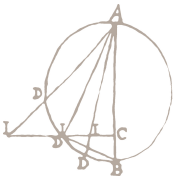

# The *Paradosis* of the Persian Tables, A Source on Astronomy between the Ilkhanate and the Eastern Roman Empire

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**Abstract**

Recent scholarship on a Byzantine astronomical handbook on how to use a set of astronomical tables stemming from Islamic tradition sheds new light on a transfer of knowledge that occurred in the fourteenth century between the Ilkhanate and Byzantium. As this source was so far unpublished, the present paper gives an outline of the main textual features, then discusses the source in the framework of the cross-cultural contacts between Byzantine and non-Byzantine scholars between the Eastern Roman Empire and the Ilkhanate.

**Keywords**
Ilkhanate, Byzantium, Persian astronomy, Byzantine astronomy, astronomical tables

## Introduction

In Otto Neugebauer's renowned *History of Ancient Mathematical Astronomy* of 1975 Byzantine astronomy was regarded as a neglected field in modern scholarship.[1] In the years that followed, this lacuna was filled by distinguished scholars, namely (in alphabetical order) Börje Bydén, Anne-Laurence Caudano, Joseph Leichter, Jéan Lempire, Régine Leurquin, Raymond Mercier, Joseph Mogenet, David Pingree, Peter Solon, and Anne Tihon–especially by the latter. These works showed the complexity of the Byzantine reception of astronomical knowledge stemming from various scholarly traditions, namely the Greek (Ptolemy), Latin, Arab, Persian, and Hebrew ones. As a result, the conception of Byzantine astronomy as a mere transmission process of Ptolemy's works

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has been irremediably cast into doubt. We are now aware that an international network of scholars has to be taken into account in order to comprehend the developments of the scientific culture in the Eastern Roman Empire. The contacts between Byzantine (Christian) and non-Byzantine (Muslim and Jew) scholars led to a production of a big amount of astronomical works, such as tables, comparisons and translations. The atten-tion of Byzantine scholars focused not only on the works of Ptolemy, of course, which were studied and copied, but also on astronomical works stemming from Islamic, Jewish and Latin astronomy. A survey of a wide variety of texts is therefore necessary to assess almost 10 centuries of scientific exchange between Christians, Muslims, and Jews. The present paper seeks to contribute to this scholarship.

Recent scholarship on a Byzantine astronomical handbook on how to use a set of astronomical tables stemming from Persian tradition has shed new light on a transfer of knowledge that occurred in the fourteenth century between the Ilkhanate and Byzantium.[2] As this source was so far unpublished, the present article gives an outline of the main textual features (section "*Textual tradition of the Paradosis*"), then discusses the new source in the cross-cultural contacts between Byzantine and non-Byzantine scholars and in the relationships between the Eastern Roman Empire and the Ilkhanate (section "The *Paradosis* in the cross-cultural encounters between the Ilkhanate and Byzantium").

## State of the art

The primary source this article presents is, as said, a Byzantine 14th-century astronomi-cal handbook on how to use a set of astronomical tables stemming from Persian tradition, entitled Παράδοσις εἰς τοὺς περσικοὺς κανόνας τῆς ἀστρονομίας, i.e., *Instructions for the Persian Tables of Astronomy* (*Paradosis* henceforth), redacted around the middle of the fourteenth century. The author is unknown (see below). The first occurrence of this *opus* in scholarly literature is to be found in the *Muhammedis Alfraganii Arabis chrono-logia et astronomiae elementa* compiled by the German scholar Jakob Christmann (1554–1613), printed in Frankfurt am Main in 1590.[3] After presenting the works of the Arab astronomer Al-Farghani (ninth century), Christmann adds an appendix in which he comments on the differences between the Byzantine and the Persian calendar systems. There, he reports an excerpt from the *Paradosis* from the manuscript *Vaticanus palatinus graecus* 278 (mid fifteenth century). In this manuscript, the *Paradosis* is ascribed to the Byzantine scholar Isaac Argyros (about 1300–1375), hence Christmann mentions Argyros as author of the text as well (cf. *Vat. pal. gr*. 278, f. 13r). The ascription to Argyros occurs also in the renowned Karl Krumbacher's *Geschichte der byzantinischen Litteratur* of 1897.[4]

In 1902, Louis H. Gray published an article about the ancient Iranian calendar, i.e., the Persian one, which points out for the first time the surprising similarities between the *Paradosis* and the third book of Theodoros Meliteniotes' *Astronomike Tribiblos* (three books on astronomy; Book III henceforth).[5] Gray's comparison was based on the excerpt of the *Paradosis* published by Christmann (i.e. from the *Vat. pal. gr.* 278) and an excerpt from Meliteniotes from the manuscript *Vaticanus graecus 1059*.[6] On this account, the scholar surmised a case of plagiarism. As a consequence, the state of the text and the

authorship of Argyros were put into question. All this called for new surveys about the *Paradosis*. In 1931, Giovanni Mercati published the results of a new comparison he made between the *Paradosis* and Meliteniotes' text.[7] He claims that they are two redac-tions of the same text, on account of the manuscripts *Vat. gr*. 1047 and *Vat. gr*. 1058 for the *Paradosis* (both from fifteenth century), and of the *Vat. gr*. 792 (before 1368) and the *Vat. gr*. 1059 (first half of the fifteenth century) for Meliteniotes. Mercati is the first to surmise that the *Paradosis* could be a draft of Meliteniotes or an epitome of it. It was he who discovered the manuscript *Vat. gr.* 792 and recognized it as the original work of Meliteniotes, written before 1368.[8]

In more recent literature about the *Paradosis*, above all in solid contributions by Anne Tihon, two main questions were at issue: who is the true author of the text (Argyros or Meliteniotes) and whether the text is a draft of Meliteniotes' Book III or not.[9] With regard to the last question, Anne Tihon added that the introduction of Meliteniotes' Book III could have been inspired by the treatise on Persian astronomy ascribed to Gregorios Chioniades in the manuscript *Laurentianus Pluteus* 28.17 (after 1346), because that text was copied by Meliteniotes himself.[10] So far, there is no solution for the two issues about the *Paradosis*. However, they are not the main problem about the *Paradosis*. The main one is the textual tradition, which has never been carefully investigated. This is also the premise to answer the two questions aroused on the *Paradosis* and its role in the cross-cultural contacts between the Ilkhanate and the Eastern Roman Empire. In the following, the main features of the textual tradition are at issue.

## *Textual tradition of the* Paradosis

As Mercati already asserted, the *Paradosis* has survived in two redactions.[11] The one is anonymous, independent, and entitled, as said, Παράδοσις εἰς τοὺς περσικοὺς κανόνας τῆς ἀστρονομίας, the other was composed as part (Book III) of a wider *opus*, the men-tioned Meliteniotes' *Tribiblos*. A list of some manuscripts containing the *Paradosis* was already offered thanks to Anne Tihon.[12] Through investigating manuscript catalogues, I have found further textual witnesses. Those non present in the previous list are signed with a * in the following outline. Between parenthesis () are mentioned manuscripts no longer at disposal, but known from catalogues.

These are the textual witnesses of the *Paradosis*:

**Guelferbytanus Gudianus graecus* 40, ff. 16r–20v
*Laurentianus Pluteus* 28.16, ff. 3–20v
*Londinensis Burneianus* 91, ff. 10–28v
**Lugdunensis Vossianus graecus* Q 44, ff. 1–23v *Marcianus graecus* Z 328, ff. 30–60v
*Marcianus graecus* Z 336, ff. 12–28
*Oxoniensis Canonicianus gr*. 81, ff. 1–88
*
*Laurentianus Pluteus 28.13, ff. 2–17*
**Lincopensis* Kl. f. 10, ff. 1–25r
**Lugdunensis Vossianus graecus* F 9, ff. 22–23 (excerpts)
*Marcianus graecus* Z 323, ff. 71–94v
*Marcianus graecus* Z 333, ff. 146–176v
*Oxoniensis Baroccianus* 58, ff. 1–42v
*Oxoniensis Seldenianus* 6 (*Seldenianus supra* 7), ff. 36v–47v

*Parisinus graecus 2107, ff. 141–145v, *160v–161r, *164v–166r, *191v, *193v–194r, *198v–201r, *205r–207v, *214r–215v
**Parisinus supplementum graecum* 754, ff. 181r–183r
*(*Scorialensis* Gamma III 15, ff. 79r–99r) *(*Taurinensis* C.VII.15, ff. 134r–141v)
**Taurinensis* C.III.7, ff. 57r–80v
*Vaticanus graecus* 1058, ff. 130–142
*Vaticanus Palatinus graecus* 278, ff. 13–27v.

*Parisinus graecus* 2501, ff. 1–31v
*(*Scorialensis* Beta IV 20, ff. 81r–179r)
*(*Scorialensis* Eta V 3, ff. 8r–26r)
**Taurinensis* B.II.18, ff. 83r–115r
*Vaticanus graecus* 1047, ff. 12–39v
*Vaticanus graecus* 1852, ff. 430–454v

The *Paradosis* is a *specimen* of a genre of scientific texts, namely the commentary on astronomical tables, to be called handbook as well. Commenting on astronomical tables as a genre was not new to Greek tradition. Its roots are to be found in the *Small commen-tary on Ptolemy's Handy Tables* by Theon Alexandrinus (fourth century A.D.).[13] This astro-nomical genre was then inherited by Arab scholars from ninth century onwards: the Arab tradition produced updated tables and commentaries thereon. Astronomical treatises and tables from the Arab tradition passed to the Persian one. Persian works on astronomy were imported in Byzantium and, according to the extant sources, were in use there from the thirteenth century onwards, because they were updated and more accurate than the ones coming directly from the Ptolemaic tradition.[14] As a matter of fact, most of Byzantine astronomical knowledge between thirteenth and fifteenth century that was not directly drawn from Ptolemy's *Almagest* and *Handy Tables* comes from Persian astronomy.
The *Paradosis* is a kind of practice text and has a sectional structure, i.e., short chap-ters mostly independent from each other. Therefore, accretions and replacements were very easy to be done. For this reason, the relationships between the text witnesses must be determined basically through macroscopic variants, i.e., manuscripts having in com-mon or missing whole chapters or parts of chapters. The same for Book III.
Three families could be recognized on account of macroscopic variants.

Family of **L**

**L** *Laurentianus Pluteus* 28.13, ff. 2–17 **K** *Marcianus graecus* Z 336, ff. 12–28

**J** *Laurentianus Pluteus* 28.16, ff. 3–20v
**S** *Vaticanus Palatinus graecus* 278, ff. 13–27v

Family **CFPQ**

**Q** *Parisinus graecus* 2501, ff. 1–31v **E** *Oxoniensis Baroccianus* 58, ff. 1–42v

**C** *Oxoniensis Canonicianus gr*. 81, ff. 1–88 **Z** **Lugdunensis Vossianus graecus* F 9, ff. 22–23
**G** **Guelferbytanus Gudianus graecus* 40, ff. 16r–20v

**P** *Parisinus graecus* 2107, ff. 141–145v, *160v–161r, *164v–166r, *191v, *193v–194r, *198v–201r, *205r–207v, *214r–215v
**H** *Vaticanus graecus* 1852, ff. 430–454v
**V** **Lugdunensis Vossianus graecus* Q 44, ff. 1–23v

**F** **Lincopensis* Kl. f. 10, ff. 1–25r

**M** *Marcianus graecus* Z 323, ff. 71–94v
**A** **Taurinensis* B.II.18, ff. 83r–115r
**D** *Oxoniensis Seldenianus* 6 (*Seldenianus supra* 7), ff. 36v–47v
**O** *Marcianus graecus* Z 333, ff. 146–176v **R** **Parisinus supplementum graecum* 754, ff. 181r–183r
**U** *Vaticanus graecus* 1058, ff. 130–142
**W** *Taurinensis C.III.7, ff. 57r–80v
**N** *Marcianus graecus* Z 328, ff. 30–60v
**T** *Vaticanus graecus* 1047, ff. 12–39v
**B** *Londinensis Burneianus* 91, ff. 10–28v

In the following, it is expedient to have a brief overview to the manuscripts that were taken into account for the critical edition (*constitutio textus*).

## *Significant manuscripts of the Paradosis*

**L)** *Laurentianus Pluteus 28.13.*[15]. L is on paper, dimensions 220 mm × 145 mm, with 247 folia. It was written before 1374 (see f. 1r: Θεμάτιον γεγονὸς μηνὶ Σεπτεμβρίῳ κε΄. τοῦ ,ϛωπβ΄ ἔτους ἐπ᾽ αὐτῆς τῆς μεσηβρίας, where the Byzantine year 6882 coincide to the 1374 C.E.), by the scholar Isaac Argyros (identification of his hand by Brigitte Mondrain, see below note 15). It also contains notes by Zanobi Acciaioli (identification per Edmund Fryde, see below note 15) in the folia 1v, 240r, 241v and notes by Giovanni Pico della Mirandola in the folia 99r-v (identification by Sebastiano Gentile, see below note 15).
Brief overview of the content: f. 1 horoscope for the year 6882 (1374); ff. 2–17r
Paradosis, 17r–19r Προγνωστικὸν ἀπὸ ἐν τῇ παλάμῃ γραμμῶν; ff. 20–90 Persian astronomical tables; ff. 91–97 Isaac Argyros, Ἰσαὰκ μοναχοὺ τοῦ ἀργυροῦ τῷ Οἰναιώτῃ κυρίῳ Ἀνδρονίκῳ μεθόδους αἰτήσαντι λογικὰς ἐκθέσθαι ἡλιακῶν καὶ σεληνιακῶν κύκλων καὶ τῶν τούτοις ἑπομένων; from f. 99 ἐκ τῶν Ἡφαιστίωνος τοῦ Θηβαίου ἀποτελεσματικῶν καὶ ἑτέρων παλαιῶν and further astrological and astronomical chapters.
Isaac Argyros copied the Paradosis between 1352 and 1374. The latter is deduced from the horoscope at the beginning of this manuscript, the former from the date used for the computations in the Paradosis, i.e., the Byzantine year 6861, which coincides with the 1352 C.E.
The bilingual titles on f. 2r and f. 247r “Πρόχειρον Περσικόν / Tabule Persarum”
allow assuming that this codex comes from Manuel Chrysoloras’ collection.16 This scholar was invited from the scholar Coluccio Salutati to Florence to teach Greek lan-guage and he stayed there from 1397 till 1400 on that purpose.17 No evidence that Chrysoloras took this manuscript with him to Italy. Demetrios Triboles18 also could be another possessor of this manuscript. From his collection, it was acquired in the private library of the Medici family. In fact, Ioannes Laskaris19 reports that in 1491, during a trip to Greece in order to search for manuscripts on behalf of Lorenzo de’ Medici, he found a manuscript in the library of Triboles in Arta. The content of that manuscript is very similar to L. After being added to Medici’s collection, it was borrowed by Giovanni Pico della Mirandola on 2 October 1493.20 Then, it was found by Zanobi Acciaioli, as his note on f. 1v reports: Olim Petri de Medicis, repertus inter libros Comitis Iohannis Mirandulanj.

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**L** is the most ancient witness of the *Paradosis* and contains "good variants" as well as corrections by Argyros to his writing (*correctiones in scribendo*). Therefore, it was taken as the basis text for the *collatio*.
From L were copied J, S, and K. Other direct copies from L are impossible. Manuscripts C, F, P, and Q are the most important for the second family.

**Q)** *Parisinus Graecus 2501.*[21] Q is on paper, dimensions 214 mm × 135 mm, 235 folia, from the fifteenth century, written by two non-recognized copyists.
Brief overview of its content: ff. 1–31v Paradosis; ff. 32–39, 30–31, 40 Isaac Argyros, Ἰσαὰκ τοῦ Ἀργουροῦ μέθοδος λογικωτέρα ἡλιακῶν καὶ σεληνιακῶν κύκλων καὶ τούτοις ἑπομένων; ff. 40v–87v astronomical tables and short texts; ff. 88–96 astronomical and astrological texts; ff. 98–100 geographical and astronomical tables; ff. 100v–105v τριακονταετηρίδες and further astronomical tables; ff. 106–143 chapters from Hephaistion of Thebes – Ἐκ τῶν Ἡφαιστίωνος τοῦ Θηβαίου ἀποτελεσματικῶν καὶ ἑτέρων παλαιῶν; ff. 144–199v astronomical and astrological texts; and ff. 200–235 Τοῦ πανσεβαστάτου καὶ κρίτου Θεσσαλονικῆς τοῦ Ἀρμενουπούλου λεξικὸν κατὰ στοιχεῖον περιέχον τὰ κοινῶς γραφόμενα ῥήματα.
No evidence about its possessor and origins.

**C)** *Oxoniensis Canonicianus Graecus 81.*[22] C is on paper, dimensions 295 mm × 216 mm, with 88 ff., very damaged from liquids, datable between 1380 and 1393. The copyist was not recognized. It stems from the collection of Matteo Luigi Canonici (1727–1805).[23]
Brief overview of the content: after the *Paradosis* (ff. 1r–55r), there are Persian astro-nomical tables and a text similar to the *Persian Syntax* by Georgios Chrysokokkes (ff. 55v–88). From C stems E.

**P)** *Parisinus Graecus 2107.*[24] **P** is on paper, dimensions 215 mm × 140 mm, with 240 ff., datable between the 14th and the 15th century (watermarks detected: 1381–1384). There is no evidence about its scribe and its origins. John Chortasmenos was its owner.
Brief overview of the content: f. 1r months of the Athenians; f. 3–10 text about dialec-tics; ff. 12–22 *Chronicon* from Adam till John Palaiologos II; f. 23 excerpt about trian-gles; ff. 26 about Akyndinos; ff. 27–58 *Optica* and *Catoptrica* of Euclid; ff. 59–112 Arithmetics of Nicomachos; ff. 115–127 Arithmetics by Isaac Argyros; ff. 129 text bout the birth; f. 131–139 geometrical demonstrations; f 140r computations; f. 140v astrologi-cal phases; ff. 141–215r *Paradosis*, mixed with Persian tables; and ff. 215v–240 tables and astronomical texts. From P stems G.

**F)** *Lincopensis Kl. F. 10.*[25] **F** is on paper, dimensions 195 mm × 132 mm, II + 202 + II' folia, from the middle of the fifteenth century. Brief overview of its content: ff. 1–27 *Paradosis* (only in this case, the text is ascribed to Georgios Chrysococces); f. 28 vacuum; f. 29 astronomical text (excerpt from Stephanus Alexandrinus); ff. 30–32 vacua; ff. 33–80v astronomical tables; ff. 81–107 tables without numbers; ff. 108–110 vacua; ff. 111–124r Michael Chrysococces, *Hexapterygon Iudaicum*; ff. 124v–125v vacua; ff. 126–148 tables; ff. 149 vacuum; ff. 150–157r computation tables; f. 157v vacuum; ff. 158–162v Ptolemy, κανὼν πόλεων ἐπισήμων; ff. 163–165v vacuum; ff. 166r–170r, 172v–178r

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Isaac Argyros, Ἰσαὰκ μοναχοὺ τοῦ ἀργυροῦ τῷ Οἰναιώτῃ κυρίῳ Ἀνδρονίκῳ μεθόδους αἰτήσαντι λογικὰς ἐκθέσθαι ἡλιακῶν καὶ σεληνιακῶν κύκλων καὶ τῶν τούτοις ἑπομένων (ff. 170v–172v contain a text about the computation of the beginning of the year); f. 178v Nikephoros Gregoras about the Easter computation; f. 179r table; ff. 179v–180r empty; ff. 180v–184v, 186 Isaac Argyros, περὶ εὑρέσεως τῶν τετραγωνικῶν πλευρῶν τῶν μὴ ῥητῶν τετραγώνων ἀριθμῶν; ff. 185, 189–190v about the use of the astrolabe; ff. 187–188 prosecution of the computus for Andronikos by Argyros; ff. 190v–191r excerpt from Περὶ χαταρχῶν of the Pseudo Maximus Astrologus; ff. 191v–193v about celestial phenomena; ff. 193v anonymous astrological text; ff. 193v–194v introduction to the *Phainomena* of Aratos; ff. 194v–196v astrological com-putations; ff. 197r–200v vacua.
About its origins: f. 1r: *Lucretii Palladii* (Lucrezio Palladio degli Olivi)[26] and f. 1v: *Ex bibliotheca Er. Benzelii Er. filii*; probably Erik Benzelius the younger.
It was acquired in the Stiftsbibliothek Linköping in 1757.

## *The family of M*

**M)** *Marcianus Graecus Z 323.*[27] **M** is on paper, dimensions 210 mm × 140 mm, two volumes, with 487 ff. (+ 5 bis, numerus 345 omissus). The folia of the older volume are damaged from liquids, the younger ones are in a better state; it stems from the end of the 14th and the beginning of the fifteenth century. It was written after 1368 (see f. 211r). Two hands wrote it. The first one, a very small minuscule, wrote folia 1–169v, 211–214v, 222–263, and 479–487v in fifteenth century, and the second one who wrote the other folia was Isaac Argyros.
Brief overview of the content: ff. 1–8 astronomical texts; ff. 9–13 Nicolaos Rhabdas, Παράδοσις σύντομος καὶ σαφεστάτη τῆς ψηφοφορίας ἐπιστήμης; ff. 14–22 Maximos Planoudes, Ψηφοφορία κατ᾽ Ἰνδοὺς ἡ λεγομένη μεγάλη; ff. 23–24 vacua; ff. 25–36 mathematical texts and computation tables; ff. 38–40 vacua; ff. 41–60 John Pediasimos, Geometry; ff. 60v–67 Heron Alexandrinus, Geodesy; ff. 67v–68v Isaac Argyros, about triangles, Πῶς ἂν τὰ μὴ ὀρθὰ τῶν τριγώνων εἰς ὀρθὰ μεταποιήσαιμεν καὶ περὶ τῶν ἄλλων σχημάτων; f. 68v–70 excerpts of Heron Alexandrinus; f. 70v vacuum; ff. 71–94v *Paradosis* (written by the anonymous copyist); f. 95 τεχνολογία ἀκριβὴς περὶ τῆς ὥρας συζυγίου ἢ πανσελήνου; ff. 95–165v astronomical tables and notes; ff. 166–169v intro-duction to the *Almagest* and to the *Handy Tables* – Προπαρασκευὴ εἰς τὴν μεγάλην σύνταξιν καὶ εἰς τοὺς προχείρους κανόνας τῆς ἀστρονομίας; f. 170 vacuum; ff. 171–204v Proclos, *Hypotyposis*; ff. 205–221 astronomical texts; ff. 222–263 Stephanus Alexandrinus' commentary to the Handy Tables of Ptolemy; ff. 263v–265v vacua; ff. 266–285 Theon Alexandrinus' Small Commentary to the Handy Tables of Ptolemy; ff. 285–287v astronomical chapters; ff. 287v–288v Isaac Argyros, introduction to the new tables; ff. 289–382 Ptolemy, *Handy Tables*; f. 383 vacuum; ff. 384–393v John Philoponos, *On the Use of the Astrolabe and its construction*; ff. 394–398v Isaac Argyros, on the construction of the astrolabe; ff. 399–400 tables and their explanation; ff. 400v–402v vacua; ff. 403–461r Ptolemy, *Apotelesmatica*; f. 461v vacuum; ff. 462–466v astronomi-cal texts; ff. 467–470v Excerpts from the Centiloquium of Pseudo-Ptolemy; ff. 471–476

Ptolemy, first book of the position of the planets; ff. 476v–478v vacua; ff. 479–485v Geminus, introduction to the phenomena; and ff. 485v–487v mathematical chapter.
Its possessor was cardinal Bessarion, and it stems from the collection Bessarion donated in 1468 to the city of Venice.

## Textual features of the *Paradosis*

The bulk of the *Paradosis* contains 18 chapters (e.g. **L**):

Παράδοσις εἰς τοὺς περσικοὺς κανόνας τῆς ἀστρονομίας «Instructions for the Persian Tables of Astronomy»
Περὶ τῶν παρὰ Πέρσαις τεσσάρων κεφαλαίων τῶν τε ἁπλῶν ἐτῶν, τοῦ μηνὸς ἡμερῶν τε καὶ ὡρῶν ἀπὸ τῆς ἔγγιστα παρελθούσης μεσημβρίας καὶ μήκους τῆς ὑποκειμένης πόλεως «On the Persian four chapters, namely, that of the simple years, of the month and the day and the hours from the most recent midday, and that of the longitude of the town taken at issue»
Περὶ τῆς τοῦ ἡλίου κατὰ μῆκος ψηφοφορίας «On the computation of solar longitude» Περὶ τῆς κατὰ τοὺς τρεῖς τρόπους διακρίσεως τῶν ὡρῶν «On the adjustment of the hours according to the three ways»
Περὶ τῆς κατὰ μῆκος τῆς σελήνης ψηφοφορίας «On the computation of lunar longitude» Περὶ τῆς διορθώσεως τῶν ἐποχῶν ἡλίου καὶ σελήνης «On the correction of the position of sun and moon»
Περὶ τῆς τοῦ ἡλίου λοξώσεως «On solar obliquity»
Περὶ τῶν συνδέσμων τοῦ τε ἀναβιβάζοντος καὶ τοῦ καταβιβάζοντος «On the nodes, the ascending one and the descending one»
Περὶ τοῦ πλάτους τῆς σελήνης «On lunar latitude»
Περὶ τῆς τῶν πέντε πλανωμένων κατὰ μῆκος ψηφοφορίας «On the computation of the longitude of the five planets»
Περὶ τῶν κατὰ πλάτος ἀπὸ τοῦ διὰ μέσων τῶν ζῳδίων ἀποστάσεων τῶν τριῶν πλανωμένων Κρόνου Διὸς καὶ Ἄρεως «On the computation of the distance in latitude from the ecliptic of the three planets Saturn, Jupiter and Mars»
Περὶ τοῦ πλάτους Ἀφροδίτης καὶ Ἑρμοῦ «On the latitude of Venus and Mercury»
Περὶ συνοδικῶν καὶ πανσεληνιακῶν συζυγιῶν «On synodic syzygies and full moons» Περὶ τῶν ἐκλειπτικῶν ὅρων ἡλίου καὶ σελήνης «On the limits of the eclipses of the Sun and the Moon»
Περὶ σεληνιακῶν ἐκλείψεων «On lunar eclipses»
Περὶ ἡλιακῶν ἐκλείψεων «On solar eclipses»
Περὶ τῆς ἀπὸ ζῳδίου εἰς ζῴδιον μεταβάσεως ἡλίου τε καὶ σελήνης καὶ τῶν πέντε πλανωμένων ἀστέρων «On the passage from sign to sign of the Sun, the Moon and of the five planets»
Περὶ τῆς παραυξήσεως τῶν κανονίων τῶν ἁπλῶν ἐτῶν ἡλίου σελήνης καὶ τῶν λοιπῶν «On the increment of the tables of the simple years of the Sun, the Moon and the rest»

Apart from manuscripts **D, G, H, R, W**, and **Z**, which contain only a selection of chapters or excerpts, all the other witnesses transmit at least 17 chapters of the group of the original" 18. Often, these chapters are modified, sometimes contaminated. Often, new chapters are added to the original series. The year 1352 is used as reference for the

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computation of astronomical magnitudes, except in chapter 16, where a solar eclipse in 1347 is considered.[28]

Time reckoning is based on the Persian calendar, i.e., according to the Yazdegerd Era, starting from 16 June 632 C.E. The chapters of the Paradosis use the year 722 from Yazdegerd as reference for the computation. The Persian year was calculated by a conversion process from the Byzantine year. The date 1352/1353 C.E. is obtained from the Byzantine year 6860/6861 (6860/6861 – 5508). The oscillation between 6860/6861 is due to the fact that the Byzantine year starts on the 1 September. Persian months, days, and hours (from 1 to 24) are the other coordinates of Persian astronomical tables. The geographical reference for the computation is a town with longitude 72° from the Fortunate Isles, called Τυβήνη. This word could well be the transcription of the ancient Armenian capital *Dvin*, because the Byzantine pronunciation of Greek should be /divini/, but its proper identification is still problematic, and the Greek word might be the result of a transcription error. On this problem, a scholarly quarrel aroused: briefly, for David Pingree Τυβήνη should correspond to Tabriz, whereas for Raymond Mercier, to Dvin.[29] Further investigations on geographical tables will clarify this question.

Chapter 1 is a brief introduction to the computations principles. Chapters 2–18 consist of a theoretical part, where one learns how to compute a well-defined astronomical magnitude, and a practical part, where the instructions expounded in the first part are applied to an exam-ple. After the practical part, computation tables are usually set out summing up the operations which have been used in the example. These are mere algorithms set out in tabular form. The main values used in the text are taken from the set of Persian tables located in the folia after the *Paradosis*. Sometimes, the tables are mixed with the chapters (e.g. **P**). These tables are mere texts entirely made of numbers, while the computation tables would have no sense without the explanation of the chapters and depend on the values of the true tables.[30]

## Textual features of the *third book* by Meliteniotes

The first book of Meliteniotes' *Tribiblos* is dedicated to computational methods with sessagesimal numbers in astronomical field (logistics) and to the use of the astrolabe, the second one to Ptolemaic astronomy, and the third to Persian astronomy. As said, this contains surprising overlaps with the *Paradosis*.[31]

Meliteniotes' work is wholly transmitted by only two manuscripts, the *Vaticanus graecus* 792 and den *Vaticanus graecus* 1059 (Y henceforth), and by few excerpts. As the manuscript *Vat. gr*. 792 (X henceforth) is written by Meliteniotes himself, only this wit-ness will be considered here for the study of the redaction of the text about Persian astronomy.

**X)** *Vaticanus graecus 792.*[32] **X** is on paper, dimensions 295 mm × 200 mm, II + 361 ff., middle of the fourteenth century, written by Theodoros Meliteniotes before 1368 and another non-recognized fifteenth century hand, which repairs the text of Meliteniotes (see f. 24v and 252 f.) after 1368.

The codex is a collection of astronomical texts. The third book is contained in the folia 244v–354r + 361r *partim*. As the reference year for the computation is mostly 1352 like in the *Paradosis*, the third book was written between 1352 and 1368.

## *General comparison between the Paradosis and the third book*

Manuscript L is the most ancient witness of the *Paradosis* and contains a good text. The third book's witness X is conserved from its very author. These are the premises for a comparison between the two redactions.

| L | X |
|---|---|
| | (Introduction) Τοῦ μεγάλου σακελλαρίου καὶ διδασκάλου τῶν διδασκάλων τῆς ἁγιωτάτης μεγάλης τοῦ θεοῦ ἐκκλησίας καὶ ἀρχιδιακόνου Θεοδώρου τοῦ Μελιτηνιώτου ἀστρονομικῆς τρίβιβλος ἡ τρίτη ἢ ψηφοφοριῶν κατὰ Πέρσας διάταξις […] + ≈ 1 L |
| 1. Παράδοσις εἰς τοὺς περσικοὺς κανόνας τῆς ἀστρονομίας | |
| 2. περὶ τῶν παρὰ Πέρσαις τεσσάρων κεφαλαίων τῶν τε ἁπλῶν ἐτῶν, τοῦ μηνὸς ἡμερῶν τε καὶ ὡρῶν ἀπὸ τῆς ἔγγιστα παρελθούσης μεσημβρίας καὶ μήκους τῆς ὑποκειμένης πόλεως | 2. Προδιάληψις ὁλοσχερὴς τῶν ὀφειλόντων προυποκεῖσθαι |
| 3. περὶ τῆς τοῦ ἡλίου κατὰ μῆκος ψηφοφορίας | 3. ≈ 2 L |
| 4. Περὶ τῆς κατὰ τοὺς τρεῖς τρόπους διακρίσεως τῶν ὡρῶν | 4. ὅτι καὶ δι᾽ ἑτέρας ἐφόδου τά τε ἁπλὰ περσικὰ ἔτη καὶ τὰς τοὺ μηνὸς ἡμέρας ἔστι εὑρίσκειν |
| 5. περὶ τῆς κατὰ μήκος τῆς σελήνης ψηφοφορίας | 5. ≈ 3 L |
| 6. περὶ τῆς διορθώσεως τῶν ἐποχῶν ἡλίου καὶ σελήνης | 6. ὅτι οὐ δεῖ τὴν ὡρῶν διάκρισιν ποιεῖσθαι ὡς προδιακεκριμμένων ≈ 4 L |
| 7. περὶ τῆς τοῦ ἡλίου λοξώσεως | 7. ≈ 5 L |
| 8. περὶ τῶν συνδέσμων τοῦ τε ἀναβιβάζοντος καὶ τοῦ καταβιβάζοντος | 8. ≈ 6 L |
| 9. περὶ τοῦ πλάτους τῆς σελήνης | |
| 10. περὶ τῆς τῶν πέντε πλανωμένων κατὰ μῆκος ψηφοφορίας | 9. ≈ 7 L<br>10. ≈ 8 L |
| 11. Περὶ τῶν κατὰ πλάτος ἀπὸ τοῦ διὰ μέσων τῶν ζῳδίων ἀποστάσεων τῶν τρεῖς πλανωμένων Κρόνου Διὸς καὶ Ἄρεως | 11. ≈ 9 L |
| 12. περὶ τοῦ πλάτους Ἀφροδίτης καὶ Ἑρμοῦ | 12. ≈ 10 L |
| 13. περὶ συνοδικῶν καὶ πανσεληνιακῶν συζυγιῶν | 13. ≈ 11 L |
| 14. περὶ τῶν ἐκλειπτικῶν ὅρων ἡλίου καὶ σελήνης | 14. ≈ 12 L |
| 15. περὶ σεληνιακῶν ἐκλείψεων | |
| 16. περὶ ἡλιακῶν ἐκλείψεων | 15. ψηφοφορία τοῦ Κάϊτ ἀστέρος κακοποιοῦ παρ᾽ Ἰνδοῖς<br>16. περὶ τῶν κατὰ μῆκος καὶ πλάτος ἐποχῶν τῶν ἁπλανῶν ἀστέρων |

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| L | X |
|---|---|
| 17. περὶ τῆς ἀπὸ ζῳδίου εἰς ζῴδιον μεταβάσεως ἡλίου τε καὶ σελήνης καὶ τῶν ε πλανωμένων ἀστέρων | 17. ≈ 13 L |
| 18. περὶ τῆς παραυξήσεως τῶν κανονίων τῶν ἁπλῶν ἐτῶν ἡλίου σελήνης καὶ τῶν λοιπῶν | 18. ≈ 14 L |
| | 19. ≈ 15 L |
| | 20. ≈ 16 L |
| | 21. ≈ 17 L |
| | 22. ≈ 18 L |
| | 23. παράδοσις πῶς ἔστιν εὑρίσκειν ἑκάστου ὁποιουοῦν μηνὸς τὴν προκειμένην ἡμέραν, εἰς ποίαν τῶν τῆς ἑβδομάδος ἡμερῶν καταλήγει |
| | 24. μέθοδοι εἰς τὴν τοῦ σεβασμίου καὶ μεγάλου Πάσχα κατάληψιν |
| | 25. ἐπίλογος |

The 18 chapters of L are also present in X in almost identical form. The difference is that the syntax of X is not as paratactic as L; the style is more accurate and more Persian astronomi-cal terms are to be found in X than in L. The version of X adds an introduction before the text of 1 L starts, then adds an historical introduction (2X), a conversion method from Byzantine to Persian years (4X), and the chapters 15X, 16X, 23X, 24X, 25X. Chapter 15X (ψηφοφορία τοῦ Κάϊτ ἀστέρος κακοποιοῦ παρ' Ἰνδοῖς) comes also at a later stage into the *Paradosis* in the fif-teenth century in the copies of ACEMUW. In some chapters in common to X and L, the ver-sion X gives algorithms in textual form, whereas L gives those computations in tabular form or do not report them. The following outline shows the differences in the computation formats used by L and X (therefore, it is not a complete account of the whole treatise):

**L**: f. 5v; no algorithm at the end of chapter 6 (περὶ τῆς διορθώσεως τῶν ἐποχῶν ἡλίου καὶ σελήνης)

**X**: f. 315r; algorithm at the end of the corresponding chapter 8X

**L**: f. 5v; no algorithm at the end of chapter 7 (περὶ τῆς τοῦ ἡλίου λοξώσεως)

**X**: f. 315v; algorithm at the end of the corresponding chapter 9X

**L**: f. 6v no algorithm at the end of chapter 9 (περὶ τοῦ πλάτους τῆς σελήνης)

**X**: f. 317r; algorithm at the end of the corresponding chapter 11X

**L**: f. 12r; algorithm in tabular form at the end of chapter 13 (περὶ συνοδικῶν καὶ πανσεληνιακῶν συζυγιῶν)

**X**: f. 334r; algorithm in textual form at the end of the corresponding chapter 17X

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To sum up, the version of X seems an enriched and refined version of the one of L. Therefore, L could be a draft of X, as it was surmised in the past in general terms concerning the two works. The dating of manuscripts X and L does not speak in favour to this. The text of X was written between 1352 and 1368, the text of L between 1352 and 1374. Therefore, L could be also an epitome of X. The dates 1368 and 1374 are only *termini ante quem*; hence, they do not allow knowing really which text was written before. Only the textual evidence could lead to a conclusion. Therefore, both hypoth-esis are possible after the comparison. They are certainly two redactions of the same text. The original version should have been composed around 1352, as the years in use for the computations in the *Paradosis* and *Book III* allow to claim. In the textual his-tory, the two redactions have been encountered since there are cases of textual con-tamination. Therefore, the contemporary scribes knew that there were two redactions of the same thing.
Let us develop the hypothesis of L being an epitome of X. In this case, manuscript X would be the original, the oldest witness of the whole transmission. Which is the direct epitome of X? Theoretically, all the manuscripts containing the *Paradosis* before the sixteenth century can be epitomes of X. Manuscript M would be the most suitable epit-ome of X, because the scribe copies not only the 18 usual chapters, but also two more chapters directly from X, namely one from f. 21, Τεχνολογία ἀκριβὴς περὶ τῆς ὥρας συνόδου ἢ πανσελήνου, and the chapter 15X (ψηφοφορία τοῦ Κάϊτ ἀστέρος κακοποιοῦ παρ' Ἰνδοῖς). Nevertheless, M could not be the first epitome of X, because L is older. Other witnesses, such as CFPQ, could be epitomes of X, but it makes no sense that eve-ryone has copied X at the same time. Therefore, it makes more sense to surmise that L is a witness of the oldest redaction of the text.

## *Summary of the textual transmission*

The scribes of the *Paradosis* do not aim at preserving an original text, but want to have a version of the commentary with the highest amount of methods. Additions and accre-tions of texts correspond to the interest of a single scribe or pursuer, as usual in scientific texts. The structure of the *Paradosis* is sectional. That is why modifications are easy and so the amount of textual variants is high. "Sectional" means that the commentary con-sists of independent sections put together. The order in which they appear is not relevant. On this account, most of the relationships between the manuscripts could be recon-structed on the basis of missing or adding big portions of text (macroscopic variants). Manuscript O is a case in point: the scribe interpolates the *Paradosis* adding two texts from M inside the usual chapters list. The scribe of O, Bessarion, contaminates the *Paradosis* adding algorithms from manuscript Y in chapters with the same topic and inserting a text about how to find the time of true syzygies from folio 83v of Y at the end of the chapter of the *Paradosis* about syzygies. This modification is adopted also by the scribes in manuscripts T, B, H, and F, but they report this text as part of the chapter about syzygies. In the case of H, chapter 18 is replaced by the corresponding chapter in Meliteniotes' version (22X). The copy from C to E is another case in point. The scribe E finds a group of astronomical texts without title after the *Paradosis* and reports some of them inside the list of the *Paradosis* according to similarity of themes. The

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contamination or interpolation processes from the *Book III* to the *Paradosis*, namely from X to M and from Y to O, goes in favour of the hypothesis that X is the witness of a refined and enriched version. Contaminations vice versa are not attested.
On the whole, the *Paradosis* has been copied according to two criteria. First by add-ing alternative methods with the same computation goal. Second by adding examples of computations with a year reference later than the usual one (1352). Some manuscripts report computations for the years 1378/1379, 1381/1382, and 1408/1409.
Most of the additional methods added to the *Paradosis* deal with the computation of syzygies and eclipses. These topics were the most favourite among Byzantine scholars.
The computational methods regarding years more recent than 1352 are evidence of the perusal of the *Paradosis*. Also the witnesses penned by Argyros (L), Abramios (J), Meliteniotes (X), Chortasmenos (Y), and Bessarion (O) are evidence for a practical use, because they contain corrections, computations, additions, and marginal notes of their authors. As said, Bessarion adds some algorithms from manuscript Y, penned by his Constantinopolitan master, Chortasmenos. Bessarion owned other three witnesses of the *Paradosis*, namely M, N, and K. In the case of K, he should have suggested a scribe to integrate the missing texts in the commentary by copying them from his own text in manuscript O.
Bessarion owned also a Latin translation of the *Paradosis*. It is to be found in the manuscript *Marcianus latinus* VIII 22 (1408–1422).[33]
After the fifteenth century, the *Paradosis* has been copied for collection's sake. In fact, manuscripts B, V, and G omit the algorithms and leave space for them, maybe to copy them later. Manuscripts G and V stem from the collections of two scholars and antiquarians, namely Marquard Gude (1635–1689) und Isaac Vossius (1618–1689). Probably, they purchased some scribe to copy the text for them. Manuscript G was owned by Matteo Macigni before being acquired by Gude. Macigni was professor in Padua in sixteenth century. Maybe the manuscript was acquired by his father Roberto, a scholar, who from Florence had moved to Venice.[34] Another Venetian scholar owned the *Paradosis* (manuscript E), namely Francesco Barozzi (1537–1604), professor of mathematics at the Padua University.[35] These data are evidence that the *Paradosis* had a certain *Nachleben* in fifteenth and sixteenth-century Europe.

## *Who wrote the* Paradosis?

The oldest extant witness of the *Paradosis* was penned before 1374 by Isaac Argyros. His hand was recognized by Brigitte Mondrain.[36] Nevertheless, Argyros does not add his name in the title on folium 2r of L, which is simply: Παράδοσις εἰς τοὺς περσικοὺς κανόνας τῆς ἀστρονομίας. On this account, the *Paradosis* remains anonymous. Manuscrpt L is a personal copy, with writing corrections (e.g. ff. 10v and 12r). The non-official target of the manuscript could explain the omission, but Argyros adds his name in the text following the *Paradosis*, an astronomical text dedicated to Andronikos
Oinaiotes,[37] at folio 91r: Ἰσαὰκ μοναχοῦ τοῦ ἀργυροῦ τῷ Οἰναιώτῃ κυρίῳ Ἀνδρονίκῳ μεθόδους αἰτήσαντι λογικὰς ἔκθεσθαι ἡλιακῶν καὶ σεληνιακῶν κύκλων καὶ τῶν τούτοις ἑπομένων. This text was written after the *Paradosis* also in manuscript S, a copy

of L. In S, a recent note ascribes the *Paradosis* to Argyros at folio 13r. It was surmised that the ascription was made on the basis of the title of the text for Oinaiotes.[38]
However it is, Argyros copied the oldest witness of the *Paradosis*, and as he was a renowned mathematician and astronomer, this *opus* could well be ascribed to him. In this scholarly field, many of his works have survived.[39]

Moreover, Argyros' witness of the *Paradosis* is evidence for his interest in Persian astronomy. Therefore, he was not a promoter of Ptolemaic astronomy, as it has been claimed so far, a claim maybe influenced by the opinion of the 15th-century renowned Jewish scholar active in Constaninople Mordekai Komtino.[40] Argyros' role in Byzantine astronomy is worth further investigation.[41]
It was noticed that Meliteniotes reports text portions from other authors in his com-mentary to the Gospels without mentioning them. Probably also the *Paradosis* in the version of Meliteniotes could consist of older texts without mentioning their author.[42] At the present state of the research, he is the author of a refined redaction of the *Paradosis*. Nevertheless, as the question of the author of the *Paradosis* is complicated, this should not be considered as the final solution to this problem. The textual tradition of Chrysokokkes will surely shed more light on the controversial relationships between the *Paradosis* and the *Book III*.

## The *Paradosis* in the cross-cultural encounters between the Ilkhanate and Byzantium

Persian astronomy means the astronomical knowledge stemming from Persia in the thir-teenth century, which was mostly produced by Islamic scholars. In thirteenth century, the area stretched out today between Iran and Azerbaijan was conquered by the Mongols, who ruled under the dynasty of the Il-Khanids. Given their interest in astronomy and astrology, they hired the Islamic astronomers already settled in that area in the new observatories they built, notably the one in Maragha, founded in 1259, by the Ilkhan Hulaghu, and the one in Tabriz, founded not much later by Ghazan Khan.
A source on contacts between Persia and Byzantium is extant in the introduction of the the so-called *Persian Syntaxis*, an astronomical handbook on Persian tables redacted at around 1347 by the Byzantine scholar Georgios Chrysokokkes.[43] We are told about him learning astronomy a few years before in Trebisond, where there was a good tradi-tion of astronomical studies, by a priest called Manuel, otherwise unknown. The latter had practised astronomy thanks to Gregorios Chioniades, who had travelled to Tabriz in order to learn astronomy by the Persian scholar Shams al-Dīn al-Bukhārī, whose works Chioniades had translated and brought to Trebisond.[44]
Chioniades authored the most ancient translations in Greek of works of Persian astronomy, or at least these works are to be ascribed to him.[45] His opus consists of trans-lations of Persian works redacted by Islamic astronomers, i.e., the *Zīj as-Sanjari* (com-posed around 1120) by al-Khāzinī and the work of the Persian astronomer Shams al-Dīn al-Bukhārī commenting on the *Zīj al-Alai* by the Arab astronomer Al-Fahhad (composed around 1176).[46] Chrysokokkes reports, as said, that he learned astronomy in Trebisond thanks to a priest named Manuel. His identity was not recognized, but for sure he lived after Chioniades, therefore in the first half of the fourteenth century, and owned the

works translated by Chioniades. Thus, at the beginning of the fourteenth century, some Persian astronomical treatises were translated into Greek.

The starting phase of the reception of Persian astronomy into the Eastern Roman Empire is a transfer process led by an individual agent, moved by the interest of Chioniades in astronomy. His works show a process of "imitation" of Persian astronomical tradition; in fact, they are translations, their style features only partially the canonical traits of Greek mathematical language, and they are full of Persian astronomical terms, which belong to a primary semantic level, and not always are translated into Greek. The Persian astronomical content, therefore, is not entirely mastered by the mathematical canons of the culture for which they are translated. This imitation process led to a success of Persian astronomy in Trebizond, the town where Chrysokokkes studies by Manuel, the priest who owned the translations of Chioniades, a city which had a strong astronomical tradition.[47] However, the first half of the fourteenth century is poor of manuscripts containing Persian astronomy and registers a production of a big amount of manuscripts containing astron-omy stemming from Ptolemy, for instance, the *Almagest* and the *Handy Tables*. At least 26 manuscripts of the *Small Commentary to the Handy Tables of Ptolemy* were redacted in fourteenth century.[48] From the middle of the fourteenth century, commentaries of the Persian tables redacted by Byzantine scholars started to appear, and the number of manuscripts containing texts of Persian astronomy gets greater from the time around the middle of the fourteenth century. The *Persian Syntaxis* by the mentioned George Chrysokokkes (redacted *c*. 1347) is handed down in more than 30 manuscripts; the *Paradosis*, composed around 1352, is handed over in 23 manuscripts (see above). The textual tradition of Chrysokokkes has never been carefully studied.[49] The one of the *Paradosis*, instead, allows to claim that renowned Byzantine scholars personally copied, annotated, and mod-ified the text. The text-witnesses of the *Paradosis* reveal a rich scholar activity on these texts, as they contain many structural reorganization of the content, marginal notes, and integrations. The transcription process is often done in a careful way. The *Persian Syntaxis* and the *Paradosis* are evidence of an "integration" process from Persian astronomy into the Byzantine one: their astronomical content is Persian, but it is explained in the canoni-cal stylistic codes of Greek mathematics attested in Greek astronomical commentaries. This style features the "procedural language" and the "algorithmic language."[50] Briefly, the procedures describe chains of operations through a normative syntax based on parti-cipial forms and indicative future, they never feature numbers (conversion factors and non-variable values excepted), but long denotative expressions to describe the astronomi-cal magnitudes involved in the computation, as they are aimed at providing the most general description of a well-defined operation; the algorithms employ the second person of the imperative mood to describe an operation, they always feature a paratactic syntax, and are aimed at summing up the operations expounded in the procedural part through applying them to a computation sample.[51]

The *Paradosis*, as said, is a commentary on a structured set of Persian tables starting from the year 720 of the Persian calendar, that is, the Yazdegerd Era, which corresponds to the year 1350 C.E.[52] As said, the original text is based on 18 chapters, each composed by two parts. The first part explains in procedural language the mathematical operations one should do to compute a determined astronomical magnitude and which values and which tables should be used in each single case. The instructions expounded are applied

to an example, again in procedural language. In the example, the computations are usu-ally applied for the year 722 of the Yazdegerd Era, that is, the year 1352 C.E. After this, the second part, in algorithmic language, is composed by the chain of the computations summed up in textual or tabular form. The structure of the chapter in two parts was already adopted by Theon Alexandrinus in the *Small Commentary*. The Greek language used in the *Paradosis* is not much different from the one used by Theon, but this is no surprise, because the technical languages are usually conservative, and the Greek math-ematical code had well-defined canons. The Byzantine scholars, as said, used the canoni-cal style used for redacting astronomical handbooks: the "procedural language" for the first part of the chapter and the "algorithmic language" for the second one.

Given the importance of Meliteniotes in Constantinople,[53] Book III of the *Tribiblos* is evidence that Persian astronomy was accepted by the milieu of the Emperor and of the Patriarch. The composition of Book III is in perfect accordance to the years in which Meliteniotes worked as professor at the Patriarchal School of Constantinople. His astro-nomical work was due to an official pedagogical framework. The legitimation of the subject Persian astronomy from philosophical and religious perspective is to be found in the prologue of Meliteniotes' treatise.[54] It is a high-level rhetoric piece, where the scholar explains, through both quotations and indirect allusions to Aristotle, Plato, Patristic, and Biblical sources, that astronomy is a road leading to God, a sustain for the orthodox faith. That is why it had to be studied by a Byzantine student. The text also provides the ethical rules a perfect Byzantine citizen had to follow to be accepted in the community. The divine inspiration is called for help in writing the three books of the *Tribiblos*, and Book III ends with a thanksgiving prayer to the Holy Trinity. Therefore, the redaction of Meliteniotes is major evidence of the legitimation of Persian astronomy in Byzantium.

In the middle of the fourteenth century, the reception process of Persian astronomy into the Byzantine Empire can be traced in the capital of the Empire, Constantinople, and it was not only moved by the interest of some scholars, such as Isaac Argyros, but went through official institutional Byzantine means. As a result, it became a subject in the Patriarchal School.

Book III of Meliteniotes also contains a list of Persian astronomers, and this mecha-nism of genealogy is another tool the author uses to legitimize Persian astronomy. The author mentions Arab and Persian astronomers who had studied the astronomy of Ptolemy and made innovations onwards. According to Meliteniotes, his sources of inspi-ration, to quote some of them, are the Arab astronomer al-Battānī (c. 858–929), known as *Albategnius* in the West, the Persian Shams al-Dīn al-Bukhārī (thirteenth to fourteenth century) and the Persian Naṣīr al-Dīn al-Ṭūsī.

All the astronomers mentioned by Meliteniotes existed and are traceable. Two of the mentioned astronomers redacted works translated by Gregory Chioniades. His work, as said, consists of two translations of Persian works, that is, the *Zīj as-Sanjari* and the work of the Persian astronomer Shams al-Dīn al-Bukhārī commenting on the *Zīj al-Alai*. A Persian source was also identified by Raymond Mercier for the *Persian Syntaxis* by George Chrysokokkes (redacted around 1347); it could be the translation of the Persian Tables of the *Zīj Īlkhānī* of the renowned Persian astronomer Naṣīr al-Dīn al-Ṭūsī.[55]

All these traceable sources are evidence about how Byzantine astronomy of the thirteenth and fourteenth century was indebted to the Arab and Persian one. What is

more, in the Greek texts of Persian astronomy the technical terms of Persian language are translated, but at the same time transliterated from the Persian, so that the Byzantine reader could learn the original sound of technical terms in his own language. Of course, the highest amount of the transliterated words is registered in the translations of Chioniades, whereas the quantity of these words is lower in the *Syntaxis* and in the *Paradosis*.[56] While Chioniades' works contain Persian words as main part of clauses, the Persian terms in the *Paradosis* are provided only as *glossae*, thus giving additional information to the reader about the original form of the word; the main semantic part is provided by a Greek technical term. All this is evidence of the importance Byzantine scholars gave to their sources (see Appendix 1 below for a list of Persian astronomical terms).

## Final remarks

The present survey shows that Persian astronomy was borrowed, translated and commented by Byzantine scholars. This kind of non-Byzantine knowledge was well received in Byzantium at the beginning of the fourteenth century and extensively used since the middle of the fourteenth century, as the big amount of manuscripts and annotations allows to claim. The initial phase of this transfer of knowledge could be interpreted as an imitation process, with regard to the translation by Chioniades of Persian and Arab works, where Chioniades acts as transfer agent, moved by personal interest. Thanks to his translation activity, Persian astronomy was spread into the Byzantine Empire; this is in accordance with the extant source we have about the history of Persian astronomy in Byzantium, namely the introductory tale of Chrysokokkes to his *Persian Syntaxis*. Thus, around the middle of the fourteenth century, the transfer became an integration process from the Persian astronomical tradition into the Byzantine one, the dominant one: the evidence of this is provided by the Greek mathematical canonical style (procedural along with algorithmic language) used by Chrysokokkes, Argyros, and Meliteniotes in the redaction of their works on how to use the Persian Tables. The integration into the domi-nant culture is not only due to private intention, but it becomes also institutionalized, as Meliteniotes let Persian astronomy enter in the official teaching programme of the Patriarchal School of Constantinople. In this framework, the epistemic value of Persian astronomy was equal to the astronomy of Ptolemy, the traditional Greek one, and per-fectly integrated in the classification of the sciences provided by the most Byzantine scholars in fourteenth century: astronomy is placed a step under theology and it is con-ceived as a road leading to God and a sustain for the orthodox faith, as its research object is the heavens created by God, where the heavenly bodies are conceived as abstract objects.

The passage from imitation of the non-Byzantine culture into an integration process in the frameworks of the dominant culture acts at two layers: linguistic and ideological. First, the scholars after Chioniades commented on the Persian Tables writing in the Greek mathematical language following the canons for Greek commentaries. Second, the Persian Tables were incorporated in the official teaching programme in Constantinople: it means that they were considered eligible by the Empire and the Patriarchate; therefore, their content had nothing against both the Byzantine imperial ideology and the dogmata of the Christian orthodox faith.

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Despite Persian astronomy being inherited and integrated into to the Byzantine culture, this transfer of knowledge did not lead to further mathematical innovations. Furthermore, the lack of production of manuscripts containing Persian astronomy in the first half of the fourteenth century still needs to be explained. As suggested by Anne Tihon, this could be due to the fact that the scholars active in astronomy in Constantinople (first of all Nikephoros Gregoras) in the first half of the fourteenth century had the tendency to consider subjects not stemming from Greek tradition not worth of intensive study. The research on Chrysokokkes will shed more light on this. Nevertheless, Persian astronomy was probably studied also in the first half of the fourteenth century; its *floruit* around the middle of that century and the integration process it knew would be otherwise impossible.

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**Notes on Contributor**

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47. The role of Trebizond as agent of transfer and intellectual exchanges is currently under research by C. Kafasis (LMU München) for his PhD Thesis.
48. See Tihon, *Le «Petit Commentaire» de Théon d’Alexandrie aux Tables Faciles de Ptolémée*, pp. 2–6 (see note 13).
49. This constitutes the subject of my ongoing research project. There is an old unpublished thesis on the subject, Etude sur la syntaxe perse des Georges Chrysococces by Françoise Oerlemans, supervised by J. Mogenet, but this resource could not be accessed even through international borrowing services of several institutions.
50. This terminology is adopted from an article by Fabio Acerbi, who detected and described the stylistic codes of Greek mathematical language for the first time. See F. Acerbi, “I codici stilistici della matematica greca: dimostrazioni, procedure, algoritmi,” *Quaderni Urbinati di Cultura Classica*, 101(2), 2012, pp. 167–214.
51. See Acerbi, “I codici stilistici della matematica greca,” pp. 183–93 (see note 50) for the description at full length of these languages.
52. The Yazdegerd Era is reckoned from the 16 June 632 C.E., the day in which the king Yazdegerd III went to the throne.
53. Biography: Leurquin, *Théodore Méliténiote, Tribiblos Astronomique. Livre I*, pp. 13–9 (see note 5). See also Mercati, *Notizie di Procoro e Demetrio Cidone*, 172 ff. (see note 7), Acerbi, “Byzantine Recensions of Greek Mathematical and Astronomical Texts: A Survey,” p. 189 (see note 39), PLP 17851.
54. Edition in Book I: Leurquin, *Théodore Méliténiote, Tribiblos Astronomique. Livre I*, pp. 82–90 (see note 5), with translation into French.
55. Mercier, ‘The Greek “Persian Syntaxis’ and the Zīj-i Īlkhānī” (see note 29). Also the tables of Chrysokokkes are currently under investigation.
56. See also the list of Arab and Persian words in the works of Chioniades: Pingree, *The Astronomical Works of Gregory Chioniades*, vol. 1, pp. 395–401 (see note 46).

**Appendix 1.** Here is a sample of the Arab and Persian technical terms I found in the Greek text of the *Paradosis*.

| Greek the *Paradosis* | Greek transcription | Persian transcription | Persian and Arab | Arab transcription | Meaning |
|---|---|---|---|---|---|
| ἀαπέτ | *Aapet* | *hābit* | هابط | *hābiṭ* | Descending |
| ἀλμανσοῦντα | *Almansuta* | *al-mabsuta* | المبسوطة | *al-mabsūṭa* | Single (year) |
| ἄλ βασάτ | *Al basat* | *al-vasat* | الوسط | *al-wasaṭ* | Mean (motion) |
| ἄλ χασάτ | *Al chasat* | *al-ḫāssa* | الخاصة | *al-ḫāṣṣa* | Proper (motion) |
| ἄουτζ | *Aoutz* | *ūğ* | اوج | *awj* | Apogee |
| βασὰτ μαντάλ | *Basat mantal* | *vasat muʾaddil* | لوسط معد | *wasaṭ muʿaddal* | Modified mean motion |
| ἐκτλεῦ | *Ektleu* | *iḫtilāf* | اختلاف | *iḫtilāf* | Anomaly |
| ἐτᾶ ἄρζ | *Eta arz* | *hissa arz* | حصة عرض | *ḥiṣṣa ʿarḍ* | Lunar longitude |
| ἰστιμά | *Istima* | *iğtimāʾ* | اجتماع | *ijtimāʿ* | Conjunction |
| ἰστικπάλη | *Istikpale* | *istiqbāl* | استقبال | *istiqbāl* | Opposition |
| μάρκαζ | *Markaz* | *markaz* | مركز | *markaz* | Centre/ centrum |
| μουκκαούμ | *Mukkaum* | *muqavvam* | مقوّم | *muqawwam* | corrected |
| ντζαὴρ χαλιτάτ | *Ntzair chalitat* | *ğazāʾir ḫālidāt* | جزائر خالدات | *jazāʾir ḫālidāt* | Fortunate Isles |
| σααέτ | *Saaet* | *sāʾid* | صاعد | *ṣāʿid* | Ascending |
| σαμάλ | *Samal* | *šamāl* | شمال | *šamāl* | North |
| ταντὶλ ἀλάχιρ | *Tantil alachir* | *tȧdīl al-āḫir* | تعديل الآخر | *taʿdīl al-āḫir* | Second equation |
| ταντὶλ ἀουάλ | *Tantil aual* | *tȧdīl avval* | تعديل | *taʿdīl awwal* | First equation |
| τζανούπ | *Tzanup* | *ğanūb* | الجنوب | *janūb* | South |
| χασὰ μαντάλ | *Chasa mantal* | *ḫāṣṣa muʾaddil* | خاصة معدّلة | *ḫāṣṣa muʿaddil* | Modified proper motion |

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