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THE GEOMETRY OF THE QUR'AN OF AMAJUR: A PRELIMINARY STUDY OF PROPORTION IN EARLY ARABIC CALLIGRAPHY

This short study of a Qur'an from the ninth century shows that it is based on numbers revered by the Ancients and reveals a geometric dimension of early Arabic calligraphy that has so far gone unnoticed. Modern scholarship on the subject, which stretches back over two centuries, has until recently focused primarily on letter forms. But the Greeks, probably beginning with Pythagoras, saw a spiritual dimension in certain numbers and the proportions related to them, which they studied in theory and applied in the arts. It appears that three of these proportions are at the basis of the script and layout of the Qur'an of Amajur, dated 262 (876).

The study of early Arabic calligraphy in Europe started in 1780, when J. G. C. Adler published some Qur'anic folios, which he called "coufique" after Arab sources.[1] Since then, a succession of authors has tried to classify early Qur'ans by script and to study Arab texts about them; these authors include de Sacy in the early nineteenth century, Amari in the 1850s, Ahlwardt three decades later, von Karabacek in the early twentieth century, and Bergstrasser in the 1930s. Little by little, they came to terms with such problems as the scarcity of dated items and the difficulty of determining places of origin. Minovi, in addition, investigated forgeries.[2] The method of classification was progressively refined. Bergstrasser imposed a strict palaeographical study of key letters. The generic name "Kufic" came under criticism, first by Amari and then repeatedly, as it became apparent that it encompassed a vast number of angular scripts. Amari introduced another important element in 1857: he discovered the chapter on calligraphy in the *Fihrist* of Ibn al-Nadim, an index of all the knowledge of its time, published in 377 (987–88). In it, Ibn al-Nadim catalogues twenty-six different types of early script. The Meccan and Medinan, he writes, are the two earliest, and he decribes the shape of their *alif*:

> Muhammad ibn Ishaq said: the first Arabic scripts were the Meccan (*makkī*) and after that the Medinan (*madanī*), then the Basran (*baṣrī*), then the Kufan (*kūfī*). As regards the Meccan and Medinan, there is in its *alif*s a bend to the right-hand side, and an elevation of the vertical strokes (*al-aṣābiʿ*, "the fingers"); and in its form, there is a slight inclination.[3]

In the 1940s, Nabia Abbott attempted to identify manuscripts that corresponded to Ibn al-Nadim's description. As she said, she wished to understand "the entire matter of the evolution and classification of scripts as the Moslem scribes and calligraphers themselves saw and understood it." But she did not reach conclusive results. More recently, Estelle Whelan published an article to criticize the study of merely the forms of letters in such scripts.[4] "The position of a given letter," she wrote, "…must be taken into account with its body form."[5] She suggested that such features as format, liturgical divisions, the elongation of the tail of some letters, the width of line spacing, and the regularity of strokes should be considered. This method had the advantage of utilizing more of the information contained in the Qur'ans she considered, but it did not yield significant results. Finally, since the 1980s, François Déroche has been engaged in an effort to classify early Qur'ans systematically by the shape of six pivotal letters.[6] Déroche has rejected the recourse to Arab sources because of their laconism and lack of precise descriptions. He has created six main categories of styles, labelled A to F, with subcategories, e.g., C.III. or F.I. Being something of a table of elements for early scripts, his work already constitutes a standard reference in the field.

Neither he nor his predecessors, however, have considered the proportions of early Qur'anic manuscripts in detail. Déroche is well aware of their potential importance, noting, "The dimensions of the text area indicate that, in some cases at least, the space was constructed according to the rules of geometry…A group of manuscripts in the B.II. style show a strong tendency for the length of the text area to be two-thirds of the width." He adds, "The quotient of the

width divided by the height is 1.5, which is that of the geometric figure known as the double rectangle of Pythagoras."[7] He also notes that "a group of folios in D.III. …have a text area in the form of a double square…and a predilection for the formula $(a) \times (a) \times (\sqrt{3})$ is apparent in folios in E."[8] He suggests that there must be in these Qur'ans a geometry that has never been studied:

> Geometric formulae similar to those set out above were employed in more recent periods, and we can only suppose that they were already in use in the ninth century A.D., even if the texts do not provide any information in this regard. The archaeology of early Qur'ans has revealed two factors that may provide support for this hypothesis. One is the importance of geometry in the preparation of the illumination. The other is the possibility that letter forms were not the only criterion used in defining a particular style of script, for the dimensions of the script seem to have played a role. It therefore seems logical that calligraphers who seem to have established a link between scripts and their dimensions would have widened this concept to take in the page as a whole by defining the written surface in terms of a set of proportions... [Therefore] the calligraphers of the Abbasid period must have been using a form of ruling which has left no visible mark on the parchment.[9]

Déroche's hypothesis is right: there was a geometrical basis to these Qur'ans, beyond what we had imagined.

When the Muslims conquered the Near East in the mid-seventh century, its cities remained largely hellenized; Greek culture also continued to exert a strong influence on the Sasanian empire. Alexandria, in particular, had succeeded Athens as a major scholastic center during the Christian era.[10] How far the Umayyads used the Greek sources of knowledge within their empire is little known, except for some fragmentary indications,[11] but they were concerned with issues of learning, as dictated by the needs of their new faith and state. At an early stage, Abu al-Aswad al-Du'ali (d. 688) codified Arabic grammar and the Arabic script. He is credited with, among other things, the introduction of diacritical marks and their colors, which two of his students made into a uniform system by order of the governor of Iraq, al-Hajjaj b. Yusuf al-Thaqafi (r. ca. 694–714). In the same period, during the reign of ʿAbd al-Malik (685–705), Arabic became the official language of the administration and a distinctive Umayyad coinage appeared. Muslim theology also took shape, to some extent against Christian doctrines of the Holy Trinity. This strong Umayyad policy of forging a distinctive identity, embodied by the language of the Qur'an, might also have included calligraphy.

Under Harun al-Rashid (r. 786–809), Khalil b. Ahmad al-Farhudi (718–91), a lexicographer, phonologist, grammarian, and musicologist, reformed anew the scriptural rules of Arabic. His work superseded that of al-Du'ali. During the same reign, Greek works still available in late antiquity began to be translated extensively, first from Syriac and then directly into Arabic.[12] The caliph al-Ma'mun (r. 814–33) systematically obtained further Greek manuscripts from the Byzantines, and founded the Bayt al-Hikma (House of Wisdom) in Baghdad. Euclid, Plato, Aristotle, Ptolemy, Galen, Plotinus, Proclus, and a wide array of ancient authors and minor commentators were read and studied.[13] Like their Greek predecessors, the learned men of the ninth century were versed in many areas of science but made their own contributions in specific fields. Al-Khwarazmi (ca. 780–850) founded modern algebra. He was probably the first mathematician to systematize a concept derived from Indian sources: the use of zero as a place holder in notation; he also wrote astronomical and geographical treatises.[14] Al-Kindi (801–73), in addition to being the first Muslim philosopher in the Greek tradition, also wrote about arithmetic, geometry, optics, and music.[15] Hunayn ibn Ishaq (808–73) set high philological standards of translation and was also an important mathematician. The Sabian Thabit ibn Qurra (821–901), a scientific translator, mathematician, mechanical theoretician, and astronomer, wrote, among other works, a book on the composition of ratios that applied arithmetical operations to geometrical constructions, a procedure unknown to the Greeks; his conception of numbers followed that of Plato.[16] At least since the time of Mughira (d. 737), a gnostic for whom letters were elements of the body of God, the word had been central to Islamic mysticism.[17] Al-Kindi also used the Qur'anic *ʿilm al-aḥruf* ("science of letters" through numbers) together with astrology to foretell the duration of the Arab empire.[18]

One of the most influential works by Plato in the ninth-century Islamic world was the *Timaeus*, his cosmological dialogue, which seems to have responded to concerns of the age, and which, as in late antiquity, was read perhaps more widely than the *Laws* or the *Republic*.[19] Its summary with numerous quotations by Galen, which is otherwise lost, survives in Hunayn

ibn Ishaq's translation, *Jawāmiʿ kitāb Tīmāūs fī al-ʿilm al-ṭabīʿī*. We also possess part of Hunayn's version of the commentary on the *Timaeus* by Proclus, Yahya ibn ʿAdi's translation of Plutarch's commentary on the same work, and a commentary on Plutarch's commentary by al-Razi.[20] In the *Timaeus* itself, Plato compares letters to physical elements, a comparison directly echoed by passages of the ninth-century alchemical corpus of Jabir ibn Hayyan, as shown by Paul Kraus.[21] Plato's passage about the genesis of the universe is worth quoting at length:

> Now anything that has come to be must be corporeal, visible, and tangible: but nothing can be visible without fire, nor tangible without solidity, and nothing can be solid without earth. So God, when he began to put together the body of the universe, made it of fire and earth. But it is not possible to combine two things properly without a third to act as a bond to hold them together. And the best bond is one that effects the closest unity between itself and the terms it is combining; and this is best done by a continued geometrical proportion. For whenever you have three cube or square numbers with a middle term such that the first term is to it as it is to the third term, and conversely…[22]

The *Timaeus* is the oldest preserved Greek work of cosmology, and like other Greek writers[23] Plato relates the creation of the universe to numbers and proportions, which are a projection of the eternal realm of the Creator onto matter. These proportions rule everything from celestial bodies to the human body. Among other numbers, Plato devotes some attention to 3/2, 4/3, and, in his discussion of triangles, $\sqrt{2}$ and $\sqrt{3}$, values to which the Pythagoreans also attributed deep spiritual meaning.[24] But perhaps most fascinating of all is the Golden Ratio. Like π for the circle, it is the geometrical basis of the pentagon and the decagon. Arithmetically, it is an irrational number, with an infinite, non-repeating series of numbers after the decimal point, approximated by 1.618.[25] Its modern mathematical symbol, ϕ *(phi)*, is the initial of Phidias, the Greek sculptor who, with the architects Ictinos and Callicrates, based the proportions of the Parthenon in Athens upon it. It may have been studied by Pythagoras and was an object of fascination for his followers, whose symbol was a pentagonal star. Its earliest extant mathematical construction is that by Euclid (ca. 325–265 B.C.), in the *Elements*, possibly under Platonic influence.[26] In a brief article, Doron Chen has shown that the Dome of the Rock (built in 692)[27] was based upon ϕ in plan, facade, and elevation.[28] The *Elements* is also among the first Greek works known to have been translated into Arabic, by al-Hajjaj in the late eighth century. [29]

Despite this converging evidence, the sacred numbers of the ancients have hardly ever been studied in modern writings about Islamic art (with the exception mentioned above).[30] We will now show that three of these numbers are used consistently in one of the best documented early Qur'ans, the Qur'an of Amajur.

The Qur'an in question is an oblong manuscript with three lines to the page. At the top of every other page, we can read *awqafahā amājūr* or *waqqafahā amājūr* ("Amajur made it a *waqf*"). Amajur governed Syria for the ʿAbbasids between 870 and 878. His revolt against his masters some time before 873 was repressed by Ibn Tulun, the governor of Egypt, who invaded Damascus in 878 before asserting the autonomy of his own provinces vis-à-vis the caliphs of Samarra.[31]

A *waqf* is the inalienable property of a religious institution. By an extraordinary chance, the *waqfiyya* (deed) of this Qur'an, which gives the details of the legal procedure, has been partly preserved. It states that the manuscript was made a *waqf* in the city of Sur, in modern Lebanon, in 876, without giving the name of the recipient religious institution.[32]

Scattered around the world, at least 251 folios from this Qur'an have survived. Two hundred and forty-two in Istanbul have been published in a short article by Déroche, who also mentions one in Dublin; one in Cairo; one in Cambridge, England; and one possibly in Riyad. A further folio, which was originally published in Tokyo by Kordachi Shirotori, is reproduced in a book on calligraphy by Naji Zayn al-Din. I have found four more: one at Oxford and three in Damascus.[33] Let us look at the double folio from Oxford in more detail (figs. 1 and 2).

Although it is austere in appearance, a closer look reveals a fascinating harmony and rhythm to the script. It is written in thick, brown, angular strokes, and its epigraphy places it in the D.I. category of Déroche's classification.[34] The space between letters within words is as large as that between words. There are no diacritical marks, and vocalization is only partly indicated.[35] Thus, the text can hardly be understood by someone who does not know the Qur'an by heart, which reminds us that these early manuscripts were only written as *aides-mémoire* for the educated reader. *Mashq*, the elongation of letters, is used repeatedly, so that the ductus of each line suggests an invisible

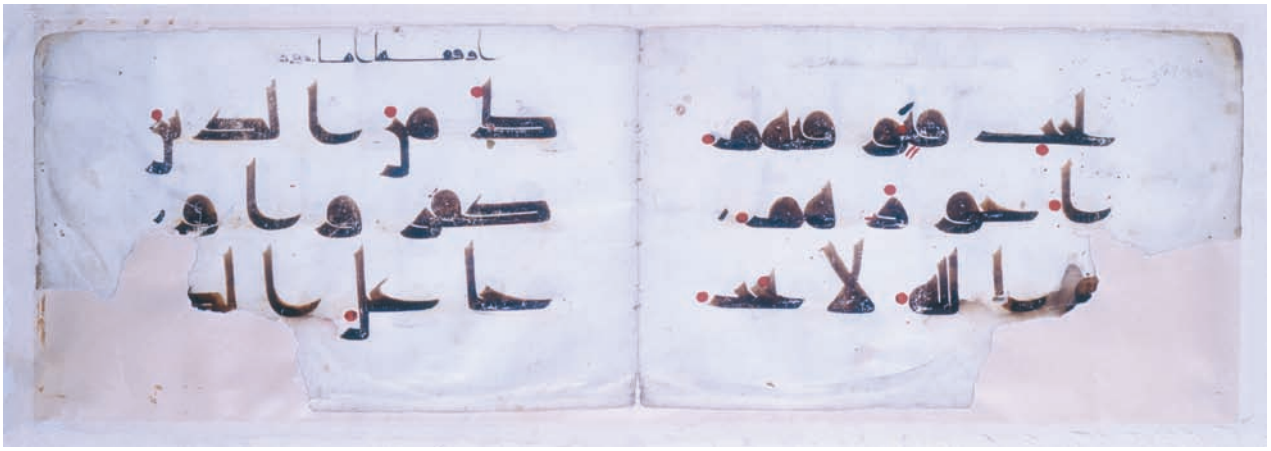

Fig. 1. Double folio from the Amajur Qur'an. Ashmolean Museum, Oxford, EA1996.53, Gift of Ralph Pinder-Wilson. (Photo: courtesy of the Ashmolean Museum)

Fig 2. Second side of a double folio from the Amajur Qur'an. Ashmolean Museum, Oxford, EA1996.53, Gift of Ralph Pinder-Wilson. (Photo: courtesy of the Ashmolean Museum)

ruling, a first element of geometry. Furthermore, the vertical line along which the text begins is so regular that it can almost be seen.[36]

Like the Qur'an of Amajur, most early Qur'ans carry no traces of a grid, although their regularity suggests invisible ruling. I know of only two exceptions. One Qur'an from San'a in the very early *ḥijāzī* script has horizontal rulings, but no traces of vertical ones.[37] Another, later, exception is the so-called Blue Qur'an. Although most of it is unmarked, in at least three of its folios, both the horizontal rulings and the vertical ruling that marks the beginning of the text lines are visible.[38] There is no vertical ruling, on the other hand, to mark the end of the lines (fig. 3). The Blue Qur'an was made either in North Africa in the tenth century or in Mesopotamia in the ninth; in either case, it is a distant cousin of the Qur'an of Amajur, being close to it in both period and epigraphy (its script is D.IV in Déroche's classification).[39]

Thus, after the ductus of the text of the Qur'an of

Fig. 3. Page from the "Blue Qur'an" with visible elements of layout. Collection of Prince Sadruddin Aga Khan. (Photo: after A. Welch and S. C. Welch, *Arts of the Islamic Book*)

Amajur, we can draw a second ruling, at the right of the text area. Let us take this further.

Step 1

We draw two horizontal rulings, which are clearly defined by the letters, below the lower and the middle lines. The space between these two rulings is the same as that between the middle and upper rulings; it is therefore our line spacing. We apply it another time above the upper line. The *waqf* inscription is slightly below this top line and might have been intended to fall right on it.

Step 2

This elementary grid provides the horizontal baselines of the writing. We note, furthermore, that the upper horizontal stroke of the *kāf* and *dāl / dhāl* is perfectly parallel to these baselines. We draw the line thus defined, which also runs through the top of the *nūn*, *rā'*, *ḥā'*, *alif maqṣūra* (short final *alif*), the base of the horn of the *bā'*, *tā'*, and the like, and the point at which the curve of the initial *'ayn / ghayn* turns right (fig. 4).

If we measure the ratio of the height of this ruling *(k)* to the total line height *(h),* we find that it is exactly equal to 1/4, that is to say: $h=4k$. Furthermore,

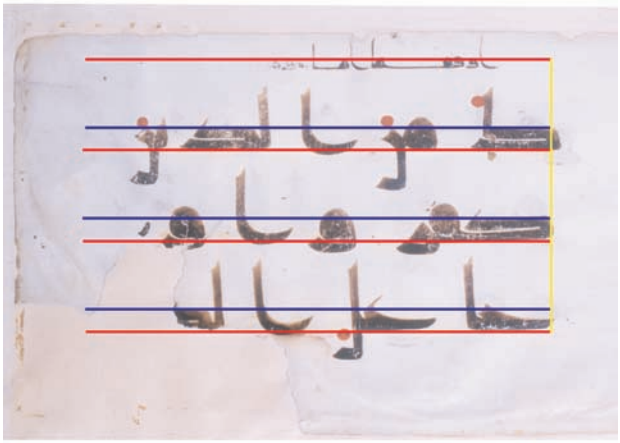

Fig. 4. Half of a double folio from the Amajur Qur'an, Oxford. (Photos for figs. 4–23: courtesy of the Ashmolean Museum)

the height of the body of the *kāf*, which is the basis on which we have defined our second horizontal ruling, is equal to two thicknesses of the pen *(p)*: $k = 2p$, and hence $h = 8p$. The line height is exactly equal to eight thicknesses of the pen. We therefore divide the interline spacing into eight equal rulings, each equal to one thickness of the pen: the grid thus drawn seems to define all the pivotal points of the calligraphy.

2.1 The first ruling defines not only *mashq* (elongation) but also the right tip of the *alif*, the "eye" of the *wāw*, the *mīm* and *lām-alif*, and the upper curve of the final *nūn* (figs. 5–7).

Fig. 5.

Fig. 6.

Fig. 7.

2.2 We have already noted the points that fall on the second ruling.

2.3 On the third ruling are the top of the *mīm*, of the intial *ʿayn / ghayn*, of the *kāf / dāl / dhāl*, and of the *wāw* except where it follows a *fāʾ / qāf*, in which case the *wāw* is on the second ruling. This is likewise true for the top of the horns of the *bāʾ*, *tāʾ*, and the like, except where they are followed by a letter of similar shape, in which case their top is also defined by the second ruling (figs. 8–12).

Fig. 8.

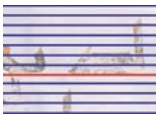

Fig. 9.

Fig. 10.

Fig. 11.

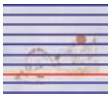

Fig. 12.

2.4 The fourth ruling defines the top of the final *hāʾ*, and some vocalization marks also fall on it. The top of the *fāʾ / qāf* is on the third or fourth ruling, or in between them (fig. 13).

Fig. 13.

2.5 The base of the horn of the *alif*, as well as that of the *lām*, falls on the fifth ruling, and its top is defined by the sixth, except where such letters follow each other, in which case the second is one ruling smaller than the first (figs. 14–16).

Fig. 14.

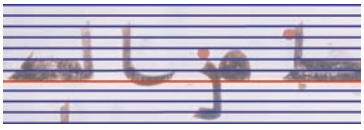

Fig. 15.

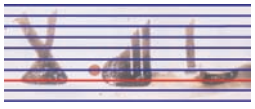

Fig. 16.

2.6 The lower stem of the *nūn* from the line above is also defined by the interval between the fifth and sixth rulings (figs. 17–18).

Fig. 17.

Fig. 18.

2.7 On the seventh ruling are the bases of the *wāw* and of the *rā'* that follows another letter (fig. 19). This ruling is also the baseline of the two *waqf* inscriptions, to which we will return.

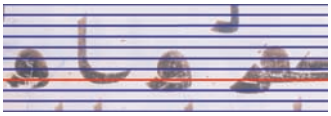

Fig. 19.

2.8 The eighth ruling is the baseline of the line above.

Thus, the height and shape of the letters are precisely defined by the thickness of the pen. A descending movement is noticeable at the top of consecutive letters of the same height. We have noted, furthermore, that the base of the horn of the *alif* is on the fifth ruling. Therefore, the ratio of the height of the line to that of the *alif* is 8/5 = 1.60, which is an extremely close approximation of ϕ on this scale.

Step 3

We try to define the rectangle of the text area. We already know all but one of its elements: its horizontal width. But whereas all letters start along the same vertical ruling, the line endings do not define a similar ruling. To determine it, we try to multiply the height of the text box by ϕ and apply this measurement horizontally: the rectangle thus defined is too long for the lines of text. On the other hand, if we multiply it by √2, the resulting rectangle is too short. This gives us an approximation of the width of the text area : $\sqrt{2} <$ text width $< \phi$. We now try the remaining pivotal value of 3/2 = 1.50. The vertical line ending thus defined might well have been used by our scribes: many vertical stems of final letters run along it, and many of the horizontal finals stop on it (fig. 20).

Step 4

We measure the dimensions of the page. Its edges are in good condition except for missing the outer corners at the bottom. The ratio of width to height is 1.52 on the left side and 1.51 on the right, because the double folio is not folded exactly in the middle. This is an extremely close approximation of 1.50; the variation can be attributed either to the cutting process or to the erosion of the margins over time. (The page should have been 2 mm higher or 3 mm narrower in order to obtain a value of exactly 3/2.)

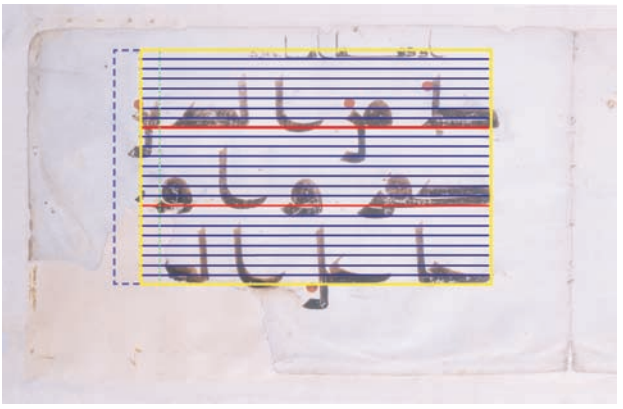

Fig. 20.

Fig. 21.

We also note that the width of the text area is exactly equal to the height of the page and, furthermore, that the text area is centered vertically on the page. The middle of the page falls on the ruling above the middle baseline of text. Likewise, horizontally, the width of the inner margin is equal to the height of a line, except on one of the pages, where there is a variation of about the thickness of the pen. On another page, the upper line of calligraphy is written one interline below its expected position (fig. 21).[40] All these slight variations in text box position, page area, and use of the interlines appear as a natural result of the process of writing.

To avoid leaving traces of rulings, a calligrapher might have placed the page on a wooden frame with thin strings corresponding to the rulings, as was done in later calligraphy. But this should have left faint marks, and they are very rare in early Qur'an manuscripts. The calligrapher(s) of the Amajur Qur'an might have made use of the transparency of its thin parchment. Whatever the method, there must have been a template grid that was placed under the page before writing. This implies moving the grid from page to page very often, given that each page has fewer than ten words. Hence slight variations in position would have been inevitable. Furthermore, with

Fig. 22.

an underlying grid, the difference between the baseline of writing and the next interline could easily have been missed, which might explain why one line of text is too low and why the *waqf* inscription is one interline below the frame of the text box, rather than on it (fig. 22).

To summarize, let us reconstruct the page geometrically. First, we draw eight horizontal lines one atop the last and separated from it by the thickness of the pen. Having thus obtained the line height, we add two more lines. By multiplying their total height by 1.50 and applying this measurement horizontally, we get the width of the text area, which is also the height of the page. By multiplying the height of the page by 1.50, we get its width. Finally, the position of the text within the page is defined vertically by placing the middle baseline of calligraphy on the middle of the page; it is defined horizontally by placing the text area one line height away from the central fold (figs. 23 and 24).

Let us now consider as a group the six published pages from Qurʾan of Amajur. We will give them the following denominations : *O* for the Oxford folio, *T* for the folio originally published in Tokyo; *D* and *D′* for the folios of Qurʾanic text from Istanbul; and finally, *W* for the *waqfiyya* and *I* for the illuminated page. *T* is from Qurʾan 2 (*al-Baqara*): 19; *O* is from 3 (*Āl ʿImrān*): 55 on one side, and 3: 57 on the other;[41] *D′* is from 6 (*al-Anʿām*): 104; and *D* from 58 (*al-Mujādila*): 11. *W* was inserted in the main text, at the end of the third *juzʾ* of *Āl ʿImrān* (3: 91).[42] The position of folio *I* is not mentioned by Déroche. He notes, on the other hand, that of the Istanbul folios, all up to sura 6 carry the inscription *awqafahā amājūr*, which thereafter becomes *waqqafahā amājūr*.[43] This is supported by *O* and *T*, the texts of which are both prior to sura 6 and carry the former inscription.

At first glance, the six folios look different in their balance of black and white and in their slightly different scripts. As it turns out, they also have slightly different proportions. The *waqfiyya (W)* has eight lines of text, and its script is not proportioned. On the other hand, its text area is laid out with a proportion of 3/2.[44]

In the page of illumination *(I)*, the relative position of the colophon and *waqf* inscription is defined by a Golden Rectangle. The four pages of sacred text *(O, D, D′*, and *T)* have the same eightfold interline spacing, with an *alif* proportion of ϕ. In *D′*, the *lām* in *ʿalaykum* is one interline higher than the others, on the sixth interline. In *D* and *D′*, the text area has

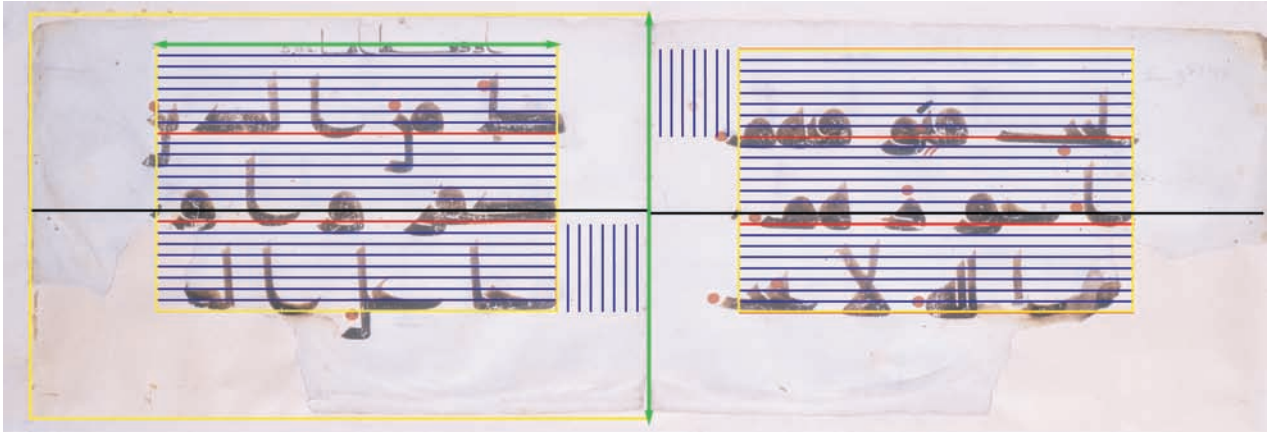

Fig. 23.

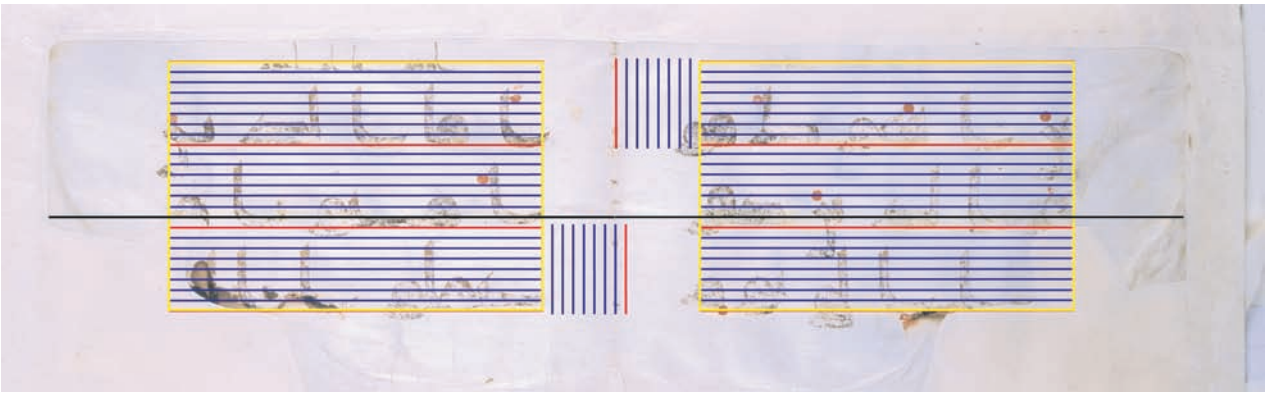

Fig. 24. The second side of the Ashmolean double folio is incomplete, and a modern paper frame hides its margins. (Photo: courtesy of the Ashmolean Museum)

a proportion of √2. In *D*, the *waqf* inscription is on the frame thus defined, but in *D′* it is one interline below it and not even straight. The entire *D* page is not visible in Déroche's publication. Although in poor condition, the edges of *D′* are. As in *O,* the page proportion is 3/2, and the text area has a width equal to the height of the page and is centered vertically on the page, one ruling above the middle baseline of text. But horizontally it is only three-quarters of a line-height from the central fold. In the page from Zayn al-Din's publication *(T)*, as in the Oxford folio *(O)*, the text area has a proportion of 3/2. The *waqf* inscription is slightly above it. The whole *T* page is not visible (figs. 25–29).

In sum, in five of the folios, the *waqf* inscription comes either at the top of the text area *(I, T*, and *D)* or one interline below it *(O* and *D′)*. The sixth folio *(W)*, being the *waqfiyya* itself, does not carry this

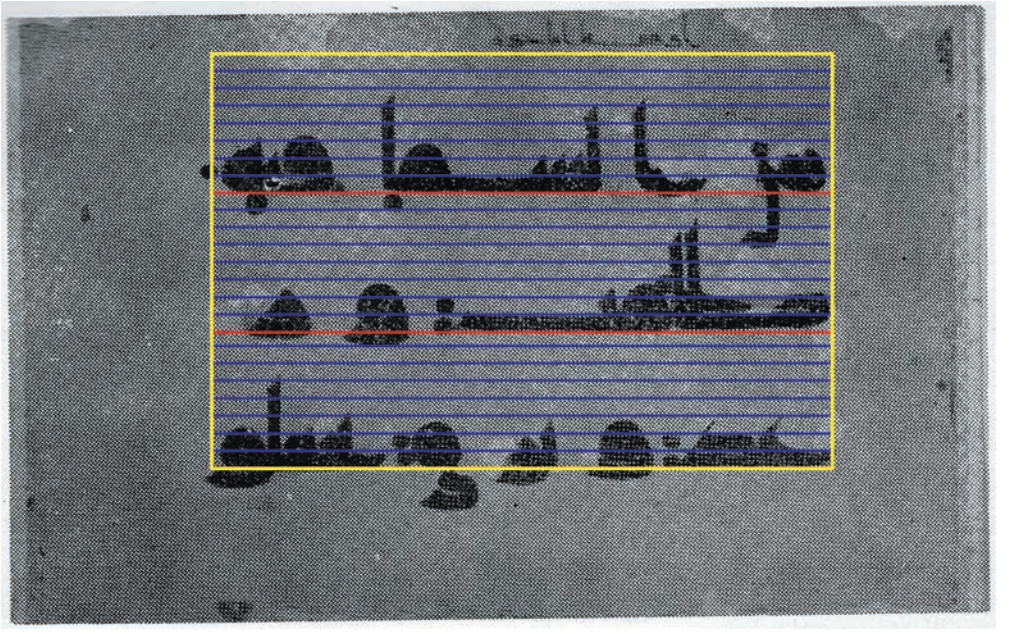

Fig. 25. Folio T (Qur'an 2: 19), present whereabouts (possibly Tokyo) unknown. (Photo: after Naji Zayn al-Din, *Muṣawwar al-khaṭṭ al-ʿArabī*)

Fig. 26. Folio *W*, the *waqfiyya*. The cursive calligraphy above the main text is probably a later addition. (Photo: after Déroche, "The Qur'ān of Amājūr")

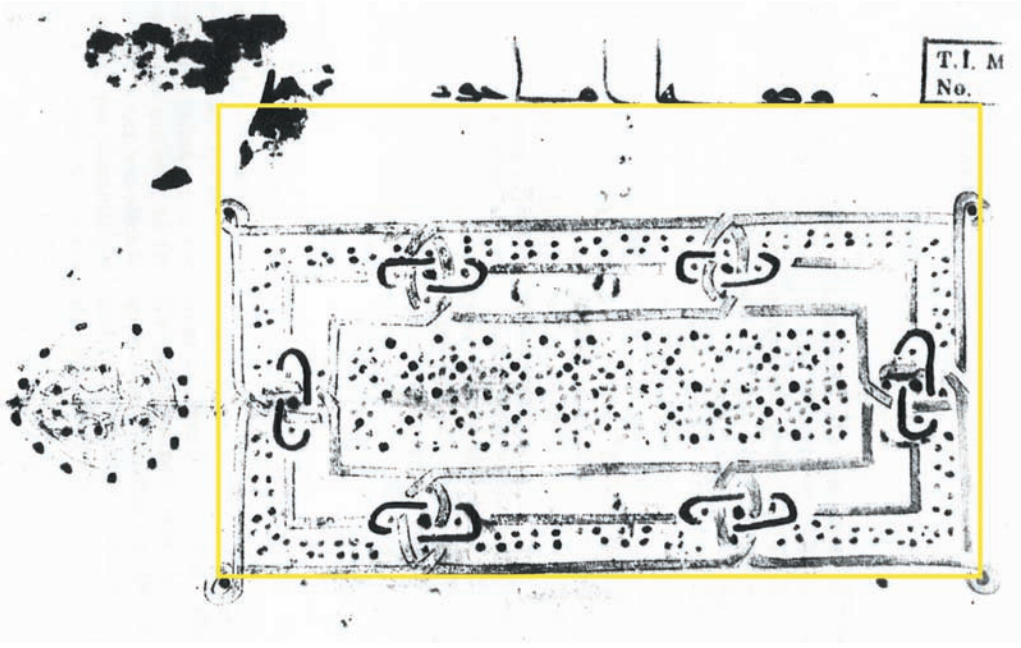

Fig. 27. Folio *I*, an illuminated page. (Photo: after Déroche, "The Qur'ān of Amājūr")

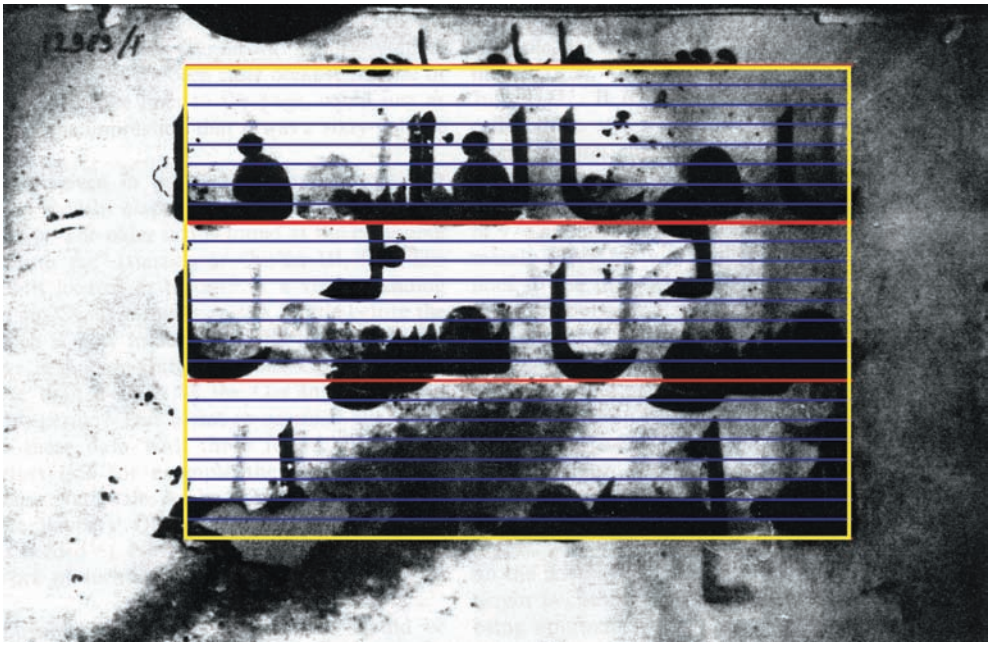

Fig. 28. Folio *D* (Qur'an 58: 11). (Photo: after Déroche, "The Qur'ān of Amājūr")

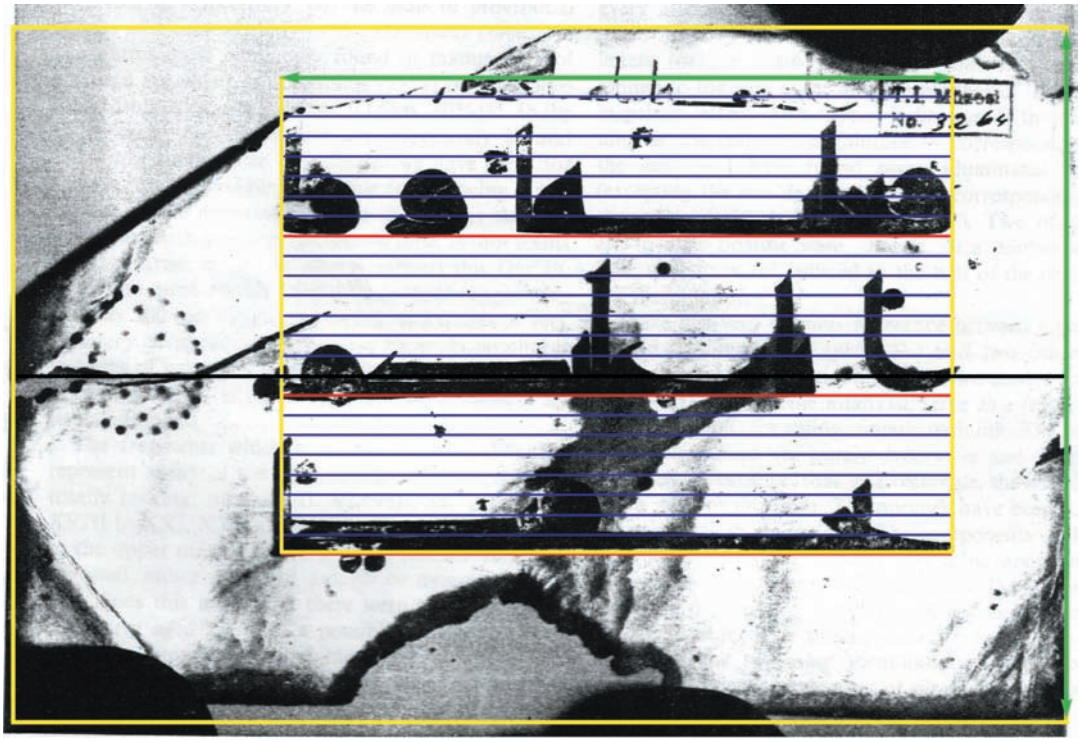

Fig. 29. Folio *D′* (Qur'an 6: 104). (Photo: after Déroche, "The Qur'ān of Amājūr")

mention. In all the pages of sacred text *(O, T, D,* and *D′)*, the calligraphy is proportioned on the same eightfold interline spacing, although, surprisingly, there are notable variations among the text areas. It is clear, however, that all these folios were proportioned on key values: the geometrical construction of the *alif*, the letters, and the page is exactly the same throughout. Furthermore, we see our results confirmed by other early Qurʾans. Almost all the 750 published early Qurʾans that I am in the process of analyzing have a geometric grid.[45]

Like the proportions, the epigraphy varies among these folios. In *D* and *T*, the space between words is less than in *O;* and in *D mashq* is hardly used, which gives a more condensed overall appearance to the page.[46] In terms of letter shapes, however, these three folios—*O, D,* and *T*—are similar. But in folio *D′* the line is thinner than in the others; furthermore, notably in the sharp angles at the bases of the *alif*s and *kāf*s, its script sets it apart from the three other folios. *Mashq* is used extensively, so that there are only six, rather than ten, words to the page. *D′* may be the work of a copyist other than the scribe of *O, T,* and *D*.

Finally, the *waqfiyya (W)* is not calligraphy *per se*. As Déroche has noted, the ductus of its *nūns* and the bend to the right of the upper shaft of its *alif*s are markedly different from the rest of the text.[47] Its unproportioned script is written with less care and on a smaller scale. It is probably by another hand than the rest of the text.[48]

The table below summarizes these results:

Fragment	*O*	*T*	*D*	*D′*	*W*	*I*
Epigraphy (variation within the D.I. category)	A	A, but more condensed	A, with less elongation	B	C	N/A*
Alif proportion	ϕ	ϕ	ϕ	ϕ	None	N/A*
Text area proportion (or equivalent)	3/2	3/2	√2	√2	3/2	ϕ
Page proportion	3/2	N/A*	N/A*	3/2	N/A*	N/A*
Waqf inscription	*awqafahā*	*awqafahā*	*waqqafahā*	*awqafahā*	N/A*	*waqqafahā*
Sura or position in the manuscript	3: 55 and 3: 57	2: 19	58: 11	6: 104	3: 91	N/A*

* Not available

How do we account for these variations? Could these leaves be from different manuscripts all dating back to the governorship of Amajur? This is unlikely. All the pages that have been measured *(O, D, D′, W,* and *I)* are the same size (approximately 125 x 195 mm). They are almost the only folios among all published early Qurʾans (about 750) with three lines to the page. Furthermore, there are no repetitions among them; all are from different parts of the Qurʾan. Folio *D* is from the last fifth; *D′* from the second fifth; *O* and *T* are from separate sections within the first fifth. These four folios have fewer than ten words to the page. Given that quires in ninety percent of all manuscripts from the same period comprise ten folios—fewer than 400 words in our Qurʾan[50]—*O, T, D,* and *D′* must have each been in a different quire. Although *O* and *W* are close to each other in the Qurʾan (3: 55–57 and 3: 91), they cannot have been in the same quire, since 400 words after the end of 3: 57, we are still only at 3: 81. In short, the six folios under study are from the same manuscript, and five of them certainly belonged to separate quires (I do not possess the relevant information about the sixth folio, *I*).

Déroche was surprised to find that the two surviving *waqfiyya*s, which are respectively dated Shaʿban and Ramadan 262, i.e., one month apart in 876, were at different ends of the manuscript, respectively at suras 3: 91 and 20: 114; did this mean that more than a third of the Qurʾan was copied during this period?[51] From the epigraphical evidence mentioned above, he concluded that there might have been a separate copyist for the *waqfiyya*s and the associated double pages of illumination.[52] Our evidence in addition suggests that, to gain time, the production of this Qurʾan was divided among several persons, hence resulting in the variations among its folios. First, even where they are too low, the *waqf* inscriptions follow the grid, so they were certainly written together with the calligraphy. It is in this case remarkable to find the *waqf* inscription written as two forms of the same verb, with the same meaning. This seems to reflect a distortion of the order given by the governor: in Arabic, *awqafahā* becomes *waqqafahā* simply by removing the initial *alif*—a difference that might suggest the hand of more than one copyist. Second, the variations in proportion bring us to the level of production: how to explain that calligraphers preparing a single manuscript in one place would use notably different text areas? There was, in all likelihood, more than one copyist involved in preparing these six folios, and maybe more than one group or even atelier of copyists. More detailed conclusions will have to

await the study of further leaves from the same manuscript.

Finally, since the *waqf* inscriptions were written together with the calligraphy, and since the *waqfiyya* has a proportioned text area like that of the rest of the manuscript, none of these were additions to a text written earlier. The Qur'an of Amajur can therefore be dated to the period immediately before 876.

In the reform of calligraphy, attributed by later Muslim historians to Ibn Muqla (886–940), the height of the *alif* was defined by the thickness of the pen, and thereupon all other letters followed.[53] Thus were set the geometrical rules of the cursive script that, within a few centuries, largely replaced Kufic. It has hitherto been assumed that it was at this moment that the geometry of Arabic calligraphy was systematically codified. But in the Qur'an of Amajur (876), the thickness of the pen defines the height of all the letters on the basis of the Golden Ratio. Thereupon, by successive geometrical steps, the whole page is constructed. A comprehensive geometry was therefore introduced into calligraphy before Ibn Muqla, which might well have remained the basis of his reformed script.[54] In a forthcoming study, I hope to show that, with different degrees of elaboration, almost all early Kufic Qur'ans were proportioned around seven key values: $\sqrt{\phi}$, 4/3, $\sqrt{2}$, 3/2, ϕ, 5/3, and $\sqrt{3}$. The architecture and stonework of the Umayyads, and what little is left from the Abbasids, may offer other surprises. But most of all, early Arabic calligraphy seems to pose a fascinating question: why did the Muslims choose numbers and proportions, the cornerstone of the universe for the Ancients, to write the word of God?

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NOTES

Author's note: I wish to thank Dr. Jeremy Johns, Dr. Julian Raby, Prof. James Allen, Prof. Richard Sorabji, Ms. Mariam Rosser-Owen, and Ms. Hiba Nasser for their help and advice during the preparation of this paper.

1. The information in this paragraph is derived from François Déroche, "Les écritures coraniques anciennes: Bilan et perspectives," *Revue des études islamiques* 48, 2 (1980): 207–24.
2. About Minovi, see Nabia Abbott, "Arabic Palaeography," *Ars Islamica* 8 (1941): 72.
3. *Qāla Muḥammad bin Isḥāq: fa awwal al-khuṭūṭ al-ʿarabiyya al-khaṭṭ al-makkī wa baʿdahu al-madanī thumma al-baṣrī thumma al-kūfī fa-ammā al-makkī wa-al-madanī fa-fī alifātihi taʿwīj ilā yamanat al-yad wa-aʿlā' al-aṣābiʿ wa-fī shaklihi inḍijāʿ yasīr.* He adds: *wa-hādhā mithāluhu: Bismillāh al-raḥmān al-raḥīm* ("and here is an example: In the name of God, the Clement, the Merciful"). From Ibn al-Nadim, *Al-Fihrist,* collated by Yusuf ʿAli Tawil (Beirut: Dār al-Kutub al-ʿIlmiyya, 2002). In surviving manuscripts of the *Fihrist,* the formula is thereafter written in calligraphy. Unfortunately, these examples cannot be taken as illustrations of the *makkī* and *madanī* scripts: they are always written in a cursive script, in the same hand as the rest of the text, and above all they do not correspond to the description that precedes them in the *Fihrist.* See Adolf Grohmann, "The Problem of Dating Early Qur'ans," *Der Islam* 33 (1958): 213–31, particularly pp. 219–21.
4. Estelle Whelan, "Writing the Word of God: Some Early Qur'an Manuscripts and Their Milieux, Part I," *Ars Orientalis* 20 (1990): 113–47.
5. Ibid., p. 115.
6. The independent and final forms of the *alif;* the medial form of the *ʿayn / ghayn;* the final form of the *mīm;* the final form of the *nūn;* and the medial form of the *hā'*; see François Déroche, *The Abbasid Tradition: Qur'ans of the Eighth to Tenth Centuries A.D.*, vol. 1 of *The Nasser D. Khalili Collection of Islamic Art*, ed. Julian Raby, London, 1992, p. 15.
7. Déroche, *Abbasid Tradition,* p. 20.
8. Ibid., p. 21.
9. Ibid.
10. Alexandria witnessed a fruitful tension between the philosophical tradition of the Greeks, which formed a sort of natural theology, and the monotheism that gradually became dominant. Such masters as the astronomer Ptolemy (mid-second century); the physician, philologist, and philosopher Galen (ca. 129–210); and the pagan founder of Neoplatonism Plotinus (201–74) lived there along with a number of lesser figures and minor commentators. The School of Athens, the other great center of learning in the late-antique Greek tradition, was closed in 529 by the Roman emperor Justinian.
11. According to Ibn al-Nadim's *Fihrist,* Greek and Coptic alchemical writings were translated by a "group of Greek philosophers who resided in the capital of Egypt" at the request of the Umayyad prince Khalid, a son of the caliph Yazid (r. 680–83). "This," he adds, "was the first translation from a foreign language in Islam." See Franz Rosenthal, *The Classical Heritage in Islam* (London: Routledge and Kegan Paul, 1975), p. 47. Rosenthal (ibid.) doubts another hypothesis suggesting that Masarjawayh translated Ahrun's Syriac medical encyclopedia in the early eighth century. Theses in favor of a strong Umayyad translation movement have been made by M. Grignaschi, *Bulletin d'études orientales de l'Institut français de Damas* 19 (1965–66): 1–83, and F. Sezgin, *Geschichte des arabischen Schrifttums,* vols. 1 and 2 (Leiden: E. J. Brill, 1967).
12. Most learned Muslims did not know Greek, and the translators were mainly Christians from the Nestorian and Jacobite minorities; Hunayn ibn Ishaq, for example, was a Nestorian. See Rosenthal, *Classical Heritage,* chap. 2, and Richard Walzer, *Greek into Arabic* (Oxford: Oxford University Press, 1962), pp. 6–8.
13. As in late antiquity, Aristotle was the most studied philoso-

pher, both directly and through commentaries (see note 23 below for his treatment of proportion). In 827, al-Hajjaj completed a translation (from a Syriac version) of Ptolemy's astronomical treatise, which he titled *Kitāb al-Majisṭī* (*Almagest,* in Latin). See *The Encyclopaedia of Islam,* 2d ed., s.v. "Ḥadj djādj." According to Ibn al-Qifti (12th c.), it was translated by Khalid ibn Barmak, Hunayn ibn Ishaq, and Thabit ibn Qurra (Rosenthal, *Classical Heritage*, pp. 30–33). Ibn al-Qifti also writes that no one after him would have dared compose a work like it. Galen's philosophy is mainly known today through its Arabic translations, notably those by Hunayn ibn Ishaq. Plotinus's influence on Islamic art is well illustrated by Gülru Neçipoğlu, *The Topkapi Scroll: Geometry and Ornament in Islamic Architecture* (Santa Monica: Getty Center for the History of Art and the Humanities, 1995).

14. These biographical elements are derived from the remarkable on-line archive compiled by Saint Andrews University in Scotland: J. J. O'Connor and E. F. Robertson, *Abu Jaʿfar Muhammad ibn Musa Al-Khwarizmi*, History of Mathematics Archive, Saint Andrews University (URL: http://www-history.mcs.st-andrews.ac.uk/history).
15. Musicology, in the early Islamic world, could have been related to calligraphy. As in antiquity, it was both a science of proportion, highly revered as a discipline, and a branch of mathematics, like astronomy and geometry but closely connected to philosophy. According to Ahmad ibn al-Tayyib al-Sarakhsi (d. 899), a student of al-Kindi, "the study of numerical relationships between percussing and percussed bodies began with the story of [Pythagoras]." Its aim was to find "harmonious proportional relationships" between them. He adds, "It is the view of the philosophers that it is always to be regarded as nobler than all other mathematical sciences" (Rosenthal, *Classical Heritage*, p. 225).
16. J. J. O'Connor and E. F. Robertson (1999), *Al-Sabi Thabit ibn Qurra al-Harrani*, History of Mathematics Archive, Saint Andrews University (address in note 14 above). See also Rosenthal, *Classical Heritage;* Walzer, *Greek into Arabic;* and Henri Corbin, *Histoire de la philosophie islamique* (Paris: Gallimard, 1986).
17. Corbin, *Histoire,* p. 117. The borders between ancient and Muslim disciplines were easily crossed. For example, Abu al-Qasim al-Junayd (d. 909), a seminal Sufi, had also received a scholastic education in the traditional sciences from a great Baghdadi scholar, Abu Thawr al-Kalbi (ibid., p. 271). According to al-Hamdani (d. 1131), "the word Sufi only began to spread in the third [ninth] century, and the first person to be called by that name was ʿAbdak al-Sufi (d. 825)" in Baghdad (ibid., p. 265).
18. Walzer, *Greek into Arabic*, p. 15.
19. Ibid., pp. 5–6, and Rosenthal, *Classical Heritage,* p. 41.
20. Richard Walzer, "Aflāṭūn" *Encyclopaedia of Islam*, 2d. ed.
21. Paul Kraus, *Jābir ibn Ḥayyān: Contribution à l'histoire des idées scientifiques dans l'Islam* (Cairo: Institut français d'archéologie orientale, 1943). Kraus also relates Jabir's philosophy of language to Plato's *Cratylus*. His *Kitāb al-Mawāzīn* ("Book of Balances") was the pinnacle of his works; for Corbin, the *mawāzīn* symbolize the search for the balance between *bāṭin* (the esoteric) and *ẓāhir* (the exoteric) in the realms of matter and spirit, leading to their transmutation. Jabir, Corbin notes, regarded the *mīzān al-aḥruf* (balance of letters) as the most perfect of all. Corbin, *Histoire,* pp. 189–93 and 209.
22. *Timaeus*, 31–32, in Plato, *Timaeus and Critias,* trans. Sir Desmond Lee (London: Penguin, 1977).
23. Aristotle in particular used these notions in his treatment of color; see R. Sorabji, "Aristotle, Mathematics, and Colour," *The Classical Quarterly* 22, 2 (1972): 293–308. He criticized the Pythagoreans of his period for their reverence for numbers; to him, ratios were of a superior nature (*Metaphysics*, 1092, b8).
24. Plato, *Timaeus*, 36 and 54.
25. Its exact numerical value, in modern arithmetical terms, is $(\sqrt{5}+1)/2$. But beyond a fixed proportion, the Golden Ratio governs patterns of growth, expressed geometrically by the Greeks in the axiom, "A line should be divided into two unequal parts, of which the first is to the second as the second is to the whole."
26. In his *Commentary on Euclid*, the principal source on the early history of Greek geometry, Proclus (5th c.) writes that Euclid "was a Platonist, being in sympathy with this philosophy, whence he made the end of the whole *Elements* the construction of the so-called Platonic figures." The mathematical study of the Golden Ratio may have been suggested by Plato himself to his student Eudoxus, who was an influence on Euclid.[26] Eudoxus, Proclus writes, "multiplied the number of propositions concerning the section which had their origin in Plato, employing the method of analysis for their solution." The "section" in question has been interpreted by modern historians of mathematics as being the Golden Ratio. Proclus Diadochus is considered to be the last great Greek philosopher, but he was also a mathematician. Quotations from J. J. O'Connor and E. F. Robertson, *The Golden Ratio,* History of Mathematics Archive, Saint Andrews University (address in note 14 above), 2001.
27. According to an inscription, which does not mention whether construction began or ended at this date.
28. Doron Chen, "The Design of the Dome of the Rock in Jerusalem," *Palestine Exploration Quarterly* (Jan.–June 1980): 41–50.
29. Al-Hajjaj's translation was reworked by Thabit ibn Qurra and commented on by al-Nayrizi in the ninth century; see *Encyclopaedia of Islam,* 2d. ed., s.v. "Ḥadj djādj."
30. Another exception is A. Fernández-Puertas, *The Alhambra* (London: Saqi, 1997), where the author finds several of these proportions in the ground plan and facade of the Alhambra in Spain.
31. Damascus was the capital of the Syrian province; interestingly, the caliph al-Mutawakkil transferred the ʿAbbasid capital there in 858, but chose to return to Samarra after 38 days (*The Encyclopaedia of Islam*, "Dimashq" and "Ibn Ṭūlūn").
32. François Déroche, "The Qurʾān of Amājūr," in *Manuscripts of the Middle East* 5 (1990–91): 59–66.
33. Istanbul: Museum of Turkish and Islamic Art; Dublin: Chester Beatty Library; Cairo: former Khedivial Library; Riyad: King Faysal Center (see Déroche, "Qurʾān of Amājūr," p. 59 and note 7, p. 65); Tokyo: fig. 20c from Naji Zayn al-Din, *Muṣawwar al-khaṭṭ al-ʿArabī* (Baghdad: Al-Majmaʿ al-ʿIlmī al-ʿIrāqī, 1968), with reference to Kordachi Shirotori, *The Islamic Orient,* which I have not managed to trace; Oxford: Ashmolean Museum; Damascus: Museum of Calligraphy. The Oxford folio is Ashmolean Museum EA1996.53, Gift of Ralph Pinder-Wilson.
34. The *alif* has a crescent-shaped lower extremity; the upper end finishes in a bevel. In the middle of a word, the *ʿayn*

has an open upper end; the right-hand stroke is vertical, but on the left it is oblique. When it is at the beginning of a syllable, there is a break in writing between the upper and lower parts of the letter, as if a stroke had been added to a *jīm*. The *mīm* has a flat base ending with a horizontal tail; its rounded shape tends towards that of a triangle; the "eye" at its center is a tiny dot (as in the *hā'* and *wāw*). The upper end of the *nūn* is slightly thicker than the rest of the body of the letter; the lower end is a short stroke parallel to the base; between them is a vertical stroke. In the *lām-alif*, the right-hand stem is slightly curved and thinner than the left; the "eye" at the base is very narrow, and the base is flat with rounded corners. See Déroche, "Qur'ān of Amājūr," p. 59.

35. Vocalization is indicated by red dots. On all *alif*s carrying a *hamza*, they are on the line for the *ḍamma*, at the top of the stem, left or right, for the *fatḥa*, and below the line for the *kasra*. On the other letters for which the vocalization is indicated, such as the final *nūn*, the red dots indicate a *fatḥa* if above the line, a *ḍamma* if on the line, and a *kasra* if below.
36. Whelan, "Writing the Word," p. 115, mentioned in a general note about Kufic scripts that "the sloping, sagging, and bulging of the written lines on most early Qur'an pages are visible to the naked eye and even more apparent when a straight-edge is applied along the base lines. Even the right-hand margins are rarely perfectly straight. Clearly, then, the scribe most often wrote "freehand," relying upon his "eye" to assemble his text of the page." While this is true of one of the manuscripts that she published, the Qur'an of Amajur contradicts these two points. As the catalog that I intend to publish will show, most early Qur'ans have straight baselines, although the right-hand margins are often less regular.
37. Published in *Maṣāḥif Ṣanʿā: Catalogue of an Exhibition at the Kuwait National Museum* (Kuwait, Dar al-Athar al-Islamiyya, 1985), p. 85 of the Arabic side of the book.
38. One folio with visible rulings is in the collection of Prince Sadruddin Aga Khan; see Anthony Welch and Stuart Cary Welch, *Arts of the Islamic Book: The Collection of Prince Sadruddin Aga Khan* (London: Cornell University Press, 1982), p. 21; another is in the Nasser D. Khalili collection; see Déroche, *The Abbasid Tradition,* fig. 42, folio 2a; a third folio was sold at an auction at Sotheby's, London (October 15, 1997), cat. Lot 6.
39. For the origins of the Blue Qur'an, see Jonathan Bloom, "The Blue Koran: An Early Fatimid Manuscript from the Maghrib," in *Les manuscrits du Moyen-Orient, essais de codicologie et paléographie, actes du Colloque d'Istanbul, 26–29 mai 1986,* ed. F. Déroche (Istanbul: Institut français d'études anatoliennes), 1989.
40. The fact that it is written exactly on this line confirms the existence of the interlines.
41. There must have been one double folio of Qur'anic text above the Oxford folio in the original quire. Since the average number of letters per line is about nine, the 108 letters between the separate Qur'anic passages in this folio correspond to twelve lines, i.e., one double folio.
42. Déroche, "Qur'ān of Amājūr," p. 61.
43. Ibid., p. 64.
44. Horizontally, the beginning of the line seems less regular than its end because of the right stems of the two *alif*s at the bottom. However, the initial letters of the six preceding lines clearly suggest an invisible vertical ruling.
45. Their text area and page are always proportioned upon key numbers, but the degree to which their script is proportioned varies.
46. Elongation seems to have been preferred to contraction in early Qur'ans since, although it consumes more parchment, it was widely used (Whelan, "Writing the Word," p. 114).
47. Déroche, "Qur'ān of Amājūr," p. 61.
48. As Déroche has already mentioned, ibid.
49. Ibid., p. 61.
50. Ibid., pp. 59–61.
51. Ibid.
52. The role of Ibn Muqla himself is not certain. Abu ʿAli ibn Muqla, whose dates are mentioned in the main text, was an Abbasid vizier, but the reform of the script is variously attributed to him or to his lesser-known brother, Abu ʿAbdallah. Contemporary sources (Ibn ʿAbd Rabbuh, d. 940; Suli, d. 946; and Ibn al-Nadim, d. ca. 995) mention only that the two brothers were fine calligraphers, and it is from the time of Abu Talib al-Mubarak ibn al-Mubarak (d. 1189) that we find the reform attributed to either of them. See Nadia Abbott, "The Contribution of Ibn Muklah to the North-Arabic Script," *American Journal of Semitic Languages and Literature* 56 (1939): 72–74.
53. A few preliminary measurements of Qur'ans in the reformed script suggest that the geometry of Kufic and cursive scripts is fundamentally similar, proceeding from letter to text area to page, and being based on the same key numbers. For example, in the famous Qur'an of Ibn al-Bawwab (finished in Baghdad in 1000–1), the proportion of the text box is the same as that of the *alif*: 3/2; it has not been possible to measure the page proportion at this stage. A sixfold interline spacing seems to define the top, bottom, and curves of the letters, although this is less clear cut than in the case of the Kufic script and can only be confirmed by further evidence.