4 Bessarion's Astronomical Manuscripts

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As articulated by Pietro Daniel Omodeo in *Political Epistemology*, reprising Italian anthropologist Ernesto De Martino,

> An absolutely non-ethnocentric perspective is theoretically absurd and practically impossible, as it would mean stepping out of history in order to contemplate all of the cultures, including the western one. Thus, the only possibility I see is to employ western categories of interpretation in a non-dogmatic manner. This is a critical use, that is, it is controlled by the explicit awareness of the western historical genesis of those categories and the need to enlarge and recast their meaning through their comparison with other historical-cultural worlds.[1]

Acknowledging these epistemological constraints is the basis for the following study of Bessarion's astronomical manuscripts. Certainly they have predominantly been scrutinised through the lenses of philology, codicology, and Byzantine studies. However, an exploration from the perspective of cross-cultural history can potentially reveal insights beyond those previously provided. The introduction of astronomical sources into Italy by Bessarion served as a conduit for intercultural exchange, necessitating an inquiry into how disparate cultural milieus responded to the knowledge encapsulated within these sources – a narrative not inherently evident within the texts

1 Transl. by Pietro D. Omodeo, in Omodeo, *Political Epistemology*, 38

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themselves. In such instances, historians are tasked with employing imagination and discernment to speculate on the dynamics of knowledge dissemination. Through this lens, Bessarion's astronomical manuscripts emerge as pivotal components in the narrative of global history.

The relevance of Bessarion's manuscripts for the history of science has already been explored, but there is still a lot to examine and assess.[2]

Bessarion's lifetime activity of preserving manuscripts intensified after the conquest of Constantinople. While in Italy, Bessarion found in Venice the ideal place to house his collection, and he decided to donate his manuscripts to the Republic of Venice in 1468, with the intention to build a library and make his materials accessible to the public. He died in 1472 and it took some time before his manuscripts were accessible to a large audience.[3] Nowadays most of Bessarion's collection is still in Venice, held at the Biblioteca Nazionale Marciana (Marciana National Library), but some of his codices are scattered throughout Europe.[4] Several works concerning the sciences of the stars and the heavens – astrology, astronomy, cosmology; the contemporary distinction of these branches is obviously not pertinent to the distant past – are preserved within Bessarion's collection.[5] The complete list is provided in the Appendix.

The focus on manuscripts is not due to an erudite or antiquarian motivation. It is an attempt to study the elements that they convey which would illuminate the manuscripts collection beyond the individual texts. In other words, taken as a whole, they reveal a wider circulation of astronomical knowledge, in which Bessarion participated as a key actor.

1 Hellenistic, Byzantine, and Arabo-Persian Astronomy in Bessarion's Collection

Within Bessarion's collection, works dealing with Ptolemy concern the mathematical foundations of astronomy (e.g. *Almagest*), the physical foundations of astronomy (e.g. *Planetary Hypotheses*) and astronomical tables (e.g. *Handy Tables*), alongside handbooks on how to use them. For the sake of simplicity, let us group them henceforth under the label 'Hellenistic astronomy'. Authors such as Argyros, Gregoras and Barlaam represent the Byzantine astronomical tradition. In the first half of the fourteenth century, Gregoras and Barlaam engaged in a controversy over astronomy, ending in a competition on the calculation of eclipses. That field saw the emergence of the use of both Ptolemaic and Arabo-Persian tables.[6]

The two manuscripts of Regiomontanus's *Epytoma in Almagest* are perhaps the most notable examples of the later Hellenistic astronomical tradition mediated and improved through the Latin astronomical literature.

2 Rigo, "Bessarione, Giovanni Regiomontano"; Bardi, "Islamic Astronomy in Fifteenth-Century Christian Environments"; Acerbi, "I codici matematici di Bessarione"; Nicolaidis, Malpangotto (éds), *Fécondité des échanges culturels*.

3 Labowsky, *Bessarion's Library*; Coggiola, "Il prestito di manoscritti della Marciana"; Volpati, "Per la storia e il prestito di codici".

4 Labowsky, *Bessarion's Library*.

5 For a full description of each manuscript, cf. Mioni, *Codices*, except where a footnote is provided.

6 Manolova, "Astronomy as Battlefield?".

The copy in manuscript *Marc. lat.* 328 is a prestigious one, and the manuscript also includes Menelaus's treatise on spherical astronomy. This manuscript was donated by Regiomontanus to Bessarion. Manuscript *Marc. lat.* 329 was the draft for the prestigious copy in *Marc. lat.* 328. Interestingly, Menelaus's treatise was extensively annotated by Bessarion with references from the Greek of the *Almagest*.[7] All this attests to the collaboration between Bessarion and Regiomontanus for the re-translation of the *Almagest* and shows Bessarion's will to keep learning astronomy during his busy time in Italy.

Examples of Arabo-Persian astronomy are works in Greek (but one in Latin) dealing with knowledge stemming from the Islamic tradition, written originally in Arabic or Persian. For instance, *Paradosis* and *Syntax* drew from astronomical works (*zījes*) written first in Persian and then in Arabic.[8] While Hellenistic astronomy in Bessarion's collection deals with both the theoretical and practical sides of astronomy, the Arabo-Persian works deal only with the latter category, consisting of structured sets of astronomical tables and handbooks on how to use them; the exception is the treatise on the astrolabe by Shams (*Marc. gr.* 309), which however does not pertain to the mathematical foundations of astronomy.[9] Tables and handbooks never deal with foundational aspects of astronomy, because they treat mathematical astronomy without explaining the theory. As such, we have to bear in mind the distinction between theoretical and practical categories of astronomical works when trying to determine the relevance of Hellenistic, Byzantine, and Arabo-Persian works in Bessarion's heritage. In this regard, the objects to be compared with the Arabo-Persian materials consist of Ptolemy's *Handy Tables* and the handbooks on them by Theon of Alexandria and by Stephanus of Alexandria.

The handbook of Arabo-Persian tables entitled *Paradosis* is extant in manuscripts *Marc. gr.* 323, 326, 327, 328, 333, 336, and a Latin version in *Marc. lat.* VIII. 31.[10] A similar handbook, authored by the Byzantine scholar George Chrysokokkes, is entitled *Persian Syntax* and is included in manuscripts *Marc. gr.* 309 and 327. The corresponding category of Hellenistic and Byzantine astronomy includes Ptolemy's *Psephophoria* (*Marc. gr.* 314), Theon's *Little Commentary on Ptolemy's Handy Tables* (*Marc. gr.* 315, 323), and Stephanus's *Commentary on Ptolemy's Handy Tables* (*Marc. gr.* 323, 325). The result is eight manuscripts of Arabo-Persian handbooks to four of Hellenistic ones. By taking a closer look at the content, we have Arabo-Persian sets of tables in manuscripts *Marc. gr.* 309, 323, 326, 327, 333, 336, *Marc. lat.* VIII. 31, alongside Ptolemy's *Handy Tables* (*Marc. gr.* 315, 323, 325, 331). In sum, concerning structured sets of tables, we have seven manuscripts of Arabo-Persian astronomy versus four copies of tables of Hellenistic astronomy.

Texts on the construction and use of astrolabes feature authors from both late Byzantium, such as Gregoras and Argyros, and early Byzantium, such as Philoponus. The only author of non-Greek tradition is the Persian Shams.

7 Valentinelli, *Bibliotheca manuscripta*, 3: 218; Rigo, 'Bessarione, Giovanni Regiomontano', 81-2.

8 Mercier, "The Greek 'Persian Syntaxis'". On Arabo-Persian sources, cf. Kennedy, "A Survey on Islamic Astronomical Tables", 125, 161-2.

9 Ragep, "New light on Shams"; Tihon, "Traités byzantins sur l'astrolabe", 333-5.

10 Bardi, "Scientific interactions".

Interestingly, the sole extant Byzantine astrolabe contains some notable features that strongly suggest the influence of Arabo-Persian astronomy. The maker himself was of Persian origin.[11]

The massive presence of handbooks is due to the fact that one did not need to know the theory to practice astronomy, such as computing planetary positions. Moreover, practical knowledge of how to use tables was needed to cast horoscopes, i.e. to practice astrology, which at the time of Bessarion was a widespread practice, at a personal level but also at military and political ones. This is also attested to in Bessarion's collection by the unsurprising presence of astrological works, such as Ptolemy's *Tetrabiblos* and Vettius Valens's *Anthologiae*.

2 The Coexistence of Hellenistic and Arabo-Persian Astronomy: Approach through Manuscripts

To explore the coexistence of Hellenistic, Byzantine, and Arabo-Persian astronomy in Bessarion's library, let us begin by describing some emblematic manuscripts. First, *Marcianus graecus* Z. 333 (644), because it was entirely transcribed by Bessarion himself. It is a fifteenth-century miscellaneous manuscript containing mathematical and astronomical texts.[12] The first unit of this manuscript provides texts of Greek mathematics and music: (ff. 26*r*-31*v*) Isaak Argyros on the square root; (ff. 34*r*-38*v*) John Pediasimos on music; (ff. 39*r*-83*r*) Nicomachos of Gerasa's *Introduction to Arithmetic*; (ff. 83*v*-86*r*) a commentary on the fifth book of Euclid's *Elements*; (ff. 86*v*-88*r*) a commentary on the tenth book of Euclid's *Elements*. A further group of texts deals with Hellenistic, Byzantine, and Arabo-Persian astronomy: (ff. 91*r*-142*r*) Cleomedes on the planetary motions (book 1 and 2); (ff. 143*r*-144*r*) Barlaam of Seminara on the Easter computus; (ff. 146*r*-176*v*) an anonymous handbook on Arabo-Persian astronomical tables; (ff. 176*v*-187*v*) a treatise by Isaak Argyros on solar and lunar cycles; (ff. 188*r*-191*v*) a method to detect the motions of the stars according to single years; (ff. 193*r*-199*r*) notes on conjunctions of celestial bodies; (ff. 200*r*-266*v*) a structured set of Arabo-Persian astronomical tables stemming from Persian, based on Naṣīr al-Dīn al-Ṭūsī's *Zīj Īlḫānī*; (ff. 267*r*-269*r*) a method for the use of the astrolabe; (ff. 269*v*-270*r*) a text on the astrological aspects of the moon; (ff. 272*r*-274*r*) Nikephoros Gregoras's treatise on the construction of the astrolabe; (ff. 275*r*-280*v*) John Philoponus's treatise on the astrolabe; (ff. 281*r*-286*r*) astrological texts.

The anonymous handbook on Arabo-Persian tables is an instruction manual on how to use the set of tables provided in the same manuscript *Marc. gr.* 333 at ff. 200*r*-266*v* (the original set of tables, the aforementioned *Zīj Īlḫānī*, was written in Persian,[13] which is why the Byzantines referred to it as the Persian tables). It is a text from the mid-fifteenth century, entitled *Instructions on the Persian Tables of Astronomy*,[14] better known as *Paradosis*, and it is handed down in five other manuscripts in Bessarion's collection,

11 Dalton "The Byzantine astrolabe at Brescia".

12 Mioni, *Codices*, 61-6.

13 Kennedy, "A Survey on Islamic Astronomical Tables", 125, 161-2.

14 Cf. Bardi, "The Paradosis of the Persian Tables"; Bardi, *Persische Astronomie in Byzanz*.

namely *Marcianus graecus* Z. 323, *Marc. gr.* Z. 326, *Marc. gr.* Z. 328, *Marc. gr.* Z. 336, and *Marc. lat.* VIII. 31.

Further manuscripts attest to the coexistence of different astronomical traditions. *Marc. gr.* Z. 323 is a fourteenth- to fifteenth-century codex covering Hellenistic, Byzantine and Arabo-Persian astronomy, and Greek mathematics and geometry.[15] *Paradosis* is provided at ff. 71-94*v*. After this, there is a text on the determination of lunar and solar conjunctions (f. 95*r*) and then (ff. 95*r*-165*v*) the set of planetary tables, which is commented on in *Paradosis*. The Islamic astronomy is followed by a text-group of Ptolemaic astronomy: an anonymous introduction to the *Almagest* (ff. 166*r*-169*v*), Proclus's *Exposition of Astronomical Hypotheses* (ff. 171*r*-204*v*), some astronomical texts (ff. 205*r*-221*r*), Stephanus of Alexandria's *Commentary on Ptolemy's Handy Tables* (ff. 222*r*-263*r*), Theon of Alexandria's *Little Commentary on Ptolemy's Handy Tables*, Isaak Argyros's treatise on astronomical tables (ff. 287*v*-288*v*), Ptolemy's *Handy Tables* (ff. 289*r*-382*r*), John Philoponus's treatise on the astrolabe (ff. 384*r*-393*v*), Isaak Argyros's treatise on the astrolabe (ff. 394*r*-398*v*) and further texts of Ptolemaic astronomy.

Marc. gr. Z. 328 is a fifteenth-century codex, prepared by an unknown scribe.[16] It includes *Paradosis* (ff. 30*r*-60*v*) along with the planetary tables on which it is supposed to comment (ff. 61*v*-122*r*). The rest of the content comprises Ptolemaic astronomy of Byzantine authors, such as astronomical treatises by Isaak Argyros and Nicephoros Gregoras.

Marc. gr. Z. 336 is a fourteenth- to fifteenth-century codex, compiled before 1436 by several scribes.[17] In addition to *Paradosis* (ff. 11*v*-30*v*) and the related Arabo-Persian tables (31*v*-132*r*), it contains Ptolemaic astronomy and astrology, Greek geometry, and treatises on astrolabes.

The set of planetary tables commented on in *Paradosis* is also provided by *Marc. gr.* Z. 326 at ff. 55*r*-179*v*, after a fragmentary witness to *Paradosis* (ff. 29*r*-54*v*).[18] Interestingly, the tables follow *Book of Six Wings*, a handbook of Hebrew astronomy on the computation of eclipses, which was translated into Greek by Michael Chrysokokkes (ff. 21*r*-54*v*).[19] Copies of both Gregoras's and Philoponus's treatises on the astrolabe are also handed down in the same manuscript.

In addition, the Arabo-Persian set of planetary tables of *Paradosis* is commented on by another Byzantine handbook, transmitted by two other manuscripts in Bessarion's collection. This is George Chrysokokkes's *Persian Syntax*, a mid-fifteenth-century Byzantine handbook on Arabo-Persian tables, composed around 1347, hence earlier than *Paradosis* (ca. 1352).[20] *Marc. gr.* Z. 309 (fourteenth century) contains *Persian Syntax*.[21] The Arabo-Persian tables are extant in the same manuscript (ff. 74*r*-114*v*). In addition to the tables, the manuscript provides a treatise on the astrolabe by Shams the

15 Mioni, *Codices*, 38-44; Mondrain, "Les écritures dans les manuscrits byzantins", 166; Jary, "Sur une recension du Traité de l'Astrolabe", 46.

16 Mioni, *Codices*, 54-6.

17 Mioni, *Codices*, 77-83.

18 Mioni, *Codices*, 50-2. *Paradosis* was not previously recognised in that manuscript.

19 Solon, "The Six Wings".

20 Mercier, "The Greek 'Persian Syntaxis'".

21 Mioni, *Codices*, 17-20.

Persian (who remains unidentified but could be Shams a-Dīn al-Buḫārī).[22] *Persian Syntax*, alongside its tables, is also handed down in *Marc. gr.* Z. 327, a fifteenth-century astronomical miscellany of Arabo-Persian and Hellenistic astronomy.[23] A Latin version of *Paradosis* is also present in Bessarion's collection. This text is preserved in *Marcianus latinus* VIII 31, a fifteenth-century codex devoted to *Paradosis*, its tables, and to Hebrew tables of chronology and eclipses. It was composed in the first half of the fifteenth century in Crete.[24]

Bessarion himself transcribed other scientific texts or parts of them in the collection, such as Euclid's *Elements*, *Prolegomena ad Euclidis Data* by Marinus of Neapolis, Euclid's *Data*, books 1 to 3 of Theodosius's *Sphaerica*, Euclid's *Phaenomena*, Barlaam's *Logistics*, and Ptolemy's *Almagest* in the manuscript *Marc. gr.* Z. 302. In *Marc. gr.* Z. 310, Bessarion copied the commentary of Nicolaus Cabasilas on the third book of the *Almagest* and Barlaam's *Treatise on the Solar Eclipses of 1333 CE and 1337 CE*. Notes on scientific texts penned by Bessarion are provided in *Marc. gr.* Z. 304, *Marc. gr.* Z. 312, and *Marc. gr.* Z. 316. These transcriptions and notes show Bessarion's interest in Ptolemaic astronomy and Greek mathematics.

Bessarion's autograph transcriptions in the manuscripts *Marc.gr.* 302, 310, 312, 333 show that in his Constantinopolitan and Mistra years he was trained not only in the *Almagest* and Greek astronomy but also in Arabo-Persian tables.[25]

3 The Coexistence of Hellenistic and Arabo-Persian Astronomy: A Global Perspective

The coexistence of Hellenistic and Arabo-Persian astronomy, when viewed from a global perspective, reveals a rich scenario of intellectual exchanges between diverse cultural and geographical spheres. The contributions from the School of Maragha and Tabriz were the original works from which the Byzantine cultural brokers, such as Chioniades, established their Greek translations, which ended up in Bessarion's manuscripts. They served as pivotal catalysts for dissemination of astronomical knowledge beyond the confines of their origins. This diffusion found resonance in various regions, not only in Byzantium, but also in the Yuan and Ming dynasties in China, where the reception of these teachings is evident from historical records and the establishment of institutions to study Arabo-Persian astronomy.[26]

While Ptolemy's works served as the foundational bedrock for both Hellenistic and Arabo-Persian traditions, the underlying methodologies and motivations diverged significantly. The Arabo-Persian tradition, characterised by its meticulous observational practices within observatories under the Caliphs' patronage, stood in contrast to the Christian world view prevalent in Byzantium, focused on contemplation and astrological practice oriented towards politics and warfare. However, pragmatic considerations eventually

22 Ragep, "New light on Shams"; Tihon, "Traités byzantins sur l'astrolabe", 333-5.

23 Mioni, *Codices*, 52-3.

24 Bardi, "Scientific interactions".

25 This confirms the claims of chapter 2.

26 Weil, "The Fourteenth-Century Transformation".

outweighed religious reservations, as Byzantine scholars recognised the efficacy of Arabo-Persian astronomical tables for computational purposes.

The transmission of these astronomical insights further extended into Europe, with works such as Ismael Boulliau's *Astronomia Philolaica* and Jacob Christmann's chronological study on the utilisation of calendars, showcasing the integration of Arabo-Persian influences into European astronomical discourse. A Byzantine version of Arabo-Persian tables, similar to those found in Bessarion's manuscripts, was published by Boulliau in his *Astronomia Philolaica*. Moreover, Boulliau incorporated Chrysokokkes's preface to the Persian tables, detailing Chioniades's journey from Constantinople to Tabriz and his astronomical investigations during his time there.[27] Boulliau's chapter on Chrysokokkes would later be reprinted in the third volume of *Geographiae veteris scriptores graeci minores* (printed in Oxford in 1712).

Christmann made a translation of the work on chronology and astronomy of the Arab astronomer Al-Farghani and printed it in 1590 (reprinted in 1618) in Frankfurt am Main (*Muhamedis Alfragani arabis, Chronologica et astronomica elementa et palatinae bibliothecae veteribus libris versa expleta et scholiis expolita*). This *opus* contains a detailed appendix on ancient calendars, among others the Persian one, taken from a Byzantine manuscript similar to those owned by Bessarion (according to the Yazdegerd era, which corresponds to the starting date 16 June 632 CE).

Although direct utilisation of Bessarion's manuscripts by early modern astronomers and chronologers may not have been feasible, scholars such as Boulliau and Christmann demonstrate use of the textual content preserved in them. Hence, the simultaneous presence of Hellenistic and Arabo-Persian astronomical sources within the intellectual legacy of figures like Bessarion serves to underscore the intricate interconnectedness characterising the dissemination of knowledge across geographical and cultural areas. This phenomenon illuminates the dynamic exchange of ideas prevalent during the medieval period, highlighting the enduring impact of cross-cultural interactions on the evolution of astronomical thought and practice.

4 An Assessment of Bessarion's Astronomical Culture

The coexistence of Hellenistic and Arabo-Persian sources in Bessarion's heritage serves as a witness to the expansive dissemination of knowledge across Islamic and Christian domains. This reconsideration under the lens of global history contains an observation that underscores the cross-cultural nature of scientific knowledge, which can transgress and almost transcends religious and geographical confines. Such an assertion prompts a reconsideration of conventional narratives surrounding the resurgence of Greek science during the Renaissance, urging scholars to adopt a more inclusive and nuanced perspective that acknowledges the multifaceted influences shaping the trajectory of scientific development. More on this is in chapter 5.

Examination of Bessarion's astronomical manuscripts shows that what he preserved is the result of a lifetime labour and reflects the education he received before expatriating to Italy. The works of Hellenistic, Byzantine, Arabo-Persian, and Hebrew astronomy are all part of his background. This solid

27 Bullialdus, *Astronomia Philolaica*, 211-14.

astronomical interest laid the foundations for further interests in Latin astronomy, such as that by Bianchini and Sacrobosco, whose works he owned.[28]

It is noteworthy that the Arabo-Persian astronomical literature, imported from the Islamic world, lacks texts that delve into the realm of physical astronomy, instead emphasising mathematical aspects. The motivations behind this particular emphasis remain subject to speculation, inviting scholarly inquiry into the underlying reasons. Indeed, while the conceptualisation of celestial phenomena in Byzantium continued to be anchored in Aristotelian philosophical frameworks and interpretations drawn from scriptural sources, the prevailing influence of the hesychast culture during the late Constantinopolitan era may have played a significant role in shaping the prevailing attitudes towards the study of astronomy. This suggests the possibility of a nuanced interplay between philosophical, religious, and cultural factors in shaping the trajectory of astronomical inquiry within Byzantine society.[29]

The presence of astrological texts, though not surprising, testifies to Bessarion's favourable views on the investigation of celestial bodies as bearers of physical properties, and, as seen for Bessarion and Regiomontanus's views, subsequent astronomical studies would take them into consideration for further developments.

The claims about Bessarion as a purist of Ptolemaic astronomy are by no means applicable to the astronomical culture that he brought to Latin Europe. In the light of his manuscripts collection, I propose to view Bessarion's astronomical culture as a hybrid one. The notion of hybridity is appropriate to describe what one finds in the study of Bessarion's education and his manuscripts, embracing the several cultural influences and the spirit of comparison and reform of astronomy that I have described thus far.

28 See Appendix.

29 Bardi, "The Relationships between Scientific and Theological Discourses".