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The Second Revival of Astronomy in the Tenth Century and the Establishment of Astronomy as an Element of Encyclopedic Education

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Abstract: In the fourth/tenth century a great number of new intellectual centers appeared in the Islamic world, and an increase in the number of persons involved in production of written works on mathematics and astronomy took place. One such new center was Aleppo under the Ḥamdanid ruler Sayf al-Dawla. According to al-Qabīṣī the generosity of Sayf al-Dawla led to the situation that ignorant people pretended to be astronomers or astrologer. Therefore, al-Qabīṣī argued, exams should be established for testing the level of competence and the completeness of knowledge of a candidate. Al-Qabīṣī was engaged in teaching by giving lectures based on a textbook, the Fuṣūl of al-Farghānī. This was a novelty in teaching astronomy, since before memorizing didactic poems and operating with astronomical instruments was the preferred method. While al-Qabīṣī's aim in teaching astronomy was to train future professional astronomers and astrologers, in other contexts astronomy was a propaedeutic subject as part of the quadrivium. The philosopher Muḥammad Ibn al-Haytham (not to be confused with the mathematician al-Ḥasan Ibn al-Haytham) wrote a commentary of the Almagest, in which his intention was "to elucidate subtle ideas for the benefit of students", and not to go into technical details of calculation. Obviously his aim was to educate future philosophers in the "philosophical sciences" (mathematics, natural sciences and metaphysics). Some generations earlier, al-Fārābī wrote a commentary on the Almagest with similar intentions. His preferred subject was the geometric proof, while observations and calculations were of little interest. Astronomy was incorporated into a curriculum of general scientific knowledge, – similar to the curriculum of the Alexandrian schools in late antiquity –, and ancient Greek texts on astronomy were preferred. This development was indeed a renaissance in the sense Jacob Burckhardt used the term.

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1 Introduction

The emergence of the sciences in human history has always been a subject of interest and a major topic of research.[1] Less well studied is the survival of the sciences. Scientific activity depends upon some sort of social support. The survival of the sciences is never a frictionless perpetuation of a momentum attained at some moment in the past; it requires the continuous effort of persons and institutions to further research and shape the next generation of scholars. If too much energy is absorbed by other needs of society, especially in a time of crisis, this task may be neglected, scientific activities abandoned, and the number of scholars in the next generation reduced. In some cases, this becomes a self-reinforcing process and leads eventually to the extinction of a science. This happened in Late Antiquity, both in the Latin West and the Greek East of the Mediterranean. More often, however, recession is followed by revival. A good example can be found in the German universities after the Thirty Years' War, which soon recovered their pre-war student numbers.[2] Such phenomena of revival after total or partial depression will be the topic of the present article, which will look in particular at the field of astronomy.

The article consists of seven parts. In the first two parts, a quantitative method is tested for the case of ancient Greek and ancient Indian astronomy. The methodology is formed on the basis of two previous studies concerned with the history of the sciences in Antiquity. It is shown that the count of scholars per generation is a solid heuristic method for discerning upswing and decline in scientific activities, which coincide with corresponding changes in society and politics. In the third part, the same method is applied to the Islamic World in the Abbasid period, whereby a decline in the second half of the ninth century and an upswing in the first half of tenth century is detected. The remaining four parts describe cases in which new methods of teaching and new motivating factors for the study of astronomy can be observed. Both phenomena were characteristic for the study of astronomy in late antiquity. They were absent in the early Abbasid period, but underwent revival in the tenth century, coinciding with the general increase of activities in the field of astronomy. The chronological profile of expansion and decline in astronomy will be connected to the

1 Cf. Van der Waerden 1954–1974.

2 Asche 2011: 179.

development of the former peripheries of the Islamic world. The emergence of new centers of power and intellectual life will be illustrated through the example of ʿAdud al-Dawla's court in Aleppo. The commentary on the Almagest of al-Fārābī, who was active there, is discussed in the fourth part. Al-Fārābī's endeavor to establish astronomy as an element in his program of an encyclopedic philosophical education must be understood in this context. In the fifth part, al-Qabīṣī's role at the court of ʿAdud al-Dawla is described. Al-Qabīṣī gives an account of a novel and more complex stratification employed in the assessment of the level of competence of an astronomer and provides evidence of a new form of teaching astronomy. The sixth part is devoted to Muḥammad Ibn al-Haytham, an Aristotelian like al-Fārābī, who made explicit remarks in his commentary on the *Almagest* concerning the way in which astronomy should be taught. In the seventh part, Abū Naṣr Ibn ʿIrāq, a heir of al-Qabīṣī's ideas on professional levels of competence is briefly referred to. In the final summary, it is proposed that, taken together, these new developments – new centers of power, new teaching methods and a new paradigm of education – were likely reasons for the rapid increase in astronomical activities in the tenth century. Appendix A contains new arguments for distinguishing Muḥammad Ibn al-Haytham from al-Ḥasan Ibn al-Haytham. In Appendix B the case of an alleged work of al-Jūzjānī with the title *Fuṣūl* is discussed. Since it is generally claimed that raw data of statistical analyses should made accessible to the public, Appendices C to F contain lists of biographical data which formed the basis for the quantitative analyses.

2 Temporal and regional development of science in Classical Antiquity

Before approaching the main topic of this article, let us look back briefly to Classical Antiquity and Greek science. The reason for doing so is that important studies already undertaken by Classicists will provide the methodological models for our own enquiry. Too often "Greek science" is referred to as an historical unit, obscuring the fact that it covers a multitude of disciplines, all with their own independent, living traditions, lasting twice as long as the epoch of modern science and covering a territory many times larger than Western Europe. One of the few investigations of the regional and temporal aspects of ancient science is Reviel Netz's study of mathematicians in Greek Antiquity.[3] Netz was able to

3 Netz 1997.

show that there existed a multitude of intellectual centers, not just Athens and Alexandria, and that within a generation, only very few mathematicians were working in a given town.[4] Even if the mathematicians known to us by name might have had a multitude of anonymous students, mathematics seems to have been a task of individuals or small groups of persons.[5] The total number of mathematicians within a generation also varied significantly. Furthermore, he perceived an inverse relationship between political centrality and the level of scientific activity.[6]

More recently, a chronological and regional analysis of ancient natural scientists has been presented by David T. Keyser.[7] This study stands out thanks to certain methodological refinements. First, the data are grouped in intervals of 35 years, corresponding to a generation. Moreover, only those scientists for whom the biographical data are sufficiently precise to relate them to a particular generation are selected. This procedure yields results that are not visible in a parallel analysis of the numbers of scientists (with "wide" date-ranges) per century. For example, only in the first case, i.e. the numbers (with "narrow" date ranges) per generation, can we discern a significant "late Hellenistic" dip in the second century BCE. Still, in both cases we see a breakdown after 150 CE. This is known as the post-Hadrian era, the scientific decline of which has been explained as a consequence of a shift in the political paradigm, the centralization of power and the loss of autonomy: the transition from the so-called "commercial syndrome" to the "extractive syndrome" took place at that time.[8] Shipwreck evidence confirms a decline in trade too.[9]

There was then a slight increase in the number of scientists in the fourth and fifth centuries, but subsequently the number drops to almost zero. The century 650–750 CE, the so-called "dark age", is remarkably weak in science.[10] The eclipse of science is further corroborated by papyrological evidence. A considerable number of Greek astronomical documents have been found in Egypt. Their number reaches a peak in the second century CE, which agrees with the evidence from the number of natural scientists in historical sources, but no Greek astronomical documents later than the early sixth century have yet been discovered.[11] This indicates the situation in Middle and Upper Egypt

4 Netz 1997: 5, maps 1 and 2.
5 Netz 1997: Figure 1.
6 Netz 1997: 15; Braudel 1984: 67–69.
7 Keyser/Irby-Massie 2012: 995–996.
8 Keyser 2010; Jacobs 1992.
9 Parker 1992: Figure 5.
10 Decker 2016: 2–3.
11 Jones 1999: 1: 34 and 281.

and is thus not representative for Alexandria, from where almost no papyri survive due to the moist soil. But literary sources do document scientific teaching there in the second half of the sixth century. This might thus have come to a definitive end only at the beginning of the seventh century. Stephanos, one of the last authors of astronomical works is said to have left Alexandria for Constantinople sometime after the accession of the emperor Hērakleios in 610 CE. Following the latter's death (641 CE), all scientific came to a halt in Constantinople too.

There is no similar study focused specifically on astronomy in Classical Antiquity. Therefore, a brief analysis is provided here. The selection of scholars is based on the list of "authors and writings on the motion and nature of the 'stars,' often very mathematical, and also often descriptive" in the *Encyclopedia of Ancient Natural Scientists*.[12] Anonymous works are excluded. The methodology of separating "narrow" date ranges and "wide" date ranges has been adopted. This leads to the two following plots (Figures 1 and 2):

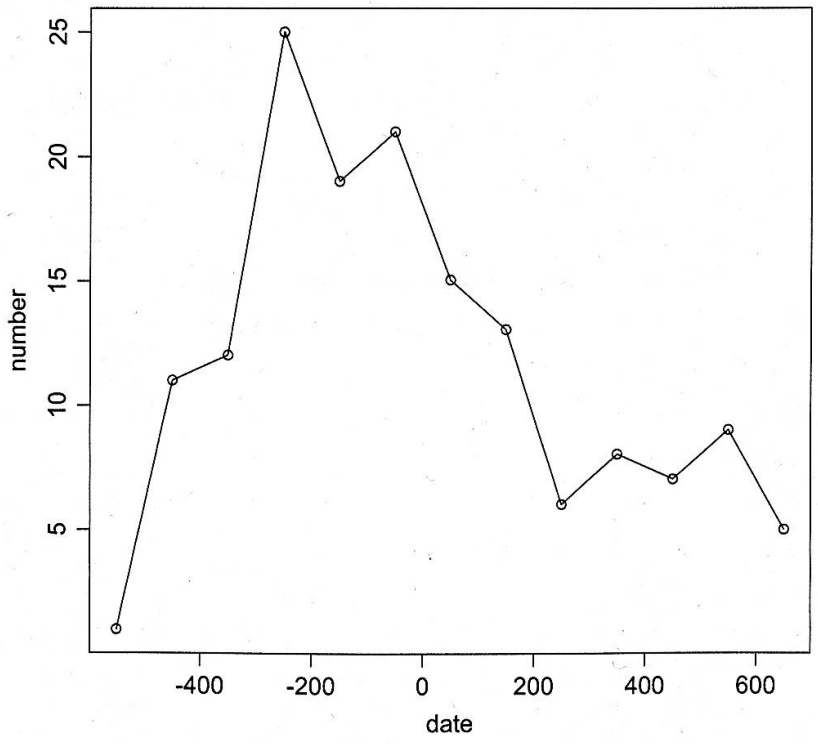

Figure 1: Ancient Astronomers (wide ranges).

12 Keyser/Irby-Massie 2012: 995–996.

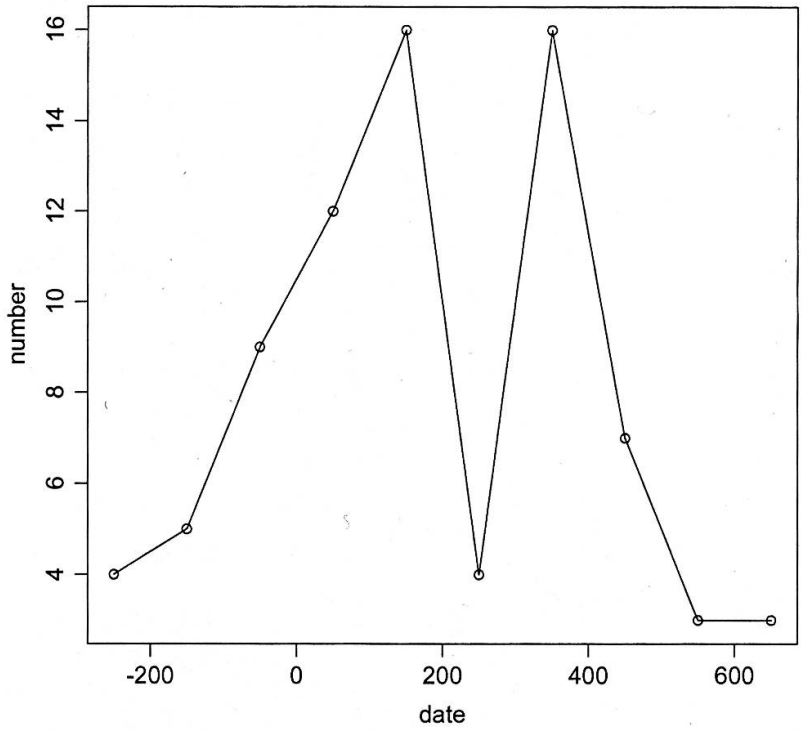

Figure 2: Ancient Astrologers (wide ranges).

The regional distribution is even more complex (61 locations) than in the case of mathematicians (51 locations).[13]

This summary of the development of the sciences in Classical Antiquity shows that a quantitative analysis of scientists and scientific activities, together with documentary evidence, helps us gain a more objective image of the historical development than is available in the often biased reports of narrative historical sources. In the first part of this article, a similar analysis will be undertaken for the first Islamic centuries. This will be contextualized with an analysis of the development of science in Sanskrit sources.

If we now compare the time-line of astronomers with that of astrologers, the earlier adoption of astronomy in the Greek world is clearly visible. A first high-point was reached in the third century BCE, when astrology had only just started to become part of Greek intellectual culture. However, both time-lines clearly reflect the breakdown of the third century CE, and – at least to some degree – the revival of the fourth, fifth and sixth centuries CE. The "dark age" (650–750 CE) is also common to both disciplines.

Following the example of the "Encyclopedia of Ancient Natural Scientists" a finer time-line is shown in the next diagram, taking only those cases where

13 Netz 1997: 6–9.

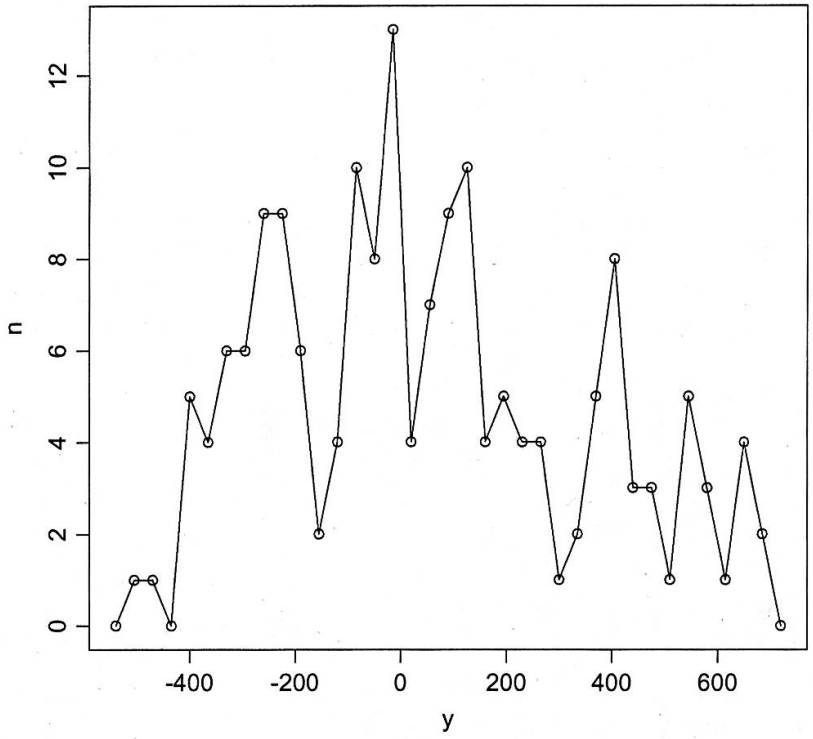

Figure 3: Astronomers and astrologers in Antiquity (narrow ranges).

biographical data allow us to place astronomers and astrologers more precisely than just within the limits of a century (Figure 3). The scholars are collated with the 35-year intervals in which the end of their period of activity falls. In this time-line, the breakdown of the third century CE is clearly visible, but also the decline of the second century BCE which has been diagnosed for natural scientists in general. This exercise shows that even with a limited number of data, the basic pattern of development can still detected. This result should be borne in mind when, in the following enquiries, generalization are made in less well researched fields of cultural history.

3 Time-line of astronomy in Ancient India

It has been already mentioned that almost no activities in the mathematical sciences were attested in the period from 650 CE to 750 CE in the Byzantine Empire. It would thus be very unlikely that any impulses from there were instrumental in the revival of astronomy which took place at the very beginning of Abbasid rule (ca. 750 CE). On the other hand, Al-Bīrūnī is able to quote, apparently literally, a passage from an Arabic translation of a Sanskrit work and

describes it as having been made "at the beginning of the Abbasid epoch".[14] Furthermore, he transmits several more samples of early translations from Sanskrit.[15] It is thus helpful for our purposes to look into the temporal and regional development of astronomy in India.

The basic data here are taken from two of David Pingree's works.[16] In accordance with the Indian categorization of the sciences, the entire field of *jyostiḥśāstra*, which covers mathematics, astronomy, astrology and some other divinatory disciplines, has been included when selecting the relevant scholars. Authors of texts on religious cosmology were excluded. Since the "Census of the Exact Sciences in Sanskrit" is incomplete and names beginning with the letters *ś, ṣ, s* and *h* are missing, the corresponding authors are excluded too. Most authors cannot be dated precisely, and therefore the presentation in generations for scholars with "narrow" date ranges has not been carried out here. Only a time-line arranged by centuries is presented.

The diagram shows a steady increase in the numbers of scholars from the second to the sixth century CE (Figure 4). Thereafter follows a breakdown in the seventh century CE. This epoch marks the end of the "classical age" and the dissolution of central power in Northern India. The middle of the seventh century heralded a Chinese/Tibetan invasion.[17] Not much is known about the following decades, but it is likely to have been a time of turmoil. In any case, in the eighth century CE, the level of activity returned to that of the sixth century CE, and even increased in the following century. Obviously, a revival took place, for which the reasons remain unclear. But the important point for us to observe is that this revival coincided with the period in which Byzantine activities in the field of astronomy and astrology had come to an end.

The time-line of astronomers in the Islamic World per generation (35 years) shows that the absolute numbers are considerably larger then in Classical Antiquity (Figure 5). The maximum number is 33 in the last third of the tenth century CE, while the maximum in Antiquity (generation 15 BCE until 20 CE) was 13. There is also a noticeable decline in the last third of the ninth century CE after three generation of steady increase. In the tenth century, the increase continues for another three generations, followed by a decline of two generations.

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14 Thomann 2014: 508; Kennedy 1976: 135–140; Pingree 1970–1994.

15 Thomann 2014: 505–509; Kennedy 1976: 1: 182–192, 2: 118–119.

16 Pingree 1981; Pingree 1970–1994.

17 Sen 2003: 22–25.

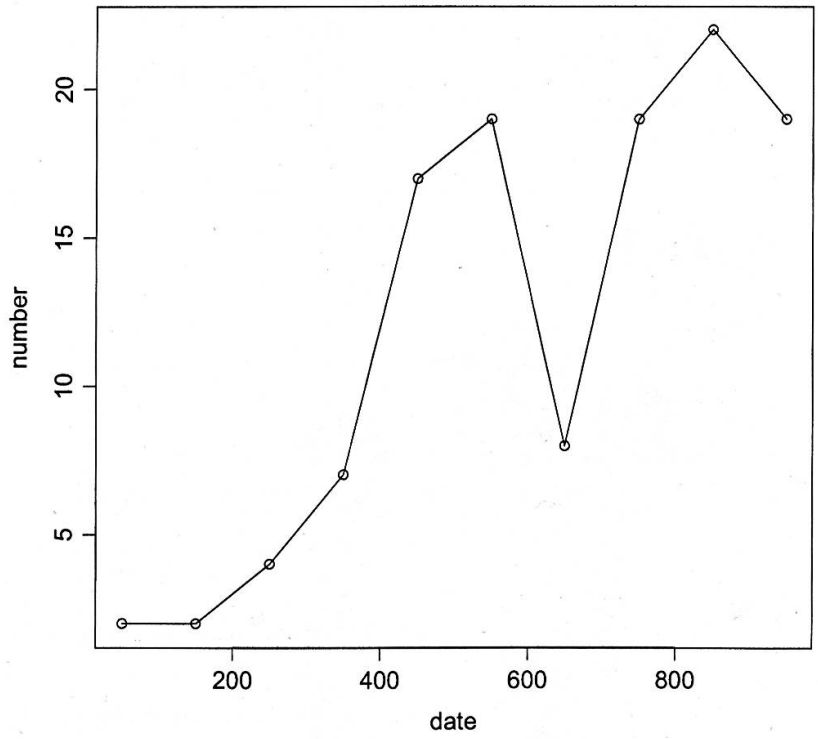

Figure 4: Indian astronomers and astrologer (wide ranges).

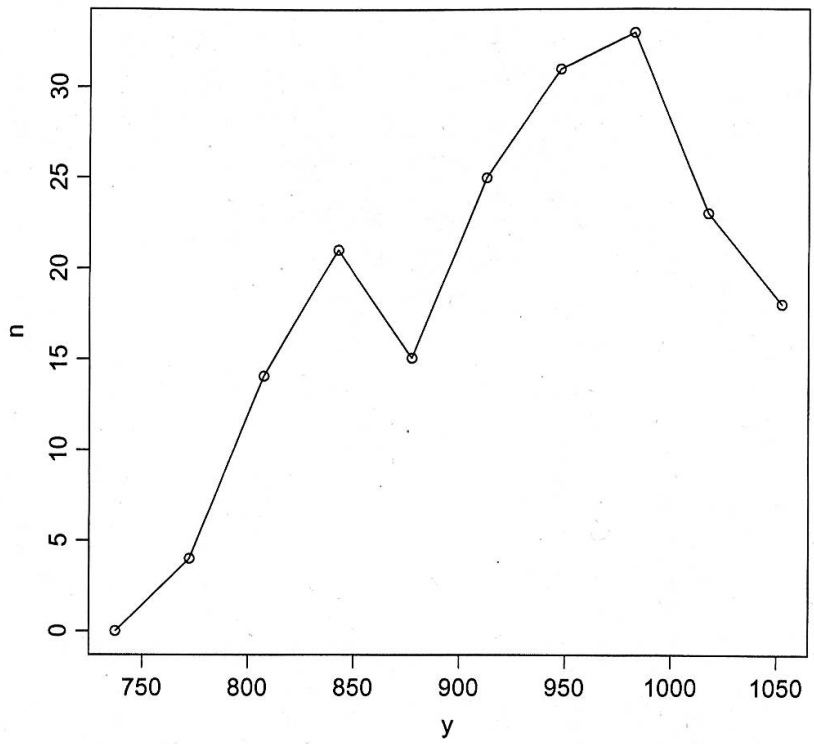

Figure 5: Astronomers in the Islamic World (narrow ranges).

4 Time-line and regional development of astronomy in the Islamic World (750–1050 CE)

A first important observation concerns the very beginnings of astronomical activity in the Islamic world. Although the revival of astronomy in the early Abbasid period (after 750 CE) is a well-known fact, it is not well understood. The first Arabic texts on astronomy were translations from Sanskrit and Middle Persian, not from Greek. It is thus worth noting that this period coincides chronologically with the distinctive increase in the number of active astronomers in India, and in their readiness to travel abroad. Up to now, this fact has not been taken into consideration in the context of the birth of mathematical sciences in the Islamic world. Perhaps it was simply an historical contingency that, at the same time, the capital of the Islamic empire was moved from the west to the east, putting scholars from India and Central Asia within easier reach of the new political and economic center of the Islamic world. Recent studies have indeed thrown more light on the significance of India and Central Asia in the intellectual history of the early Abbasid epoch.[18] It was to be two generations later still, during the reign of al-Ma'mūn, that Greek astronomical and mathematical texts were translated. In the case of Ptolemy's Almagest, it required five attempts and more than half a century to produce a satisfactory Arabic version.[19]

A second observation concerns the decline during the last third of the ninth century. It has been argued that at this time astrology came under attack from the theologians.[20] Since the prestige of astrology provided a favorable climate also for astronomers, its damaged reputation could well have contributed to the decline of astronomy.[21] However, it coincides also with an epoch of political instability, which has been designated "the waning of empire".[22] Abbasid power began to disintegrate and civil wars led to a breakdown in infrastructure and social order. After this period however, new local rulers were able to create smaller, but stable political units. The new rulers had to strive for legitimacy and some of them invested fortunes in attracting and maintaining famous poets and renowned scholars of many disciplines to their courts. This may well have contributed to the second revival in astronomy observed in the three generations of the tenth century. The connection of the two phenomena—the emergence of

18 Van Bladel 2014a; Van Bladel 2014b; Thomann 2014.

19 Grupe 2012; Kunitzsch 1986: 2–5; Kunitzsch 1975: 77–79; Kunitzsch 1974: 15–82. .

20 Borrut 2014: 459; Morrison 2009: 60–62.

21 I thank the anonymous reviewer for pointing this out to me.

22 Bonner 2010.

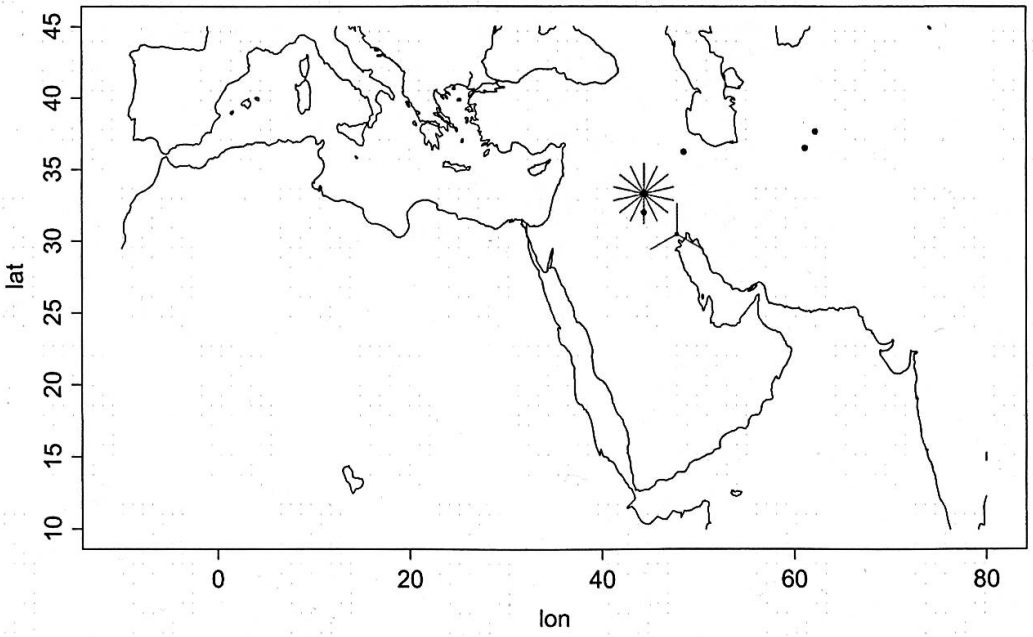

Figure 6: Mathematicians and Astronomers 750–850 C.E.

new political centers and the increase of active astronomers—is corroborated by a closer examination of the locations of astronomical activity.[23]

A comparison of the regional distribution of astronomical activities from 750 CE to 1050 CE presents a clear image of increasing decentralization. In the first century, Bagdad is clearly dominant, and only some individual cases occur in Khurasan and Central Asia (Figure 6). The western provinces are entirely empty. In the second century (850 CE–950 CE), the new center of Cordoba in al-Andalus emerges but is still second to Baghdad (Figure 7). In the third century (950 CE–1050 CE), a greater number of new centers come into view; Samarqand, Bukhara, Balkh, Ahwaz, Sarakhs, Herat, Rayy, Hamadan and Isfahan in the east; Mosul, Aleppo, Raqqa, Jerusalem, Damascus, Cairo, Kairouan in the west (Figure 8). In al-Andalus, new centers outside Cordoba are encountered: Ecija, Denia, Sevilla and Zaragoza. This remarkable growth in new intellectual centers might have been a reason for the revival of astronomy which was visible in the

23 As a side note, this second revival period coincides with the "Renaissance of Islam", the subject of Adam Mez's book of the same title (Mez 1922; Mez 1937.). There are indeed common characteristics of this epoch with Italy in the 14th and 15th centuries as described by Jacob Buckhardt: Emergence of new centers of power, an increased search for legitimization and a new ideal of education inspired by Classical Antiquity (Burckhardt 1901: 189; cf. Mez 1922: 1–7; Mez 1937: 1–7.).

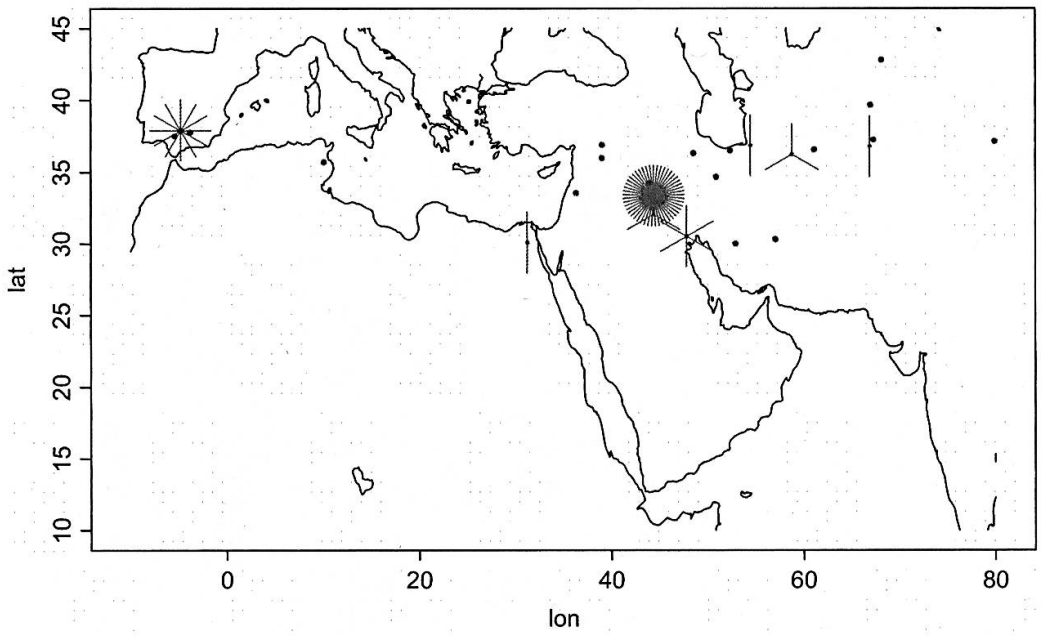

Figure 7: Mathematicians and Astronomers 850–950 C.E.

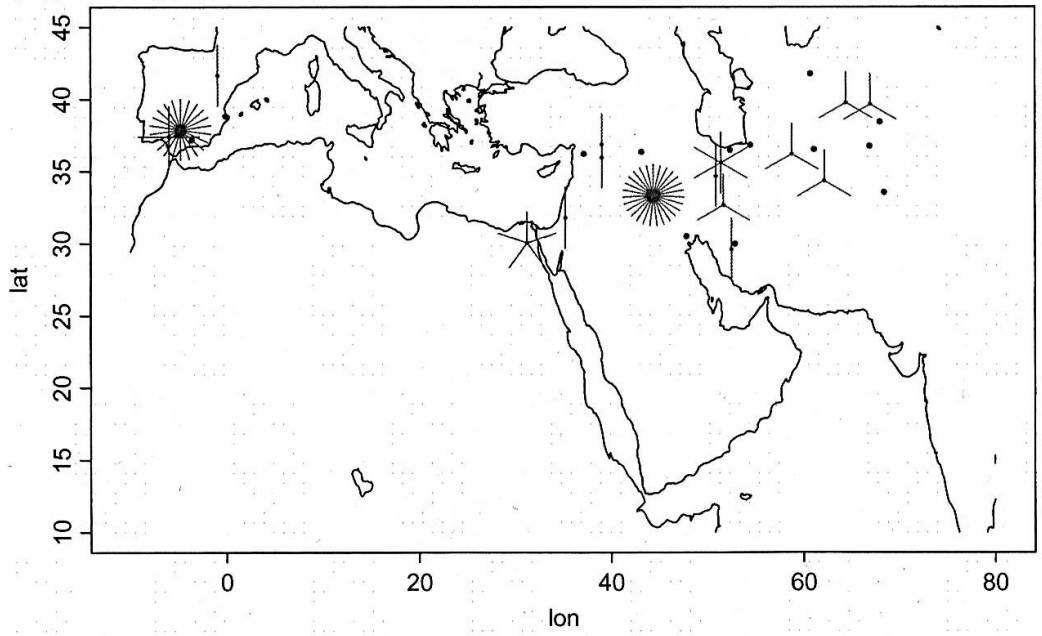

Figure 8: Mathematicians and Astronomers 950–1050 C.E.

time-line. Besides this external factor, an internal factor of intellectual history might have provided another reason: Astronomy became an element of a new conception of encyclopedic education. A key figure in this development was al-Fārābī.

5 Al-Fārābī's commentary on the *Almagest*[24]

Ptolemy's *Almagest* was translated into Arabic four times in the ninth century CE.[25] Besides professional astronomers who referred to the Almagest, the philosopher al-Kindī (died 873 CE) wrote an introduction into the Almagest with the title *Kitāb fī l-Ṣināʿa al-ʿuẓmā*.[26] It is a summary of the cosmological chapters in the first book, and testifies to al-Kindī's striving to integrate astronomy in his philosophical curriculum. He also defended astrology as a philosophical science.[27] However, his endeavor did not go beyond general cosmological concepts and elementary spherical astronomy. Only in the following century was full-fledged mathematical astronomy addressed in a philosophical context.

The great philosopher al-Fārābī (died 950 CE), who was called "the second teacher" (after Aristotle), personifies the general development of the sciences in the Islamic world. He was probably born in Fārāb, a district on the Syr Darya (Jaxartes) in Central Asia. He moved to Baghdad, where he studied and where he spent most of his life. In 942/943 CE, already in his seventies, he left Baghdad for Damascus, also visiting Egypt for a short period. He lived out his final years in Syria, partly in Aleppo at the court of Sayf al-Dawla, where he died December 950 CE/ January 951 CE.[28] The course of his life thus reflects the general drift from east to west, and from the center to the periphery.

Al-Fārābī was convinced of the pedagogical value of the mathematical disciplines[29] and his main contribution to the revival of astronomy consisted in his inclusion of the mathematical part of astronomy into the canon of disciplines of his intended philosophical curriculum. It has been known for some time that al-Fārābī wrote a commentary (*sharḥ*) on Ptolemy's Almagest, and that it was a comprehensive commentary.[30] Biographers and astronomers confirm this to have been the case.[31] However, only very recently have parts of the text been discovered.[32] Ibn al-Sarīʿ, a mathematician of the twelfth century, wrote a critique of a chapter from al-Fārābī's commentary and quoted long passages of the work literally. A comparison of these quotation with a long

24 Cf. Thomann 2014: 518–521.
25 Grupe 2012; Thomann 2018.
26 Al-Kindī 1987; Endress / Adamson 2017: 176–177.
27 Adamson 2002; Burnett 2002: 201–202.
28 Rudolph 2017: 537–539.
29 Janos 2012: 66.
30 Steinscheider 1869: 78; Schirmer 1926–1927: 81–82; Thomann 2011: 51.
31 Thomann 2010–2011: 48–53.
32 Thomann 2011; Thomann 2015; Thomann 2016; cf. Rudolph 2017: 566–567, 610.

part of an anonymous commentary on books IX to XIII of the Almagest corroborates the attribution of this text to al-Fārābī, which was previously based only on historical and stylistic arguments.[33]

In his commentary on book IX, al-Fārābī gave a general account on the value of the study of astronomy.[34] It belongs, he states, to the mathematical sciences. Besides astronomy, he mentions the science of music, followed by geometry, arithmetic and optics. The value of astronomy lies, according to him, in two things, its beauty (*jamāl*) and its (spatial) extremity (*ghāya*). He closes his excursus by quoting Aristotle (in the words of his commentator Themistios) to the effect that astronomy is the most philosophical of the mathematical sciences. Themistios added the reason for this: "since its subject is the visible eternal substance", a statement which al-Fārābī paraphrases at an earlier occasion, where he described the planets as "the divine bodies (*al-ajsām al-ilāhiyya*) which are among the visible bodies."[35]

In the commentary on book XIII, al-Fārābī criticized Ptolemy, who had written a digression on the difference between simplicity from the standpoint of human beings and simplicity from the standpoint of God.[36] Al-Fārābī refuses to comment on this in the context of mathematics and says that such questions should be discussed in the context of physics and metaphysics, since they presuppose the Aristotelian theory of motion. This statement implies that al-Fārābī expected mathematics to be taught before physics and metaphysics. It seems that he saw mathematics as a kind of "boot camp", in which students learned to follow the long and tortuous demonstrative steps of a proof. Proofs were indeed the preferred subject in his commentary and he inserted intermediate steps in them, while the use of tables and details of observations were of minor importance. In fact, the two extant manuscripts contain no tables at all.

A similar approach is found in Ibn Sīnā's *Talkhīṣ* on the Almagest, which belongs to the mathematical books of his *Shifāʾ*. At the beginning, he says explicitly that he does not want to deal with the details of calculation and the use of tables.[37] In the composition of the *Shifāʾ*, the four mathematical books, including the *Talkhīṣ* on the Almagest, are situated between the books on physics and the book on metaphysics. This arrangement corresponds to the curriculum of the school of Alexandria in Late Antiquity.[38] However, there is

33 Thomann 2015; Thomann 2016.
34 MS Tehran Majlis 6430 ff. 9v–10r.
35 Themistius 1999: 101.
36 MS Tehran Majlis 6531 f. 188r.
37 Ibn Sīnā 1980: 16.
38 Westerink 1980: 20.

no evidence of permanent institutions with regular classes in the times of al-Fārābī and Ibn Sīnā.

6 Al-Qabīsī's Lectures on astronomy

Abū l-Ṣaqr ʿAbd al-ʿAzīz ibn ʿUthmān al-Qabīṣī was a professional astronomer and astrologer who worked in the same place and possibly at the same time as al-Fārābī in Aleppo. No precise dates of his life are available but, like al-Fārābī, he was in the service of Sayf al-Dawla and he dedicated at least four works to him.[39] In his youth, he lived in Mosul and was a pupil of ʿAlī ibn Aḥmad al-ʿImrānī (d. 955/956 CE). He is said to have studied the Almagest under the supervision of his master. Later, when he was at the court of Aleppo, he might well have met al-Fārābī, or at least have heard about al-Fārābī's teaching method. At the court of Aleppo, al-Fārābī was still teaching, since Ibrāhīm ibn ʿAdī studied with him there. Al-Fārābī even dictated a large commentary on the *Posterior Analytics* to him.[40] The teaching method of commenting section by section on a textbook was not common in astronomy[41] and it may have been the model of al-Fārābī's extensive commenting on textbooks– be it orally or in writing – that inspired al-Qabīṣī to use this method for an introductory course on astronomy. However, his aim was different from that of al-Fārābī. He was not a philosopher and for him, as a specialist, astronomy had its value in itself, only connected to astrology as its basis and necessary prerequisite.

There exists a text which sheds light on al-Qabīṣī's method of teaching astronomy. MS Aya Sofya 4832 contains a commentary of al-Qabīṣī on the *Fuṣūl* of al-Farghānī.[42] The *Fuṣūl* is an introduction to astronomy which was widely read, and was later translated into Latin and Hebrew.[43] The work is written in an easy style and presents the Ptolemaic system in simplified form. One may wonder why al-Qabīṣī would write a commentary on a work which was already easily understandable by itself. In fact, al-Qabīṣī's approach was only partly to repeat the content of al-Farghānī's text. Rather, there are long

39 Al-Qabīṣī 2004: 2.
40 Rudolph 2017: 538.
41 Thomann 2014: 518–521.
42 Facsimile edition of al-Qabīṣī's commentary: Sezgin 2010.
43 Sezgin 1978: 149–151.

passages in which he digresses on the background of some brief statements in the text. In the case of the lengths of the months, for example, al-Qabīṣī goes on to narrate how Ptolemy used the dates and times of eclipses to determine the precise length of the lunar month. Such supplementary material seems to have been added in an attempt to motivate his students to go beyond the propaedeutic *Fuṣūl* and to embark on the larger enterprise of reading the *Almagest* itself. Further, the commentary does not give the impression of a well composed treatise. It seems rather to have been an extemporization, most likely a lecture for a group of students. A chapter of al-Farghānī's *Fuṣūl* was apparently read first, then al-Qabīṣī made his remarks on some points in the text afterwards. In some cases, he declared that a comment would not be necessary or that he would give his comment together with that of the next chapter.

Al-Qabīṣī's comments differ considerably more in length then the underlying text of al-Farghānī (Figures 9 and 10):

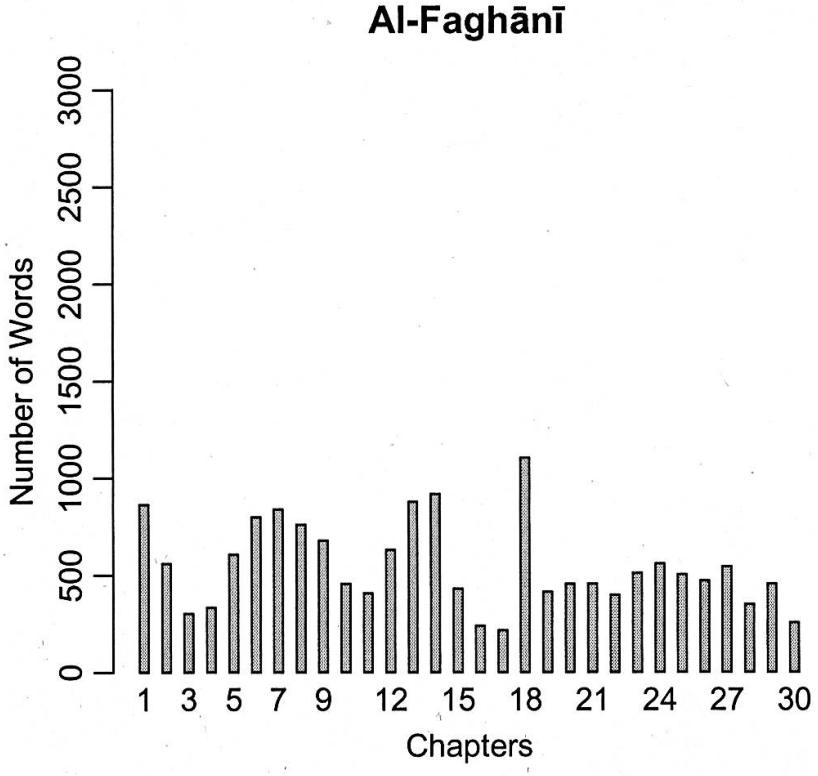

Figure 9: al-Farghānī's chapters.

This is typical for oral lectures. Olympiodoros held lectures on the astrological work *Eisagogika* of Paulos of Alexandria in the year 564 CE, of which the

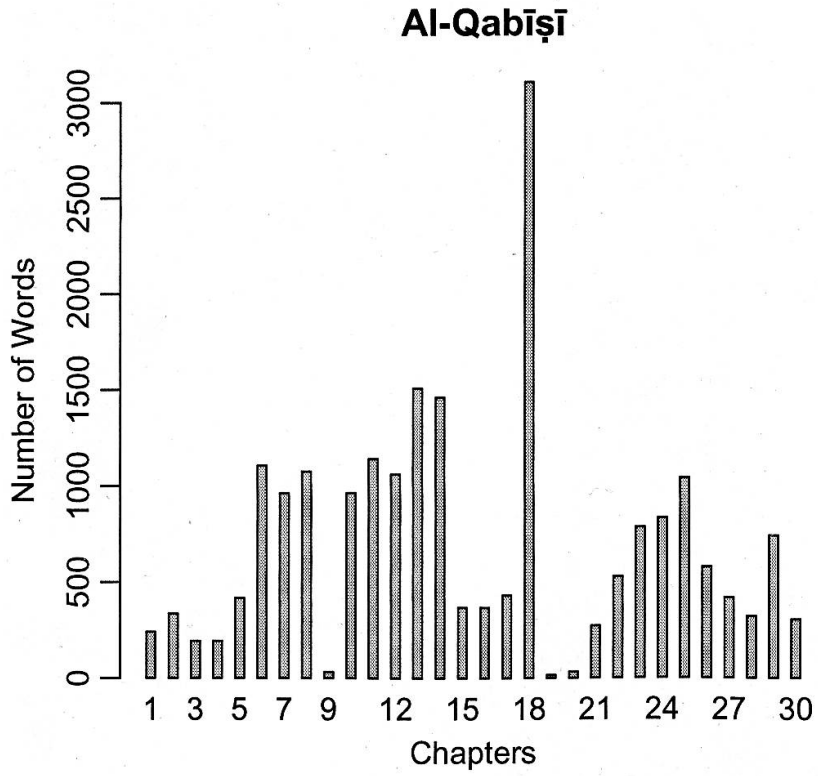

Figure 10: al-Qabīṣī's chapters.

accurate notes of a student are preserved.[44] In these notes, the dates and hours of the individual lectures (the *praxeis*) are recorded. The length of the notes differs more than the lengths of the pertaining passages in the book of Paulos of Alexandria, except for one overlong passage (Figures 11 and 12).

There is another work of al-Qabīṣī which documents his pedagogical approach: a treatise on how to examine a *munajjim*, which at that time meant a scholar versed both in astronomy and astrology.[45] At the beginning, al-Qābīṣī depicts a lively image of the rampant dilettantism among the *munajjimūn* at Sayf al-Dawla's court[46]:

"Some called by this name [*munajjim*] who were attached to him [Sayf al-Dawla] are at the top [of their field], and some fall just short of the top, but some whom his generosity retains and who are content with his funding had not learned anything of the science of the stars except its name.

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44 Transmitted under the name of Heliodorus: Heliodorus 1962; but see Westerink 1971.

45 al-Qabīṣī 2011; for a summary see Burnett 2002: 203–204.

46 Arabic text: al-Qabīṣī 2011: 118.

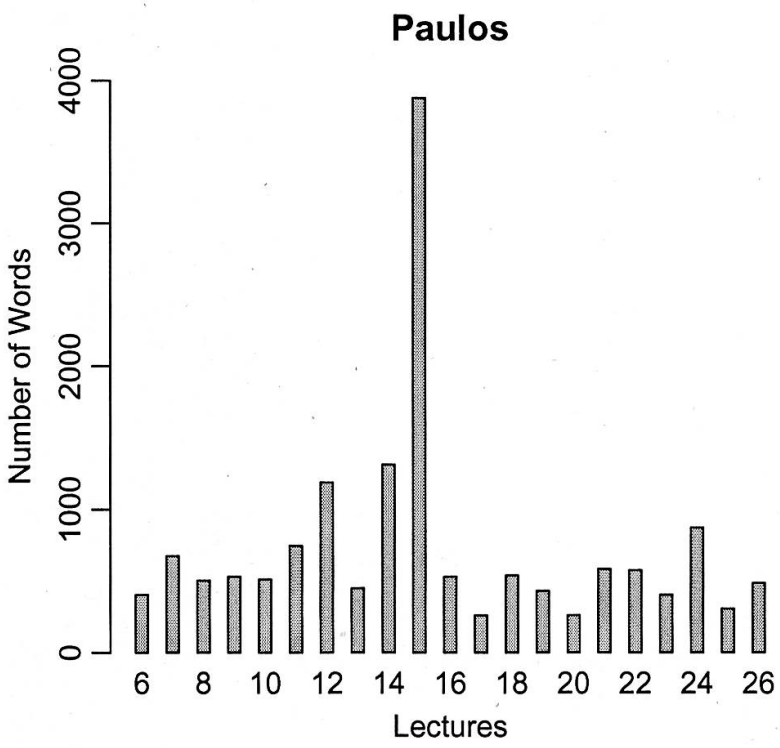

Figure 11: Paulos' lectures.

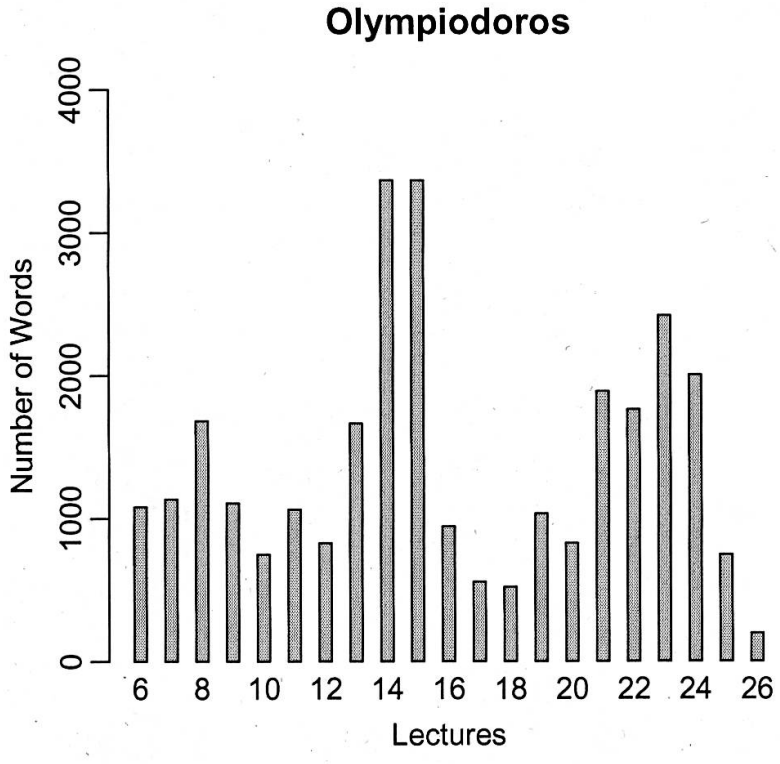

Figure 12: Olympiodoros' lectures.

Our lord the Amīr – may God long aid him– generously prevented them from being tested and examined concerning the [knowledge] they have inside. This deluded them, because they then felt safe from severe trial. They dispensed with the hard work of theory and the adventure of research and reasoning, although they [thereby] eased their own humiliation, if they were ever to be examined.

When someone has read the ephemeris, has fixed the ascendant, has deciphered the *Zīj Sindhind*, and has read the abridgment of the *Madkhal* superficially, not thoroughly, then he thinks that he has thereby obtained the science in its full extent, that he has assembled knowledge subtle and sublime, and that he has understood what nobody else in his time understands. If someone knowledgeable and intelligent is mentioned to him, he criticizes him, in order that people will say: 'He must be one of the same class.' When he sees the work of someone who is more knowledgeable than he, he looks down on it and accuses it of error, in order to make it seem by that action that he is more knowledgeable. He offers stubborn resistance to truth and fairness. The victory of the stupid succeeds by means of impertinence, haughtiness and camouflage. But truth itself is one and mandatory among those who know it, if they seek it."

Al-Qabīṣī makes clear that performance was much more important than substance at court. He implies that it was crucial to play the role of a competent scholar, rather than to engage in serious scientific study. This emphasis on performance raises the question of the stage upon which the theater of science was performed. In order to appreciate al-Qabīṣī's account fully, one has to consider the luxurious ambiance at Aleppo in which encounters with the ruler took place. Under the rule of Sayf al-Dawla, Aleppo became a splendid residential city, attracting eminent poets like al-Mutanabbī and Ṣanawbarī,[47] but also philologists, theologians, philosophers and astronomers.[48]

At first, one would think that the impressive citadel in the center of the town was the place were the main courtly activities took place. However, Ibn Shiḥna reported that Sayf al-Dawla had built a tremendous palace west of the city, surrounded by the river Quwayq.[49] The palace, called *ḥalba* had fresh air, pleasant entertainment and a view over the river. Its further attractions were a vineyard and two equestrian race courses. We know that it was fashionable to have race courses in different shapes. Four were discovered in Samarra.[50] One of them had a starting and end point on a hill and was more than 10 km long. Another had the shape of a cloverleaf with narrow curves. The palace at Samarra

47 For a list of poets see Bianquis 2016 [1995].

48 See also Bianquis 2016 [1995].

49 Arabic text: Canard 1934: 204–205. Cf. Canard 1951: 654–556.

50 Northedge 1990.

may well have been a model for Sayf al-Dawla's palace outside Aleppo.[51] Such ambitious projects are indications that efforts at urban development existed under the Ḥamdānids. Maya Shatzmiller has shown that there was increased output in the manufacturing sector, increased division of labour, increased literacy of the workforce, increased volume of trade and development and elaboration of state fiscal institutions with an efficient system of tax collection.[52] But after the breakdown of Ḥamdanid rule, the cities in the region underwent decline.[53]

Al-Qabīṣī's intention in his book was to create a tool for testing a person who pretends to be a *munajjim*. It should serve to detect what is "inside" a scholar, literally "what is inside his body", and eventually to unmask the ignoramus playing at the role of scholar.

Al-Qabīṣī initially makes the distinction between what we today call astronomy and astrology. The test is thus divided into two sections according to Ptolemy's division of the science of the stars into two parts: the science of the motion of the planets; and the science of their influence on the sublunar world.

In the first section, on astronomical calculation, al-Qabīṣī considers four levels of competence in this field[54]:

1. On the highest level is the perfect astronomer. He has read Ptolemy's *Almagest* and knows the proofs that are necessary to determine the motions, the shapes and sizes of the planets. He is able to establish astronomical tables based on them and on his own observations.
2. On the second level is the astronomer who knows the motions, the shapes and the sizes of the spheres and planets, and is able to form a mental image of the heaven at any time, and his knowledge is based on his imaginative capability, not by knowing a textbook by heart. He is capable of all tasks in astronomy, but he is not able to give a mathematical proof of what he is doing.
3. On the third level is the astronomer who knows how to do astronomical calculations by means of astronomical tables. He has learned this only by pure imitation of calculatory procedures, without knowing the real significance of the values in them. He is like a blind man who is led to a certain place of which he has no perception. Al-Qabīṣī states that most astronomers of his time belonged to this class.

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51 Canard 1951: 655.

52 Shatzmiller 2011.

53 Heidemann 2002: 447–448.

54 Arabic text: al-Qabīṣī 2011: 120–121; a *resumé* is given in Al-Qabīṣī 2004: 5–7.

4. On the fourth level is the astronomer who knows nothing of the things mentioned in the other cases. He is capable only of handling an astrolabe and sundials and knows how to determine the direction of the qibla and the like.

Al-Qabīṣī explains that he did not include questions for the first level of competence, because for this purpose one could use his work *Shukūk fī l-Majisṭī* ("Doubts on the Almagest"), which contained many relevant questions.[55]

As far as the field of astrology is concerned, al-Qabīṣī divides it into five parts[56]:

1. Mundane astrology: Prognostics for dynasties and peoples.
2. Individual nativities: Birth horoscopes for general prognostics of a person.
3. Annual horoscopes: Prognostics for a year of life of a person.
4. Interrogations: Methods for finding answers to particular questions of customers.
5. Electional astrology: Methods for finding a favorable time for a particular task.

The first ten questions in his text concern topics in astronomy, then follow questions on astrological subjects.

As a text on examination of professional astronomers it has no predecessor. But there are earlier texts on the examination of physicians, and they might have been models for al-Qabīṣī.[57]

Al-Qabīṣī's relatively small work is a novelty in the history of astronomy and astrology, since it encompasses both disciplines. In this respect, it is a precursor of al-Bīrūnī's *Tafhīm*.[58] Before al-Qabīṣī, his five parts of astrology were dealt with only in separate works, whilst previous astronomical works corresponded in most cases to one single level in al-Qabīṣī's typology of competence. The motivation for this encyclopedic approach is clearly expressed. The courtly policy of engaging as many astronomers as possible in one place, instead of engaging one court astrologer, had led to a highly competitive situation among the scholars. Under these conditions, al-Qabīṣī's saw his task as that of professionalizing his discipline and introducing measurable standards of competence. Completeness was understood as a core concept, both in terms of the completeness of mastered tasks in each discipline, and in the profoundness of

55 Arabic text: al-Qabīṣī 2011: 121.

56 Arabic text: al-Qabīṣī 2011: 112.

57 Bürgel 2016: 177–214; I thank the anonymous reviewer for pointing this out to me.

58 Al-Bīrūnī 1934.

understanding and internalization of concepts. Based on these standards, al-Qabīṣī defined a professional identity of the *munajjim*, especially that of the *munajjim tāmm*, the "perfect astronomer".

7 Muḥammad ibn al-Haytham: A heir to al-Fārābī's procedure of commenting on the *Almagest*

The use of a commentary as a didactic tool for beginners is explicitly expressed in the introduction of another commentary on the Almagest. The name of the author is clearly written at the beginning of this commentary as Abū ʿAlī Muḥammad Ibn al-Ḥasan Ibn al-Haytham. It is the work of the philosopher whose family lived in the region of Basra, probably in Ahwāz. He was born in 965 CE, conducted his career in Bagdad and was still alive in 1028 CE. Of the 90 works in the two lists attached to his autobiography only two are extant today in manuscript, both unedited. One is a commentary on the *Spherics* of Menelaos, the classic work on spherical geometry; the other is the commentary on the Almagest. At the beginning, Muḥammad Ibn al-Haytham says:

"I found the main intention of the majority of those who have given their commentary on the Almagest was to describe the chapters on calculation and to expand on them, revealing aspects other than those revealed by Ptolemy, without clarifying those chapter containing ideas too obscure for the beginner. [...] in this way al-Nayrīzī filled his book with endless variations of the same chapters on calculation, motivated by the desire to inflate and glorify what he wrote. [...] I had the idea of setting out a proposition in the commentary of this book, the Almagest, where my principal objective would be to elucidate subtle ideas for the benefit of students."[59]

He explicitly connects his refusal to discuss recent developments in astronomy with the didactical purpose of his commentary: it should help beginners to understand what Ptolemy wrote. His approach is strictly text-immanent and excludes references to the contemporary scientific context. His critique of al-Nayrīzī goes in the same direction. Al-Nayrīzī's lost commentary included discussions of recent achievements in astronomy, a fact which is confirmed by al-Bīrūnī, who quotes Nayrīzī at several junctures.[60] Muḥammad Ibn al-Haytham's

59 Rashed 2012: 21–22.

60 Thomann 2010–2011: 41 n. 50; Sezgin 1978: 192.

commentary on the Almagest is the complete opposite of al-Ḥasan Ibn al-Haytham's work on the doubts in the Almagest, probably the most aggressive critique ever written about this book.[61]

Muḥammad Ibn al-Haytham argued that the *Almagest* is the best text-book for the training of mathematics, but he did not say that the *Almagest* should be read as the first book in this field. Generally, it became customary to begin with Euclid's Elements and to continue with some shorter texts on spherical astronomy, known as the *Middle books*, i.e. the books to be read between the *Elements* and the *Almagest*. The indispensability of the *Almagest* in the educational context can be explained when al-Qabīṣī's classification of competence in astronomy is considered. There the perfect astronomer distinguishes himself by his capability to perform observations in establishing astronomical tables and to prove all necessary steps. If this was the goal, the Almagest was the only possible choice for a textbook. The famous Arabic works on astronomy by Ḥabash al-Ḥāsib and al-Battānī instead followed the pattern of Ptolemy's *Handy Tables* and did not include proofs. But for an Aristotelian philosopher, such as Muḥammad Ibn al-Haytham, science distinguishes itself from opinions precisely by its provability.

In his autobiography, he describes how he became skeptical about the doctrines and dogmas of the people of his time and that he found firm ground only in Aristotle's writings. He went on to study what he called the "philosophical sciences" (*ʿulūm al-falsafa*): mathematical sciences (*riyāḍiyya*), natural sciences (*ṭabīʿiyya*) and metaphysics (*ilāhiyya*).[62] If this sequence is taken literally, the mathematical sciences were studied first. They were seen as propaedeutic subjects in preparation for the study of physics and metaphysics.

8 Abū Naṣr ibn ʿIrāq: A heir of al-Qabīṣī's ideas on professional levels of competence

Al-Qabīṣī's experiment of writing a commentary al-Farghānī's *Fuṣūl* was not repeated.[63]

Abū Naṣr Ibn ʿIrāq (d. ca. 1036 CE), the teacher and mentor of al-Bīrūnī was an excellent mathematician, who could well have claimed to be a "perfect astronomer", since his works contain a wealth of proofs. He was one of the

61 Ibn al-Haytham 1971.

62 Arabic Text Heinen 1979: 259; German translation Wiedemann 1906: 158.

63 On the alleged commentary on the *Fuṣūl* by al-Jūzjānī see Appendix B.

first who provided a geometrical proof for the spherical sine theorem. In a polemical work against the way adherents of the Ismāʿīliyya were arguing in astronomy, he coined a term for a certain professional level of competence using the expression *aṣḥāb al-azyāj*, the "masters of the astronomical tables".[64] From the context it can be deduced that by this expression, Abū Naṣr Ibn ʿIrāq designated astronomers who combined al-Qabīṣī's three first levels of competence: the ability to prove, intuitive mastering of spatial structures and motions, and acquaintance with the technicalities of astronomical tables. He accused his adversaries of having no sense for geometrical proofs and methodical steps.[65] At the heart of his reasoning was a kind of quantitative thinking, based on geometrical models, while his adversaries were just arguing qualitatively with words. This polemical work of Abū Naṣr Ibn ʿIrāq can be read as a plea for mathematical reasoning against a pseudo-scientific discourse promoting a religious agenda. At the same time, it documents the professional pride of Abū Naṣr, based on his confidence in his own scientific competence.

9 Conclusions

It has been argued that astronomy underwent a crisis in the second half of the ninth century CE, and that in the tenth century a second revival took place, indicated by a steady increase in scientific activity. Generally, a drift from east to west and from the former center of power to the periphery, where new centers of learning emerged. The court of Sayf al-Dawla in Aleppo was taken as an example. Two famous scholars, al-Fārābī and al-Qabīṣī developed new forms of teaching astronomy, both through commentaries on textbooks, but with distinct intentions. For al-Fārābī, astronomy formed part of a general curriculum of encyclopedic education and was conceived as a propaedeutic discipline with the purpose of preparing students for the even more abstract subject of metaphysics. For al-Qabīṣī astronomy had value in its own right, as far as the highest level of competence is concerned. Only the lower, more technical levels served the needs of astrology. In his commentary on the *Fuṣūl* of al-Farghānī, he tried to guide students from the simplified presentation of that text to the more demanding task of reading the *Almagest* itself. Further, al-Qabīṣī attempted to professionalize his discipline.

64 Thomann 2013: 500; Ibn ʿIrāq 1948: 8.
65 Thomann 2013: 498–500.

Al-Fārābī's and al-Qabīṣī's enterprises seem to have met new demands in society for universally educated scholars on the one hand and for specialized professionals on the other. These increased demands were connected with the formation of independent regional centers and their rulers' quest for legitimization. Both methods of education offered their recipients good career opportunities. The most prominent examples in the following years were Ibn Sīnā and al-Bīrūnī, the first as the unsurpassed universal scholar, the second as the unsurpassed professional astronomer. Ibn Sīnā stressed the importance of al-Fārābī's works in his education, and al-Bīrūnī's mentor Abū Naṣr ibn 'Iraq must have had a similar attitude to al-Qabīṣī as regards the rigorous claims of professional competence.

The second revival of astronomy was a complex phenomenon and there may have been numerous underlying factors. In this article, a first attempt has been made to give at least one historical explanation for the upswing seen in the timeline based on the number of scholars per generation. There is ample room for further investigation both by the present author and, hopefully, by other historians of science.

Appendix A: al-Ḥasan Ibn al-Haytham and Muḥammad Ibn al-Ḥaytham

At the beginning of the commentary on the Almagest, discussed in the main part of this article, the name of the author is given as Muḥammad ibn al-Ḥasan ibn al-Haytham (MS Istanbul Topkapı Saray Ahmet III 3329). The question is whether he is identical with the famous author of the Book on Optics (*Kitāb al-Manāẓir*), who in the Latin west became known as Alhacen, or if he was a philosopher and physician who was active in Baghdad. This was the subject of a controversy between Abdelhamid Sabra and Roshdi Rashed.

Rashed argued in 1993 that one has to distinguish between the mathematician, al-Ḥasan ibn al-Ḥasan ibn al-Haytham, and the philosopher, Muḥammad ibn al-Ḥasan ibn al-Haytham.[66] He further argued that from the three lists of works quoted by Ibn Abī Usaybī'a, only the third pertains to the mathematician and the two other to the philosopher.

Sabra defended the traditional identification of Ibn al-Haytham as one person in 1998 and 2003, and he repeated his standpoint in 2008, in the much influential *New Encyclopedia of Scientific Biography*.[67]

66 Rashed 1993: 8–19.

67 Sabra 1998; Sabra 2003; Sabra 2007.

Rashed presented further arguments for a distinction of al-Ḥasan and Muḥammad in 2000, 2002, 2006 and 2007.[68] The main reason for assuming two different authors is the different character of works connected with the two names. Muḥammad is credited mainly with works on Galenic medicine and Aristotelian philosophy together with fewer works on mathematical disciplines, mostly in the form of commentaries. Al-Ḥasan is credited with all the works on mathematics and optics which made him famous in the history of science.

In the view of Sabra, these latter works were written after 1028 CE, and therefore do not occur in the first two lists of works. In 2014, an article on Ibn al-Haytham's work on the shape of solar eclipses was published, in which the solar eclipse observed by Ibn al-Haytham with a *camera obscura* was identified as that which took place on 21st October 990 C.E. in Basra.[69] It has gone unnoticed that this finding has far-reaching consequences for the chronology of Ibn al-Haytham's work. It can be assumed that Ibn al-Haytham wrote his work shortly after 990 C.E. Moreover, Ibn al-Haytham refers in this work to his own work on optics, the *Kitāb al-Manāẓir* the most famous of all his works.[70] Therefore it must have been written before or around 990 C.E. This refutes Sabra's assumption of a date after 1028 C.E. This new evidence thus corroborates Rashed's distinction of two authors, al-Ḥasan Ibn al-Ḥasan Ibn al-Haytham, the mathematician, and Muḥammad Ibn al-Ḥasan Ibn al-Haytham, the philosopher.

Appendix B: Another commentary on the *Fuṣūl* by al- Jūzjānī?

It has been said that ʿAbd al-Wāḥid Ibn Muḥammad al-Jūzjānī, the famous pupil and redactor of Ibn Sīnā wrote a commentary on the *Fuṣūl* of al-Farghānī too.[71] A manuscript in Mashhad contains a work of al- Jūzjānī with the title *Khilāṣ tarkīb al-aflāk*, and is described in the catalogue as a *sharḥ* on the *Fuṣūl*.[72] However, the beginning of the work does not confirm this, but seems rather to be the introduction to a work on the order of the celestial spheres, which does not correspond to the first chapters in the *Fuṣūl* of al-Farghānī.[73] Al- Jūzjānī refers in the first lines to the Almagest and the *Kitāb al-Manshūrāt* of Ptolemy, to his master Ibn Sīnā and to

68 Rashed 2000: 937–941; Rashed 2002: 957–959; Rashed 2006: 881–894; Rashed 2007.
69 Raynaud 2014.
70 Wiedemann 1914: 156.
71 Sezgin 1978: 281.
72 Maʿānī 1971: 347.
73 MS Mashhad 5593 p. 92.

the *Zīj al-Ṣafā'iḥ* of Abū Ja'far al-Khāzīn. A reason for the author of the catalogue to relate the work to al-Farghānī might have been the fact that a work with the title *Tarkīb al-aflāk* was indeed attributed to al-Farghānī.[74] But this attribution seems to be erroneous, since the work in the manuscript with this attribution is a work of the twelfth century author Muḥammad Ibn Aḥmad al-Kharaqī.[75] Nevertheless, the title *Khilāṣ Tarkīb al-aflāk* seems to imply a short commentary on a work with the title *Tarkīb al-aflāk*. Four authors up to the time of al-Jūzjānī are known to have written a work with that title: Ya'qūb Ibn Ṭāriq, Māshā'allāh (*Tarkīb al-aflāk wa-ḥarkātihā*), 'Uṭārid, and al-Sijzī.[76] Since al-Jūzjānī discusses Ptolemaic astronomy, the first three early authors can be dismissed. Only the work of al-Sijzī would have been a feasible text for al-Jūzjānī to comment upon.[77] Considering the scarce information available, a firm decision cannot be made, but it seems rather unlikely that a commentary of al-Jūzjānī on the *Fuṣūl* of al-Farghānī ever existed. Therefore, the *sharḥ* of al-Qabīṣī was not only a novelty but also a unique approach to the teaching of astronomy.

Appendix C: Astronomers in Antiquity

Name	Start	End	Place
Mandroutos	−585	−525	Priene
Kleostratos of Tenedos	−530	−470	
Phaeinos	−460	−430	Athens
Anaxagoras	−480	−428	Klazomenoi
Iōn	−460	−421	Chios
Oinopidēs	−450	−420	Chios
Metōn	−440	−410	Athens
Aiskhulos	−430	−400	Khios
Harpalos	−500	−400	
Hippokratēs of Khios	−440	−400	Chios
Philolaos	−430	−400	Krotōn
Theodōros of Kurēnē	−470	−400	Athens
Ekphantos	−400	−360	Syracuse
Hiketas	−400	−359	Syracuse
Helikōn	−375	−350	Kyzikos

(*continued*)

74 MS Baghdad Awqāf 5497.

75 Sezgin 1978: 151 fn. 1.

76 Sezgin 1978: 126, 129, 161 and 225.

77 The work is upublished; see Sezgin 1978: 225; Rosenfeld/İhsanoğlu 2003: 113 no. A2.

(*continued*)

Name	Start	End	Place
Plato	–390	–347	Athens
Eudoxos of Knidos	–365	–340	Athens
Philippos of Opous	–365	–335	Opous
Phokos	–330	–330	Samos
Polemarkhos	–360	–330	Kyzikos
Hērakleidēs of Hērakleia Pontikē	–365	–320	Athens
Kallippos of Kuzikos	–350	–320	Kuzikos
Matriketas	–320	–320	Lesbos
Autolukos	–300	–300	Pitanē
Nearkhos of Crete	–315	–295	Amphipolis
Dionusios	–285	–285	Alexandria
Eudēmos of Rhodes	–330	–285	Rhodes
Parmeniōn	–310	–280	Alexandreia
Aristarkhos of Samos	–280	–270	Samos
Biōn of Abdēra	–330	–270	Abdēra
Aristullos	–300	–265	
Timokharis	–300	–265	Alexandreia
Patroklēs	–312	–261	Macedonia
Euclid	–300	–260	Alexandreia
Alexander of Pleuron	–290	–250	Alexandreia/Pella
Aristotheros	–250	–250	
Kritōn of Naxos	–335	–250	Naxos
Lasos	–300	–250	Magnesia
Menestratos (I)	–400	–250	
Nautelēs	–400	–250	
Pheidias	–300	–250	Syracuse
Sminthēs	–500	–250	Rhodes?
Aratos of Soloi	–290	–240	Macedonia
Sudinēs	–240	–240	Babylon
Alexander of Lukaia	–250	–230	Lukaia
Dōsitheos of Pēlousion	–250	–210	Alexandreia
Kharmandros	–350	–200	
Konōn	–250	–200	Samos
Zēnodōros	–200	–200	
Eratosthenēs	–240	–194	Alexandreia
Fuluius Nobilior	–190	–179	Rome
Hēgēsianax	–215	–175	Syria
Linos	–250	–150	
Skopinas	–200	–150	Syracuse
C. Sulpicius Gallus	–170	–150	Rome
Seleukos of Seleukeia	–165	–135	Seleukia
Attalos of Rhodes	–150	–125	Rhodos

(*continued*)

(*continued*)

Name	Start	End	Place
Hipparkhos of Nikaia	−140	−120	Nikaia
Zēnodotos of Mallos	−170	−120	Mallos
Anakreōn	−300	−100	
Diogenēs of Tarsos	−150	−100	Tarsos
Euainetos	−250	−100	
Hupsiklēs	−150	−100	Alexandreia
Kalyāṇa	−100	−100	Miletos
Leptinēs (II)	−200	−100	Seleukeia
Mēnodotos	−250	−100	
Purros of Magnesia	−250	−100	Magnesia
Timotheos	−250	−100	
Philippos	−150	−90	Delos
Adrasos of Kuzikos	−120	−80	Kyzikos
Andrias	−120	−80	
Diōn of Neapolis	−120	−80	Neapolis
Parmeniskos	−120	−80	Alexandreia
Billaros	−105	−75	Thessalia
Diodotos (I)	−95	−60	
Artemidōros of Parion	−70	−50	Parion
Egnatius	−100	−50	Spain
Kidēnas	−150	−50	Babylon
Mētrodōros (I)	−150	−50	Italy/Sicily
Naburianos	−50	−50	Babylon
Theodosios (of Bithuania)	−200	−50	Bithynia
Alexander of Ephesos	−75	−45	Ephesos
P. Nigidius Figulus	−70	−45	Rome
M. Tullius Cicero	−80	−43	Rome
Q. Tullius Cicero	−55	−43	Rome
M. Terentius Varro	−81	−27	Rome
Sōsigenēs (I)	−75	−25	Alexandreia
P. Ouidius Naso	−20	−17	Rome
Geminus	−100	0	Rhodes
C. Iulius Hyginus	−30	10	Rome
Sabinus	−15	15	Rome
Xenarkhos	−45	17	Seleukia
Germ. Iulius Caesar	10	19	Rome
L. Sextilius Paconianus	26	35	Rome
Thrasullos	4	36	Rome
Diophil-	−150	50	
L. Iulius Columella	40	70	Rome
T. Flauius Vespasianus	70	78	Rome
Leōnidas of Alexandria	50	80	Alexandreia

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Name	Start	End	Place
Ammōnios of Alexandria, M. Annius	40	85	Athens
Agrippa of Bithunia	92	92	Bithynia
Didumos of Knidos	–250	100	Knidos
Menelaos of Alexandria	90	100	Alexandreia
Derkullidēs	–50	120	
Plutarch	80	120	Khairōneia
Theōn of Smurna	100	130	Smyrna
Theōn	127	132	
Ptolemy	127	146	Alexandreia
Apuleius of Madaurus	150	170	Alexandreia
Apollinarios	30	180	Aizanoi
Herminos	160	180	Pergamon
Sōsigenēs (II)	125	190	
Alkinoos	100	200	
Atticus	150	200	
Diogenēs of Oinoanda	120	200	Oinoanda
Kleomēdēs	–50	200	
Artemidōros	210	215	
Censorinus (II)	230	250	
Diodōros of Alexandria	–150	250	Alexandreia
Samuel	254	254	Nehardea
Akhilleus	200	300	
Mētrodōros (II)	10	300	
Pappos of Alexandria	285	320	Alexandreia
Andreas of Athens	345	355	Athens
Serapiōn	150	360	
Hēliodōros	350	370	
Apollōnios of Laodikeia	180	380	Laodikeia
Theōn of Alexandria	360	385	Alexandreia
Diodōros of Tarsos	365	393	Tarsos
Mallius	385	395	Milan
Calcidius	400	400	Milan
Hupatia	380	415	Alexandreia
Fauonius	380	420	Carthage
Victorius	445	465	Aquitania
Anthedius	450	470	Vesunnici
Iulianus Vertacus	300	470	
Āryabhaṭa	500	500	Pāṭaliputra = Patna
Hēliodōros of Alexandria	475	510	Alexandreia
Ammōnios, son of Hermeias	470	517	Alexandreia
Boetius	500	524	Rome
Priscianus of Caesarea	500	525	Caesarea, Mauretania

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(*continued*)

Name	Start	End	Place
Eutokios	510	530	Alexandreia
Priscianus of Ludia	530	530	Athens
Varāhamihira	550	550	Ujjain
Gregory of Tours	570	594	Tours
Tukhikos	500	600	Trapezunt/Antiochia/ Jerusalem/Alexandreia/ Rome/Constantinople
Abiyūn al-Biṭriq	630	630	
Stephanos	580	640	Alexandreia
Leontios	600	650	
Seuerus Sebokht	630	667	Nisibis
Anania of Shirak	610	685	Shirak
Euktēmōn	−440	eia	Athens

Appendix D: Astrologers in Antiquity

Name	Start	End	Place
Zarathuštra	−600	−600	Afghanistan
Zoroaster, pseudo	−500	−300	
Bērossos	−330	−280	Babylōn
Leptinēs (I)	−260	−240	Seleukeia (Seleukos II)
Melampous	−300	−200	
Serapiōn of Alexandria	−240	−200	Alexandria
Ankhialos	−105	−105	
Bōlos of Mendēs	−250	−115	Mendēs
Kassandros	−135	−105	
Antipatros	−200	−100	Tarsos
Petosiris	−150	−100	
Skulax of Halikarnassos	−140	−90	Halikarnassos
Apollōnios of Mundos	−120	−80	Mundos
"Lion Horoscope" of Kommagēnē	−109	−62	Mt. Nemrud
Nigidius Figulus, P.	−70	−45	Rome
Anitokhos of Athens	260	260	Athens
Epigenēs of Buzantion	−120	−30	Byzantium
Fonteius Capito	−50	−30	Rome
Tarutius of Firmum Picenum, L.	−75	−30	Rome
Akhinapolos	−150	−25	
Manilius, M.	10	30	

(*continued*)

(*continued*)

Name	Start	End	Place
Thrasullus, Ti. Claudius (of Mendēs?)	4	36	Rome
Kárpos of Antioch	–10	40	Antioch
Krinas of Massalia	25	50	Rome
Kritodēmos	–50	50	
Thessalos of Tralleis	20	70	Tralleis
Attius	–30	75	
Khairēmōn	25	75	
Timaios	75	79	
Balbillos	40	80	Rome
Anoubiōn	1	100	Diospolis
Dōrotheos of Sidōn	50	100	Sidōn
Pitenius, T.	100	100	Lower Egypt
Teukros of Seleukeia	30	100	Babylōn, Egypt
Pollēs of Aigai	80	120	Aigai
Zēnarion	50	120	
Antigonos of Nikaia	175	175	Nikaia
Calpurnius Piso (I)	90	130	Rome
Manethōn	120	140	
Ptolemy	127	146	Alexandria
Abram	–150	150	
Hermeias	–150	150	
Kallikratēs	50	150	
Puthagoras, pseudo	1	150	Samos
Vicellius	–100	150	Rome
Yavaneśvara	149	150	India
Vettius Valens of Antioch	150	180	Antioch
Orpheus, pseudo	–200	200	
Sextus Empiricus	100	200	
Bardaisan	174	222	Edessa
Censorinus (II)	230	250	
Spujidhvaja	269	270	India
Erasistratos	200	300	
Neilos	250	300	
Mīnarāja	300	325	Gujara/Rajastan
Iamblikhos	300	327	Khalkis, Syria
Fronto	–120	350	
Prōtagoras of Nikaia	–100	350	Nikaia
Andreas of Athens	345	355	Athens
Firmicus Maternus, Iulius	334	357	
Hēliodōros	350	370	Antioch
Astrologos of 379	379	379	Rome
Pankharios	140	380	

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Name	Start	End	Place
Diodōros of Tarsos	365	393	Tarsos
Ammōn	–100	400	
Campestris	–100	400	
"Hermēs Trismegistos"	–100	400	
Macharius	395	400	Rome
Maximus	300	400	Ēpereiros/Byzantium, Rome
Ōdapsos of Thebes	150	400	Thebes
Paulos of Alexandria	350	400	Alexandria
Petros	449	449	Constantia
Hephaistiōn	420	450	Thebes, Egypt
Fullonis Satruninus, L.	300	470	
Thrasubulus	220	470	
Bothros	–150	500	
Euax	400	500	
Iulianus of Laodikeia	500?	500?	Laodikeia
Asklatiōn	50	535	Rome
Varāhamihira	550	550	Ujjain
Iōannēs of Philadelpheia, "Lydus"	540	561	Constantinople
Wuzurgmihr	531	579	Persepolis
Tribonianus	540	580	Sidē
Stephanos of Alexandria	580	640	Constantinople
Imbrasios of Ephesos	–300	650	Ephesos
Rhētorios	600	700	

Appendix E: Astronomers in India

Author	Work	Date
Āpastamba	Āpastambaśrautasūtra	6th c. B.C._
Mahāvīra	?	d. ca. /480
Lagadha	Jyotiṣavedāṅga 1	–400
Anon.	Jyotiṣavedāṅga 2	–100?
Kalyāṇa	?	fl. before 100 B.C.
Garga	Gargasaṃhitā	1st c.
Garga	Vṛddhagargasaṃhitā	1st c.
Garga	Vṛddhagargīsaṃhitā	1st c.
Garga	Gargasaṃhitā	1st c.
Garga	Gargasaṃhitā	1st c.
Garga	Uttaragārgyasaṃhitā	1st c.

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Author	Work	Date
Umāsvāti Vācaka	Tattvārthādhigamasūtra	1th c.
Umāsvāti Vācaka	Kṣetrasarmāsa	1th c.
Nāgara Vācaka	?	fr. 1st c.
Kālakācārya	?	fl. ca. 100–150 B.C.
Yavaneśvara		fl. 149
Kāmandaka	Nīttisāra	ff. c. 3rd c.
Maṇittha	?	2nd, 3rd or 4th c.
Parāśara	?	fl. 3rd c.
Spujidhvaja	Yavanajātaka	1
Anon.	Romakasiddhānta	3th/4th c.
Cyavana	Cyavanasiddānta	cited by Varaham. 550
Devala	Kākaruta	fl. 3rd or 4th c.
Devala	Gomukhajananaśānti	fl. 3rd or 4th c.
Pauliśa	Pauliśasiddhānta	fl. 3rd or 4th c.
Romaka		3th/4th c.
Mīnarāja	Vṛddhayavanajātaka	fl. ca. 325
Añgiras	Bārhaspatyasaṃhitā	?
Anon.	Paitāmahasiddhānta	early 5th c.
Atri	Ātreyasaṃhitā	?
Bādarāyaṇa	?	f. 4th or 5th c.
Jīvaśarman	?	fl. 4th or 5th c.
Satya	?	fl. 4th c.
Kālakācārya	Kālakasaṃhitā	d. ca. 409
Bhāguri	?	fl. before 550
Bhāradvāja	Bhāradvājīya	fl. before 550
Bhṛgu	?	fl. before 550
Bṛhaspati	Bṛhaspatisaṃhitā	before ca. 550
Bṛhaspati	?	before ca. 550
Manu	?	fl. before 550
Maya	?	fl. before 550
Parāśara	Parāśarasmṛti	fr. 3rd to 5th c.
Pradyumna	?	fl. 5th c.
Anon.	Vasiṣṭhasiddhānta	before 499
Anon.	Pauliśasiddhānta 1	before 499
Āryabhaṭa I	Āryabhaṭīya	499
Āryabhaṭa I	Āryabhaṭasiddhānta	after 499
Dravyavardhana	?	fl. ca. 500
Gautama	?	before ca. 550
Kapiṣṭhala	?	mentioned 550
Kaśyapa	Kaśyapasaṃhitā	quoted 550
Maskarī Purāṇa	?	fl. 5th or 6th c.
Nagnajit	?	before ca. 550

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Author	Work	Date
Nārada	Nāradasaṃhitā	fl. before ca. 550
Brabhākara	?	fl. ca. 500
Ṛṣabha	?	before 550
Ṛṣiputra	?	before 550
Lāṭadeva	Sūryasiddhānta 2	505
Lāṭadeva		505
Pāṇḍurañga Svāmin	?	fl. ca. 500/525
Varāhamihira	Pañcasiddhāntikā	532
Mudgala	?	fl. before 629
Vijayanandin		before 550
Pṛthuyaśas	Ṣaṭpañcāśikā	fl. ca. 575
Tāraka	?	fl. ca. 590
Viṣṇucandra		ca. 600/550–600
Jinabhadra Gaṇi Kṣamāśramaṇa	Kṣetrasamāsa	fl. 609
Anon.	Dhyānagrahopādjyāya	628?
Brahmagupta	Brāhmasphuṭasiddānta	628
Bhāskara	Mahābhāskarīya	629
Bhāskara	Āryabhaṭīyabhāṣya	629
Bhāskara	Laghubhāskarīya	629
Andubarius	?	7th c.
Brahmagupta	Khaṇḍakhādyaka	665
Haridatta	Grahacāranibandhana	683
Haridatta	Mahāmārganibandhana	683
Devācārya	Karaṇratna	689
Agnikeśa	?	before ca. 750
Devakīrti	?	fl. before 800
Parāśara	Bṛhatpārāśarahorā	fr. 7th or 8th c.
Ṛṣi	?	before late 8th c.
Gautama Siddhārta	Chiu-chih li	718
Anon.	Zīj-i Arkand	735
Balbhadra	Kānyakubja	725–750
Akalañka	Tattvārtgavārtujākañkāra	7th/9th c.
Anon.	Pauliśasiddhānta 2	8th c.
Anon.	Bakhshālī MS	8th c.?
Bhadrabāhu	Bhadrabāhusaṃhitā	fl. 7th, 8th or 9th c.
Bhagadatta	?	fl. before 800/850
Citragupta	Jātaka	fl. before ca. 750
Pauliśa	Pauliśasiddhānta	fr. 8th c.
Śrīdhara	Algebra	8th c.
Śrīdhara	Pāṭīgaṇita	8th c.
Śrīdhara	Pāṭīgaṇitasāra/Triśatikā	8th c.
Śrīdhara	Gaṇitapañcaviṃśī	8th c.

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Author	Work	Date
Amoghavajra	Xiuyao jing	759
Anon.	Mahāsidhānta	1
Kanaka	?	775–800
Kandala	?	fl. before ca. 800
Anon.	Sūryasiddhānta 3	800
Āryakula	?	?
Cūḍāmaṇi	?	fl. before ca. 800
Guḍa	?	fl. ca. 800
Jina	?	cit 9th c.
Kakka	?	c. 800
Kalyāṇavarman	Sārāvalī	fl. c. 800
Kātyāyana	Śulbasūtra	quoted 966
Khindika	?	Abbasid
Kṛṣṇa	_	before 800
Lalla	Śiṣyadhīvṛddhidatantra	8th/early 9th c.
Yavana	Candrābharaṇahorā	before 800
Lalla		ca. 800
Govindasvāmin	Comm. Mahābhāskarīya	800–850
Mahāvīra	Baṇitasārasaṅgraha	814–880
Bādarāyaṇa	Praśnaviyā	fl. before 966/969
Bhānubhaṭṭa	?	fl. before 966/969
Yavana		before 850
Yavana, Cirantana		before 850
Pṛthūdakasvāmin	C. Khaṇḍakhādyaka	864
Pṛthūdakasvāmin	Vāsanābhāṣya	860–870
Śaṅkaranārāyaṇa	Comm. Laghubhāskarīya	869
Vateśvara	Karaṇasāra	899
Bhānurajas	?	fr. before 1000
Divyatattva	Saṃhitā	fl. before 1000
Garga	Paśakevalī	fl. ca. 900
Jitāri	?	
Nandin	Nāndīyātrā	fl. before ca. 966
Parāśara	Pārāśarya	fl. 9th or 10th c.
Vateśvara	Vateśvarasiddhānta	904
Durlabha	Koṣṭaka	932
Muñjāla	Bṛhanmānasa	932
Muñjāla	Laghumānasa	after 932
Praśastadhara	C. Laghumānasa	958
Vijayananda	Karaṇatilaka	966
Yama		before 966
Vijayananda		966
Bhaṭṭopala	C. Khaṇḍakhādyaka	969

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Author	Work	Date
Bhaṭṭopala	C. Saṃhitāvivṛti	969
Bhaṭṭopala	C. Jagaccandrikā	969
Bhaṭṭopala	C. Śiṣyahitā	969
Bhaṭṭopala	C. Bṛhadyātrā	969
Bhaṭṭopala	C. Yogayātrā	969
Bhaṭṭopala	Cintāmaṇi	969
Bhaṭṭopala	C. Ṣaṭpañcāśikā	969
Bhaṭṭopala	C. Praśnaviyā	969
Bhaṭṭopala	Praśnajñāna	969
Āryabhaṭa II	Mahāsidhānta	950–1000
Nemicandra	Trilokasāra	frl ca. 975
Padmanandin	Jambūdvīpaprajñaptisañgraha	fl. ca. 975
Bīrūnī	?	b. 973
Mādhava	Siddhāntacūḍāmaṇi	fl. 10th or 11th c.
Mādhavacandra	Comm. Trilokasāra	fl. 1000
Lakṣaka		before 1100
Lakṣamaṇasena		ca. 1178

Appendix F: Astronomers in the Islamic World[78]

MAOSIC	Name	Date	Place
1	ʿAlī Ibn Abī Ṭālib	661	Mecca -> Medina
2	Severus Sebokht	667	Nisibis -> Qinnasrin
3	Yaʿqob of Edessa	633–708	ʿEndebha (Antiochia)
4	Ǧirǧis Usquf al-ʿArab	724	Mesopotamia
5	Ǧaʿfar aṣ-Ṣādiq	700–765	–
6	Ibrāhīm al-Fazārī	777	–
7	an-Nawbaḫt	777	Baġdād
8	Sufyān aṯ-Ṯawrī	713–778	–
9	Ǧābir Ibn Ḥayyān	8./10.Jh.	Kufa
10	Ṯiyūfīl Ibn Ṯūmā	695–785	Edessa -> Baġdād
11	Yaʿqūb Ibn Ṭāriq	796	Baġdād
12	Abū ʿĀṣim ʿIsam	8. Jh.	Baġdād

(*continued*)

78 The list is based on Rosenfeld/İhsanoğlu 2003. The reference numbers are in the first column. In this list the transliteration is according to the ISO standard.

(*continued*)

MAOSIC	Name	Date	Place
13	Simʿān Ibn Sayyār al-Kābūlī	8. Jh.	Kabul
14	Abū Yaḥyā al-Baṭrīq	800	Baġdād
15	Muḥammad al-Fazārī	2.H. 8. Jh.	–
16	Muʾarriğ Ibn ʿUmar	810	–
17	al-Faḍl Ibn Nawbaḫt	815	Baġdād
18	Māšāllāh	815	Basra
19	ʿAlī Ibn al-Aʿrābī aš-Šaybānī	860	Kufa
20	Ḍirār Ibn ʿAmr	8.-9.Jh.	–
21	Hišām al-Fuwaṭī	813	–
22	Abū Hudayl al-ʿAllāf	752–840	Basra -> Baġdād
23	ʿAbdallāh al-Asnī	815	Baġdād
24	al-Faḍl as-Saraḫsī	770–818	Saraḫs (Turkmenistan)
25	an-Naẓr Ibn Šumayl	818	–
26	Yaḥyā al-Farrāʾ	761–822	Kufa -> Baġdād
27	ʿUmar Ibn al-Farruḫān aṭ-Ṭabarī	815	Tabaristan -> Baġdād
28	Isḥāq aš-Šaybānī	728–818	–
29	Saʿīd Ibn Aws al-Anṣārī	738–830	–
30	Abū Saʿīd al-Asmaʿī	740–831	–
31	Yaḥyā Ibn Abī Manṣūr	830	Iran -> Baġdād
32	ʿAbdallāh al-Maʾmūn	reg. 813-833	Baġdād
33	al-Ḥasan at-Tamīmī al-Abaḥḥ	E. 8.-A.9. Jh.	Ṭūs (Ḫurasan) -> Baġdād
34	al-Ḥağğağ Ibn Maṭar	8.-9.Jh.	Baġdād
35	Salam	9. Jh.	Bagdād
36	Muʿammar Ibn ʿAbbād	830	–
37	Yaḥyā al-Ḫayyāṭ	835	-> 18 Basra
38	Ayyūb al-Baṣrī	9. Jh.	Basra
39	Aḥmad al-Nahamandī	840	Nahawand (Ğibal) -> Gundišapūr (Fars)
40	Muḥammad Ibn al-ʿArabī	767–825	Kufa
41	Muḥammad al-Ḫwārizmī	780–850	Ḫwārizm -> Marw -> Baġdād
42	Ḫālid al-Marwarrūḏī	1.H. 9. Jh.	Marwarrūḏ (Maruchak, N.-Afġanistan)
43	al-ʿAbbās al-Ğawharī	1. H. 9. Jh.	Gawhar (Farab, S. Kazaḫstān)
44	Abū ăl-ʿAbbās Ibn Ḥamdūn	9. Jh.	Nišāpūr
45	Manṣūr al-Ḫuzāʿī	854	Marw, Amul, Ḫwārizm
46	Ḥabaš al-Ḥāsib	770–870	Marw -> Baġdād
47	ʿAlī al-Asṭurlābī	9. Jh.	Ḥarrān -> Baġdād
48	Sanad Ibn ʿAlī	9. Jh.	Baġdād
49	Sahl aṭ-Ṭabarī	1. H. 9. Jh.	Ṭabaristān
50	Sahl Ibn Bišr	850	Ḫurasān -> Baġdād
51	al-Ḥasan Ibn Nawbaḫt	9. Jh.	Baġdād
52	ʿAbdallāh Ibn Nawbaḫt	9, Jh.	Baġdād

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MAOSIC	Name	Date	Place
53	Yaḥyā al-Baṭrīq	9. Jh. ?	~ 14
54	Muḥammad Ibn al-Bāzyār	9. Jh.	Iran ~ 46
55	Ibn Hibinta	9. Jh.	Baġdād
56	Ibrāhīm Ibn aṣ-Ṣalt	9. Jh.	–
57	Ibn Rāhiwayh al-Arraǧānī	9. Jh.	Arraǧǧān (Fars)
58	Muḥammad aṭ-Ṭabarī	9. Jh.	Ṭabaristān ~ 27
59	ʿAbd al-Ḥamīd Ibn Turk al-Ḫuttalī	1. H. 9. Jh.	Baġdād
60	Ibrāhīm an-Naẓẓām	840	Balḫ -> Basra, Baġdād
61	ʿAbd al-Malik al-Qurṭubī	790–852	Cordoba
62	Yaʿqūb Ibn as-Sikkīt	802–858	Kufa
63	Muḥammad al-Barmakī	9. Jh.	Balḫ -> Baġdād
64	Ibn Isḥāq Ibn Kusūf	9. Jh.	–
65	Yuḥannā Ibn Māsawayh	776–857	Gundišāpūr -> Baġdād
66	ʿĪsā Ibn Yūnis	9. Jh.	Baġdād
67	Aḥmad al-Farġānī	861	Farġāna -> Baġdād, Cairo
68	Muḥammad Ibn aṣ-Ṣabbāḥ	9. Jh.	–
69	Ibrāhīm Ibn aṣ-Ṣabbāḥ	9. Jh.	–
70	al-Ḥasan aṣ-Ṣabbāḥ	9. Jh.	–
71	al-Hāriṯ al-Ḫurasānī	9. Jh.	Ḫurasān -> Baġdād
72	ʿAlī aṭ-Ṭabarī	800–864	Ṭabaristān-> Irāq
73	Ḫurzād Ibn Dāršad	9. Jh.	Irān
74	Banū Mūsā	872	Ḫurasān-> Baġdād
75	Nuʿaym Ibn Šākir	9. Jh.	Baġdād (?)
76	ʿAmr al-Ǧāḥiẓ	767–868	Baṣra
77	Ḫunayn Ibn Isḥāq al-ʿIbādī	809–873	Hira-> Gundišapūr-> Baġdād
78	Muḥammad al-Makkī	9. Jh.	Makka -> Nīšapūr (852)
79	Yaʿqūb al-Kindī	873	Baṣra -> Baġdād
80	Aḥmad Ibn ad-Dāya	796–878	Baġdād
81	Muḥammad al-Marwarrūḏī	9. Jh.	Marwarrūḏ
82	Muḥammad al-Māhānī	880	Māhān
83	ad-Darīr al-Ǧurǧānī	9. Jh.	Gurgān
84	Hilāl al-Ḥimsī	880	Ḥims-> Baġdād
85	al-Ḥusayn al-Adamī	9. Jh.	?
86	Abū Ǧaʿfar Ibn Ḥabaš	9. Jh.	?
87	Muḥammad as-Samarkandī	9. Jh.	Samarkand
88	Abū Maʿšar Ǧaʿfar al-Balḫī	786–886	Balḫ-> Baġdād
89	Abū Saʿīd Šāḏān	9. Jh.	Baġdād ?
90	Muḥammad Ibn Aḵtam	9. Jh.	Baṣra-> Baġdād
91	ʿAbdallāh ad-Dandānī	9. Jh.	Dandān?
92	ʿAbbās Ibn Firnās	887	Takurunna?-> Cordoba
93	Muḥammad aṣ-Ṣaymarī	826–888	Kūfa-> Ṣaymar/Baṣra

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MAOSIC	Name	Date	Place
94	ʿAbdallāh Ibn Quṭayba ad-Dīnawarī	828–889	Transoxania?- > Baġdād | Kūfa- > Dīnawar- > Baġdād
95	Yaʿqūb al-Qaṣrānī	9. Jh.	al-Qaršī
96	Muḥammad Ibn Samʿān	9. Jh.	~ Abū Maʿšar
97	Abū Ḥanīfa ad-Dīnawārī	820–895	Isfahan, Dinawar
98	Muḥammad al-Kilāʿī	815–896	Jaen
99	Abū Bakr al-Ḥasan Ibn al-Ḫāṣib	9. Jh.	Iran
100	Aḥmad as-Saraḫsī	899	Saraḫs (Ḫurasan)
101	Abū ʿAlī Ibn Abī Qurra	9. Jh.	Baṣra
102	Hārūn Ibn Abī Manṣūr	901	Baġdād
103	Ṯābit Ibn Qurra	836–901	Ḥarrān - > Baġdād
104	Abū ăl-ʿAbbās al-Īrānšahrī	9. Jh.	Nišapur
105	Aḥmad al-Yaʿqūbī	900	Armenia - > Ḫurasān
106	Muḥammad as-Sabāʾī	9. Jh.	Cordoba
107	ʿAbdallāh an-Naṣrānī	9. Jh.	~ Abū Maʿšar
108	ʿUmar al-Marwarrūḏī	9. Jh.	~ Muḥammad al-Marwarrūḏī
109	ʿAlī Ibn Dāwūd	9. Jh.	Baġdād
110	Ibn Sīmawayh	9. Jh.	Baġdād
111	Abū ăl-Ḥamīd al-Qāḍī	905	Kūfa, Karḫ (Baġdād)
112	Aḥmad Ibn Rusta	9.-10. Jh.	–
113	Muslim al-Layṯī	910	Cordoba
114	Isḥāq Ibn Ḥunayn al-ʿIbādī	830–910	Baġdād
115	al-Faḍl Ibn Muḥammad	910	~ Ibn Turk al-Ḫuttalī 59
116	Ḥāmid al-Wāsiṭī	9. Jh.	Wāsiṭ
117	Yūsuf al-Qass	9.-10. Jh.	–
118	Qusṭā Ibn Lūqā	910	Baʿalbak - > Baġdād
119	Aḥmad al-Miṣrī	910	Cairo ~ Yūsuf Ibn ad-Dāya 80
120	ʿUbayd Allāh Ibn Ḫurdāḏbih	912	Īrān - > al-Ǧibāl, Samarrāʾ
121	Yaḥyā al-Munaǧǧim	856–912	Baġdād ~
122	Abū ăl-Ḥasan Ibn Abī Rāfiʿ	9. Jh.	–
123	Isḥāq Ibn Karnīb	9. Jh.	Baġdād
124	Abū Kāmil al-Miṣrī	850–930	Cairo
125	Muḥammad Ibn al-Ādamī	9.-10. Jh.	~ 85
126	Ibrāhīm Ibn al-Ḥassāb	920	Kairuwan
127	al-Ḥasan an-Nawbaḫtī	920	–
128	Dawūd Ibn Sulaymān	9.-10. Jh.	–
129	Abū ăl-Qāsim al-Munaǧǧim	9.-10. Jh.	Gurgan
130	Salhab al-Farḍī	922	Cordoba
131	Ibrāhīm az-Zaǧǧāǧ	844–923	- al-Muʿtaḍid
132	Yaḥyā Ibn as-Samīna	927	Cordoba
133	Yaḥyā Ibn ʿAǧlān	10. Jh.	Zaragoza

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MAOSIC	Name	Date	Place
134	Yaḥyā Ibn Asāma	10. Jh.	Zaragoza
135	al-Faḍl an-Nayrīzī	922	Nayrīz (Šīrāz) -> Baġdād
136	Ǧābir al-Ḥarrānī	2. H. 9. Jh.	Ḥarrān
137	Muḥammad al-Battānī	850–929	Ḥarrān -> Raqqa (Syria), Baġdād
138	ʿUmar Ibn ʿAbd al-Ḫāliq	932	Aljecira (Spain)
139	Abū ăl-ʿAbbās Ibn Yaḥyā	9.-10. Jh.	–
140	Bakr al-Marādī	10. Jh.	Cordoba
141	Ḥubāb al-Faraḍī	10. Jh.	Cordoba
142	Muḥammad ar-Rāzī	865–925	Rayy -> Baġdād
143	Muḥammad Ibn as-Sarrāǧ	928	Baṣra
144	Makḥūl an-Nasafī	930	Balḫ
145	al-Ḥasan Ibn Wahb	10. Jh.	~ al-Muʿtaḍid -> Baġdād
146	Abū ăl-Qāsim al-Kaʿbī	931	Balḫ -> Baġdād, Balḫ
147	Muḥammad Ibn Abī ʿAbbād	10. Jh.	–
148	Muḥammad al-Ḥākim at-Tirmiḏī	859–932	Tirmiḏ
149	Muḥammad Ibn Durayd	838–933	–
150	Abū Hāšim al-Ǧubbāʾī	890–933	Ǧubbāʾ (Ḫūsistān) -> Baṣra, Baġdād
151	Abū Yaḥyā al-Marwazī	940	?
152	Muḥammad Basṭūlus Asṭurlābī	1. H. 10. Jh.	–
153	al-Ḥasan al-Aḥwal	9.-10. Jh.	–
154	Abū ăl-ʿAlā	10. Jh.	~ Ibn Qurra
155	Saʿīd ad-Dimašqī	10. Jh.	Damascus -> Baġdād ~ al-Muqtadir
156	Abū Zayd al-Balhī	850–934	Balḫ ~ al-Kindī 79
157	Banū Amāǧūr at-Turkī	9.-10. Jh.	Farġāna -> Baġdād, Šīrāz
158	ʿAlī al-Aš'arī	873–935	Baṣra -> Baġdād
159	Abū Rašīd an-Nayšabūrī	10.-11.Jh.	Nayšabūr -> Baġdād, Rayy, Nayšabūr
160	Muḥammad Ibn Labīb	939	Estija (Spain) -> Cordoba, Mecca
161	ʿUmar Ibn Yūsuf	940	Baġdād
162	Mattā Ibn Yūnis	940	Baġdād
163	al-Iṣṭaḫrī	9.-10. Jh.	Iṣṭaḫr (Fars)
164	Fatḥ al-Asṭurlābī	940	Baġdād
165	ʿAbdallāh Ibn Rāfiʿ	10. Jh.	–
166	Mūsā Ibn Yāsīn	10. Jh.	Morocco -> Spain
167	Aqāṭūn	9.-10. Jh.	–
168	Muḥammad an-Naḥwī	863–943	Cordoba
169	Sinān Ibn Ṯābit	942	Baġdād
170	Aḥmad Ibn Naṣr	944	Cordoba
171	ʿAbdallāh al-Muġīlī	946	Cordoba
172	Ḥassān Ibn Ḥassān	890–946	Esija (Spain)
173	al-Ḥasan al-Ḥamdānī	946	Yemen

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MAOSIC	Name	Date	Place
174	Ibrāhīm Ibn Sīnān	908–946	Baġdād -> Ḫurasān -> Baġdād
175	Aḥmad Ibn al-Qass aṭ-Ṭabarī	946	Ṭabaristan -> Tarsus -> Baġdād
176	Muḥammad Ibn ʿArūs	949	Mawzur (betw. Seville and Cordoba)
177	ʿAbd ar-Raḥmān az-Zaǧǧāǧī	949	Baġdād -> Damascus -> Aleppo
178	Saʿīd al-Faradī	950	Cordoba
179	Ibrāhīm	?	?
180	Muḥammad al-Fārābī	874–950	Fārāb (Kazaḫstān)
181	Sulaymān Ibn ʿIsma as-Samarkandī	9.-10. Jh.	Samarkand -> Balḫ
182	Qāsim al-Qaṭṭān al-Andalusī	9.-10. Jh.	Cordoba
183	Muḥammad al-Qummī	9.-10. Jh.	Qum
184	Muḥammad at-Tanūḫī	892–953	Antiochia-> Baṣra, Ahwaz,Baṣra
185	ʿAlī Ibn ʿImrānī	955	Mosul
186	ʿAlī al-Masʿūdī	956	Baġdād -> Persia, India, China, Zanzibar
187	ʿAlī Ibn Maʿdān	9.-10. Jh.	–
188	Yūsuf al-Harawī	10. Jh.	Herat
189	Saʿīd al-Samarkandī	912–1000	Samarkand
190	Muhāb al-ʿAdawī al-Faraḍī	963	Cordoba -> Esija
191	ʿAlī al-Munaǧǧim	889–963	Baġdād
192	ʿAlī at-Tamīmī	965	Bust (Siǧistān) -> Samarkand, Nasa, Nišabūr
193	Aḥmad al-Ahwāzī	10. Jh.	Ahwaz
194	Abū Ǧaʿfar al-Ḫāzin	+961/971	Ḫurasān -> Rayy
195	Muḥammad al-Kātib	970	Rayy
196	Ḥamza al-Isfahānī	893–970	Isfahan
197	Ṯābit Ibn Sinān	974	Baġdād
198	Yaḥyā Ibn ʿAdī	893–974	Takrit (Syria) -> Baġdād
199	Muḥammad al-Azdī al-Faraḍī	976	Esija -> Cordoba, Toledo
200	Ṯābit Ibn Ibrāhīm al-Ḥarrānī	900–980	Ḥarrān
201	Aḥmad al-Ǧayhānī	10. Jh.	Buḫara
202	ʿAbdallāh as-Sīrāfī	10. Jh.	Siraf (Persian Gulf)
203	al-Ḥasan as-Sīrāfī	979	
204	Yuḥannā Ibn Yūsuf	980	Hamadan
205	ʿAbd al-ʿAzīz al-Qabīṣī	10. Jh.	Sayf ad-Dawla (Hamdanid 945–967)
206	ʿĪsā ar-Raqqī at-Tiflīsī	10. Jh.	Tiflis -> Raqqa ~ Sayf ad-Dawla
207	ʿAbdallāh al-Masarrī	984	Esija -> Cordoba -> East
208	Lubnā	985	Cordoba
209	Abū ʿAbd al-Malik aṭ-Ṭaqifī	10. Jh.	Cordoba
210	Aḥmad Ibn al-Muṭannā	10. Jh.	–
211	ʿAlī Ibn al-Aʿlam	985	Baġdād
212	ʿAbd ar-Raḥmān aṣ-Ṣūfī	903–998	Rayy -> Fars

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MAOSIC	Name	Date	Place
213	Ibrāhīm al-Iṣṭaḫrī	10. Jh.	Iṣṭaḫr (Fars)
214	Muḥammad Ibn al-Ḥawqal an-Nasībī	10. Jh.	Nisibis (Turkey) -> Baġdād
215	Muḥammad al-Muqaddasī	947–1000	Jerusalem
216	Abū ʿAlī aṣ-Ṣūfī	10.-11. Jh.	Šīrāz
217	Ġulām Zuḥal	998	~ ʿAdud ad-Dawla (949–983) Šīrāz ?
218	Yūsuf an-Naysābūrī	10. Jh.	Nišābūr
219	ʿAlī al-Anṭakī	987	Antiochia -> Baġdād
220	Abū ăl-Fatḥ as-Samarkandī	10. Jh.	Samarkand
221	ʿAlī Ibn Bišr	911–987	Antiochia -> Spain
222	Ğaʿfar Ibn al-Muqtafī	907–987	Baġdād
223	Aḥmad aṣ-Ṣaġānī	990	Saġāniyya (Chaghanian, Uzbekistan) -> Baġdād
224	Aḥmad al-Karābīsī	10. Jh.	India
225	Yaʿqūb al-Miṣṣīṣī	10. Jh.	–
226	Iḫwān aṣ-Ṣafāʾ	10. Jh.	Baṣra, Baġdād, Nišābūr, Samarkand
227	Muḥammad as-Saraḫsī	9.-10. Jh.	Saraḫs (Ḫurasān)
228	ʿAlī al-Miṣṣīṣī	10. Jh. ?	
229	Yaʿqūb ar-Rāzī	10. Jh.	Rayy
230	Muḥammad Ibn Lurra	10. Jh.	Isfahan
231	Sinān Ibn al-Fatḥ	10. Jh.	Ḥarrān
232	Aḥmad al-Uqlīdisī	10. Jh.	–
233	ʿUṭārid	10. Jh.	–
234	Ḥayyūn Ibn aṣ-Ṣalt al-Kātib	9.-10. Jh.	–
235	Ğaʿfar Mawazağī	10. Jh.	–
236	ʿAbdallāh aṣ-Ṣaydanānī	10. Jh.	–
237	Abū ăl-Faḍl al-Ḥayyānī	10. Jh.	–
238	al-ʿAbbās Ibn ar-Rabīʿ	10. Jh.	–
239	Muḥammad aš-Šaṭawī	10. Jh.	–
240	Ğaʿfar al-Makkī	10. Jh.	Mecca
241	Ibn Rawḥ	10. Jh.	–
242	Muḥammad Ibn Nāğiya	10. Jh.	–
243	Naẓīf Ibn Yumn	990	–
244	Muḥammad Ibn Zarb	991	Cordoba
245	Ṣāliḥ al-Qassām	10. Jh.	? Umawī
246	Muḥammad al-ʿAḏrī	10. Jh.	ʿAḏra (Spain) -> Cordoba -> East
247	Abū Muḥammad as-Sayfī	10. Jh.	–
248	Abū ăl-ʿAbbās al-Āmulī	10. Jh.	Āmul
249	ʿArīb al-Qurṭubī	976	Cordoba
250	Rabīʿ al-Usquf	10. Jh.	Cordoba
251	Ibrāhīm Ibn Hilāl	925–994	Ḥarrān -> Baġdād
252	Ğābir Ibn Ibrāhīm aṣ-Ṣābiʿ	10. Jh.	~ 251

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MAOSIC	Name	Date	Place
253	al-Muḥassin Ibn Ibrāhīm aṣ-Ṣābiʿ	10. Jh.	~ 251
254	Muḥammad al-Ifrīqī	995	Tunis -> Cairo
255	Abū ʿAbdallāh Ibn al-Balansī	996	Valencia -> Cairo
256	Abū ăl-Wafā al-Būzğānī	940-998	Būzğān (Ḫurasān) -> Baġdād
257	ʿUmar Ibn Abī ăl-Wafā	10.-11. Jh.	~ 256
258	Sahl Ibn al-ʿAṭṭār	912-997	Esija -> Cordoba
259	Nūr ad-Dīn al-Balḫī	10. Jh.	Balḫ
260	Mūsā an-Nawbaḫt	1000	~ 127
261	ʿAbd ar-Raḥmān Ibn Badr	10. Jh.	Andalus
262	Saʿīd as-Saraqusṭī	10.-11. Jh.	Zaragoza -> Cordoba -> Sicily
263	Šaʿyā Ibn Firīğūn	10.-11. Jh.	~ 156
264	Muḥammad al-Kalwāḏānī	10. Jh.	Baġdād
265	Dunāš al-Qarawī	10. Jh.	Qayrawān
266	al-Ḥasan Ibn al-Ḫammār	942–1020?	Gurganğ -> Ġazna
267	ʿAlī as-Sulamī	10. Jh.	Syria
268	Naṣr al-ʿAzīzī	2. H. 10. Jh.	–
269	Ḥāmid al-Ḫuğandī	1000	Ḫuğand (Tajikistan) -> Rayy
270	ʿAlī as-Sumaysāṭī	983–1061	Sumaysat (Syria)
271	Aḥmad al-Harawī	10. Jh.	Herat -> Rayy
272	Muḥammad Ibn an-Nadīm	993	Baġdād
273	al-Ḥasan Qummī	1000	Qum
274	Muḥammad al-Kātib al-Ḫwārizmī	2. H. 10. Jh.	Buḫara
275	Abū Bakr	10. Jh.	–
276	al-Ḥasan al-Anṣārī	10.-11. Jh.	–
277	Wayğan al-Kūhī	10.-11. Jh.	Kūh (Ṭabaristan) -> Baġdād
278	al-Ḥasan al-Ḫubūbī	10.-11. Jh.	Ḫwārizm
279	al-Ḥasan al-ʿAskarī	1004	–
280	Aḥmad Ibn Fāris al-Qazwīnī	1005	Qazwīn -> Hamadan, Baġdād
281	Maslama al-Maǧrīṭī	1008	Madrid -> Cordoba
282	ʿĪsā Ibn Zurʿa	943–1008	Baġdād
283	ʿAlī Ibn Yūnus aṣ-Ṣadafī	950–1009	Cairo
284	Muḥammad Ibn al-ʿAṭṭār	942–1009	Cordoba
285	ʿĪsā al-Masīḥī	977–1011	Ğurğān
286	ʿAbdallāh Ibn al-Faraḍī	962–1012	Cordoba-> Mecca, Egypt, Qarawan, Valencia
287	Muḥammad al-Hāšimī	10. Jh.	Raqqa (Syria)
288	al-Ḥasan Ibn al-Bahlūl	10. Jh.	Syria
289	Yūsuf ar-Ramādī	1012	Cordoba
290	ʿAbdallāh aṯ-Ṯaqafī	1013	–
291	ʿAbdallāh al-Ḥāsib	10. Jh.	Buḫara

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MAOSIC	Name	Date	Place
292	Muḥammad as-Siǧzī	10.-11. Jh.	~ 296
293	Abū ăl-Ḥasan aš-Šamsī al-Harawī	10.-11.Jh.	Herat
294	Abū ăl-Qāsim al-Qaṣrānī	1022	Baġdād
295	ʿAlī an-Naysābūrī	10.-11. Jh.	Nišābūr
296	Abū Saʿīd as-Siǧzī	950-1025	Siǧistan
297	Aḥmad Ibn Ibrāhīm as-Sanǧarī	10.-11. Jh.	–
298	Yaʿqūb as-Siǧistānī	10.-11. Jh.	Siǧistān
299	Abū Naṣr Ibn ʿIrāq	1036	Kat -> Gurganǧ -> Ġazna
300	Dāwūd al-ʿAllāmī	1038	Iraq
301	Muḥammad aṭ-Ṭabarī	10.-11. Jh.	Ṭabaristan -> Rayy
302	al-ʿAlā Ibn Sahl	10.-11. Jh.	–
303	Aḥmad aṭ-Ṭunayzī	950–1025	Cordoba -> Sevilla -> Almeria
304	Ǧaʿfar al-Ḥaḍramī	* 969	Sevilla
305	ʿAlī az-Zahrāwī	10.11.2009	~ 281
306	ʿAlī al-Hāšimī	1020	Cairo
307	Aḥmad al-Mazrūqī	971–1030	–
308	Kušyār Ibn Labbān	970–1030	Gilan
309	Muḥammad al-Karaǧī	1025	Karaǧ (Iran) -> Rayy, Isfahan
310	Aṣbaġ Ibn as-Samḥ	984–1035	Granada
311	ʿAbdallāh Ibn aš-Šiqāq	954–1035	Cordoba
312	Aḥmad Ibn aṣ-Ṣaffār al-Ġāfiqī	1035	Cordoba -> Denia
313	Muḥammad al-Ġāfiqī	10.-11.Jh. ?	~ 312
314	ʿAlī al-Ǧawharī	10.-11. Jh.	Baġdād
315	Abū Muḥammad al-ʿAdlī al-Qa'īnī	vor M. 11. Jh.	Qa'īn
316	Ḫalaf Ibn Ḥayyān	948–1036	Cordoba
317	Abū ʿAlī Ibn Sīnā	980–1037	Buḫara -> Gurgan, Gurganǧ, Hamadan, Isfahan
318	ʿAbd al-Wāḥid al-Ǧūzǧānī	11. Jh.	~ Ibn Sīnā 317
319	al-Ḥasan al-Kirmānī	10.-11. Jh.	Kirman
320	ʿAbd al-Qāhir al-Baġdādī	1038	Baġdād -> Nišābūr, Isfahan
321	al-Ḥasan Ibn al-Baġdādī	10.-11. Jh.	Baġdād
322	ʿAbd al-Malik Ibn al-Qūṭīya	1038	Sevilla
323	Muḥammad an-Naǧǧād	1038	Cordoba
324	Muḥammad al-Masrūrī	981–1028	Cordoba -> Syria, Iraq
325	Aḥmad aṣ-Ṣaffār	1035	–
326	Ibn al-ʿAǧīm	1039	Iran, Iraq
327	Muḥammad Ibn al-Hayṯam	10.-11. Jh.	Basra -> Baġdād
328	al-Ḥasan Ibn al-Hayṯam	965–1041	Basra -> Cairo

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MAOSIC	Name	Date	Place
329	ʿAlā al-Kirmānī	10.-11. Jh.	Kerman
330	al-Ḫāqānī al-Munağğim	1040	–
331	Muḥammad al-Qummī	10.-11. Jh.	Qum
332	Muḥammad Ibn aš-Šiqaq	1041	Cordoba
333	Muḥammad Ibn Mazīn	959–1042	Cordoba, Sevilla
334	ʿAlī Ibn Ḫalaf	11. Jh.	Cordoba
335	Yūsuf al-Ǧuhanī	1044	Cordoba
336	Abū Bakr	1. H. 11. Jh.	–
337	Abū Bakr Ibn ʿĀbis	10.-11. Jh.	–
338	Ḫālid al-Adīb	995–1045	Sevilla -> Badajos
339	ʿAbdallāh as-Saraquṣṭī	1056	Zaragoza -> Valencia
340	Muḥammad al-Ǧayyānī	989–1079	Jaen -> Egypt, Sevilla
341	ʿAlī an-Nasawī	970–1070	Nasa (Ašqabad, Turkmenistan)
342	Abū ăl-Ǧūd Ibn al-Layṯ	10.-11. Jh.	–
343	Abū ăl-Ḥasan al-Miṣrī as-Samarkandī	10.-11. Jh.	Egypt, Samarkand
344	Muḥammad aš-Šannī	10.-11. Jh.	Egypt
345	Āḏarḫūrā-yi Yazdāhḫasīs	9. - 10. Jh.	Iran
346	ʿAlī al-Qāʾinī	10.-11. Jh.	Qāʾin (Ḫurasan)
347	Musāfir al-Muqawwī	10.-11. Jh.	~ 348
348	Abū ăr-Rayḥān al-Bīrūnī	973–1048	Kaṯ, Gurgan, Gurganǧ, Ġazna
349	Eliās Bar Šināyā	975–1050	Mosul -> Beṯ Nuhaḏre, Nisibis

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