The Archimedes Palimpsest edited by Reviel Netz, William Noel, Natalie Tchernetska, and Nigel Wilson

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The book is an outcome of the project of reading with modern techniques the so-called 'Archimedean palimpsest' (= Codex C), a prayer-book or εὐχο-λόγιον retaining beneath its surface-text some writings of Archimedes and Hyperides as well as portions of a commentary on Aristotle's *Categories*. The Archimedean texts were identified and read for the first time when the Danish scholar J. L. Heiberg first inspected the palimpsest in Istanbul in summer of 1906; the non-Archimedean fragments have been identified in the earlier stages of this project. After Heiberg's travels to Istanbul, Codex C was stolen and underwent several vicissitudes until it was recovered and then acquired by an anonymous collector at an auction in 1998. It is now located with the owner.

The importance of the palimpsest can be understood immediately if one looks at the Archimedean manuscript tradition. This tradition, for most of the treatises, derives from three independent sources:

(a) the 10th century Codex C standing alone, the subject of the book under review;
(b) the lost Codex A, which can be reconstructed from a series of apographs of it that were made between *ca.* 1455 and 1 January 1544;
(c) the Latin translation of William of Moerbeke, achieved *ca.* 31 December 1269 and based partly on Codex A and, most importantly, partly on a further Archimedean exemplar, Codex B, last heard of in 1311.

Therefore, only Codex C has survived among the Archimedean manuscripts written before the 13th century, while the texts contained in Codex A and B can only be reconstructed by standard philological methods. What is more, the palimpsest is our unique source for two Archimedean treatises: the

Stomachion (of which, however, only a short fragment remains) and the celebrated *Method*, addressed to the distinguished Alexandrian scholar Eratosthenes. Codex C contains also an almost complete Greek text of *On Floating Bodies*, which otherwise can only be read in William of Moerbeke's translation. It was on account of this new evidence that Heiberg published in 1910–1915 a critical edition of Archimedes' *Opera omnia* which replaced his earlier edition of 1880–1881 [cf. 1907].

The book under review is the 'official' outcome in print of the project of restoring, conserving, and reading the palimpsest with modern techniques, a project that was developed at the Walters Art Museum in Baltimore where the palimpsest was located until recently. The result of this renewed reading is a series of digitally-processed images of the leaves of the manuscript, which are stored on the palimpsest website [http://www.archimedespalimpsest.org/]. These images can be downloaded freely and are also reproduced in the book.

After an introduction by William Noel, who was apparently the driving force of the whole project, volume 1 is divided into five parts:

- ○ a detailed codicological description of the manuscript;[1]
- ○ the history of the codex from the making of the εὐχολόγιον to Heiberg's travels to Istanbul to read the Archimedean texts;[2]
- ○ a monothematic section by Abigail Quandt on 'Conserving the Archimedes Palimpsest';
- ○ descriptions of the image-processing and organization of the data mounted on the palimpsest website;[3] and
- ○ a presentation of the texts.[4]

Volume 2 contains digitally-processed images of (almost) all leaves of the palimpsest (either recto or verso of a single folio in one single image) with

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[1] This part was collectively authored by 'Abigail Quandt and the editors', assisted by S. Lucà, S. Parenti, and J. Lowden.

[2] In succession: 'The Making of the Euchologion' by A. Quandt, 'The Strange and Eventful History of the Archimedes Palimpsest' by J. Lowden, and '*Itinera Archimedea*: On Heiberg in Constantinople and Archimedes in Copenhagen' by E. Petersen.

[3] In succession: 'Imaging and Image-Processing Techniques' by W. A. Christens-Barry, R. L. Easton, Jr., and K. T. Knox; 'Imaging with X-Ray Fluorescence' by U. Bergmann; and 'The Palimpsest Data Set' by D. Emery, A. Lee, and M. B. Toth.

[4] In succession: 'The Palimpsest in Context' by N. Tchernetska and N. Wilson, and 'The Place of Codex C in Archimedes Scholarship' by R. Netz.

facing transcription. The order of the images is such as to provide a continu-
ous reading of the works in the palimpsest; the foliation of Codex C being
thereby perturbed, the reader can locate specific folios by resorting to the
useful 'Concordance of Foliations' that closes volume 1. When the original
folios are too damaged to produce readable images, these are replaced by
Heiberg's photographs or, if none of these was available, by scans of his
critical edition of Archimedes [!]. (In the latter case, I have been unable to
find indications as to what the facing transcription corresponds to.)

The transcriptions have been carried out by a host of scholars. In the case
of the Hyperides texts, the job was done well before the publication of the
book.[5] The Archimedean writings were transcribed by Nigel Wilson and
Reviel Netz.

The Archimedes Palimpsest has several merits: it presents all images in a
handy format, though for more refined investigations the images stored on
the website are better ('weighing in' at over 250 Mb each). Further, it collects
in a single publication the transcriptions and an introduction to the non-
Archimedean texts, explains in detail the image-processing techniques, and
offers a most interesting exposition of the actions and techniques that were
used to conserve the palimpsest. Most chapters of the book are pleasant to
read and even entertaining. It is, however, less satisfying if one wishes to
use it for scholarly purposes.

Let us say first that the only material of any value about the non-Archimedean
texts is the transcriptions. The scanty and quite generic information on
these texts presented in the section 'The Palimpsest in Context' (2½ pages
on Hyperides, 3 pages on the commentary on Aristotle's *Categories*) does
not even provide a full bibliographical record in the first case, and, in the
second, consists in no more than an inconclusive discussion of authorship
and some paleographical notes.

So let us then turn to Archimedes. I shall focus first on the 'diacritic and
punctuation' section at 1.46–47. There are four pieces of information in it
requiring comment.

> (1) Regarding the presence of an 'unexplained abbreviation' in *Spiral
>   Lines*, prop. 24, one reads that 'the required text is τριπλασίων ἔςτω'.

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[5] See the bibliography appended at the end of this review.

In fact, it is simply «τριπλαςίων», as the transcription at 2.173 has it. The abbreviation is clearly visible even in the facing image: it is a «Γ» with a superimposed «π». The explanation is straightforward: in mathematical manuscripts, «Γ» (usually, «Γ̄») is the cardinal 'three', «Γ′» is the ordinal 'third' or the aliquot part '⅓', «Γ» with a superimposed «κ» stands for the adverb «τριάκις»,[6] «Γ» with a superimposed «π» stands for «τριπλαςίων».[7]

(2) It is reported that the sign for «ἔςτω» is 'fairly rare but not totally unknown'. Hundreds of instances of it can be found in reading mathematical manuscripts [see also 40n13 below]. Where do we have to set the threshold for a sign's being no longer 'fairly rare'?

(3) A variant of the sign for «ἔςται» in the *Method*[8] is described as 'a semicircle with two dots'. It is said to be 'exceptionally rare' on the grounds of evidence that we owe to G. Vitelli and dating to 1885.[9] More details would have been welcome, as some strokes of the palimpsest's sign might no longer be visible and insensibly different variants of it are attested: four occurrences of one such variant occur in the first folio of Vat. gr. 218 [see Figure 1].

Figure 1. The sign for «ἔςται» in Vat. gr. 218, f. 1

In addition, it is questionable that what can be seen in the 250 Mb digital image can be termed without hesitation 'a semicircle with two dots': Heiberg read or guessed the standard sign for «ἐςτι» (an oblique straight stroke with two dots in the same positions as the

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[6] The Cod. Matrit. 4678 (Diophantus) offers many occurrences of this abbreviation, and for several numeral adverbs.

[7] Or «τριπλάςιος». On what grounds, then, did the editors choose the former? Of course, the fact that this is the reading of the other branch of the Archimedean tradition should not interfere with a transcription of Codex C.

[8] At f. 158r, col. 1, line 6 = 2.120 = Heiberg 1910–1915, 2.500.4.

[9] The sign can be found in Laur. Plut. 32.9 and is recorded in Allen 1889 and Cereteli 1904.

implied one for «ἔςται») and I suspect that his reading should be retained.

(4)   An abbreviation closing propositions 3 and 4 of the *Method* that looks like «$\overline{OI}$» and apparently stands for the canonical «ὅπερ ἔδει δεῖξαι».[10] This is left unexplained: the authors recall, just to dismiss the connection, that the 'combination of the first and last letters of the words abbreviated reminds one of *nomina sacra*'. Yet the bar on f. 63v is quite distant from the underlying letters in comparison with the location it has when it marks denotative letters. Maybe the copyist only found in his exemplar, and misunderstood, the residual horizontal stroke of a superimposed «π», which was in fact a canonical abbreviation for «ὅπερ» [see, e.g., Ephrem's Euclid in Laur. Plut. 28.3] followed by some diacritical sign that he misread for an «I». Ending a proposition with a simple «ὅπερ» + sign[11] is not uncommon, as we gather from Pappus' Vat. gr. 218 [see Addendum, p. 44]

Turning from the 'diacritic and punctuation' section to the section on 'codex C and Archimedean scholarship', I give three examples of its unreliability, bearing respectively: on the treatment of the 'Archimedean scholarship' in question, on the evidence coming from the figures, and on that coming from the transcription.

First, Netz asserts that *On the Sphere and the Cylinder* 'is written in pure Koine dialect, no traces remaining of Doric' [1.277]. This is strictly speaking false, as already noted by Heiberg [1879, 69–70], since the word «τῆνος» is Doric [f. 109v, col. 2, line 2 = 2.190 = Heiberg 1910–1915, 1.4.15]. Netz suggests that this treatise was originally written 'in (some version) of Doric, which then becomes koinicized in the milieu of Eutocius', and asserts that this is 'the *communis opinio*, to the extent that anyone other than [he] has opinions on the matter' [1.278]. Contrary to what Netz suggests, this really is a *communis opinio*, since it has been part of Archimedean scholarly folklore since Heiberg's 'Philologische Studien zu griechischen Mathematikern' [1883, 543–544]. Still, there are serious problems with this view. On the one hand, the Archimedean lemmata accompanying the Eutocean commentary *On*

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[10] At ff. 63v, col. 2, line 30 = 2.84 = Heiberg 1910–1915, 2.454.7; 44v, col. 1, line 36 = 2.88, which was not read by Heiberg.

[11] On f. 44v of the palimpsest, the abbreviation is followed by the usual sign ':—'.
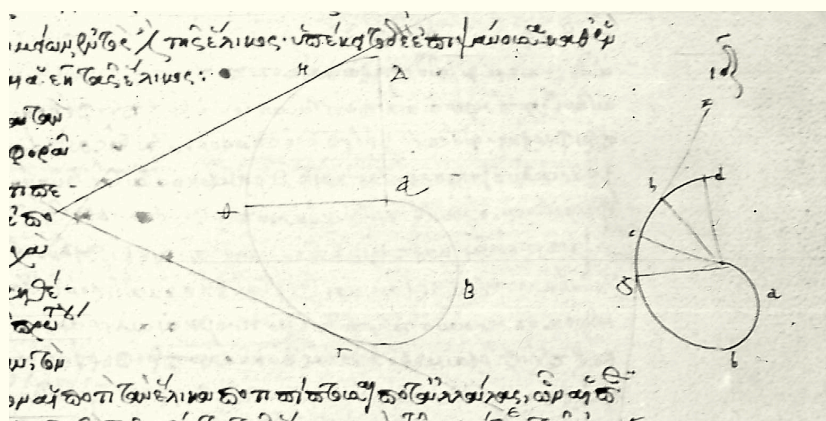
Figure 2. The diagram of *Spiral Lines* prop. 13 in Marc. gr. 305, f. 70r
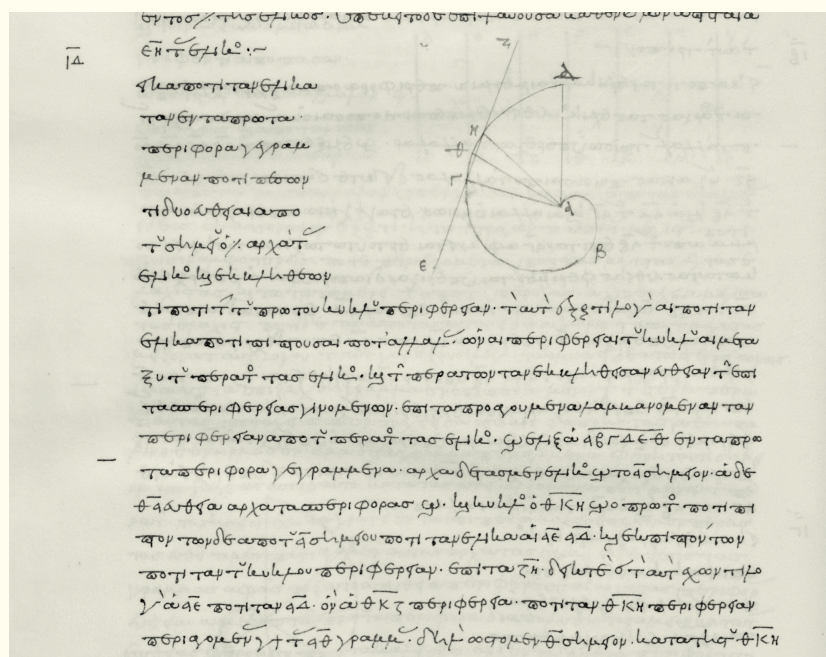
Figure 3. The diagram of *Spiral Lines* prop. 13 in Laur. Plut. 28.4, f. 79v

the Sphere and the Cylinder are in Koine; on the other hand, Eutocius himself asserts that he had recovered what he took to be a lost Archimedean appendix to *On the Sphere and the Cylinder* because it retained in part the author's 'beloved Doric dialect', and that he set out to rewrite it. Since a similar claim is not made concerning the main text of *On the Sphere and the Cylinder*, one may submit that the doricisms of this treatise were lost before Eutocius began his commentary on it but that he took it as obvious that the Archimedes should have written his treatise in Doric.

Second, the evidence from the figures is treated unreliably. Let us consider the nearly incredible 12-line paragraph at 1.284, inclusive of footnote 51. The aim is to show that '[a]ncient diagrams seem to wish to emphasize the impossibility of an impossible case' envisaged in a proof by *reductio*. A 'very clear example' is allegedly provided by the figure associated with *Spiral Lines* prop. 13 and said by Netz to be '[his] reconstruction' of a diagram representing as a broken straight line the impossible tangent at two points of a spiral. The figure presented by Netz cannot be termed a 'reconstruction' because it is attested exactly as it is reproduced, in Codex C (with the omission of the letters «E» and «Z») and in two apographs of Valla's lost Codex A, namely, in Marc. gr. 305, f. 70r [see Figure 2, left], and Par. gr. 2361, p. 204. What Netz omits to say is that the other two apographs of Codex A [Laur. Plut. 28.4, f. 79v, and Par. gr. 2360, f. 51r] and William of Moerbeke's translation in Vat. Ottob. lat. 1850,[12] which most probably derives from Codex A itself, have two figures different from the one just seen but similar to each other: these are reproduced from the first manuscript as Figure 3 and from the second as Figure 4 below.[13]

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[12] And in the margin of Marc. gr. 305, as we see again in Figure 2. Note that it is a figure with Latin lettering, identical with the one in the Vat. Ottob. gr. 1850; this phenomenon is unique in Marc. gr. 305.

[13] In Figure 3, I have included also a stretch of text from *Spiral Lines* prop. 14 in order to show four consecutive occurrences of the sign for «ἔϲτω» discussed under point 2 above; these are all contained in the three lines centered on the horizontal stroke on the left margin. The reader can easily estimate by extrapolation how many occurrences of this sign are found in Laur. Plut. 28.4, written in an imitative script by Johannes Scutariotes in about 1491–1492 [Rollo 2012].
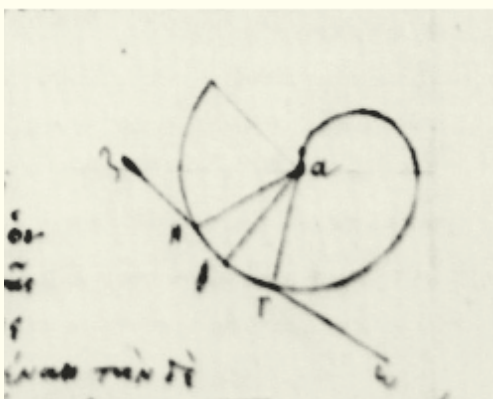
Figure 4. The diagram of *Spiral Lines* prop. 13 in Par. gr. 2360, f. 51r

It follows from this that Codex A had two figures, a 'weird' and a more 'regular' one. The 'regular' diagram was added, probably, in the margins at some stage of the tradition, simply because the former does not represent the 'impossible' configuration supposed in *Spiral Lines* prop. 13: the *reductio* proves that straight lines ZE and ΘA intersect each other somewhere between Θ and A, which is subsequently shown to be impossible. As a consequence, the 'weird' diagram does not even represent the 'impossible case': it is simply and plainly wrong. Furthermore, one might ask what is a 'weird' behavior of a straight line and what is a more 'regular' one. Netz expends a rhetorical question and an exclamation mark to highlight the 'contortions' that the (broken) line 'has to go through'! Well, just one 'contortion', the point of inflexion. Still, it is debatable which is the line that has had to go through more 'contortions', whether it is

- the one in Figure 2 (left)—recall that for a Greek geometer a broken straight line remains just a single, though broken, straight line,
- the one in Figure 3: a tangent that crosses a curve—quite an impossible object after all, or
- the one in Figure 4: the 'straight line' that has a curved portion, as it partly coincides with the spiral—this is Heiberg's figure.

But this is not the end of the story. It remains to read footnote 51; I quote it in full, inserting my comments in italics:

The figure itself is identical in Codices A and C; [*This is false, as we have just seen.*] however, Codex A [*It should be 'Codex C'.*] omits the letters «E» and «Z» (once again we see an error in the mathematical execution [*What does this mean?*] of Codex C; not that Codex A is free of such mistakes). This diagram in Heiberg is not only geometrically different [*Of course, since he chose the other figure that is attested in the manuscripts.*] but also, nearly uniquely, contains a misprint: O for Θ. [*There is no misprint in Heiberg's edition: Netz apparently has in his hands the phototypeset reproduction made in 1972 of the 1913 volume. Such reproductions, as often happens, tend to fade out some details of the letters. In the reprint of 1972, the horizontal stroke of the «Θ», which features as it should in the original figure of 1913, has nearly disappeared, the outcome being an «*O*» with an irregular internal outline. It is easy to check this by looking at the same figure in* Heiberg 1880–1881, *2.56, a complete scan of which is available online. Of course, Heiberg recycled the clichés of the diagrams from his first edition to the second.*]
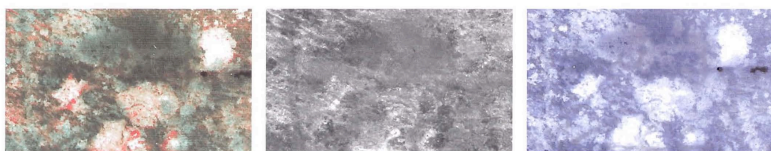

FIG. 11. Enhancements of the word *plethos* (multitude) in Codex C, fol. 177v + 172r 1.1, left: processed pseudocolor image, center: processed subtraction image, right: processed ultraviolet image

Figure 5

Third, the evidence from the transcribed text is treated unreliably. The entire interpretation of the *Stomachion*,[14] a work preserved only in the palimpsest, as dealing with combinatorics 'hangs on' reading a «πλῆθος» that Heiberg 'missed' [1.316n78]. Three images are adduced at 1.293 as evidence for there being such a word [see Figure 5]. I challenge anyone to see it. Heiberg had about 15 working days to read the palimpsest in Istanbul; he was granted no more than six hours a day—still, on the way back from his last journey, he wrote to a colleague of his in Copenhagen that, after all, it is dangerous to stare too long at letters: they tend to generate whole words. Staring at digital images apparently has the same effect. But there is more to the issue. Netz only says at 1.316n77 that the clause containing the crucial word must be corrected to accommodate for the presence of «πλῆθος» («ὀλίγον» for the palimpsest's «ὀλίγων»); the correction is tacitly included in the clause

[14] I urge the reader conversant with Italian to look at Morelli 2009.

when this is discussed at 1.293 but the 'official' transcription at 2.285, has «ὀλίγων»—thankfully.

The goal of the 'transcription' of the Greek text is 'to produce the best reconstruction possible of the reading in the codex as it existed in the tenth century'; therefore, it

> was made on the basis of images of Codex C, Heiberg's reading of the manuscript as they can be deduced from his critical edition…, and on the immediate textual context of the characters no longer visible. [2.vii]

How can this be called a 'transcription'? Any reading can be justified resting on such principles. These have also the harmless but disturbing consequence of making the authors encumber their apparatus with 100s of doricisms restored by Heiberg in his critical text of the still 'unkoinicized' treatises.[15] To give an extreme example, the apparatus to the transcription on 2.19 [ff. 14v + 19r] counts 113 items, 108 of which are pseudo-variants indicating restored doricisms: 27 «ποτί» instead of «πρός», 41 «τᾶς» instead of «τῆς», and so on. In the transcription of the inscriptions and subscriptions of the Archimedean treatises, there is also a mistake: one of the crosses surrounding the inscription of *On the Sphere and the Cylinder* at f. 109r, col. 2, is taken for an abbreviation of an article «τῆς», so that at 2.189, we read the ungrammatical title «ΑΡΧΙΜΗΔΟΥϹ (ΠΕΡΙ) Τ(ΗϹ) ϹΦΑΙΡΑϹ (ΚΑΙ) ΚΥΛΙ(Ν)ΔΡΟΥ».[16] Further, several figures are drawn incorrectly; in each case, the erroneous diagram quite appropriately counts as a separative variant with respect to the 'readings' attested in the tradition of the lost codex A, thereby enhancing the alleged divergence between A and C.[17]

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[15] Heiberg listed all of these interventions at 1910–1915, 2.x–xviii.

[16] I owe the example of the inscription of *On the Sphere and the Cylinder* to D'Alessandro and Napolitani 2012.

[17] Recall that one of the disturbing features of Codex C is that its text quite often coincides with A's: as Heiberg put it, Codex C

> saepius, quam exspectaueris, cum A in erroribus conspirat, non modo in lacunis…, sed etiam in erroribus minoribus…. [1910–1915, 3.lxxxix]

For further details concerning the incorrectly reported figures, see again D'Alessandro and Napolitani 2012.

Providing a diplomatic transcription of what can be read now in the (digital images of the)[18] palimpsest would have served the needs of the scholarly community far better than this un-philological patchwork. Scholars seriously interested in the Archimedean palimpsest are advised to spend a night downloading the images from the website instead.

Addendum to item (4) on p. 38

A very similar abbreviation, followed by the canonical paragrapheme *dicolon* + *paragraphos*, can be found as the last sign of *Alm.* 2.2 in the most authoritative manuscripts of Ptolemy's treatise. It is located as follows: Par. gr. 2389, f. 28v [Figure 6], Vat. gr. 1594, f. 29v [Figure 7], Marc. gr. 313, f. 56v [Figure 8], Vat. gr. 184, f. 96r [Figure 9]. On the grounds of Vat. gr. 180, f. 27v, where one reads «ἐδει δειξαι» [Figure 10], Heiberg prints «ὅπερ ἔδει δεῖξαι» in his edition [1898–1903, 1.92.15 app.].
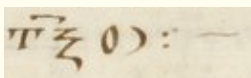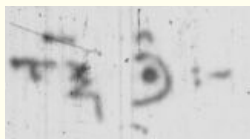

Figure 6. Par.
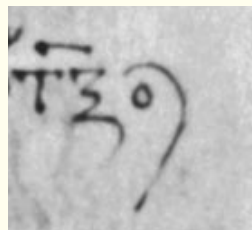gr. 2389, f. 28v

Figure 7. Vat.
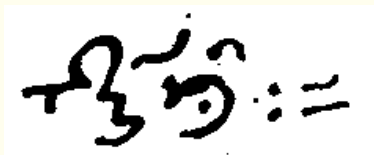gr. 1594, f. 29v

Figure 8. Marc.
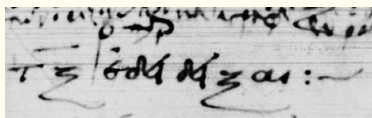gr. 313, f. 56v

Figure 9. Vat. gr. 184, f. 96r

Figure 10. Vat. gr. 180, f. 27v

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[18] As said above, the low quality of the images printed in this book makes them useless for this purpose.

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