] These are just a few traces for the high esteem in which Ibn al-Ṣalāḥ was held due to his commentaries already in the Middle Ages and for the fact, that not only modern, but also medieval researchers benefitted from his works.

[117] See again al-Qifṭī, *Taʾrīḫ al-ḥukamāʾ*, p. 428:16.