Islamic sacred geography for finding the *qibla* by the sun and stars

A survey of the historical sources

مسح كتب دلائل القبلة

with an appendix on some recent fallacies about mosque orientations

David A. King

Johann Wolfgang Goethe University, Frankfurt
www.davidaking.academia.edu

Contents:

Keywords: Islam, sacred geography, folk astronomy, Kaaba / Kaʿba, Mecca / Makka / Makkah, Canopus, winter & summer sunrise and sunset, cardinal directions, solstitial, qibla, mihrab, mosque orientation,
الاسلام ، كعبة ، مكة ، قبلة ، علم الفالك التقليدي ، كتب دلائل القبلة ، كتب الأنواء ،
سهيل ، مطلع الشمس، مغرب الشمس ، الاعتدال ، الانقلاب ، مسجد مساجد ، اتجاهات المحاريب

قد نرى تقلّب وجهك في السماء فنولّينّك قبلة ترضاها

فولّ وجهك شطر المسجد الحرام وحيث ما كنتم فولّوا وجوهكم شطره ...

“We (God) may see the turning of thy face (in confusion and seeking guidance) to the Heavens. So We shall indeed turn thee toward a (sacred) direction (*qibla*) that shall please thee. So turn thy face toward the sacred Mosque: wherever ye may be, turn your faces toward it.”
Qur’ān II.144.

وبالنجم هم يهتدون

“ ... and by the star(s) they (Man) will be guided. ... ”
Qur’ān XVI.16.

"The Kaʿba is the *qibla* for the Sacred Mosque, the Sacred Mosque is the *qibla* for the sacred precincts (of Mecca and its environs), and the sacred precincts are the *qibla* for the inhabitants of the whole world from where the sun rises to where it sets." Ibn al-Qāṣṣ (*ca*. 975).

"The inhabitants of al-Qadisiyya, Kufa, Baghdad, Hulwan, Hamadhan, Rayy, Nishapur, Marwarrudh, Khwarazm, Bukhara, Tashkent, Farghana, and localities lying in the same direction, face (the section of) the Kaʿba between the *Muṣallā* of Adam - may peace be upon Him - and its Door. So whoever is in one of those localities or in a line with them (and the Kaʿba) and wants to face the *qibla*, should have the Banāt Naʿsh (stars of the Plough) rising behind his right ear, (the lunar mansion) al-Hanʿa (rising) directly behind him, the Pole Star at his right shoulder, the East wind at his left shoulder, the North wind between the right side of his neck and the nape of his neck, the West wind at his right cheek, and the South wind at his left cheek. Anyone who uses one or some of these prescriptions in these localities or (others) in the same direction will be facing the (appropriate) section (*jiha*) of the Kaʿba." Ibn Surāqa (*ca*. 1000).

"Every challenge calls for the right men. ... ... When (some people) were asked to determine the direction of the *qibla* they were perplexed, because the solution of this problem was beyond their scientific powers. You see that they have been discussing completely irrelevant phenomena, like the directions from which the winds blow, and the rising points of the lunar mansions. ... ... Of the majority of people (who write about the *qibla* in non-mathematical terms) none are closer to the truth than those who use (*ʿitabarahu bi-*) the Pole Star known as *al-Judayy*. By means of its fixed position the direction of a person travelling can be specified approximately." al-Bīrūnī (*ca*. 1025).

"The science of star nomenclature, the appearances of the stars, their risings and settings, ... , the finding of the direction of the *qibla* by means of the stars, and the knowledge of the times of prayer and the hours of the night by the appearances and the settings of the stars." al-Khaṭīb al-Baghdādī, the 11th-century religious scholar and historian, outlining the acceptable aspects of astronomy in his treatise against astrology (slightly modified from Heinen, *Islamic Cosmology*, p. 25).

"The most significant characteristic of the mosque is the direction that it faces." H. Masud Taj (1999).

Introductory remarks

Some colleagues have asked me (... قد سألني بعض الإخوان) to identify some medieval Arabic texts which advocate the use of astronomical horizon phenomena for the *qibla* or sacred direction toward the sacred Kaʿba in Mecca.

Such texts offer an approach completely different from that of the better-known texts on the mathematical determination of the *qibla*. In the latter, a basis of **mathematical geography** and a knowledge of the longitudes and latitudes of the locality in question and of Mecca is assumed and then a mathematical procedure, geometric or trigonometric, is required to calculate the *qibla*. This tradition produced not only a range of mathematical procedures and tables displaying the *qibla* for the whole world, but also geographical tables giving *qibla*-values for hundreds of localities, and even highly ingenious world-maps centred on Mecca, with which one could simply read off the *qibla* and distance to Mecca with a circumferential graduated scale and a diametral graduated rule.[1]

The texts and diagrams presented here are of a very different nature, for they deal with a quite distinctive kind of **sacred geography**, or, should we say, **sacred folk geography**, involving a world divided in sectors around the Kaʿba. Each sector is associated with a segment of the perimeter of the Kaʿba and the *qibla* in each sector is the direction in which one stands in front of the Kaʿba facing that segment of its perimeter.

In spite of the considerable documentation already available, there seems to be some incredulity that *qibla*s were actually determined using astronomical risings and settings, not least because the historical mosque orientations, which are often curious to moderns, have persuaded some ill-informed writers to claim that the mosques were not oriented toward Mecca at all, but rather to some alternative cult-site. These authors overlook the fact that the

---

1 See King, *World-Maps for finding the direction and distance of Mecca* (1999), which includes a survey of *qibla*-determinations by both folk-astronomical and mathematical techniques, as well as editions of all known medieval lists of *qibla*-values for cities.

qibla is toward the Kaʿba not toward Mecca – there is, as we shall see, a subtle difference. These authors, although they essentially seek to denigrate Islam, are not revisionists in the traditional sense because, having no idea about historical *qibla* determinations, they revise nothing; rather, they simply generate "false news" about the *qibla* (see the Appendix to this paper).

I therefore present here a brief list of such medieval sources that have come to my attention. To this list, now made available for the first time, could surely be added many other texts on Islamic law and folk astronomy, as well as encyclopaedias. These materials are not the kind that one can identify from the frequent designations of manuscripts by "author, title, date". In this brief introduction to the sources, the bibliographical references to the authors have been removed, not only because these needed updating but also because there are ample bio-bibliographical sources available for that purpose.

Even though the sources listed below are unrelated at least in methodology to the substantial medieval Islamic sources on the determination of the *qibla* as a problem of mathematical geography, they have, of course, the same goal, to determine the *qibla*. Roughly, one could maintain that the sacred geography texts favour using folk astronomical techniques to face the walls and corners of a distant sacred edifice, the Kaʿba, and the scientific texts favour using mathematical techniques to face the distant city where that edifice is situated, namely, Mecca. It is not surprising that some of the most significant sources are or Yemeni origin for in the colourful medieval Yemeni tradition of astronomy both the mathematical and the folk traditions of astronomy were practiced, in certain cases, even by the same scholar.

The sources on Islamic sacred geography are also unrelated to the ancient and medieval tradition of the geographical 'climates' (اقـــالـــيم ج. اقـــليم), the importance of whose extensive influence in Islamic astronomy and geography and instrumentation has been stressed elsewhere.[2]

---

2 King, *World-Maps*, pp. 23-28 & 230-234; and *In Synchrony with the Heavens*, XVI: pp. 925-932. On the basic notion see the *EI*$_2$ article "*Iḳlīm* [climate]" by André Miquel.

The texts listed below belong to the tradition of folk science that flourished in Islamic civilization alongside mathematical science. Inevitably, the former tradition, based mainly on pre-Islamic Arabian folk science, preceded the latter, based on Hellenistic, Indian and Iranian science.[3] Also inevitably, the latter alone has attracted the attention of historians of science, with a few notable exceptions, that being a discipline often mainly concerned with what the Muslims took from the Greeks and what 'we' took from the Muslims.

Several of the works cited belong to a class of literature that is little known nowadays. The genre was called كتب دلائل القبلة , *kutub dalā'l al-qibla*, or books on the ways of finding the *qibla* by simple (non-scientific) means. Other works belong to the better-known genre كتب الأنواء , *kutub al-anwā'*, dealing with the seasons and general folk astronomy.

Our sources on sacred geography contain two kinds of information:

(1) instructions on how to find the *qibla* using the risings and settings of the sun and certain *qibla*-stars (and in some cases, the winds) or the Pole Star for a specific region; or

(2) details in words or in diagrams on the way in which the medieval Islamic world was thought to be divided in sectors around the Kaʿba, each sector associated with a segment of the perimeter of the edifice, with an associated *qibla* derived from the orientation of that wall-segment.

One of the reasons why this sacred geography developed as it did was because the rectangular base of the Kaʿba itself is astronomically aligned, and its corners roughly face the cardinal directions. The main axis of the Kaʿba points toward the rising of Canopus, the brightest star in the southern sky, and the setting of the stars of the Plough; its minor axis points toward summer sunrise and winter sunset – for the latitude of Mecca these two directions happen to be more or less perpendicular. Since the pre-Islamic folklore surrounding the Kaʿba also involved each of the four 'cardinal' winds hitting the appropriate wall of the Kaʿba head-on, some of the instructions for facing the Kaʿba involve the way in which a person stands

---

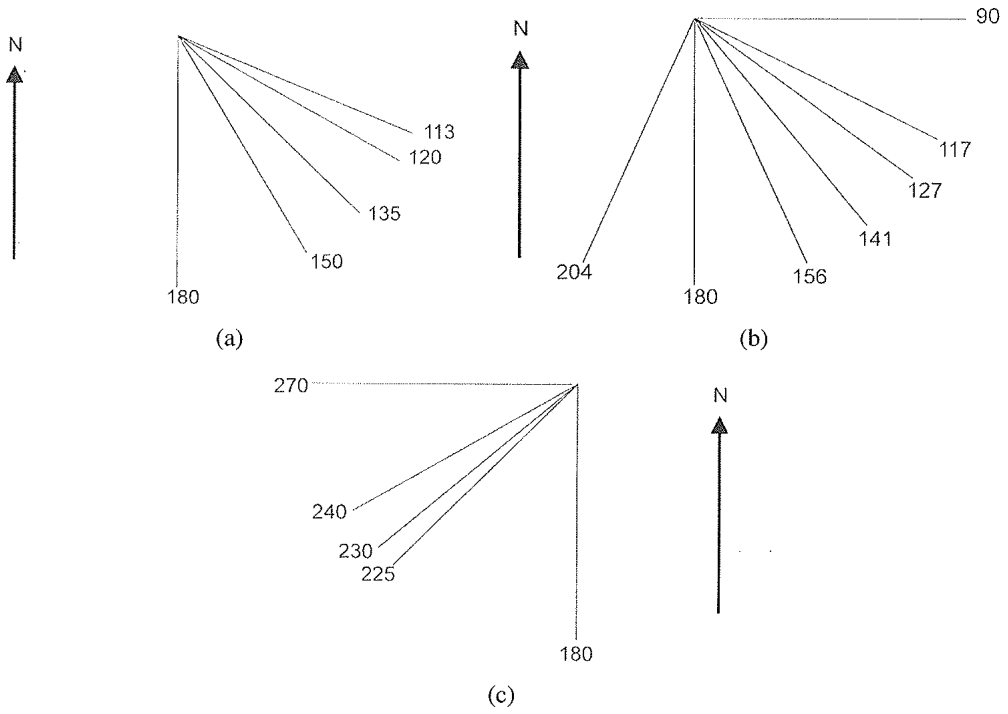
3 See three overviews of the history of Islamic astronomy by C. A. Nallino (1921), DAK (1996), and Robert Morrison (2010).

with respect to the winds, in addition to the way he/she stands with respect to astronomical risings and settings. This information was first rediscovered in modern times in the writings of the 13th-century Yemeni astronomer Muḥammad ibn Abī Bakr al-Fārisī, a man well versed in both mathematical astronomy and folk astronomy; the astronomical alignments stated in the text were confirmed by satellite images.[4] The very distinctive orientation of the Kaʿba is now known to be mentioned in several other medieval sources. It would be naïve to think that it has ever been changed over the centuries; additional proof that it has not is provided by the fact that the corners roughly face the cardinal directions and the existence of the low semi-circular wall (الحجر , *al-ḥijr*) attached to the NW Wall.[5]

---

4 See Hawkins & King, "Orientation of the Kaʿba" (1982). (The basic information in this article has been hijacked by several authors so that, for example, it is not mentioned in the article "History of the Kaaba" in Wikipedia.)

5 In the article "Ḳibla. Legal aspects" in the 1st edition of the *Encyclopedia of Islam*, reprinted in the 2nd edition, the *qibla* is defined as "the direction of Mecca (to be exact of the Kaʿba or the place between the water-spout (*mīzāb*) and the western corner) ... ". This definition actually applies only to a specific region, the information being originally derived from some scheme of sacred geography. A modern fiction is that the *qibla* is toward the Black Stone in the SE corner of the Kaʿba.

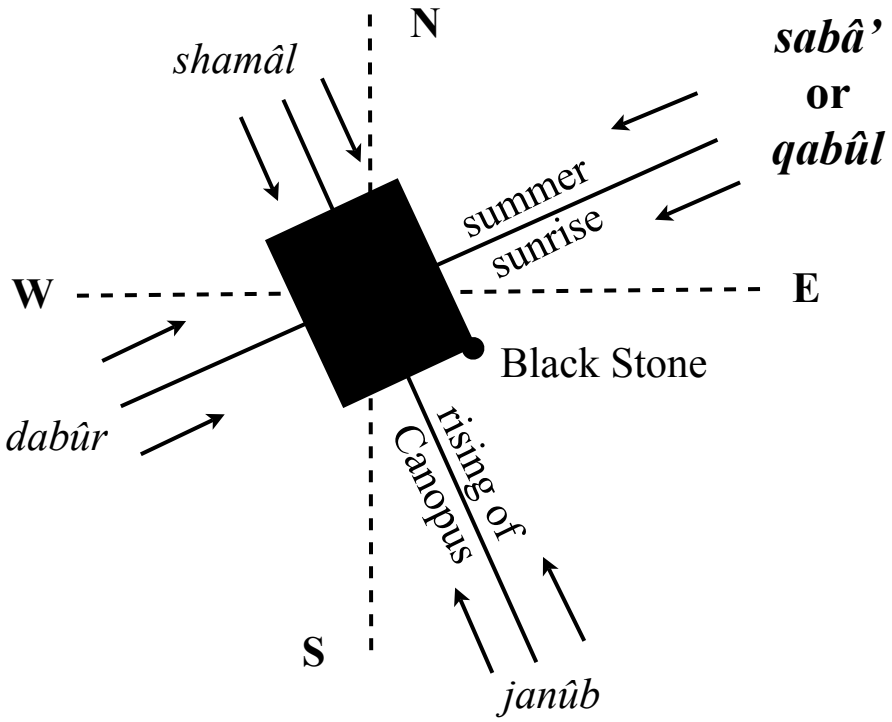


Various *qibla*-directions and mosque orientations accepted in medieval cities of (a) Córdoba, (b) Cairo, and (c) Samarqand. These include astronomical directions, cardinal and solstitial, and *qibla*s determined by mathematical procedures.

In Córdoba there is no accurately-computed *qibla* attested, only one derived by an approximate formula (113°), which competed with winter sunrise (120°). The striking orientation of the Grand Mosque (150°) results from the street-plan of the Roman suburb where it was built, and it is 'parallel' to the main axis of the Kaʿba.

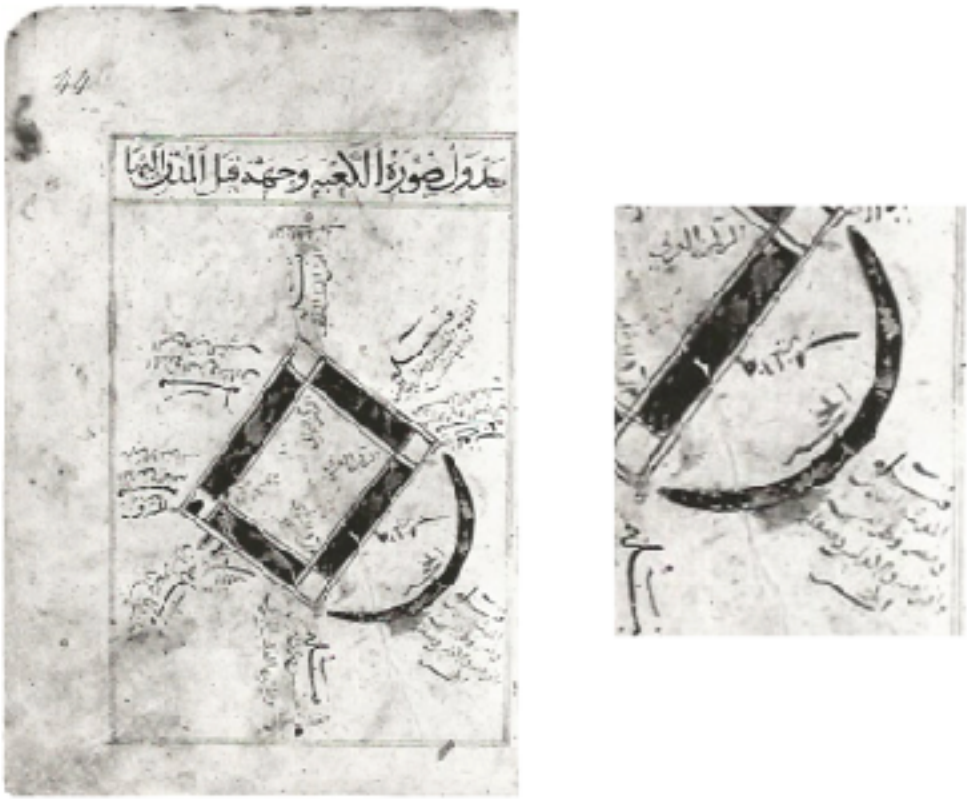
In the case of Cairo, the *qibla* of the Companions of the Prophet was winter sunrise (117°) and in the 10th century the *qibla* of the astronomers (127°) started to become popular. Some Mamluk mosques are aligned with the Fatimid city plan on the outside and the qibla of the astronomers on the inside. In some suburbs any direction between the rising and setting of the star Canopus (156°/204°), favoured as a south indicator, was used.

In Samarqand the *qibla* of the Companions was toward winter sunset (240°) but the *qibla* of the Shāfiʿīs was due south (since the Prophet had prayed due south in Medina) and that of the Ḥanafīs was due west (since the road to Mecca left Samarqand in a westerly direction).



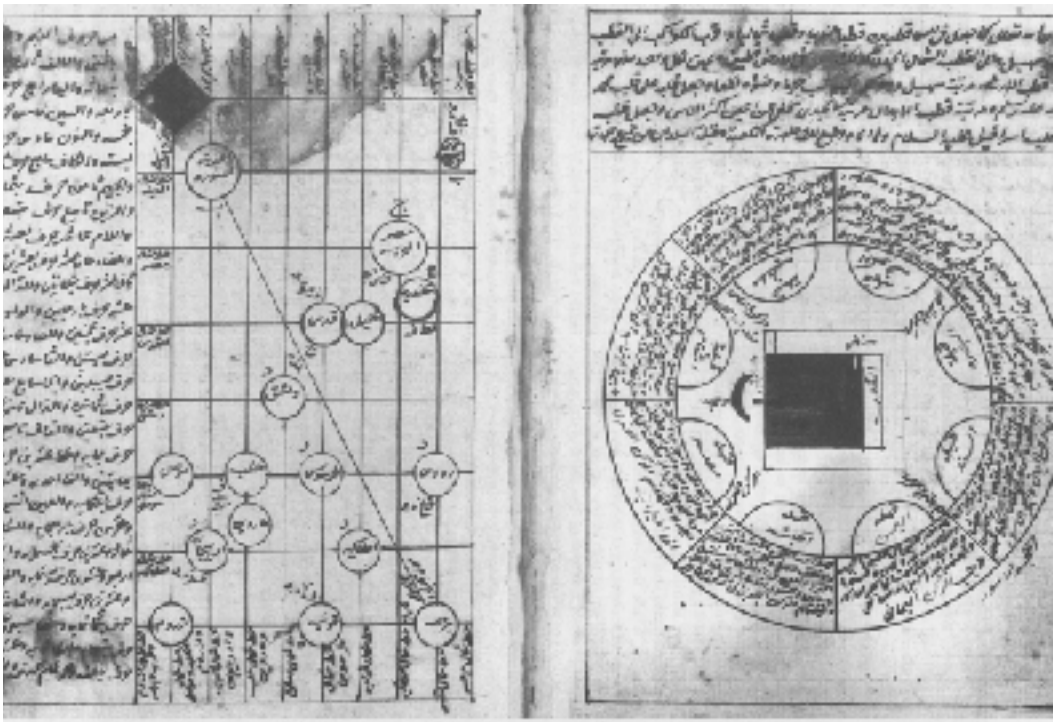
*The orientation of the Kaʿba mentioned in medieval texts and confirmed by satellite images, taking into consideration the surrounding skyline. Canopus (*سهيل , Suhayl*) is the brightest star in the southern sky. The direction of the rising of Canopus is conveniently perpendicular to the axis between summer sunrise and winter sunset for the latitude of Mecca. The ratio of the major axis of the edifice to the minor axis is actually about 8:7.*

*In pre-Islamic folklore the walls of the Kaʿba were associated with the four 'cardinal' winds. Note that if one is standing in front of the SW wall one is facing (*استقبل, istaqbala*) the* قبول , qabūl *wind, also called* صبا , ṣabā*'; in this position one is facing summer sunrise with (formerly) fortunate Yemen (*اليمن , *al-Yaman) on the right and (forever) ominous Syria (*الشأم, *al-Sha'm*) *on the left.*



A diagram of an 8-sector scheme of sacred geography in which the sector of the world including Medina, Jerusalem, Egypt, Tripoli in Libya, Ifrīqīya and al-Andalus is shown facing the ḥijr *and the* mīzāb*, the low semi-circular wall and the water-pipe on the roof, which are the principal features of the NW Wall of the Kaʿba. Other examples of such schemes might add that the* qibla *is toward the rising of Canopus, indicating that this prescription was formulated in Mecca or the Yemen since the rising of Canopus is much closer to south in the regions stated and at about latitude 36° the star is no longer visible. To be safe, our authors might add an indication such as summer sunrise is on the left.*
From MS Paris B.n.F. ar. 2186, fol. 44r,
courtesy of the Bibliothèque nationale de France.

The following is an extract from the 8-sector scheme of Ibn al-Surāqa

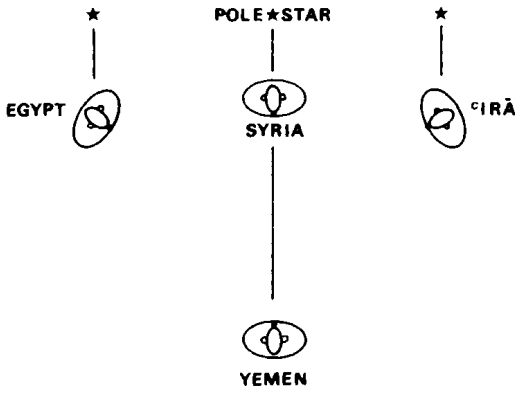


The diagram on the right is a particularly important 8-sector scheme of sacred geography because although it is found in an 18th-century Ottoman Egyptian manuscript it is in fact many centuries (6? 7?) older. On the left is a rather primitive 'map' showing various cities on a longitude-latitude grid with their positions relative to the Kaʿba in the upper left. The city of Bursa in the lower right is joined by a line to Medina with Mecca beyond. The Kaʿba is appropriately shown as a rectangle inclined to the meridian. In judging this somewhat flawed attempt to merge two traditions of sacred geography, mathematical and folk, of which this is the only known example, it should be borne in mind that the vast majority of medieval maps have no coordinate grid at all. Those world-maps which did have such a grid with cities correctly marked according to their (medieval) coordinates have mainly disappeared without trace, but fortunately, not all of them. From MS Cairo Ṭalʿat majāmīʿ 811,7, fols. 60v-61r, courtesy of the Egyptian National Library.

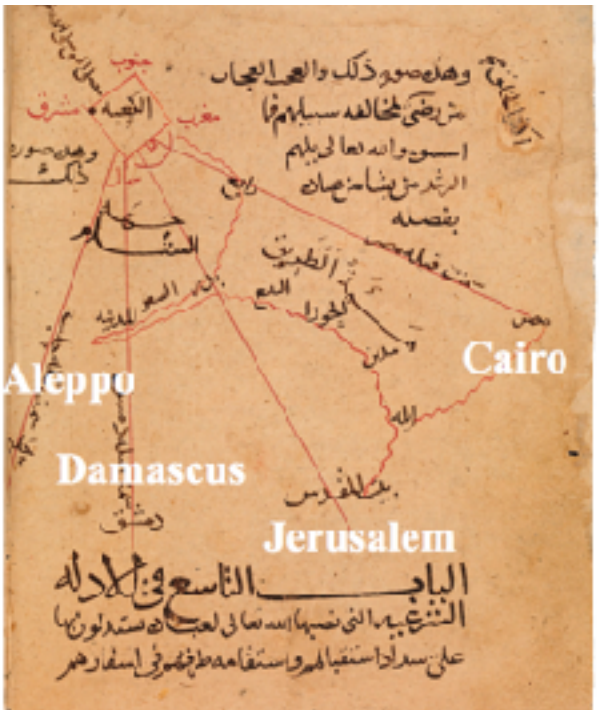
(Yemen and Basra, *ca*. 1000):

> "The inhabitants of Medina ... , and of the Hejaz, Ramla, Jerusalem, Palestine, and places in the same direction pray toward the Waterspout of the Kaʿba (at the middle of the NW Wall). ... Anyone in these places who stands so that the Banāt Naʿsh (stars of the Plough) set behind him, Canopus rises directly in front of him, Vega rises at his left ear and sets behind his right ear, the East Wind is at his left eye, the North Wind is behind his left ear, the West Wind is behind his right ear, or the South Wind is at his right side, will be facing the direction of the Kaʿba."

In these instructions the stars and winds are used as indicators (دلائل , *dalā'il*); in other texts it is the actual risings and settings of the sun and stars which define the *qibla*. In not a few texts the instructions are mutually inconsistent with regard to the direction that one should be facing. One of the reasons for this is that the texts were conceived by authors themselves in Mecca standing in front of the Kaʿba. Thus they may advocate a *qibla* for a locality such as Syria or al-Andalus toward the rising of Canopus when that southern star cannot be seen in those regions. Particularly problematic are the winds, because it is the 'cardinal' winds at Mecca that underly these recommendations. The safest procedure for the non-mathematically inclined, as noted by the great scientist al-Bīrūnī (Ghazna, *ca*. 1025), was to orient oneself with respect to the Pole Star. This obviated the need to determine the meridian by day and to catch up with the sun, as well as to get involved with stars which moved across the sky. It was al-Bīrūnī who authored the most sophisticated book ever compiled by a Muslim on mathematical geography and the determination of the *qibla* by mathematical means.[6]



6 References are given below and in more detail in "Bibliography of books, articles and websites on the determination of the qibla" (2018).



A diagram in the treatise on finding the qibla *by non-mathematical means by the 12th-century Egyptian legal scholar al-Dimyāṭī. The* qiblas *in the four major Mamluk cities are toward a particular segment of the perimeter of the Kaʿba, here shown more or less correctly aligned in its actual orientation. Elsewhere al-Dimyāṭī presents a complicated 13-sector scheme of sacred geography. This text is the most significant treatise on the subject in the known sources on Islamic sacred geography but both the author and his work were unknown before the unique manuscript was rediscovered in 1982. From MS Oxford Bodleian Marsh 592, fol. 88v, courtesy of the Bodleian Library.*

For another example we turn to Ibn al-Ajdābī (Ajdabiya, Libya, *ca*. 1225):

> "In the Eastern sector to the South of the parallel of Mecca the *qibla* is towards summer sunset and what is close to this, which is (the direction) facing the wall of the Kaʿba going from the Yemeni Corner to the Black Corner (that is, the Eastern corner with the Black Stone). The localities in this sector are the Eastern parts of the Yemen, al-Shiḥr, India, and the parts of Southern China beyond."

Here the *qibla* proposed for the Yemen is toward summer sunset, about 30° N of W, which seems to have been used for the earliest mosque in China. It is at variance with the orientation of the Great Mosque of Sanaa at about 60° N of W, perhaps originally aligned toward the SE Wall of the Kaʿba. Consistency is not a feature of the 20 different schemes of Islamic sacred geography formulated over the centuries, and the information about the *qibla* contained in them should not be used willy-nilly to interpret mosque orientations.

The major scholars responsible for the development of serious Islamic sacred geography were Ibn Surāqa (Yemen & Basra, *ca*. 975), Ibn Raḥīq (Mecca, *ca*. 1050) and al-Dimyāṭī (Cairo, *ca*. 1175), whose names are totally unfamiliar to mainstream Islamic studies, as well as the better-known astronomer al-Fārisī (Aden, *ca*. 1275). Some of the later schemes of sacred geography show only localities in sectors surrounding the Kaʿba, without giving any information on the associated *qibla*s. Such are the schemes of the well-known authors Yāqūt (Hama, *ca*. 1225) and al-Qazwīnī (Syria & Iraq, *ca*. 1250), as well as the splendid multi-coloured scheme in the navigational atlas of al-Ṣafāqusī (Sfax, *ca*. 1550), which was destined to adorn the covers of several coffee-table books on Islamic civilization long before it was ever seriously studied. At least the two known copies of al-Ṣafāqusī's scheme have a circumferential scale, albeit with unnumbered divisions, surrounding them.

The information in these texts explains how it comes to be that some historical mosques are not aligned in the *qibla*-directions we moderns might expect. For the *qibla*s advocated in these texts are necessarily different from those derived by Muslim astronomers from the 9th century onwards based on medieval geographical coordinates and some mathematical procedure, exact or approximate. Each set is also necessarily different from the modern *qibla*-direction, based on modern geographical coordinates and exact mathematical procedures. For this reason, it is not sensible to investigate historical mosque orientations using modern criteria for the *qibla*. Those who have done that have inevitably overlooked the use of astronomical alignments even in the most important early mosques, sometimes replacing earlier religious edifices themselves astronomically aligned (as in Córdoba, Kairouan, Cairo, Jerusalem, Damascus, Samarqand, to name just a few). On some of these situations, publications based on medieval texts havea appeared elsewhere. To unravel the complexities from mosque orientations alone without medieval texts which more or less explain it all would have been much more difficult.

These materials constitute the only known tradition in world history of written and pictorial evidence of the use of astronomical alignments for sacred architecture. As such, they have been welcomed with enthusiasm by colleagues in ethnoastronomy and archaeoastronomy, if not yet by those in the history of Islamic architecture.

The theme of sacred geography in Islamic civilisation has not previously been accorded due attention. Two schemes from published texts were illustrated by Konrad Miller in his monumental *Mappæ arabicæ* (1931). In the mid 20th century, it was overlooked entirely but in all innocence by two of the leading scholars of the history of Islamic geography, S. Maqbul Ahmad on geographical literature and André Miquel on human geography. More recently it has been ignored altogether for different reasons by my colleague Fuat Sezgin in his monumental history of mathematical geography and cartography in Islamic civilization. The same scholar also edited some 318 volumes of reprints and facsimiles on Islamic geography and cartography, but sacred geography – both highly sophisticated maps centred on Mecca and splendid diagrams of the world centred on the Kaʿba – seems

to have escaped his attention. His intention was, of course, to show the extent to which Islamic cartography influenced European cartography. Our present subject has indeed little to do with cartography, but it is aptly referred to as "sacred geography". The first independent book on Islamic cartography and geography to seriously mention this notion of the world around the Kaʿba is *Medieval Islamic maps – An exploration* (2016) by Karen Pinto.

I first announced the existence of these then newly-discovered materials in the 1980s at various conferences (A.O.S. & M.E.S.A.) in the U.S. I published several articles describing the materials of this kind, notably, the illustrated article "Makka as centre of the world" in the *Encyclopaedia of Islam* (1987).[7] My colleague Richard Lorch was preparing a chapter on the mathematical determination of the *qibla* for *The History of Cartography*, and the editors readily agreed to include a section on the new materials.[8]

I also prepared a book-length manuscript introducing the materials in chronological order, presenting the Arabic texts and manuscript illustrations, and concluding with an analysis thereof and a surveying their implications for mosque orientations. This work, provisionally entitled *Thw World about the Kaaba – The Sacred Geography of Islam*, was alas shelved when I moved from New York University (Near Eastern Languages & Literatures) to Frankfurt University (History of Science). What follows here is the information on the sources for the study of Islamic geography, taken from the original introduction to that work. Only the most basic biographical information has been included here, and no descriptions or analyses of the schemes. Various studies documented in the bibliography, in particular, studies of the folk-astronomical treatises containing elaborate schemes of sacred geography and considerable discussion of the determination of the

---

7 When commissioned to write the article "Ḳibla (astronomical aspects)" (*ḳibla* being a perverse rendering of *qibla*) for the *Encyclopedia of Islam*, which was published in 1979, I had only a vague idea of the existence of the material presented here.

8 Lorch & DAK, "Qibla charts, qibla maps, and related instruments" (1992).

qibla by non-mathematical procedures, are available to the interested reader.[9]

---

9 Another genre of Islamic literature also investigated for the first time in the 1980s – the كـتب الـمواقـيت , *kutub al-mawāqīt*, books on the determination of the times of prayer by non-technical procedures – reveals the reasons why the times of the daytime prayers are defined in terms of increases over the minimum shadow at midday, definitions that are not mentioned in neither the *Qur'ān* nor the Prophetic *ḥadīth* nor the earliest legal texts. See King, *In Synchrony with the Heavens*, esp. IV: 529-622 on the development of the definitions of the times of prayer, and III: 457-527 on simple shadow-schemes for reckoning the time of day. On the way in which the astronomers contributed to the regulation of the prayer-times in various cities over the centuries see *ibid*., II: 191-456, based on some 500 previously-unstudied manuscripts.

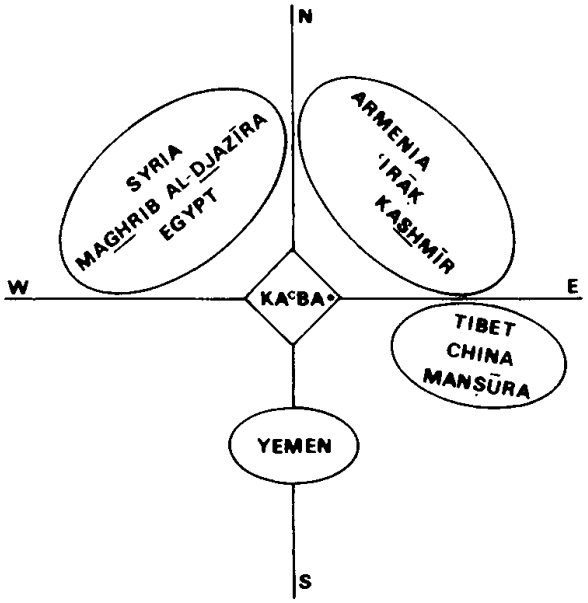
Index of authors on Islamic sacred geography

Note: Surely numerous specialists on Islamic law and on folk astronomy could be added here.

Texts on Islamic sacred geography

0) The earliest prescription to finding the *qibla* by means of the Pole Star is attributed to the fourth Caliph ʿ**Alī ibn Abī Ṭālib** but its authenticity, as in the case of most of the scientific or pseudo-scientific utterances attributed to him (on which see King, "Algebra in Zabid", pp. 226-227, esp. n. 14), must be viewed with some scepticism.

1) The *Kitāb al-Masālik wa-ʻl-mamālik* (= *Book on the routes and regions (of the Islamic world)*), is a geographical work by **Ibn Khurradādhbeh**, who worked in al-ʿIraq in the 9th century. His simple scheme of sacred geography is described in words on p. 5 of the published text. See "Makka as centre of the world" in *EI*$_2$ and the detailed study by Herrera & Schmidl.



An interpretation of the simple scheme of Ibn Khurradādhbeh. From the article "Makka as centre of the world" in EI$_2$.

2) Another early scheme we can attribute to a **Pseudo-al-Muqaddasī**, who has been confused with the famous geographer al-Muqaddasī, born in Jerusalem around 945. Neither the printed version of the *Aḥsan al-taqāsīm fī maʿrifat al-aqālīm* (= *The best divisions concerning the knowledge of the geographical climates*) of this late-10th-century scholar nor the splendid MS Istanbul Aya Sofia 2971 (*bis*),1, copied 658 H / 1260, contains any *qibla* diagram. However, another manuscript of this work, namely, MS Berlin Deutsche Staatsbibliothek Ahlwardt 6034 (= Sprenger 5), copied in the year 899 H / 1494, does contain an 8-sector diagram (fol. 34r). The details are extremely corrupt, and although the scheme cannot securely be attributed to al-Muqaddisī, it is clearly very early. See "Makka as centre of the world" in *EI*$_2$, *World-Maps for finding the direction of Mecca*, p. 52, and the detailed study by Herrera & Schmidl.

3) The *Kitāb Dalāʿil al-qibla* (= *Book on ways to find the qibla*) was compiled by the 10th-century legal scholar **Ibn al-Qāṣṣ** of Tabaristan on the south-eastern shores of the Caspian Sea. The author is mentioned disparagingly by the great 11th-century scientist al-Bīrūnī in his monumental treatise on chronology (pp. 59 & 239), and it is probable that he was the target of al-Bīrūnī's treatise against those who used astronomical alignments for the *qibla*.

The treatise *Dalā'il al-qibla* was in the 1980s available only in two fragments preserved in MS Cairo Dār al-Kutub *mīqāt* 1201 (27 fols., copied *ca*. 1100 H / *ca*. 1700) as well as a later anonymous work based on it preserved in MS Istanbul Veliyüddin 2453,2 (fols. 147r-169r, copied 845 H / 1441-42). The Cairo and Istanbul manuscripts are quite different in content, the former dealing with *qibla* stars and the latter with geography.

Another manuscript was described by Girgis Safa in 1913 in the catalogue of his private collection in Beirut and obviously bore some resemblance to the Istanbul manuscript; however, the Librarian of St. Joseph's informed me in 1981 that he was unaware of the fate of the manuscript. In 1989, my colleague, Fuat Sezgin, published a facsimile of MS Cairo Dār al-Kutub *buldān* 103 (81 pp., copied 781 H / 1379-80), which appears to be that "missing" Beirut manuscript. In this there is a division of the world into seven sectors about the Kaʿba (the author presents them as four). Ibn al-Qāṣṣ

also gives information on finding the *qibla* using the Pole Star, as well as an account of the practice of some of his predecessors. See further a series of publications by Jean-Charles Ducène.

4) The Yemeni legal scholar **Ibn Surāqa al-ʿĀmirī** studied in Basra and then returned to his native Yemen, where he died in the year 1019. He appears to have compiled three different *qibla* schemes, one with 8 sectors, another with 11, and a third with 12. The work or works in which he described these schemes are not known to have survived. Their title or titles were *Kitāb Dalāʾil al-qibla* (= *Book on ways to find the qibla*). The need to expand these early 4- and 8-sector schemes resulted from the fact that Greater Syria had wide span of *qibla*-directions, and even more so, the sector featuring Yemen and S. China.

Ibn Surāqa's 8-sector scheme is described by Ibn Raḥīq (§6) in MS Berlin Ahlwardt 5664, fols. 23r-25v. His 11-sector scheme is described in al-Sarūjī's commentary to al-Marghīnānī's *Hidāya* (§8 & §18); in Ibn Faḍlallāh's encyclopaedia (§17); and in an anonymous Mamluk source (§19). A 12-sector scheme due to Ibn Surāqa appears to underlie the 13-sector scheme of al-Dimyāṭī (§7). Only Ibn Raḥīq records the attribution to Ibn Surāqa; in the other sources the authors introduce the material as if it were their own. On Ibn Surāqa's three schemes see already King, "Makka as centre of the world".

5) al-Dimyāṭī (see §7) in his shorter treatise (fols. 11r-11v and 12v of the Ẓāhirīya manuscript) states that one Muḥyi 'l-Dīn ibn Yaḥyā of Khurasan (see fol. 12v) explained the *qibla* directions of different regions of the world in his treatise *al-Muḥīṭ*, which was a commentary on the legal treatise *al-Wasīṭ* by the celebrated scholar al-Ghazzālī. The scholar is the famous 13th-century scholar of tradition and sacred law, **Muḥyi 'l-Dīn ibn Yaḥyā al-Nawawī** (see also §9).

6) **Ibn Raḥīq**, whose full name was Abū ʿAbdallāh Muḥammad ibn Raḥīq ibn ʿAbd al-Karīm, is apparently known only from the unique copy of his treatise on folk astronomy, preserved in MS Berlin Deutsche Staatsbibliothek Ahlwardt 5664 (71 fols., copied *ca*. 700 H / *ca*. 1300). From internal evidence in this work it is clear that he lived in Mecca. Ibn Raḥīq

describes in words the 8-sector system of Ibn Surāqa. On his treatise see Schmidl, *Volkstümliche Astronomie*.

7) The legal scholar **Abu ‘l-Manṣūr Fatḥ** a**l-Dimyāṭī**, a native of Damietta who worked in Cairo in the latter half of the 12th century, compiled two treatises on the *qibla* that are amongst the most significant works on the subject compiled by any Muslim legal scholar in the entire medieval period, if not the most significant. It seems that both the author and his book have fallen through the cracks in both the medieval and the modern bio-bibliographical sources.[10]

The shorter of the two works is extant in the unique copy MS Damascus Ẓāhirīya 5579 (18 fols., copied 802 H / 1399-1400). This contains some material on an earlier scheme associated with Muḥyi ‘l-Dīn ibn Yaḥyā (al-Nawawī) (§5). al-Dimyāṭī also presents a scheme of his own: the *qibla* chart on fol. 14r of this manuscript. In the text of the treatise the author mentions a longer work of his on the same subject entitled *Kitāb al-Tahdhīb fī maʿrifat dalāʿil al-qibla wa-naṣb al-maḥārīb* (= *The Book of instruction on the ways to find the qibla and to set up prayer-niches*), a title not listed in any of the bibliographical sources known to me.

An incomplete and disordered copy of the *Tahdhīb* was located in the Bodleian Library in July, 1982, namely, MS Marsh 592 (120 fols., copied 592 H / 1196). In this *magnum opus* al-Dimyāṭī presents (fols. 97v-101v + 26r-28r) what appears to be a 12-sector scheme due to Ibn Surāqa, with one additional sector to make 13, as well as a diagram of his 13-sector scheme. See King, “Cairo orientations”, where al-Dimyāṭī’s treatise is introduced for the first time.

---

10 He is called Zayn (al-Dīn) al-Dimyāṭī by al-Qarāfī (§12, p. 499). On fol. 113v of the Oxford manuscript he is identified as Najīb al-Dīn Nāṣir al-Sunna Abu ‘l-Manṣūr Fatḥ ibn Muḥammad ibn ʿAlī ibn Khalaf al-Dimyāṭī. On the title folio of the Damascus manuscript he is incorrectly named as both Nūr al-Dīn and Sharaf al-Dīn. Our author is not to be identified with any of the scholars named al-Dimyāṭī (*i.e.* from Damietta in the Nile Delta) listed in Brockelmann, *GAL*, or in *EI*$_2$. However, he is known to have written a treatise refuting Christianity which was not appreciated by the Coptic Ibn al-ʿAssāl family.

8) ʿAlī ibn Abī Bakr **al-Marghīnānī** was a Ḥanafī legal scholar who died in 593 H / 1197. He is best known for two works, the *Bidāyat al-mubtadi'* (= *A Beginning for the beginner*), an introductory work on Ḥanafī law, and a much more extensive compendium on the same entitled *al-Hidāya*, *Guidance*. The latter was one of the most influential works on Ḥanafī law, as can be judged by the dozens of commentaries written on it over the centuries This notwithstanding, the work contains no information on prayer in general or on the *qibla* in particular. A fragment of a commentary by al-Sarūjī (§18) quotes Ibn Surāqa (§4) without mentioning his name.

9) The geographical dictionary entitled *Muʿjam al-buldān* (= *Dictionary of localities*) was compiled by the celebrated scholar **Yāqūt al-Rūmī** in Hama during the period 1215-1229. The work was edited by F. Wüstenfeld in 1866-73, and uncritical editions have been published in Cairo and Beirut. It contains a simplified 12-sector *qibla* chart, reproduced by Wüstenfeld; the same chart reappears in the Beirut edition (I, p. 33). Yāqūt states that his chart shows how one can face the Kaʿba approximately and remarks that there is some controversy about it. Unfortunately he gives no indication of its provenance. The published chart contains not a few errors. But several manuscripts of Yāqūt's work are available, and of these I have inspected two. MS Istanbul Topkapı Arabic 6530 = Ahmet III 2700, copied in an elegant hand *ca*. 825 H / 1425 has a *qibla* chart on fol. 23r. MS Istanbul Hamidiye 990 (785 fols.) purports to be in the author's hand and dated 621 H / 1224 but in fact it is a late Ottoman copy from about 1800; the *qibla* chart occurs here on fol. 11r.

10) The treatise on folk astronomy entitled *Kitāb al-Azmina wa-'l-anwā'* (= *Book on the seasons and associated astronomical phenomena*) by **Ibn al-Ajdābī,** a philologist from Ajdābiyya in Libya who lived in the early 13th century, contains a description in words of an 8-sector system of sacred geography (pp. 120-125 of the published text).

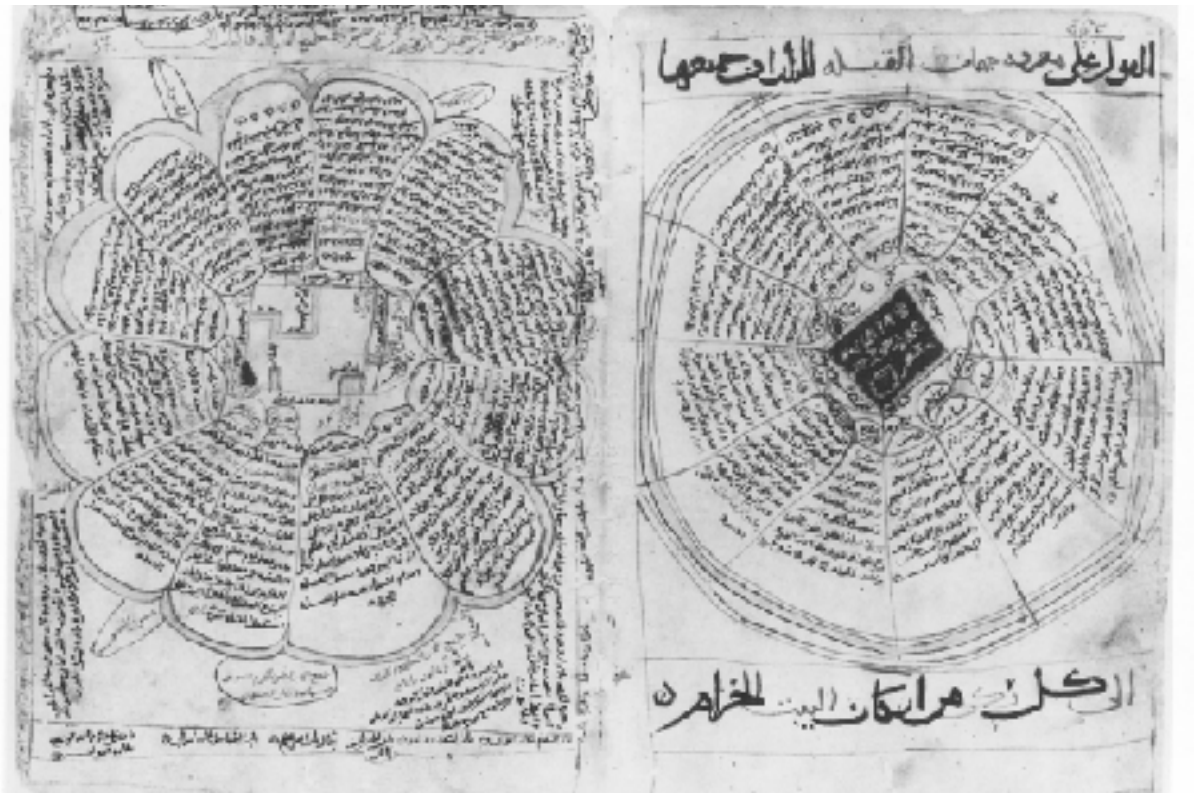
11) The celebrated scholar **al-Qazwīnī**, who was born in Qazwin *ca*. 1205 and worked in Syria and Iraq where he died in 1283, wrote two major works on geography and cosmography. A simplified 12-sector *qibla* chart is contained in the former, the *Āthār al-bilād* (= *Book about the monuments* (?)

of the countries (of the world)), but not the latter, the *ʿAjā'ib al-makhlūqāt* (= *Book on the wonders of creation*). al-Qazwīnī's scheme is slightly different from that of Yāqūt (§9).

12) A scheme for finding the *qibla* in nine regions of the world by means of the Pole Star is presented by the distinguished 13th-century Egyptian legal scholar Shihāb al-Dīn **al-Qarāfī**. The scheme is described in words in his major treatise entitled *al-Dhakhīra* (= *The Treasure*), the first part of which was published in Cairo in 1961 (pp. 489-508).

13) Ḍiyā' al-Dīn **al-Dīrīnī**, an Egyptian mystic of the early 13th century who spent part of his life wandering around the Nile Delta as a dervish, wrote a lengthy poem on folk astronomy entitled *al-Yawāqīt fī maʿrifat al-mawāqīt* (= *Sapphires for finding the times of prayer*), which is extant in several manuscript copies. The poem concludes with a section on the *qibla* and an 8-sector *qibla* diagram.

14) A treatise on folk astronomy entitled *Tuḥfat al-rāghib ...* (= *The Gem for the person who seeks...*) by the late-13th-century Yemeni astronomer **Muḥammad ibn Abī Bakr al-Fārisī** survives in a unique complete copy, MS Milan Ambrosiana X73 sup. (unfoliated, copied *ca*. 900 H / *ca*. 1500). This manuscript contains a total of three 12-sector *qibla* schemes. One is described verbally in the 11th chapter of al-Fārisī's text. The other two are represented on diagrams found at the end of the treatise and separate from it. See Schmidl, *Volkstümliche Astronomie*, for a full treatment. In al-Fārisī's *Tuḥfa* we find a statement concerning the orientation of the Kaʿba (see Hawkins & King, "Orientation of the Kaʿba"). In his other astronomical works, he presents mathematical methods for determining the *qibla*.



A description in words of a 12-sector scheme of sacred geography is contained in al-Fārisī's treatise on folk astronomy. Appended to the treatise in the only known copy are these two diagrams which contain different information. From MS Milan Ambrosiana X73 sup., courtesy of the Biblioteca Ambrosiana. See Schmidl, Volkstümliche Astronomie*, for details.*

15) The Rasulid Yemeni **Sultan al-Ashraf** authored a compendium on mathematical astrology entitled *al-Tabṣira fī ʿilm al-nujūm* (= *The Book of instruction in astrology*) at the end of the 13th century. It survives in the unique MS Oxford Bodleian Hunt. 233 (166 fols., copied *ca*. 700 H / 1300), the copy in Tehran being late and corrupt. A 12-sector diagram of sacred geography occurs on fol. 116v of the Oxford manuscript. A detailed analysis of this work is being conducted by Dr. Petra Schmidl.

16) An **anonymous Yemeni almanac and ephemeris** for the year 727 Hijra (=1326-27) is preserved in MS Cairo Dār al-Kutub *mīqāt* 817,2 (fols.

55r-84v, copied probably in 1325). It contains a 12-sector diagram of sacred geography.

17) **Ibn Faḍlallāh al-ʿUmarī** (1301-1349) was a distinguished author and administrator of the Mamluk period, who served in the chanceries of Cairo and Damascus and compiled important works on the organization and administration of the Mamluk state. One of his two major works was an enormous encyclopaedia entitled *Masālik al-abṣār fī mamālik al-amṣār* (= *The roads of vision concerning the empires of cities*), arranged in 27 volumes dealing with literature, history, geography, religion, law and politics, as well as with administration. The work is extant in its entirety, some volumes even in the author's hand, and a facsimile based on a multiplicity of manuscripts has been published (Frankfurt, IGAIW). The discussion of the *qibla* is to be found in vol 2, of which apparently the only available copy is MS Istanbul Süleymaniye yazma bağişlar 2227 (no date of copying, but clearly early). The material merits more thorough treatment than is possible here (as is the case with the writings of al-Dimyāṭī and al-Maqrīzī), and I restricted attention to the following.

First, on pp. 229-230 there is an example of the use of the Pole Star for finding the *qibla* in Iran, quoted from the 13th-century Shāfiʿī jurist **Muḥyī al-Dīn al-Nawawī** (§5, see also §9) together with a critique thereof by the mid-14th-century Damascene astronomer Ibn al-Shāṭir. Second, there is a *qibla* diagram on p. 243 (< fol. 142r). There is no indication of the provenance of the scheme; it is of the simple 12-sector variety but unrelated in detail to any other that has come to my attention. I find it hard to imagine that Ibn Faḍlallāh, familiar with what Ibn al-Shāṭir had written about such schemes, would have dared present one of his own. Third, immediately following this diagram (pp. 244-247) by a description of Ibn Surāqa's 11-sector scheme (§4), without mention of its provenance. Again Ibn Faḍlallāh had no qualms about presenting this scheme without critical comment. Finally, the author continues with some historical remarks about the *qibla* in various locations, also found in al-Sarūjī (§18).

Ibn Faḍlallāh influenced al-Qalqashandī (§25), but the latter's description of the world about the Kaʿba is independent.

(It has been claimed that the world-map presented by Ibn Faḍlallāh reproduces the world-map of the ʿAbbāsid Caliph al-Ma'mūn, but this is based on an illusion, not least because the latter was rectangular and Ibn Faḍlallāh's later map is semi-circular. Also without foundation is the claim that al-Ma'mūn had a spherical world-map.)

18) Aḥmad ibn ʿAbd al-Ghanī **al-Sarūjī** is known to us only as a commentator on the *Hidāya* of al-Marghīnānī (§8). His work is extant in a manuscript in Istanbul (not consulted) and a fragment in MS Cairo Dār al-Kutub Muṣṭafā Fāḍil *majāmīʿ* 183, 5 (fols. 107r-114v, copied *ca*. 1150 H / 1750, anonymous). By good fortune the latter just happens to deal with our subject. It contains the opinions of various early authorities on the *qibla* in different localities, also found in Ibn Faḍlallāh (§17); a statement on the orientation of the Kaʿba; information on the stars used for finding the *qibla* and on the winds; a diagram of the Kaʿba (fol. 111r), as well as what concerns us more here: a full description (fols. 111r-114r) of the 11-sector scheme of Ibn Surāqa (§4) without any attribution. The other material in this source merits detailed investigation.

19) A short fragment of an anonymous Egyptian treatise on the *qibla* is preserved in MS Milan Ambrosiana II.75 (A75),20 (fols. 174r-177v, copied *ca*. 1000 / *ca*. 1600). The text describes in words a 12-sector *qibla* scheme attributed to the early-14th-century legal scholar ʿ**Izz al-Dīn ibn Jamāʿa** *ʿan abīhi*, that is, on the authority of his father Badr al-Dīn ibn Jamāʿa, who was also a celebrated legal scholar. The father was born in Syria and worked in Damascus and Cairo, whereas the son worked in Cairo. Only descriptions of four sectors are contained in this fragment. The author then presents a different 11-sector scheme due to Ibn Surāqa (§4), his description being preserved in its entirety.

The corrupt 12-sector *qibla* diagram in the printed version of the *Cosmography* of Pseudo-Ibn al-Wardī (§29) is attributed to Ibn Jamāʿa, but I have not noticed this association in any of the available manuscripts of his treatise examined.

20) The early-14th-century scholar ʿAbdallāh ibn Asʿad **al-Yāfiʿī** was born in the Yemen and began his studies in Aden, but he spent most of his

life in Mecca and Medina. His treatise is entitled *Sirāj al-tawḥīd ...* , (= *The lamp of belief in the unity of God ...*) and survives in several copies. I have used MS Cairo Dār al-Kutub Taymūr *riyāḍa* 322 (79 pp., copied 877 H / 1472-73), where the relevant passage occurs on pp. 20-23. al-Yāfiʿī is of especial interest for his critique of the 11-sector scheme of Ibn Surāqa (§4). His remarks were lifted *in toto* by the author of the Ottoman navigational text (see §41).

21) A diagram of sacred geography is contained amidst some notes at the end of a Yemeni copy of a recension of the anonymous 13th-century Egyptian ***Muṣṭalaḥ Zīj*** (= *The popular astronomical handbook*), preserved in MS Paris Bibliothèque nationale de France ar. 2513 (copied *ca*. 750 H / *ca*. 1350), esp. fol. 94r. No such diagram appears in other manuscripts of this *Zīj* or related commentaries, and there is no reason to suppose that this diagram was original to the *Zīj*. Furthermore, no other Islamic *zīj*es currently known to me contain such *qibla* diagrams (though see §26 and §35 below).

22) The late-14th-century Cairo legal scholar **Ibn al-Qāṣiḥ** wrote *inter alia* two separate treatises on the use of the astronomical instruments called the sine quadrant and the astrolabic quadrant. Both treatises survive in unique contemporaneous manuscripts and both contain information relevant to our study. They also contain a discussion of the astronomically-aligned ventilators of medieval Cairo, which has been analyzed elsewhere: see "Cairo orientations", pp. 111-112.

Ibn al-Qāṣiḥ's treatise on the use of the sine quadrant is extant in MS Vatican ar. 317,4 (fols. 95r-113v, copied *ca*. 800 H / 1400). In Chapter 63 he discusses the determination of the *qibla* by the standard approximate geometric construction (see King, "Earliest methods for finding the qibla"). Then in Chapter 64 he presents an 11-sector division of the world about the Kaʿba which is in fact based on the scheme of Ibn Surāqa (§4), and in Chapter 65 he discusses the winds and their relationship to the corners of the Kaʿba.

Some remarks by Ibn al-Qāṣiḥ on the *qibla* sector for Egypt and the Maghrib are also recorded in his treatise on the use of the astrolabic quadrant, which is extant in MS Cairo Dār al-Kutub *mīqāt* 26 (29 fols., copied *ca*. 800 H / *ca*.

1400). The author mentions that he had written "a short compilation on the ways to find the direction of the Kaʿba by the blowing of the four winds". No copies of this treatise are known to me, and the Milan fragment mentioned in §19 is probably not due to Ibn al-Qāṣiḥ because it corresponds to Ibn Surāqa's 12-sector scheme and not his 11-sector one.

23) MS Leiden Universiteitsbibliotheek Or. 563 (*ca*. 50 fols., copied 760 H / 1358-59) is a beautifully-executed **Persian astrological almanac** full of tables of a non-numerical kind. The copy was (apparently?) prepared for the treasury of the enigmatic ruler ʿAlā' al-Dīn Beg (d. 1333), son of ʿUthmān, the founder of the Ottoman State. On fols. 37v-38r there is a diagram of the world about the Kaʿba in nine sectors.

24) **Ḥamdallāh Mustawfī** was a scholar of early 14th-century Qazwin who compiled works on history and geography. In the geographical section of his treatise entitled *Nuzhat al-qulūb* (= *Recreation for the hearts ...*), which has been edited and translated by Guy Le Strange, he presents a section on finding the *qibla* in different parts of Iran (text, pp. 22-23, and trans., p. 24). MS Istanbul Fatih 4517 (354 fols., copied 881 H / 1476-77), has the relevant passage on fols. 222v-223r.

25) The encyclopaedia entitled *Ṣubḥ al-aʿshā* (= *The daybreak of the night-blind*) by the early-15th-century Egyptian scholar **al-Qalqashandī** contains a description of the Kaʿba (IV, pp. 251-255). al-Qalqashandī describes in words the 12 divisions of the perimeter and the sectors of the world that are associated with them with *qibla* indications.

26) A *qibla* chart with 12 sectors is found in MS Cairo Dār al-Kutub *mīqāt* 637, fol. 46v, copied *ca*. 850 H / *ca*. 1450. It occurs at the end of a copy of the astronomical handbook (*zīj*) entitled *al-Lumʿa fī ḥall al-kawākib al-sabʿa* (= *The Flash for finding the positions of the sun, moon and planets*), which was compiled in Cairo *ca*. 800 H / *ca*. 1400 by the *muwaqqit* (official mosque timekeeper) Shihāb al-Dīn al-Kawm al-Rīshī. The chart is copied in a different hand from the rest of the manuscript, and there are no such diagrams in any of the numerous other copies of this *zīj*.

27) An anonymous 12-sector qibla chart is found in MS Berlin Deutsche Staatsbibliothek Ahlwardt 6071 (Wetzstein 1098) (1 sheet, copied *ca*. 1000 H / *ca*. 1600).

28) The celebrated historian **al-Maqrīzī**, who worked in Cairo in the early 15th century, discussed the problem of mosque orientation in Egypt in his book known as the *Khiṭaṭ* (= *The City-Sectors (of Cairo)*). In the course of his discussion (I, pp. 257-258 of the 1853 Cairo edition) he mentions various *qibla* sectors and their positions relative to the Kaʿba. al-Maqrīzī's writings on this subject were doubtless inspired by al-Dimyāṭī's *Tahdhīb* (§7), but they are only partly derived from this earlier work. See King, "Cairo orientations", for al-Maqrīzī's comments.

29) The cosmography entitled *Kharīdat al-ʿajāʿib wa-farīdat al-gharāʿib* (= *The unbored pearl of wonders and the solitaire of marvels*) was compiled in Aleppo *ca*. 1420. The author was Ibn al-Wardī, a government secretary. Because of the problems associated with the identification of this individual, We shall refer to him as **Pseudo-Ibn al-Wardī**. What is not in question is the fact that the treatise was the most popular work of its genre from the 16th to 19th centuries. Dozens of manuscript copies, mostly of Egyptian, Yemeni and Turkish provenance, but also some in Maghribi script, survive in manuscript libraries around the world. Various kinds of *qibla* schemes are contained in the twenty or so copies that I have examined.

According to Carl Brockelmann (*GAL*, II, p. 163), Pseudo-Ibn al-Wardī's *Cosmography* was largely plagiarized from the encyclopaedia entitled *Jāmiʿ al-funūn* (= *A compendium of the arts*) compiled by the early-14th-century Egyptian scholar **Najm al-Dīn al-Ḥarrānī**. MS Istanbul Aya Sofia 3834 (176 fols., copied *ca*. 900 H / *ca*. 1500) of this work contains no schemes of sacred geography. It is not clear from my examination of the manuscripts of Pseudo-Ibn al-Wardī's treatise which scheme or schemes, if any, he proposed himself. I have not investigated the possibility that the different schemes derive from different recensions of the work.

The uncritical edition of this work published in Cairo in 1863 contains two extremely corrupt diagrams (pp. 70-71), one with 12 sectors and the other

with 8. The former is specifically attributed to ʿIzz al-Dīn ibn Jamāʿa (§19). The latter is so corrupt that it can barely be recognized.

The 12-sector chart in the printed text is of the simplified variety. A different 12-sector diagram with prescriptions for the qibla in each sector, yet more corrupt than the one in the published text, occurs in MS Paris BnF ar. 2188, fol. 25r, which is of Maghribi provenance. (Another such chart is in MS Princeton Yahuda 667, copied 1014 H / 1605-06, fol. 49v.)

In the following six manuscripts, the qibla chart has only 11 sectors: MS Istanbul Laleli 2121, copied 995 H / 1586-87 in an elegant hand, fol. 61r; MS Laleli 2122, copied *ca*. 1100 / *ca*. 1700, fol. 49v (smeared); MS Istanbul Topkapı Arabic 6552 (= Ahmet III 3020), copied 984 H / 1576 in an elegant hand, fol. 52v; MS Topkapı Arabic 6554 = A. III 3022, fol. 86v; MS Istanbul Yeni Cami 789, copied 998 H / 1589-1590, fol. 49v; and MS Princeton Garrett 267B-770, 16th century, fol. 45v.

An 8-sector qibla chart occurs in MS Paris B.N. ar. 2186, fol. 44r, of an early ʿIrāqī (Mosul?) or Syrian copy of Pseudo-Ibn al-Wardī's treatise. The same scheme is recorded by Ibn al-Ajdābī and al-Dīrīnī (§§10 & 13).

A different 8-sector scheme is attested in two manuscripts, namely, MSS Istanbul Topkapı Ahmed III 3025, fol. 30v, and 3021, fol. 40r.

One copy, MS Istanbul Reisülkuttab Mustafa Efendi 1009, copied 982 H / 1584, contains a *qibla* diagram with 18 sectors (fol. 56v), each subdivided into two. The chart in MS Istanbul Kılıç Ali Paşa 736/745, fol. 45r, displays 36 divisions. A 34-sector chart occurs in MS London B.L. Or. 9590 of Pseudo-Ibn al-Wardī's treatise; this copy is in Maghribi script and has an incorrectly-oriented plan for the Kaʿba with the *ḥijr* and *mīzāb* facing due east. In MS Princeton Yahuda 326, copied 983 H / 1575-76, there is an additional folio (14v) with a 38-sector scheme in a different and much later hand. A similar chart in MS Milan Ambrosiana B13, fol. 80r, shows just how corrupt these *qibla* charts could become after successive rehashing by hapless copyists.

Several copies have a blank space where the *qibla* diagram might have been. Either the copyists did not like drawing diagrams or they could not choose

which one to copy! In MS Princeton Garrett 39L-769 (copied 1019 H / 1610-11), there are no diagrams and no spaces left for them. But neither can the latter possibility be ruled out: for example, in MS Istanbul Haci Beşir Ağa 435 (copied 994 H / 1586), the copyist has included an elegant *mappa mundi* (fols. 3v-4r) but left blank the page for the *qibla* chart (fol. 41v).

The *qibla* charts in two copies of a Turkish translation of the *Kharīda*. These are MSS Istanbul Topkapı Revan 1088, fol. 94r, and Hazine 409, fol. 99r: both contain only 11 sectors with prescriptions for finding the *qibla*, also in Turkish. On the Turkish translation by Maḥmūd al-Khaṭīb al-Rūmī see §33.

In four manuscripts, the *qibla* chart has 11 sectors: MSS Istanbul Laleli 2121, copied 995 H / 1586-87 in an elegant hand, fol. 61r; Laleli 2122, copied *ca*. 1100 / *ca*. 1700, smeared, fol. 49v; Topkapı 6552 (=Ahmed III 3020), copied 984 H / 1576 in an elegant hand, fol. 52v; Topkapı 6554 (= A 3022), fol. 86v; and Yeni Cami 789, copied 998 H / 1589-90, fol. 49v.

30) **Ibn Mājid** was the author of several works on navigational astronomy. His family hailed from Oman and he was active around the year 1500. In the introduction to his major work *al-Fawā'id fī uṣūl al-baḥr wa-'l-qawāʿid* (= *Useful information on the fundamentals and basics of navigation*), Ibn Mājid states that his purpose in writing the book is not only to present an overview of navigational theory but also to show his readers how they can find directions in order to know the proper *qibla*. Unfortunately, his discussion of the *qibla* as such does not go beyond the expression of this hope. However, he does mention the division of the earth proposed by (Pseudo-) Ibn al-Wardī (§29) "and others".

31) The Egyptian Ḥanafī *qāḍī* ʿ**Abd al-Bāsiṭ al-Malaṭī** (*fl*. *ca*. 1500) compiled a short work entitled *Kitāb al-Wuṣla li-maʿrifat al-qibla* (= *The link for finding the qibla*). This is extant in the unique copy MS Istanbul Topkapı 8653 (= Ahmet III 527),5, fols. 90r-93v, copied *ca*. 950 H / *ca*. 1550. The author presents a diagram of sacred geography with 20 divisions about the Kaʿba which is not found elsewhere.

32) An imposing diagram of sacred geography with *miḥrāb*s of 40 sets of localities displayed about the Kaʿba and imposed on a wind-rose is presented

in the navigational atlas prepared by the 16th-century Tunisian scholar **Aḥmad al-Sharafī al-Ṣafāqusī**. Two copies of this atlas are known, namely, MSS Paris Bibliothèque nationale de France ar. 2273 and Oxford Bodleian Marsh 294, both copied *ca*. 1000 H / *ca*. 1600. The localities represented are slightly different in the two copies. For introductions to this work and its *qibla*-scheme see Herrera-Casais, "The nautical atlases of ʿAlī al-Sharafī", and Ledger, *Mapping Mediterranean Geographies.*

33) In MS Istanbul Topkapı Turkish 1340 = Bağdatli 179 (260 fols., copied 1093 H (= 1682) in Filibe (Plovdiv) of the Turkish translation of the *Cosmography* of Pseudo-Ibn al-Wardī (§29) by **Maḥmūd al-Khaṭīb al-Rūmī** (1562), there is a *qibla* chart with 72 sectors drawn about the Kaʿba. This is independent of the schemes with 34, 35, 36 and 38 sectors in other copies of the original Arabic work.

34) The 16th-century Egyptian astronomer **Ghars al-Dīn al-Ḥalabī** mentioned the ʿIrāqī *qibla*-sector in his treatise on the *qibla*. This treatise is extant as MS Cairo Dār al-Kutub Muṣṭafā Fāḍil *mīqāt* 114 (9 fols., copied *ca*. 1000 H / *ca*. 1600), in which this information occurs on fol. 5v. See King, "Cairo orientations", pp. 112-113.

35) An **anonymous Ottoman source**: MS Paris B.N. ar. 2520 (175 fols., copied 1050 H / *ca*. 1650) is a copy of the recension of the *Zīj* of the mid-14th-century Damascus astronomer Ibn al-Shāṭir by the mid-16th-century astronomer Ibn Zurayq, also of Damascus. It is not clear whether the manuscript was copied in Syria or Turkey, but there are indications on the fly-leaves that it was in Istanbul *ca*. 1600. On these fly-leaves there are altogether four schemes of sacred geography, two represented in circular form and the other two crudely copied in the form of lists. There is also a diagram for locating the mysterious *rijāl al-ghayb*, supposed intermediaries between man and God (see also §37). The outline of a fourth circular diagram, again with 8 divisions, has also been drawn. Only one of the four schemes is attested elsewhere. (The reader can perhaps imagine my mixed feelings upon locating these schemes in 1985 after I thought that I had completed this study and had turned my attention to other matters.)

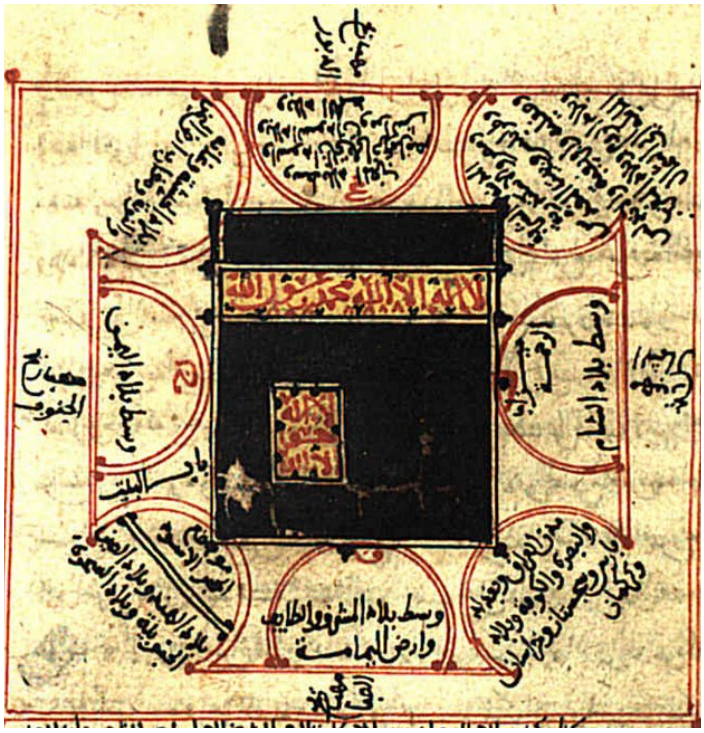
36) The 17th-century Egyptian legal scholar Shihāb al-Dīn Aḥmad ibn Aḥmad **al-Qalyūbī** compiled a treatise entitled كتاب الهداية من الضلالة في معرفة الوقت والقبلة من غير آلة , *Kitāb al-Hidāya mina ʻl-ḍalāla fī maʿrifat al-waqt wa-ʻl-qibla min ghayr āla* (= *Guidance from going astray on the knowledge of timekeeping and the qibla without astronomical instruments*). (A similar title is used in the Appendix to this paper.) al-Qalyūbī's treatise contains a section on finding the *qibla* in different parts of the world by means of astronomical risings and settings. This work exists in numerous copies, such as MSS Vatican ar. 1792 (fols. 14v-23v, copied *ca*. 1150 H / *ca*. 1750), where the discussion of the *qibla* occurs on fols. 21v-22r, and Istanbul Topkapı 7131 (= Hazine 469) (18 fols., copied 1033 H / 1623-24), especially fols. 14v-15v.

37) An 8-sector *qibla* scheme is illustrated in an anonymous treatise on the *qibla* and the Kaʿba preserved in the unique source MS Cairo Ṭalʿat *majāmīʿ* 811,7 (fols. 59r-61r, copied 1198 H / 1783-84). The treatise follows immediately after another on a device for finding the locations of the mysterious *rijāl al-ghayb*, intermediaries between man and God (see already §35), authored by the 17th-century Egyptian scholar ʿ**Abdallāh ibn** ʿ**Abd al-Raḥmān al-Ṭūlūnī**, whose father was *imām* of the Mosque of Ibn Ṭūlūn in Cairo. The treatises were copied in Cairo, but the one on the *qibla* may be of Ottoman Turkish provenance. Certainly the *qibla* scheme predates the 13th century because a 12-sector Yemeni scheme from that century is based upon it. Also it is related to a Persian scheme copied in the 14th-century (§23**)**. Another 8-division scheme illustrated in the same Cairo manuscript (fol. 59v) is probably of even earlier origin. For discussions see, for example, "Makka as centre of the world", "Sacred geography", and *In Synchrony with the Heavens*, VIIa: p. 757, VIIb: p. 815.

38) An anonymous Egyptian treatise on the calendar, the prayer-times and the *qibla* is preserved in MS Leiden Universiteitsbibliotheek 2575 (2 fols., copied *ca*. 1200 H / *ca*. 1800) describes a scheme for finding the *qibla* by the Pole Star. This particular treatise is entitled *Aqrab al-adilla fī maʿrifat al-tawārīkh wa-ʻl-awqāt wa-ʻl-qibla* (= *The easiest ways to know the calendars, the prayer-times and the qibla*), and is representative of a genre

of simple Egyptian treatises on these subjects compiled during the Ottoman period.

39) An illustration of a simple 8-sector scheme of sacred geography without *qibla* indications is found in a manuscript of mixed contents mainly in a Maghribi script but with possible Egyptian connections: MS Istanbul Şehit Ali Paşa 2776,2, fol. 56v, copied *ca*. 980 H / *ca*. 1575). The manuscript contains *inter alia* various treatises on folk astronomy (including that of al-Tājūrī), arithmetic, as well as a solar table for Cairo (based on Ulugh Beg) and a table of longitudes and latitudes, but the diagram does not seem to belong to these.[11]



The anonymous 8-sector scheme in MS Şehit Ali Paşa 2776,2, fol. 56v, courtesy of the Süleymaniye Library, Istanbul, which has kindly made the entire manuscript available on the internet.

11 Rumour has it that the manuscript is a copy of the partly lost *al-Zīj al-Mukhtaṣar* of Ibn al-Ṣaffār, the well-known astronomer who worked in Córdoba around the year 1000; this is unfortunately false.

40) An **anonymous Ottoman navigational manual** is preserved in MS Cairo Dār al-Kutub *mīqāt* 570 (*ca*. 150 fols., copied *ca*. 1300 H / *ca*. 1880). It contains a series of texts, diagrams, and tables relating to navigation. The work is written in Arabic but betrays both Turkish and European influences. I have not found any indication of the geographical provenance of the author, but the material can be dated to *ca*. 1860 (see fol. 6v). On fols. 12v-13v, the anonymous compiler presents a scheme of sacred geography in which he purports to record his criticisms based upon his own observations. In fact, the passage is simply lifted *in toto* from the treatise of al-Yāfiʿī (§20).

41) The following is an **Ottoman text for marking a scheme of sacred geography on instruments**. Copied in a late hand on the back flyleaf (fol. 169v) of MS Berlin Ahlwardt 5750 (168 fols., *ca*. 700 H / *ca*. 1300) of a recension of one of the *zīj*es of the renowned 9th-century Baghdad astronomer Ḥabash al-Ḥāsib, there are some tables and notes for calendar conversion and a semicircular *qibla*-diagram containing 18 sectors. The southern parts of a 36-sector scheme have been superposed on the northern parts. The two sets of localities are separated by 10°-divisions in *abjad* (alphanumerical) notation, and there is an additional set of numbers, one for each division which make no sense. The scheme belongs to the Ottoman tradition and was originally intended as an aid for marking *qibla* directions on a semi-circular instrument.

42-50) The miscellaneous instruments listed below all display schemes of sacred geography combined with otherwise scientifically-sound features such as sundials or graduated circular scales. Doubtless there are many more such instruments preserved in uncatalogued museum collections around the world. See Lorch & King, “Qibla charts”, for an introduction to such objects, and King, *World-Maps*, pp. 100-124, and *Synchrony*, X: 94-99, for more details.

42) A circular instrument, consisting of a sundial and *qibla*-indicator, made out of ivory, some 11 cm. in diameter is preserved in the British Museum, London (inv. no. 1921, 625.I). It bears the signature of **Bayram ibn Ilyās** and is dated 990 H / 1581-82. In the central part is a simple pictorial representation of the Kaʿba, a wind-rose, and two sundials, one for

determining the time remaining to the afternoon prayer, and the other with a string gnomon and circular hour-scale. Within this is an annulus with 72 equal divisions, mainly with three localities mentioned in each. On this see DAK, *World-Maps*, pp. 116-117, and *Synchrony*, X: pp. 98-99, and an enthusiastic account in Doyle, "Qibla indicator".

43) An instrument resembling that of Bayram (§42), at least in spirit, is preserved in the Deutsche Staatsbibliothek (Sammlung Sprenger) in Berlin. It was made in Istanbul in 1179 H / 1765-66 by **Ibrāhīm al-Kamālī**. A sundial showing time before sunset and the beginning of the *ʿaṣr* for a specific latitude, as well as hours before and after midday (marked around the outer rim) is also marked with a primitive wind-rose and a ring of 36 sectors each subdivided into two parts for the *qibla*. The gnomon has suffered two indignities: firstly, it has been bent, and secondly, it has been used to attach a completely spurious astrolabic plate and rete. These have no place on such an instrument and may obscure an inscription. On the back are circular scales for finding the solar longitude for the Coptic and Jalālī calendars. The names Edirne, Islāmbūl and Bursa are marked in red on the qibla ring, which roughly pinpoints the provenance. See DAK, *World-Maps*, pp. 116-117.

44) An equatorial semicircle *cum qibla*-indicator of the variety known as *dā'irat al-muʿaddil* used to be preserved in the Museum of History of Science at Kandilli Observatory near Istanbul. The instrument was invented by the well-known 15th-century Egyptian astronomer al-Wafā'ī. This particular example was constructed by **Abu 'l-Fatḥ**, a *muwaqqit* in Istanbul, in the year 1066 H / 1655-56, and it was published by Muammer Dizer in 1986. The horizontal base of this instrument, which is 30.5 cm. in diameter, is divided into 72 equal sectors each containing place-names. See DAK, *World-Maps*, pp. 96-98.

45) A celestial globe completed in the year 1113 H / 1701-02, one of several made by the Egyptian astronomer **Riḍwān Efendī**, is preserved in the M. V. Lomonosov Museum in Leningrad (inv. no. 02721). It was published by Bernard Dorn in 1865 (pp. 39-41) and has been described again in Emilie Savage-Smith's survey of Islamic globes (pp. 233-234). On the

horizon ring of this instrument are marked 72 equal divisions, each containing names of localities.

46) A semi-circular *qibla*-indicator, made by one Muḥammad **al-Ṣabbāgh** in *ca*. 1100 H / *ca*. 1700, is preserved in the Museum of the Institut du Monde Arabe in Paris. It was published by Hana Chidyaq in 1989. The feature of this instrument that concerns us here is a *qibla* chart based on 36 equal divisions of the horizon.

47) A *qibla*-indicator made by Muḥammad ibn Muḥammad **al-Nīshlī** in 1108 / 1696-97 is preserved in the Institut du Monde Arabe in Paris (inv. AI 85-5). On the maker, whose mixed Arabic-Turkish *nisba* indicates that he or his family originated in Niš, now in Serbia. The instrument bears two different *qibla* schemes with 36 divisions, one on each side.

48) An unsigned equatorial dial preserved in the National Museum, Damascus (inv. no. 11741), was evidently assembled from parts of other instruments. The equatorial semi-circle bears a date 1050 H / 1640-41 and the signature of **... (?)** ʿ**Alī** but the date 1140 H / 1692-93 is inscribed on the base. There is a 72-sector *qibla*-scheme around the base that I have not examined in detail.

49) A compendium consisting of an equatorial dial, a sundial, and a qibla-indicator is also preserved in the National Museum, Damascus (inv. no. 4468). It bears the signature of ʿAbd al-Ḥasan, clearly a Shiʿite, and the date 1301 H / 1883-84. The *qibla*s are arranged on a semi-circular horizontal frame below the equatorial semi-circle.

50) An anonymous Persian *qibla*-instrument preserved in the Maritime Museum in Haifa bears a crude diagram of sacred geography with some absurdities. The Haifa Museum possesses a remarkably large number of *qibla* compasses but this appears to be the only one bearing a scheme of sacred geography.

Concluding remarks

We can distinguish close to 20 different traditions in the sources investigated in this study. There are schemes with the world divided about the Kaʿba into

4, 7, 8, 9, 11, 12, 13, 18, 20, 24,
34 / 35 / 36 / 38, 40, 52, and 72 sectors.

The number and variety of these schemes indicates that the notion of a sacred geography was accepted amongst the educated *élite* if not amongst the scientists. And I do not doubt that there were other compilations on the subject that have either escaped my notice or are now lost without trace.

It is important to stress that Islamic sacred geography is not a simplistic notion that the world is actually centred on the Kaʿba, but rather an ingenious response to the religious obligation to observe the sacred direction toward the Kaʿba in all parts of the world. It is furthermore a notion that is in complete accord with the universal spirit of Islam. In encompassing the entire (known) world it resembles the valiant attempts by Muslim astronomers to produce solutions to problems of spherical astronomy which were universal, that is, serving all terrestrial latitudes.[12]

In brief, we have found several early four- and eight-sector schemes that were apparently without much influence. The same can be said of the seven-sector scheme of Ibn al-Qāṣṣ. One early eight-sector scheme, however, albeit of uncertain origin, was known in later centuries in Egypt, the Yemen, and Iran. But with the schemes of Ibn Surāqa a tradition began that lasted almost a millennium. What rôle Ibn al-Wardī himself played in the development of simplified versions of these schemes with about 36 sectors we do not know.

Where al-Ṣafāqusī found the inspiration for his 40-sector scheme is a secret that went with him. But the development of the Ottoman 72-sector schemes from 36-sector schemes such as are found in some copies of (Pseudo-) Ibn al-Wardī's treatise is clear: it was convenient to mark them on instruments

---

12 On these highly impressive 'universal' solutions see King, *In Synchrony with the Heavens*, XVI: pp. 679-739.

with a scale running from 0° to 360° divided into 5° intervals. The way in which these detailed Ottoman schemes survived alongside the lists of *qibla*-values computed for the major cities is, however, not clear. Sheer aesthetics must have contributed to their popularity on instruments, in the same way that the elegant engraving of the *qibla*-lists on Iranian astrolabes and compass-boxes ensured their use until the 19th century. *Qibla*-indicators on which directions based on calculation are illustrated graphically, of which only one rather late example is known, are rather awkward from an aesthetic point of view because the distribution of important localities around the Kaʿba is not even.[13]

No-one should be surprised that the information recorded in these two traditions – finding the *qibla* by means of astronomical horizon phenomena on the one hand and by calculation on the other – leads to different results. The implications of this textual and instrumental material for the history of Islamic architecture were considerable.

****

13 Illustrated in King, *World-Maps*, p. 102.

Bibliography

Note: On historical determinations of the *qibla* see "Bibliography of books, articles and websites on historical *qibla* determinations" (2018), available at www.davidaking.academia.edu.

Published primary sources

Note: The following list of published primary sources used in this study has not been fully updated since the 1980s. In particular, most of these works have been eprinted in 318 volumes of the series *Islamic Geography* published by the Institut für Geschichte des arabisch-islamischen Wissenschaften in Frankfurt (www.igaiw.de) during 1992-2010.

Abu l-Fidā': Joseph Toussaint Reinaud & (M. le Baron) Mac Guckin de Slane, eds., *Géographie d'Aboulféda*, Paris: L'Imprimerie Royale, 1840.

al-Azraqī: *Akbār Makka*, in F. Wustenfeld, *Die Chroniken der Stadt Mekka*, vol. I, 1857, repr. Beirut n.d. Also, R. Tottoli, introd. and trans., *Al-Azraqī - La Kaʿba - Tempio al centro del mondo - Akhbār Makkah*, Trieste: Società Italiana testi islamici, 1992.

al-Bazdawi: DAK, "al-Bazdawī on the *qibla* in early Islamic Transoxania", *Journal for the History of Arabic Science* (Aleppo) 7 (1983), pp. 3-38, repr. in *idem*, *Islamic astronomy and geography*, Aldershot: Variorum, 2012, IX.

al-Bīrūnī, *Astrology*: al-Bīrūnī, *Kitāb al-Tafhīm li-awā'il ṣināʿat al-tanjīm*, published as R. R. Wright, *The Book of Instruction in the Elements of the Art of Astrology by Abu 'l-Rayḥān Muḥammad ibn Aḥmad al-Bīrūnī*, (photo-offset reproduction of MS London B.L. Or. 8349 with translation from manuscripts of the Persian text), London: Luzac & Co., 1934. (Repr. Baghdad: Maktabat al-Muthannā, n.d.)

al-Bīrūnī, *Chronology*: al-Bīrūnī, *al-Āthār al-bāqiya ʿan al-qurūn al-khāliya*, ed. by C. E. Sachau as *Chronologie orientalischer Völker von Al-Bīrūnī*, Leipzig: F. A. Brockhaus and Otto Harrassowitz, 1923, translated by C. E. Sachau as *The Chronology of the Ancient Nations*, London: W. H. Allen Co., 1879.

al-Bīrūnī, *Geography*: al-Bīrūnī, *Kitāb Taḥdīd nihāyat al-amākin li-taṣḥīḥ masāfat al-masākin*, edited by P. Bulgakov, Majallat Maʿhad al-Makhṭūṭāt al-ʿArabiyya (Cairo) 8:1-2 (1962), translated by Jamil Ali as *The Determination of the Coordinates of Cities: al-Bīrūnī's Taḥdīd nihāyat al-amākin*, Beirut: American University of Beirut, 1967, with commentary by E. S. Kennedy, *A Commentary upon al-Bīrūnī's Taḥdīd nihāyāt al-amākin*, Beirut: A.U.B., 1973. (The most important single medieval work on the determination of the *qibla* as a problem of mathematical geography.)

Ḥājjī Khalīfa (Kātib Chelebī): Ḥājjī Khalīfa, *Jihān-numā*, Istanbul, 1145 Hijra (= 1732-33).

Ibn al-Ajdābī: Abū Isḥāq Ibrāhīm known as Ibn al-Ajdābī, *al-Azmina wa-'l-anwā'*, ed. I. Ḥasan, Damascus: Wizārat al-thaqāfa wa-'l-irshād al-qawmī, 1964.

Ibn Faḍlallāh al-ʿUmarī: Fuat Sezgin, ed., *Routes toward Insight into the Capital Empires* (?)*, Masālik al-abṣār fī mamālik al-amṣār by Ibn Faḍlallāh al-'Umarī ...* , [modified facsimile "edition" of various manuscripts], 27 vols., Frankfurt am Main: IGAIW, 1988.

Ibn Khurradādhbih: M. J. de Goeje, ed., *Compendium libri Kitab al-Boldān*, *auctore Ibn al-Fakīh al-Hamadhānī*, Leiden: E. J. Brill, 1889, repr. 1967.

Ibn Mājid: Ibrahim Khoury, ed. and comm., *Muṣannafāt Shihāb al-Dīn Aḥmad ibn Mājid ... : Kitāb al-Fawā'id fī uṣūl ʿilm al-baḥr wa-'l-qawāʿid*, Part II, §I of *al-ʿUlūm al-baḥrīya ʿinda 'l-ʿArab*, Damascus: Majmaʿ al-lughat al-ʿarabiyya, 1971, also Gerald R. Tibbetts, *Arab navigation in the Indian Ocean before the coming of the Portuguese...* , London: Royal Asiatic Society and Luzac & Co., 1971, repr. 1981.

Ibn al-Qāṣṣ: Fuat Sezgin, "*Kitāb Dalā'il al-qibla* li-bn al-Qāṣṣ", *Zeitschrift für Geschichte der arabisch-islamischen Wissenschaften* 4 (1987/88), Arabic section, pp. 7-91 (facsimile of Cairo MS); Jean-Charles Ducène, "Le *Kitāb dalā'il al-qibla* d'Ibn al-Qāṣṣ : analyse des trois manuscrits et des emprunts d'Abū Ḥāmid al-Ġarnāṭī", *Zeitschrift für Geschichte der arabisch-islamischen Wissenschaften* 14 (2001), pp. 169-187, and "La carte circulaire du *Kitāb dalā'il al-qibla* d'Ibn al-Qāṣṣ : représentation du monde et toponymie originales", *Folia Orientalia* 38 (2002), pp. 115-146.

Ibn al-Wardī: Ibn al-Wardī, *Kharīdat al-ʿajā'ib wa-farīdat al-gharā'ib*, Cairo, 1280 Hijra (=1863).

al-Maqrīzī: al-Maqrīzī, *Kitāb al-Khiṭāṭ al-Maqrīziyya*, 2 vols., Cairo, 1853.; also available in 4 vols. (1896-98), 3 vols. (1959), and 2 vols. (repr. of 1853 ed.) (1970).

Mustawfī: G. Le Strange, ed. and trans., *The Geographical Part of the* Nuzhat-al-Qulūb *composed by Ḥamd-Allāh Mustawfī of Qazwīn in 740 (1340)*, 2 vols., Leiden: E. J. Brill & London: Luzac & Co., 1915 and 1919.

al-Qalqashandī: al-Qalqashandī, *Ṣubḥ al-aʿshā fī ṣināʿat al-inshā'*, 13 vols., Cairo: Ministry of Culture, 1963.

al-Qarāfī: Shihāb al-Dīn Abu 'l-ʿAbbās Aḥmad ibn Idrīs al-Qarāfī, *al-Dhakhīra*, vol. I, Cairo: Maṭbaʿat Kullīyat al-Sharīʿa, 1961.

al-Qazwīnī: F. Wüstenfeld, ed., *Zakarījā ... el-Cazwīnī's Kosmographie*, 2. Teil: *Kitāb āthār al-buldān, Die Denkmaler der Länder*, Göttingen: Dieterische Buchhandlung, 1848. (The 1960 Beirut edition is based on this.)

al-Sharafī: his navigational atlas is studied in Herrera-Casais, "The nautical atlases of ʿAlī al-Sharafī" (2008) & Ledger, *Mapping Mediterranean Geographies*, 2016.

al-Ṣafāqusī: see al-Sharafī.

al-Suyūṭī: Heinen: Anton M. Heinen, *Islamic Cosmology: A Study of al-Suyūṭī's al-Hay'a as-saniya fi l-hay'a as-sunniyya*, with critical edition, translation, and commentary, Beirut, (in commission for Franz Steiner Verlag, Wiesbaden), 1982.

Yāqūt: Yāqūt ibn ʿAbdallāh al-Ḥamawī, *Muʿjam al-buldān*, ed. by F. Wüstenfeld as *Jacuts geographisches Wörterbuch*, 6 vols., Leipzig, 1866-73, and ed. by A. A. Shinqiti, 8 vols., Cairo, 1323 H / 1906, and an anonymous edition (based on Wüstenfeld) in 5 vols., Beirut: Dar Sader and Dar Beirut, 1955-57. See also W. Jwaideh, *The Introductory chapters of Yāqūt's* Muʿjam al-buldān, Leiden: E. J. Brill, 1967.

In future research the series *Islamic Geography*, F. Sezgin, ed., 318 vols., Frankfurt: IGAIW, 1992-2010, should be consulted.

Unpublished primary sources

Manuscripts are identified in the text of the article. Many were identified in the major collections in Istanbul and Cairo at a time when these were not fully catalogued. The richly-illustrated volume *Images of Islamic science* (coordinated by A. Beschaouch, Paris & Tehran, 2009) displaying many illustrations from scientific manuscripts in Iranian collections contains no materials relevant to the present study. For an introduction to Arabic

scientific manuscripts by a scholar, Prof Nahyan Fancy, who knows their historical significance see www.qdl.qa/en/arabic-scientific-tradition.

Published secondary sources

Note: The bio-bibliographical sources for medieval Muslim authors are mainly listed here only by the names of their authors: Carl Brockelmann (general, Arabic); Heinrich Suter (scientists, Arabic); Max Krause (Istanbul scientific manuscripts); Charles Storey (general, Persian); Fuat Sezgin (authors on all subjects until *ca*. 1050, especially mathematics, astronomy, astrology, geography & cartography); Leon A. Mayer (instrument-makers); Boris A. Rosenfeld & Galina Matvievskaya (scientists, general); Ekmeleddin İhsanoğlu *et al*. (scientists, Ottoman period); B. A. Rosenfeld & Ekmeleddin İhsanoğlu (scientists, general); King (Yemeni astronomical manuscripts & Cairo scientific manuscripts); articles in *DSB*, *BEA*, and EI_1 & EI_2. For modern studies of Islamic instruments see *AIOS* and King, *In Synchrony with the Heavens*, vol. 2.

Reference works

BEA: Thomas Hockey *et al*., eds., *The Biographical Encyclopedia of Astronomers*, New York: Springer, 2007, available at http://islamsci.mcgill.ca/RASI/BEA/, and now https://ismi.mpiwg-berlin.mpg.de/biographies-list (2018) (This is the standard reference work on the most significant Muslim astronomers.)

DSB: *Dictionary of Scientific Biography*, 14 vols. and 2 supp. vols., New York: Charles Scribner's Sons, 1970-80. (Biographical articles ofter superior to those in *BEA*.)

EI_1: *The Encyclopaedia of Islam*, 1st ed., 4 vols., Leiden: E. J. Brill, 1913-34.

EI_2: *The Encyclopaedia of Islam*, 2nd edn., 13 vols., Leiden: E. J. Brill, 1960-1980. (See below for relevant articles.)

Manuscript catalogues and bibliographical works (selected)

Berlin Catalogue: Wilhelm Ahlwardt, *Die Handschrift-Verzeichnisse der Königlichen Bibliothek zu Berlin*, 17. Band: *Verzeichniss der arabischen Handschriften*, 5. Band, Berlin: A. Asher, 1893.

Carl Brockelmann, *Geschichte der arabischen Litteratur*, 2nd edn., 2 vols., Leiden: E. J. Brill, 1943-49, and Supplementbände, 3 vols., Leiden: E. J. Brill, 1937-42.

Cairo Survey: D. A. King, *A Survey of the Scientific Manuscripts in the Egyptian National Library*, (Publications of the American Research Center in Egypt), Winona Lake, Indiana: Eisenbrauns, 1985.

– , *Mathematical astronomy in medieval Yemen: A bio-bibliographical survey*, (Publications of the American Research Center in Egypt), Malibu, Ca.: Undena Publications, 1983.

Fuat Sezgin, *Geschichte des arabischen Schrifttums*, V: *Mathematik* & VI: *Astronomie* & VII: *Astrologie – Meteorologie und Verwandtes*, Leiden: E. J. Brill, 1974/1978/1979; and XIII: *Mathematische Geographie und Kartographie im Islam und ihr Fortleben im Abendland – Autoren*, Frankfurt: IGAIW, 2007. (Vol. VII, section "Nationale Meterologie und Astronomie der Araber", lists none of our authors; vol. XIII lists two of our authors, namely, Ibn Surāqa and Ḥamdallāh Mustawfī, but does not mention sacred geography; vol. XII presents hundreds of maps but no diagrams of sacred geography.)

Islamic astronomy (general)

Carlo Alfonso Nallino, "[Islamic astronomy]", in James Hastings, ed., *Encyclopaedia of Religion and Ethics*, 12 vols., Edinburgh: T. & T. Clark, vol. 12 (1921), pp. 88-101. (Perhaps the best overview ever written.)

DAK, "Islamic astronomy", in Christopher Walker, ed., *Astronomy before the Telescope*, London: British Museum Press, 1996, pp. 143-174, repr. in *Islamic astronomy and geography*, Farnham & Burlington VT: Ashgate–Variorum, 2012, I, also available on www.muslimheritage.com/article/islamic-astronomy.

Robert G. Morrison, "Islamic astronomy and astrology", in Robert Irwin, ed., *New Cambridge History of Islam*, vol. 4, Cambridge, *etc*.: Cambridge University Press, 2010, pp. 589-613.

– , "Islamic astronomy", in David C. Lindberg & Michael H. Shank, eds., *The Cambridge History of Science*, vol. 2: *Medieval science*, Cambridge University Press, 2013, pp. 109-138.

Kennedy *et al*., *Studies*: E. S. Kennedy, Colleagues and Former Students, *Studies in the Islamic Exact Sciences*, DAK and Mary Helen Kennedy, eds., Beirut: American University of Beirut, 1983. (Over 50 studies written or inspired by the leading scholar of the history of Islamic astronomy in the second half of the 20th century.)

DAK, *Islamic mathematical astronomy*, Aldershot: Variorum, 1986/1993 (contains "al-Khalīlī's qibla table" (1975)); *Astronomy in the service of*

Islam, Aldershot: Variorum, 1993 (contains "Orientation of the Kaʿba" (1982),"Earliest qibla methods ... " (1986) and *EI*$_2$ articles "*Ḳibla*" & "Makka as centre of the world" & "*Maṭlaʿ* (rising points)", and "Astronomical alignments in medieval Islamic religious architecture" (1982)); and *Islamic astronomy and geography*, Farnham & Burlington VT: Ashgate–Variorum, 2012 (contains "al-Bazdawī on the *qibla* in Transoxania" (1983) and "The sacred geography of Islam" (2005)).

– , *In Synchrony with the Heavens – Studies in Astronomical Timekeeping and Instrumentation in Islamic Civilization*, vol. 1: *The Call of the Muezzin*, & vol. 2: *Instruments of Mass Calculation*, Leiden, *etc*.: Brill, 2004-05. (Includes new versions VIIa: "The orientation of medieval Islamic religious architecture and cities", pp. 741-771; VIIb: "Architecture and astronomy: the ventilators of medieval Cairo and their secrets", pp. 773-823; and VIIc: "Safavid world-maps centred on Mecca – A third example and some new insights on their original inspiration", pp. 825-846.)

– & Julio Samsó, with a contribution from Bernard R. Goldstein, "Astronomical handbooks and tables from the Islamic world (750-1900): An interim report", *Suhayl – International Journal for the History of the Exact and Natural Sciences in Islamic Civilisation* (Barcelona) 2 (2001), pp. 9-105. (Supplements the 1956 survey by E. S. Kennedy in anticipation of the new survey of some 225 *zīj*es by Benno van Dalen.)

Clive N. Ruggles, ed., *Handbook of archaeoastronomy and ethnoastronomy*, 3 vols., New York, *etc*.: Springer, 2015, contains the following articles: DAK, "Astronomy in the service of Islam", pp. 181-196; Mònica Rius, "Qibla in the Mediterranean'', pp. 1687-1694; Clemency Montelle, "Islamic mathematical astronomy", pp. 1909-1916; Tofigh Heidarzadeh, "Islamic astronomical instruments and observatories", pp. 1917-1926; Petra G. Schmidl, "Islamic folk astronomy", pp. 1927-1934; & Daniel Martin Varisco, "Folk astronomy and calendars in Yemen", pp. 1935-1940. See also Stephen C. McCluskey, "Astronomy in the service of Christianity", pp. 181-196, and "Orientation of Christian churches", pp. 1703-1710.

Encyclopaedia of Islam (*EI*$_2$, see above), especially articles "*Anwā'* (pre-Islamic calendrical system)"; "*Asṭurlāb* (astrolabe)"; "*Hay'a* (astronomy)"; Kaʿba"; "*Ḳibla* (sacred direction)"; "*Layl wa-nahār* (simple timekeeping)"; "Makka as centre of the world (sacred geography and mosque orientation)"; "Maṭlaʿ (rising points)"; "*Mīḳāt* (astronomical timekeeping and times of prayer)"; "*Mizwala* (sundials)"; "*Rubʿ* (quadrant)"; "*Nudjūm* (star-lore)"; "*Rīḥ* (winds); "*Ru'yat al-hilāl* (lunar crescent visibility)"; "*Shakkāziyya*

(universal projections)"; "*Ṭāsa* (magnetic compass)"; and "*Zīdj* (astronomical handbooks and tables)".

The orientation of the Kaʿba

Gerald S Hawkins & DAK, "On the orientation of the Kaʿba", *Journal for the History of Astronomy* 13 (1982), pp. 102-109, repr. in DAK, *Astronomy in the service of Islam*, Aldershot: Variorum, 1993, I.

The sacred direction in Islam (general)

A. J. Wensinck, article "Ḳibla. i. Legal aspects" in *Encyclopedia of Islam*, 1st edn., also *ibid*., new edn.

Karl Schoy, article "Ḳibla. ii. Astronomical aspects" in *Encyclopedia of Islam*, 1st edn.

DAK, "Ḳibla. ii. Astronomical aspects", in *The Encyclopaedia of Islam*, new edition, vol. V, fascs. 79-80, Leiden: E. J. Brill, 1979, pp. 83-88, repr. in *idem*, *Astronomy in the service of Islam*, Aldershot: Variorum, 1993, IX.

– , "The sacred geography of Islam", in T. Koetsier and L. Bergmans, eds., *Mathematics and the Divine – A Historical Study*, Dordrecht: Elsevier, 2005, pp. 161-178, repr. in *idem*, *Islamic Astronomy and Geography*, Farnham & Burlington VT: Ashgate–Variorum, 2012, VIII.

Daniel Z. Levin, "Which way is Jerusalem? Which way is Mecca? The direction-facing problem in religion and geography", *Journal of Geography* 101 (2002), pp. 27-37.

DAK, "Bibliography of books, articles and websites on historical *qibla* determinations" (2018), available at www.davidaking.academia.edu.

Determination of the *qibla* by mathematical methods

Jamil Ali, *The Determination of the Coordinates of Cities: al-Bīrūnī's Taḥdīd nihāyat al-Amākin*, Beirut: American University of Beirut Press, 1967, with commentary by E. S. Kennedy, *A Commentary upon al-Bīrūnī's Taḥdīd nihāyāt al-amākin*, Beirut: A.U.B. Press, 1973. (The most important single medieval work on the determination of the *qibla* as a problem of mathematical geography.)

Richard P. Lorch & DAK, "Qibla charts, qibla maps, and related instruments", in J. B. Harley & David Woodward, eds., *History of Cartography*, vol. 2, book 1: *Cartography in the traditional Islamic and South Asian societies*, Chicago & London: University of Chicago Press, 1992, pp. 189-205.

DAK, "The earliest Islamic mathematical methods and tables for finding the direction of Mecca", *Zeitschrift für Geschichte der arabisch-islamischen Wissenschaften* 3(1986), pp. 82-149, repr. in *idem*, *Astronomy in the service of Islam*, Aldershot: Variorum, 1993, XIV.

– , *World-Maps for finding the direction and distance of Mecca: Innovation and tradition in Islamic science*, Leiden: Brill & London: Al-Furqan Islamic Heritage Foundation, 1999. (Includes detailed overviews of *qibla* determinations by mathematical and folk-astronomical methods, as well as all known medieval tables showing *qibla*-directions for dozens or hundreds of locations.)

– , "Bibliography of books, articles and websites on historical *qibla* determinations" (2018), available at www.davidaking.academia.edu. (Contains references to numerous studies of procedures by Muslim scientists.

Determination of the *qibla* based on mathematical cartography

Karl Schoy, "Die Mekka- oder Qiblakarte (Gegenazimutale mittabstandstreue Projektion mit Mekka als Kartenmitte)" (1917). (The first European map preserving direction and distance to Mecca at the centre.)

DAK, *World-Maps for finding the direction and distance to Mecca* (see above), *passim*, on two 17th-century Safavid maps centred on Mecca. For a third example and insights into the origin of the mathematics underlying the grids (from 10th-century Baghdad and 11th-century Isfahan) see *In Synchrony with the Heavens*, VIIc: pp. 825-846.

A. Jon Kimerling, "Cartographic methods for determining the *qibla*", *Journal of Geography*, 101 (2002), pp. 20-26.

Razie Sadat Musavi, "*Jām-e Gītī-namā* – A late Iranian qibla-indicator", *Tarikh-e elm* (Tehran) 12 (2015-2016), pp. 17-40.

Islamic sacred geography

Konrad Miller, *Mappae Arabicae: Arabische Welt- und Länderkarten*, V. Band: *Weltkarten*, Stuttgart: K. Miller, 1931 (illustrates published diagrams of al-Qazwīnī and Ibn al-Wardī).

DAK, "Makka. iv. As centre of the world [sacred geography and orientation of mosques]", in *The Encyclopaedia of Islam*, 2nd edn., vol. VI, pp. 180-187, repr. in *idem*, *Astronomy in the service of Islam*, Aldershot: Variorum, 1993, X.

– , "The sacred geography of Islam", in T. Koetsier and L. Bergmans, eds., *Mathematics and the Divine – A historical study*, Dordrecht: Elsevier, 2005, pp. 161-178, repr. in *idem*, *Islamic astronomy and geography*, Farnham & Burlington VT: Ashgate–Variorum, 2012, VIII.

Petra G. Schmidl & Mónica Herrera Casais, "The earliest known schemes of Islamic sacred geography", in A. Akasoy & W. Raven, eds., *Islamic thought in the Middle Ages: Studies in text, transmission and translation in honour of Hans Daiber*, Leiden: Brill, 2008, pp. 275-300. (Detailed investigations of schemes by Ibn Khurradādhbeh & Pseudo-al-Muqaddisī.)

Jean-Charles Ducène, "Le *Kitāb dalā'il al-qibla* d'Ibn al-Qāṣṣ : analyse des trois manuscrits et des emprunts d'Abū Ḥāmid al-Ġarnāṭī", *Zeitschrift für Geschichte der arabisch-islamischen Wissenschaften* 14 (2001), pp. 169-187.

– , "La carte circulaire du *Kitāb dalā'il al-qibla* d'Ibn al-Qāṣṣ : représentation du monde et toponymie originales", *Folia Orientalia* 38 (2002), pp. 115-146.

Petra G. Schmidl, *Volkstümliche Astronomie im islamischen Mittelalter. Zur Bestimmung der Gebetszeiten und der Qibla bei al-Asbahî, Ibn Rahîq und al-Fârisî*, 2 vols., Leiden, *etc*.: Brill, 2007. (The first study of its kind, based on medieval Yemeni treatises on folk astronomy compiled by legal scholars and astronomers.)

– , "Zur Bestimmung der Qibla mittels der Winde", in P. Eisenhardt, F. Linhard and K. Petanides, eds., *Der Weg der Wahrheit. Aufsätze zur Einheit der Wissenschaftsgeschichte. Festgabe zum 60. Geburtstag von Walter G. Saltzer*, Hildesheim: Georg Olms, 1999), pp. 135-146.

DAK, "Some Ottoman schemes of sacred geography", *Proceedings of the II. International Symposium on the History of Turkish and Islamic Science and Technology, Istanbul, 1986*, 2 vols., Istanbul: Istanbul Technical University, 1986, I, pp. 45-57.

Mai Lootah, "Science and scripture: How did faith influence cartographic methods used to determine the qibla, the sacred direction of Islam?", *Spica – Postgraduate Journal for Cosmology in Culture* (Sophia Centre for the Study of Cosmology in Culture – University of Wales Trinity Saint David) 4:2 (2016), pp. 32-59 (a serious popular overview with no technicalities).

Mónica Herrera-Casais, "The nautical atlases of ʿAlī al-Sharafī", *Suhayl – International Journal for the History of the Exact and Natural Sciences in*

Islamic Civilisation (Barcelona) 8 (2008), pp. 223–63. (Includes discussion of Alī al-Sharafī al-Ṣafāqusī's *qibla*-diagram.)

Jeremy Francis Ledger, *Mapping Mediterranean Geographies: Geographic and Cartographic Encounters between the Islamic World and Europe*, c. 1100-1600, Ph.D. dissertation, University of Michigan, 2016. (Includes discussion of al-Ṣafāqusī's *qibla*-diagram.)

DAK, "Bibliography of books, articles and websites on historical qibla determinations" (2018), available at www.davidaking.academia.edu.

Astronomical instruments for finding the *qibla* based on sacred geography

AIOS: F. Sezgin *et al*., eds., *Astronomische Instrumente in orientalistischen Schriften*, 6 vols., Frankfurt: Institut für Geschichte der arabisch-islamischen Wissenschaften, 1990-91. (Reprints of studies mainly from the 19th and early 20th centuries.)

Richard P. Lorch & DAK, "Qibla charts, qibla maps, and related instruments", in J. B. Harley & David Woodward, eds., *History of Cartography*, vol. 2, book 1: *Cartography in the traditional Islamic and South Asian societies*, Chicago & London: University of Chicago Press, 1992, pp. 189-205.

DAK, *World-Maps for finding the direction of Mecca ...* , pp. 89-124; and *In Synchrony with the Heavens*, X: 94-101.

Hana Chidyaq, "Un indicateur de *qibla* signé Muḥammad ʿIzz al-Ṣabbāgh", *Astrolabica* (Paris) 5 (1989), pp. 27-36.

Meghan Doyle, "The whole world in his hands: What a qibla indicator illuminates about Islamic community in sixteenth-century Ottoman Turkey", *Global Tides* 12 (2018), article 8. (Enthusiastic overview with no analysis.)

Orientation of Islamic religious architecture (general)

DAK, "Astronomical alignments in medieval Islamic religious architecture", *Annals of the New York Academy of Sciences* 385 (1982), pp. 303-312, reprinted in *idem* , *Astronomy in the service of Islam*, Aldershot: Variorum, 1993, XIII.

– , "The orientation of medieval Islamic religious architecture and cities", *Journal for the History of Astronomy* 26 (1995), pp. 253-274 (a new version is in *In Synchrony with the Heavens*, VIIa: 741-771).

Orientations in specific localities

Orientations in al-Andalus: Jiménez, "La qibla extraviada" (1991); Rius, *La Alquibla en al-Andalus ...* (2000).

Orientations in Córdoba: see "Enigmatic orientation ... " (2016).

Orientations in Cairo: see "Architecture and astronomy ... " (1983).

Orientations in Morocco and Tunisia: see Bonine (1990/2008).

Orientations in Samarqand: see "al-Bazdawī on the *qibla* ... " (1983).

Orientations in Turkey": see Yilmaz & Tiryakioglu, "Astronomical orientation of the historical Grand mosques" (2018).

DAK, "Architecture and astronomy: The ventilators of medieval Cairo and their secrets", *Journal of the American Oriental Society* 104 (1984), pp. 97-133; with a revised version in *In Synchrony with the Heavens*, VIIb: 741-771)

– , "al-Bazdawī on the *qibla* in early Islamic Transoxania", *Journal for the History of Arabic Science* (Aleppo) 7 (1983), pp. 3-38, repr. in *idem*, *Islamic astronomy and geography*, Farnham & Burlington VT: Ashgate–Variorum, 2012, IX.

Michael E. Bonine, "The sacred direction and city structure: A preliminary analysis of the Islamic cities of Morocco", *Muqarnas* 7 (1990), pp. 50-72.

– , "Romans, astronomy and the *qibla*: urban form and orientation of Islamic cities of Tunisia", in J. C. Holbrook & R. T. Medupe & J. O. Urama, eds., *African Cultural Astronomy – Current Archaeoastronomy and Ethnoastronomy Research in Africa*, Berlin: Springer, 2008, pp. 145-178.

Alfonso Jiménez, "La qibla extraviada", *Cuadernos de Madīnat al-Zahrā'* 3 (1991), pp. 189-209. (An important study, the first of its kind for any region of the medieval Muslim world, presenting the orientations of all surviving historical mosques in the Iberian Peninsula.)

Mònica Rius Piniés, *La Alquibla en al-Andalus y al-Magrib al-Aqsà*, Barcelona: Institut "Millás Vallicrosa" de Història de la Ciència Àrab, 2000. (This is the first investigation of mosque orientations in al-Andalus and the Maghrib in the light of medieval folk astronomical and legal texts on the *qibla*.)

Mustafa Yilmaz & Ibrahim Tiryakioglu, "The astronomical orientation of the historical Grand mosques in Anatolia (Turkey)", *Archive for History of Exact Sciences* 72 (2018), pp. 565–590.

DAK, "The enigmatic orientation of the Great Mosque of Córdoba", *Suhayl – International Journal for the History of the Exact and Natural Sciences in Islamic Civilisation* (2018-19), to appear, preprint available on www.davidaking.academia since 2016. (Shows how the suburban Roman street-plan influenced the layout of the Mosque and how schemes of Islamic sacred geography confirmed that the Mosque was appropriately oriented with respect to the NW wall of the Kaʿba).

– , "Bibliography of books, articles and websites on historical qibla determinations" (2018), available at www.davidaking.academia.edu.

Miscellaneous significant works with some relevance to this study

Uri Rubin, "The Kaʿba: Aspects of its ritual functions", *Jerusalem Studies in Arabic and Islam* 8 (1986), pp. 97–131.

Oleg Grabar, "Upon reading al-Azraqi", *Muqarnas – An annual on the visual culture of the Islamic world* 3 (1985), pp. 1-7.

K. A. C. Creswell, "The Kaʿba in A.D. 608", *Archaeologia* 94 (1951), pp. 97-102.

Joseph Chelhod, "A contribution to the problem of the pre-eminence of the right based upon Arabic evidence" (translated from the French), in R. Needham, ed., *Right & Left*, Chicago: University of Chicago Press, 1973, pp. 239-262.

A. J. Wensinck, "The ideas of the Western Semites concerning the navel of the Earth", (Amsterdam, 1916), repr. in *Studies of A. J. Wensinck*, New York: Arno Press, 1978. (Lest we forget.)

Richard Ettinghausen, "Die bildliche Darstellung der Kaʿba im islamischen Kulturkreis", *Zeitschrift der Deutschen Morgenländischen Gesellschaft* 12 (1933), pp. 111-137. (No diagrams of sacred geography.)

Geoffrey R. D. King, "The Paintings of the pre-Islamic Kaʿba", *Muqarnas – An annual on the visual culture of the Islamic world* 21 (2004), pp. 219-230.

M. Hamidullah, "Le Pèlerinage à la Mecque", in *Les Pèlerinages*, Paris: Seuil, 1960, pp. 89-138. (Contains a modern interpretation of sacred geography.)

Anton M. Heinen, *Islamic Cosmology: A study of al-Suyūṭī's al-Hay'a as-saniya fi l-hay'a as-sunniya*, with critical edition, translation, and commentary, Beirut, (in commission for Franz Steiner Verlag, Wiesbaden), 1982. (A study of major importance since al-Suyūṭī bases his work on early sources which are no longer extant.)

E. S. Kennedy & Mary Helen Kennedy, *Geographical coordinates of localities from Islamic sources*, Frankfurt: IGAIW, 1987. (The fundamental research tool for the history of Islamic mathematical geography, based on longitudes and latitudes in some 80 Islamic geographical and astronomical lists. Some 14,000 pairs of coordinates are arranged by place-name, by source, by increasing longitude, and by increasing latitude.)

DAK, "The invention of algebra in Zabid: Between legend and fact", in David Reisman & Felicitas Opwis, eds., *Islamic Philosophy, Science, Culture, and Religion: Studies in Honor of Dimitri Gutas*, Leiden: Brill, 2011, pp. 223-231. (Contains new 'scientific' material attributed to ʿAlī ibn Abī Ṭālib.)

Annemarie Schimmel, "Sacred geography in Islam", in Jamie Scott & P. Simpson-Housley, eds., *Sacred places and profane spaces: Essays in the geographics of Judaism, Christianity, and Islam*, New York Greenwood, 1991, pp. 163-175. (Relates to notions of sacred geography different from those treated in this paper.)

Franz Landsberger, "The sacred direction in synagogue and church", *Hebrew Union College Annual* (Cincinnati OH) 28 (1957), pp. 181-203.

DAK, "Astronomy in the service of Islam", in Ruggles, ed., *Handbook of archaeoastronomy*, pp. 181-196.

– , "Aspects of practical astronomy in mosques and monasteries", in *idem*, *In Synchrony with the Heavens*, IX: 847- 880.

Stephen C. McCluskey, "Astronomy in the service of Christianity", in Ruggles, ed., *Handbook of archaeoastronomy*, pp. 181-196, and "Orientation of Christian churches", pp. 1703-1710.

Karen Pinto, *Medieval Islamic maps – An exploration*, Chicago: University of Chicago Press, 2016. (Includes serious mention of sacred geography.)

*****

Appendix – ملحق

الهداية من الضلالة في معرفة القبلة
لمن ليست عنده فكرة في امرها

al-Hidāya min al-ḍalāla fī maʿrifat al-qibla
li-man laysat ʿindahu fikra fī amrihā

Guidance from going astray concerning the *qibla* for those who know nothing about it (Gibson, Deus)

As anyone who has measured the orientation of a historical mosque will know, it will not generally be facing the **MODERN** direction of Mecca. If it does, then this is a coincidence. This situation results from the fact that historical *qibla* determinations were based either on

- folk techniques using **SIMPLE APPROXIMATE** non-mathematical procedures, or
- mathematical procedures using **PRE-MODERN** geographical data.

Two recent ill-conceived projects to investigate historical mosque orientations have used (irrelevant) **MODERN** *qibla* directions for comparison. They have inevitably come to false, nay, ridiculous conclusions. They merit some credit, however, for realizing that mosque orientations constitute an important potential source of historical information, something that the vast majority of our colleagues in the history of Islamic architecture have alas never taken seriously.

*****

Dan Gibson and Petra

"I wish to present a different opinion, and in doing so realize that I am not only going against modern scholars, but against the general opinion expressed by Muslim writers for the last thousand years.". Dan Gibson, *Early Islamic Qiblas* (2017), p. 127.

" … During the time of the founding of Islam, the Arabs … taking celestial bearings and using mathematical solutions … had an understanding of basic formulas for spherical trigonometry. With this knowledge, it comes as no surprise that the qiblas of early mosques [toward Petra] all over the ancient world are accurate to within several degrees." Gibson, pp. 170-171.

"So it is possible that qiblas were set without any science or math, just by transporting a number of homing pigeons from Petra [to places in Syria], and releasing them at the construction site a few at a time until an accurate direction could be established." Gibson, p. 169.

"Dr. King on the other hand is convinced that the sloppy [!] *qibla*s actually intended to point: east, west, solstices, sunrises and so forth. I have not come across anything in Islamic religious manuscripts that support these *qibla*s [DAK: they are mentioned in the article "Makka as the centre of the world", in the *Encyclopaedia of Islam* (1987)]. But perhaps in time someone, somewhere will stumble across something that will change our understanding of *qibla*s. All I have found so far, is that every Muslim expects the *qibla* to point to Mashjad [!] Al Harām."
Dan Gibson, totally astray at https://en.wikipedia.org/wiki/Dan_Gibson_(author).

The Canadian amateur archaeologist Dan Gibson has shown to his own satisfaction that the orientations of the earliest 50 mosques are connected with Petra rather than with Mecca, or rather, with the **MODERN** direction of Petra rather than the **MODERN** direction of Mecca. This confirms his wild theory that Islam began in Petra (where there were neither Arabs nor

Muslims in the early 7th century) rather than in Mecca. Therefore he maintains that these early mosques faced his (imaginary) Kaaba in Petra, which was later moved to Mecca (!). Gibson, with no serious academic training in Islamic Studies, thinks he has found several references to Petra in the *Qur'ān* which no *mufassir* has noticed in over 1,400 years.

Unfortunately for Gibson's Petra theory, all of these early mosques face the Kaʿba in Mecca in one way or other. Of course they do not face (the **MODERN** direction of) Mecca. And if some of them face (accurately toward the **MODERN** direction of) Petra, as Gibson can show, then this does not mean that

(a) they were intended to face (the **MODERN** direction of) Petra, and

(b) any Muslims from Petra who spread out to al-Andalus and China were so clever that they could determine the accurate (**MODERN**) direction of Petra from anywhere in the known world.

Gibson's investigations present an interesting problem for statistical analysis because many of the earliest mosques are roughly to the north or south of both Mecca and Petra. Early mosques further west and east were often laid out by astronomical risings and settings (which really confused Cook & Crone in the 1970s so they started the myth about the birth-place of Islam and a focus of Muslim worship somewhere in N. W. Arabia). From one end of the new Muslim world to the other several important mosques were erected on the sites of earlier religious architecture, which was invariably cardinally or solstitially aligned. In the Maghrib and al-Andalus the earliest mosques were often laid out alongside Roman city-plans, whose minor axes were themselves solstitially aligned. Gibson would have all of these mosques somehow facing (the **MODERN** direction of) Petra. In Iraq, Iran and Central Asia some of the earliest mosques were laid out towards winter sunset, and in S. China towards summer sunset. In fact, **all of these mosques face the Kaaba**, somehow.

An interesting twist to this sad tale is that Gibson is forced to believe, and wants his readers to believe that the Muslims in the 7th and 8th centuries were so scientifically advanced that they used astrolabes and spherical

trigonometry to determine accurately the *pibla* (my word), that is, the **MODERN** direction to Petra. This is of course complete nonsense. The Muslims encountered the astrolabe in the mid-8th century in Harran, and no surviving astrolabe from the 8th, 9th or 10th (some 20 in number, all published in detail) contains any means of determining the *qibla* / *pibla*. The earliest Muslim methods to calculate the *qibla* were based on plane trigonometry (they are all published). The earliest methods to calculate the *qibla* by spherical trigonometry date from the late 10th century (literature readily available).

*****

A. J. Deus and the warring Turks

"Most papers [!] about Muslim mosque orientations accept the tradition that these buildings point in the 'direction' of Mecca as long as they are within the correct intercardinal quadrant [DAK: al-Dimyāṭī wrote this in Cairo in the 12th century]. Others theorize about alternative focal locations, in particular in early Islam [*viz*., Dan Gibson & Petra]. Unchallenged remains the notion that some mosques were oriented according to celestial events or alignments."
A. J. Deus, also very confused, in "Monuments of Jihad" (2018), p. 1.

"Builders were able to orient structured precisely to a distant target long before the advent of Islam ... [*sic*]." Deus, p. 10.

" ... Turkish architects were not smart enough to read an angle off a table and draw a corresponding line on the ground [*sic*]." Deus, p. 7.

" ... none of the mosques by (the greatest Ottoman architect) Mimar Sinan point to Mecca [*sic*] ... ." Deus, p. 19.

"The main finding of this research is difficult to fathom and express: The orientations of the Turkish mosques in this data collection unmask Islam of the Turk dynasts' flavors as militarily aggressive in it core religious fabric." Deus,p. 30.

The Canada-based economist and self-styled ‘space archaeologist’ A. J. Deus, a self-styled “space archaeologist”, has shown to his own satisfaction that 250 Turkish mosques do not face (the **MODERN** direction of) Mecca but do face, more or less exactly at that, contemporaneous battle-fields on the ever-expanding frontiers of the Turkish world. His investigations involve consideration of both ends of each perpendicular axis of each mosque, so that a given mosque might not be facing Mecca (according to Deus) but is facing somewhere in that general direction (Medina, Axum), and exactly toward three other locations where the Turkish armies were currently campaigning (say, in Armenia, Tunisia, Albania) to the sides and back of the mosque (roughly, ✠ in four directions instead of ➢ toward the *qibla*). All these directions were, according to Deus, accurately calculated (even though **MODERN** geographical coordinates of border cities were not available to those who built the mosques).

Deus’ goal was to show that the mosques were “monuments of jihad” rather than places of worship, but he could never attain that goal because **all of the mosques actually face the Kaʿba**. To show that, one has to know how people found the *qibla* in historical times, be it by tradition, folk astronomy, or mathematical astronomy. And for that one needs to access the available literature, which Deus takes care not to cite. But even if one is aware of how people used to find the *qibla*, it would be the height of arrogance for us moderns to suppose that we could explain all individual historical mosque orientations.

Again there is a twist. Deus claims that the Ottoman Turks could have calculated the (**MODERN**) direction to Mecca if they had wanted to, but they did not do this. In fact, they could <u>not</u> have calculated the (**MODERN**) direction to Mecca or toward anywhere else (such as a frontier battle-ground in the Crimea). If they had the geographical coordinates of those frontier battle-grounds, which they did not, these would not have been the accurate modern coordinates. Furthermore, the Ottoman astronomers in general favoured approximate mathematical methods for finding the *qibla*, namely, one derived in the 8th century and generally (but wrongly) associated with the astronomer al-Battānī (Raqqa, *ca*. 910), which was widely used for over a thousand years (as opposed to the more cumbersome accurate formulae).

So, for example, Muslim astronomers in al-Andalus favoured this *qibla* method, which yielded a result in error of some 10° compared with the exact formula applied to the same (inaccurate) pre-modern geographical data.

Deus has converted these mosques from places of worship to "monuments of jihad". What he did not know when he wrote his vehement attack on Ottoman mosques, and on Turks and Muslims in general, is that we have

(a) lists of historical *qibla*-values for hundreds of Muslim cities, including more than one Ottoman list, and

(b) details of the ways in which architects laid out new mosques in the *qibla*.

*****

"The overwhelming guiding principle of academia rests on
selective interpretation of traditions and wishful thinking." Deus, p. 31.

Nobody in recorded history ever laid out a mosque in any other direction than the *qibla*. What Muslims might have thought was the *qibla* in their milieu and location and time is up to investigation; historical sources are available. (Yes, in Samarqand the Shāfiʿīs faced south and the Ḥanafīs faced west. Yes, in Cairo the *qibla* was changed from winter sunrise to a mathematically-computed direction. Yes, in Córdoba those who built the Grand Mosque and the legal scholars and the astronomers favoured three different directions.) The intention (النية , *al-nīya*) of Muslims was always to face the Kaʿba, and this they have achieved one way or another for over 1,400 years. It is not without interest to compare the situation in other, related religious traditions where some sacred edifices are aligned toward sunrise at the equinoxes, that is, due east. Or are they? Or are they aligned toward Jerusalem? Or did anybody in the past two millennia ever compile a table of the directions of localities throughout the world toward Jerusalem?

Both Gibson and Deus hoped their ground-breaking 'discoveries' could serve as ammunition in the new crusade against Islam. Their greatest mistake was to play around with data from the one historical civilization that has taken the sacred direction more seriously than any other in world history. They will just have to live with the fact that historical mosques are indeed facing the Kaʿba one way or other, even though neither of them understands how.

*****

Bibliography of recent works misinterpreting historical mosque orientations

Dan Gibson, *Early Islamic Qiblas: A Survey of mosques built between 1AH/ 622 C.E. and 263 AH/876 C.E. (with maps, charts and photographs)*, 296 pp., Vancouver BC: Independent Scholars Press, 2017 (several reviewers, none informed about orientations), and "Qibla Tool" (2018), available at http://thesacredcity.ca/data/index.html.

DAK, "From Petra back to Mecca – From *pibla* back to *qibla*" (2017), available at www.davidaking.academia.edu, also www.muslimheritage.com/article/from-petraback-to-makka, and *idem*, "The Petra fallacy – Early mosques do face the Sacred Kaaba in Mecca but Dan Gibson doesn't know how" (2018), available at www.davidaking.academia.edu.

A. J. Deus, "Monuments of Jihad – The thought process of determining *qibla* orientations by Turks", at www.academia.edu/37688323/ (based on an illusion).

DAK, "The Ottoman mosque fallacy – Places of worship facing the Kaaba or "Monuments of Jihad"? A. J. Deus has got it all hopelessly wrong" (Nov., 2018), available at www.davidaking.academia.edu.