THE RECEPTION AND REJECTION OF "FOREIGN" ASTRONOMICAL KNOWLEDGE IN BYZANTIUM

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Methodological Premises and State of the Art

The present article focuses on the reception of astronomical tables stemming from Persian tradition within the Byzantine Empire in the thirteenth and fourteenth century CE.[1] In order to investigate this case of the transfer of knowledge across cultural boundaries, a historical-philological approach was utilized, following the methods and terminology proposed by Hans-Jürgen Lüsebrinck for describing cross-cultural contacts and transfers.[2]

Astronomical tables contain values (numbers), except for the titles and the names of chronological or astronomical parameters mentioned in them, such as years, months, days, hours, and longitude, latitude, signs, degrees, etc. Such values must be combined through precise mathematical operations in order to get the true position of a celestial body or to predict a celestial phenomenon, such as syzygies, or solar and lunar eclipses. The system upon which these tables are based is Ptolemy's *Almagest*, the major astronomical work for

1 The article presents the preliminary results of a work in progress. Some of these results were published in an article of mine. I have partially reprised that work here in the section "Conclusions" (see below). See BARDI, ALBERTO, The Paradosis of the Persian Tables. A Source on Astronomy between the Ilkhanate and the Eastern Roman Empire, in: Journal for the History of Astronomy 49.2 (2018), pp. 239-260, especially pp. 252-255. New insights and updates from ongoing research will be published in due time. I am grateful to the editors of this volume and the organizers of the congress.

2 For instance, LÜSEBRINCK, 2005, pp. 129-138.

Western and Middle Eastern astronomy from the second century CE until the age of Copernicus.[3] Several commentaries on astronomical tables were written from the fourth century CE onwards. The most famous is the so-called *Small Commentary to the Handy Tables of Ptolemy* by Theon of Alexandria (fourth century CE).[4]

The *Handy Tables* of Ptolemy of Alexandria (second century CE) are the model of all subsequent structured sets of tables.[5] They were later imported into the Islamic world. Arab scholars translated the *Almagest* and the *Handy Tables* from the ninth century CE onwards. This was not a mere process of direct inheritance. Arab scholars realized that the tables were outdated, because the observational data did not correspond to the mathematical data the tables provided. Therefore, Arab astronomers made innovations on the mathematical astronomy of the Greek tradition, and later also Persian astronomers (from at least as early as the twelfth and thirteenth centuries) inherited the innovations of the Arabs and made their own improvements to the mathematical astronomy of the Greek tradition. To sum up, the results of the improvements of those scholars are the updated astronomical tables and commentaries on how to use them.[6]

In thirteenth- and fourteenth-century Constantinople, Byzantine astronomers regarded themselves as the successors of the Greek tradition. Therefore, the astronomy stemming from Ptolemy was not considered as foreign astronomical knowledge by Byzantine scholars. Foreign astronomy is the astronomical knowledge *not* directly stemming from Ptolemy, which came to Byzantium for instance from the Persian tradition of astronomy, *Persia* corresponding today to the area across Azerbaijan, Iran, Iraq, and Armenia, which was ruled by the Mongols of the Il-khanid dynasty in the thirteenth century. Astronomy had flourished there thanks to observatories built in Maragheh, Baghdad, and Tabriz through the support of the Il-khanids, and to brilliant scholars, as for instance the renowned Muslim astronomer Naṣīr al-Dīn al-Ṭūsī (1201-1274). In the Byzantine Empire, Ptolemy's tables were outdated in the thirteenth century. Therefore, Byzantine scholars imported Persian astronomical tables and commented on them, because they were more accurate than those set out in Ptolemy's *Handy Tables*.

3 Edition of the *Almagest*: HEIBERG, 1898-1903. See also JONES/PEDERSEN, 2011.
4 Edition: TIHON, 1978.
5 Edition: TIHON/MERCIER, 2011.
6 See KENNEDY, 1956 and KING et al., 2001.

In the following sections, the process of importation of the Persian Tables in Byzantium will be accurately analyzed. The analysis is based on, firstly, a series of primary-source texts, entirely or partially edited, of Byzantine commentaries on Persian Tables, and secondly, on a series of scholarly contributions in this research field, especially those of Anne Tihon.[7] The primary texts have been studied from a historical-philological perspective, paying attention to the features of the reception process and the different ways in which the material was read and used among Byzantine scholars. The existing data about the process of importation were also discussed in terms of my research on the text entitled Παράδοσις εἰς τοὺς περσικοὺς κανόνας τῆς ἀστρονομίας (*Instructions for the Persian Tables of Astronomy*), henceforth referred to as the *Paradosis*. It is a Byzantine astronomical commentary on how to use a set of Persian Tables, composed in the middle of the fourteenth century.

The *Paradosis* was examined in the light of the existing research on the reception of Persian astronomy in Byzantium. The results of this examination are structured following the guidelines proposed by the main questions of this volume.

The historical-philological approach used in the present article benefits from a survey by Fabio Acerbi.[8] Some words on the methodology I adopted are necessary before going on. Studying Byzantine and Greek astronomical texts, such as the *Paradosis*, according to the standard methods of classical philology may be misleading, because it could happen that a branch of a tradition offers a “good text”, but this may be the result of a revision, therefore deceptive for the editor, as the “good text” in that case is not a clue to a text close to the original.

Editing such texts seems a simple task, as those texts provide no great linguistic difficulties in comparison to the texts of classical literature. The content of mathematical and astronomical texts is characterized by variants of mechanical nature and errors related to the content; the vocabulary used in Greek mathematics is coherently technical, the syntax is rigid. Variants interesting for the editor of a mathematical text are, in most cases, portions of text that are of considerable length. We may talk about macro-variants, which can be the result of interpolation, contamination, or omission; in any case, they are evidence of a

7 Cf. PINGREE, 1964; NEUGEBAUER, 1975; TIHON, 1987a; TIHON, 1996; BYDÉN, 2003, pp. 241-257; SALIBA, 2011.

8 See ACERBI, 2016, especially pp. 137-143 for a full-length discussion on the problems in editing Greek mathematical and astronomical texts.

will to modify the text at some point in its transmission. When this type of intervention is recorded in significant quantities or occurs systematically in the branch of a tradition, then this branch probably represents and transmits a recension. We will see one case of such a recension in the following sections, which gives new hints of the nature of the reception of Persian astronomy in Byzantium. The recension will be evidence of a process of "integration" of the Persian astronomical tradition into Byzantine astronomy.

Revisions were frequent because the Byzantine scribes worked within a specific genre of texts, which were read and studied with a practical goal, and which were used for teaching purposes. In Classical Antiquity, mathematics was learned by writing mathematics, that is, by mastering the stylistic codes of Greek mathematics: it was a common practice handed down for centuries among educated people, who became, through practice, experts in mathematical texts, that is, masters in adopting and redacting them. Even in the Byzantine era, as will be seen in the case of *Paradosis*, those who revise the text relate to a well-defined canon within the history of Greek mathematics. These features illustrate an astronomical and mathematical tradition with well-defined canons and with a normative character. That is why processes of "integration" from other astronomical traditions into the dominant Byzantine astronomy were successful, as we will see.

Authority and Legitimation of Persian Astronomy in Byzantium

During the reign of Andronikos II Palaiologos (ruled 1282-1328), astronomy flourished among Byzantine scholars. The number of edited and unpublished sources in this field is very high and of heterogeneous nature; therefore, I will only be able to briefly discuss some of the key points.[9] The renowned Byzantine scholar Theodoros Metochites (1270-1332) is considered the restorer of Ptolemaic astronomy in Byzantium, because of his strong interest in this tradition. He wrote a primer to the *Almagest*, entitled the *Stoicheiosis astronomiké*, and a commentary on the same work.[10] Through his work, an interest in Ptolemaic astronomy was transmitted to a further generation of

9 See TIHON, 1996 for a broader survey on this topic.
10 See BYDÉN, 2003.

Byzantine scholars. Among them the interest in astronomy grew considerably and it became a field of challenge. The controversy involving Metochites’ pupil Nikephoros Gregoras[11] (1290/1-1358/61) and the philosopher Barlaam of Seminara[12] (around 1290-1348) is a case in point. The controversy was caused basically by different theological opinions, but developed also in the sphere of astronomy, precisely in predicting eclipses using the tables of Ptolemy, as knowledge of the heavenly bodies was conceived as a road leading to God.[13]

Still, Ptolemy’s *Handy Tables* were outdated in the thirteenth century. Differently from their Arab and Persian counterparts, the Byzantine astronomers did not have observatories at their disposal, as far as it is known. Once Byzantine scholars recognized the better accuracy of the Persian Tables, they consequently imported them to Constantinople. The Byzantine scholar George Chrysokokkes (active in the middle of the fourteenth century) is the only one at the time explicitly writing about this process of importation in the introduction to his astronomical work, the so-called *Persian Syntaxis*.

The history seems to have gone as follows.[14] Between the end of the thirteenth century and the beginning of the fourteenth century, the Byzantine scholar Gregory Chioniades (ca. 1250-1320) was granted financial support by Alexios II Komnenus to travel to Tabriz and study astronomy there. Chioniades authored the earliest known translations into Greek of works of Persian astronomy, or at least these works are ascribed to him.[15] His opus consists of translations of Persian works founded on earlier works: the *Zīj as-Sanjari* (composed around 1120) by al-Khāzinī, and the work of the Persian astronomer Shams al-Dīn al-Bukhārī commenting on the *Zīj al-Alai* (composed by the Arab astronomer Al-Fahhad around 1176); al-Bukhārī was recognized by Pingree as teacher of Chioniades.[16] Chrysokokkes reports also that he learned astronomy in Trebizond from a priest named Manuel. His identity was not recognized, but he certainly lived after Chioniades, and therefore in the first half of the fourteenth century, and owned the works translated by Chioniades.

11 PLP 4443.
12 PLP 2284.
13 See MOGENET et al., 1983 and TIHON, 2011.
14 The text by Chrysokokkes is partially published in USENER, 1876, p. 27. For a further discussion of Chrysokokkes, see LAMPSIDES, 1938.
15 PINGREE, 1964, p. 141.
16 See LEICHTER, 2004, pp. 6-12. Editions of Chioniades’ works: PINGREE, 1985; PASCHOS-SOTIROUDIS, 1998.

The starting phase of the reception of Persian astronomy into the Byzantine Empire is thus led by an individual agent, Chioniades, motivated by a strong interest in astronomy. His works show a process of "imitation" of the Persian astronomical tradition. In fact, however, these works are better regarded as translations, their style only partially features the canonical traits of Greek mathematical language: the Persian astronomical content, therefore, is not entirely subsumed by the mathematical canons of the dominant culture. This process of imitation led to Persian astronomy achieving a measure of success in Trebizond.

However, the number of manuscripts containing Persian astronomy from the first half of the fourteenth century is miniscule in comparison to the large amount of manuscripts containing astronomy stemming from Ptolemy, and especially his *Almagest* and *Handy Tables*. From the middle of the fourteenth century, commentaries on the Persian Tables redacted by Byzantine scholars began to appear, with the number of manuscripts containing texts of Persian astronomy greatly increasing from about the middle of the fourteenth century onward.

The *Persian Syntaxis* by the aforementioned George Chrysokokkes (redacted ca. 1347) is transmitted in more than thirty manuscripts; the *Paradosis*, composed around 1352, in twenty-one manuscripts.[17] The textual tradition originating with Chrysokokkes has never been carefully studied.[18] The transmission of the *Paradosis*, instead, makes it likely that renowned Byzantine scholars personally copied, annotated, and modified the text, for instance Isaac Argyros (around 1300-1375)[19] and Bessarion (1399/1400-1472).[20] The manuscripts of the *Paradosis* are documents of a rich scholarly activity on these texts, as they contain many structural reorganizations of the content, marginal notes, and integrations. The transcription process is often done in a careful manner.

The *Persian Syntaxis* and the *Paradosis* are evidence of a process of integration of material from Persian astronomy into the Byzantine tradition:

17 For a manuscript lists, see TIHON, 1987a, pp. 486f. and BARDI, 2017.

18 This constitutes the subject of my ongoing research project. There is an unpublished thesis on the subject, *Etude sur la syntaxe perse de Georges Chrysococcès* by Françoise Oerlemans, supervised by J. Mogenet, but this resource could not be accessed even through the international borrowing services of several institutions.

19 PLP 1285.

20 PLP 2707.

their astronomical content is Persian, but it is explained in the canonical stylistic codes of Greek mathematics, as attested in Greek astronomical commentaries. This style features the "procedural language" and the "algorithmic language".[21] Briefly, the procedures describe chains of operations through a normative syntax based on participial forms and indicative future. They never feature numbers (conversion factors and non-variable values excepted) but employ long denotative expressions to describe the astronomical magnitudes involved in the computation of planetary positions, 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.[22]

The *Paradosis*, as already stated, 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 CE.[23] The original text is based on eighteen chapters, each composed of 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 usually applied to the year 722 of the Yazdegerd Era, that is the year 1352 CE. 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 in the *Small Commentary* in the fourth century CE. 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 involved are usually conservative, and the Greek mathematical code had well-defined canons. The Byzantine scholars, as already stated, used the canonical style employed for redacting astronomical handbooks: the "procedural language" for the first part of the chapter and the "algorithmic language" for the second.

21 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 ACERBI, 2012.
22 See ACERBI, 2012, pp. 183-193 for the description at full length of these languages.
23 The Yazdegerd Era is reckoned from the June 16, 632 CE, the day in which the king Yazdegerd III ascended to the throne.

The textual tradition of the *Paradosis* shows that Byzantine scholars aimed at possessing the most complete version of the instructions for this set of tables. On this account, most of the scribes modify the original structure of eighteen chapters, adding new chapters with new computations based on years more recent than 1352 CE, adding alternative computations, or omitting some chapters, according to the interest of each single scribe.

Although no edition has been produced – to date – of the tables commented on in the *Persian Syntaxis* and in the *Paradosis*, the translations of Chioniades and the significant amount of manuscripts containing the *Paradosis* are evidence of a real interest in the Persian Tables on the part of Byzantine scholars. Persian astronomy in Constantinople was given authority through translating, copying, and using for practical purposes the manuscripts containing the Persian Tables, and later through adapting them to the canons of Greek astronomy.

Another Byzantine astronomical treatise provides significant evidence for the processes underlying the legitimation of Persian astronomy in Byzantium. Before 1368, the renowned scholar Theodoros Meliteniotes (1320-1393?),[24] archdeacon of the Church Hagia Sophia, major treasure minister (μέγας σακελλάριος) of the Patriarchate, and director of the Patriarchal School in Constantinople, redacted an astronomical work in three books, the *Tribiblos Astronomike*.[25] The first book deals with logistics (calculations in the sexagesimal system applied to astronomy) and the use of the astrolabe, the second with Ptolemaic astronomy, the third with Persian astronomy. The third book is, more specifically, a commentary on the same set of tables commented in the *Paradosis*, and it constitutes a refined and enriched version of the *Paradosis*. In principle, the text of the third book is "better", but its style and variants, once compared to the *Paradosis*, reveal that we are dealing with a recension of the *Paradosis*, rather than an independent text.[26] Briefly, the style is systematically "normalized" and additional texts are added to ensure a religious, historical-philosophical, and ethical framework for the Byzantine reader.

Given the importance of Meliteniotes in Constantinople, Book III of the *Tribiblos* is evidence that Persian astronomy was accepted within the milieu of the Emperor and of the Patriarch. The composition of the Book III is in perfect

24 PLP 17851.
25 About this work and its textual tradition: LEURQUIN, 1985; 1990-1993; 1991. About the Patriarchal School of Constantinople see SPECK, 1974.
26 See BARDI, 2017 for an in-depth comparison of the two redactions.

accordance to the years in which Meliteniotes worked as a professor at the Patriarchal School of Constantinople. His recension adapted the work to an official pedagogical framework, and there are also traces of use by a student (see below).

The legitimation of the subject of Persian astronomy from both a philosophical and religious perspective is to be found in the prologue of Meliteniotes' treatise.[27] 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 pillar of 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 in order to be accepted by the community. Divine inspiration is invoked for help in writing the three books of the *Tribiblos*, and Book III ends with a thanksgiving prayer to the holy Trinity.

In its introduction, Book III of Meliteniotes also contains a list of Persian astronomers, and this mechanism of genealogy is another tool the author uses to legitimate Persian astronomy. The author mentions Arab and Persian astronomers who had studied the astronomy of Ptolemy and made innovations onwards. This genealogy leads us to look for the sources of the translation of Persian astronomy into Greek.

According to Meliteniotes, his sources of inspiration, to quote some of them, al-Battānī (ca. 858-929), known as Albategnius in the West, Shams al-Dīn al-Bukhārī (thirteenth-fourteenth century) and Naṣīr al-Dīn al-Ṭūsī (thirteenth century).

All the astronomers mentioned by Meliteniotes existed and are traceable. Two of them redacted works translated by Gregory Chioniades. 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-ī Īlkhānī* of the renowned Persian astronomer Naṣīr al-Dīn al-Ṭūsī.[28] All these traceable sources are evidence of how Byzantine astronomy of the thirteenth and fourteenth century was indebted to the Arab and Persian traditions.

27 Edition in Leurquin, 1990-1993, I, pp. 82-90, with translation into French.
28 Mercier, 1984. Also, the sources of Chrysokokkes are currently under investigation.

Effects of the act of borrowing

During the act of borrowing from Persian astronomy, Byzantine astronomers did not create new concepts, but took over the innovations of Arab and Persian astronomers.[29] The fundamental principles of the tables are those made by Persian astronomers. The mathematical devices introduced by Islamic scholars, which are innovative compared to those of Ptolemy, are usually not modified by the Byzantines.[30] Moreover, in all Byzantine commentaries on Persian astronomy, the meridian of reference for the tables is not Constantinople, but a town of the Middle East, namely Tabriz for Chioniades, and *Tybini* (Τυβήνη), i.e., the ancient Armenian capital Dvin, for Chrysokokkes, for the *Paradosis* and for Meliteniotes, like in Al-Tusi's *Zīj-ī Īlkhānī*.[31] The tables are organized with respect to the Persian calendar, namely the Yazdegerd Era (reckoned from June 16, 632 CE), and not according to the Julian calendar or Byzantine Years (from September 1, 5509 BC), that were reckoned from the creation of the world. Therefore, Byzantine astronomers had to convert their calendar to the Persian one in order to use the tables, and this often led to errors. For this reason, and of course because of the complexity of the innovative mathematical devices provided by the Persian Tables, using the tables was usually difficult for Byzantine scholars.

Social Implications of Persian Astronomy in Byzantium

Among Byzantine scholars, from the beginning of the thirteenth century, one had to study astronomy as a compulsory subject and a learning trend, not only as pure interest.[32] Astronomy was ranked second, after theology, in the hierarchy of science introduced by Metochites in his *Stoicheiosis astronomike*.[33] This classification, based on Aristotelian principles, lasted until the fall of Constantinople in 1453. Similar statements about astronomy to those

29 See SALIBA, 2007, pp. 131-170 for the innovations of Islamic astronomy.
30 A survey on this topic is currently ongoing.
31 MERCIER, 1984, p. 56.
32 See TIHON, 2009.
33 See ŠEVČENKO, 1962, pp. 69-76.

of Metochites are to be found in Meliteniotes’ treatise, as discussed above.[34] The epistemic value of Persian astronomy was integrated into this general classification of sciences, as the prologue of Meliteniotes shows.

Byzantine astronomers were especially interested in the Easter computus, and by implication in the calculation of syzygies[35] and eclipses, which are preliminary steps to calculating the date of Easter. Although in the fourteenth century, the Easter computus was no more at issue, calculating syzygies and eclipses was a field of challenge between scholars.[36] Therefore, scholars needed updated and accurate tables. That is why renowned Byzantine scholars of the thirteenth, fourteenth, and fifteenth centuries showed an interest in Persian astronomy. Because of the difficulties in the use of Persian Tables for such computations, Byzantine scholars used at the same time the *Handy Tables* or mixed methods from both sets.[37]

As was common in Byzantium, the scholars interested in Persian astronomy had knowledge above all in theology,[38] and most of them were linked to the social milieu of the Emperor and the Patriarchate. Moreover, some of them taught at schools, and Persian astronomy was among the subjects. The already mentioned Theodoros Meliteniotes[39] is author of the *Tribiblos astronomike*; his personal copy is preserved in the manuscript *Vaticanus graecus* 792.[40] John Chortasmenos[41] (1370-1431) was professor at the Patriarchal School in Constantinople in the first quarter of the fifteenth century, then notary at the patriarchal chancellery in Constantinople (1391-1415). His transcription of Meliteniotes’ *Tribiblos* from the manuscript *Vaticanus graecus* 792 appears in the manuscript *Vaticanus graecus* 1059, adding further computations, and organizing the context of the *Tribiblos* in two columns per pages, so that the theories and their practical application can be

34 For the text see LEURQUIN, 1990-1993, I, pp. 82-84.
35 This word usually means the conjunctions and oppositions of the Sun and the Moon taken the Earth as observational reference. See NEUGEBAUER, 1975, I, pp. 118-124 and JONES/PEDERSEN, 2011, pp. 221-226.
36 See PINGREE, 1971, p. 198 and TIHON, 1987b.
37 See examples in CAUDANO, 2003.
38 For further discussion of the system of education in Byzantium in the fourteenth century see COSTANTINIDES, 1982; CACOUROS, 1997; TIHON, 2009.
39 PLP 17851.
40 Further details about the manuscript are available in LEURQUIN, 1985.
41 PLP 30897; HUNGER, 1969; CACOUROS, 1997.

read in parallel.[42] Bessarion,[43] one of the pupils of Chortasmenos during the first quarter of the fifteenth century in Constantinople, uses the manuscript of his teacher to write integrations to his own copy of the *Paradosis*, preserved in his own manuscript *Marcianus graecus* Z 333.[44] Bessarion (1399/ 1400-1472) was a polymath: he was appointed metropolitan bishop of Nicaea in 1437, he participated at the council of Ferrara-Florence as unionist, converted to the Catholic faith in 1439, and was elevated to the position of cardinal, following which, he moved to Italy. He was also a collector of manuscripts and owned manuscripts not only containing Ptolemaic, but also Persian astronomy. For instance, he was the owner of some manuscripts which contain the *Paradosis* and several other astronomical texts, and the iterations of the *Paradosis* in those versions show hints of a particular interest in the text on the part of Bessarion.[45]

The political positions held by Meliteniotes, Chortasmenos, and Bessarion, and the teaching activity of Meliteniotes and Chortasmenos are evidence of the importance the subject Persian astronomy gained in Byzantium in the middle of the fourteenth century.

Conclusions

It is difficult to assess the reception of Persian astronomy in Byzantium, for a huge number of documents makes this page of history very complicated. It seems that Persian astronomy was considered not so important, or even worse than Ptolemaic astronomy and somewhat heretic in Byzantium, as it was partially developed by Islamic scholars.[46] Probably due to his interest in Persian astronomy, Gregory Chioniades was charged of heresy by the Patriarchate at the beginning of the fourteenth century and had to undertake a public defense in Constantinople and reaffirm his orthodox Christian faith.[47]

42 For a further discussion of the manuscript and its properties, see CANART/PRATO, 1981, pp. 125-131; LEURQUIN, 1990-1993, pp. 51-67.
43 MOHLER, 1923, 1927, 1942; FIACCADORI, 1994; MÄRTL et al., 2013. See also PLP 2707.
44 See MIONI, 1985, pp. 62-66 for a description of the manuscript.
45 See BARDI, 2017.
46 PINGREE, 1964, p. 140; TIHON, 1987a, p. 484.
47 See WESTERINK, 1980.

It is true that astronomical tables could also have been used to make astrological predictions, and astrological texts do appear in manuscripts in which Persian Tables are also contained, but they are to be found in manuscripts containing Ptolemaic astronomy as well. This is no surprise. Astrology and magic were known and practiced by scholars in Byzantium even before the introduction of Persian astronomy, and the difference between these two activities was known in Byzantium.[48] Theodoros Meliteniotes himself explained the theoretic and epistemic differences between the two activities and condemned astrology in the introduction of his *Tribiblos*. Briefly, astronomy aims at explaining the movements of the celestial bodies through mathematics, whereas astrology aims at connecting those movements to personal human actions in order to find justification through the former for the latter. The outcome of this is a deterministic system. That is why astrology was seen as being against Christian orthodox faith, against God, against the Byzantine State, and therefore to be rejected and condemned.[49]

It is possible that Byzantine scholars interested in Persian astronomy used the tables to make astrological predictions. However, astrology was also practiced by scholars who used the *Handy Tables* of Ptolemy, as it was a fashionable activity. In any case, no Byzantine scholar, either from the Patriarchate or from the Emperor’s group, ever put in question the better accuracy of the Persian Tables. Even Byzantine scholars, such as Nikephoros Gregoras, who seems to have studied only Ptolemaic astronomy, admitted that the *Handy Tables* of Ptolemy were not reliable anymore in the fourteenth century.[50]

The present survey shows that Persian astronomy, namely astronomical tables made by Persian astronomers, were borrowed, translated, and commented upon by Byzantine scholars. Therefore, this kind of foreign 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 large amount of associated manuscripts and annotations allows us to claim. The initial phase of this transfer of knowledge could be interpreted as an imitative process, with regard to the translation by Chioniades of Persian and Arab

48 Astrology was object of different interpretations in Byzantium. This topic still requires surveys. See MAGDALINO-MAVROUDI, 2006 and especially the essay by Anne Tihon within that collection.

49 See the Greek text in LEURQUIN, 1990-1993, I, p. 88.

50 BYDÉN, 2003, pp. 252f.

works, where Chioniades acts as an agent of transfer 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 integrative process from the Persian astronomical tradition into the more dominant Byzantine 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 dominant culture is not only due to private intention, but it becomes also institutionalized, as Meliteniotes let Persian astronomy enter into the program of official teaching at the Patriarchal School of Constantinople. In this framework, the epistemic value of Persian astronomy was equal to the astronomy of Ptolemy, the dominant Greek tradition, and perfectly integrated into the classification of the sciences employed by most Byzantine scholars in fourteenth century: Astronomy is placed a step under theology and it is conceived as a road leading to God and a sustain for the orthodox faith, because its research object is the heavens created by God, and the heavenly bodies as abstract objects.

The passage from imitation of the non-Byzantine culture into a process of incorporation into the frameworks of the dominant culture acts on two levels: 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. Secondly, the Persian Tables were incorporated into the official teaching program 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.

Despite the fact that Persian astronomy was inherited and integrated into the Byzantine culture, this transfer of knowledge did not lead to further mathematical innovations. The lack of production of manuscripts containing Persian astronomy in the first half of the fourteenth century still needs to be explained.

The important political appointments obtained by some scholars who wrote and worked on the *Paradosis* are evidence of the interest Persian astronomy gained in the upper echelons of Byzantine society around the middle of the fourteenth century (as discussed above, Theodoros Meliteniotes, John Chortasmenos, Bessarion). The recension by Meliteniotes aimed at teaching Persian astronomy at the Patriarchal School in Constantinople and the integrations transcribed by Bessarion from Chortasmenos’ copy of Book III show that Persian astronomy was taught in official pedagogical environments.

The historical-philological approach used to reconstruct the textual tradition of the *Paradosis* brought enough data to explain with more accuracy than was previously possible the reception of Persian astronomy in the Byzantine Empire, and especially in Constantinople. This transfer is indeed a case of reception from a non-Byzantine culture into the Byzantine (dominant) one, a multifaceted phenomenon involving processes of imitation and integration, with linguistic and ideological layers; individual and institutional interests. More evidence about the importance of Persian astronomy in Byzantium and its intricate connections with other astronomical traditions will be reached through studying both the textual tradition of the *Persian Syntaxis* and the tables commented on by Chrysokokkes and by the *Paradosis*, a task I am currently tackling at the time of writing.

Abbreviations

MM = *Acta et diplomata graeca medii aevi sacra et profana*, edited by FRANZ MIKLOSICH/JOSEPH MÜLLER, vol. I-IV, Vienna 1860-1890.

PLP = *Prosopographisches Lexikon der Palaiologenzeit*, edited by ERICH TRAPP/RAINER WALTER/HANS-VEIT BEYER, vol. 1-12, Vienna 1976-1996.

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