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and

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Alan C. Bowen and Francesca Rochberg, editors
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Contents

From the Editors

15 Aug 2021

We, the editors of *Aestimatio*, welcome articles concerning texts and ideas in the history of science that focus on the Old World, ranging from Eurasia to Africa before the modern era, where scientific activity has left its traces by producing bodies and systems of knowledge that either counted as science or bore some significant relation to what counted as science at the time. Our specifying the focus of *Aestimatio* in this way does not involve our taking for granted any particular view of the way or ways in which science is defined or practiced in history. For us, science is not to be characterized solely as a body of knowledge or as a function of social networks and communities, but instead as the product of an engagement between communities and the worlds that they seek to describe or understand. This conception of premodern science in the Old World is, we maintain, the best rubric for the great number of ways in which its history may be studied.

In addition to reviews of noteworthy books, this issue of *Aestimatio* includes some very fine studies and discussions that will, we trust, interest our readers. Potential contributors should bear in mind that we also seek to publish sources, that is, editions and translations of texts falling within the journal's remit.

Alan C. Bowen and Francesca Rochberg

The *Tabulae eclypsium* by Giovanni Bianchini

by

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Abstract

The *Tabulae eclypsium* by Giovanni Bianchini (d. after 1469) was part of a larger work, the *Flores Almagesti*, on mathematical astronomy. In his work on eclipses, which hitherto has not been studied in depth, Bianchini compiled new tables, strictly adhering to Ptolemy's procedures, and explained their use by means of worked examples to facilitate the task of computers. Bianchini's works were influential among his contemporaries, especially Peurbach and his student Regiomontanus, with whom Bianchini corresponded. For a variety of reasons, Regiomontanus' works have eclipsed Bianchini's. In this article, we present one of Bianchini's major works, with the aim of restoring a more balanced perspective on 15th-century mathematical astronomy in Europe.

About the Authors

José Chabás is professor emeritus at the Universitat Pompeu Fabra (Barcelona, Spain) and has been working on the history of late medieval and early modern astronomy. His latest book, *Computational Astronomy in the Middle Ages: Sets of Astronomical Tables in Latin* (Madrid: CSIC, 2019), surveys the major astronomical tables in that period. He contributed to this article within the framework of the European Research Council project ALFA Shaping a European Scientific Scene: Alfonsine Astronomy (grant agreement 723085), a project in which he remains actively engaged.

Bernard R. Goldstein, university professor emeritus in the Dietrich School of Arts and Sciences of the University of Pittsburgh, has been collaborating with José Chabás for close to three decades. Among their joint publications are *The Alfonsine Tables of Toledo* (Archimedes: New Studies in the History and Philosophy of Science and Technology 8. Dordrecht: Kluwer, 2003); *Essays on Medieval Computational Astronomy* (Leiden: Brill, 2015); and "The Medieval Moon in a Matrix: Double Argument Tables for Lunar Motion", *Archive for History of Exact Sciences* 73 (2019) 335–359.

Giovanni Bianchini (d. after 1469) worked in Ferrara as general administrator of the estate of the powerful family d'Este, first for Nicolò (d. 1441), Signore of Ferrara, Modena, Parma, and Reggio, then for Leonello (d. 1450), and finally for Borso (d. 1471). While not much is known about his life and his professional activities, Bianchini's scientific work, which focused on mathematics and astronomy, has been the subject of research in recent years.[1] A survey of his works on astronomy and trigonometry has recently appeared [Chabás 2019, 337–364]. Bianchini also composed a text on an instrument to determine the altitude of celestial bodies [Garuti 1992]. However, his main work on astronomy is a long text entitled *Flores Almagesti*, which deals with all major problems of astronomy and includes extensive discussions on arithmetic and algebra.[2] Of particular interest to us are several sets of astronomical and trigonometrical tables that Bianchini compiled.

The *Flores Almagesti*, Bianchini's most ambitious work, was composed over a long period, from 1440 to at least 1456. The text has not yet been edited and its contents have not been thoroughly examined.[3] His most extensive set of tables, called *Tabulae astronomiae,* concerns planetary motion and was completed in 1442. Ten years later, he presented this set to the Holy Roman emperor Frederick III (1415–1493) during his visit to Ferrara. It is Bianchini's only work to have been published (first edition: Venice 1495) and has recently been studied in Chabás and Goldstein 2009. In addition to a series of precise trigonometric tables with a norm of 60,000, Bianchini compiled three other sets of tables. The *Tabulae magistrales* is an independent set of eight auxiliary tables addressing problems in spherical astronomy,

[1] For Bianchini's life and works, see Federici Vescovini 1968: cf. Boffito 1907–1908, and Magrini 1917.

[2] For Bianchini's mathematical activity, see Rosińska 1984, 1996, 1997, 1998, and 2006.

[3] A list of the rubrics of the *Flores Almagesti*, based on Paris, BnF, MS lat. 10253, was published in Thorndike 1950, 176–180. See also Thorndike 1953, 5–17. These two articles provide relevant information on Bianchini's works and the manuscripts containing them.

which has been analyzed recently in Chabás 2016. Among these tables is an innovative decimal table for the tangent function. The study of the *Tabulae primi mobilis*, a set of tables focusing on problems related to spherical astronomy accompanied by a text, is now underway and preliminary results are already available [see Van Brummelen 2018 and 2021]. The third set, the *Tabulae eclypsium*, consisting of a text and various tables, is the subject of the present paper.

1. Texts and tables

The text that accompanies the *Tabulae eclypsium* consists of 39 chapters under the title "Canones tabularum de eclypsibus luminarium de Blanchini editarum". The contents of this text have not been addressed in the modern scholarly literature. The canons are preceded by a *Prohemium* beginning "In libro Florum Almagesti per Ioannem Blanchinum demonstrati est componere tabulas necessarias". The titles of the chapters, or their *incipits* when there is no title, are listed in the Appendix [p. 38 below]. The tables associated with the text are sometimes found independently, often together with other tables compiled by Bianchini, not necessarily on eclipses.

We examined the following manuscripts:

- Bologna, Biblioteca Comunale, MS 1601, 17v–30r (canons), 71v–73v (tables) [henceforth, BC];
- Cracow, Biblioteka Jagiellońska, MS 556, 25r–34v (canons), 40r–41v (tables), dated 1469 [henceforth, C1];
- Oxford, Bodleian Library, MS Can. Misc. 517, 99v–111r (canons), 157r–159v (tables);
- Paris, Bibliothèque nationale de France, MS lat. 7270, 167r–181r (canons), 233r–235v (tables), dated 1461[henceforth, P1];
- Paris, Bibliothèque nationale de France, MS lat. 7271, 169r–180r (canons), 237r–238r, 240r–v (tables);
- Paris, Bibliothèque nationale de France, MS lat. 7286, 82r–92r (canons), 136r, 137r–138v (tables) [henceforth, P2];
- Paris, Bibliothèque nationale de France, MS lat. 10265, 84r–85v, 87r, 222r (tables) [henceforth P3];
- Paris, Bibliothèque nationale de France, MS lat. 10267, 81r–106v (canons), dated 1468 [henceforth, P4];
- Vatican, Biblioteca Apostolica, MS Vat. lat. 2228, 1r–16r (canons), dated 1470 [henceforth, Va];
- Vatican, Biblioteca Apostolica, MS Vat. lat. 3538, 38r–41r (tables);
- Venice, Museo Civico Correr, MS Cicogna 3748, 153r–164r (canons).

For the canons, we have used MS P1 as a guide, since it is the earliest manuscript known to contain this work (dated 1461). But for the tables, we have mainly used MS C1.

By far, the predecessor most cited in the canons is Ptolemy, for whom Bianchini had great admiration, specifically for his *Almagest*. Other ancient scholars mentioned are Euclid and Hipparchus. Bianchini also refers to some later scholars, notably al-Battānī (d. 929) and Ioannes Anglicus (13th century), as well as to several astronomical works, such as the Toledan Tables and the Alfonsine Tables.

The text of the *Tabulae eclypsium* contains many references to Bianchini's *Flores Almagesti*. As will be explained below, a few chapters of the canons to the *Tabulae eclypsium* were taken verbatim from the *Flores Almagesti*, which is extant in a small number of manuscripts:

- Bologna, Biblioteca Universitaria, MS 293, 3r–109v [henceforth BU];
- Cracow, Biblioteka Jagiellońska, MS 558, 1r–100r [henceforth C2];
- Paris, Bibliothèque nationale de France, MS lat. 10253, 6r–138v (dated 1481);
- Perugia, Biblioteca Comunale Augusta, MS 1004, 1r–77r;
- Vatican, Biblioteca Apostolica, MS Vat. lat. 2228, 16v–51v, 78r–120r (dated 1470).

In addition to the above manuscripts, the *Flores Almagesti* is partially preserved in Cracow, Biblioteka Jagiellońska, MS 601, 62v–68v, and Vatican, Biblioteca Apostolica, MS Reg. lat. 1904, 1r–56r.

The *Flores Almagesti* consists of eight treatises, divided into books and then into chapters. The text begins

> Tractatus primus de arismetica per Iohannem de Blanchinis. Liber primus, Incipit prohemium. Aritmethrica dico quod determinator per numeros,

and ends "cum quibus perficientur opus nutu Dei gloriosi".

The various copyists did not agree on the number of treatises in the *Flores Almagesti*, and it is often the case that the titles and the numbering of the chapters have been omitted. This has generated many errors in cataloging this work. Fortunately, the sequence of chapters is almost the same in all manuscripts. Comparison of the different copies indicates the following structure:

- treatise 1 on arithmetic;
- treatise 2 on algebra;
- treatises 3 and 4 on trigonometry;
- treatise 5 on spherical astronomy;

- treatises 6, 7, and 8 on astronomy.

The *Flores Almagesti* and the *Tabulae eclypsium* are closely related, and one part of the *Flores* (specifically, the closing chapters of treatise 7) was "recycled" as the first six chapters of the canons to the *Tabulae eclypsium*.[4] In MS C2, a manuscript of Italian provenance with annotations ascribed to Regiomontanus, the *Flores* ends on f. 100r. In the remainder of the manuscript there is a copy of other chapters (7–21 and 24–38) of the *Tabulae eclypsium*, as well as short canons on the lunar node and the color of eclipses, up to f. 116r. The same arrangement is found in MS BU, where the *Flores* ends on f. 109v, and chapters 7–21 and 24–38 of the *Tabulae eclypsium* were appended, together with the short canons on the lunar node and the color of eclipses. The copyist considered these additions as treatises 9 and 10. The additions in MSS C2 and BU point to a strong relationship between these two manuscripts.

The date of the *Flores Almagesti* is uncertain, but it is known that the text was still being written in 1456, as stated in treatise 6, chapter 1;[5] and during the period that it took Bianchini to complete it, he wrote other texts and compiled other tables. Considered as a whole, the *Flores Almagesti* seems to be an attempt by Bianchini to update Ptolemy's *Almagest*.

2. Table for the angle between the meridian and the ecliptic

In the computation of eclipses, lunar parallax plays a critical role, and this is the first topic that Bianchini addresses in his *Tabulae eclypsium*, thus following Ptolemy closely.

In *Almagest* 5.18, Ptolemy presents a table in nine columns to compute parallax in altitude, from which the components in longitude and latitude can be determined [Toomer 1984, 265]. For that purpose, the angle between the great circle passing through the zenith (i.e., a vertical circle) and the lunar orb is needed. In *Alm.* 5.19, Ptolemy explains that it is sufficient to approximate this angle by taking the angle between a vertical circle and the ecliptic; and in *Alm.* 2.13, he provides tables for the angles between the ecliptic and the verticals for the seven climates, each zodiacal sign, and

[4] The text of the relevant chapter in *Flores Almagesti* is the same as that opening the *Tabulae eclypsium* but for slight differences in the *incipits*: "Hucusque demonstrandum est componere tabulas necessarias" (*Flores Almagesti*) and "In libro Florum Almagesti per Ioannem Blanchinum demostratum est componere tabulas necessarias" (*Tabulae eclypsium*).

[5] See, e.g., MS C2, 49r–v, where 1456 is referred to as "the present year".

each hour of the day [Toomer 1984, 267, 122–130; Neugebauer 1975, 47–52]. We note that for each zodiacal sign the values for noon, that is, the angles between the ecliptic and the local meridian, are the same in all climates, and are thus valid for all geographical latitudes. Hence, only one entry is given for each zodiacal sign. The situation is illustrated in Figure 1, where V is the vernal point and the Moon is at M.

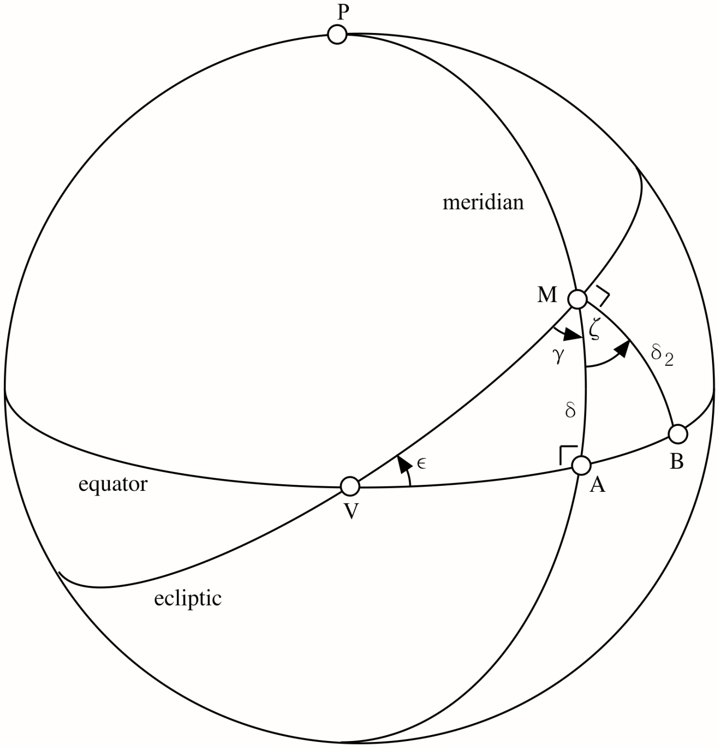

Figure 1. The angle between the ecliptic and the meridian

The first table in Bianchini's set is entitled "Tabula angulorum ex meridiano et orbe signorum in omni regione", and it is indeed a table listing the values of the eastern angles between the local meridian and the ecliptic at noon. The title correctly indicates that the table is valid for all places on Earth.

There are two major differences between Ptolemy's and Bianchini's tables. First, Bianchini gives 30 entries for each zodiacal sign at noon whereas Ptolemy only lists one—for the beginning of the sign. Second, Bianchini uses a value of 23;33,30° for the obliquity of the ecliptic, whereas Ptolemy uses 23;51,20°.

The argument in Bianchini's table ranges from 0° to 360° at intervals of 1°, and it is presented in 12 columns, one for each zodiacal sign, beginning in Aries, in contrast to Ptolemy's tables, which begin in Cancer. The first entry in the table, for Ari 0°, is 66;26° and the entry for Lib 0° is 113;33°. However, in three copies, MSS C1, P2, and BnF 7271, the two entries are given as 66;26½° (= 90° − 23;33,30°) and 113;33½° (= 90° + 23;33,30°). Although inspired in Ptolemy, this table is unprecedented in its format.

	Ari	Tau	Gem	Cnc	Leo	Vir
0	66;26½	69;19	77;42	90; 0	102;18	110;41
...						
10	66;48	71;32[a]	81;31	94;20	105;40	112;18
...						
20	67;42	74;20[a]	85;40[a]	98;29	108;28	113;12
...						
30	69;19	77;42	90; 0	102;18	110;41	113;33½

[a] For the location of scribal or author's errors, see below.

Table 1. Angle between the meridian and the ecliptic
(Excerpt of the first half of the table)

Let $e(x)$ be an entry in the table. Then the following symmetry relations hold:

$$e(x) + e(180–x) = 180^\circ \text{ and } e(x) = e(360–x).$$

These symmetry relations make it easy to visualize the second half of the table (not displayed here) with its symmetrical entries, and to identify the faulty entries in the table.

We have found three such scribal or author's errors in the entries in Table 1.

(1) Tau 10° has 71;33°, but Aqr 20° has 71;32°, which corresponds to the entry 108;28° both for Leo 20° and Sco 10°;
(2) Tau 20° has 74;26°, but Aqr 10° has 74;20°, which corresponds to the entry 105;40° both for Leo 10° and Sco 20°;
(3) Gem 20° has 85;46°, but Cap 10° has 85;40°, which corresponds to the entry 94;20° both for Cnc 10° and Sgr 20°.

We note that the corresponding entries in the second half of the table are correct.

Surprisingly, all but two of the manuscripts examined share exactly the same three scribal errors and have no other such errors. The exceptions are MSS P2 and BC: in both, two errors (Tau 10° and Gem 20°) are corrected, and a new one in Ari 20° occurs (67;43° rather than 67;42°, as found in the second half of the table in all manuscripts).

This topic is addressed by Bianchini in his *Flores Almagesti*, treatise 7, chapter 2, which is entitled "Quantitatem anguli ex meridiano et orbe signorum apud punctum quemlibet per declinationem notam invenire" [MS BU, 80v–81v]. Bianchini explains Ptolemy's method for finding the angle between the meridian and the ecliptic [cf. Neugebauer 1975, 47–48]. He illustrates this method with a figure, consisting of four great circles [see Figure 2, p. 10 below]. The meridian and the equator are so labeled in the original figure. The ecliptic passes through b, r (Libra 0°), and t. The fourth circle is drawn so that its pole is b and passes through c (the East point). Although not specified by Bianchini, this situation defines a spherical Menelaus configuration where h is the vertex, hc and hb are the external arcs, and ac and bt are the internal arcs. On the external arc hc, the unknown, $\gamma{-}90°$, is arc ct and $hc = 90°$. On the external arc hb, the lunar declination, $\delta(M)$ is arc ba, whereas arc $ah = 90°{-}\delta(M)$. On the internal arc bt, we have $br = 180°{-}\lambda(M)$ and $rt = \lambda(M){-}90°$.

In general, the Menelaus configuration in Figure 2, using sines rather than chords, may be written as

$$\sin ct = \frac{\sin ba}{\sin ah} \cdot \frac{\sin rt}{\sin br} \cdot \sin 90°$$

that is, as

$$\sin(\gamma{-}90°) = \frac{\sin \delta(M)}{\sin(90°{-}\delta(M))} \cdot \frac{\sin(\lambda(M){-}90°)}{\sin(180°{-}\lambda(M))} \cdot \sin 90°. \qquad (1)$$

Bianchini considers only one case, where the Moon is at b, the beginning of Virgo ($\lambda = 150°$). On the external arc which lies on the meridian, the declination ba is correctly given as $\delta = 11;32°$, and ah is its complement in 90°. On the internal arc on the ecliptic, br is 30° and rt is its complement in 90°. On the external arc through h, c, and k, the arc hc is 90°, and the unknown is arc ct.

For this special case and using sines normed to 60,000, Bianchini computes:

$$\sin(\gamma{-}90°) = \frac{\sin 11;32° \cdot \sin 60° \cdot \sin 90°}{\sin(90°{-}11;32°) \cdot \sin 30°} = 21{,}206.$$

In Bianchini's sine table, 21,206 is indeed the sine of 20;42°. Therefore, the angle between the meridian and the ecliptic is $90° + 20;42° = 110;42°$, which corresponds almost exactly to the entry for Vir 0° in Table 1 [p. 8 above]

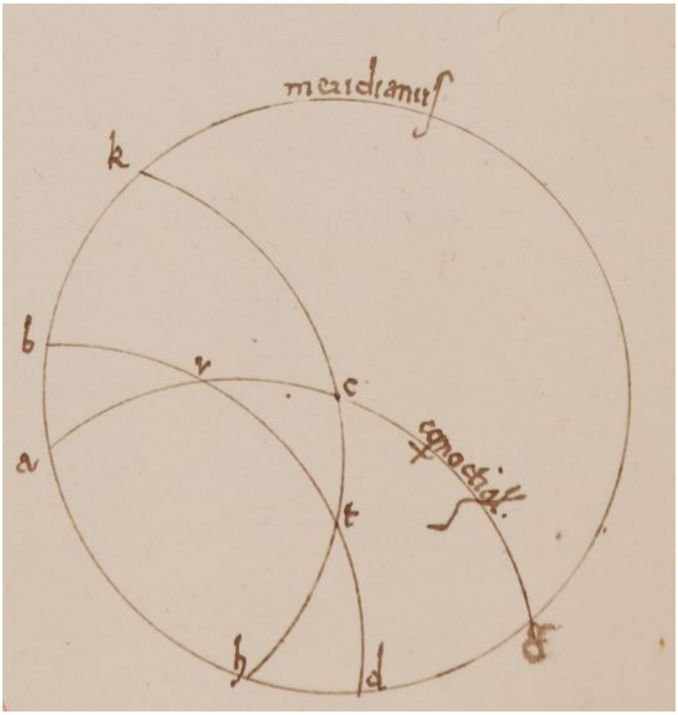

Figure 2. Bianchini's drawing for the angle between the ecliptic and the meridian [MS BU, 80v]

(110;41°). This value is consistent with the symmetrical values for Sco 0° (110;41°), Tau 0°, and Psc 0° (69;19°). Bianchini adds that Ptolemy found this angle to be 111;0° because he used a value for the obliquity of the ecliptic (23;51,20°) that is different from his (23;33,30°) [cf. *Alm.* 2.13].

In chapter 11 of the *Tabulae eclypsium*, entitled "De inventione angulorum ex meridiano & orbe signorum equaliter correspondentium in omni regione" [MS P1, 171v], Bianchini addresses the same problem and introduces another method for computing this angle, which can be expressed as:

$$\sin(\gamma - 90°) = \frac{\tan\delta(M)}{\tan\lambda(M)}. \qquad (2)$$

Equation (2) is equivalent to equation (1) because $\sin\delta/\sin(90°-\delta)$ reduces to $\tan\delta$ and $\sin(\lambda-90°)/\sin(180°-\lambda)$ reduces to $\tan\lambda$. The declination, δ, can be derived by using the corresponding table or by means of the formula:

$$\sin\delta = \sin\varepsilon \cdot \sin\lambda, \qquad (3)$$

where the obliquity of the ecliptic, ε, is taken to be 23;33,30°. In this chapter, Bianchini explicitly mentions a tangent table, which he calls the fourth *tabula magistralis*, for computing the tangents of δ and λ [Chabás 2016, 548, 550]. This table is mentioned several times in the *Tabulae eclypsium* and is used here for the first time outside spherical astronomy. In our recomputation, we have used equations (2) and (3), rather than a table for the solar declination as a function of its longitude. As shown in Table 2, the agreement between text and computation is excellent.

λ	δ	γ	Text	
0	0	66;26,30	66;26	or 66;26½
10	3;58,47	66;45,41	66;48	
20	7;51,25	67;43,10	67;42	
30	11;31,40	69;18,47	69;19	
40	14;53,12	71;31,48	71;33	71;32 in the other half
50	17;49,44	74;20,36	74;26	74;20 in the other half
60	20;15, 4	77;42, 5	77;42	
70	22; 3,36	81;31, 5	81;31	
80	23;10,46	85;40,12	85;46	85;40 in the other half
90	23;33,30	90	90	

Table 2. Recomputation of the entries in Table 1
(All entries are in degrees)

Bianchini could have computed the entries in this table in various other ways, since he had compiled several tables that could serve as auxiliary tables. Of particular interest here are his two different tables for declinations. One is for the usual declination, which he calls *vera*, measured from the equator on a great circle perpendicular to it, and the other is for what he calls *novissima declinatio*, a "declination" measured from the equator on a great circle perpendicular to the ecliptic, which has been called "second declination".[6] These two quantities are illustrated in spherical right triangle MAB in Figure 1 [p. 7 above]: MA is the declination δ and MB is the second declination δ_2. The angle at M between the meridian and the perpendicular to the ecliptic, that is, between MA and MB, is $\zeta = 90°-\gamma$. In this triangle,

$$\cos(90°-\gamma) = \frac{\tan\delta}{\tan\delta_2}. \quad (4)$$

[6] See Van Brummelen 2018. Both tables are found in MS P3, 92r.

This equation yields γ, the angle between the meridian and the ecliptic, either using its cosine or its sine, since $\cos(90°-\gamma) = \sin\gamma$.

As mentioned above, Bianchini follows Ptolemy closely by appealing to Menelaus configurations, and updates Ptolemy's computations with new auxiliary functions, as is the case here. Table 3 displays a comparison between the results obtained by Ptolemy in *Alm.* 2.13, based on the value for the obliquity of the ecliptic of 23;51,20°, and those by Bianchini, based on the value of 23;33,30°.

λ	Ptolemy	Bianchini
0	66; 9	66;26½
30	69; 0	69;19
60	77;30	77;42
90	90	90
120	102;30	102;18
150	111; 0	110;41
180	113;51	113;33½

Table 3. Comparison between the entries in Ptolemy and Bianchini for the angle between the ecliptic and the meridian
(All entries are in degrees)

Angle γ is essential for determining the components of lunar parallax in longitude π_λ and latitude π_β when the Moon is on the meridian. But, before determining the components, it is necessary to compute the lunar parallax on a vertical circle. Bianchini does so, and the results of his computation are displayed in Tables 4 [p. 15] and 5 [p. 16].

3. Tables for lunar parallax

Computing lunar parallax is far from being a trivial problem. Ptolemy solved it by means of what we now call a function of three variables, which he presents in *Alm.* 5.18 as a table of nine columns [Toomer 1984, 265]. The entries in this table determine the lunar parallax in altitude as a function of the lunar zenith distance, anomaly, and elongation. Figure 3 [p. 13 below] shows the total parallax of the Moon, $\pi = z' - z$, where z' is the apparent zenith distance of the Moon for an observer at O, and z is its true zenith distance from the center of the Earth. In Bianchini's words, total parallax is "differentia inter locum eius visibilem et locum verum ad regionum latitudines" [MS BU, 98r].

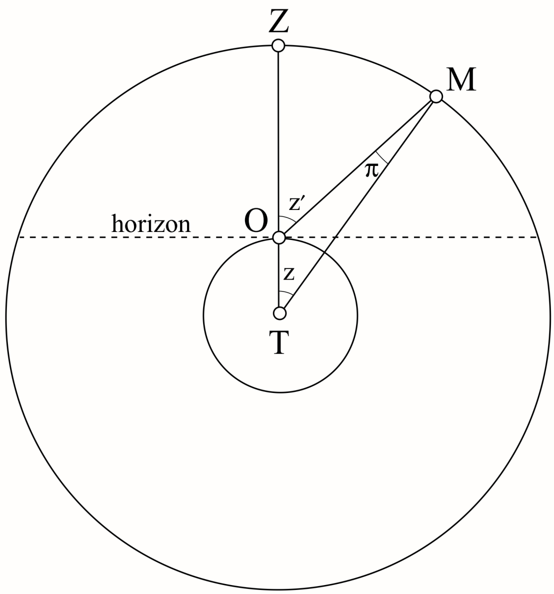

Figure 3. Lunar parallax as a function of the zenith distance z

Bianchini's two tables for the computation of parallax [see Tables 4 and 5] are addressed in chapter 7 of his *Tabulae eclypsium*, and a succinct description is given that follows the pattern established by Ptolemy. This subject was already addressed in chapters 18 and 19, at the end of treatise 7, book 2, of the *Flores Almagesti*, under the general title, "De modo componendi tabulas de diversitate aspectus lune" [MS BU, 98r–99v].

In contrast to Ptolemy's table in nine columns for solar and lunar parallax, Bianchini deals exclusively with lunar parallax, and thus has no column for solar parallax—we have no explanation for this. Moreover, Bianchini has two separate tables, one for the Moon at syzygy and the other for the Moon at quadrature. Despite borrowing the format already used by Ptolemy, there are a few noticeable differences. The most obvious is that in Ptolemy's table the argument ranges from 2° to 90° at steps of 2°, while in Bianchini's the argument is given for all integer values from 1° to 180°. Thus, Bianchini extends the 45 rows in Ptolemy's table to 180 rows, thereby providing four times as many entries. This change was intended to overcome a difficulty already mentioned by Ptolemy himself in *Alm*. 5.19: to use his table, the three independent variables involved (lunar zenith distance, anomaly, and elongation between the two luminaries) must be halved. In his table, Bianchini adheres to the proper meaning of the variables: zenith distance, anomaly, and double elongation.

A second departure from Ptolemy is that the entries common to both tables do not agree. This may be surprising at first glance, given that the same model and the same parameters are used in both cases. Close examination of the entries indicates that Ptolemy computed a selection of entries in each column and applied linear interpolation, generally at intervals of 6°, to obtain the rest. In contrast, Bianchini seems to have computed all entries anew, without taking into account Ptolemy's entries or appealing to interpolation. Indeed, in chapter 14 of the *Tabulae eclypsium*, Bianchini calls attention to the fact that this is a new table: "in tabula diversitatis aspectus lune per me noviter constructa". As far as we are aware, Bianchini was the only astronomer to recompute and extend Ptolemy's table for solar and lunar parallax, which was otherwise left untouched for centuries. For example, al-Battānī limited himself to reproducing Ptolemy's table, with some variant readings [Nallino 1903–1907, 2.93–94].

In Tables 4 and 5, which display excerpts of Bianchini's tables for lunar parallax, we have used as headings the column numbers in Ptolemy's table in nine columns. In both tables, the argument c_1 is the zenith distance z and it is given for each integer degree from 0° to 180° and its complement in 360°.

In Table 4 [p. 15 below], the other three columns are given in minutes of arc and all apply to the Moon at syzygy. Column c_3 is a function of the zenith distance and gives the lunar parallax when the Moon is at the apogee of the epicycle at syzygy. Column c_4, also a function of the zenith distance, provides the increment to be applied to an entry in c_3 to obtain the parallax at perigee. For intermediary situations, a column for interpolation (called "minutes of proportion"), c_7, is needed. Note, however, that c_7 depends on true anomaly, α. As shown by Neugebauer [1975, 112–115], the parallax at syzygy π_s is then:

$$\pi_s = c_3(z) + c_7(\alpha) \cdot c_4(z). \qquad (5)$$

In Table 5 [p. 16 below], in addition to the column for the argument, there are four columns, all concerning the Moon at quadrature. The entries in columns 6, 8, and 9 are given in minutes of arc; whereas those in column 5 are displayed in degrees. As was the case with column 3 for syzygy, column c_5 is a function of the zenith distance z (found in c_1), and yields the

	c_1 (°)	c_3 (′)	c_4 (′)	c_7 (′)
1	359	0;28	0; 5	0; 1
…				
30	330	14; 0	2;43[a]	3;43
…				
60	300	27; 5	5;16[b]	14; 4
…				
90	270	38; 7	7;25	28;41
…				
120	240	46;38	9; 2	43;58
…				
150	210	51;44	9;59	55;40
…				
180	180	53;26	10;14	60; 0

[a] MSS BC, P2, and Paris 7271 read 2;44, and MS P3 reads 2;48?
[b] MS Paris 7271 reads 4;16.

Table 4. Bianchini's lunar parallax at syzygy (excerpted)

lunar parallax when the Moon is at the apogee of the epicycle at quadrature. Analogously, column c_6, also a function of the zenith distance, provides the increment to be applied to an entry in c_5 to obtain the parallax at perigee. For intermediary situations, there is also a column here for the minutes of proportion, c_8, which depends on true anomaly α. The parallax at quadrature π_q is then:

$$\pi_q = c_5(z) + c_8(\alpha) \cdot c_6(z). \quad (6)$$

Equations (5) and (6) serve as the extremes for all situations between syzygy, where the mean elongation of the Sun and the Moon is 0°, and quadrature, where the mean elongation is 90°. For intermediary situations, it is necessary to introduce an interpolation scheme, column 9, with entries given in minutes as a function of mean elongation, $\bar{\eta}$. The 3-variable function for total lunar parallax thus becomes

$$\pi = \pi_s + c_9(\bar{\eta}) \cdot (\pi_q - \pi_s). \quad (7)$$

Use of Tables 1 [p. 8 above], 4, and 5 [p. 16 below] together makes it possible to compute the longitudinal π_λ and latitudinal π_β components of total lunar parallax π [see Figure 4, p. 17 below]. Since π (= arc MM') is small, one may apply plane rather than spherical trigonometry, without introducing significant errors, as Ptolemy explains [*Alm.* 5.19: see Toomer 1984, 266 with Neugebauer 1975, 116]:

$$\pi_\lambda = \pi \cos \gamma \text{ and } \pi_\beta = \pi \sin \gamma,$$

where γ is the angle between the ecliptic and the meridian.

c_1 (°)		c_5 (°)	c_6 (′)	c_8 (′)	c_9 (′)
1	359	0; 0,42	0;13	0; 2	0; 2
…					
30	330	0;20,38	6;35	3;31	4;48
…					
60	300	0;39,52[a]	12;31	13;36	17;21
…					
90	270	0;56, 3	17;41	28; 1	33; 9
…					
120	240	1; 8,24	21;29	43;24[b]	47;21
…					
150	210	1;15,51	23;35	55;26[c]	56;46
…					
180	180	1;18, 7	24;10	60; 0	60; 0

[a] MSS BC, P2, and Paris 7271read 0;39,57, and the entry in MS C1is blank.
[b] MS BC reads 42;24.
[c] MS Va reads 55;27.

Table 5. Bianchini's lunar parallax at quadrature (excerpted)

By accepting Ptolemy's parameters for the Moon in his parallax table, Bianchini was implicitly adhering to his predecessor's approach to the variation in lunar distance from the Earth. Some astronomers, notably Levi ben Gerson (d. 1344) and Ibn al-Shāṭir (d. 1375), had already noticed that, with Ptolemy's premises, the Moon-Earth distance varies from 33;33 to 64;10 terrestrial radii [*Alm.* 5.17], thus suggesting that the Moon is twice the size in diameter at quadrature than at syzygy, contrary to observation [Goldstein 1997, 17; Saliba 1996, 102]. Regiomontanus was also aware of this problem.

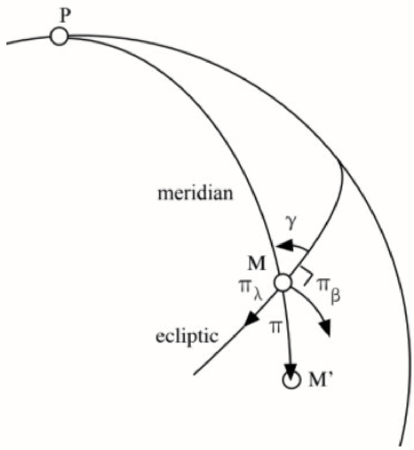

Figure 4. The components of total lunar parallax

In answering a letter he had received from Bianchini on 11 February 1464, he writes:

> And if the moon has an eccentric and an epicycle in the way that has been claimed [by Ptolemy and his followers], it will follow necessarily that in a particular position the moon appear [in area] about four times greater than in another position, other things being in the same condition. [Swerdlow 1990, 174]

This variation was further emphasized by Regiomontanus in book 5, chapter 22 of his *Epitome*, printed in 1496:

> But it is remarkable that when the moon is in quadrature in the perigee of the epicycle, it does not appear so large [i.e., 0;56,22°] in diameter since if the entire moon were illuminated it should appear four times the size (i.e., in area) that it appears in opposition when it is at the apogee of the epicycle. [Swerdlow 1973, 462]

4. Table for the lunar diameter and velocities

Following the order in the *Almagest*, after parallax Bianchini turns to the apparent diameters of the bodies involved in the computation of eclipses and presents a table for the lunar diameter, to which he adds columns for lunar velocities. Table 6 [p. 18 below] displays an excerpt taken from MS C1 that gives velocities with a higher precision than in the other manuscripts that we have examined.

In MS C1, the entries for both velocities, in anomaly and in argument of latitude, are given to thirds, and in MS BC only to minutes; the entry for 1h

Equation Argument (°)	Lunar Diameter (′)	Equation Argument (°)	Lunar Diameter (′)	Equation of Center (h) (°)	Velocity in Anomaly (h) (°)	Velocity in Argument of Latitude (h) (°)
0	31;20					
6	31;21	96	33;27[a]	1 0; 9	1 0;32,39	1 0;33, 4
…						
30	31;35	120	34;16	5 0;45[b]	5 2;43,18	5 2;45,22
…						
60	32;16	150	35; 3	10 1;29[c]	10 4;53,58	10 5;30,44
…						
90	33;15	180	35;20	15 2;13[d]	15 8; 9,56	15 8;16, 6

[a] MS BC reads 33;22.
[b] All but two of the manuscripts consulted read 0;46.
[c] All other manuscripts consulted read 1;30.
[d] All other manuscripts consulted read 2;15.

Table 6. Bianchini's table for lunar diameter and velocities (excerpted)

in MS Cracow is 0;32,39,44°/h, corresponding to the Alfonsine daily mean velocity in anomaly, 13;3,53,57,30°/d. MSS BC and P2 add a column for lunar latitude with a maximum value of 5°, as in the *Almagest*.

In this table, the argument is displayed at intervals of 6° from 0° to 180°, and the entries for the lunar diameter are given in minutes and seconds. The extremal values, 0;31,20° and 0;35,20°, are indeed those found in the canons to chapters 9 and 10 of the *Tabulae eclypsium*. They also agree with those in Ptolemy's *Alm.* 5.14 and 6.5, although Ptolemy did not compile a full table for the lunar diameter [Toomer 1984, 252–254, 284]. From these extremal values, the rest of the entries may be recomputed using an auxiliary table of corrections, c(α), such as that in *Alm.* 6.8, for interpolating between apogee and perigee in lunar eclipses [Toomer 1984, 308]. The entries for the lunar diameter may be computed from the expression

$$0;31,20 + c(\alpha) \cdot (0;35,20–0;31,20),$$

that is,

$$0;31,20 + c(\alpha) \cdot 0;4.$$

Table 7 [p. 19 below] displays the results.

α	c(α)	Lunar Diameter	Text
30	0; 4, 1	0;31,36	0;31,35
60	0;14, 0	0;32,16	0;32,16
90	0;28,42	0;33,15	0;33,15
120	0;44, 0	0;34,16	0;34,16
150	0;55,32	0;35, 2	0;35, 3
180	0;60, 0	0;35,20	0;35,20

Table 7. Recomputation of the entries for the lunar diameter

In chapter 19, Bianchini explains that Ptolemy had derived the extremal values of the lunar diameter, 0;31,20° at apogee and 0;35,20° at perigee [*Alm.* 6.5], from the data of two eclipses in each case and adds that al-Battānī applied the same procedure. Mirroring the *Almagest*, Bianchini proceeds analogously, and in chapter 20 of his *Tabulae eclypsium*,[7] he derives the extremal values of the lunar diameter at apogee and perigee from the data of four lunar eclipses. Note that nowhere in chapter 20 does Bianchini mention any observation or computation of these eclipses. Rather, he only says that he "considered" four eclipses. The information provided is displayed in Table 8 [p. 20 below].

To derive these two values of the apparent diameter of the Moon, Bianchini follows Ptolemy's procedure as presented in *Alm.* 5.14 for the value at apogee, and *Alm.* 6.5 for the value at perigee [Toomer 1984, 253–254, 283–285, resp.]. However, Bianchini's method differs slightly from Ptolemy's, as explained by Neugebauer [1975, 104–108, 1235]: Bianchini considers the lunar latitude (perpendicular to the ecliptic), whereas Ptolemy considers quantities on the great circle perpendicular to the lunar orb, thereby introducing a small difference.For the Moon at apogee, Bianchini uses the lunar eclipses of 1440 and 1451, when the Moon was close to its epicyclic apogee, and the anomaly was thus close to 0°. For the Moon at perigee, he uses the eclipses dated 1448 and 1455, when the lunar anomaly was close to 180°. The entries for the Sun, the Moon, mean anomaly, arguments of latitude and latitude were not observed; rather, they were computed from the time of mid-eclipse whether observed or computed.

[7] A transcription of this chapter is found in Thorndike 1950, 175–176.

	(1) 16 Feb 1440	(2) 12 Sep 1448	(3) 13 Jul 1451	(4) 1 May 1455
Time	16;43h	11;3h	12;16h	12;28h
Sun	Psc 8;3°	Vir 28;47°	Cnc 29;7°	Tau 19;39°
Moon	Vir 8;3°	Psc 28;47°	Cap 29;7°	Sco 19;39°
Mean anomaly	5;54°	"3.23.45"[a]	34;12°	"2.48.40"[b]
Arg. latitude	5;4°	11;28°	6;34°	10;35°
Latitude	0;26,27°	0;39,32°[c]	0;26,27°	0;55,1°
Magnitude	11½	1;25	8;34	2;57

[a] That is, 203;45°.

[b] That is, 168;40°.

[c] This is a mistake for 0;59,32°, as computed from the latitude table. More accurately, it is 0;59,33°.

Table 8. Data of the four eclipses used by Bianchini to determine the lunar diameter

At apogee (eclipses 1 and 3), Bianchini transforms the two lunar arguments of latitude into latitude and obtains 0;26,27° and 0;34,16°, respectively. For this he uses a table for lunar latitude with a maximum of 5°. Actually, for the first eclipse, he should have obtained 0;26,28°. Then, Bianchini finds the difference between these two values and correctly obtains 0;7,49°. For the difference in magnitude, he correctly obtains 2;56 digits (where the lunar diameter is 12 digits), which he takes to be equal to 11/45, given that $2;56 \cdot 45 = 132 = 12 \cdot 11$. He then divides the difference in latitude by the difference in the eclipsed diameters: 0;7,49°/(11/45). The result, 0;31,59°, is not mentioned, and Bianchini indicates that had the Moon been precisely at apogee, the diameter would have been that found by Ptolemy, explicitly given as 0;31,20°.

At perigee (eclipses 2 and 4), the difference in latitude is 0;4,31°. This value is correctly computed if one considers the latitude of eclipse 1 to be 0;59,32° rather than 0;39,32°, as mistakenly given in the text. The resulting difference in magnitude is 1;32, which is said to be 23/180 of the total diameter. Indeed, $1;32 \cdot 180 = 276 = 12 \cdot 23$. As was the case above, the result, 0;35,21°, is not mentioned. Instead, we are told that it is close to Ptolemy's value, explicitly given as 0;35,20°.

It would thus seem that Bianchini was just confirming Ptolemy's data and justifying his use of them. In a more general way, Bianchini seems here to be updating the *Almagest* by appealing to recent eclipses.

We now turn to the three other tabulated quantities in Table 6 [p. 18 above] (equation of center, hourly velocity in anomaly, and hourly velocity in argument of anomaly). In all three cases, the argument ranges from 1 to 15 and is given in hours.

The equation of center is given in degrees and minutes, and indeed in MS C1 the 15 values displayed correspond to the Alfonsine equation of center for arguments 1° to 15°. As for the columns for the lunar velocities in anomaly and in argument of latitude, the entries are displayed in degrees, minutes, and seconds per hour in MS C1. But in the other manuscripts examined, they are rounded to minutes. The entries for one hour, 0;32,39°/h (anomaly) and 0;33,4°/h (argument of latitude), or better, those derived from 15 hours (0;32,39,44°/h and 0;34,4,24°/d, respectively), are rounded values of the Alfonsine daily mean velocities in anomaly, 13;3,53,57,30°/d, and in argument of latitude, 13;13,45,39,22°/d, respectively. In the case of the lunar velocity in anomaly, the use of different precision in the values for one hour in MSS C1 and BC is the reason that the entries from 6 to 11 are increased by 0;1° and those from 12 to 15 are increased by 0;2°.

5. Other tables

In addition to the three tables reviewed above, Bianchini included five tables for the digits of eclipse. Two of them are for solar eclipses and two others for lunar eclipses, each at greatest distance (*ad longitudinem longiorem*) as well as at least distance (*ad longitudinem propinquiorem).* The fifth table is presented in three columns, one for the argument (the fraction of the diameter), and one for each luminary that displays the eclipsed part of its disk. The format is the same as in Ptolemy, al-Battānī, the Toledan Tables, and the Parisian Alfonsine Tables.

The argument in the four tables for the digits of eclipse is the argument of lunar latitude, the variable used in the *Almagest* and in the *zij* of al-Battānī, in contrast to the lunar latitude, which is the variable in Ptolemy's *Handy Tables* and in the *zij* of al-Khwārizmī. Moreover, comparison with the tables in previous sets shows that Bianchini followed most closely *Alm.* 6.8. There is, however, an obvious difference: Bianchini employs the argument of lunar latitude starting at the lunar node, whereas in the *Almagest* it is increased by 90° or 270°. The steps of the argument are the same for Bianchini and Ptolemy: 0;30° for both solar tables and the Moon at greatest distance, and

Argument of Latitude						
North (°)		South (°)		Magnitude (p)	Immersion (′)	Half Totality (′)
12;16	167;44	192;16	347;44	0; 0	0; 0	0; 0
11;42	168;18	191;42	348;18	1; 0	19; 2	0; 0
11; 8	168;52	191; 8	348;52	2; 0	26;45[a]	0 ;0
10;34	169;26	190;14	349;26	3; 0	32;17	0; 0
10; 0	170; 0	190; 0	350; 0	4; 0	36;51	0; 0
9;26	170;34	189;26	350;34	5; 0	40;41	0; 0
8;52	171, 8	188;52	351; 8	6; 0	44; 0	0; 0
8;18	172;42	188;18	351;42	7; 0	46;51	0; 0
7;44	172;16	187;44	352;16	8; 0	49;33	0; 0
7;10	172;50	187;10	352;50	9; 0	51;40	0; 0
6;36	173;24	186;36	353;24	10; 0	53;40	0; 0
6; 2	173;58	186; 2	353;48	11; 0	55;33	0; 0
5;28	174;32	185;28	354;32	12; 0	56;59	0; 0
4;54	175; 6	184;54	355; 6	13; 0	45;50	12;31
4;20	175;40	184;20	355;40	14; 0	42;18	17;35
3;46	176;14	183;46	356;24	15; 0	40; 3	20;30[b]
3;12	176;48	183;12	356;48	16; 0	38;28	22;58
2;38	177;22	182;38	357;22	17; 0	37;19	24;48
2; 4	177;56	182; 4	357;56	18; 0	36;27	26;14
1;30	178;30	181;30	358;30	19; 0	35;57	27;12
0;56	179; 4	180;56	359; 4	20; 0	35;23[c]	27;53[d]
0;22	179;38	180;22	359;38	21; 0	35;23	28;14
0; 0	180; 0	180; 0	360; 0	21;36	35;22	28;17

[a] MS C1 reads 54.
[b] MS C1 reads 31.
[c] MS C1 reads 33.
[d] MS C1 reads 13?

Table 9. Lunar eclipses at least distance in MS BC

0;34° for the Moon at least distance. The maximum values of the argument also agree for the Sun (6° and 6;24°), but not for the Moon (10;48° and 12;12° for Ptolemy; 10;51° and 12;16° for Bianchini). This shows that the values of the argument in Bianchini's lunar tables differ from those in the *Almagest*. Table 9 [p. 22 above] displays one of Bianchini's two tables for the Moon.

All four tables have columns for the magnitude of the eclipse in digits of the diameter. For immersion, that is, the arc between first contact and second contact (beginning of totality), the entry is in minutes of arc. The two tables for lunar eclipses add a column for the half-duration of totality, that is, the arc from second contact to mid-eclipse, which is also given in minutes of arc. Note that these two "durations" are actually arcs and are, therefore, expressed in minutes of arc.

The entries in Bianchini's lunar eclipse tables differ slightly from those in the *Almagest*. Table 10 [p. 24 below] displays selected entries for least distance by the two authors. It should be noted that even though the values of the argument differ—Bianchini chose to have as maximum entry 12;16° instead of the12;12° in the *Almagest*—the magnitudes are common to both Bianchini and Ptolemy. As a matter of fact, magnitude is the underlying argument in tables for the digits of eclipses.

The differences between the corresponding entries of both authors do not reflect copyists' errors; rather, they suggest that Bianchini recomputed the entries in his table. In order to verify this claim and to recompute the entries in Table 9, consider Figure 5 [p. 25 below]. When using Ptolemy's values for the radii of the Moon (0;17,40°) and the Earth's shadow (0;46°) at perigee, and following Ptolemy's procedure, one can derive the entries for the arcs of immersion and half-duration of totality. The first step consists in defining a quantity, μ, proportional to m, the magnitude of the lunar eclipse, $\mu = m(d/12)$, where d is the lunar diameter. Let us call r and s the radii of the Moon and the Earth's shadow, respectively, and S the center of the shadow circle at the middle of the eclipse, when m is maximum. The distance between S and the center of the Moon at first contact, A, is $r+s$, and the distance between S and the center of the Moon at mid-eclipse, B, is $s-(\mu-r)$. Now, let us call C the center of the Moon at the beginning of totality. Then $SC = s-r$. In the right triangle SBC, BC is the distance called half-duration of the eclipse and displayed in Table 9. In the right triangle SBA, BA is the sum of the half-duration and arc CA, called immersion, also displayed in Table 9.

As an example, let us consider the entries for magnitude 18;0, corresponding to arguments of latitude 2;0° in the case of the *Almagest* and 2;4° in the case

Argument of Latitude		Magnitude	Immersion		Half Totality	
Bianchini	Ptolemy		Bianchini	Ptolemy	Bianchini	Ptolemy
12;16	12;12	0; 0	0; 0	0; 0	0; 0	0; 0
11;42	11;38	1; 0	19; 2	19; 9	0; 0	0; 0
…						
10; 0	9;56	4; 0	36;51	36;53	0; 0	0; 0
…						
7;44	7;40	8; 0	49;33	49;25	0; 0	0; 0
…						
5;28	5;24	12; 0	56;59	56;59	0; 0	0; 0
4;54	4;50	13; 0	45;50	45;47	12;31	12;34
…						
2;38	2;34	17; 0	37;19	37;20	24;48	24;49
…						
0;22	0;18	21; 0	35;23	35;22	28;14	28;12
0; 0	0; 0	21;36	35;22	35;20	28;17	28;16

Table 10. Entries for lunar eclipses at least distance given by Bianchini and Ptolemy (excerpted)

of the *Tabulae eclypsium*. This example is of special interest because the entries given by the two authors disagree to the greatest extent: 0;10′ for the arc of immersion and 0;13′ for the arc of half-duration of totality. When $m = 18$, then $\mu = m(d/12) = 0;53$. Therefore,

$$SB = s-(\mu-r) = 0;46^\circ-(0;53^\circ-0;17,40^\circ) = 0;10,40^\circ.$$

Now,

$$SC = s-r = 0;46^\circ-0;17,40^\circ = 0;28,20^\circ$$

and

$$SA = s + r = 0;46^\circ + 0;17,40^\circ = 1;3,40^\circ.$$

Hence, $BC = \sqrt{(SC^2-SB^2)} = 0;26,15^\circ$ is the computed value for the half-duration of the eclipse, and it is to be compared with the entries given by Ptolemy (26;1′) and Bianchini (26;14′). As for the immersion, we first compute

$$BA = \sqrt{(SA^2-SB^2)} = 1;2,46^\circ$$

and subtract from it the half-duration previously computed, 0;26,15° to obtain 0;36,31°. This value is to be compared with the entries given by Ptolemy

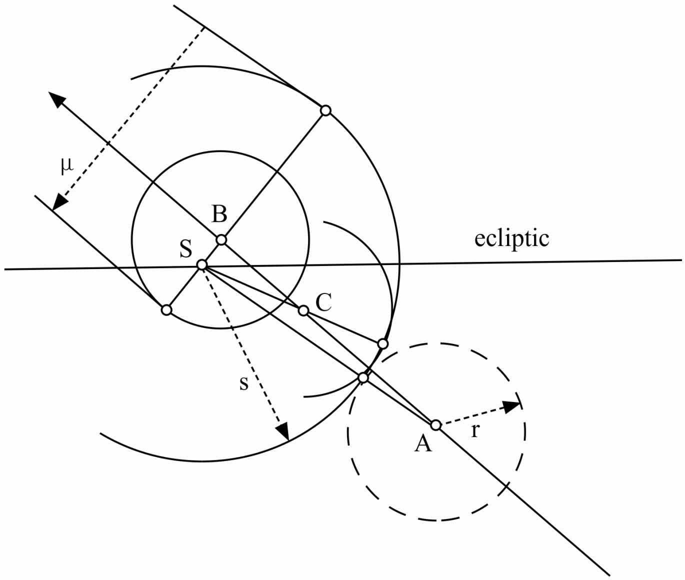

Figure 5. Arcs of immersion and half-duration of a lunar eclipse

(36;37′) and Bianchini (36;27′). In both cases, the recomputed values are closer to Bianchini's entries.

This is not always so. For example, when magnitude m = 14;0, computation for half-duration yields 0;17,17°. The entry in Ptolemy's table is exactly 17;17′, whereas Bianchini gives 17;35′. Other examples indicate that the two authors computed the entries in their respective tables accurately, for the residuals in all cases only affect the seconds. It is impossible to decide who did a better job because the differences between their results are so small that they are obscured by a long tradition of possible copyists' errors in the transmission of the tables.

The fifth table displays the eclipsed parts of the solar and lunar disks. In this instance, the argument is the fraction of the diameter in digits with a maximum value of 12, and the entries for the two luminaries are integrated in a single table [see Table 11, p. 26 below], in contrast to most of the previous tables for the same purpose.

Diameter Linear digits	Sun Area digits	Moon Area digits
1	0;20	0;30
2	1; 0	1;20
3	1;40	2; 4
4	2;40	3;10
5	3;40	4;20
6	4;48	5;30
7	5;50	6:45
8	7; 0	8; 0
9	8;20	9;10
10	9;40	10;20
11	10;50	11;20
12	12; 0	12; 0

Table 11. The eclipsed part of the solar and lunar disks in MS BC

This table appears, with numerous variants, in many sets of astronomical tables, thus making it problematic to determine the direct antecedent for Bianchini's table [see, e.g., Chabás and Goldstein 2012, 175].

6. Detailed computations of a solar and a lunar eclipse in 1460[8]

The computation of a solar eclipse to be observed in the future in Ferrara, in July 1460, begins in chapter 24 and ends in chapter 35. The initial step is to determine the true conjunction of the Sun and the Moon, by first computing their mean conjunction using tables for the radices and mean motions for conjunction integrated in Bianchini's set of planetary tables [Chabás and Goldstein 2009, 79–85, Tables 57–62]. The results for mean conjunction are:

> Time: July 18, 1460 at 1;6h after noon;
> Mean longitude of both luminaries: "2.5.26" (= 125;26°);
> Mean lunar anomaly: "g.211. m.7." (= 211;7°);
> Mean argument of lunar anomaly: "0.7.14" (= 7;14°).

The longitude of the solar apogee for 1460, taken from another table of his, is given as "1.30.48" (= 90;48°) [Chabás and Goldstein 2009, 40–41, Table

[8] The base manuscript for this explanation is MS P1. For checking, we have used MSS BC, C1, P4, and Va.

8]; thus, the solar anomaly is “0.34.38” (= 34;38°). The use of signs of 60° is maintained throughout the text, but the notation, as will be seen in other examples below, varies.

The next step is to determine the true positions of the Sun and the Moon at mean conjunction. For the Sun, Bianchini enters the appropriate table and finds its true longitude, 124;16°, and the corresponding hourly solar velocity, 0;2,23°/h [Chabás and Goldstein 2009, 85–87, Table 63]. For the true position of the Moon at mean conjunction, he enters the appropriate table and obtains 128;10° for the lunar longitude and 0;36,0°/h for the corresponding hourly lunar velocity [Chabás and Goldstein 2009, 87–91, Table 64]. The difference between the two true longitudes at mean conjunction is “g.3. m.54” (= 3;54°).[9] He then finds the *superatio*, that is, the difference between the hourly velocities of the Moon and the Sun, 0;36,0°/h – 0;2,23°/h = 0;33,37°/h, and divides the elongation found above, 3;54°, by the *superatio*, yielding 6;59h (correctly: 6;57,39h).[10] Bianchini then subtracts this amount from the time of mean conjunction, July 18, 1;6h, and finds the time of true conjunction: July 17, 18;7h. The true longitude of the Sun at true conjunction follows:

$$124;16^\circ - 6;59\text{h} \cdot 0;2,23^\circ/\text{h} \approx 123;59^\circ.$$

Analogously for the Moon, he obtains

$$123;59^\circ = 128;10^\circ - 6;59\text{h} \cdot 0;36,0^\circ/\text{h}.$$

We note that with the correctly rounded value 6;58h instead of 6;59h, the results for the true positions of the Sun and the Moon would have been the same, 123;59°.

Then, Bianchini determines the mean argument of lunar latitude at true conjunction and finds 9;18° [Chabás and Goldstein 2009, 87–91, Table 64]. This is a mistake in MS P1 for 9;58°.[11] Next he derives the true argument of latitude:

$$9;58^\circ - 6;59\text{h} \cdot 0;36,0^\circ/\text{h} = 5;47^\circ.$$

MSS C1 and Va disagree and give the result as 5;45°. Bianchini comments that this value implies that the eclipse is possible.

For the computation of the position of the lunar node, Bianchini determines the motion of the center of the Moon in the time between mean and true syzygy, 6;59h, and finds 7;0° and its complement in 360°, 353;0°. He then

---

[9] Note the change in notation.

[10] All manuscripts examined have 6;59h.

[11] MS Va has the proper reading and MSS C1 and BC have 9;18° emended to 9;58°.

subtracts the argument of lunar latitude 5;47° from the lunar longitude 123;59° both at true conjunction and finds 118;54° (correctly: 118;12°) for the longitude of the node at true conjunction.[12]

Analogously, from the mean lunar anomaly at mean conjunction, 211;7°, Bianchini derives its value at true conjunction, 6;59h earlier. Rather than multiply this interval by the velocity in anomaly, Bianchini uses the table for lunar diameter and velocities [see Table 6, p. 18 above], listing multiples of the hourly velocity in anomaly (0;32,39°/h or 0;32,39,44°/h). The entry found is then subtracted from the lunar anomaly at mean conjunction to obtain 207;19°, the mean lunar anomaly at true conjunction. This has to be converted into a true anomaly. In the same table, called *tabula gracilis* in the text, the corresponding value for the equation of center is 1;2°, which he subtracts from the previous one to get 206;17°, the equated anomaly at true conjunction.

To close chapter 24, Bianchini summarizes the results obtained for true conjunction at Ferrara.

> Time: 1460 “imperfecto”, July 18 at 5;53h before noon (“diebus non equatis”) or at 5;41h, after the equation of time is applied
> True longitude of the luminaries: “g.3. m.59. leonis” (= 123;59°)[13]
> Longitude of the lunar node: “g.28. m.14. cancri” (=118;14°)
> Argument of lunar latitude: 5;41°[14]
> True lunar anomaly: 206;17°
> Mean center: 5;53°[15]
> Motion of the Sun in an hour: 0;2,23°/h
> Motion of the Moon in an hour: 0;36,0°/h
> Lunar latitude: +0;30,1°

In the following chapters, Bianchini computes other quantities involved in this eclipse. Chapter 25 is devoted to the computation of the zenith distance of the Moon at the time of the eclipse. For that purpose, he uses several

[12] MSS P1, P4, BC, and Va read 118;54°. MS C1 reads 118;14°. See also the values quoted at the end of chapter 24, and chapter 33, below.

[13] Note a new variant in notation. The value mentioned above is 118;54° (correctly 118;12°). As the digits 1 and 5 are easily confused in a humanist hand, it is likely that the scribe wrote “28.54” rather than “28.14”. MS BC reads “28.24”.

[14] The value mentioned above is 5;47° in MSS P1, P4, and BC, but 5;45° in MS Va. Again, a confusion between the numerals for 1 and 5 is possible.

[15] MS Va reads correctly 353°, as above.

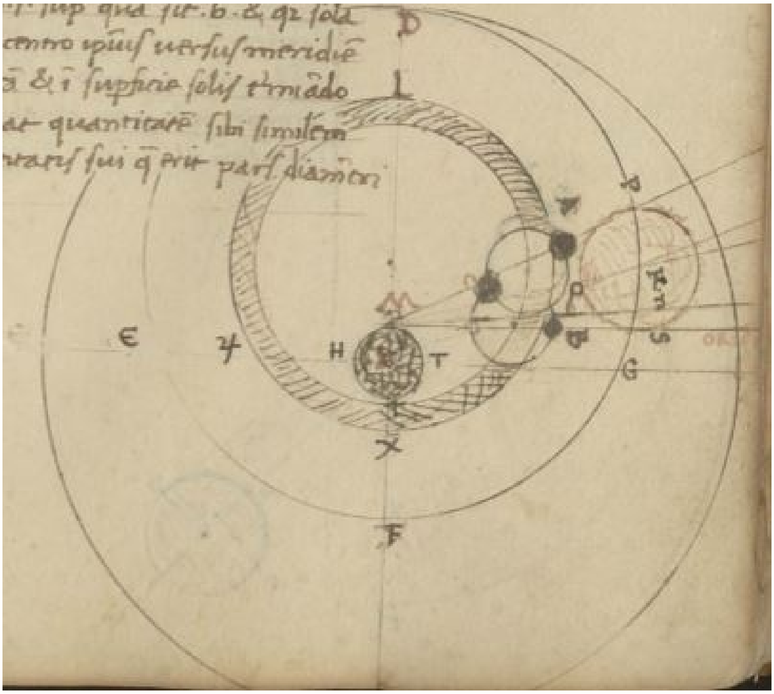

Figure 6. Solar eclipse, MS C1, 26r (chapter 5)

This manuscript is the only one, among those we have examined, to display diagrams for the solar and lunar eclipses in the *Tabulae eclypsium* [cf. Figure 7, p. 33 below].

tables: right ascension "ariete incipiente" (starting with Aries 0°), oblique ascension for 45° (latitude of Ferrara), declination, and sine. The result is 73;9° for the lunar distance from the zenith.

In chapters 26 and 27, Bianchini deals with the computation of the eastern and western angles between the ecliptic and the local meridian, respectively. For the time of this eclipse, he uses a procedure equivalent to equation (2) described in section 1 [p. 4 above], and finds 151;5° for the eastern angle. Then, Bianchini gives instructions for computing the western angle when the eclipse occurs after noon by means of a table composed by Bianchini himself [see Table 1, p. 8 above].

Bianchini computes total parallax at the time of conjunction in chapter 28, following a procedure analogous to equation (5) described in section 3 [p. 12 above]. He enters his table for lunar parallax at syzygy [see Table 4, p. 15 above] with twice the zenith distance for the entries *diversitas* (c_3)

and *equatio* (c_4) and with the true anomaly of the Moon for the minutes of proportion (c_7). The result for the total lunar parallax at syzygy is given as 60;38′.[16]

The determination of the longitudinal component of parallax is explained in chapter 29. Detailed instructions are given: take the eastern angle previously obtained (151;5°) and find its cosine (52519); take the value of parallax (60;38°) and find its sine (1057); multiply both numbers; discard from the product—55,512,583, no result is given—the four digits (*figuras*) to the right; divide the resulting number by 6 to obtain 925; and find 53;0′ in the corresponding entry in the sine table.[17] In addition to the convoluted instructions for "dividing by 60,000" since the sine table is normed 60,000, we are told that the cosine of the angle between the ecliptic and the meridian is to be multiplied by the sine of the parallax, not just by the parallax. This procedure indicates that Bianchini is applying spherical trigonometry to derive π_λ, in contrast to Ptolemy's procedure in *Alm.* 5.19. However, the result obtained for the longitudinal component of parallax, 53;0′, can only be obtained if the sine function is not applied to the parallax.

Next, Bianchini transforms into time the parallax in longitude by dividing its value by the *superatio*, that is, the difference between the hourly velocities of the Moon and the Sun (0;33,37°/h), to obtain 1;35h, which he adds to the time of the eclipse after the equation of time is applied, which was already found to be 5;41h before noon. Thus, Bianchini reports that the time of the "visible" conjunction is 7;16h before noon, and notes that this is a first equated time.

In chapters 30 and 31, Bianchini iterates the procedure to find the time of the eclipse. Having found the first equated time after taking parallax into account, he recomputes the new zenith distance of the Moon, finds the new eastern angle, and then the new parallax. This results in a new time of the eclipse, that is, a second equated time (7;13h). Another iteration leads to a third equated time (7;14h). Bianchini indicates that there is no need to proceed further ("non curavi amplius in hoc labore"), for the last two

16 The interpolated value for the *equatio* c_4 is 9;52′ in MSS P1 and P4, but 9;53′ in MSS BC and Va. The correct result, 60;38′, is obtained with the intermediate value 9;53′.

17 A simpler way to address this kind of computation, where the product of the sines of two quantities is the sine of a third ($\sin a = \sin b \cdot \sin c$), was later displayed in a single table by Regiomontanus. This table, computed in 1467, was published in Vienna in 1514 in a volume bound together with Peurbach's *Tabulae eclypsium* (see below).

equated times differ by less than one minute. Accordingly, the final equated values are 88;32° for the zenith distance, 146;8° for the eastern angle, and 63;2′for the total parallax. Bianchini's procedure is essentially the same as that outlined by Ptolemy in *Alm.* 6.10, except that Bianchini does not take into account solar parallax.

Bianchini computes parallax in latitude in chapter 32 following the same procedure as described in chapter 29 for the longitudinal component of parallax. The result is 35;5′, which he designates by "aspectus lune in latitudine equata". In chapter 33, he derives the equated argument of lunar latitude at the middle of the visible eclipse. The starting point is the argument of lunar latitude at true conjunction, which is given as 5;45°. We note that this value differs from the two found previously, 5;47° and 5;41°, but agrees with that given in MS Va. Bianchini finds 358;10° for the argument of lunar latitude at the time of mid-eclipse, corresponding to a southern latitude of 0;9°.

As explained in chapter 34, with this value for the argument of lunar latitude, one enters the two tables for solar eclipses and, after interpolation, finds 8;20 digits and 9;8 digits at greatest and least distances, respectively, for the fraction of the solar diameter eclipsed. For the true lunar anomaly determined previously, 206;17°, Bianchini computes 9;6 digits, which corresponds to an eclipsed area of the solar disk of 8;22 digits. The chapter ends with a reference to "tractatus 8° capitulo" of his *Flores Almagesti* where he had explained this issue.[18]

The computations of the times and arcs associated with the duration of the eclipse are addressed in chapters 35 and 37. To compute the arc corresponding to immersion, that is, from first contact to eclipse-middle, we are told to proceed in the same way as for the fraction of the solar diameter eclipsed in the previous chapter, and to enter the two tables for solar eclipses with the argument of lunar latitude. After interpolation, Bianchini finds 31;51′ for the arc that he calls *minuta casus*, corresponding to the time "a principio usque ad medium". Dividing it by the *superatio*, 0;33,37°/h, he gets 0;57h. Since the time previously computed for eclipse-middle was 7;14h, the resulting times for the beginning and the end of the solar eclipse are found to be 8;13h and 6;17h, respectively, before noon.[19] As indicated by Bianchini, sunrise

[18] The reference seems incomplete. MS C1 agrees with MS P1, whereas MS P4 reads "tractatus 8°" and MSS BC and Va read "8° capitulo".

[19] "8;13" is a scribal error for "8;11". Note that 7;14h + 0;57h = 8;11h. MSS C1 and Va have the correct reading, 8;11h.

on 18 July 1460 at Ferrara occurs at “ho.9. m.14. horologii”, that is, 9;14h “on the clock”. The time referred to the clock is counted from sunset, as was often the custom in Italian towns. In a paragraph in the same chapter, but not found in all manuscripts, we are told that the beginning of the eclipse occurs at 8;26h on the clock, which corresponds to 0;48h before sunrise. Thus, the times for the beginning, middle, and end of the eclipse are 8;26h,[20] 9;23h, and 10;20h after sunset (local time), respectively, making a little more than half the duration of the eclipse visible after sunrise and providing the citizens of Ferrara with a superb spectacle to be observed in the future: a partially-eclipsed Sun rising above the eastern horizon.

Chapter 35 closes with a summary of the main data for the visible eclipse:

> Beginning: 2;30h before true conjunction;
> Middle: 1;33h before true conjunction;
> End: 0;36h after true conjunction.

With the hourly velocities of the two luminaries, Bianchini derives the apparent positions at these times:

> Apparent position of the Sun at the beginning, middle, and end of the eclipse: Leo 3;53°, Leo 3;55°, and Leo 3;57°, respectively;
> Apparent position of the Moon at the beginning, middle, and end of the eclipse: Leo 2;29°, Leo 3;3°, and Leo 3;37°, respectively.

Chapters 36–38 address the computation of the lunar eclipse of July 1460.[21] As was the case for the solar eclipse, the initial step consists in computing true opposition of the Sun and the Moon. For this purpose, Bianchini uses the tables for the radices and mean motions for conjunction belonging to his set of planetary tables [Chabás and Goldstein 2009, 79–85, Tables 57–62]. The results for mean opposition are:

> Time: 3 July 1460 at 6;44h after noon;
> Mean solar longitude: 110;52°;
> Mean lunar anomaly: 18;14°;
> Mean argument of lunar anomaly: 171;54°.

Since the value of the solar apogee for 1460 is 90;48° as already noted in chapter 24, the resulting solar anomaly is 20;4°. The corresponding true solar longitude at mean opposition is 110;9° and its hourly motion is 0;2,23°/h [Chabás and Goldstein 2009, 85–87, Table 63]. Bianchini enters the table for the Moon at mean conjunction and finds the true longitude of the Moon,

[20] MS P4 reads erroneously 8;36h.

[21] Chapter 36 is missing in MS Va.

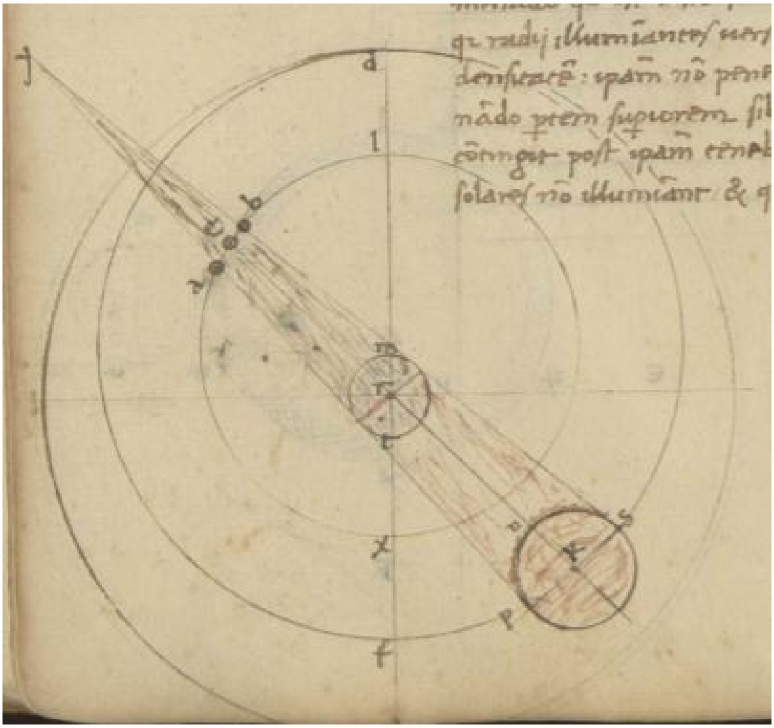

Figure 7. Lunar eclipse, MS C1, 26v
(chapter 6)

288;28°,[22] its hourly velocity, 0;29,47°/h, and the argument of lunar latitude at mean opposition, 210;30° [Chabás and Goldstein 2009, 87–91, Table 64]. With the hourly velocity in elongation, 0;27,24°/h, he finds the time between mean and true opposition, 1;30h, and deduces from it the time of true opposition: July 3, 8;14h, corresponding to 8;27h after noon, local time in Ferrara, after taking into account the equation of time.

In chapter 37, Bianchini computes the times of the lunar eclipse. He first computes the argument of lunar latitude at true opposition, given as "2.51.15. id est.g.171.15".[23] With this value, he enters the tables for lunar eclipses at

[22] MSS P1, P4, and C1 refer to true opposition, whereas the reference should be to mean opposition. MS BC has "vere oppositionis" where "vere" is crossed out and replaced by "medie" above it. MSS P1 and P4 give 288;28° for the true longitude of the Moon, whereas MSS BC and C1 have, correctly, 289;28°.

[23] Here is an example of both notations.

greatest and least distances [see Table 9, p. 22 above] and finds the magnitude in digits (*puncta*) and the arc of immersion (*minuta casus*) corresponding to these two extreme positions. He notes that there is no totality. After computing the true anomaly at true opposition, 19;15°, he interpolates in the table of parallax, yielding 4;15 digits for the magnitude of the eclipse and 33;26′ for the *minuta casus*. The result of dividing this last value by the *superatio* is 1;14h, which is then subtracted and added to the time of true opposition, 8;27h after noon, to obtain the times of the beginning and the end of the eclipse, 7;13h and 9;41h after noon, respectively, at Ferrara, on 3 July 1460.

The computation of the positions of the Sun and the Moon at the beginning, middle, and end of the eclipse follows in chapter 38. First, Bianchini enumerates the values at mean opposition for the longitudes of the two luminaries, their velocities, and the time between mean and true opposition.[24] Again, by means of the *superatio*, he finds the Sun at Cnc 20;13° and the Moon at Cap 20;13° at true opposition. At the beginning of the eclipse, the positions are Cnc 20;10° and Cap 19;36°, respectively. At the end of the eclipse, they are Cnc 20;16° and Cap 20;50°, respectively.

7. Giovanni Bianchini and Georg Peurbach

Other astronomers had computed solar and lunar eclipses and had given detailed accounts of their calculations. John of Genoa, one of the earliest Alfonsine astronomers in Paris, computed the solar eclipse of 3 March 1337, and displayed all the intermediate results in *Investigatio eclipsis solis anno Christi 1337* [Miolo 2021]. Two contemporaries observed this particular eclipse: John of Murs, whose observations are recorded in El Escorial, Biblioteca del Real Monasterio, MS O-II-10, and Levi ben Gerson, who observed and computed four solar and six lunar eclipses.[25]

[24] The values given confirm that MSS P1 and P4 referred erroneously to true, rather than mean, opposition and that they gave a faulty entry for the true longitude of the Moon.

[25] In the report on his observation of the solar eclipse of 1337, John of Murs clearly distinguished visible first contact from true first contact, a distinction rarely mentioned in the Middle Ages:

> *Vidimus initium eclipsis Solis, Sole in altitudine 10 gradum et jam erat pars sensibilis eclipsata, quare conclusimus periferias luminarium posse contingere in altitudine 9g*. [Beaujouan 1974, 30]

For Levi's observations and computations of eclipses, see Goldstein 1979.

Most relevant to our case are the two worked examples of eclipse computation by Georg Peurbach (1423–1461), which were reproduced in his treatise *Tabulae eclypsium*. Peurbach's work was completed probably in 1459 and first published in Vienna in 1514 by Georg Tannstetter in a volume bound together with the *Tabula primi mobilis* by Regiomontanus (1436–1476). Peurbach gives detailed computations of the solar eclipse of July 1460 and the lunar eclipse of December 1460. For the solar eclipse, which is the same one that Bianchini had computed, Peurbach used his own impressive double argument table for determining the time from mean to true conjunction, which takes up 48 pages in print and provides very accurate results. He also depended on his own table for parallax, where the longitudinal component is given in hours, thus avoiding the complicated procedure used by Bianchini for finding the angle between the meridian and the ecliptic. Table 12 displays some of their results.

	Bianchini (Ferrara)	Peurbach (Vienna)
Mean conjunction	18d 1;6h	18d 1;1,57h
True conjunction	17d 18;17h	17d 18;15h
Beginning of eclipse	17d 15;47h	17d 15;54h
Middle of eclipse	17d 16;46h	17d 16;49h
End of eclipse	17d 17;43h	17d 17;44h

Table 12. Comparison between the times of the eclipse of July 1460 given by Bianchini and Peurbach
(All hours are counted from noon)

Bianchini indicated that the beginning of the eclipse occurs at 8;26h "on the clock", which corresponds to 0;48h before sunrise at Ferrara; whereas Peurbach tells us that at Vienna it occurs about 35 minutes (*fere*) before sunrise. The modern difference in longitude between the two cities is about 4;45°, corresponding to about 19 minutes of an hour.

Bianchini and Peurbach computed with their own tables, the former using signs of 60° and the latter signs of 30°, and there are differences in the various steps in the computation, notable for finding parallax. Nevertheless, their results are in very good agreement and both authors computed correctly according to the method that they described. This comes as no surprise, for both were using the same basic tool, the Parisian Alfonsine Tables, although in different versions.

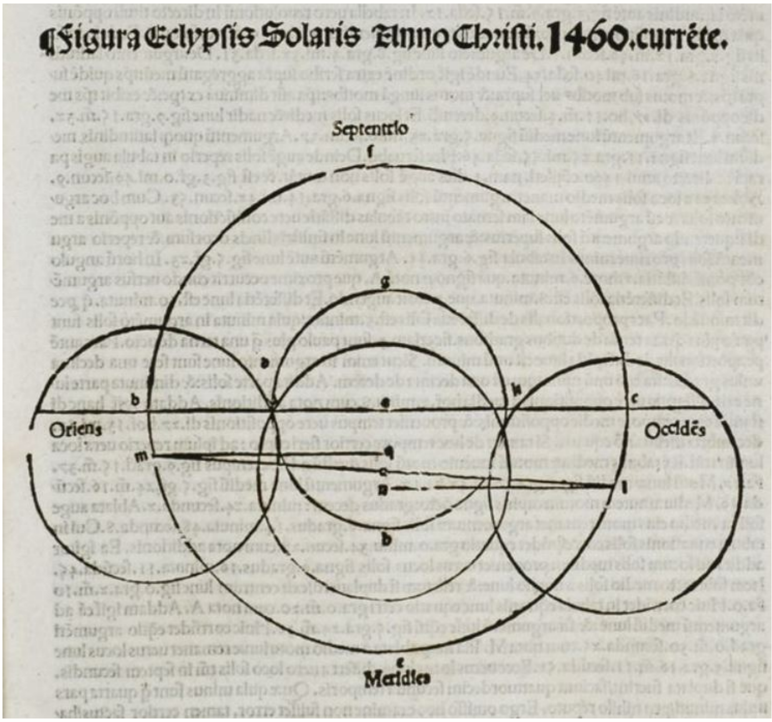

Figure 8. Peurbach's drawing of the solar eclipse of July 1460 in his *Tabulae eclypsium*, ch. 6 (Vienna, 1514)

In his *Tabulae eclypsium,* Bianchini did not include diagrams for the two specific eclipses that he computed in advance. Rather, in chapters 5 and 6, which deal with the drawing of figures of eclipses in general, he provides diagrams to support the explanation [see Figure 6, p. 29 and Figure 7, p. 33, above]. In contrast, Peurbach's treatise includes illustrations for the two particular eclipses given as worked examples, of which only one is displayed in Figure 8.

8. Conclusions

A few conclusions arise from a close reading of Bianchini's *Tabulae eclypsium.* First is that the text of this treatise was composed after the *Flores Almagesti*, since a few chapters in the *Tabulae eclypsium* were taken from the part of the *Flores Almagesti* concerning eclipses. Second, the *Tabulae eclypsium* is a separate work consisting of text and tables that were intended for a readership of competent astronomers, since it offers complete and detailed worked examples of two eclipses, one solar and one lunar, to take place in 1460. This date, moreover, sets an upper limit to the period when this treatise was composed. Since the text also provides specific data of four lunar eclipses, the last of which is dated 1 May 1455, and in the *Flores Almagesti* year 1456 is mentioned as the "current year", it is likely that the *Tabulae eclypsium* was not finished before that date. This suggests that Bianchini's *Tabulae eclypsium* was written between 1456 and 1460.

In the two worked examples, there are many intermediate computations, the results of which are not always displayed but are always correct, indicating that the purpose was not just pedagogical. Bianchini was indeed a good and precise computer, who understood well the procedures that he was using and, in particular, those in the *Almagest*. Characteristic of Bianchini's work is the dominant use of signs of 60°, although various other notations are found. Sexagesimal numbers are often presented as digits separated by dots, as in "1.2.3", without specifying the unit of each part, meaning "one sign of 60°, 2°, and 3′", which, when combined with the standard notation, becomes "s.1.g.2.m.3". Sometimes, however, Bianchini uses decimal notation for degrees, as in 62°, or zodiacal signs, as in Gem 2°.

In the text, there are references to quite a number of tables. Some are found in Bianchini's *Tabulae astronomiae*, the large set of tables for the planets that he had completed in about 1442. In particular, he uses his extensive and unprecedented tables for syzygies. For the *Tabulae eclypsium*, Bianchini also compiled new tables, all based on tables and procedures already in the *Almagest*, but going beyond them in that he recomputed and extended Ptolemy's tables, while introducing a different value for the obliquity of the ecliptic and applying spherical trigonometry where Ptolemy had used plane trigonometry. In this sense, Bianchini combined innovation with strict adherence to Ptolemy's *Almagest*.

8.1 *Acknowledgment* We thank an anonymous referee for providing us with insightful comments.

APPENDIX
TITLES AND INCIPITS OF THE CANONS TO THE *TABULAE ECLYPSIUM*

Base manuscript: Paris, BnF 7270 (MS P1), 167r–181r. Copied in 1461.

In those instances where the base manuscript offers no title, we have added in italics the one given in MS Vat. lat. 2228 (MS Va), 1r–16r, copied in 1470 by Joannes Carpensis at Ferrara.

Title: Canones tabularum de eclypsibus luminarium de blan[chinis] editarum
Prohemium. In libro Florum Almagesti per Ioannem Blanchinum…

1. Primo sciendum est quod sol de per se non eclypsatur…
2. Eclypsis autem lune causatur ex interpositione…
3. Diversitatis aspectus declaratio
4. De certis erroribus in tabulis veteribus observatis
5. De figura eclypsis solis actualiter demonstranda
6. De figura eclypsis lune actualiter demonstranda
7. De imperfecta compositione tabularum observatarum pro diversitate aspectus lune invenienda
8. De erroribus Albategni in acceptione quantitatis diametri lune
9. *De quantitate diametri lune secundum ptholomeum veraciter invenienda*.
   Dico ergo ad inveniendum diametrum lune…
10. Altitudinem lune temporibus eclypsis in qualibet hora diei invenire
11. De inventione angulorum ex meridiano & orbe signorum equaliter correspondentium in omni regione
12. Angulos orientales in quacumque particulari regione invenire
13. De angulis orientalibus atque occidentalibus zodiaci cum circulo altitudinis in qualibet hora diei & loco invenire
14. De diversitate aspectus lune prima que est ex distantia ipsius a zenith in quacumque regione volueris
15. De diversitate aspectus lune in longitudine & latitudine tam ante quam post meridiem invenienda
16. *De quantitate temporis et corporis solis obscuratione.* Data est in precedentibus doctrina ad inveniendam diversitatis aspectus lune…
17. Et quia supra inventum est quantum ex diametro solis
18. Prout ab intuentibus videri…
19. Ptholomeus ipse prout ante dictum est demonstravit

20. *Sequitur demonstratio per experientiam.*
    Prima eclypsis per me ex 40r consideratis…
21. De proportione diametri umbre ad diametrum lune in eclypsibus
22. De eclypsi lune narratio
23. *Quantitatem superficiei per quantitatem diametri lune eclipsati invenies.*
    Habitis enim punctis diametri lune eclypsatis…
24. De eclypsi solis futura que erit 1460 de mense iulii ad situm ferrarie perscrutari
25. Altitudinem luna ab orizonte invenire
26. Angulum orientalem lune invenire
27. Angulum occidentalem invenire
28. Diversitatem aspectus primam invenire
29. Diversitatem aspectus lune in longitudine tantum invenire
30. Sequitur pro horis eclypsis visibilis 2° equandis invenire
31. Sequitur pro horis eclypsis visibilis 3° equandis perscrutatio
32. De diversitate aspectus lune in latitudine invenienda
33. Argumentum latitudinis lune ad medium eclypsis visibilis perscrutari
34. De quantitate diametri solis eclypsati invenire
35. De minutis casus ultimo propalandis
36. Eclypsim lune per tabulas invenire
37. De quantitate durationis & mora lunaris eclypsis invenienda
38. Loca solis & lune in principio, medio & fine eclypsis perscrutari
39. Ad inveniendum diversitatem effectus [*read:* aspectus] lune centro epicicli distante ab auge deferentis

Explicit: cum quibus operari potes in omnibus operationibus ad propositum. Finis – Τελοσ[26]

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[26] In the manuscript, the last letter is an ordinary sigma rather than a sigma in final position.

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The Babylonian *Dodecatemoria* and Calendar Texts

Inverse Schemes for Determining Position and Times for the Schematic Sun and Moon

by

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Abstract

The *Dodecatemoria* may be understood as a very simple reproduction of the Moon's movement: for each day in the schematic year, the *Dodecatemoria*-scheme gives the position of the schematic Moon in the zodiacal circle. The Moon's angular velocity was calculated as 13°/day and the Sun's, as 1°/day. The scheme of the Calendar Texts may also be interpreted astronomically: for each position in the zodiacal circle, it gives the date at which the schematic Moon was in that position. We know that the schemes are inverse. A closer analysis of the texts accompanying the Calendar Text (*LBAT* 1586+1587) shows that the Babylonians also knew and utilized that fact as well.

About the Author

LIS BRACK-BERNSEN'S research is in the history of mathematics and astronomy, especially the development of Babylonian astronomy and the use of computer simulations of ancient Babylonian observational data in systematic analyses. Her aim is to reconstruct the ancient rules governing prediction and to discover the concepts and methods behind early Babylonian astronomy.

The *Dodecatemoria* may be understood as a very simple reproduction of the Moon's movement: for each day in the schematic year, the *Dodecatemoria* gives the position of the schematic Moon in the zodiacal circle.[1] The Moon's angular velocity was calculated as 13°/day, and the Sun's as 1°/day. The Calendar Text (*Kalendertext*) may also be interpreted astronomically: for each position in the zodiacal circle, it gives the date at which the schematic Moon [contra Wee 2016] was in that position. We know that the schemes are inverse. A closer analysis of the texts accompanying the Calendar Text (*LBAT* 1586+1587) shows that the Babylonians also knew and utilized that fact as well.

The following paper is part of a talk given at the conference "In Time: Astronomy and Calendars in the Ancient Near East", which was held in Jerusalem in June 2018. Its title was: "Babylonian Astronomy/Astrology, and the Role of (Modern and Babylonian) Mathematics in the Interpretation of Ancient Cuneiform Texts". The aim of the talk was to point to the effectiveness of modern mathematics for understanding old texts with numerical calculations or schemes, but also to warn against transferring too much modern knowledge into old texts. Our mathematics is a very rigorous tool which may give insights that the Babylonians did not have. Therefore, it is necessary to know how Babylonian mathematics worked and how calculations were performed in order to interpret the ancient texts as realistically as possible. (If we are solving an Old Babylonian mathematical exercise in "our way", and if this deviates from the directions given in the school text, we can be sure that we have not understood the method behind the exercise correctly.)

In sum, mathematical and astronomical knowledge are important instruments for deciphering and understanding ancient technical cuneiform texts. We must, however, be aware of the danger of silently (and unconsciously) transferring too much modern knowledge and mathematical handicraft into these texts.

[1] The zodiacal circle is the division of the path of the Sun into 12 zodiacal signs of equal length. Before the introduction of this «lu-maš», the Babylonians used a number of constellations to locate bodies in the sky. The zodiac is a band consisting in constellations along the ecliptic through which the Moon, Sun, and planets move.

With this in mind, in an article on *Dodecatemoria* and Calendar Text schemes [Brack-Bernsen and Steele 2004], we mentioned merely that these were inverse schemes—knowledge which the Babylonians did not necessarily have. Therefore, at that time, we surmised that Calendar Texts were constructed from the *Dodecatemoria* by "number magics"; symmetries and play with numbers led to a strange scheme according to which, from line to line (i.e., for consecutive days), a position within the zodiac was shifted by 277°. In the *Dodecatemoria*, the lunar position shifted by 13° from line to line. I have since found evidence, however, that the Babylonians indeed knew that the Calendar Text scheme, taken as a function, was the inverse of the *Dodecatemoria* function, and that it was constructed with this in mind.[2]

The *Dodecatemoria* scheme answers the question, Where is the schematic Moon <☽>[3] on day d of month M in the schematic calendar? I will now argue that the Babylonians constructed the Calendar Text scheme as an easy solution to the question, At which date will the schematic Moon be in sign S at degree d? The answer to this question will give us a date which, at the same time, is the position of the schematic Sun on that day. Therefore, we can also formulate the task of the Calendar Text as follows: for each position of the schematic Moon within the zodiac, it gives us the corresponding date and position of the schematic Sun.

1. The *Dodecatemoria* scheme

The Babylonians assumed that the schematic Sun <⊙> was at the beginning of Aries at the beginning of the schematic year, and that it moved 1° per day, so that on day d in month M the <⊙> would be situated at degree d of sign M.[4] As a result, the date "month M day d" was identified with "sign M degree d" in the zodiacal circle, which is the position of the schematic Sun on that day.

Month M day d ≡ zodiacal sign M degree d, the position of <⊙>.

The schematic Moon was supposed to move 13° per day, i.e., 1° as the Sun plus 12° in elongation. When both start in conjunction at the beginning of

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2 For a more recent discussion of Calendar Texts and their use and role within Late Babylonian culture, see Steele 2011 and 2017 as well as Wee 2016, which investigates the schemes thoroughly and gives many references.

3 I use the angle brackets < > to indicate that we are dealing with the schematic "mean value".

4 The symbol <n>, where n is a number, denotes the mean value of a series of numbers n.

sign M, then after 30 days the <☉> will have moved 30° and the <☽> 390° = 30° + 360°. At the beginning of the next month $M+1$, they are in conjunction again at the beginning of sign $M+1$. The mean value of 12° for the elongation movement (that is, the mean movement of the Moon with respect to the Sun) can be found in schemes B and D of *Enūma Anu Enlil* 14.[5] At the time when *EAE* was compiled (around 700 BC), this 12° was understood as the daily retardation of the Moon. Later, the number schemes from *EAE* and MUL.APIN[6] were used for astronomical considerations and predictions. At that time, the scribes evidently knew that the daily retardation of the Moon is also a measure for the movement of the Moon with respect to the Sun [Brack-Bernsen and Hunger 2002, TU 11 §19: cf. Brack-Bernsen 1999, 152–154].

For each day of the schematic year, the *Dodecatemoria* lists simple mean-value positions of the Sun and Moon within the newly invented zodiacal circle. The schematic year consists of 12 months of 30 days each; it is a practical approximation to the Babylonian lunisolar year of 12 synodic months, each of which having a duration of either 29 or 30 days. The length of the synodic month varies in a very irregular and (for the early Babylonians) unpredictable way. The real, observable Moon (☽) moves irregularly, but such that its full phase always occurs close to day 15 of the Babylonian calendar. This is a consequence of the convention of letting the month begin on the evening when the waxing crescent was seen for the first time after conjunction. The schemes from MUL.APIN, *EAE* 14, and the *Dodecatemoria* do not give us precise numbers (times or positions) of the real Sun or Moon, but approximations which were utilized especially for astrological purposes. We call such astronomical investigations, based on the schematic calendar and mean movements of the Sun and Moon, schematic astronomy. MUL.APIN and *EAE* 14 are early examples of this astronomical tradition.

Table 1 [p. 48 below] lists a part of the *Dodecatemoria* scheme, specifically, that for the schematic months 1 and 6. Reading the two first columns as a date (month and day) and the last two columns as the position (sign and degree) of <☽>, we see that the schematic Moon moves 13° per day. Knowing that the schematic date equals the solar position, we can, therefore, also read the first two columns of each set of four columns as sign and degree

[5] *EAE* 14 is the 14th of a series of astrological/astronomical tablets. See Al-Rawi and George 1991, 56 and 59 for schemes B and D.

[6] MUL.APIN is a Babylonian Astronomical compendium consisting in two cuneiform tablets. See Hunger and Pingree 1989 or Hunger and Steele 2019.

(= solar position), and we have the position of the schematic Sun during the first 15 days of months 1 and 6.

The schematic Sun <☉> moves 1°/day.

The schematic Moon <☽> moves 13°/day = 1°/day + 12°/day.

The numbers for the position of the Moon in the scheme in Table 1 seems to be calculated by adding 13° per day, but its position can also be found from the solar position by adding 12° per day. From a mathematical point of view, the two ways of calculating the position of the schematic Moon are equivalent.

Date		<☽> Position		Date		<☽> Position	
Month	day	Sign	degree	Month	day	Sign	degree
1	1	1	13	6	1	6	13
1	2	1	26	6	2	6	26
1	3	2	9	6	3	7	9
1	4	2	22	6	4	7	22
1	5	3	5	6	5	8	5
1	6	3	18	6	6	8	18
1	7	4	1	6	7	9	1
1	8	4	14	6	8	9	14
1	9	4	27	6	9	9	27
1	10	5	10	6	10	10	10
1	11	5	23	6	11	10	23
1	12	6	6	6	12	11	6
1	13	6	19	6	13	11	19
1	14	7	2	6	14	12	2
1	15	7	15	6	15	12	15
				6	21	3	3
1	30	1	30	6	30	6	30

Table 1. *Dodecatemoria* schemes for the schematic Moon <☽> in months 1 and 6

Such schemes make it easy to find the lunar position <☽> for all days of the schematic year. In one month, the Sun has moved 30° and the Moon 390°, so that they have reached each other at 30°, that is, the end of the sign on day 30, which also is the beginning of the next sign on day 0 of the next month.

According to the scheme, the Moon moves 13°/day = 1°/day + 12°/day. The movement of the Moon with respect to the Sun is called the movement in elongation. Here the mean value of 12°/day is used. The Babylonians had a correct understanding of elongation: they calculated the lunar movement in elongation as a function of the month and used it for finding the position of the Moon with respect to the Sun in the days around the New Moon (conjunction) [Brack-Bernsen 1999, 151–164; Brack-Bernsen and Hunger 2002, 72–75].

It is supposedly due to the connection

$$13^\circ/\text{day} = 1^\circ/\text{day} + 12^\circ/\text{day},$$

that the Babylonians subdivided each zodiacal sign (of 30°) into 12 micro-signs of 2½° each. Beginning with the name of the sign that is being subdivided, the micro-signs have the same names and sequences as the 30°-signs (see the example in Figure 1). Each micro-sign measures 2½°, but it represents a real zodiacal sign of 30°. We have a scale factor of 12: 2½ × 12 = 30. Thus, the movement of 1° in the zodiacal-sign (ZS) scale corresponds to 12° on the micro-sign (m-s) scale. Let us imagine the schematic Sun <⊙> moving through ZS S during month S. Its position in sign S is $d°$ on day d, but this position at the same time indicates the elongation of the Moon through its position in the micro-sign. In order to find the position of the Moon, one just has to add the number of days (= the number of degrees moved by the Sun) to the elongation, which is given through the solar position in the micro-sign scale.[7]

Figure 1 illustrates how this works. The whole sign Virgo (ZS 6) is divided into 12 micro-signs VI, VII,…V, each of the length of 2½°. The schematic Sun travels through Virgo during the 30 days of month 6, i.e., at one degree per day. On day 21, the <⊙> will be in Virgo 21°, which is 1° past the m-s II. This 1° corresponds to 12° in the m-s. Therefore, we can find the position of the schematic Moon as m-s II 12° plus 21° and we find the lunar position to

[7] Thus, at the beginning of month 6 (day 0), both Sun and Moon are at 0° of sign VI. On day 1, the Sun will be at 1° of VI and 12 micro-degrees of micro-sign VI. Adding the 1° to this position, we get 13° in micro-sign VI, which gives us the schematic position of the Moon. On day 2 the Sun will be at ZS VI 2° and at 24 micro-degrees in m-s VI. On this day, the Moon is at 26° of VI, which can be found from 24 of m-s VI by adding 2°. On day 3, the Sun will be at VI 3° and 6 micro-degrees of m-s VII. We find the position of the schematic Moon in the micro-zodiac by adding 3 to the 6 micro-degrees of VII, ending with m-s VII 9 micro-degrees, in agreement with the *Dodecatemoria* of month 6

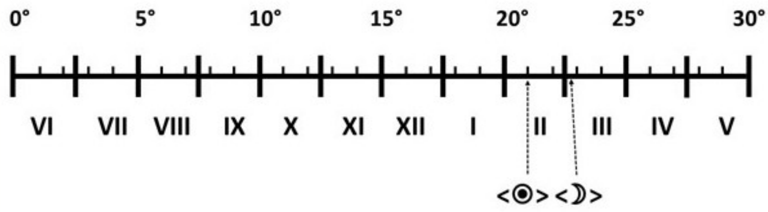


Figure 1. Division of the zodiacal sign Virgo (= ZS 6)

This sign is divided into 12 micro-signs in which the positions of the schematic Sun and Moon on month 6 day 21 are indicated: <☉> is at 21° of sign VI, which at the same time is 12° in micro-sign II. <☽> is at 3° in m-s III. Note that III 3° = II 12° + 21°.

be m-s III 3° = II 12° + 21°. This is exactly the position given by the numbers 6 21 3 3 in the *Dodecatemoria* scheme for month 6. We read it as follows: in month 6 on day 21, the schematic Sun is in position 21° of Virgo (= ZS 6 21°), the schematic Moon is situated in 3° of micro-Gemini (= m-s III 3°).

2. Calendar Texts

The earliest Calendar Texts that we know about are BM 96258 and BM 96293, probably originating from the fifth century BC, shortly after the invention of the zodiacal circle. These texts only list four columns of numbers, without any indication as to how these numbers should be read. Table 2 [p. 51 below] reproduces on the left the Calendar Text scheme, and on the right the *Dodecatemoria* scheme for the first month 1, Nisan, of the schematic year. There exist schemes for all 12 months of the year. The texts display numbers, only. Other Calendar Texts identify the numbers in different ways. The columns marked by ⇩ list the numbers 1, 2, 3, ...12, while the columns marked by ↓ display all the numbers from 1 to 30. Thus, we may infer that the numbers in the first and third columns marked by ⇩ present either a month or a zodiacal sign, or both, while the numbers in columns 2 and 4, marked by ↓, present either the days in a month or the 30° of a zodiacal sign, or both.

3. Inverse functions

Let me give an example of inverse functions: sine and arcsine. For each angle ϑ, where $-90° < \vartheta < 90°$, $\sin\vartheta$ equals a number n, where $-1 < n < 1$. And for each n between -1 and 1, $\arcsin n$ equals the number ϑ, so that $\arcsin(\sin\vartheta) = \vartheta$.

Calendar Text				*Dodecatemoria*			
⇩	↓	⇩	↓	⇩	↓	⇩	↓
1	1	10	7	**1**	**1**	**1**	**13**
1	2	7	14	**1**	**2**	**1**	**26**
1	3	4	21	1	3	2	9
1	4	1	28	1	4	2	22
1	5	11	5	1	5	3	5
1	6	8	12	1	6	3	18
1	7	5	19	1	7	4	1
1	8	2	26	1	8	4	14
1	9	12	3	1	9	4	27
1	10	9	10	1	10	5	10
1	11	6	17	1	11	5	23
1	12	3	24	1	12	6	6
1	**13**	**1**	**1**	1	13	6	19
1	14	10	8	1	14	7	2
1	15	7	15	1	15	7	15
1	16	4	22	1	16	7	28
1	17	1	29	1	17	8	11
1	18	11	6	1	18	8	24
1	19	8	13	1	19	9	7
1	20	5	20	1	20	9	20
1	21	2	27	1	21	10	3
1	22	12	4	1	22	10	16
1	23	9	11	1	23	10	29
1	24	6	18	1	24	11	12
1	25	3	25	1	25	11	25
1	**26**	**1**	**2**	1	26	12	8
1	27	10	9	1	27	12	21
1	28	7	16	1	28	1	4
1	29	4	23	1	29	1	17
1	30	1	30	1	30	1	30

Table 2. The Calendar Text and the *Dodecatemoria* schemes for month 1

The position changes by 13° from line to line in the last scheme, while the change of the number pair given in columns 3 and 4 of the Calendar Text changes by 277 from line to line. The pairs on bold red and magenta illustrate that the two schemes are inverse. The entry 1 1 (month 1 day 1) in the *Dodecatemoria* scheme gives 1 13 as the position of <☽>. If in the Calendar Text scheme you look up what corresponds to 1 13, you get back to 1 1.

An inverse function brings us back to the starting point. That the two number schemes are inverse is illustrated by arrows in Table 2: the number quadruple (1 2 1 26) from line 2 in the *Dodecatemoria* scheme is reversed by the number quadruple in line 26 (1 26 1 2) of the Calendar Text scheme. This relation—that the number schemes are mutually inverse—can also be expressed by two inverse functions D and K. For each line in the schemes, we read the first number pair as an independent variable for finding the "result", namely, the number pair given in columns 3 and 4.

The relation between the number pairs (M_i, m_i), (N_i, n_i) in line i of the *Dodecatemoria* scheme can be expressed by a function D:

$$D(M_i, m_i) = (N_i, n_i)$$

which is to be read

"On month M_i day m_i, the schematic Moon will be at $n_i°$ of sign N_i".

Similarly, the relation between the number pairs (N_j, n_j), (M_j, m_j) in line j of the Calendar Text can be expressed by a function K:

$$K(N_j, n_j) = (M_j, m_j).$$

Here the generating pair is (N_j, n_j) and the result is (M_j, m_j).

The Calendar Text scheme is constructed such that when the generating pair (N_j, n_j) in line j of K equals the result (N_i, n_i) in line i of D, then the result is:

$$K(N_j, n_j) = (M_j, m_j) = (M_i, m_i).$$

And, inversely, if

$$(M_i, m_i) = (M_j, m_j),$$

then

$$(N_i, n_i) = (N_j, n_j).$$

In conclusion, for all pairs of numbers (N, n) and (M, m), where N and M are two of the numbers 1, 2, 3,…12, and n and m are two of the numbers 1, 2, 3, 4…30, the following is true: if

$$D(M, m) = (N, n),$$

then

$$K(N, n) = (M, m)$$

and *vice versa*. Thus, it is always true that

$$K(D(M, m)) = K(N, n) = (M, m) \text{ and } D(K(N, n)) = D(M, m) = (N, n)$$

The functions D and K are thus inverse.

We know that the *Dodecatemoria* function gives the position of <☽> for all days in the schematic year. Therefore, we conclude that the inverse Calendar Text function for all lunar positions in the zodiacal circle gives the date at which the Moon occupies that position (according to the *Dodecatemoria*). Note that this date equals the position of <☉> at that day.

The Babylonians could have constructed the Calendar Text scheme from the *Dodecatemoria* by "number magic". First, they could have changed the order of the columns, letting columns 3 and 4 come first, followed by columns 1 and 2. Then, they could have reorganized the lines so that the numbers in the first two columns come in "chronological order". Had it been constructed in this way, it would not now be evident that the Babylonians had any notion of inverse functions. Luckily, we have a text (*LBAT* 1586+1587) that gives us the position of <☽> for consecutive degrees in Gemini and the corresponding dates (M, d), together with the comment that "<☽> is in sign M at the position of Gemini". This clearly demonstrates that the Babylonians, indeed, had our understanding of these schemes: each degree of a zodiacal sign (S, d), listed in the first two columns of the Calendar Text scheme, the date (M, d) at which <☽> occupied that position is listed in the last two columns. The date indicates at the same time the position of <☉>. According to this interpretation, we can identify the number columns of the Calendar Text and *Dodecatemoria* schemes in Table 2 [p. 51 above]: see Table 3.

Calendar Text				*Dodecatemoria*			
<☽>		Date		Date		<☽>	
1	1	10	7	1	1	1	13
1	2	7	14	1	2	1	26
1	3	4	21	1	3	2	9
1	4	1	28	1	4	2	22
1	5	11	5	1	5	3	5
1	6	8	12	1	6	3	18
1	7	5	19	1	7	4	1
1	8	2	26	1	8	4	14

Table 3. Number columns of the two schemes

The numbers in the Calendar Text have been identified: columns 1 and 2 indicate the position of <☽>, arranged so that it changes by 1° from one line to the next. Columns 3 and 4 give the dates at which the schematic Moon was at that position according to *Dodecatemoria*. In the *Dodecatemoria*, the columns are identified as previously stated, that is, as date and corresponding position of the schematic Moon.

4. How the Calendar Texts were used for medicine

We have several texts which show that the Calendar Texts were used in medicine to determine the ingredients of ointments: three Calendar Texts, each covering one month, have been found; presumably they were part of a series of 12 tables covering a whole year. Some lines of the Calendar Text W22704 [von Weiher 1988] are reproduced below in a concentrated form. Maddalena Rumor [2021] has convincingly shown that Pliny the Elder, who criticized the medicine of the *magics* (Chaldeans), mentioned remedies which exactly match with the ones given in this Calendar Text covering month 4. Pliny's comments are very useful. They support our interpretation of the text and help clarify remedies and principles behind the scheme. Rumor concluded that ingredient names such as "eagle blood" were indeed *Decknamen*, which were referring to real medical herbs and plants.

Date		ZS or Month			You anoint
Month 4 day	1	(for Aries)	1	7	Sheep-blood, -fat, and -hair
—	2	Capricorn		14	Goat-blood, -fat, and-hair
—	3	Libra		21	"empty place"*
—	4	(for Cancer)	4	28	Crab-blood or crab-fat
—	5	Taurus		5	Bull-blood, -fat, or -hair
—	6	Aquarius		12	Eagle-head, wing, and blood
—	12	Virgo		24	Barley-flour, raven-head and -wing
—	13	(for Cancer)	4	1	Crab-blood or crab-fat
—	14	(for Aries)	1	8	Sheep-blood, -fat, and -hair
—	15	Capricorn		15	Goat-blood, -fat, and-hair
—	16	Libra		22	"empty place"*
—	17	(for Cancer)	4	29	Crab-blood or crab-fat

* Wee 2016, 178 n109 proposes "Molted-skin of Scorpion".

Table 4. A section of the Calendar Text W22704

These lines show the close connection between the zodiacal sign and the ingredient written in the same line.

In Table 4, columns 1 and 2 list all 30 days of month 4, ŠU, which we also can read as all positions in Sign IV. Columns 3 and 4 seem to list positions in the zodiac, and column 5 lists ingredients which shall be used for ointments to be produced for the day in question.[8]. As it has often been noticed, the ingredients listed in column 5 are closely connected to the zodiacal sign listed in column 3. But note also that for days 1 and 14, the name BAR of month 1 is written instead of Aries, and similarly, by the days 4, 13, and 17, the name ŠU of month 4 is written instead of the fourth zodiacal sign, Cancer. In cuneiform texts we often find that a date and the position of <⊙> are identified or interchanged. Therefore, we may have a hint here that columns 3 and 4 list solar positions. That this really is the case, I show below. An astrological text (*LBAT* 1593), published by E. Reiner [2000] confirms that the Calendar Texts were used to produce medical remedies:

> For the animal(s) of 13 and 4,37 (=277) you take one with the other, you salve, feed, and fumigate the patient with stone, herb, and wood (respectively).

We understand that the "animals" denotes the zodiacal signs while number 13 belongs to the *Dodecatemoria* and 277, to the Calendar Text.

5. The movement of the schematic Moon

There are three Late Babylonian tables with beautiful drawings of the zodiacal signs Taurus, Leo, and Virgo, where these signs are divided into 12 micro-signs [Weidner 1967, Tables 1, 2, 5–10]. In Plate 1 [p. 56 below], the text at the top describes a lunar eclipse. Below it, in many small squares, some remedies are listed: stones, temples, trees, plants, and other (medical) ingredients. I have added Roman numerals (V, VI,...) representing the zodiacal signs.

Let us imagine the Sun moving through Leo during the 30 days of month 5. On day 10, it will have moved 10° since the beginning of the month and reached the position Leo 10°, which is also the beginning of Micro Sagittarius, that is, m-s IX, a point which measures the Moon's movement in elongation during these 10 days. The position of the Moon on month 5 day 10 can be found by adding the 10° (micro-degrees) to the solar position 0° in m-s IX. Thus, we come to 10° in m-s IX.

In short, on month 5 day 10 the position of <⊙> is Leo 10° (m-s IX 0°), and the position of <☽> is found to be 10° in m-s IX. In the *Dodecatemoria*, it is listed as 5 10 9 10 [see Plate 1].

[8] For more details, see Rumor 2021, §1.4 and Steele 2011, where the latter argues convincingly for the idea that some of the ingredients (e.g., blood of lion or eagle) are used as synonyms for medical plants or herbs

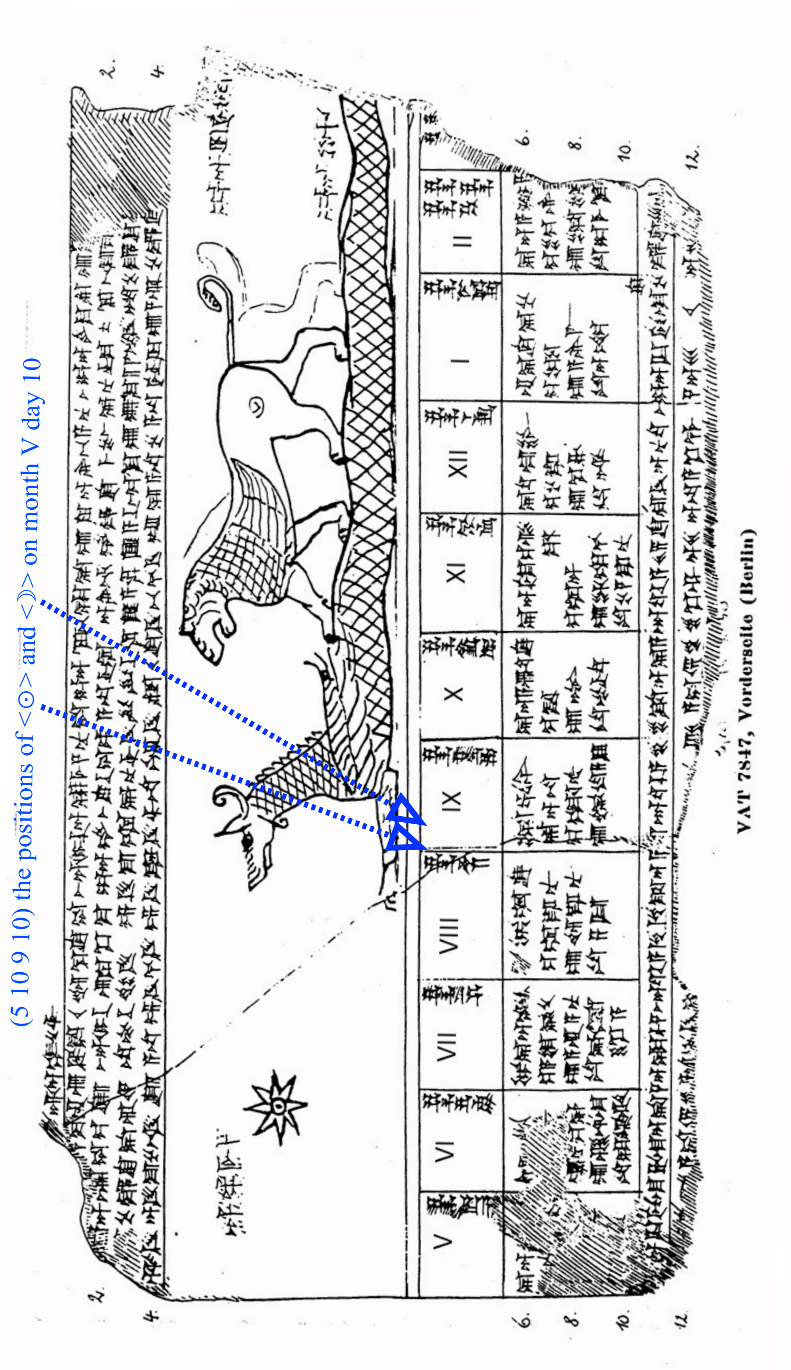


Plate 1. The *Dodecatemoria* scheme for month 5

A visual representation of the numbers V 10 IX 10. It shows the position of the middle of <⊙>, at Leo 10° m-s IX 0°, and the position of the middle of <☽> at 10° in IX.

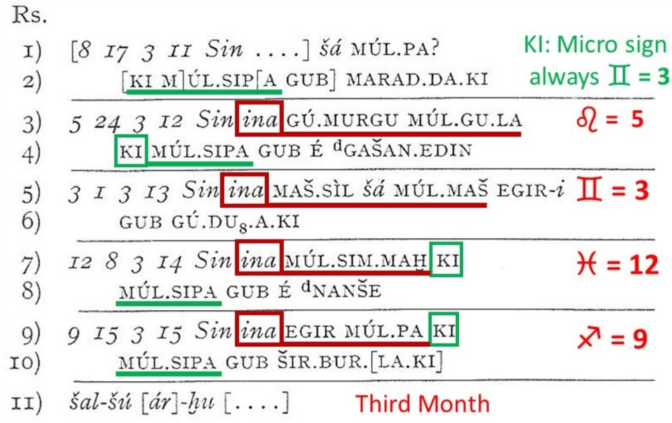
Plate 1 illustrates how the *Dodecatemoria* numbers, V 10 IX 10, or 5 10 9 10, can easily be found by means of the Babylonian concept of describing the movement of the schematic Sun and Moon. In the number schemes, <☉> moves 1°/day and <☽> 13°/day. That this model is equivalent to the calculation based on the daily movement of <☉> plus the movement in elongation by <☽> is evident, but it was also known to the Babylonians. The situation depicted in Plate 1 may be described as follows: the Sun is in 10° of Leo and the Moon is in Leo at the position of 10° Sagittarius.

We are in the lucky situation to have Calendar Texts in which special words describe exactly such situations: e.g., the Moon is in (= *ina*) the zodiacal sign *Z* at the position (KI) of some micro-sign. This shows that the illustration in Plate 1 [p. 56 above] is not a modern speculation but rather one of the ways by which the Babylonians actually argued. On Table BM34452 + 34738 (= *LBAT* 1586+1587 [see Hunger 1975]), we find number quadruples which we know from the Calendar Text schemes, with one difference: the columns have been interchanged so that the pairs of numbers, listed in the first two columns, rise by 277 from line to line, while the number-pairs in columns 3 and 4 rise by one from line to line. Therefore, according to our identification (in Table 3, p. 53 above), the two first columns of our Calendar Text shown in Plate 2 [p. 58 below], which increase by 277 from row to row, give us the date (that is, the position of <☉>) at which the schematic Moon <☽> was at the position given in columns 3 and 4. We have now identified the Calendar Text numbers at the beginning of each section of Plate 2. Let us look closer at the accompanying text.

We have in Plate 2 a description similar to that of Plate 1. A translation, e.g., of lines 9–10, might run as follows:

> 9 15 3 15: The Moon stands in (*ina*) the back of Pabilsag (sign 9, ♐) at the position of [KI] the micro-sign Gemini, namely at 15° within micro-sign 3.

This text supports our new interpretation. In almost all legible cases of the whole text, the month given by the number in column 1 agrees with the zodiacal sign written after «ina», while the micro-sign within which the Moon is situated, written after «KI», always is Gemini = micro-sign III (which is also written as 3 in column 3). This is not just an accident; it must have been intended by the Babylonians. We now understand the structure of the text and are able to fill some holes and correct a few errors. Obv. 5–6 may be reconstructed to 6 21 3 3. The Moon stands in the waist of Virgo within the micro-sign Gemini.



Rs.

1) [8 17 3 11 *Sin* . . . .] *šá* MÚL.PA?
2) [KI M]ÚL.SIP[A GUB] MARAD.DA.KI

3) 5 24 3 12 *Sin ina* GÚ.MURGU MÚL.GU.LA
4) KI MÚL.SIPA GUB É ^{d}GAŠAN.EDIN

5) 3 1 3 13 *Sin ina* MAŠ.SÌL *šá* MÚL.MAŠ EGIR-*i*
6) GUB GÚ.DU$_8$.A.KI

7) 12 8 3 14 *Sin ina* MÚL.SIM.MAH KI
8) MÚL.SIPA GUB É ^{d}NANŠE

9) 9 15 3 15 *Sin ina* EGIR MÚL.PA KI
10) MÚL.SIPA GUB ŠIR.BUR.[LA.KI]

11) *šal-šú* [*ár*]-*ḫu* [. . . .]

Plate 2. The last readable lines of the Calendar Text *LBAT* 1586+1587 rev 10–11 in Hunger 1975

On the date given in the first two columns, the schematic Moon has reached the position given in columns 3 and 4. The text after the numbers confirms this interpretation: The structure of all comments is alike; the Moon stands in (*ina*) some zodiacal sign (which in all cases is the same as the month of column 1) at the position (KI) of the micro-sign Gemini = III, given in column 3.

Let me try to render the content of lines rev. 3 – 10:

rev. 3–4	**5** 24 **3** 12	The Moon stands in (*ina*) the backbone of the **Lion** at the place (KI) the **Shepherd = micro-Gemini**....
rev. 5–6	**3** 1 **3** 13	The Moon stands in (*ina*) the shoulder of the rear **Twin (= micro-Gemini)**....
rev. 7–8	**12** 8 **3** 14	The Moon stands in (*ina*) the **Swallow** at the place of (KI) the **Shepherd = micro-Gemini**....
rev. 9–10	**9** 15 **3** 15	The Moon stands in (*ina*) the back of **Pabilsag** at the place of (KI) the **Shepherd = micro-Gemini**. ....
rev. 11	Third month.	

In the last line, rev. 11, month 3 is clearly mentioned. This has led to the reading of all numbers 3 in column 3 as indicating month 3. But when we consider what this text might have been used for, we see that the identification is not compelling. I propose that we have an instruction here:

> For consecutive days in month III you find in this text the zodiacal sign (of the Sun) and the micro-sign (of the Moon), given by the numbers in columns 1 and 3.

These signs were used to determine ingredients for ointments as indicated in *LBAT* 1593 and demonstrated in Calendar Text W22704 [see Table 4, p. 54 above], and they are repeated by words in the accompanying text. This means that we can read the pair of numbers (III, n) in columns 3 and 4 in two ways: as index, date (III, n), for finding remedies for month 3, day n. And at the same time, we understand (III, n) as the position of the <☽>, namely, as n° in ZS III. The date (M,d) at which this happened, according to the *Dodecatemoria*, is listed in the columns 1 and 2. Here again, we have a double reading since date (M,d) also indicates the position of <☉> as (M,d). The text following the numbers (M, d, III, n) mentions the zodiacal sign M of the Sun (on date (M,d)) and the micro-sign III of the Moon. They may both have served to determine remedies for ointments for month 3 day n.

This analysis shows us that the Babylonians, indeed, knew and utilized the fact that the Calendar Text and *Dodecatemoria* functions are inverse functions. It means that our first interpretation of the Calendar Text as a construction reached from playing around with numbers and symmetries, without any astronomical significance must be revised [Brack-Bernsen and Steele 2004, 118].

We have explained the fact that the Calendar Text scheme is inverse to the *Dodecatemoria* and we have also seen that the Babylonians knew and utilized this knowledge. Accordingly, we reject John Wee's interpretation [2016], in which the imaginary point that changes its position by 277 per day is a "virtual Moon". This must be replaced by the following:

> After 277 days = 277° movement of the schematic Sun <☉> the position of the schematic Moon<☽> has increased by 1°.

We do not have a "virtual Moon"; rather, we have the schematic Sun. We do agree, however, that each zodiacal sign was divided into 12 micro-signs.

In sum, the first two columns of the normal Calendar Text scheme, the rows of which increase by 1, list consecutive positions of <☽> in the zodiacal circle; and the last two columns, the rows of which increase by 277, give the date at which <☽> was in the listed position. At the same time, the first two columns could be used as index (read as month day) for finding the zodiacal signs (given by the month listed in column 3), which determined the remedies for ointments to be produced for that day.

Let us return to *LBAT* 1593, §2:

> When the animal(s) of the 13 are before you, you take 1, 1, 1, 13 animal(s) of month V for? (month?) I, you take 1, 2, 1, 26 animal(s) of month XI for? (month?) I, you make the animal(s) of the trees, the date palm, the goose, the date palm for? The animal(s) of 13, the writing board? of month VII for? (month) I for? (month) X, for the animal(s) of 4,37 the date palm, the goose, the date palm "you take away from"[9] the constellation Old Man…stone, herb, tree, the animal(s) of 13 and 4,37 you take one with the other, you salve, feed, and fumigate the patient with the stone, herb, and wood (respectively), the *biblu* (almanac?) of month I, from the 1st to the 30th…. [Reiner 2000, 424]

This text is damaged and very difficult to read—Reiner has inserted many question marks—but I think that we can still learn something from it. It mentions the numbers 13 and 4,37 = 277, so that it is clearly referring to the *Dodecatemoria* and Calendar Text schemes. And it gives advice on how to determine medical ingredients for ointments by means of those schemes, starting with the first two lines (1 1 1 13) and (1 2 1 26) of the *Dodecatemoria* for month 1. For these days, one has to take the animals of months 5 and 11, respectively.

But it is not evident where such months ≈signs come from: Are they eventually determined by the micro-signs of 1 13 and 1 26? The text is too damaged and unclear to allow any reconstruction. The last line mentions month 1 and its 30 days from the 1st to the 30th. This shows that month 1 was used as an example to illustrate the method for finding astral ingredients by means of the *Dodecatemoria* and Calendar Text schemes. In astronomical procedure texts, we find the same practice, namely, demonstration of a method by model calculations for month 1, where the method was meant to be applied for all months. We do not know how the remedies were found by the *Dodecatemoria* scheme. But the Calendar Text procedure for finding the zodiacal sign, which determines the astral ingredients on an arbitrary date (month N day n), is well known: read (N, n) as a lunar position and find the date (M, d) at which the Moon was at the position (N, n). $(M d)$ is found in the Calendar Text scheme as partner to (N, n). M is the deciding sign.

Let the two first lines of the Calendar Text (1 1 **10** 7) and (1 2 **7** 14) serve as an example:

[9] Here I have used a reading proposed by Hermann Hunger, see Reiner 2000, 422 n5.

On date (I, 1), the "animal" is indicated by the third number 10 (in bold dark blue), and similarly for date (I, 2), the "animal" for ointment is given by the third number 7 (in bold dark blue).

6. Conclusions

The Babylonians knew that the two astrological number schemes, the *Dodecatemoria* and the Calendar Text, were inverse schemes or functions, and used both in medicine. This conclusion is based on two Calendar Texts which give us two important insights.

(1) W22704 (treated in Table 4 [p. 54 above]) shows that Month $M =$ Sign M given in column 3 determines the ingredients of ointments. The advice in column 5, indicating the "animal" to be used, always mentions remedies connected to Sign M.

(2) *LBAT* 1586+1587 (shown in Plate 2 [p. 58 above]) confirms the identification of the number pairs as lunar position and corresponding date. Note, however, that the order of the columns has changed. Here the **last** two numbers indicate the position of the schematic Moon for consecutive degrees in the zodiacal Sign Z, while the **first** two numbers give the date (M, d) at which this happened, and which at the same time indicate the position of the schematic Sun on that day. For each quadruple of numbers, the accompanying text always describes the schematic Moon to be in Sign M at the position of micro-sign Z.

(3) *LBAT* 1593 confirms that the ingredients to be used in medicine were indeed determined through the numbers from the Calendar-Text scheme (and the *Dodecatemoria*). Thus, when used for finding ingredients ("animals") for medicine for a special day, the *Dodecatemoria* might have indicated the "animals" through the position of <☽> in the zodiacal circle and micro-sign on that day. The Calendar Text found the ingredients for month N day n from the date (month M day d), at which <☽> was in sign N $n°$. Based on the identification of date and position of <☉>, we know that <☉> was in zodiacal sign M ("the animal") of that date, while the micro-sign was the same, namely, N, for all 30 lines of the Calendar Text of sign N.

Accordingly, we now understand the inner structure and, hence, the interplay between the two schemes and have shown that the Calendar Texts do not record positions of *any* "virtual Moon", but deliver the date at which <☽> was at the given position according to the *Dodecatemoria*.

7. Addendum

We observe the flexibility with which the Babylonians manipulated the two imaginative number schemes, that of the *Dodecatemoria* and of the Calendar Texts. Both concern numbers, which sometimes are identified as a date and position, or as a position with a date, or as a date with date, or as a position with a position.

The Calendar Text BM 47851, published in Hunger 1996, is an example:

Line	Month	Day	Month	Day	Month	Day	Month	Day
1	V	1	V	13	V	1	II	7
2	V	2	V	26	V	2	XI	14
3	V	3	VI	9	V	3	VIII	21
4	V	4	VI	22	V	4	V	28
5	V	5	VII	5	V	5	III	5
28	V	28	V	4	V	28	XI	16
29	V	29	V	17	V	29	VIII	23
30	V	30	V	30	V	30	V	30
31	VI	1	VI	13	VI	1	III	7
32		I?	1	I	11	18	19	
33			14			26		
34			21			27		
35			22			28		

Table 5. Calendar Text BM 47851

What the numbers in lines 32 to 35 stand for, I do not know. But maybe they are connected to the micro-sign indicated by <☉> and <☽>. The micro-sign indicating the position of the Moon sometimes is the same as the one indicated by the Sun [see Plate 1, p. 56 above], and sometimes the lunar micro-sign is one position further than that of the Sun [see Figure 1, p. 50 above]. For all 12 months, this is the case for the days (5),[10] 7, (10), 12, 14, (15), 17, 19, (20), 21, 22, 24, (25), 26, 27, 28, 29. But for days 1, 2, 3, 4, 6, 8, 9, 11, 13, 16, 18, 23, and 30, the micro-sign of the schematic Sun and Moon will be the same. We also find the numbers 1, 11, and 18, in line 32, in the list of "same micro-sign" dates, while 19 is also written in line 32. All the

[10] The numbers 5, 10, 15, 20 and 25 all signify dates at which the Sun was at the end of one micro-sign, which at the same time is the beginning of the next micro-sign.

rest of the numbers (written in lines 33, 34, and 35) would be days at which the solar micro-sign was the one just before the lunar micro-sign. The tablet is, however, too damaged and too many relevant numbers are missing to prove that they were listed as indicators of days at which the micro-signs of the <☉> and <☽> were the same or consecutive.

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The Creation of the World in Jewish Esoteric Philosophy

by

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Abstract

A discussion of *Création du monde et limites du langage. Sur l'art d'écrire des philosophes juifs médiévaux* by David Lemler

About the Author

IGOR H. DE SOUZA specializes in Jewish thought and gender studies. He is the author of *Rewriting Maimonides*, a study of medieval commentaries on the *Guide of the Perplexed*. His book in progress, *The Pure People: Sodomy and the Jew*s, examines discourses on same-sex relations in pre-modern Judaism. He is currently a lecturer and research fellow at Yale University.

The notion of esoteric writing has been deeply influential in the study of medieval Jewish philosophical texts. David Lemler's *Création du monde et limites du langage. Sur l'art d'écrire des philosophes juifs médiévaux*[1] is the most recent addition to a shelf that continues to grow since Leo Strauss' landmark studies on Maimonides' *Guide of the Perplexed* [Strauss 1952: cf. e.g., Halbertal 2007; Schwartz 2005, 149–222]. Strauss' argument is that Maimonides chose to express himself esoterically for political-religious reasons: the fear of persecution, stemming from the socially-fragile status of philosophers in the medieval world. Though not without detractors and critics, Strauss' basic approach to medieval Jewish philosophy—which he extends to much of Western philosophy, with Socrates' demise as a preeminent example of what takes place when philosophers are not careful—has been widely accepted among specialists. It bears noting that the esoteric approach to texts championed by Strauss was not original to him. Rather, he derives it from the earliest commentators on the *Guide of the Perplexed* who wrote in the 13th and 14th centuries, although he does not emphasize the historical predecessors of his approach.

The growing shelf on esotericism and esoteric language has expanded far beyond the boundaries of the study of medieval Jewish philosophy. Classicists and historians of philosophy have pointed out esoteric strategies in the writings of late-ancient readers of Aristotle and Plato. The well-known division of Aristotle's writings into acroamatic (exoteric) and akroatic (esoteric) disciplines is a strategy of esoteric writing [Boas 1953]. More recently, Arthur Melzer has proposed that virtually all philosophers until the modern age have written esoterically. His claim is actually stronger: it is that we cannot properly understand pre-modern philosophy if we ignore the esoteric dimension of philosophical writing [Melzer 2014]. Indeed, the argument has been made that esoteric writing reveals more than simply how people wrote: it reveals how they constructed the world [Talmage 1999].

While there is no universal definition of esoteric writing, we can point to some of its historical forms. Generally speaking, esoteric writing takes place

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when an author attempts to conceal some aspect of their thought, for reasons that will be outlined below. A variety of strategies can then take place:

- employing purposeful contradictions within the same text;
- employing code-words or allusions, the significance of which will be grasped by some readers but not all;
- fashioning a general and surface explanation of some topic, only to put forward a deeper explanation of the same topic subsequently;
- providing distinct explanations of the same phenomenon in different works.

Esoteric works are said to contain two levels: one is the external, "exoteric" level, which any reader can access; and the other is the internal, "esoteric" level, which requires specific decoding skills on the part of readers. Esoteric writing is different from symbolism and metaphor, although it can employ either as a part of a larger rhetorical strategy. In esoteric writing, unlike symbolism and metaphor, the "surface" or exoteric level does not necessarily lose its rhetorical force even once a reader has been able to access the esoteric level. Both levels exist simultaneously, each carrying their own truths (which may or may not converge into the same truth).

As studies by Melzer and others have shown, there are many varieties of esoteric writing responding to different motivations. One such motivation, highlighted by Strauss, is the fear of persecution. Another is pedagogical: as any member of the modern academic faculty knows, not all texts (or even all arguments within some texts) are appropriate for all students or all contexts. An esoteric-minded writer may then choose to write in such a way that will transmit *something* to every student, while being most helpful for advanced students. Yet another motivation for esoteric writing has to do with the subject matter itself, an embryonic point in Aristotle's *Nicomachean Ethics*, where the Stagirite writes that each discipline requires its own methods [see Anagnostopoulos 1994, 320–362]. A difficult topic, naturally, will demand a certain kind of explanation that is not matched by the explanation of a simple concept. Some topics or questions *must* be approached esoterically, not necessarily because the author wishes to hide their "true" thoughts—although, as we have noted, that is generally true of esoteric writing—but rather because they cannot be treated in any other way. Ibn Falaquera, a 13th century Spanish Jewish thinker, offers the analogy of trying to teach a blind person about colors. Straightforward descriptions would be useless, and the discourse of the teacher would quickly fall into incoherence. The only meaningful procedure is to indicate to the student the path that the teacher took, from non-seeing to seeing and then seeing colors—and trust that the student has the skills to understand and apply the indications [De Souza 2018, 169–170]. This last motivation for esotericism is designated by Lemler as "essential" or "philosophical" esotericism, in which there is an "intrinsic connection between the employment of esoteric writing and the topics discussed through such writing" [12].

Lemler is interested in the approach to the creation of the world as a topic that demands esoteric writing. This is because, Lemler explains, Creation is a subject that lies at the very limits of what can be said. What is at stake is "no less than seeking to put into words something about the radical origin of everything, while language always presupposes the existence of anything of which it speaks" [14]. In support of his position, he quotes Wittgenstein's *Lecture on Ethics*: "the right expression in language for the miracle of the existence of the world, though it is not any proposition in language, is the existence of language itself" [Zamuner, Di Lascio, and Levy 2014, 50]. Lemler concludes that Creation is a question that we cannot avoid, and yet "every attempt to answer it necessarily leads to inextricable problems regarding the correct way to speak of it" [14].

A central problem with esoteric writing is that readers can never be sure that they have grasped the author's "true" views. It is very easy to be distracted by an insignificant remark placed in the text precisely to throw the reader off. Even competent readers who may understand most of the author's allusions will still have to make critical hermeneutical decisions. This is the case, as Lemler shows, for readers of Maimonides' *Guide of the Perplexed*, a *locus classicus* in medieval Jewish philosophy on the problem of Creation. Maimonides presents no fewer than three theories of Creation without clearly and unambiguously taking any sides. It is up to the reader to figure out what is Maimonides' "real" position. As early as Maimonides' medieval readers, and continuing through modern academia, different scholars have attributed to Maimonides each of the three theories. The dispute continues, with strong arguments on all sides, and no one can truly say what Maimonides personally "really" thought about Creation (on which more below).

With this idea in mind, Lemler is to be applauded for the very sensible choice of bypassing any search for the author's "true" intention in the texts that he studies. What matters is the text, the questions raised therein. The esoteric text is language without author [20, citing Barthes 1977]. The challenge for readers of an esoteric text is not (or should not be) to understand what some author meant to say regarding Creation; rather, it is to seize on what the text has to say on the subject. Hence, Lemler's broad project in this book is to analyze esoteric strategies of writing not as devices that hide an author's true views, but as attempts to expose the limits of language "within and through language". Such strategies of writing are a means to "know, as much as possible, something that is inherently outside the field of human knowledge" [21].

Lemler's project, then, is one where the philosophy of language crosses over into epistemology and vice-versa. Esoteric writing, in Lemler's formulation, manifests not merely as a method of writing, but as a means for knowing about the world, and here—crucially for Creation—as a means for articulating, however tentatively, the limits of the world and of language.

Lemler follows this thought-provoking theoretical scaffolding with individual chapters dedicated to six medieval Jewish philosophers: Saadia Gaon, Abraham ibn Ezra, Maimonides (two chapters), Gersonides, and Isaac Albalag/Hasdai Crescas (together in one chapter). He closes with a brief conclusion. Lemler chooses these thinkers because, in his description, they each espouse a distinct view of the origin of the world.

While the choice of Abraham ibn Ezra and Maimonides is clear—these authors have long been read esoterically, and they employ clear esoteric rhetorical markers—the choice of the other thinkers for a work on esoteric language is something of a question mark. Saadia is not known as an esoteric writer, and Gersonides is most certainly not an esotericist—he writes vigorously against the practice in the introduction to his *Wars of the Lord* [Feldman 1984, 100–101]. Crescas has likewise not been known as an esotericist, but Lemler makes a persuasive case for esotericism in chapter 6 by investigating an explicit contradiction in Crescas' treatise, *Light of the Lord*. Many other authors could have been included, including openly esoteric authors such as Joseph ibn Kaspi [Sackson 2017] or Levi ben Abraham ben Ḥayim, the persecuted author of an allegorical treatise on Creation [cf. Halkin 1966, Kreisel 2004], as well as authors who adopt esotericism to some extent, such as Ibn Falaquera [De Souza 2018, 44] and the onetime student of Crescas, Joseph Albo [Ehrlich 2009].

To summarize each chapter briefly: chapter 1, on Saadia, studies the different treatments of Creation in the *Book of Beliefs and Opinions* and the commentary on the *Sefer Yeẓirah* (Book of Creation). According to Lemler's reading of these texts, in the *Book of Beliefs and Opinions*, we have an argument that Creation has taken place, although humans are not able to represent *what* it was: it cannot be known in itself; we can only know that it has occurred. The commentary on *Sefer Yeẓirah*, however, insists on the will to know: it explains the *how* of Creation, its principle and order, as if it were an ordinary object of knowledge that can be known. (Hence, Lemler compares the commentary on *Sefer Yeẓirah* to Kant's vice of *Schwärmerei*, enthusiasm that blunts the self-critique of reason). While the chapter does contain some interesting material about language, it is primarily epistemological in approach.

Chapter 2, on Abraham ibn Ezra, takes up his well-known contention that "the Torah speaks in the language of humans", which in Lemler's reading means that the language of the Bible represents "natural" language (i.e., everyday language) rather than scientific discourse. The biblical narrative of Creation is an attempt to describe in terms accessible to all and any an experience that is by definition impossible to know. There is no term in natural language that can be used to designate the creation of the world, and Creation can only be understood, therefore, in terms of analogy with what has been created in the world [45].

Chapters 3 and 4 focus on Maimonides and the *Guide of the Perplexed*. Lemler was wise to write two separate chapters on Maimonides because Maimonides is not only a central figure of medieval Jewish philosophy, he also theorized esoteric writing to a greater extent than any of the other philosophers in Lemler's book. Due to the influence of Maimonides, esotericism became a more central concern in post-Maimonidean Jewish philosophy. In the paragraphs to follow, then, I will reconstruct the arguments in the remaining chapters in greater detail.

Chapter 3 introduces the basic problems of Maimonidean esotericism, primarily with attention to indications contained in the introduction to the *Guide*. As I have argued elsewhere, the introduction to the *Guide* is a self-contained work that stands on its own as a theoretical expression of the Maimonidean project. It is a statement of Maimonides' method and anxieties concerning the use of esoteric writing. Much of Jewish philosophy between Maimonides and Spinoza builds upon concepts brought forward in this introduction [De Souza 2018, 4–5]. Lemler shows that in the interpretive tradition of the *Guide* two groups of readers have emerged: esotericists and exotericists. Esotericists, à la Strauss, are attentive to potentially underlying meanings in the text. For esotericists, Maimonides' strong or numerous arguments in favor of any one position in the *Guide* are *a priori* suspect, a stratagem to throw off casual readers. Exotericists, on the other hand, tend to focus on the arguments of the *Guide* rather than on its avowedly esoteric method. The two camps come away from the *Guide* with contradictory, mutually exclusive ideas about Maimonides' "true" opinions.

Lemler's intervention consists of dispensing with any search for what Maimonides "really" meant to say. He contends that Maimonides' intention is precisely to place the reader in such a quandary:

> Maimonides himself, through his introductory remarks, has placed the reader faced with the text of the *Guide* within an epistemological situation where it is impossible for the reader to have access to the position of the author. [75]

Chapter 4, therefore, focuses on the text rather than on the author. In his approach to the Maimonidean issue of Creation—a subject on which much ink has been spilled[2]—Lemler centers his analysis on what he calls the "Maimonidean Principle":

> No inference can be drawn in any respect from the nature of a thing after it has been generated, has attained its final state, and has achieved stability in its most perfect state, to the state of that thing while it moved toward being generated. [*Guide* 2:17: Pines 1963, 295].

Lemler deploys this passage to argue that the ambiguity of the *Guide* on Creation might be better explained by the difficulty of speaking of the subject rather than an authorial desire to dissimulate his own opinion. In his reading of this Maimonidean Principle, Lemler argues that the text advocates both the religious and the Aristotelian views of Creation as valid. The Principle, according to Lemler, leaves open the possibility of Creation *de novo* and *ex nihilo*, preserving the sense of the world as a miracle, an irruption of the divine will into the laws of nature. "To decide that the world is created means to decide to consider its existence as having meaning" [107]. Concurrently, the Principle allows for the possibility of the world as an Aristotelian, uncreated brute fact, an object strictly ruled by laws of nature, hence, something that can be known and described. This intellectual practice of observing and knowing the world, in Lemler's reading of Maimonides, is the highest ideal for human life according to Judaism [107]. In this manner, both the religious and the Aristotelian readings of Creation are valid even though they may seem mutually exclusive. Lemler concludes that this apparent contradiction should be read as producing an original theory of Creation: the religious, created world appears to us as if it is objective and uncreated. The position of the *Guide* on Creation, then, is to project subjective conditions of knowledge onto an objective world [108].

[2] Readers have identified Maimonides as a Platonist, an Aristotelian, a religious Jew, or a sceptic on the matter of Creation. See Lemler 68 n6. On Maimonides and scepticism, see Stern 2013, 132–249. For Maimonides as holding the traditional religious view, see Seeskin 2005.

Chapter 5, on Gersonides, illustrates the ideological diversity of medieval Jewish philosophical writing. Alongside those who employ esoteric writing to a greater or lesser extent, there are thinkers like Levi ben Gershom (widely known as Ralbag or Gersonides) who purposefully dispense with the esoteric program. Arguing directly against Maimonides, Gersonides conducts a radical critique of esotericism; and as a correlate, he insists that Creation is a concept that is fully within the sphere of human knowledge and which can be conclusively demonstrated. As Lemler points out, Gersonides rejects the notion of essential esotericism (according to which certain subjects require an esoteric presentation), as well as the notion of political-religious esotericism (according to which esotericism is required because of the potential danger of persecution for the philosopher). Unlike Maimonides, Gersonides

> does not recoil from a clear and univocal account of heterodox doctrines, while acknowledging that such an account should be preceded by a prior preparation that will render them acceptable. [120]

While the account of Creation in the Hebrew Bible is not itself a demonstration, for Gersonides it constitutes a *haysharah*, that is, guidance or an indication. Such *haysharah* is meant to convey only that Creation is a subject that should be analyzed and demonstrated by science, but without prior assumptions or conclusions. I employ the term "science" deliberately, as Lemler outlines how Gersonides—atypically for his time—attributed singular importance to empirical observation in the construction of scientific hypotheses [126–127]. That is not to say that the biblical text has no significance; rather, it means that Gersonides is located within a "hermeneutical circle" [128]. Understood as *haysharah*, the biblical account is true and does not contradict reason, which should be developed freely and independently; but the rational project has no meaning unless the biblical account is possible.

Last, Lemler turns his attention to Gersonides' critique of the Maimonidean Principle (enunciated earlier). While Maimonides employs the principle to insist on a radical break between the before and after of Creation—thus opening the possibility for Creation *ex nihilo*—Gersonides finds Creation *ex nihilo* to be a logical impossibility equivalent to the simultaneous existence of two contraries, or the idea of God creating another God [130–131]. The Maimonidean Principle, Gersonides argues, makes it impossible for the world as it is to be an object of knowledge because the nature of its cause cannot be known. Instead, Gersonides develops his theory of Creation along the lines of the Platonic pattern (Creation *de novo* but "from something", *ex aliquo*). For Gersonides, only the hypothesis of a primordial preexistent body (in the minimal sense, without form or nature, fluid or ungraspable), which cannot be known directly but can be known logically, is the only theory that can make sense of the universe as it is. Such a hypothesis "makes it possible for reason to grasp or to describe its own origin" [136].

Chapter 6 is on Isaac Albalag and Ḥasdai Crescas, philosophers who have been characterized as extremely divergent from one another. Albalag has become known as a partisan of the theory of "double truth" and a strict Aristotelian [Touati 1962]; Crescas has come down to us as a conservative religious thinker [Davidson 1983]. In this chapter, Lemler intends to dispel both of these stereotypes. He argues that both thinkers agree that a continuously created world is more appropriately attributable to God than a world created *de novo* [139]. Once again, Lemler interprets the use of esoteric language not as an attempt to hide some opinion but as a philosophical practice that implies something about the nature of the subject [140].

On Albalag, Lemler shows that the notion of a "double truth" (which maintains the simultaneous validity of religious and scientific accounts, even if they are contradictory and mutually exclusive) was never seriously held by any Latin philosophers. Some scholars of Albalag have interpreted his allegiance to the idea of "double truth" as a case of strategic and insincere dissimulation along the lines of the religious-philosophical esoteric paradigm (fear of persecution) [144n3]. Lemler focuses on the meaning of this doctrine as proposed by Albalag rather than on his sincerity. In his view, the doctrine of a "double truth" is the theoretical foundation for a specific Jewish philosophical practice in that it gives the Jewish philosopher complete freedom of inquiry, on the one hand, while guaranteeing the autonomy of the biblical text, on the other. Rational inquiry and text come together in exegesis, which brings that philosopher into rapport with a given truth. The philosophical exegesis of the biblical text becomes a "spiritual exercise", in the sense given to this term by Hadot and Foucault [149]. Lemler emphasizes that the dispute is not between two sources of knowledge, but rather between truth and its representation: the philosopher knows, scientifically, that the First Cause creates the world continuously, but believes that Creation takes place within a temporal framework, as it is represented in the biblical text. There is a back-and-forth between the concept and its "inseparable but inadequate" representation [152]. The philosopher's allegiance to the biblical text implies that the philosopher, like simple religious believers, has a faculty of imagination, while the

> allegorization of the temporal account of Genesis is the perennially renewed effort to rediscover the concept through the imagination. [152]

Albalag's solution, then, is an epistemological solution for the problem of the Creation of the universe.

Lemler then goes on to discuss Crescas. He focuses on the fact that in Crescas' treatment of Creation, Crescas offers several arguments against Creation *de novo*, before hastily concluding that Creation *de novo*, which he has just refuted, is the "absolute truth" [Weiss 2018, 276]. Such a procedure, consisting of an explicit contradiction, is a hallmark of philosophical esoteric writing, as it leads the reader to question just what is Crescas' real opinion. Eschewing again any attempt to learn what Crescas "really" thought, Lemler moves on to focus on Crescas' arguments. As he notes, Crescas maintains that the biblical text imposes a notion of Creation *de novo* which maintains God's voluntariness in the process of creating world(s) ontologically dependent on God, but which also raises questions concerning the extent of divine power.[3] Crescas argues that the true condition of possibility for the Torah to exist, however, is not Creation *de novo* but Creation *tout court*.

Why, then, does the biblical text maintain that Creation is specifically *de novo*? As Lemler puts it, the problem is to learn why an all-powerful God would wish to be represented as less powerful since stating that God merely creates *de novo* implies a less powerful God than depicting one who creates continuously. Lemler resolves the conundrum by arguing that Crescas relies on a principle of divine wisdom (which Lemler also identifies in Saadia Gaon), according to which "infinite divine power can only manifest in the human realm by paradoxically limiting itself, by inscribing Creation within the length of a narrative" [168]. The appeal to an unknowable divine wisdom is meant to resolve a difficulty that is both conceptual and epistemological. The biblical belief, contrary to reason, becomes a paradoxical means to imprint a certain representation onto the idea of Creation [169]. Lemler concludes that, for Crescas, we might have to believe in the newness of the world in order to learn (*connaître*) its Creation [169].

It is this paradox, which Lemler reads in both Albalag and Crescas, that allows us to get beyond esoteric agendas and double-truth theories. If these contradictions are something beyond a political strategy, they suggest that the concept of Creation is a paradoxical structure, a logical consequence

[3] Crescas maintains that continuous Creation implies the formation and destruction of an infinite number of worlds, which raises the question of why God would not simply create the best of all possible worlds. See Weiss 2018, 276–277.

of the idea of God and God's relation to what is other than God, a structure that cannot be apprehended unless it can represent itself as limited in scope [171].

In his conclusion, Lemler insists that our strategies of reading medieval Jewish sources on Creation cannot end where esotericism begins. Instead, he argues that the treatment of Creation implies a new practice of philosophizing, and indeed a modification of what philosophy is. While esotericists have emphasized the modifications that philosophical inquiry operated on religious beliefs and texts, such as rationalization and demythologization, Lemler points to the idea that the tension between religion and philosophy brings dramatic changes to the notion of philosophy and its practitioners, raising the status of a philosophical demonstration, in their eyes, to that of religious revelation [181].

Lemler's study significantly advances the debate on the interpretation of medieval Jewish texts. It offers a path beyond the esoteric-exoteric paradigm, opening a new vista where esoteric techniques are read not as a desire to conceal. Rather, esoteric writing on Creation embodies a fundamental epistemological quandary about what can be known of the origins of the world, and, hence, of language and knowledge. Through this process, religion and philosophy both emerge autonomous, but scathed and transformed. Above all, it is the subjects—the readers—who are transformed by the investigation into Creation, and who become aware of their own epistemological limits.

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The Circulation of Treatises on Divination and Magic from the 12th to the 17th Century

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Abstract

A discussion of *Geomancy and Other Forms of Divination* edited by Alessandro Palazzo and Irene Zavattero and of *La magia naturale tra Medioevo e prima età moderna* edited by Lorenzo Bianchi and Antonella Sannino.

About the Author

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In the modern-day classification of the forms of knowledge, the divinatory arts have been viewed as tantalizing, even amusing, but unfounded practices. If we pay any attention to them, it is for some indefinite kind of superstition, at least in the minds of people who live south of the Alps, where I live. Nothing has changed in the epistemic status of such practices, and yet—no need to linger on it—scholarly interest has increased in divination insofar as it reveals a distinctive feature of the cultural history of *Homo sapiens sapiens* since our first inception as social beings.

The two books under review here do not contain anthropological or sociological studies in a strict sense. Rather, they examine the history and circulation of treatises on divination in a specific period of time beginning in the second half of the 12th century AD when divinatory practices, rooted in astronomy and astrology, migrated to the Latin world from their Arabic cradle. It is well known among medievalists what the so-called 12th-century "renaissance" meant for the Latin West. It is precisely this dynamic, indeed magmatic, context that provides the chronological starting point for the studies collected by Alessandro Palazzo and Irene Zavattero,[1] covering plenty of ground up to the threshold of the 15th century. The subsequent history of magic, beginning with the later Middle Ages and extending all the way to the 17th century, is picked up by another collection of studies edited by Lorenzo Bianchi and Antonella Sannino[2] which also features in the present review.

I do not deem it necessary to justify the choice of having both volumes covered in one review. My reasons are clear enough in my comments on the following passage from Palazzo's introduction, "New Perspectives on Geomancy: Introductory Remarks" [ix–xxx]:

[1] *Geomancy and Other Forms of Divination*. Micrologus Library 87. Florence: SISMEL – Edizioni del Galluzzo, 2017. Pp. xxx + 572. ISBN 978–88–8450–842–3. Paper €75.00

[2] *La magia naturale tra Medioevo e prima età moderna*. Micrologus Library 89. Florence: SISMEL – Edizioni del Galluzzo, 2017. Pp. 361. ISBN 978–88–8450–848–5. Paper €55.00

> Despite its fortune and cultural relevance, scholarly literature on medieval geomancy has thus far been relatively modest when compared with the massive output of studies dedicated to astrology. [xii]

Palazzo notes that his edited collection is probably the first attempt at a synchronic overview of this predictive form of knowledge as it was cultivated in the medieval civilizations surrounding the Mediterranean. This is certainly true. However, in order to understand this remark adequately, one should add that treatises on geomancy, as well as on astrology or magic, both Latin and non-Latin, cannot be appreciated without adequate background knowledge of astronomy and mathematics, their history, and also ideally the history of "numbers" and their symbolic representations. This is to call attention to the "applicative" status of geomancy as a practice which brought to fruition notions of astronomy and astrology by furnishing, as it were, a particular technique with a specific function. This is not to belittle the function that was once served, and is still ostensibly served to some extent, in geomancy and other forms of divination across the history of culture. These two collections of studies can, in this sense, be viewed as hosting investigations into various "applicative" aspects of astronomy and mathematics within the ambit and history of religious, philosophical, and social thought. Indeed, the range of competences that are required for a proper appreciation of geomancy and the predictive arts is not narrow, upon reflection, despite the typical technicality of treatises in geomancy.

The two volumes contain a true wealth of contributions and information. *Geomancy and Other Forms of Divination* hosts the proceedings of a conference that was held at the University of Trento on 11–12 June 2015. The conference was organized by scholars from the universities of Trento, Bari, and Lecce within the project Foreseeing Events and Dominating Nature: Models of Operative Rationality and the Circulation of Knowledge in the Arab, Hebrew and Latin Middle Ages, funded by the MIUR (Italian ministry of education, university, and research). It aimed to discuss the state of the art in studies on the history of divinatory techniques across the Latin, Arabic, and Hebrew Middle Ages.

In the introduction, Palazzo reminds the reader of what is meant by "geomancy", and notes the absence of geomancy in the Graeco-Roman world. He recalls its Arabic origin and dissemination among the Byzantines as much as the Latins. In addition, he provides an overview of contributions, organized into four main sections of unequal size:

(1) "Texts and Geomantic Tradition" [5–221],
(2) "Hebrew and Arabic Geomancy" [223–288],

(3) "Divination and Astrology" [289–442], and
(4) "Magic and Images" [443–535].

The volume ends with some observations by Agostino Paravicini Bagliani, "Géomancie et autres formes de divination. Remarques conclusives" [537–552], that bring out the common thread which runs throughout the collected essays.

The opening essay, "La géomancie médiévale: les traités et leur diffusion" [5–29], is the work of Thérèse Charmasson, to whom we owe the most important systematic treatment of geomancy in the western Middle Ages [Charmasson 1980]. Within a few pages, Charmasson introduces her readers to the nature of geomantic procedures, informs them of the main treatises which were composed in Latin, and outlines a general picture of research that came out after the publication of her doctoral dissertation.

The first section of the volume, thus opened by Charmasson, consists of three studies dealing with editorial work which was executed on three "manuals" of geomancy of Arabic origin:

- Irene Zavattero, "*Estimaverunt Indi*: la tradizione testuale di un anonimo trattato di geomanzia" [31–63];
- Pasquale Arfé, "L'*Ars geomantiae* di Ugo di Santalla: il testo e la sua tradizione" [65–91];
- Elisa Rubino, "Per una edizione della *Geomantia* di Guglielmo di Moerbeke: il testo del proemio e della prima distinzione della prima parte" [93–134]

and two other studies which relate in one case to the anonymous treatise *Estimaverunt Indi*:

> Alessandro Palazzo, "L'*Estimaverunt Indi* e la condanna del 1277" [167–221])

and in the other, if indirectly, to William of Moerbeke:

> Pasquale Porro, "Divinazione e geomanzia in Tommaso d'Aquino: qualche osservazione sul *De sortibus*" [143–166].

In addition, Charles Burnett, in "Hermetic Geomancy, 'Ratione certis experimentis usitata'" [135–141], discusses the extent to which unedited Latin texts of geomancy belonging to the so-called Hermetic tradition appeal to reason instead of inspiration. Burnett presents a comparative analysis of various enunciations found in the prologues to the anonymous *Lectura geomantiae* [Bos, Burnett, Charmasson, Kunitzsch, Lelli, and Lucentini 2001, 349–397], the *Ars geomantiae* of Hugh of Santalla, the anonymous *Speculum astronomiae*[3] formerly ascribed to Albert the Great, and the *Tractatus geomantiae* composed "per magistrum Burnettum de Viella".

With the exceptions of Charmasson, Burnett, and Porro, the contributions in this first section lay out the main results of scholars engaged in the aforementioned project to research the doctrines and traditions of three treatises of geomancy, two of them dating to the 12th century (the *Estimaverunt Indi* and Hugh of Santalla's *Ars geomantiae*) and one attributed to William of Moerbeke. The essays provide a special occasion to discuss crucial questions for the study of the traditions of such texts. As already mentioned, it is widely assumed that the treatises stemmed from material of Arabic, rather than Graeco-Roman or Byzantine, origin. On the present state of research, the sources behind the compilations by Hugh of Santalla and the anonymous translator of the *Estimaverunt Indi* remain unidentified. The same holds for any sources, other than the two just mentioned, of the *Geomantia* by Moerbeke, who was in no position to draw on Arabic material directly. This state of affairs is recalled by Charmasson in her opening essay, based on an analysis of Latin medieval geomancy: the earliest such treatise which is extant in Latin is by Hugh of Santalla and presents itself as a translation from Arabic:

> Incipit prologus supra artem geomancie, secundum Hugonem Sanctelliensem interpretem, qui eam de arabico in latinum transtulit.
>
> Here begins the prologue of the *Ars geomantie* as rendered by Hugh of Santalla, who translated it from Arabic into Latin.

At the same time, the extant Arabic treatises would date no earlier than the 13th century AD, even though some practice of geomancy is documented in North Africa, Egypt, and Syria already from the 12th century [6]. Increasing scholarly engagement with the subject of Arabic divination, Islamic and pre-Islamic alike, has led to the localization of several new manuscripts with writings in geomancy.[4]

Let us now turn to investigations into the manuscript traditions of the three treatises that shape the first section of the volume and their conclusions.

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[3] For a concise but complete discussion of the attribution of the *Speculum*, see the recent study by J. Hackett [2013].

[4] Cf. Fahd 1966, 201 n2, quoted in Charmasson 1980, 72 n4. Charmasson admittedly failed to verify the information, having no knowledge of Arabic. Fahd lists numerous manuscripts in Arabic, Turkish, and Persian held in the libraries of Istanbul, Ankara, Cairo, Berlin, Gotha, Bankipore, Vatican City, Alef, Oxford, and Paris.

As stated, the earliest known work on geomancy written in Latin is Hugh of Santalla's *Ars geomantiae*, whose tradition is studied by Pasquale Arfé with an eye to a critical edition of the text [65–91]. Arfé notes that the earliest known manuscript of the treatise (MS Paris, lat. 7354) stands alone in preserving an addition, following the explicit, which appears to be a second *accessus* (introduction) but is termed "Epilogue" by Arfé. Based on comparative analysis of the structures of both the prologue and the "epilogue", Arfé concludes that, contrary to what was argued by Paul Tannery, both texts drew upon identical inspiration and, hence, both must be compositions by Hugh of Santalla "based on doctrinal, historical, scientific and paleographic grounds" [77]. Reading the prologue and the "epilogue" [see Tannery 1920, 324–329], however, one is struck by the apparent redundancy of the so-called epilogue, which has the typical structure of an *accessus*, and it is hard to see why Hugh should have felt the need to write a second introduction.

The treatise is transmitted by 13 presently-known testimonies. In examining their text, the editor was guided by the assumption that manuals of divination are similar to the literary genre

> of encyclopedia entries, that is, they are endowed with their own formal as well as semantic distinction and completeness, as such liable to a kind of textual transmission that is often independent of the rest of the work to which they originally belonged. [79]

On this basis, it is argued that such texts may have had a kind of tradition, which Arfé calls "composite", that results from the incorporation of independent items into different compilations. While it is true that, in principle, sections from different kinds of manuals could be extracted from their wholes in accord with the aims of those who extracted them (just as glosses could, conversely, become incorporated into the body text), it remains unclear how this situation is supposed to bear upon the editor's procedure. Of the 13 codices carrying the treatise, three turn out to transmit very limited portions of text—as would appear from the sheer number of folios [80: MSS E, R, U]—while others would display various discrepancies in the arrangement of textual sections, including the arrangement of individual figures. Picking up on what is documented by Charmasson [97–109], Arfé takes as his starting point in his analysis of the tradition, the arrangement of the text as transmitted by MS P (= Paris, BNF, lat. 7354, 13th century), which is for two thirds of the text in agreement with MS W (= Wien, ÖNB, lat. 5508). The applied criteria are as follows:

(1) relations between testimonies as documented by the denomination and arrangement of geomantic figures in specific sections dedicated

to them, and especially in the complementary figures of *Mundus facie* and *Imberbis*;

(2) the relation between testimonies "based on the simplification and use of lemmatical formulas with conditional meaning" (i.e., *Si vis scire*);

(3) significant additions and omissions.

Arfé lays out these criteria after distinguishing between "text" and "metatext" in accord with the definition proposed by Louis Holtz.[5] However, Holtz's definition was to address entirely different genres and manufacts: that is, Latin classical or ecclesiastical manuscripts whose margins became furnished during the development of earlier medieval culture with ample sets of glosses and running commentaries, as documented in numerous studies. In addition, the final tripartite stemma [86] is left with no commentary: On what grounds should the text of P be regarded as the most complete, the best structured and, hence, in the closest relation to the supposed archetype? On what criteria will the critical text be established, since nothing is being said regarding the quality of the text transmitted by testimonies to different branches? Finally, in what sense and with reference to what transmitted text, and what transmitting manuscripts, does the editor affirm that what matters historically "is the state of the *textus receptus* rather than that of a presumed original" [88]? In present-day textual criticism, *textus receptus* means the vulgate text. But how can a text be vulgate when it is supposedly complete in only two out of 13 codices? Answers to such questions will, it is hoped, be supplied in a proper edition of the treatise. In the meantime, a further question remains to be addressed with regard to the sources of Hugh's treatise, which scholarly consensus locates in the Arabic tradition.

The last question will be best addressed as we turn to the other treatises on geomancy discussed in the volume, in particular the *Estimaverunt Indi*. This work was translated from Arabic and it also constitutes a "manual" of geomantic technique. Its tradition is analyzed by Irene Zavattero [31–63], and we shall present Zavattero's results in conjunction with Palazzo's "L'*Estimaverunt Indi* e la condanna del 1277" [167–221], which focuses on an

[5] Holtz 1984, 142:

> J'entends par là tout ce qui vient se greffer après coup sur le texte d'un auteur connu ou inconnu, c'est-à-dire tous les éléments qui n'ont pas d'autre raison d'être que de faciliter, de guider, d'orienter la lecture: capitulation ou sous-titres ajoutés à l'œuvre,...et surtout éléments visant l'interprétation (paraphrases, gloses, commentaires).

aspect that is by no means secondary in this text, which was expressly cited by Etienne Tempier in his syllabus of 1277.

The *Estimaverunt Indi* has a tradition that is somewhat similar to that of Hugh's *Ars geomantiae*, and is even attributed to Hugh in some manuscripts, although it is currently held to be the work of an anonymous author. Its testimonies are relatively few: eight manuscripts, four of which carry a text that appears to be incomplete when compared to the text transmitted by the others. For sections of text of various lengths, an independent circulation has been documented (as is the case for sections of the *Estimaverunt Indi* in a different translation). Some dissimilarity affects the internal text division. There is also a problem with the actual *explicit* of the treatise [see 51–54]. In an appendix to her study, Zavattero prints the text of the prologue on the basis of six manuscripts, in fact accepting the short textual notes carried solely by MS Laurentianus, Plut. 30.29, from which Tannery transcribed the prologue [403–404]. Furthermore, her analysis of the tradition is exclusively concerned with the correspondence between parts of the treatise across its testimonies. It results in Zavattero's proposal, couched in merely tentative terms, to exclude a number of "chapters" of the treatise from the critical text. The rationale for these choices remains obscure, however. The reader would expect to be able to follow the argument through a synopsis of the text transmitted by those manuscripts which can be held to be reliable testimonies. What the reader is being offered is, however, nothing more than provisional reports on research projects that are still in progress and that fail as such to exhaust some inherent questions.

In order to bring out the importance of accessing the treatise in a critical fashion, Palazzo, co-editor with Zavattero, raises a question that is quite familiar to medievalists but has yet to receive adequate treatment. Of all writings on divination, the *Estimaverunt Indi* appears to be the only work that Etienne Tempier explicitly makes reference to, and targets, in both the *incipit* and *explicit* of his syllabus of 1277:

> …item libros, rotulos seu quaternos nigromanticos aut continentes experimenta sortilegiorum, inuocationes demonum, siue as coniurationes in periculo animarum, seu in quibus de talibus et similibus fidei orthodoxe et bonis moribus euidenter aduersantibus tractatur….

> …and also those books, rolls, or quires containing necromancy, sortilege, demon summoning, or oaths endangering souls, as well as those which expressly deal with any such or other practices that are opposed to orthodoxy and good customs…. [167]

In Palazzo's judgment, scholars have generally chosen to gloss over this datum, which is held to be of the utmost importance. Palazzo's informative study contains a reappraisal of the entire issue. The main thesis is that, by singling out the treatise for explicit reference, Tempier intended to identify it as the principal propagator of a divinatory technique which could cause great harm to the Christian doctrine. The attack was launched within the context of a general condemnation of views intertwining astral fatalism with magic and divination [171]. Palazzo then applies this historiographical perspective in interpreting various testimonies, censures, and condemnations subsequent to the year 1277. In his view, the main threat posed by geomancy consisted in its aspiration to constitute an all-embracing form of knowledge in the hands of human beings.

The analysis continues with a discussion of the extant testimonies to the treatise as well as the independent circulation of parts thereof, which would be evidence for its widespread dissemination. Some circulation of the *Estimaverunt Indi* in Paris would be attested by the aforementioned manuscript Laurentianus, Plut. 30. 29, dating to around 1280, and by the earliest manuscript of the *Speculum* formerly attributed to Albert the Great. It is not possible, within the limits of the present review, to trace the full argument in support of this conclusion. My own impression is that the argument rests upon David Pingree's claim that the codex was copied in Paris,

> ... it <*scil.* the Laurentianus manuscript> is the oldest manuscript, having been copied within 15 years of the composition of the *Speculum*. Already by 1280 then a manuscript was copied, presumably in Paris, from one that Fournival had used, and in the same codex were transcribed Fournival's own work and the *Speculum*. Laurentianus 30, 29 clearly comes from the same circle of Parisian scholars to which Fournival and Albert belonged. [Pingree 1987, 87]

as well as on Pingree's references to the edition of the *Speculum*, where the codex is dated between the years 1260 and 1280 on paleographic grounds [Caroti, Pereira, Zamponi, and Zambelli 1977, 3].[6] Considering the importance that is thus assigned the Laurentianus, a detailed description of its paleographic features would have been highly desirable. There is hope that at least the announced edition of the text will be made a suitable home to it.

[6] The description of the codex can be found at 130–131: "...Sec. XIII Seconda metà ...textus universitario di modulo assai minuto ...". Zambelli 1992, 110–111 also has a reference to Pingree.

The Paris condemnation punctuates Palazzo's analysis of a significant passage from the *Estimaverunt Indi* following the prologue, and his first treatment of the elements on which geomancy is grounded. The passage in question figures also in the shorter version of the treatise, which was specifically targeted by Tempier, and it is printed in an appendix to Palazzo's chapter [211–218]. In this passage, "the *compositor* illustrates the nature of the work, sets out the reasons for its composition, and highlights its religious character as well as divine origin" [196]. Palazzo builds upon previous studies in the alleged Arabic source of the Latin text—"... editus ab alatrabuluci translatione", with a reference to Abū Saʿīd al-Ṭarābulusī or "Tripolitanus"—and he lays emphasis on those aspects which could explain why the treatise is singled out in the Tempier's syllabus.

The opinion of this reviewer is that a coherent interpretation of such texts should be informed by specific knowledge of the rhetorical conventions in use among Arabic writers, e.g., the Arabist scholar would be best placed to identify what underlies medieval translations into Latin. I have no knowledge of Arabic, but anyone familiar with Arabic-Latin versions, and not so much from Aristotle or the ancients as from original compositions by Arabic-speaking scholars, is unlikely to be much impressed by such conventional phraseology as "Inquit compositor", or standard eulogies like "sublimis et magni". Furthermore, the stated connection in the treatise between geomancy and the Islamic tradition would make sense within the Islamic context (which notoriously includes figures and categories of biblical derivation, well known to Latin Christians). It is striking, however, that such ties were preserved in the Latin translation. To my knowledge, this is unusual for the scientific literature, where the tendency was rather to de-Islamicize the texts translated.

In drawing my first set of remarks to a close, I shall add a few notes about the presented and progressing editions of Hugh of Santalla's *Ars geomantiae* and the anonymous *Estimaverunt Indi*. To begin with, the tradition of these works would best be studied when complementary information is gathered about the history of testimonies (origin, chronology, composition, handwriting, notes of ownership) and areas of dissemination of the works themselves.[7] This will prompt the further question of why so (comparatively) few testimonies are preserved from the 13th and 14th centuries, despite the fact that no printed editions were produced with the advent of

[7] It would be interesting to know, for example, what hand, whether Italian or other, copied MS Digby 50, one of the earliest testimonies to the *Ars geomantiae*, acquired

the printing press. Next, textual analysis ought not to lay exclusive emphasis on the retention or alteration of the works' internal structure, and it should make clear on what grounds the arrangement that is found in a given codex qualifies as "complete and ordered", as opposed to that which appears in other codices. Finally, and most decisively, it is essential to define clearly the criteria that are applied in editing Latin translations from Arabic sources when the extant Arabic tradition underlying Latin geomancy is ignored. Such pioneers as Charles Homer Haskins, who explored the universe of 12th-century translators [Haskins 1924, 66–81], and Paul Tannery, editor of Descartes and the first to work towards a comprehensive picture of "Latin" geomancy informed by previous research, broke much new ground, but they failed to address the Arabic tradition in and of itself.

The essays just reviewed testify to the progress of scholarship since the second half of the last century by referencing several scholars of geomancy and other divination, beginning with Fahd (for the Arabic tradition) and Charmasson (for the Latin). At the same time, some of the essays themselves, as is the case with the two dealing with divination in the Jewish tradition, lament the limited availability of critically edited Arabic sources. Josefina Rodríguez-Arribas, in her essay "Divination According to Goralot: Lots and Geomancy in Hebrew Manuscripts", writes:

> The author of this article is preparing a critical edition of this text (i.e.: Yehudah al-Ḥarizi's *Sefer ha-goralot*) with an English translation and commentary, however no serious study can be carried out without the consideration of the geomantic texts and practices among the Arabs (and Berbers), who seem to have been introducers and models of this divinatory technique in Europe and the Near East. Although geomancy had been studied (Binsbergen and Regound) Arabic treatises on geomancy remain mostly in manuscripts and a few are published in uncritical editions. All of them require critical edition and further study to understand their transmission and impact in the emergence and development of geomancy among Muslims, Christians, and Jews. [269]

A similar concern is voiced by Blanca Villuendas Sabaté, in "Arabic Geomancy in Jewish Hands: Specimens from the Cairo Genizah" [274 and n5], who is working to decipher, catalog, and pinpoint geomancy-related material in the numerous fragments retrieved from the Cairo Genizah and

by Kenelm Digby in Florence in the year 1620. Also wanting, as mentioned, is a detailed description of codicological and paleographical features of MS Laurentianus Plut. 30. 29.

presently housed in Cambridge. One of these fragments would—in Villuendas Sabaté's estimation—display some resonance with a passage from Hugh of Santalla's *Ars geomantiae* [287: cf. Villuendas-Sabaté 2012].

These remarks about the indispensability of trustworthy Arabic texts in editing Latin translations are aptly rounded out by an observation that comes from Hugh of Santalla. In the dedicatory epistle to Michael, bishop of Tarazona, accompanying the translation of the *Liber imbrium ab antiquo Indorum astrologo nomine Iafar editus*, Hugh censured the practice of translators who would produce free (and obscure) translations with the purpose of hiding their embarrassment whenever faced with Arabic words that they would not understand because the words were unusual or unintelligible, sometimes due to missing or unexpected diacritical marks (Latin: *apices*). Hugh's censure is glossed as follows by Charles Burnett, editor of the *Liber imbrium*:

> It appears that Hugo is now speaking in his own person, since he discusses in some detail how the contents of the discipline can be perverted through the faults of scribes and translators. He specifically mentions the confusion caused by the absence of diacritical marks—a particularly acute problem for the translator of Arabic texts. This seems to be a general complaint—not levelled at this work or works on weather forecasting in particular. [Burnett 2004, 65][8]

The treatise on geomancy attributed in our manuscripts to William of Moerbeke represents the third "manual" whose tradition and structure are examined in the volume. This was not a translation from Arabic (of which language William had no knowledge), nor a translation from Greek, but an original composition by the Flemish Dominican. The treatise is discussed by Elisa Rubino, in "Per una edizione della Geomantia di Guglielmo di Moerbeke: il testo del proemio e della prima distinzione della prima parte" [93–134], who studies its tradition and both provides an edition of the

[8] For the Latin text, see Burnett 2004, 88:

> Plerunque etiam interpres—sed tunc minime fidelis—inter angustiarum pressuras hanelans, nomen quodlibet peregrinum quod aut elementorum diversi apices aut eorum penuria, sepius etiam linguarum impacabilis diversditas quibus omnibus ethimologie variatur significatio, recte non patiuntur transmutari, ne quid pretermisisse aut ne iam desipiens <magis> desipere videatur, ad libitum transfert, ut quamvis natura neget, elationis tamen arrogantia versum profecto excutiat. Secundario autem assidua scriptorum et minus perfecta eruditio. Verum hec omnia lectoris industriam non possunt effugere.

See also the interesting article by Antonella Braga [1987, 347–348].

prologues and distinguishes for the first time the first of the eight parts comprising the text.

Aside from Rubino's own, two further contributions engage with the treatise, one more directly (Alessandra Beccarisi, "Guglielmo di Moerbeke e la divinazione" [371–395]), the other more tangentially (Pasquale Porro, "Divinazione e geomanzia in Tommaso d'Aquino: qualche osservazione sul *De sortibus*" [143–146]) in that it deals primarily with Thomas Aquinas' *De sortibus* and touches upon a recurrent issue in debates over the treatise and William's authorship.

William's *Geomantia* is transmitted in 15 manuscripts, five of which carry what is assumed to be its complete text, whereas the other 10 contain only the first four (or five, or six) of its eight parts. One exception is MS Würzburg, UB, M. ch. f 212, which contains a collection of excerpts [94–95]. The tradition of the *Geomantia* displays various analogies with that of the other manuals, beginning with the partial transmission of the eight parts of the text and some recurrent tendency towards innovation. In regard to the latter, Rubino speaks of "redactional tendencies" (from various copyists) and variant readings having a "substitutive" function, which would be so numerous and of such a kind as to make it "altogether inadmissible to subject these materials to a philological treatment based on Lachmann's methodology" [96].

It remains unclear, on this account, what exactly is meant by "substitutive" variants, a notion that would typically apply to authorial variants as distinct from scribal errors. Such errors have to be handled as equally plausible readings, unless they are obvious corruptions due to omission or lacunae; their use for the establishment of the text is dictated by the stemma of testimonies. Therefore, what transmitted text is to be considered closest to the original? Which of its testimonies enjoy higher status? Rubino's solution hinges on the notion of a *codex optimus* [99: "a good manuscript"]: that is, a complete and trustworthy testimony to the transmitted work. Of the five manuscripts transmitting the text in its integrity, one (E_3) has damaged and partially illegible margins, another one dates to the 16th century and sticks out for the poor quality of its text; two more (E_1 and G) preserve a redaction of the text "which has a tendency to condensation", and is claimed to be derivative. There remains only K, namely MS Kassel, Landesbibliothek u. Murhardsche Bibliothek, 4° Ms. astron. 16 (second half of the 14th century). Rubino consequently chooses to give the text according to K, and, if necessary, to emend it with the aid of G, also dating to the 14th century. The editor's choice is somewhat puzzling, however, in that G itself transmits what is, on Rubino's own account [99], a derivative redaction of the text of the treatise.

Beccarisi [371–395] tackles the attribution of the *Geomantia* to William of Moerbeke and she discusses its date of composition. She reviews existing proposals to conclude that the treatise can be ascribed to William and was composed during the pontificate of Gregory X (1271–1276). William's authorship would be corroborated by the testimony of the manuscript tradition and by the fact that no evidence has been produced to this day "which can contradict the attribution" [379]. As such, the treatise would be no translation but an original work of William, where the influence of the *Estimaverunt Indi* is often noticeable [379–380]. In the remainder of her essay, Beccarisi dwells on the art of geomancy, and addresses the oft-debated question of how Moerbeke's geomantic scholarship can have coexisted with the theology of Thomas Aquinas.

The alleged attribution to William has recently been questioned by Pieter Beullens in his review of both studies by Rubino and Beccarisi [2019]. Close analysis of the arguments for and against the attribution falls outside the scope of the present review. I shall confine myself here to observing that the attribution finds no support besides the manuscripts that carry it, the earliest of which date from the second half of the 14th century. Also noteworthy, all extant testimonies belong to the "Germanic" area, and contain colophons and opening rubrics informing us that William entrusted the text "pro secreto" to an otherwise unknown nephew of his named Arnulphus. The information should be interpreted in light of the widely documented practice of having unorthodox texts circulate under a false attribution to respected figures for their standing and doctrine, and it points as such in the direction of pseudo-epigraphy.

Among the least studied of Aquinas' writings is the *De sortibus*, forming the subject of Pasquale Porro's contribution. Porro outlines Aquinas' stance on the legitimacy of divination considered both in its own right and in its various applications. The unambiguous reproof that Aquinas expresses of divination, including geomancy, raises an obvious question of consistency between his mind and that of his Flemish confrère. Porro submits that Aquinas did not know of William's geomancy. One would wonder, however, whether William could also be in the dark about Aquinas' censure. This and other such questions remain unanswered and they are likely to bedevil future research on the authorship of the *Geomantia*.

Next in the wealth of essays collected by Palazzo and Zavattero is a section dedicated to geomancy in Jewish and Islamic cultures [223–288]. The section opens with a study by Marienza Benedetto, “Geomancy and Other Forms of Divination in the Jewish Middle Ages” [225–241], complementing the two aforementioned chapters by Rodríguez-Arribas and Villuendas Sabaté. Benedetto outlines the general question of geomancy and focuses on Maimonides’ doctrine of divination, especially in his *Epistle on Astrology* and *Guide for the Perplexed*.

The following section opens still wider horizons by ranging across various forms of divination and astrology. The first that we encounter, in David Juste’s essay “A Medieval Treatise of Onomancy: The *Spera Sancti Donati*” [291–328], is onomancy, as it features in the edition of another medieval treatise. The *Spera Sancti Donati* is a compilation of passages taken from the *Alchandreana*, a collection of astrological texts of Arabic origin that was assembled in Catalonia during the 10th century. The *Alchandreana* was published in an important study by Juste [2007], who has made it the subject of several first-hand explorations. His essay stands out in this volume for its author’s complete command of the subject. The *Spera* has not reached us in its original form, nor do we have any information about what the original was like. It is transmitted principally by MS Egerton 821 of the British Library (second half of the 12th century, southern France) as well as MS Vienna, ÖNB, 5327 (15th century), which has only some of its chapters. Of special interest, in the analysis, are Juste’s remarks concerning the peculiar syntax and the Latin vocabulary of the *Spera*. Those who like myself chance to have a “Romance” dialect besides Italian as their mother tongue encounter relatively few difficulties in reading the text [315–328], to be sure. In regard to authorship and the place of composition, Juste advances several reasonable yet tentative proposals, which he judiciously presents as such.

Our journey into Latin divination treatises continues in the third section of the volume with contributions by Danielle Jacquart, Irene Caiazzo, Sebastià Giralt, and Stefano Rapisarda. Jacquart, in “La gamme diversifiée des condamnations des techniques divinatoires dans les commentaires bibliques (XIIe-XIIIe s.)” [331–350], explores various condemnations of divination in biblical exegesis, particularly on the Book of Genesis. She takes as a starting point the reaction against divination by Raymond of Marseille, and proceeds to discuss the different attitudes exemplified by Hugh and Andrew of Saint Victor (more lenient) *vis-à-vis* Abelard and Robert Grosseteste, who fiercely opposed divination in his *Hexaemeron*, following in Basil the Great’s footsteps. No further commentaries on Genesis were produced over the course of the 13th century, and yet the stances of such masters as Bonaventure, Albert the Great, and Thomas Aquinas can be extracted from their theological writings.

Irene Caiazzo's essay, "Causalità celeste, astrologia e predizione nel secolo XII: qualche considerazione" [351–370], traces summarily the Western reception of a large amount of Arabic astronomical and astrological material, and its philosophical impact on scholars such as Herman of Carinthia and Raymond of Marseille. At the same time, the study of divination propagated well beyond philosophy, percolating into other sciences and medicine in particular.

A renowned physician, the Catalan Arnaldus de Villa Nova, is the focus of the next piece by Sebastià Giralt ("The Astrological Works Attributed to Arnau De Vilanova: The Question of Their Authenticity", [397–420]). Giralt begins with a reference to Giovanni Pico della Mirandola, who cites Arnaldus in his *Disputationes adversus astrologiam divinatricem* for he (erroneously) predicted the advent of the Antichrist in the years 1345 or 1454 based on a couple of astral conjunctions. Giralt raises the question of whether this astrological calculation could truly be found in Arnaldus. He inclines towards a negative answer. Arnaldus' authentic work does contain some application of astrology to medicine, but only in specific contexts, and—on Giralt's account—Arnaldus' main contribution was, rather, the medical use of the so-called astrological seals, dating to the last decade of his life. The attribution to Arnaldus of various astrological writings, which can be found in the manuscript tradition, remains an open question. Giralt concentrates on the tradition and text of three such writings: the *De aqua simplici et composita*, the *De sigillis* (along with other texts on astrological seals), and the very popular *Introductorium ad iudicia astrologie quantum pertinet ad medicinam*.[9] Giralt concludes that none of these writings is the work of Arnaldus.

The section is brought to an end by Stefano Rapisarda, who offers some outlook onto the large tradition of translations of various kinds of treatises on divination into the vernacular. Rapisarda, in "Chiromanzia e scapulomanzia in anglo-normanno nel ms. Londra, British Library, Add. 18210" [421–442], focuses particularly on exchanges and connections between the Iberian Peninsula and the British islands between the 12th and 13th centuries. With Eleanor of Aquitaine's marriage to Henry II, contacts intensified between

9 See pages 416–419 for an appendix with a list compiled in collaboration with David Juste of manuscripts transmitting the longer and shorter versions of this text.

the British islands, the Ebro Valley, and reconquered Spain: an area that lay at the intersection of different cultures and civilizations and has long attracted the attention of medievalists. As recalled by Rapisarda, parallel to the dynastic and political channel, "a channel of intellectual communication" gained momentum. This channel transmitted not only a good deal of science and philosophy, but also material related to the art of divination such as chiromancy and scapulimancy, "whose earliest texts emerge almost simultaneously in Spain and England at the end of the 12th century" [423–424]. After a brief outline of historico-cultural trajectories followed by the two arts in the classical and the Byzantine worlds, Rapisarda moves on to his analysis of a London codex which contains a translation into the vernacular—previously published by the author—of several tracts: the *Chiromantia parva*, a Latin scapulimancy treatise titled *Liber alius de eadem*, and another text on "l'art del saut", i.e., the study of involuntary movements of bodies and their parts, sneezing, and spasms.

The fourth and last section of the volume, "Magic and Images", hosts only one study: Nicolas Weill-Parot's "Des images qui disent et font dire l'avenir? Talismans, divination et bonne fortune (XIIIe-XVe siècle)" [519–535], which concerns "operative" magic performed by images and talismans as distinct, in the texts themselves, from divination through images. Weill-Parot builds on his experience to clarify the different functions and connotations assumed by talismanic arts. The clarification is made necessary due to the amount of confusion that, beginning presumably with Albert the Great, affected geomantic figures and talismanic techniques as astrological images.

Another short but interesting contribution, "'Nigromantia': brève histoire d'un mot" [445–462] by Jean-Patrice Boudet, is dedicated to the term "nigromantia" and helpfully highlights the polysemy of the term in Western culture since Graeco-Roman antiquity. "Necromantia" is a calque from the Greek meaning the interrogation of the dead for divinatory purposes. Boudet's investigation runs across an extended period of time in collecting suitable sources (classical authors; juridical, theological, and astronomical texts) to classify meanings of "necromantia" and "nigromantia" from the 12th to the 15th century.

I shall conclude my remarks on this collection with observations on the rich study by Isabelle Draelants, "'Magica vero sub philosophia non continetur': statut des arts magiques et divinatoires dans les encyclopédies et leurs 'auctoritates'" [463–518], which is specifically centered on the place of "magical sciences" in the medieval encyclopedia of sciences and philosophy. Draelants is a scholar of the medieval encyclopedia genre, among other subjects, which she investigates in the present volume with regard to short texts of magical and divinatory knowledge in Latin encyclopedias from 1225 to 1260. After a quick survey of the literature, Draelants focuses on Vincent of Beauvais' *Specula*, to discuss recurrent *exempla* of sorcerers, Gerbert of Aurillac and Simon Magus. She situates them in the context of their sources (Varro, Augustine, Isidore, Hugh of Saint Victor) and also touches on some 13th-century masters (Alexander of Hales, Albert the Great, Thomas Aquinas). In addition, she shows how definitions and views of divinatory sciences fared across the medieval millennium. Eloquent in this regard is the comparison between Hugh of Saint Victor's and Vincent of Beauvais' works [476–482] concerning the question of where (*ad quam partem philosophiae*) divinatory sciences can be assigned. Hugh's answer, taken up by Vincent, is unambiguous: *Magica in philosophiam non recipitur*, which runs against the inclusion of magic under natural astrology, postulated since the 12th century by Arabic sources in their classifications of natural sciences *qua* concerned with the "natural properties" of beings. In fact, for all the interest taken by Arabic authors in divination, it would never be regarded "comme une véritable discipline théorisée" [515] according to Draelants. Nor did the *proprietates rerum* enjoy right to citizenship in the Aristotelian epistemology of science. After all, Robert Kilwardby himself followed Hugh on divinatory sciences in his *De ortu scientiarum*, which was composed precisely in the period that is investigated by Draelants. Like Hugh at the end of his guide, so Kilwardby ended his introduction to the encyclopedia of sciences with a transcription of the closing chapter of the *Didascalicon*: "Cap. LXVII De artibus magicis brevis sermo secundum Hugonem" [Judy 1976, 225–226].

We have fared a long way, but our journey is not over yet and it is now going to take us to different centuries, authors, and perspectives. The papers collected by Lorenzo Bianchi and Antonella Sannino belong to a series of studies presented between 2005 and 2015 at the international workshop "La magia naturale tra Medioevo e prima età moderna" of Università degli Studi di Napoli "L'Orientale". The introduction to the collection guides us throughout themes and problems discussed in the various chapters. These are concerned not so much with textual or editorial issues as with the nature and function of magic and divination, explored through a selection of moments and figures across more than three centuries. They squarely belong in the "Latin" tradition, although the first three essays examine once again the decisive influence of Jewish and Islamic thought on the transformation of science in Latin Europe between the 12th and the 13th centuries. At the same time, we cannot ignore the unprecedented possibilities that were opened by the new access to Greek sources in the early 1100s. While northern Spain borders on the "Arabic" world, the Italian peninsula and the commercial partners of Maritime Republics were mostly rooted in the Greek *milieu*.

With Carmela Baffioni's chapter, "L'Epistola 52 degli *Iḫwān al-Ṣafā 'Sulla Magia'*" [15–37], we remain, as it were, within the genre of encyclopedia and on the side of sciences somehow esoteric, like magic. Baffioni skillfully guides the reader through the complex and complicated history of the grand encyclopedia ascribed to the "Brethren of Purity". At the same time, important and longstanding questions are not eluded as regards the origin, authorship, and purpose of this collection, comprising 52 treatises or epistles, and divided into four sections. The collection incorporates various elements from nearly all ancient civilizations, from the Babylonians to the Indians, Persians, Jews, and Christians, as well as the Greek scientists and philosophers, to the extent that "the encyclopedia can be considered as a compendium of foreign sciences, albeit reinterpreted in the light of religious convictions proper to the Iḫwān" [17].

Special attention is devoted to epistle 52, "On Magic", with regard to the contents of both its "short" and "long" versions. Baffioni dwells on some of the stories narrated in the epistle, which become allegories, one might say, of the peculiar knowledge that is discussed therein, in sharp contrast to the custom of similar encyclopedic texts in the Latin tradition. Two passages from the epistle dealing with the operations of the "agent Intellect" and the "universal Soul" stand out in the analysis. These agencies shape the lower world, along with the "souls" of its inhabitants, in dependance on the souls of the stars. This dependence is then claimed to ground the connection between astronomy and magic, "since magic consists in the influence of a soul on another one" [29].

A similar doctrine is detected by Daniel De Smet in the *Kitāb Ġāyat al-Ḥakīm*, better known as *Picatrix* from its Latin version (second half of the 13th century). Here, doctrine serves the purpose of legitimizing magic on a philosophical level so that it may gain legitimacy within Islam. De Smet's piece, "La cosmologie néoplatonicienne du Kitāb Ġāyat al-Ḥakīm et la légitimation philosophique de la magie" [39–54], opens up with an outline of issues pertaining to the attribution and also to the composite, unsystematic nature of the text. It continues with an analysis of the Arabic original—the Latin being allegedly preserved in an altered form—which is centered on the influence of cosmological doctrine of Neoplatonic ancestry. The author finds a vocabulary which he takes to derive not so much from al-Fārābī as the Arabic compilation of Proclus' *Elementatio theologica*, that is, the famous

Liber de causis, in its Latin version. Alongside the hierarchical metaphysics that is typical of Neoplatonism, De Smet identifies the characteristic five substances theory (Prime Matter, Intellect, Soul, Nature, Corporeal Matter) that issued from the so-called *Empedocles Arabus* and reemerges in other doctrines that are discussed here. Such metaphysics and the "Platonic" theory of Forms jointly ground the "science of talismans" for those capable of decoding its symbols, with the figure of the sorcerer even enjoying the status of a revived demiurge.

Marienza Benedetto, in "Tra illusione e scienza: la magia nel medioevo ebraico" [55 – 79], brings to a close the handful of studies dedicated to comprehensive investigations of the magical tradition in non-Latin cultures. In the collection edited by Palazzo and Zavattero, Benedetto concerned herself with geomancy and other kinds of divination in the Jewish Middle Ages, with special regard to Maimonides. This more recent essay is also focused predominantly, if not exclusively, on Maimonides. From a comparative reading of the two pieces, various topics and references appear to recur with some frequency and match across the papers.[10] Finally, Benedetto expounds Isaac Pulgar's (13th century) words in his *ʿEzer ha-dat* (*The Support of Faith*) about magical practices, and reports on the views of his contemporary Qalonymos ben Qalonymos ben Me'ir. An appendix presents an Italian translation of section 4 of *ʿEzer ha-dat*, on believing in magic.

With the essay by Antonella Sannino, we delve into the Latin Middle Ages and explore the metamorphoses, so to speak, of literature on magic. The exploration is paralleled by a similar venture into discussions of magic up to the drastic change in scholarly attitude towards the nature of science in the 16th and 17th centuries. In the opening of Sannino's work on natural magic in William of Auvergne—"*Nigromantia secundum physicam, nigromantia imaginum*: arte e immagine in Guglielmo d'Alvernia" [81–130]—prominence is given to a vexed historiographical question concerning the contentious dignity of "magical" knowledge as a science. The question has been long debated, and we will come back to it in the conclusion of my remarks. William was notoriously involved in the early debates at the University of Paris, first as a theologian and subsequently as bishop (1228–1249). Sannino proposes a careful reading of William's position in some of his texts on magic. In addition, she supplies an Italian translation of passages from the *De legibus* and *De universo creaturarum et spiritualium*, whose Latin editions

[10] Compare page 228 in the former with page 60 in the latter; 233 with 61; 234 and 235 with 63.

she currently has underway [115–130]. Sannino has a longstanding familiarity with William and eases the reader's way throughout his translated texts. Despite such care and guidance, however, the reader's impression is that in the featured texts William is somewhat inconsistent in his semantics of *scientia*, *ars*, *experimentum*, or in the use of such recurrent and ambiguous phrases as *secundum physicam*.

With her chapter on Thaddeus of Parma, "Note sulla magia nell'averroismo bolognese: Taddeo da Parma" [131–148], Valeria Sorge takes us into the specific context of philosophical instruction at the University of Bologna in the first half of the 14th century. Close analysis of the prologue to the *Expositio super Theorica planetarum Gerardi* brings out Thaddeus' view on magic and his Arabic (or other) sources, as evidenced by Thaddeus' account of the position of astronomy within theoretical sciences. Here it may be worth noting that Thaddeus' reference to the *Lincolniensis in principio secundi posteriorum* [137n7] is precisely to the words:

> Et in his dictis cum his que predicta sunt in priori libro completa est scientia demonstrativa et universaliter faciens scire, quia quicquid scitur aut per artem demonstrandi aut per artem diffiniendi scitur. [Rossi 1981, 289.45–48]
>
> With what has been said here and in the previous book, [the study of] demonstrative science affording knowledge by universal concepts comes to completion. For all that is known, is known either through demonstration or the technique of definition.

Likewise, the reference to Grosseteste that follows in the text [137 n8] is to the well-known passage on modes of cognition in God, separate intellects, and man. However, unlike what seems to be the case with Thaddeus, Grosseteste assigns no illuminative function to the agent intellect in his theory of knowledge [Rossi 1981, 212–214.216–252].

As remarked by the editors [4], the first of the two ideal sections which make up the volume is brought to completion by Nicholas of Cusa. At the same time, the Cusan might also be viewed as releasing that peculiar, pervasive force which, over the 1400s and 1500s, propelled novel and almost alternative interpretations of nature and man in both science and philosophy. The phenomenon is well documented by the next contributions, the first of which, "Hermetic Magic in Cusanus" distills Pasquale Arfé's long experience in the "hermetic" thread running through Nicholas' thought. Arfé presents us with Nicholas' reflection on magic in his pastoral work. He examines a number of sermons which illustrate how the bishop's attention to, and censuring of, magic in his preaching is evidence for the wide circulation of such censured practices and forms of magic.

The following analysis by Simonetta Bassi, "Figure della trasformazione: Circe fra magia e politica" [175–202], traces the transformations undergone by the myth of Circe. More precisely, it analyzes the significance of the myth in 15th- and 16th-century thinkers. Lorenzo Bianchi introduces us to Italian philosophy through the works of Giovanni Battista Della Porta and Tommaso Campanella in "La magia naturale a Napoli tra Della Porta e Campanella" [203–228]. Oreste Trabucco moves on to the complex world of 17th-century France and the life, work, and "vainglory" of Lazare Meyssonnier, in "La 'Belle magie' di Lazare Meyssonnier" [229–274]. Mariassunta Picardi's "'Il ne s'en faut servir que par récréation': Charles Sorel, la magia e l'unguento delle armi" looks into the activity of Charles Sorel, which aimed at stigmatizing magic and especially its application to medicine. These are all rich and thought-provoking readings, offering a variety of diachronic outlooks from the vantage points of specific themes and figures.

Myth in the Renaissance is one of the most researched features in the mindset of its protagonists and their accomplishments. Within this framework, Bassi recalls the interpretations of the myth of Circe by Giovanni Pico, Ficino, and Agrippa, to highlight its reappraisal by Pomponazzi and Jean Bodin. Pride of place is accorded to Giordano Bruno, in whose mind "the figure of Circe assumes a radically different meaning in the context of the 1500s" [186]. That is a social and political meaning: Circe is the figure who assigns animal bodies to humans with human bodies and animal souls. Further material is taken from Erasmus and Machiavelli, which Bassi connects with Bruno.

The livelihood of 16th- and 17th-century Neapolitan culture is the frame of reference within which Bianchi traces the history of Campanella's *Del senso delle cose e della magia*, where

> the analysis of magic is developed in the fourth and last book, in completion of a complex "sensible" itinerary that involves not only humans but also animals and all elements. For it is not just animals who "have sensation" but "it must be said that elements themselves do too". [204]

From this observation, Bianchi proceeds to track contacts, interactions, and explicit references in Campanella to Della Porta—author of the well-known *Magia naturalis*—as well as other of his contemporaries. The result is a picture of interests and doctrines ("sympathy" and "antipathy", attraction and repulsion across the natural world) which would circulate parallel to the Aristotelian tradition.

Trabucco and Picardi take us to 17th-century France. Lyon is Trabucco's chosen setting, as the venue of the overwhelming publishing activity of Meyssonnier, a physician who boasted connections with numerous acclaimed and sometimes truly outstanding figures, including Descartes. In Trabucco's account, Meyssonnier's debut on Lyon's editorial scene dates to the year 1639, with the *Pentagonum philosoph.-medicum sive ars nova reminiscentiae*. This was a concoction "of the most disparate sources, flavored with heavy Hermetic and cabalistic ingredients" [235], and the manifesto of a medical doctrine with "a magical-astrological basis abundantly advertised and also, arguably embedded within it, a strong proclivity for Paracelsus' medical alchemy" [238]. Trabucco's itinerary takes off from the hectic publishing activity and the various connections, both direct and indirect, boasted by Meyssonnier, the admirer of Campanella and editor of the French edition of Della Porta's *Magia naturalis.* His itinerary leads to *La Belle Magie* or *Science de l'esprit* that appeared in Lyon in 1669, which is described by Trabucco as

> the comprehensive picture where he came to situate the meaning of all his work; Meyssonnier's *belle magie* was not mere *magie naturelle*, as he immediately made clear, since he placed his devotional writings under *magie surnaturelle*, beginning with his *Philosophie des anges* and the peculiar mysticism in which it was rooted. [268][11]

An opposite view on magic and its applications was defended by Charles Sorel (1602–1674), an intellectual related to the *libertinage érudit*. His *Science universelle* is examined by Picardi with special regard to the sections on magic, and in connection with the construction of a "universal science", "in light of the new ideas on the methodology of knowledge" [278]. The *Science universelle* is an encyclopedic work in four volumes where Sorel "validates Bacon's doctrine, and develops an encyclopedic system in which priority is accorded to natural science" over metaphysics and theology [278]. Picardi's constant reference is the so-called treatise "Ointment of Arms", published in Paris in 1636 together with other writings of Sorel, and used in the "remote" healing of blade-inflicted injuries. An annotated translation of the entire treatise into Italian features in an appendix to Picardi's piece [313–341].

The last of the contributions illustrate the scholarly change of attitude to, and respect for, the knowledge of magic since Humanism and the Renaissance. Parallel to this, the relevant vocabulary underwent similar transformation

[11] Due to the complexity of the work, Trabucco refers the reader to Trevisani 1979 for further details.

and "dignification", if not in its more technical component, at least inasmuch as it was directed at the philosophical foundation of magic, astrology, and divination. I am aware that, with such general observations, we stand on the threshold of one of the vexed questions of philosophical historiography and the history of science: that is to say, the question of scholarly prejudices injected, since the 19th century, into the study of sciences and methodologies developed in the past. In presenting Sannino's essay, "Quid sit magica naturalis? Scientia aut ars? Quid sit scientia imaginum?" [84–91], we noted that it opens with a paragraph on "The Historiographical Debate" that is concerned, apparently, with the questions that William of Auvergne posed for himself, either expressly or implicitly. In her quick incursion into historiography, Sannino starts from James G. Frazer's *The Golden Bough*, goes through Wittgenstein's notes about Frazer's work, Lynn Thorndike, Sarton, and Duhem, and reaches the Italian context between the previous and the present centuries, ending with a reminiscence of the views of Paolo Lucentini, her mentor and the initiator of the Hermes Latinus. Without going into the details of this debate, I will recall the contributions of such distinguished scholars as Richard Lemay and David Pingree which mark the historiography of science since the second half of the last century, including the historiography of magic, astrology, and divination in the Middle Ages.

It is probably an established fact for medievalists that the methodology of historical research suffers from various limitations and prejudices, both subjective and objective. Every researcher knows how to deal with the sources; and it is widely known that, when Aristotelianism established itself in the 13th century, a specific notion of science shaped up from which other forms of knowledge would be both distinguished and evaluated. Research in the medieval interpretations of Aristotle's theory of science has documented an important shift in its reception. First received as a kind of meta-theory of knowledge (e.g., Robert Grosseteste, whose *Commentary* is at the origin of the medieval exegesis of the *Posterior Analytics*), the Aristotelian theory was gradually subjected to a "deconstructivist" interpretation. On this model, Aristotle's system was made, as it were, more fluid by appealing to such notions as the subalternation or subordination of sciences naturally suited to legitimate a certain measure of osmosis between different disciplines. Over the course of the 14th century, increasing attention was given to the problematic status of the "sciences of nature" and the "empirical sciences". Whenever information is required about the meanings of "scientia", "experimentum", and "scientia experimentalis", it is in the commentaries on the *Posterior Analytics* that it can be found. Equally important are Aristotle's passages about the nature of *scientia,* the *accessus* to his treatises, and the prologues to the commentaries on Peter Lombard's *Sentences*—where the question "Utrum theologia sit scientia" morphs progressively into an independent treatise on the nature of human knowledge, its forms, and the conditions for its certainty.

As I said at the outset, the two volumes discussed here contain mostly reports on research that is still in progress. Other papers provide scholars of medieval thought and culture with the *status quaestionis* of specific subjects and problems. Still others introduce them to features and texts of divination and astrology. The first group includes the majority of papers in the volume on geomancy. (As a matter of fact, the edition of *Particule* I–IV, 4 of the *Geomantia* attributed to William of Moerbeke, came out while the present discussion was going to press). But some of the papers are the work of eminent scholars who have long distinguished themselves in the vast and complex fields of astronomy, astrology, and related sciences such as those which have been explored. We have been able to gain insight into some of the freshest research that is being developed, and we have looked at comprehensive overviews of some of the trajectories followed by sciences and techniques at a given point of time, across different lands in the multimillennial history of civilization. We could appreciate how far sciences and techniques travelled across time, space, linguistic barriers, contributing in the end to shape and define the modern worldview. Such is the area of scholarly activity that has long distinguished the editorial policy of the Micrologus Library, where the two volumes discussed here first appeared.[12]

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[12] See Akasoy, Burnett, and Yoeli-Tlalim 2008; Bianchi 2019; Bohak and Burnett 2021; Boudet 2020; Boudet, Collard, and Weill-Parot 2013; Boudet, Osterero, and Paravicini Bagliani 2017;Ducos and Lucken 2018; Martinez Gasquez 2016; Jacquart and Paravicini Bagliani 2021; Picardi 2019; and Rapisarda and Niblaeus 2014.

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In memoriam Noel M. Swerdlow

We have recently received the sad news that Noel Swerdlow (1941–2021) passed away this Saturday 24 July. Noel was a leading historian of science who specialized in premodern astronomy from the Babylonian astronomical ephemerides of the Hellenistic period across the entire range of Western astronomy to the Renaissance, focusing on the works of Regiomontanus, Copernicus, Tycho Brahe, Kepler, and Galileo.

He received a B.A. (1964) from the University of California, Los Angeles, and an M.A. (1967) and Ph.D. (1968) from Yale University. Turning from the study of medieval music to astronomy, Noel's doctoral dissertation was titled "Ptolemy's Theory of the Distances and Sizes of the Planets: A Study of the Scientific Foundations of Medieval Cosmology" (Yale University, 1968). He produced a translation and commentary on Copernicus' early astronomical work, *The Commentariolus* (1973), and co-authored with the late O. Neugebauer *Mathematical Astronomy in Copernicus's De Revolutionibus* (1984). Noel is also the author of *The Babylonian Theory of the Planets* (1998). His many articles constitute an important body of work dealing with the technical aspects of mathematical astronomical theory and its centrality to the history of science.

Noel was a professor in the Department of Astronomy and Astrophysics and in the Department of History at the University of Chicago from 1982 until 2008. He was a member of the Institute for Advanced Study (1973, 1985) in Princeton, New Jersey, and a MacArthur fellow (class of 1988). In 1998, he was elected to membership in the American Philosophical Society. In 2008 he retired to Caltech as visiting associate in history in the Division of the Humanities and Social Sciences.

Noel was also an accomplished pianist and had a detailed knowledge of the Romantic tradition, not only of the piano oeuvres of Beethoven, Brahms, Schuman, Schubert, Liszt and others, but also of chamber and orchestral music as well as of opera, about which he was a true specialist. He taught a legendary course on Wagner's *Ring of the Niebelungen* at the University of Chicago.

Noel's wife of 32 years, Nadia Swerdlow of Sierra Madre, CA, and Noel's son from a previous marriage, Dorian, were with him to the end. To them we extend our deepest condolences.

As Noel's colleagues, students, and friends, we learned much from his rigorous approach and the broad understanding and the depth of his scholarship that stemmed from his rigor and exactitude. For all he gave us, we are profoundly grateful.

The Editors

Das Horn des Steinbocks. Die Treppen und der Dachkiosk in Dendara als Quellen zum Neujahrsfest by Alexa Rickert

Studien zur spätägyptischen Religion 23. Wiesbaden: Harrassowitz, 2019. 2 parts. Pp. xviii + 858. ISBN 978–3–447–11143–0. Cloth €198.00

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The publication reviewed here is a slightly revised version of the doctoral thesis submitted by the Alexa Rickert in 2017 to the Faculty of Philosophy at the University of Tubingen. It deals with the evidence for the Egyptian Festival of the New Year found in the stairwells and roof kiosk of the Temple of Hathor in Dendara.

Section 1 of part 1 is devoted to the introduction and an examination of terms. Rickert bases the calendar days on the religious texts from the Greco-Roman temples presenting an idealized calendar in which the I. Achet 1 was marked by the actual rising of Sothis [3]. The first day of the new year started with sunrise [4]. The extensive information on the theology and ritual practice of the New Year begins with the temple inscriptions of the Greco-Roman era [5]. The first part of «wp rnp.t» is interpreted as "Eröffner" due to parallels from the Old Kingdom [9]. In the inscriptions from Dendara, the substantive «wp rnp.t» is mentioned 139 times as the most common name for the New Year's Day, of which 81 spread over the walls of the stairwells and kiosk [10–11]. In the temples of the Greco-Roman period, the explicit identification of «wp rnp.t» with I. Achet 1 occurs primarily in the fixed calendars [13]. The term «wp rnp.t» was also used as the name of a month, where it originally goes back to the first month of a solar year [15]. The term «wp rnp.t» could also refer to a rising of Sothis, which does not take place on I. Achet 1 [17]. The Canopus Decree applies «wp rnp.t» to a ruler's personal annual cycle [19]. The term «wp rnp.t» could also serve as designation for the I. Peret 1 [20]. The distinction between «tp rnp.t»

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(Beginning of the Year) and « tpi rnp.t » (First of the Year) has probably to be dropped [25]. The Morning of Purity is likely to be on the New Year's Day [36]. The New Year's designation « tr n win tr.w » (Time of Departure of the Seasons) may indicate that the old cycle finished [38]. The birth of Isis in her small temple in Dendara, associated with the "Night of the Child in his Nest", is connected with the early heliacal rising of Sothis [40]. In the inscriptions of the stairwells and kiosk, the "Night of the Child in his Nest" is related to New Year's Day on I. Achet 1. [46]. The term "Horn of the Ibex" for the first day of the year hints at the knowledge of the Greek zodiac [47]. The New Year's designation "The First Festival" occurs 22 times in the texts of the stairs and kiosk [52]. The New Year's Festival could also be called the First Day of Drunkenness [53].

The transliteration and translation of the texts for Stairs W and X, Roof Kiosk W' and the Chamber of the eastern Stairs V are developed in part 2. The catalog of the text components is, among other things, made up of calls, requests, exclamations, and building inscriptions offering ritual formulas and descriptions of festivals [69–78].

The evaluation is undertaken in part 3. In section 1, the spatial and temporal embedding of the stairs and kiosk in the festive events is examined. The starting point of the New Year's procession is probably to be found in Krypta South 1 [340]. Room J must have served as end point of the procession [346]. *Couloir mystérieux* was used as passage to certain places of worship on New Year's Day [349]. Chamber F' and Stairs X probably played an important role in transporting things for the New Year's ritual to the roof [358]. The ensemble of Wabet [S] and Court [R] took an important position before the New Year's procession ascended to the roof [359]. The Wabet has clear architectural references to the kiosk such as stairs, columns with Hathor capitals, and door with a "broken lintel" [362].

In section 2, the stairs and kiosk are treated as locations for the festivities. The ensemble of stairs and kiosk belongs to the Naos, which was built between 54–20 BC [386]. The stair decoration most closely related to Dendara appears in the Horus temple from Edfu [395]. The ascent and descent of the New Year's procession in Dendara may be linked to the course of the Sun [407]. The "Sonnenschatten" of the New Kingdom may be considered the forerunners of the roof kiosk in Dendara [434].

In section 3 of part 3, Rickert comments on the participants in the festivities. In the New Year's procession in Dendara, the main form of the goddess Hathor emerges most prominently [470]. The close relationship to the Sun

God was strongly emphasized [471]. The descriptions of the Sun God are characterized by a high degree of abstraction [481]. Next, attention should be paid to the group of gods carried in 10 Naoi behind the shrine of Hathor [482]. The king holds the most important place among the non-divine participants [493]. The standard group in the stairwells seems to be in the tradition of the Hebsed and foundation depictions [510]. Priests and the bearers of offerings also march in the procession [513]. The procession at the end of the staircase is held by the priestly bearers of the Naos of Hathor and her godly followers [534]. The sides of the entrances to the kiosk show a special concentration of groups of divinities [540]. The human actors appear joyful and jubilant at the celebration of the New Year [562].

In section 4, chronological processes, events in the sky, and their theological interpretation are considered. The union with the disc of the Sun is to be set as the central cult act of New Year's Day in the morning [571]. The personal relationship between Hathor and the Sun God is in the foreground in the union ritual on New Year's Day [580].

Festival-specific items and New Year gifts are discussed in section 5. The image of Hathor carried in the procession is probably anthropomorphic [600]. The stick in the hand of the first of two representations of the king is an important utensil, which obviously had a geographical meaning [613–614]. In the texts of New Year's Day, minerals and metals play a crucial role [618]. The "Stoffopfer" in connection with the "Salbenopfer" can be counted among the most important gifts of the New Year [656].

In section 6, the structural features of the texts in the stairwells and kiosk are analyzed. The first text-pattern includes accompanying text in spatial and content-related proximity to representations of persons or a group of persons [667]. The second text-pattern is formed by ritual scenes with the juxtaposition of king and gods [673]. The text-pattern of the ritual scenes occurs particularly frequently in stairwells and on door lintels as well as on the bars and columns of the kiosk [676]. The third text-pattern can be seen in the monographs,[1] for which there are two examples on the outer door jambs of the door between sacrificial hall and Stairwell V [677]. The fourth text-pattern confirms the close relationship between king and temple lord [678]. The fifth-text pattern consists of hymns, the main concern of which is praise [680].

[1] In Egyptian temples of the Greco-Roman period, the term "monograph" refers to a group of texts in which the religious peculiarities of a cult site or a larger cult region are recorded and explained theologically.

Some facts are compiled in the synthesis. The representations and inscriptions in the stairwells and kiosk show parallels to other cult buildings [702]. In several cases there are allusions to the ritual Opening of the Mouth [702].

In the synopsis, selected texts are compared [711–725]. The parallels are clearly arranged.

The book contains bibliography [737–765], indices [767–809], tables [1a–41b], and color tables [1–7].

The following remarks may be of some help to readers:

page 90	The « n » after « dw3 » (to praise) can also serve as an indirect object connecter. For this use of the preposition, cf. A. H. Gardiner. *Late–Egyptian Stories*. BibAeg 1. Bruxelles, 1932. p. 69a; G. Vittmann. *Der demotische Papyrus Rylands 9*. ÄAT 38. Wiesbaden, 1998. p. 514.
page 96	In the German translation "Der Sohn des Re ist dauerhaft auf seiner Thronestrade", the word "dauerhaft" has to be canceled.
page 112	for the verb « bd » (to purify): cf. N. Tacke. *Das Opferritual des ägyptischen Neuen Reiches*. Band 2: Übersetzung und Kommentar. OLA 222. Leuven/Paris/Walpole MA, 2013. p. 108.
page 120	for the verb « wrh » (to dance): cf. D. Klotz, "Remarks on Ptolemaic Epigraphy and Lexicography". *RdE* (2013) 64: 34ff.
page 123	The German translation "indem sie ihren Leib mit der Salbe des Gottesopfers schmücken" should be corrected to "indem sie ihren Leib mit der Salbe des Gottesopfers angenehm machen".
page 144	In the German translation, "weil sich das rechte Auge des Re mit der [Sonnen]Scheibe vereint", the word « stw.t » (rays) has been accidentally omitted.
page 288	The German translation, "ich habe deinen Leib weich gemacht" has to be corrected to "ich habe deinen Leib gesalbt".
page 472	In the German translation "wie Re inmitten seiner Genossen", the word "Genossen" has to be replaced by "Hofstaat".

Rickert's book is quite interesting to read. The translations are correct in most cases, though they rely too often on outside help. The factual backgrounds are adequately described. The Egyptian texts might have been streamlined in one place or another.

Aristotle and His Commentators: Studies in Memory of Paraskevi Kotzia edited by Pantelis Golitsis and Katerina Ierodiakonou

Commentaria in Aristotelem Graeca et Byzantina 7. Berlin/Boston: De Gruyter, 2019. ISBN 978–3–11–060183–1. Cloth US$107.99

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This commemorative volume, dedicated to the late scholar of Greek antiquity and one-time scientific coordinator of the Center of Aristotelian Studies at the University of Thessaloniki, Paraskevi Kotzia, draws together 12 important essays on various aspects of Aristotle's thought and the late ancient and Byzantine tradition of commentary, nine of which were presented at an international and interdisciplinary conference held in her memory in September 2014.

The contents of the volume are unevenly split into two topical parts, with four articles grouped under the heading "Aristotle" and eight contributions under the heading "Commentators," though certainly some of the articles in the former part (especially Stavros Kouloumentas' penetrating exploration of Aristotle's remarks on Alcmaeon in the *Metaphysics*) make heavy use of the later commentary tradition, and many of the essays in the latter section take on issues central to the understanding of Aristotle's own philosophical project (see in particular the contribution from Katerina Ierodiakonou and Nikos Agiotis on the signification of the title of Aristotle's *Prior Analytics*). This interdependence of the two sections of the volume reaffirms the need to consider the late-ancient and Byzantine commentators when investigating problems in Aristotle's thought, a theme which was central to Kotzia's own work on the purpose (σκοπός) of Aristotle's *Categories* [1992].

The individual articles cover a wide range of themes, and with the exception of two articles on Aristotle's politics (by Fransisco Lisi and Chloe Balla),

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they are only loosely connected to one another. Some contributors to the volume (Stavros Kouloumentas and Dimitrios Nikitas) treat specific textual and philosophical issues in works of Aristotle and his philosophical successors, while others (Rapp[1] and Wildberg) offer more general meditations on the contemporary study of Aristotle and late antiquity, as well as recommendations and directions for future scholarship in these fields. In what follows I hope to draw attention to those pieces which challenge and otherwise inform the more universal aspects of the study of Aristotle and the late-ancient world.

The volume begins with an English translation of Christof Rapp's thoughtful reflections on the problem of hypotheses of "development" in the history of philosophy broadly speaking, and in the history of the study of Aristotle in particular. While tracing the history of such hypotheses as applied in the study of Aristotle (focusing on Werner Jaeger's influential work [1923] and the subsequent controversy it engendered), Rapp stresses the real risk that such hypotheses become self-affirming in their circularity, and draws attention to more promising alternative approaches to resolving or explaining inconsistencies across Aristotle's work.

The section on Aristotle continues with two separate examinations of different aspects of Aristotle's political thought, as well as an essay on the significance of an obscure reference to the Presocratic thinker Alcmaeon. Fransisco L. Lisi explores a fundamental difference in approach to political relationships between Aristotle and Plato. Lisi is convincing in his argument that, for Aristotle, the "master-slave" relationship which dominates so many political images across Plato's works is simply not a political relationship. This claim offers a promising avenue for future studies of the nuanced accounts of the politics of Aristotle and Plato alike.

Chloe Balla makes the case for what she calls a "sophistic" background to the "empirical" accounts of different political systems that one can find in certain passages of Aristotle, particularly the *Rhetoric*. There is, however, the enduring problem (acknowledged by Balla) of determining what exactly is to be understood by many of these terms ("sophistic", "empirical", and so on).

[1] Christof Rapp's contribution, "The Explanatory Value of Developmental Hypotheses as Exemplified by the Interpretation of Aristotle", is an English translation of his earlier article "Der Erklärungswert von Entwicklungshypothesen. Das Beispiel der Aristoteles-Interpretation", which was published in 2006.

Stavros Kouloumentas offers a comprehensive investigation into the much-disputed passage of *Metaphysics* A5 where Aristotle says mysterious things about the relationship between Alcmaeon and Pythagoras. In this article, Kouloumentas provides a convincing reading of the text that avoids earlier, unnecessary emendations, and makes the case for this passage's being an authentic element of Aristotle's text, and not a later scribal addition.

Christian Wildberg introduces the section on the late-ancient commentary tradition by promoting the following two theses in a delightfully crafted essay:

> Of all the historical periods into which antiquity is traditionally divided…Late Antiquity…was in fact the most formative and influential in the subsequent course of the history of western culture, not only for the middle ages but in certain respects also for modernity, indeed for us now.
>
> Late Antiquity is actually of prime importance in terms of understanding the fundamental tenets and beliefs of our intellectual history. [73]

Wildberg terms the first thesis as "prima facie plausible" but leaves its defense to others, and concentrates instead on defending the second. His arguments are aimed primarily at those who see Plato and Aristotle as the truly significant thinkers in the history of western thought, and at those who discount much of Late Ancient thought on the grounds of a dubious distinction between theology and philosophy. Wildberg argues persuasively that

> the facile separation of what is supposed to be religious thought from what is philosophical thought is one of the greatest obstacles that stand in the way of understanding [late antiquity]. [75]

This is indeed an obstacle to the study of the intellectual history not only of late antiquity, but also of later periods including the medieval Islamicate and Latin traditions. Wildberg concludes his essay with an appeal for "a larger dose of critical distance, and less wide-eyed adulation" in our approach to the study of the western canon, picking up on his earlier observation that the "age of the commentary" begins in late antiquity and continues until today.

Pantelis Golitsis' groundbreaking piece on the method, style, and relative chronology of Philoponus' commentaries is, in a sense, an affirmation of the validity of several of Rapp's recommendations for alternative approaches to the developmental hypothesis, transferred from the study of Aristotle to the study of Philoponus. Like Aristotle, Philoponus has been the victim of a problematic attempt to periodize his works on the basis of a supposed spiritual "development" [Verrycken 1990, 233–243]. The perceived need to periodize his writings (reaching in Verrycken's work the uncomfortable result that we ought to speak not of a single Philoponus but of a "Philoponus 1" followed by a "Philoponus 2") arose because of the presence of a number of points of inconsistency and tension in and across commentaries and other writings ascribed to Philoponus. Through a holistic and multi-directional approach to Philoponus' career, Golitsis has shown that, for certain of the commentaries under Philoponus' name, there is a need to disentangle Philoponus' thought (critical or otherwise) from the teachings of his late master Ammonius Hermeiou.

More importantly, Golitsis has provided, through careful philological study of Philoponus' commentaries, the techniques for how this disentangling is to be performed. Applying these techniques, Golitsis is able to argue persuasively that Philoponus commented on different books of Aristotle's *Physics* at different times in his career, and in accordance with different editorial practices. In the final sections of the article, Golitsis provides a helpful new chronology of Philoponus' major works. This more nuanced approach to the study of Philoponus' writings will surely allow for more exacting study of Philoponus' thought in the future and will contribute to the ongoing scholarly effort to understand the practice of philosophical education at the end of late antiquity. It also offers important reflections on the role of the commentary in philosophical development, which will be of interest to scholars working in any number of areas in the history of philosophy.

In full harmony with the findings of Golitsis, Ioannis Papachristou is able to use the prolegomenon of the commentary on the *De anima* that was edited by Philoponus to reconstruct Ammonius Hermeiou's teachings on the soul, and in particular its connection with various corporeal "vehicles". Papachristou delves into the intricacies of Ammonius' broadly Proclean psychology, drawing attention to the continuity of the teachings found in the prolegomenon to those expounded by Proclus but also pointing out the subtle divergencies that mark as unique Ammonius' theory of ghostly apparitions. This careful and thorough exposition brings out an important aspect of Ammonius' attempt to synthesize the theories of soul put forth by Plato and Aristotle, a part of the increasingly well-documented "Ammonian synthesis".[2]

[2] To use a term introduced by Robert Wisnovsky [2003] in his study of the background of Avicenna's metaphysics.

Katerina Ieordiakonou and Nikos Agiotis bring a number of major and minor figures from the late-ancient and Byzantine commentary tradition to bear on the problem of interpreting the title of Aristotle's *Prior Analytics*. Their systematic presentation of the problem of how to understand «ἀνάλυσις» in the work's traditional epigraph, and their comprehensive survey of the solutions to this problem proposed by centuries of commentators from Alexander of Aphrodisias and Ammonius Hermeiou to Eustratius and John Pediasimus, set the stage for a thoughtful consideration of three major philosophical, historical, and philological problems associated with the title of the *Prior Analytics*.

Much more could be said about the remaining articles, but the following comments ought to allow the interested specialist to identify the article matching their more specific research interests:

Paul Kalligas provides a rich and exacting study of the nature of Plotinus' criticisms of Aristotle's theory of (prime) substance. After situating and contextualizing Plotinus' approach to the *Categories* and *Metaphysics* by giving a helpful survey of criticisms and interpretations from Stoics (Athenodorus), Peripatetics (Androndicus of Rhodes), and Platonists (Lucius and Nicostratus), Kalligas then seeks to provide clarity on exactly which aspects of Aristotle's theory of substance Plotinus was keen to preserve, albeit "limiting its application to the sensible world" [88].

Maria Chriti focuses our attention on the way in which three thinkers (Ammonius, Simplicius, and Philoponus) handled the issue of the emergence of human language, exposing the ways in which they interweave Neoplatonic emanationist cosmology and Aristotelian logic into surprisingly negative theories explaining the emergence and variety of spoken language.

Dimitrios Nikitas offers a compelling analysis of the literary style in Boethius' first commentary on Porphyry's *Isagoge*, in which Nikitas underscores Boethius' debt to the traditional distinction, promulgated by the Aristotelians at Alexandria, between Aristotle's exoteric and esoteric works. He also brings out the Ciceronian elements of the same work.

Finally, Sten Ebbesen offers an excellent edition, translation, and analysis of two "untraditional" though delightful sophisms by an unknown Byzantine author.

Due to its eclectic and diverse nature, the articles in this important volume (which also includes a full bibliography of Kotzia's many published works, as well as crucial indices of names and passages cited) are sure to excite the interests of scholars working on many diverse areas of the history of philosophy, not simply on Aristotle and his commentators but also on earlier traditions (including Pythagoreans like Alcmaeon) and later developments in Latin and Arabic thought. To its editors, we owe great thanks for collecting these valuable contributions, a testament to the breadth and depth of the professional life of Kotzia.

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The Interactions of Ancient Astral Science by David Brown with contributions by Jonathan Ben-Dov, Harry Falk, Geoffrey Lloyd, Raymond Mercier, Antonio Panaino, Joachim Quack, Alexandra von Lieven, and Michio Yano

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This book is an admirable attempt by its author, assisted by eight reputed colleagues, to present an overview of our present knowledge of astrology and astronomy as practiced in ancient Mesopotamia, Greece, Egypt, Rome, India, China, and Japan, and of the possible interactions leading to borrowing and/or transmission of astral science between these cultures from ancient times onwards up to about AD 600. Yet it is also a somewhat impossible task because it requires a working knowledge of at least several of the scripts and languages of these ancient cultures, of the astrological and astronomical techniques employed by the practitioners of ancient astral science, and of the historical and cultural context within which these practitioners were functioning.

This created an almost unsurmountable obstacle not only to the authors of this book, and potentially to its readers as well, but also to its reviewer. David Brown himself remarks,

> It was mentioned above how difficult it is to master both the ancient languages and the technicalities of astral science, and there will be some who will glance through this book and wonder if there are more than five people in the world who can understand and evaluate it in its entirety. There are probably not. At times I felt that the book was being written for the deceased, namely Neugebauer and Pingree. [7]

This is why the incubation time for this review has been long and it is the reason—at least in part—for some of its shortcomings. Nevertheless, I have

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read Brown's book with great pleasure and not seldom with excitement; the subject matter is close to my heart and the author has both a pleasant, personal style of writing, and strong opinions. Moreover, he makes a serious and, in my opinion, successful effort to approach the problem of the possible transmission between ancient systems of astral science afresh and with an open mind by introducing the more general concepts of "resonance" and "interaction" to replace "borrowing", "transmission", or "adoption". The advantage of his choice of terms is that it leaves the direction and intensity of the process initially unspecified, to be determined later by further study and analysis.

The book is thick, covering almost 900 pages, with Brown responsible for about 75% of the text and the other eight contributors for the remaining 25%. Rather than summarize the contents in words, I give here a condensed version of the table of contents from which the main topics treated and the emphasis they receive in the book can be directly derived:

1. Introduction (30 pages)
2. Mesopotamian Astral Science (31 pages)
3. Egyptian Astral Science (9 pages)
   a. Egypt as Astronomical-Astrological Centre between Mesopotamia, and India (Joachim Quack) (56 pages)
   b. From Crocodile to Dragon – History and Transformations of the *Dodekaoros* (Alexandra von Lieven) (15 pages)
4. West Semitic Astral Science (with Jonathan Ben-Dov) (24 pages)
   a. Babylonian Astral Sciences in West Semitic Sources: The Case of Qumran (Jonathan Ben Dov) (32 pages)
5. Astral Science in Greek and Latin (122 pages)
   a. Transmission Successes and Failures. Methodological Issues and the Case of 4th Century BCE Greek Astronomy: A Preliminary Sketch (G. E. R. Lloyd) (12 pages)
6. Astral Science in the Hellenistic Period (133 pages)
7. Iranian Astral Science (27 pages)
   a. On Iran's Role in the Transmission of Ancient Astral Sciences and the Ramifications Thereof (Antonio Panaino) (34 pages)
8. Indian Astral Science (13 pages)
   a. The Early Use of Naksatras (Harry Falk) (7 pages)
   b. Alleged Mesopotamian Astrology in India (116 pages)
   c. Alleged Mesopotamian Astronomy in India (65 pages)
   d. The Earliest Greek Astral Science in India (23 pages)

   e. On the Originality of Indian Mathematical Astronomy (Raymond Mercier) (44 pages)
9. Astral Science in China (15 pages)
10. The Japanese Iconography of the Decans (Michio Yano) (16 pages)
11. Final Reflections (12 pages)
12. Bibliography of Resonances (49 pages)
13. Index (29 pages)

Brown describes the composition of the book in his introduction:

> The alert reader will soon notice that the external contributions and my text are not always coherent. It was ambitious to experiment with the tried and tested formats that are either a book written by a single author or a collection of contributions with an introduction by the editor that attempts an overview. This is a book that is meant to be read from start to finish, and the connecting chapters are meant to concentrate the focus on the questions at hand—-what interactions took place and why, and can we produce a convincing and coherent description of the development of the astral sciences in the Old World that takes into full consideration their interactions? While this means that I can eschew the usual convention of summarizing the external contributions in this introduction, I cannot pretend that the format works flawlessly. The placing of von Lieven's article was most difficult, for example, since it deals with a supposed connection between Egypt and China. It is also less minimalist in its assumption of influence than my parts, or those of Falk, Quack, Mercier, or Ben-Dov. Panaino is also rather more maximalist in approach than I might be. The first part of Lloyd's contribution would sit better in this introduction, and Yano's contribution in part goes beyond the temporal limits of the project. In this regard, it is fair to say that while all contributions are valuable works of scholarship, some are more apposite to the express aim of this book than others. [5]

One of the main theses proposed in the Brown bible, as I have called it among colleagues, is that astrology is the driving force behind all astronomy carried out in antiquity. His views are summarized in the introduction:

> We may be tempted to think that Hipparchus availed himself of Babylonian observational data and astronomical parameters because of an "academic" interest in astronomy, but a different motivation is suggested in ch.5. The spread of zodiacal astrology was affected by historical circumstance, by the transmissibility of the astronomy that accompanied it, and by the presence of existing astrological techniques in the adopting cultures, but can we deny that the private, commercial exploitation of the heavens was not the dominant factor in the transmission of astrology and astronomy first from Babylonia to Egypt, Iran, the West Semitic areas, Greece, and Rome, and thence from Roman Egypt to Iran and India?

We may have an aversion to thinking that private astral divination was the driving force behind these two great spreads of astral science in the pre-Muslim period. The ground may have been prepared by those with agendas other than the exploitation of a market based on human fascination with the heavens and the future, but it was those who saw a way to make a living out of personal astrology and who made the effort to familiarize themselves with the complexities of cuneiform arithmetic astronomy and the rules of astrological interpretation who drove the spread. Let us not ignore the fact that theirs was a great effort. It was far more than the adopting of a few easy-to remember parameters, as with the 19-year calendrical cycle, say, or some ancient wisdom vis a vis the malefic quality of a planet. It required *translation.* It was these entrepreneurs, largely unknown, who happily elaborated on the astrological techniques used in Mesopotamia, while making next to no contribution to the quality of the accompanying arithmetic astronomy, save altering the predicted dates to the local calendar and adapting the methods to suit their needs better. This seems typical of commercialization. No program of making and recording observations akin to that which had existed in Babylonia was available in those areas that then made free use of those hard won parameters and techniques, that is until we turn to that strand of Graeco-Roman thought which continued to adhere to a view that astronomy should be formulated in a way that was coherent with philosophical teachings.

The *Syntaxis* records for us the traces of another observational program, one which had begun long before the second century CE, but seemingly without much success when it came to generating predictions comparably accurate to those made using arithmetic techniques. The *Syntaxis* also records for us a polemic in favor of spherical-trigonometric astronomy, and critical of arithmetic astronomy. At the same time, it avails itself of the parameters of arithmetic astronomy. Ptolemy presents his work as exemplary of a "method", a "scientific method" if we may use the terms anachronistically, leading from qualitative hypotheses to observations of what we might term "boundary condition" situations, to the mathematical determination of parameters, which in turn fill out the hypotheses and make the model quantitative. It is all very convincingly presented, but closer analysis reveals some fundamental flaws in both hypotheses and methodology. The flaws are passed over in silence, the adjustment of results disguised.

Why? Is this no more than sloppiness on Ptolemy's part? He was, indeed, remarkably prolific, but his exactness when it comes to the mathematical calculations speaks against this. Who was his audience? Who was he trying to convince? It seems to me we must look to his work on astrology, the *Tetrabiblos,* and his simplification of sphericaltrigonometric [*sic*]astronomical procedures for everyday use by astrologers in the *Handy Tables,* and the ultimate success of both compositions in the ancient world, to understand Ptolemy's agenda. He too, I argue, was trying to exploit the market in personal zodiacal astrology, and he was competing with the dominant market leader, arithmetic astronomy, in doing this. The universality of trigonometric astronomy, its greater accuracy, and its alleged basis in careful observations, as well as its adherence to circular motion were all means by which to attract followers. His aims were doubtless far wider, and it is not clear that his works brought him substantial reward in his lifetime. His works drew on the achievements of earlier mathematicians and trigonometric astronomers and must be understood in this light, too. His was not the only form of trigonometric astronomy available either.

Astrologers were slow to embrace the new astronomy, but eventually embrace it they did. One of Ptolemy's aims, albeit delayed, was realized. By around CE 400 the new astronomy had such a large part of the market that astrologers in India, who had since familiarized themselves with astrology and arithmetic astronomical techniques from the West, made the supreme effort to learn the trigonometric ones too. Some of the greatest amongst them were able to make substantial and meaningful adaptations to the Graeco-Roman-Egyptian (and perhaps Sasanian, see ch.7) versions, and their agendas, too, may have exceeded the requirements of the mere commercial exploitation of the heavens by means of facilitating the writing of horoscopes. However, the rapid adaptation to the Indian context of zodiacal astrology and its further elaboration there, shows that India had become another market for this form of human psychological comfort.

The identification of the need was made in Babylonia, as was the creation of a great product. The size of the market there is still hard to assess, but it must have been substantial (Brown, 2008). Similar markets opened up in Egypt, Greece and Rome, the Levant, Iran, India, and finally around the world, though not without setbacks in the form of the opposition posed by organized religion, for example. The fact that trigonometric astronomy could portray itself as more convincingly coherent with some of the more popular ideas of the Roman world, was potentially more accurate, and worked at all locations, no doubt further assisted the spread of the personal astrology it came to underpin. More crucial, though, was the ease with which Babylonian zodiacal astrology was able to have Aristotelian, Stoic, Epicurean, native Egyptian, Iranian, native Indian and many other ideas grafted on to it, so much so, in fact, that it became in each of these cultures an almost "indigenous" tradition. In particular, such was the extent to which this Babylonian discipline was Egyptianized, that Egypt became known as the home of astrology for many Greeks. For the Indians, in turn, astrology is a *Yavana* science. In all these cases, the very ignorance of the adopting culture as to the true origin reflects on the nature of the transmissions. This is not transmission driven by interested academics, but business people, for whom the truth is what sells. Strabo, for example, is well aware of Babylon and Uruk's role in the development of astrology (ch. 2, here).

It is a coherent story that I am attempting to tell here, with the help of the team of invited experts. In answer to the self-evident critique, why not deal in the ancient categories themselves, I would answer that such an approach has failed

> in the past to produce clarity when it comes to the question of transmission and interaction. Scholars immersed in their respective fields do indeed have the best chance of producing the most robust account of the development of "astral science" within those cultures, if we accept for the moment that the category "astral science" can be, at least roughly, defined in each. Where that development, though, is dependent on outside influence the specialist scholar is confronted by specific difficulties emerging from their non-nuanced understanding of the other cultures. It is all too easy to try and fit the astral science of the other culture into the ancient categories of the culture one knows best and detect all kinds of parallels that do not really exist. The solution, of course, is to have experts in differing fields collaborate, which is what is attempted here, but first they must have a series of terms with which they can communicate that can more or less be imposed on their data without too much damage being done to the native categories. It is with this in mind that a reductive approach has been adopted, and astral science broken down into the categories listed above. [22–25]

Brown questions the opinions of previous generations of scholars who saw too often transmission where there was none (Pingree) or who denied transmission where later research has shown its undeniable existence (Neugebauer). To illustrate the latter, he writes,

> Equally, as regards Mesopotamian influence on Graeco-Roman astral science, Neugebauer's views of 1975 were falsifiable, and I argue, have been falsified, in particular as a result of the papyrus material from Egypt. Neugebauer's view in 1975 was that the influence was minimal, but he had altered his view on that by the late 80s. So radical is the revision since then that as this book will argue, Hellenistic Astral Science is a term that should now be understood to mean "Babylonian Astral Science in the Hellenistic Period", albeit often written in Greek and other cursive scripts. The discipline had been taken up by the Hellenes, and they made important contributions to its various manifestations, but despite its being attributed to the *Yavanas,* "Ionians", or Greeks by the Indians, even in India the core of the discipline after c. CE 300 remained Mesopotamian. [5]

Brown introduces his new concepts of "resonances" and "interactions":

> The casual use of terms such as "adopting", "borrowing", "transmission", and so forth characterizes many works that attempt to compare and contrast ancient systems of astral science. It is all too easy to spot what appears to be a case of a parallel approach to a problem and suggest "transmission" and leave it at that. Indeed, one can show off one's breadth of knowledge and fill pages with copious notes in various ancient languages of "possible parallels" and prove almost nothing. In order to avoid this, a strategy has been developed which will now be outlined.
>
> Examples of alleged "parallel approaches", of identical or similar parameters or names, in two or more languages written in different geographical areas are termed *resonances.* Thus termed, no assumption is made as to whether

> the resonance in question does or does not attest to the use in one culture of a method, system, parameter, or name devised in an earlier. The term "interaction" rather than "transmission" will be commonly used so as not to prejudice the interpretation as to what reasons lay behind the use in one culture of astral science developed in another. Was it driven by the recipient or the creator of the work? Most of the resonances studied here have long since been noted by various authorities. Not all, however, for the reader will see that this author has not been immune to proposing some cases of interaction of intellectual ideas based on resonances he has seen and which have not yet been noted by others.
>
> Theoretically, I would have liked to have assessed every resonance noted in material dating to the period up to c. 650 CE, from Rome to China, but this was not feasible when it came to the wealth of astrological material, in particular. In this case, I decided that a detailed assessment of the Indo-Babylonian resonances in astral omens would be made, and of the few Sino-Babylonian ones. A detailed, but by no means comprehensive, study of Graeco-Roman-Babylonian resonances in zodiacal astrology is offered, but the study of resonances in classical texts of Babylonian omens has only been made cursorily. Similarly, only the broad outline of the Indian debt to Hellenistic astrology will be made on the basis of the long-known resonances there. As to the calendar, and its varied manifestations, it is not our central concern here, though where it plays a part in a wider astronomical scheme it will be considered. No attempt at comprehensiveness has been attempted when it comes to astral religion, cosmography, cosmology, time-keeping, astral magic, geography, and mathematics in astral science, and instrumentation has been all but ignored. It is hoped that so far as the astronomical systems and the evidence for astral mapping are concerned the following chapters have missed but few of the resonances noted by other scholars.
>
> Each "resonance" will be treated on its own merits, based on the sources surviving, and also, importantly, the agenda of the scholar noting the resonance. We cannot escape the fact that some scholars see more resonances in a text than do others, and evaluation at this subjective level is extremely hard. Pingree, for example, saw resonances with Babylonian omens and arithmetic techniques in early Indian compositions that I do not see at all. Other times, I accept that there is a resonance, but see no reason to attribute it to cultural influence rather than to independent discovery. A third variant is one where it has been asserted that the resonances indicate that a transmission of written material from Babylon made its way to India, say, perhaps via Iran and perhaps in translation, but I have argued instead that the resonance, though it exists, attests at most to an informal passing of astral lore by word of mouth, probably from layman to layman along a trade route. [27–28]

He discusses some recent results in the transmission of ancient astral science in terms of these new concepts:

It is an opportune moment to reconsider the interactions of ancient astral science in that geographically connected landmass from China to Europe. Developments *within* the fields of cuneiform, Greek, Demotic, Coptic, and West Semitic astral science over the last few years have meant that the assumptions of the previous generation of scholars needed to be overhauled. Some of these have been mentioned already. A significant contribution to the history of Indian astral science was made by Falk (2001) with his careful redating [*sic*] of the *Yavanajataka,* and this and our joint re-reading of the last chapter of that composition have now permitted a radical reevaluation of early Graeco-Indian interactions in the astral sciences (see ch. 8.c). A careful reanalysis of the contexts of both Indian and Mesopotamian astral science has led me to conclude that there is no Mesopotamian influence on India in this area in the period prior to c. 300 BCE, and thereafter none that is not mediated by other cultures (chs. 8.b and 8.c). The reevaluation of the early history of Greek astronomy fits well with this new model of early Hellenistic contacts with India. We know a little more about the earliest astral science in Iran, and a great deal more about early West Semitic astronomy-astrology and calendrics, thanks in part to the discoveries at Qumran. In ch. 4.a, Ben-Dov has provided a snapshot of the spread of Babylonian astral science to the West Semitic areas in the period prior to c. 150 BCE, and both his and Panaino's description of the situation in Iran fit well with the picture pieced together from the cuneiform and Greek sources of that period of astral science in and around Mesopotamia.

The recent surge in interest amongst Egyptologists in the astral sciences preserved in the late papyri, and in a reassessment of earlier data, has forced us to rethink the extent of the debt Hellenistic and Roman astrology and astronomy owe to the ancient Egyptians, and both Quack and von Lieven are at the forefront of this new movement. Quack's contribution here (ch. 3.a) is a major summary of the new state of the field.

We have learned a great deal more in recent years about the extent to which arithmetic astronomy played a dominant role in the first three to four centuries CE in Egypt, and more about the way that astronomy both borrowed and adapted Babylonian methods preserved on cuneiform tablets. We are also better able, on the basis of this work, to recognize that Ptolemy's works were not of central importance precisely at the time when sophisticated arithmetic astronomy began to be taken up in India and Iran. We know more about the background to Ptolemy's achievements, suggesting at once that he was typical of his era, but also that his era produced a great leap forward when it came to trigonometric, predictive astronomy. All of this fits well with the description of and explanation for the development of astral science in India in the first few centuries CE. Mercier's contribution (ch. 8.e) conclusively solves a debate that has raged since the early 1970s as to the extent to which the early Indian trigonometric *siddhāntas* made use of parameters perfected on the basis of

> locally made observations. This has profound implications as to our understanding of the nature and purpose of the most sophisticated of Indian astronomy in the pre-Muslim period, and the nature of astronomical interaction at this time. It emphasizes India's paramount significance in the astral sciences just as our period of concern comes to an end, and helps explain India's role in the transmission of astral science thereafter, an area which in recent years has been most successfully explored by Michio Yano. [26–27]

Once again, while some of Brown's opinions are strong and some of his arguments controversial, I find his book worth reading and often stimulating. It is an erudite collection of knowledge of ancient astral science and of ideas about its transmission between different cultures in the Old World. I recommend it for purchase to all libraries of learned institutions of the history of science and to those interested individuals and scholars who can afford it.

It seems appropriate to end this review by quoting Brown for the last time:

> Historians of astronomy or science may criticize our approach or suggest a better way to piece together the evidence we have presented, and all will find reading the whole book somewhat of a challenge. As Tony Wilkinson put it "by covering such a broad canvas, there should be something in this book to annoy everyone". [8]

Sourcebook in the Mathematics of Medieval Europe and North Africa edited by Victor Katz

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1. Introduction

The story of mathematics, like any good story, is about the actors and their activities. While a narrative can help weave fragmentary episodes into a coherent tale, the richness in its telling lies in the performative nuances of the characters themselves. The ways in which individual actors confront the situations that they encounter shape the stories of their interconnected histories. In the chronicle of mathematics, the probative force of this agency is most excellently demonstrated by looking at the writings of the practitioners themselves, and this is precisely what a sourcebook is meant to provide.

The *Sourcebook in the Mathematics of Medieval Europe and North Africa* brings together a selection of mathematical writings in Latin, Hebrew, and Arabic from medieval Europe and North Africa (the Maghreb). At the very outset, it offers its readers an opportunity to survey briefly the mathematical contributions of scholars writing in different languages, at different times, and in different places across the intellectual geography of the medieval West. The three main chapters of this sourcebook present a collection of topics studied by mathematicians writing in Latin, Hebrew, and Arabic from the ninth to the 15th centuries. The contributors to this sourcebook have provided, often for the very first time, English translations of excerpted Latin, Hebrew, and Arabic texts for the benefit of readers unacquainted with the source languages. These translated passages not only give readers direct

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access to the mathematical thinking of the authors, they also reveal the reticulated nature of developments in premodern mathematical thought. In fact, right in the general introduction, readers are made aware of the dilemma in situating individual mathematical works within the three chapters. The ensuing editorial choice to use the linguistic identity of the original author when known, and if not, to follow the language in which the extant material source is written, already betrays the complexity and dynamism of the exchange of knowledge between these cultures. By citing substantial excerpts from different textual traditions, this sourcebook illustrates beautifully the vibrancy of the intellectual commerce that thrived as Christian, Jewish, and Islamic scholars came to cohabit the space of medieval Western Europe.

It is perhaps also worthwhile to remember that a sourcebook is not didactic in the ordinary sense of a textbook. The paucity of introductory essays is intentional as it allows more room for reflective examination of the carefully selected source material. The editor's hope that readers "come to appreciate the mathematical struggles of our medieval ancestors and the answers they found to the problems they posed" [2] serves as a reminder that any threads connecting different episodes in the story of a subject are to be found while journeying through the episodes themselves.

Some readers may consider this to be a shortfall of the sourcebook, as it lacks a prefatory discourse connecting the selected passages into a coherent whole. Indeed, in grouping these excerpts into different subject-categories (more on this below), it is not always clear as to why these particular authors (or their works) are selected. The ontological consequence of this categorization notwithstanding, it does, however, offer some insights into the milieus in which authors posed the questions that they tried to answer.

The following remarks on the *Sourcebook*'s three chapters highlight some of the more notable aspects in their presentation of Latin, Hebrew, and Islamic mathematics. By no means do they exhaust the contents of this book.

2. The Latin mathematics of medieval Europe

The first chapter of this sourcebook surveys the contributions made by Latin (Christian) scholars of Europe from 800 to 1480. It categorizes the developments in the history of Latin mathematics into three periods—

- Latin schools, 800–1140
- A school becomes a university, 1140–1480
- Abbacist schools, 1300–1480

—with each period treated as an individual section. The collection of excerpts in each section is further categorized under a topical theme: for instance, the second section on universities includes passages on the topics of arithmetic, algebra, geometry, trigonometry, and so on, which are grouped under separate topical headings. Although not explicitly stated, a quick look at the names of the works grouped in each section will convince readers that these topical categories are not necessarily those identified by the original authors (i.e., actor's categories). For instance, excerpts from Fibonacci's *Book on Calculation* appear under both arithmetic and algebra in the section on universities. This topical (or subject-based) categorization of works in different sections is an editorial choice, in much the same way as the chronological division into three sections itself is an expository exercise.

2.1 *Latin schools* The system of representing numbers by the positions of fingers ("finger-reckoning") in the *De temporum ratione* (The Reckoning of Time) by Bede the Venerable (*ca* 672–735) provides an entertaining beginning to this section. Subsequent excerpts from theoretical texts such as Boethius' *De institutione arithmetica* (*Introduction to Arithmetic*, *ca* 500), and practical texts written for beginners in the use of the abacus such as Pandulf of Capua's *Liber de calculatione* (*Book of Calculations*, *ca* late 11th century), reveal how Latin scholarship in arithmetic was motivated by both theory and praxis. The passage from Franco of Liège's *De quadratura circuli* (*Squaring the Circle*, *ca* 1050) is particularly interesting. Franco accepts that the areas of a circle and a square are unequal in number, yet he attempts to demonstrate their equality by geometry. His attempt, although only partially successful, nevertheless shows how mathematical thinking in Latin Christian Europe began to embrace novelty in the late 11th century. Towards the end of this first section, examples of recreational mathematics in the form of number puzzles, e.g., *De arithmeticis propositionibus* (*Arithmetical Representations*) by Bede, and thought problems, e.g., *Problems to Sharpen Young Minds* by Alcuin of York (735–804), are presented. Among these, the description of the rules of the 11th-century mathematical game *Rithmimachia* or *Rithmomachia* (*Fight with Ratios of Numbers*) is as delightful as it is educational to read. It shows the pedagogical value of arithmetical games in the Middle Ages [59–64].

2.2 *A school becomes a university* In the first topic of this section, readers are presented with literal English translations of the first theorem of the first book of Euclid's *Elements* that are derived from its Greek version vis-à-vis the ones that are derived from its Latin versions (as well as from its subsequently reworked versions). The conceptual differences that arise due to different channels of transmission—for example, from Greek to Arabic to Latin, or from Greek to Arabic to Castilian to Latin, as well as those that follow from later re-workings in the 12th and 13th centuries—are made demonstrably clear to the reader [71–75].

The passages from al-Khwārizmī's *Arithmetic* (in Latin, *ca* 12th century) show how the Hindu-Arabic place-value system and the concept of zero were initially difficult to understand in the Latin West. The excerpts from John of Sacrobosco's *Algorismus vulgaris* (*ca* 1230), a popular work derived from al-Khwārizmī's *Arithmetic*, reveal the increasing significance of the study of the "art of numbering" among university students. On a more practical level, the examples from chapter 12 of Leonardo of Pisa's (*alias* Fibonacci) *Liber abbaci* (*Book on Calculations*, 1202) explain the use of arithmetic in everyday problem-solving. The problem "On the Finding of a Purse", where Fibonacci understands negative numbers as amounts to be in "debit", is certainly noteworthy. The contributors to this chapter also point to a commonality in the nature of this problem as it first appears in India (Mahāvīra's *Gaṇitasārasaṃgraha*, *ca* eighth century [563–64: appendix 3]) and subsequently manifests in numerous Islamic and medieval Latin works.

Turning to algebra, the small excerpts from the translation of al-Khwārizmī's *Algebra* (*ca* 830) by Robert of Chester (*ca* 1145) show how concepts, methods, and proofs came to define the study of Latin Algebra in the High Middle Ages. In the selections from Fibonacci's *Liber abbaci*, we see Fibonacci's "direct method" using algebra (as opposed to arithmetic) in solving practical problems. Some readers may find particularly interesting the geometrical justifications that Fibonacci uses in describing his "double false position" method of solving equations of the form $mx + r = c$ (from chapter 13), as well as those that he gives for his method of solving "squares plus numbers equal roots" (from chapter 15) [107–112].

There are several captivating episodes that highlight developments in the topics of geometry and trigonometry in Latin Europe. For example: the proof of Heron's formula in Gerard of Cremona's translation of the *The Book of the Measurement of Plane and Spherical Figures* (*ca* late 12th century) by Banū Mūsā; Fibonacci's algebraic explanations on measuring fields of varying shapes in his *De practica geometrie* (*Practical Geometry*, 1220); or even Ptolemy's derivation of chord lengths in a circle of radius 60—including his own proof for "Ptolemy's Theorem"—from his *Almagest* (*ca* second century). The discussions on planar and spherical trigonometry from Regiomantanus' (*alias* Johannes Müller) *De triangulis omnimodis libri quinque* (*Five Books on Triangles of Every Kind*, *ca* 1462/64) deserves particular mention.

On the notion of infinity in Latin Europe, the excerpts from Campanus of Novara's reworking of Euclid's *Elements* (*ca ante* 1259) and Thomas Bradwardine's *Geometria speculativa* (*ca* early 14th century) show how infinitesimals were interpreted geometrically: that is, how a non-rectilinear or horn-like angle—called an *angulus contingentiae* (angle of contingence)—between a tangent and the circumference of a circle at the point of tangency could be infinitely divided into smaller parts. In fact, in his *Tractus de continuo* (*On the Continuum*, *ca* early 14th century), Thomas Bradwardine offers an excellent review of the scholarly opinions on continuity and discreteness prevalent at his time.

With his cautionary passage, Robert Grosseteste spelled out the separation that he felt needed to be maintained between mathematics and the experiential world in his *De lineis, angulis et figuris* (*On Lines, Angles, and Figures*; *ca* early 13th century). For Robert, the corporeality of the world was evident in movable matter and, hence, explicable by the science of mechanics; geometry was just the language of mechanics. Building on this idea, scholars at Merton College in Oxford wrote works on kinematics (spatial and temporal changes in movement: the effect) and dynamics (forces producing the changes: the cause) that came to influence mathematical physics of late medieval Europe. Excerpts from the chapters in part 1 of Nicole Oresme's *De configurationibus qualitatum et motuum* (*On the Configurations of Qualities and Motions*, *ca* 1350) are remarkable as they show how Oresme used geometrical graph-like figures with rectangular coordinates to represent changing (uniform and non-uniform) distribution of various quantities before Descartes.

2.3 *Abbacist schools* The third and last section of this chapter is on the Abbacist schools of northern Italy (1300–1480) that helped educate members of the mercantile class. With Florence becoming the center of European banking, the practical curriculum in mathematics taught at Florentine Abbacist schools—in vernacular Italian instead of Latin—was designed for commercial applicability. For instance, excerpts concerning the calculation of foreign exchange illustrate the need for merchants to understand the Rule of Three; and excerpts about land measurements demonstrate the need for practical geometry. In fact, the passages from the lecture notes of Gilio da Siena (*flor*. 1374–1407) show what students might have learned in a course on introductory algebra at an Abbacist school.

Overall, the chapter on Latin mathematics includes many interesting excerpts that readers might find enjoyable to discover. A few such examples are cited here: the allegorical way of interpreting numbers as mysterious (or sacred) in Isidore of Seville's *Liber numerorum* (*Book of Numbers*); the combinatorial calculations in the anonymous poem *De vetula* from *ca* mid-13th century France; the "shadow square" (a numbered U-shaped figure on the back of an astrolabe) in the English poet Geoffrey Chaucer's *A Treatise on the Astrolabe* from the 14th century; the mathematical impossibility of "angels" being impelled by continuous motion in a lecture on indivisibles and theology by John Duns Scotus (*ca.* 1266–1307); the first use of geometrical diagrams representing a "function" in Giovanni di Casali's *De velocitate motus alterationis* (*On the Velocity of Motion of Alteration*, from 1346); and the unique solution of cubic and quartic equations proposed by Master Dardi (*flor*. 1344).

3. Mathematics in Hebrew in medieval Europe

The second chapter of this sourcebook discusses the contributions made by Hebrew (Jewish) scholars of mathematics between the 11th and 16th centuries in Europe. Beginning with a chronology of Hebrew mathematical texts written in this period, the chapter proposes to analyze the historical development and continuity in these works by categorizing them into five thematic sections with increasing complexity:

- Practical and Scholarly Arithmetic
- Numerology, Combinatorics, and Number Theory
- Measurement and Practical Geometry
- Scholarly Geometry;
- Algebra.

The contributors to this chapter state that the English translations of (most) Hebrew excerpts are directly based on primary sources (manuscripts or editions). Readers unfamiliar with the history of Hebrew mathematics (or the language of Hebrew) should find this information reassuring. The chapter's contributors are scholars of repute and hence their translations adhere to rigorous academic standards.

3.1 *Practical and scholarly arithmetic* Excerpts from the foundational text of Abraham ibn Ezra, *Sefer Hamispar* (*The Book of Numbers*, *ca* 12th century) describes the arithmetic of numbers and fractions, geometric and harmonic ratios, calculations of square roots, calendrical and commercial problems using proportions, and techniques of geometrical mensuration, among other topics. The translations show how Ibn Ezra's instructions on some of these topics, including his explanation of the Hindu-Arabic decimal system, are interwoven with Jewish mysticism.[1] Immanuel Ben Jacob Bonfils' description of sexagesimal division that contextualizes the treatment of decimal fractions, or Rabbi Jacob Canpanṭon's iterative algorithm to extract the roots of integers (*ca* 14th–15th century), illustrate aptly how medieval Jewish scholars combined everyday practicality and conceptual reasoning in explaining arithmetical techniques.

3.2 *Numerology* Excerpts from Ibn Ezra's *Sefer Haʿolam (Book of the World*, *ca* 12th century) and Levi Ben Gershon's *Maʿase Ḥoshev* (*The Art of the Calculator*,1321) offer examples of how Jewish scholars discussed combinatorial reasoning. Ben Gershon's analysis of various paired numbers and their connection to harmonic tones in music, skillfully described in his work *On Harmonic Numbers* commissioned by the French composer Phillipe de Vitry, is included in comprehensive detail [277–283]. With selections from Qalonymos Ben Qalonymos' *Sefer Melakhim* (*Book of Kings*, *ca* 14th century), Don Benveniste ben Lavi's *Encyclopedia* (1395), and Aaron Ben Isaac's *Arithmetic* (*ca* 15th century), readers can learn about "amicable numbers"—a pair of integers where the sum of the divisors of one number equals the other. These discussions are thought to be based on Thābit ibn Qurra's theorem (and proof) of finding amicable numbers from around the ninth century.

3.3 *Measurement and practical geometry* The passages from the 11th-century Jewish scholar Abraham Bar Ḥiyya's *Ḥibur Hameshiḥa Vehatishboret* (*The Treatise on Measuring Areas and Volumes*), an influential Hebrew work that was (partly) translated into Latin by Plato of Tivoli in 1145, show how Bar Ḥiyya's introduction to abstract geometry essentially resembles a manual on mensuration. Its purpose is more aligned with the Arabic tradition of *muʿāmalāt* (rulings governing commercial transactions) than with scholarly geometrical expositions. The method of heuristic reasoning (*heqesh taḥbuli*)—an iterative application of the classical method of "double false position"—applied by Levi Ben Gershon in calculating the Sine[2] of the fourth part of a degree as a minimum interval of his Sine table and described in his *Astronomy*[3] is particularly interesting [320–322].

[1] See, e.g., pp. 228–229 on the multiplication sphere.

[2] The sine (Latin *sinus*) is a trigonometric function of an arc-angle. Capitalized "Sines" represent rescaled sine values for a non-unitary maximum sine (*sinus totus*).

[3] This is book 5 of part 1 of his major religious work, *Sefer Milḥamot HaShem* (*Wars of the Lord*).

3.4 *Scholarly geometry* The detailed English translations of Ben Gershon's commentary on Euclid's parallel postulate [*Elem.* 1.post. 5], especially of Ben Gershon's proof of this postulate by invoking his own more "self-evident" postulates, provide a remarkable introduction to the scholarship of medieval Jewish authors on conceptual geometry. The excerpt from his *Treatise on Geometry* (written after his larger full commentary on books 1–5 of Euclid's *Elements*, *ca post* 1337) shows his attempt to construct geometry on foundations stronger than Euclid's own work. The passages from *Sefer Meyasher ʿAqov* (*Book of the Rectifying of the Curved*) by Abner of Burgos—*alias* Alfonso di Valladolid, 1270–1348)—show Alfonso's treatment of the quadrature of the lune and the conchoid of Nicomedes. The editorial commentary about Alfonso's applications of the conchoid, an application that is different from parallels known in Greek sources, as well as its recognition in the West in the 14th century earlier than hitherto believed, will offer historians of mathematics a fascinating read [347–353].

3.5 *Algebra* Passages from Ben Gershon's *The Art of the Calculator*, an anonymously authored work from around 1200, and Elijah Mizraḥi's *Book of Number* illustrate various procedures for solving quadratic problems without using explicitly algebraic methods. Two unknown quantities are arithmetically derived from known values of their product and their sum (or difference). Ibn al-Aḥdab's Hebrew translation *Igeret Hamispar* (*The Epistle of the Number*, *ca* 15th century) of the Arabic mathematical text *Talkhīṣ aʿmāl al-ḥisāb* (*A Summary Account of the Operations of Computation*) written by Aḥmad ibn al-Bannāʾ (1256–1321) describes the arithmetical procedure of "double false position" (or the method of scales). In fact, al-Aḥdab's translation is the first Hebrew text to include explicitly algebraic terms (e.g., roots or "things", squares or "estates") along with their rules for multiplication and division [367–374].

In summary, the chapter on medieval Jewish mathematics offers historians unfamiliar with the Jewish (Hebrew) tradition a fascinating review of its ingenuity. For example, the method of solving plane triangles, a technique important for astronomical problems, in Ben Gershon's *Astronomy* is believed to be one of the earliest European accounts of the Islamic trigonometric solutions of planar triangles. In providing English translations based on primary Hebrew sources, often for the first time, the contributors of this chapter certainly warrant commendation from professional historians who are now able to reference this work in their own research.

4. Mathematics in the Islamic world in medieval Spain and North Africa

The third and last chapter of this sourcebook discusses the mathematical contributions made by Islamic scholars from medieval Spain and North Africa. The chapter begins by succinctly tracing the development of mathematics as successive rulers came to power in Muslim Iberia (*al-ʾAndalus*) during the Middle Ages. Subsequently, it outlines the mathematical activities in North Africa (*al-Maghrīb*) during this same period. The introductory essay contains useful pieces of information for readers wishing to see how mathematical ideas transferred between cultures. For example, in the introduction to chapter 3 we find:

> Al-Haṣṣār [*c*. twelfth century] wrote at least two mathematical works. One, the *Book of Demonstration and Recollection*, dealt with calculation and is the first book known using the horizontal bar to separate the numerator from the denominator of fractions. This practice spread rapidly in mathematical teaching in the Maghrib, where Fibonacci (who died sometime after 1240) learned of it and used it in his famous *Liber abbaci*. The book was also translated into Hebrew in the thirteenth century by Moses ibn Tibbon. [385]

Like the previous chapters, this chapter also categorizes the excerpts on medieval Islamic mathematics from al-Andalus and the Maghreb into topical sections:

- Arithmetic
- Algebra
- Combinatorics
- Geometry, and
- Trigonometry.

4.1 *Arithmetic* The excerpts from *Al-talkhīṣ aʿmāl al-ḥisāb* (*A Summary Account of the Operations of Computation*) and *Raf ʿal-ḥijāb ʿan wujūh aʿmāl al-ḥisāb* (*Raising the Veil on the Various Procedures of Calculation*) by Aḥmad ibn al-Bannāʾ (1256–1321) show his exposition of whole numbers, addition, subtraction, multiplication, division, and fractions in detail. Common arithmetical themes—for instance, the different orders (*martaba*) of numbers—are brought together from both these works to indicate as well his philosophical and mathematical reflections [387–388]. The excerpts from *Removing the Veil from the Science of Calculation* by 15th-century Maghrebi mathematician ʿAlī bin Muḥammad al-Qalaṣādī reveal how his account of arithmetical procedures differs from that of Ibn al-Bannāʾ. For instance, on the topic of multiplication [400–402], we see the contrast between al-Qalaṣādī's multiplicative method of "finding unknowns from knowns" and Ibn al-Bannāʾ's method of explaining multiplication in terms of addition.

4.2 *Algebra* In reading the excerpts from Ibn al-Bannāʾ's *Al-talkhīṣ aʿmāl al-ḥisāb* and *Raf ʿal-ḥijāb ʿan wujūh aʿmāl al-ḥisāb*, as well as those from his *Al-ʾuṣūlwa al-muqaddimāt fī al-jabr wa al-muqābala* (*Book on Fundamentals and Preliminaries for Algebra*, *ca* late 13th century), readers can see how Ibn al-Bannāʾ's explanation of the terms *al-jabr* "restoring" (adding to both sides of an equation the quantity subtracted from any one side) and *al-muqābala* "balancing" (subtracting terms among themselves so that the final equation does not contain the same terms on both sides) made these "techniques" integral to the calculations (*ḥisāb*) of unknown quantities. The operative rules for transacting with these *species*, i.e., numbers, unknowns, and squares, formed the arithmetic of algebra. These were then applied to solve various word problems in the two-part division of Ibn al-Bannāʾ's *Al-ʾuṣūl wa al-muqaddimāt fī al-jabr wa al-muqābala* [415–422].

4.3 *Combinatorics* Aḥmad ibn Munʿim's combinatorial problems from his *Fiqh al-Hiṣāb* (*On the Science of Calculation*, *ca* 13th century) are particularly interesting. In them, Ibn Munʿim discusses the combinations of possible words that can be formed from the 28 letters of the Arabic alphabet when specific rules of Arabic orthography are applied. The six problems from section 11 of Ibn Munʿim's book reveal how combinatorial mathematics was skillfully applied to semantic investigation [434–446]. Interested readers may compare this with the combinatorial expositions of the Indian mathematician Nārāyaṇa Paṇḍita, in his *Gaṇitakaumudī* (*Lotus Delight of Calculation*, 1356) [Kasuba and Plofker 2013, 55–61].

4.4 *Geometry* The excerpts from *On Measurement* of Abū ʿAbd Allah Muḥammad ibn ʿAbdūn (d. 976) reveal how geometrical shapes were actually measured, an activity of the *muhandis* "ones who measure". Interestingly, Ibn ʿAbdūn identifies the components of geometrical shapes that are *measurable*; his subsequent discussion on how each component is derived from the other shows what shapes meant to medieval Islamic geometers (or surveyors). The 11th-century geometer from medieval Spain, Al-Mutʾtaman ibn Hūd, the king of Saragossa (1081), blended Greek and Arabic geometry in his *Kitāb al-Istikmāl* (*Book of Perfection*). The passages on Ibn Hūd's proof of Heron's theorem [478–480], and his proof of Ceva's theorem using Menelaus' theorem almost 600 years before Giovanni Ceva proposed it in his *De lineis rectis* in 1678 [482–484], are especially insightful.

The selections from Muḥyī al-Dīn ibn al-Shukr al-Maghribī's *Recension of Euclid's* Elements (*ca* 13th century)—in particular, al-Maghribī's book 15, an adaptation of an unknown Arabic work on polyhedra—extended Hypsicles' treatment to all five regular solids [497–502]. In fact, a Hebrew translation of this anonymous Arabic work was made by the Jewish scholar Qalonymos ben Qalonymos in the 14th century. The section on scholarly geometry in the second chapter of this sourcebook includes excerpts from this Hebrew work [337–339].

4.5 *Trigonometry* Ibn Muʿādh's geometrical proof for determining the unknown lengths of arcs, their differences, and the ratio of their chord-lengths (or Sines), from his *Book of Unknowns of Arcs of the Sphere* (*ca.* 10th century) is an exemplary study of trigonometry in Muslim Spain during the Middle Ages. Ibn Muʿādh's exposition of the Sine theorem (and its application to a right triangle) as well as his method of solving spherical triangles, an important trigonometric result in determining the direction of Mecca, are particularly revealing of his scholarship [512–520]. Among later scholars, the passages on Jābir's Rule of Four Quantities from *Correction of the Almagest*, a 12th-century work by the influential Sevillian astronomer Abū Muḥammad Jābir ibn Aflaḥ, attest to the mastery Islamic scholars achieved in the study of spherical trigonometry during this period.

For attentive readers, this chapter brings to light several important and influential discoveries made by scholars from the Islamic West. Two in particular stand out for their mathematical elegance and conceptual geometry. The first is in the Cordovan astronomer Abū al-Qāsim ibn al-Samḥ's *The Plane Sections of a Cylinder and the Determination of Their Areas* (partially surviving in Qalonymos ben Qalonymos' Hebrew translation), where he proves the equivalence of the oblique section of a right circular cylinder and an ellipse constructed using the ordinary "gardener's method", i.e., moving a taut loop of string staked at two fixed ends, which he called a "triangle of movement" [457–468]. Incidentally, Ibn al-Samḥ also goes on to describe a method for measuring the area of this ellipse by relating its areal measure to that of circles inscribing and circumscribing the ellipse. The other remarkable excerpt is from Ibn Muʿādh's *On Twilight and the Rising of Clouds* where he offers geometrical arguments to ascertain the height of the Earth's atmosphere, a measure related to his analysis of what causes twilight [520–530].

5. Comments

The most valuable feature of this sourcebook is the frequent referencing of mathematical content (cited as excerpts of problems, solutions, or proofs) across different authors writing in different languages and in different timelines. For example, when reading about the Jewish scholar Bar Ḥiyya's method of dividing the area of a quadrilateral as found in his *Treatise on Measuring Areas and Volumes* [310], readers are made aware of its resemblance to the geometrical methods presented in an Arabic translation of Euclid's *On Divisions* by the 10th-century Persian geometer al-Sijzī [Hogendijk 1993, 143–162] as well as Fibonacci's methods described in the fourth chapter of his *Practical Geometry* [135–139]. Similarly, one comes to see the connection between medieval Islamic scholars (like al-Maghribī) and Jewish scholars (like Levi Ben Gershon) on their proposing "proofs" of Euclid's parallel postulate [495]. Such interconnections across traditions are extremely useful to professional historians tracing the development of a particular mathematical idea.

At the end of every chapter, the contributors have provided a list of primary and secondary sources from where the excerpted passages are cited. These lists, along with the chapter-bibliographies, make this sourcebook a credible research resource for historians of mathematics. There are, however, a few instances where references are lacking. For instance, in talking about the antiquity of treating quadratic problems, the contributors to the section in chapter 2 on algebra in Hebrew sources state:

> But even before the "official" algebra using the Khwārizmian terms (root/thing, square/property, cube, etc.) and six normal forms of linear and quadratic equations, quadratic problems were treated by methods that go back to Mesopotamia, namely, the reduction of problems to deriving the values of two unknown from their product and sum/difference with an implicit or explicit geometric model. [354]

Citing apposite references to studies on algebra in Mesopotamian sources—for example, Høyrup 2002 or Robson 2007, 102–127—would have helped interested readers pursue this assertion conveniently.

The layout of the original translations (mostly typeset in regular Arial font) followed by editorial commentaries (typeset in regular Times Roman font) is problematic in that it uses mixed typefaces and short first-line indentations that compress the textual content and strain readability. It is often the case with lengthy publications that good typography is compromised to meet the demands of printing. Such concessions, however, should be carefully considered given the time and money readers invest in the printed copy. Future editions of this sourcebook would benefit from a refreshed typography.

6. Conclusion

The exemplary scholarship made available through this sourcebook certainly towers over the minor shortcomings in its production. This sourcebook continues in the scholarly tradition of presenting excerpted translations of mathematical writings from the ancient and medieval worlds.[4] In this respect, it rises above its pedagogic or repertorial purposes to itself become the object of future studies in the historiography of mathematics.

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[4] See, for instance, Yǎn and Shírán 1987, Clagett 1999, Datta and Singh 2001, Katz 2007, and Rashed and El-Bizri 2012.

Cycles de la nature, cycles de l'histoire: de la découverte des météores à la fin de l'âge d'or edited by Estelle Bertrand and Rita Compatangelo-Soussignan

Scripta Antiqua 76. Bordeaux: Ausonius éditions, 2015. Pp. 296. ISBN 978–2–35613–128–7. Paper €25.00

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This volume of essays represents the fruit of an ambitious project driven by two working groups (Sociétés, milieux, climats and Normes et représentations du pouvoir) of the Centre de Recherche en Archéologie, Archéosciences, Histoire at Le Mans Université.[1] The project aims to explore theories from antiquity about the cyclical patterns that guide both natural processes and human history, and at the same time to question the place of those theories in the modern world, where scientific exploration comes to be dominated by theories of linear progress rather than cyclical repetition.

This is obviously a weighty analytical task, and it is to the credit of the editors that this compact volume manages to take in as many of the relevant questions as it does. Naturally, the reader does not leave the volume feeling that the questions have been settled. Rather, the volume serves as a provocation to think not only about the questions addressed by the individual essays, but also about the challenges and rewards of attempting to establish a mutually intelligible conversation between the histories of premodern and modern science, incommensurable as they are often regarded.

The editors have opted to bisect the essays into the eponymous "cycles de la nature" and "cycles de l'histoire", but to indicate in the brief preface to the volume (each of the two halves also receives its own brisk introduction) that the reader should expect analogies, reflections, and symmetries to bind the two halves together. The strategies employed by ancient authors to liken

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[1] http://www.univ-lemans.fr/fr/recherche/panorama-de-la-recherche/les-laboratoires/creaah.html.

the duration of mankind to the life of a man (with an infancy, prime, and old age) or to the span of a day (with a dawn, noon, twilight, and dark), or to liken a single human being to a world (in the Democritean tag with which the editors close the volume), are a constant refrain here.

The volume's essays on ancient science largely land in "meteorological" territory, in both the ancient and the modern senses of the word: floods and weather cycles, comets, and tides—a welcome addition to a corpus of scholarship on ancient meteorology recently brought more into the mainstream by Liba Taub's *Ancient Meteorology*. The initial essay, by Germaine Aujac, casts a glance further upward into the celestial domain, offering an informative yet readable review of the cycles of celestial bodies through the eyes of Geminus, Hipparchus, and Ptolemy. The second brings the reader back down to Earth for Frédéric Le Blay's consideration of analogical links between meteorological and medical thought in Aristotle and the Stoics, arguably the volume's strongest fulfillment of the preface's promise to invoke connections between biological and cosmic cycles.

Modern science, or at any rate geoscience, appears in the form of two essays inset within the "cycles de la nature" section: Pierre Savaton's "James Hutton (1726–1797): pour une histoire cyclique de la surface du globe" and Nathalie Richard's "Cycles glaciaires et préhistoire humaine: les premiers débats (France et Grande-Bretagne, 1850–1914)". Savaton traces the biography and career of Hutton, whose *Theory of the Earth* (1795) proposed that the Earth was subject to a never-ending cycle of self-formation, as rocks were upheaved by subterranean heat, eroded, and shifted to new sites to be transformed anew through heat, pressure, and sedimentation. Hutton's cyclical theory is often situated in a simplistic narrative of the struggle of "modern" geology to supplant biblical theories of the Earth's sharply delimited temporality. Savaton's treatment provides a more nuanced view of Hutton's influences (including Descartes, Hooke, and Buffon) and the development of his theories in the competitive crucible of contemporary scientific discourse.

A still more productive reflection on ancient and modern thinking about history (natural and unnatural) caps Philippe Leveau's chapter on meteorological prodigies and catastrophes in antiquity, where he uses the recent earthquake at Aquila as a lens for comparing modern and ancient reactions to anomalous meteorological phenomena that damaged cherished religious images after not having been correctly predicted by technical experts (be they seismologists or haruspices). Leveau begins his essay by reflecting on the "deep past" proposed in Stephen Jay Gould's *Time's Arrow, Time's Cycle*, follows through by considering data on floods of the Tiber from the fifth century BC to the present alongside more discursive accounts from ancient historians, and ultimately concludes with some provocative comparisons between ancient and modern ways of conceiving temporality. This comes with nods to Jean-Louis Le Moigne's discrimination between "entropique", "anthropique", and "téléologique" ways of conceiving ecological time-frames, as well as David Lewis' modal theory. This essay is perhaps the volume's most successful marriage of big ideas that span natural and human history, literature and science, antiquity and modernity.

Anca Dan also works to span the distance between antiquity and modernity by mentioning modern investigations into the geology and hydrology of the Black Sea. Questions about the currents leading into and out of the Black Sea, particularly the "double current" of the Bosphorus, and concomitant questions about the shifting geology of the area, fascinated authors including the Presocratics, Eratosthenes, Strabo, Seneca, and Diogenes of Apollonia. Dan situates these ancient readings of the peculiarities of the Black Sea in a richly meaningful context of ancient chronological thought, finding in Pontus an opportunity to question the conventional focus on cyclical models of time in antiquity and to tease out some fascinating ancient thinking about linear flows of time. While she is principally concerned with the changing significance of "Pontus" as a cultural touchstone for the "tension" between linear and cyclical models of time in antiquity, Dan touches as well on modern hydrological theories about the Bosphorus and the Black Sea's geomorphology more generally.

Out of regard for the readers of *Aestimatio*, I have focused principally on the chapters of the volume of interest to historians of science, and in doing so have surely done injustice to the chapters oriented more purely toward historiography. A few words, then, about some standouts among these.

Christian cosmology makes its most sustained appearance in Therese Fuhrer's "Déchéance – échecs – régénération: une figure de pensée dans la littérature antique", which traces thinking about the world's old age from the myth of the "Iron Age," through Christian thought of late antiquity, to Gibbon's *Decline and Fall*. Without question the second of these is Fuhrer's primary concern.

Abdellatif Idrissi offers the volume a glimpse of the development of Muslim models of historiography, beginning from the institution of the Hegira cycle and its gradual incorporation of the traditions of *hadith* and prophetic biography, which carried historiographical weight of their own. Idrissi further follows the adaptation of Arab Muslim historiography as it absorbed and responded to the Persian historiography of the Sassanids, Roman imperial history, and even the Greek past (largely in the form of fantastical histories of Alexander and his line). This multilayered history was marked, Idrissi argues, by a kind of “selective amnesia” which allowed Muslim historians to craft a richly multicultural narrative that nevertheless remained theirs distinctly.

In short, this volume offers the reader a varied menu of thought-provoking readings, and while one might wish that the collection were integrated more robustly as a whole, this fascinating and ambitious project certainly serves to suggest a wide field of future work that promises to bring scholars of ancient science and ancient history into closer touch. The editors follow Aldo Schiavone’s *Storia e destino* in proposing a “spiral” as an alternative to a purely cyclical or linear topology of time. While Schiavone’s model does not in any sense become a guiding dogma of the volume’s essays as a group, it does stand as a neat symbol for the potential trajectory of the work done here: onward and outward.

Logoi and Muthoi: Further Essays in Greek Philosophy and Literature edited by William Wians

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This volume of essays is the second devoted to exploring philosophical themes in Greek literature that William Wians has edited. The first, *Logos and Muthos: Philosophical Essays in Greek Literature*, was published in 2010. Both attempt to correct and clarify the old schema of Nestle's *Vom Mythos zum Logos* [1940], a work tinged with the ideology that prevailed in Germany at the time. To this end, the volumes propose to avoid simplistic schemas, such as that of the "Greek miracle" or of the transformation of the irrational into the rational. *Muthoi* and *logoi* are realities that have much richer and more complex relationships with each other than the mere substitution proposed by Nestle.

In the introduction, "From Logos and Muthos to…" [1–15], Wians presents the purpose and content of the book. He points out that the aim of this volume is

> to consider philosophical themes and ideas in works not ordinarily included in the canon of Greek philosophical texts, both to shed light on canonical philosophical authors and also for their own sake. [2]

He thus brings together 12 essays whose purpose is

> to reinforce, at least implicitly, the recognition that current disciplinary boundaries are our own, and that much fruitful work remains to be done by crossing them, [2]

a principle with which I cannot agree more [cf. Bernabé 2008]. Wians tries a definition of myth [3] which, like all such definitions, is acceptable to a wide number of instances, but, like all of them, leaves out instances of a

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reality much richer than any simple definition can encompass. On the other hand, he suggests an acceptable proposal for what is considered *logos* and develops the axes on which its relation to *muthos* moves:

- "Story vs. Argument" [2],
- "Pedagogy and Suthority"[5],
- "Reception and Revision" [7], and
- "Myth as Narrative Construction" [8].

In chapter 1, "*Xenia, Hiketeia*, and the Homeric Language of Morals: The Origins of Western Ethics" [17-53], Kevin Robb argues that *xenia* (guest-friendship), and *hiketeia* (supplication) are the two social proprieties most prominent in Homer. To prove his point, he concentrates on the first eight books of the *Odyssey* and argues that "*xenia* and *hiketeia* dominate much of the actions of the most characters, as well as the moral language they use". Robb defines both concepts, focuses on Homer's emotive language of morals, and presents the cases of book 1 of the *Odyssey* (in which the suitors are demanding to be treated as authentic *xenoi*), and books 3–4 (in which Telemachus appears as a *xenos*). In referring to books 5 and 6 of the *Odyssey*, Robb proposes to distinguish among three variant forms of supplication: "rhetorical supplication" (for instance, the plea led by Telemachus to Nestor in book 3 and to Menelaus in book 4), "virtual supplication" (in which "the sincere intent of the supplicating person is to go through the full ritual, but for some reason is inhibited to doing so" [40]), and "full physical supplication" (for instance, that undertaken by Priam to recover the body of Hector). After he examines Odysseus' transformation from supplicant (*hiketês*) to *xenos* in book 7 of the *Odyssey* [42–45], he turns to the pleasures of *xenia* [45–46].

In chapter 2, "The Muses' Faithful Servant: Moral Knowledge in Homer, Hesiod and Xenophanes" [55–77], William Wians examines the great gulf separating the factual knowledge of gods and human beings, especially the problem of moral knowledge. He concentrates on Homer, Hesiod, and Xenophanes. All of them "express a naïve if pervasive skepticism", and, according Wians, "all three nevertheless proceed confidently, even proudly". On the other hand, the analysis proposed offers insight into the so-called rivalry between ancient poets and philosophers. Wians reviews the various attitudes of the three poets towards the problem.

In chapter 3, "How Philosophy is Rooted in Tradition: Stories Describing the Appearance of Man and Woman in Ancient Greece" [79-94], Luc Brisson studies the Hesiodic myths of the separation of men and gods, specifically, that of Prometheus and that of Pandora. Brisson continues to maintain his criticism of the existence of an Orphic myth of the origin of human beings and his strange theory about Olympiodorus' version of this Orphic myth as an alchemical interpretation, sustained in previous works, despite the abundant bibliography against it [cf. Graf and Johnston 2005, Bernabé and Casadesús 2008, and Scalera 2016].[1]

In chapter 4, "*Muthos* and *Logos* on New Year's Day: Trial and Error in Anaximander's Seasonal Sundial" [95–134], Robert Hahn explores Anaximander's idea of a seasonal sundial, and tries to reconstruct this piece and illuminate the context of this finding. He focuses on the experimental techniques of trials and errors that philosophers can have, and uses all the textual and archaeological evidence possible, with extremely interesting results.

In chapter 5, "Tragic Values in Homer and Sophocles" [135–164], Lawrence J. Hatab examines *Resp*. 607b, in which Socrates, after condemning the tragic poetry and Homer, says, "nonetheless, if poetry…has any argument to bring forward that proves it ought to have a place in a well-governed city, we would be glad to admit it", in the hope of hearing a defense of "tragic values". He examines the world-order in Hesiod's *Theogony*, the heroic values as evident in the works of Homer and Sophocles, focusing on the figures of Odysseus in Homer and Oedipus in tragedy in contrast with the Platonic vision of Greek poetry. He concludes that "what may actually be disturbing …is that Greek poetry does affirm the importance of certain values while simultaneously acknowledging their intrinsic limits" [159].

In chapter 6, "Sketches of Oedipus in Sophocles' Play about Tyranny" [165–196], Marina Marren asks two questions:

(1) What has Oedipus to do with Athens?, and
(2) What has Oedipus to do with tyranny?

To answer these questions, she analyzes the literary and philosophical evidence, reviews the visual images in the staged performance of the play, probes the mettle of Oedipus' self-proclaimed perspicacity, and explains that Oedipus seeks power not to do good but to hide his weakness. Marren presents Oedipus' encounter with the Sphinx as a metaphor for Oedipus'

[1] Bernabé and Pérez de Tudela 2011, a book dedicated to this topic, is missing in the bibliography, which is strange, because Brisson himself contributed to it a chapter on the myth of Pandora, a chapter with many elements in common with the one presented here. Specifically, in pages 89–92, he presents exactly the same conclusions as those maintained in Bernabé and Pérez de Tudela 2011, 150–152.

blindness to his own monstrosity. Moreover, she reflects on what it would mean for the audience in ancient Athens not to see Sophocles' Oedipus as a glorious king but to understand the play as a warning issued to the bellicose city. Marren thus offers a clarifying and extremely interesting view of the meaning of the work and its value for the Athens of its time.

In chapter 7, "Helen and the Divine Defense: Homer, Gorgias, Euripides" [197–221], Ruby Blondell focuses on three texts used to exonerate Helen of Troy, examinining Priam's parliament in *Iliad* 3.164–165, the *Encomium of Helen* by Gorgias, and the apology by Helen in Euripides' *Trojan Women* 940–941, 948–950. The common theme of these texts is that the blame for the war lies not with Helen but with the gods, especially Aphrodite. With this, Blondell tries to show how in none of them is the divine defense presented seriously, in judicial terms: "Nevertheless, the contexts of utterance …shape our responses to the argument in ways that significantly affect our judgement of Helen and her responsibility" [214].

In the chapter 8, "The Hero and the Saint: Sophocles' Antigone and Plato's Socrates" [223–262], Roslyn Weiss maintains the peculiar point that, while Plato's Socrates' attitude characterizes him as a saint, Sophocles presents Antigone as a hero. To prove this claim, she reviews the attitudes to Antigone throughout the tragedy and those to Socrates in the Platonic dialogues. The problem is that in reality she compares entities that are not really comparable. Antigone is a fictional character and, as such, she is subject to the limitations imposed by the genre in which she appears, tragedy, while Socrates was a real character, although one surely idealized by Plato to make him a model of the philosopher. Consequently, they are characters that are not on the same plane and it is difficult to obtain reliable results from their comparison.

In chapter 9, "Myth and Argument in Glaucon's account of Gyges' Ring and Adeimantus' Use of Poetry" [263–278], Marina McCoy examines how Glaucon adapts the episode of Gyges that is narrated by Herodotus and how the new details that Glaucon adds are philosophically and psychologically significant to the argument in its relation to the problem of whether the unjust life can be happy. The chapter helps to clarify Socrates' argument, bringing this text from prose into the critique of poetry.

In chapter 10, "Myth inside the Walls: Er and the Argument of the *Republic*" [279–296], Pierre Destrée studies the myth of Er, which he considers "a philosophical rewriting of…the famous Nekuia from *Odyssey* 11" [279]. No doubt the statement is to some extent true. But I think that the myth of Er is rather a philosophical rewriting of the Orpheus' κατάβασις and Orphic proposals. There are some reasons for this: first is that in other earlier passages of the *Republic* there are critical references to eschatological visions of Musaeus and his son (636cd), to the *teletai* of Orpheus and Musaeus [364e], and to punishments in Hades which are certainly not postulated by Homer [330d] but are postulated in Orphic texts [Bernabé 2011, 172ff. and 2013]. Another reason is that the "geography" of the beyond is a clear transposition of that found in such Orphic gold tablets as that of Hyponion.[2] Finally, there is even an allusion that is evidently ironic and parodic to Orpheus himself within the myth of Er [*Resp*. 620a].[3]

In chapter 11, "Priam's Despair and Courage: An Aristotelian Reading of Fear Hope, and Suffering in Homer's *Iliad*" [297–317], Marjolein Oele examines the figure of Priam in the *Iliad* as a sign of Homer's mastery of expressing how, even amidst incredible sufferings, affections can be shaped into virtue. To do this she draws on Aristotle's ideas about πάθος and his discussion of how affections can serve as underpinnings of virtuous behavior. Her analysis of the figure of Priam focuses on book 22 and her references to Aristotle, on the discussion of ἕξεις in the *Rhetoric*. She also points out how these circumstances allow for mutual understanding between Priam and Achilles as they come to recognize and relate to each other's sufferings.

In chapter 12, "Poets as Philosophers and Philosophers as Poets: Parmenides, Plato, Lucretius, and Wordsworth" [319–334], A. A. Long makes an original proposal, which follows the steps presented to a class on "divinity" held by Eric James in 1953, to make a comparative study of the relations between poetry and philosophy in four authors: Parmenides, Plato, Lucretius, and Wordsworth. This comparison, between authors who are in principle so diverse, allows one to underscore the difficulty of precisely differentiating poetry and philosophy, and raises the question of whether there are poetic and philosophic universals. Long concludes that there are no such universals, nor a determinate formula; but that just occasionally, a philosopher has also been a poet and a poet has been a philosopher.

In short, this interesting book brings together works that address, from very present-day perspectives, various aspects of the complex relations between

[2] See Bernabé 2011, 175–178, with reference to previous contributions and the balance of similarities and differences.

[3] By the way, Destrée mentions the "psuchai who choose their lives…expressly named" [283], and he is not surprised that Orpheus is the only one who does not appear in Homer—the same is true of Atalanta, but she is quoted by Hesiod.

muthos and *logos*; and shed light on areas of confluence and differentiation between these two essential manifestations of Greek culture, manifestations that are more complex than some reductionist proposals would allow. In this way, new paths are established to deepen the analysis of *muthos* and *logos*, two realities which never replaced one another but rather maintained their own courses throughout the history of Greek culture while establishing contacts between them that are both diverse and very interesting.

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The Rhetoric of Medicine: Lessons of Professionalism from Ancient Greece by Nigel Nicholson and Nathan R. Selden

Oxford: Oxford University Press, 2019. Pp. xxiv + 259. ISBN 978–01–9045–748–8. Cloth £45.99

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This is not a book about formal or classical rhetoric in medical writing. The authors' approach to "rhetoric" has more to do with examining the ethical elements found in the socio-cultural conceptualizations and self-presentations of physicians, particularly in respect to ancient Greek physicians of the sixth and fifth centuries BC and modern physicians. With this definition of rhetoric in mind, the authors' goal in *The Rhetoric of Medicine* is "to convince readers, and especially medical practitioners, of the importance, and indeed urgency, of attending to the rhetoric of medicine" [9]. This ethical endeavor is best located in William Osler's *desiderata* for a humanistic program in the education of physicians. In many respects, the authors have provided a commendable example of how to make use of the history of ancient Greek medicine as "a kindly, useful mentor" to help navigate the ethical dilemmas in modern American medicine and, therefore, this work is best located within programs teaching medical humanities.

The structure of each chapter effectively brings together the unique expertise of each author. Nigel Nicholson, a respected classical scholar who has written extensively on ancient Greek athletics and epinician poetry, begins each chapter with a thematic analysis of non-medical and medical textual sources, as well as of material culture, from the archaic and classical periods. Nicholson's analyses are directed towards illustrating specific ethical dilemmas and challenges that ancient physicians faced due to the socio-cultural conceptualizations of the practice of medicine that can be found in the presentations of physicians. The problems that Nicholson's analysis

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puts forward at the beginning of each chapter are then addressed by Nathan Selden, who is a neurosurgeon and the chair of the Department of Neurological Surgery at Oregon Health and Science University in Portland, OR. Using his insight as a medical practitioner and educator, Selden provides a wealth of information as to why the questions that were raised by Nicholson are relevant to the practice of modern medicine. Each chapter ends in a conclusion that reiterates the issues raised and suggests ways in which to navigate the problems of self-presentation that modern physicians face. In this way, each chapter creates a purposeful forum of discussion between a classical historian and a physician.

The chapters in *The Rhetoric of Medicine* are ordered according to seven topics:

- Body,
- Money,
- Competition,
- Restriction,
- Autonomy,
- Mentoring, and
- Self.

In chapter 1, “Body”, Nicholson uses Greek literature and art to show how ancient depictions of the athletic body’s being immune to injury had “serious ramifications for healthcare and quality of life of individuals” [16] because it ran in competition with the medical portrayals of the human body’s constant susceptibility to disease. Selden dovetails this theme of competing narratives by discussing modern medicine’s commitment to bringing attention to the susceptibility of athletes to concussions and traumatic brain injuries, which requires coming to terms with modern society’s conceptualization of athletes as being impervious to injury or as unique in their ability to overcome injury.

In chapter 2, “Money”, Nicholson contrasts the differences in gift exchange and commodity exchange. He uses Pindar’s description of Asclepius’ death [*Pythian* 3.47–60] and Herodotus’ account of the traitorous Democedes as examples of negative presentations of physicians because they both used their medical abilities to acquire portable wealth (i.e., a commodity). He contrasts this with examples of positive representations of physicians who, through their practice contextualized as an exchange of gifts between members of a society, were viewed as being embedded in their communities. Selden observes that this rhetoric of remuneration may be recognized as having an effect on the modern physician-patient relationship, and he goes on to suggest that the physician's self-presentation of his or her commitment to the community and the interests of the patient would go a long way in avoiding barriers to healing.

In chapter 3, "Competition", Nicholson argues that ancient Greek physicians viewed athletic trainers as competitors in the medical market place of the fifth century BC. Based on Hippocrates' *Regimen* 1.24, he argues that Hippocratic physicians had a polemical relationship with a class of athletic trainers called *gymnastes*. However, he suggests that in archaic Croton there was a cooperative relationship between physicians and trainers, which accounts for why the Crotoniate physician, Democedes, was allowed to cure the dislocated ankle of the Persian King Darius. This theme of benefits of cooperation in the medical market place is taken up by Selden in his discussion of allopathic *versus* alternative medicine, where he provides a detailed history of the competition and cooperation between allopathic medical doctors and doctors of osteopathy.

The topic of restriction is addressed in chapter 4, where Nicholson argues that certain individuals would avoid being called an *iatros* (doctor/healer) because this term denoted a well-recognized profession that did not engage in philosophical speculation, which was viewed as incompatible with being a doctor, and because an *iatros* was understood as being different from other "healthcare workers such as rootcutters, pharmacists, midwives, and athletic trainers" [120]. This restrictive image of the physician is contrasted with Nicholson's belief that the *iatromantis* (doctor-seer), Empedocles, was fighting for a broader definition of the *iatros*, one that incorporated patient care with philosophical and political discourse. Selden sees the modern physician facing a similar difficulty when he or she moves into political and non-medical realms due to society's perception that a physician's ability and knowledge are limited to the treatment of patients.

Chapter 5 addresses the physician's autonomy. Nicholson again turns to the figure of Democedes in Herodotus' *Histories*. He argues that Democedes' medical ability and his pursuit of money ultimately led to his loss of autonomy as exemplified by his forced service to the Greek tyrant, Polycrates, and later to the Persian King Darius. Selden likens Democedes' loss of autonomy to the tyranny of the urgent that subjugates the modern American physician to a frantic pace due to false expectations and the desire for remunerations for medical services. He concludes that both of these factors have led to a loss of autonomy, burnout, and poor patient-physician interactions.

In chapter 6, Nicholson addresses the topic of mentoring by using Pindar's portrayals of Chiron's education of Asclepius, Jason, and Achilles, as well as the athletic trainer-trainee relationship, as evidence for the ideal elements, potential problems, and complex nature of mentorship in antiquity. In his discussion of modern medicine, Selden picks up on Nicholson's discussion of the importance of agency in the mentor-mentee relationship, as well as his notion that mentorship can be used as a mechanism for exclusion. He argues that modern medicine must be aware of these issues as it moves more toward a mentorship model in medical education.

Chapter 7, "Self", takes up the physician's relationship to his own body. Nicholson compares how the description of disease in Thucydides' account of the plague of Athens resembles the case studies in the Hippocratic *Epidemics*. Following Brooke Holmes' notion that the dispassionate third-person narratives of the medical authors of the Hippocratic corpus represent a rhetoric of disembodiment that was used to establish credibility, Nicholson suggests that the physician's self-presentation as an expert without a body was not natural and led to physicians not recognizing their own vulnerabilities to the very diseases that they were treating [221]. Selden likewise argues that the idea of the disembodied physician has had deleterious effects on the modern physician's health, and he suggests that the way forward is for physicians, patients, and policymakers to be mindful of the problematic nature of this rhetoric of disembodiment and to encourage realistic expectations of the "human physicality of physicians" [231].

As to the appropriateness of the evidence used in each chapter, both authors utilize their expertise effectively for their target audience. Selden shows a good understanding of the historical developments in the history of modern American medicine, and he supports his argument with a wealth of medical journals and books. Nicholson's use of traditional classical authors such as Pindar, Bacchylides, Thucydides, and Herodotus, as well as his scholarly approach to the history of ancient Greek athletics, provides some interesting sources for his contextualization of ancient Greek medicine. That said, a historian of ancient Greek medicine will take issue with Nicholson over his reliance on these non-medical sources. For example, he claims that "there is little about mentoring in the Hippocratic texts from the classical period" [178], which seems to be his justification for why he uses Pindar's depiction of Chiron's education of Greek heroes to speak to mentorship in ancient medicine. In so doing, he disregards relevant evidence available in Hippocratic works, such as the father-son/mentor-mentee relationship that is part of the *Oath*. When interpreting the actions and abilities of ancient physicians, he also has a tendency to rely on speculation rather than ancient medical texts to support his argument. For example, Hippocratic works such as *On Joints* and *On Fractures* would reveal that one should not assume that ancient Greek physicians, such as Democedes, derived their expertise in relocating joints from their cooperative interactions with athletic trainers [98]. While this detracts from the specificity of his account of ancient Greek medicine, it does not destroy the historical foundations that Nicholson has established *via* his scholarly assessment of classical literature and the evidence found in material culture.

The arrangement of this book, the level of evidence, and the writing styles of the authors make it both interesting and accessible to its target audiences of medical students and practitioners. Such a reader will also appreciate this book's numerous black-and-white images and its critical apparatus of scholarly footnotes, a bibliography replete with classical and medical scholarship [237–250], and an index locorum [251–259]. Although *The Rhetoric of Medicine* does not break new ground in respect to academic research in the history of medicine, it is an exemplar of how historians and physicians can address realistic problems facing modern medicine through a collaborative approach that is grounded in an appreciation for the lessons to be learned from the history of medicine.

The Art of Divination in the Ancient Near East: Reading the Signs of Heaven and Earth by Stefan M. Maul

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Although the front cover of this volume displays an image of a clay model of entrails—giving the impression that the content describes the practice of extispicy only—it links to the development of early astral sciences in their connection with the tradition of oracular omens. The two main genres of omens here discussed are the "signs of earth", in particular, the markings on a sheep's liver, and the "signs of heaven", understood from the calculation of the cycles of the heavenly bodies and the astronomical phenomena related to them.

For clarity's sake and for a chronological perspective, I am making a distinction between the terms "astral divination" and "astrology". In the context of this review, the former is not based on the zodiac or the zodiacal constellations, while the latter dates from the very late fifth century BC and is based on the zodiac as it appears in different forms [Britton 2010].

This book's contribution to the wider scholarly corpus on divination and to the history of the philosophy associated with this belief system rests on the various ways in which the gods speak as well as on the messages received by earthly mediators. Its study of the connections that diviners made between heaven (that which is written in the stars and is predestined but not oracular in the strict sense) and earth (terrestrial omens or signs, which may be read as answers from the deities to questions from the king or a common person), and of how diviners of the former operated together with diviners of the latter, offers welcome insight into the space between heavenly and earthly

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prognostic procedures. The volume further describes responses from the royal courts in the ancient Near East to putatively oracular judgments or signals from the heavenly bodies, particularly during the second and the first half of the first millennium BC.

The reader learns that the skills of astral and terrestrial diviners were tested and rigorously examined and re-examined. The social and political process by which this was achieved and the consequences of this bureaucratic system, as discussed by the author, are enjoyably imaginative and well illustrated by colorful examples from cuneiform documents, as well as by images of miniature models of livers used to teach apprentices heptoscopy and tiny reproductions of actual extispicies.

Stefan Maul divides his book into 10 chapters plus a final concluding chapter. It is fair to say that the first six chapters form a natural "part 1": thematically, stylistically, and methodologically. Chapter 1, "Signs of Heaven and Earth", a brief introduction for the non-specialist to the social history of the subject, situates the origins of divination (both heavenly and earthly) firmly in the ancient Near East. Knowledge was passed down over two millennia, influencing the later genesis, transmission, and preservation of Mesopotamian oracular procedures in the Etruscan, Greek, and Roman worlds.

Citing ancient scholars from the Greco-Roman world, such as Pliny the Elder, Berossos, Diodorus, and Strabo, Maul states that the attribution "Chaldeans" was used by these writers to bestow authoritative status on Mesopotamian divinatory knowledge by virtue of its great antiquity [3–5]. He reminds us that this literature on the subject was substantiated by archaeological discoveries in the mid 19th century, and he usefully explains the difference between the Akkadian, Babylonian, and Sumerian languages as background.

No word on the history of the decipherment of cuneiform is offered here, though it would have been of interest, as Maul notes the ongoing task facing scholars today in translating, joining, and making sense of lacunae from duplicate texts [5–7]. But our job, he suggests, is to make sense not of the wedge writing pressed into clay but of how these people regarded their relationship with the cosmos, a relationship which was ultimately subject to a plurality of divine wills but still within their control if the right procedures were followed [8].

The very short chapter 2, "Sacrifice and the Art of Divination", contextualizes the early history of extispicy as an art of sacrifice to communicate with the gods, acts described in early Mesopotamian literature. The procedures for extispicy performed by a "seer" (*bārû*) differed from that of a regular sacrifice to feed the gods [13–14]. From a sacrificial offering to please a deity, Maul suggests that people progressed from asking the gods for favor to repurposing the tradition as an oracle as well. Divine approval or rejection of a plan could be indicated by examining the sacrificial animal's entrails, particularly its liver [14–15]. Remarkably, the practice did not disappear until the eighth century AD and became a prestigious tradition in Hellenistic Greece, Etruria, and Rome, outliving its use in ancient Mesopotamia and cuneiform culture. He adds that in ancient Mesopotamia, lambs were used for the wealthy, while poorer people could offer a bird, flour, oil, or incense for purposes of divination, thereby signposting a chapter later in the book.

The substantial third chapter, "Messages in Livers and Entrails: Extispicy's Essentials", is more detailed, containing examples from cuneiform documents with information about the practice over many centuries. Textual evidence from the third millennium BC onwards reveals that only a male lamb—preferably a very young male lamb, without any blemish, that had never come into contact with someone regarded as unclean—or dove-like birds could be used for extispicy [17]. In the Neo-Assyrian period (*ca* 1000–609 BC), sheep are specified in the texts, whereas pure lambs—lambs with white fleeces, probably—less than a year old are mentioned for this purpose in Old Babylonian texts (*ca* 2000–1500 BC) [17]. A sign or a list of features and qualifications needed to become an oracular lamb developed between the 21st century BC and the Old Babylonian period. Dealing in these animals was a cottage industry among diviners, and Maul provides social testimony for a conflict of interest among the seers who were providing animals for clients, or stealing them and performing the ritual themselves [17–18].

According to documents containing the royal accounts in the Old Babylonian period, huge numbers of lambs were sacrificed for this purpose. One tablet notes that more than 4,000 were bought in eight months, an average of more than 500 lambs per month [19]. Maul describes details of the ritual slaughter at length [35–38] and explains that what we would anachronistically call scientific principles were in force: the result was double checked with a second extispicy performed by a different seer [37], although it is not known if this procedure took place at the same time in the same ritual or the next day with another lamb [38].

Sacrifices took place at dawn before the Sun god Shamash rose in the east after the diurnal revolution of the fixed stars [20, 33–34]. In order to achieve a positive result, the seers did not leave the timing of the sacrifice to chance; there are numerically good and bad days of the month, so they had to ensure that the act took place on the most auspicious date [22]. The sky had to be clear, not cloudy; the sacrifice had to take place in the open air, away from crowds, in a pure place [24]. The diviner stayed up all night in full view of the rising of the constellations in the parts of the sky assigned to the sky gods Anu, Enlil, and Ea and of the setting of the stars, which brought the client's request to the underworld, the place where the Sun resided during the night before rising in the east with his response [26–27]. The seer whispered the question into ear of the animal while it was still alive, possibly at the moment when the Sun god appeared on the horizon, and then the sacrifice was enacted [31–32]. The seer also plugged his ears with tamarisk and cedar to cut himself off from the world, to be free of external influences. Notes have survived in the state archives of Neo-Assyrian kings that preserve the prayers accompanying the rituals [33–34] and details of how the sacrifice was carried out [35–37].

Maul describes the process of examination in one extispicy by two seers [38–47], which is illustrated with clay models from the royal palace of Mari, dated to the 19th century BC [49, fig.]. The procedure, as intricate as it is, apparently took less than half an hour [55]. In order for the reader to understand the diviners' readings better, Maul examines a sheep's liver, complete with blemishes, using modern anatomical information and the interpretation of blemishes in the cuneiform manuals. Here, the sheep's liver is analyzed according to 12 regions known as "canonical markings" [46–80]. At one point, Maul states that it is "doubtless hardly by chance" that there are 12 "canonical markings" and 12 divisions of the zodiac [53]. Although he is probably right, the 12 sections of the zodiac date to the late fifth century BC. (Such missing links of divinatory mathematical thought, spanning some 14 centuries, remain intriguing.)

The systematic method and its implications for historical techniques of divination are explained: points of interest include an area of the liver that "belongs to the enemy" (the left side), while the right side represented the person asking the question. In a sense, two divinations may have been performed from different perspectives on the same sacrificial lamb or possibly on two lambs [66]. In some cases, two sacrifices were indeed carried out, the second being a "control" or a second opinion when adverse signs were involved. Maul supports this practice with letters from the royal palace of Mari, Old Babylonian extispicy records, and "handbooks" containing model oracular questions [67–68].

A "college of diviners" would collectively weigh up the meaning of the signs. Maul gives examples of the records of a Hittite extispicy of the second millennium BC in which the "control" consisted of an extispicy performed upon a dove or a similar bird, or the casting of lots [78–79]. Some information about divination by lots would have been an interesting contextualization of the different kinds of oracular procedures.[1]

Kings often did not rely solely on the college of diviners but could judge their deductions themselves through the use of clay models. Maul suggests that some of the collections of miniature clay models of livers contained reports of actual extispicies [80], so the royal ruler could "inform himself most exactly" of the gods' will, according to one account from Old Babylonian Mari.

One of the most interesting sections of this chapter deals with the issue of a permanently problematic reading [81–85], whereby the inquirer appears to be shunned by his celestial masters. The implication that the gods could reject a sacrifice is dramatic on all levels. In literary terms, the reader is reminded of the biblical story of Cain and Abel [Gen 4: 2–6]. Readers or audiences in the ancient Near East would have readily understood the tension between wanting to offer a sacrifice to please the gods and fearing that it might fail to please them. Maul reproduces a poem written in Babylonian of the "righteous sufferer" [81–82], which was written in the first person, about a man abandoned by the gods, shunned by his community, and afraid of an uncertain future. The emotions conveyed are reminiscent of the biblical book of Job. This composition and the other apotropaic prayers cited in this section [81–85] are of interest to biblical studies.

Magical practices and intercessory prayers were used in rituals to appease the gods in an attempt to change divine "judicial verdicts", some of which, interestingly, find an echo in biblical remedies for disease, prayers, and the rituals performed on the Jewish New Year's Day (Rosh Hashanah) and the Day of Atonement (Yom Kippur) in different forms [82–84]. The rich illustration of these problems with case studies, including a reproduction of a tablet with unfavorable results regarding the health of the Assyrian king Ashurbanipal, dated to the early summer of 651 BC, provides ample evidence of the need for these practices and the conclusion that it was not always possible even for powerful kings to enjoy heavenly favor. Despite "controls", prayers, and secondary oracular opinions, diviners could not always bring the hoped-for good tidings. This is an extremely rich and readable section, well written and accessible to readers of all levels.

[1] On page 79, the footnote [n350] for lots refers the reader to page 180; however, the information on this page does not mention lots but other forms of non-sacrificial divination.

The somewhat shorter chapter 4, "The Fine Art of Asking Questions", describes some of the tricks of the trade in trying to obtain a clear response to an extispical inquiry. It was important to frame the question in such a way as to receive an unambiguous, useable response. Maul gives several examples of surprisingly detailed questions and of pre-written specimen "books of examples" that list multiple questions covering common queries concerning timeless human anxieties [88–91]. The range of questions that were asked by clients, though very few were preserved in Assyrian state archives, could include inquiries about the intentions of third parties or about current situations and were not only about the future [93–94].

More examples from actual cases are given for diviners' queries that included the duration of the validity of the "instruction", and ranged from questions of general health to military tactics [95–96]. If the result was unfavorable for the time-period intended for a plan of action, the question could be repeated after the period of validity had expired to see if the course of action would be successful at the later date, and to ascertain the most auspicious time for the undertaking [96–97]. Tablets survive in which the king of Mari assessed the security of his kingdom regularly each month by these means. If the powers-that-be consistently gave an unfavorable response, different time-scales notwithstanding, clients would have to consider abandoning their plan of action, or whatever their scheme may be, and leave their fate in the lap of the gods [98].

Maul quotes from a remarkable double-extispicy cast for King Zimrilim of Mari by the same diviner asking whether he should hand over one of his cities to the Babylonian King Hammurapi, who had requested it, and whether by refusing to do so he would jeopardize his kingdom. The diviner carried out two extispicies, phrasing the question first in the positive and then in the negative. Based on the readings, the diviner advised his king not to relinquish the city [98–99]. Further examples of tablets from royal archives include one concerning the queen at a Hittite court that covered matters of state security and information not in the public domain. This indicated that the diviners were comparable to modern-day civil servants who had access to classified information that could not be divulged. This chapter, like the one before, is vivid and methodically presented.

Despite its light-hearted title, chapter 5, "An Option of Going Cheap: The Inspection of Sacrificial Birds", is no less serious than the earlier chapters focusing on heptoscopy. It is a tour—like the examination of lamb offerings—of the inspection of sacrificial birds (here, termed ornithoscopy), and the parallels are evident [103–121]. Although records of this practice are sparser than for the more expensive procedure of obtaining a divine "instruction" from a sacrificial lamb, Maul argues convincingly that this practice became common in daily life during the second half of the first millennium BC, when doves were bred in Babylonian temples for this purpose. (The lives of ordinary people are missing from royal archives in the ancient Near East; hence, there is a shortage of case studies [103–104].)

At an earlier time, from the Old Babylonian period (*ca* 2000–1500 BC) until the first millennium BC, ornithoscopy was a secondary divinatory procedure employed in royal oracular consultations. What is not missing, scanty records notwithstanding, are the detailed anatomical oracular procedures of this practice, presented by Maul, in a similar format to that described for the inspection of lambs in extispicy. And indeed, the sacrificial process, terminology of areas of internal organs, and interpretations of markings and blemishes were similar. Maul suggests the possibility that the birds, which were sacrificed to feed the temple deities rather than to ascertain an instruction connected to war, politics, and economics—the primary purpose of this form of bird divination—were probably also examined for any messages connected to the gods' welfare. Ornithoscopy survived in Greco-Roman culture, as is known from satirical literature [120–121].

The slightly amusing titular headings continue with chapter 6, "Divination 'To Go' and Prognostication 'On a Shoestring'", which deals with divination by the use of flour, incense, or oil, with each method discussed in turn along with their recorded histories. In his introduction to this subject, Maul points out that an offering to the deities for the purpose of prognostication had to be the product of either labour-intense husbandry (lambs or doves), or intensive non-animal production processes involving vegetable origins (such as the manufacture of flour, incense, or oil). Wild animals or foraged fruits would be unacceptable as oracular offerings [124]. The sacrificial offerings of Cain and Abel, thus, have verifiably ancient traditions.

A single tablet written in the hand of a schoolboy in the Old Babylonian period (*ca* 2000–1500 BC) is the most detailed collection of the reading of signs from different methods of prognostication by flour, e.g., by aleuromancy ("divination with wheat") or by alphitomancy ("divination with barley") [128]. Another method ("putting grain on fresh water") is recorded more briefly in the first millennium BC and attested in a Sumerian royal inscription and other sources, including Homer [128]. Interestingly, the principles for divination by flour are the same as those for extispicy. The procedure would also take place at sunrise, and findings in the different methods followed similar readings. Markings, blemishes (on living sacrifices), or various movements (on inanimate offerings) were favorable if they were on the side of sunrise (east) or to the south (right), and unfavorable if they were on the side of sunset (west) or to the north (left). Maul takes us through an apprentice diviner's exercises inscribed on his tablet and challenges us to interpret a sign in the cuneiform text, as the boy's teacher may have tested his pupil 4,000 years ago, thereby ensuring that the reader, student, and specialist alike engage with the ancient mindset [123–129].

Textual evidence for prognostication by incense (libanomancy), divining by means of the ascending smoke and pleasant smells from a censer, is similarly scarce: it is found in but two sources from the Old Babylonian period which describe the procedure and its interpretations in depth. The practice is also mentioned in a copy of a Sumerian prayer from the seventh-century BC about another Job-like figure abandoned by the gods. Libanomancy is also referred to in a self-eulogy by King Shulgi in the 21st century BC, as well as in an Old Babylonian collection of omens in which the result has a military context [129–131].

Maul suggests that libanomancy (flour is included in the mix of aromatic woods, resins, and herbs) would have been ideal for oracular decisions during warfare, as the process was simple. The interpretations of the movement of the smoke is seemingly uncomplicated (as deduced from the texts), and the procedure could be used for urgent decisions, presumably without second opinions and controls (not mentioned by the author).

Divination by drops of oil (leconomancy) used the same sacred oil for oracular purposes as that used for offerings of food to the gods, that is, oil from pressed sesame seeds that was usually placed in a special bowl or mixed in a cup with various liquids such as beer, water, and milk. To receive an "instruction", a seer mixed oil and water and judged the result [133–143]. This procedure was accessible to common people and was used in the royal court as evidenced by several tablets that Maul adduces from the Old and Middle Babylonian periods. It is well attested from a wide range of literary texts and omen collections in the second millennium BC. There is also an allusion to it in a very old Sumerian proverb. Maul's comprehensive overview of this well-known form of divination informs the reader that the inquirer was represented by the oil, and the forces against them by the water [138].

Like all the omen texts for each medium of instruction, the structure of the interpretations was set out formulaically in the conditional (protasis-apodosis) format, or what Maul calls "compound sentences" of the sort "If *p* then *q*", where *p* is the description of the sign, that is, how the medium is acting or appearing at the moment of the question, and *q* is the meaning for the client, the economy, the country, or whatever the context is. The rules for non-animal divination were the same as for animal sacrifices, with the same exceptions: negative readings for military, political and economic outcomes turned into their opposite, and vice versa, when the question concerned sickness. Like extispicy, ornithoscopy, flour divination, and prognostication by oil also involved a double examination in which the question pertaining to the situation was asked again but rephrased from its opposite perspective in order to confirm the first result [140].

An interesting variant in Maul's absorbing and thorough survey is cited for a question about marriage that involved not the mixing oil with water, but the pouring out one drop of oil for the man and one drop of oil for the woman to see if the drops met. There were also different possible outcomes and corresponding interpretations: if either drop turns black, that person, the man or the woman, will die [141]. The technical details connected to all of these methods of reaching out to the supernatural to ask advice about the future implied a system of phenomenological hermeneutics that modern minds can relate to.

The simple, age-old Old Babylonian marriage question in an omen collection, like queries on military strategy, is interesting because there is the strong implication that if the drops of oil did not meet, or a drop of oil turned black, the diviner would have advised the couple not to marry. Indeed, the plethora of selected examples throughout the book demonstrate, in a thought-provoking way, that early Babylonian divination concerned questions on wider human actions that invited choice and what modern audiences would describe as "free will". In omen divination, a person's or a people's fate is not absolutely predetermined; clients, from kings to ordinary people, could avoid certain actions and their consequences if forewarned either by the blemishes on the liver from a pure lamb, or by drops of sesame oil. If the philosophy of irreversible and unavoidable Fate had existed in the second millennium BC, there would have been no need for the *bārû*, or, in later Greek, Roman, and Etruscan cultures, the haruspex.

A very wide chronological and sociological perspective on the development of Mesopotamian divinatory thought is taken in chapter 7, "From Meat Inspection to 'Science'", a 42-page historical study. Some of the earliest evidence for the practice of extispicy survives in a stone tablet from the 26th century BC concerning the appointment of a high priest. Similar evidence for the appointment of priests and the commencement of building projects with divine approval are found in inscriptions from the third millennium BC.

Maul suggests that in its early stages, the oracles were binary—the diviner could receive a yes or no answer only when, it seems likely, all the animal's organs were examined—and that the oracular system may have arisen out of the offering of sacrifices when the diviner ascertained whether a gift to the gods pleased the deity concerned (compare with Cain and Abel, again) [145–150].

A philosophy of what we might also anachronistically describe as ancient epistemology and rationalist reasoning is evidenced in the Third Dynasty of Ur (21st century BC) in the self-eulogy of King Shulgi, who appears to have officially institutionalized the tradition of extispicy. He used diviners before political decisions were finally approved; the interpretative process, however, was transmitted orally and not written down. Written compendia of omens existed in the 18th century BC in the form of "If *p*, then *q*", comprising detailed anatomical knowledge of the liver and the meanings of blemishes on significantly named micro-physiological regions of an organ. This same form of omen literature continued until the birth of early astronomy/astrology in Mesopotamia in the seventh century BC, and lasted to the mid-Byzantine era and beyond, even though the use of astronomical cycles (and meteorological phenomena) in the world of divination introduced a more rigid, deterministic, and fatalistic mindset, which was seemingly immune to oracles approached at sunrise [150–160].

The reader learns that the art of divination developed after the reign of King Shulgi and that extispicy appeared to take precedence over prophecy in matters of political/military decisions. This is demonstrated by a message from a prophet from Mari in the Old Babylonian period articulating in the first person the words of his god to his king [161]. Diviners apparently had their own professional associations which were independent of the royal court, thereby ensuring their neutrality. Their code of practice appeared to include offering their oracular services with flour or oil to the poor, although, as stated earlier, recorded evidence for this is scarce [162–163]. Sociological information based on tablets from which information about their relationships, familial and professional (with their masters and their colleagues), may be drawn, is in no short supply.

Divinatory knowledge was passed from father to son and kept within family groups sworn to secrecy regarding matters of state that were shared with them by the king. Loyalty and trustworthiness were imperative and were duly rewarded. A diviner co-led the army in the kingdom of Mari along with two generals and received the same salary as them—a psychological boost to soldiers thus carried the same weight as strategic direction [163–165].

The divination industry expanded during the reign of Hammurapi (first half of the 18th century BC) under whose watch compendia of omens from different regions in the Near East were collected, compiled, written down, unified, and fixed or canonized [166–167]. Maul's style becomes more like narrative in this historical chapter, as there is much to summarize. An expert on Mari, he relates the regional difference between divination practices in that kingdom and those in Babylon [166–167]. This attention to the minutiae in comparing the written records on this subject shows that until the omen traditions were unified in favor of Babylonian practices during the Old Babylonian period (2000–1500 BC), there was considerable local diversity in the seers' art across Mesopotamia and the Near East, including northern Babylonia where we primarily have texts from Sippar, and the south. Literacy increased during this time with the demise of Sumerian and the rise of Akkadian as the official written language and the reform of the cuneiform script. Maul notes that at this early stage the "If *p*, then *q*" formula was already emerging [171–172]. By the Late Babylonian period (the second half of the first millennium BC), trainee seers copied not only standardized omen series but also the by-then unified ritual prayers [173].

The author takes us on a journey of the diviner's apprentice that spans several centuries [168–175]. Prior to the compilations of written omen series during the early second millennium BC, teaching aids in the form of miniature model clay livers complete with inscriptions regarding their location, significance, and interpretation were used in the instruction of extispicy. Some 30 such exemplars have been excavated from the royal palace of Mari. The replicas were not always based on empirical observation: one is ascribed to King Gilgamesh, presumed to be a model of the application of hermeneutical principles [168–169].

In the section of chapter 7 on the circulation of divinatory knowledge from the Old Babylonian period onwards, Maul contextualizes the preservation in translated copies of the guarded secrets of extispicy in cultures far and wide by the end of the second millennium BC. He reports that excavators have unearthed texts from the residence of the King of Elam in the royal city of Susa, in Iran, that contained terminology for the gall bladder unique to Old Babylonian tablets from Mari [181]. This was not by chance, as throughout much of the second millennium teams of seers collected, collated, and redacted all available divinatory knowledge on extispicy, and in the latter third of the millennium compiled it into a series called the "art of extispicy" (*iškar bārûti*), filling almost 100 numbered tablets and abridged "pocket editions” on single tablets [181–182]. However, in the first millennium, esoteric knowledge was transmitted in a different kind of script to re-establish access to Babylonian divinatory knowledge for a select few, where necessary [183–184].

The final section in this historical chapter, “Assyria Forcibly Acquires the Inheritance of the Babylonian South”, describes the looting of Babylonian libraries in the 13th century BC. We learn that much of the foregoing information has been gained from excavations at Assyrian sites such as Assur and Nineveh: for example, the Babylonian “art of extispicy” was unearthed at the latter site and copied for the library of Ashurbanipal (*reg*. 669–631 BC). The high degree to which this skill was deemed important for political purposes is shown by the fact that Babylonian diviners found a home in the Assyrian court of the seventh-century BC but had to swear an oath of loyalty to their new rulers.

Although chapter 7 is fascinating for its details and the plethora of cases and examples, it would have benefitted from a map and a timeline. A historical overview of the political complexities would have made it easier to follow the dominant power relationships in the region at a given time. As it stands, the structure is not framed with an eye to the wider picture in the ancient Near East across 2,000 years, which would be expected from a chapter inclined to the chronology of its subject. Related to this observation, it would have been easier to read if the case studies citied had been arranged in a historical pattern. It sometimes felt like the micro-content jumped around between millennia, and halves and thirds of millennia, often between paragraphs, necessitating the re-reading of the historical contexts to be clear oneself. Furthermore, some examples of information on a few tablets raise questions about the consistency of the system presented in several texts. If there had to be two diviners involved in an extispicy so that the first “instruction” could be confirmed, one may ask why, then, did an army have two generals to lead it and only one diviner to perform the public oracular sacrifice when in a battle itself? Perhaps there was a practical matter of time and urgency [164].

The development and growth of astral divination comes in at chapter 8, “New Constellations: The Inexorable Rise of Babylonian Astral Divination”, a little more than half-way through the book. These diviners, the “scribes” (*ṭupšarru*), or scribes of the second millennium canonical omen series, *Enuma Anu Enlil* (*ṭupšar Enuma Anu Enlil*) [211], co-existed with the seers. As with the previous chapter, there are fine and valuable details—but it is a job to piece together the overall historical picture. The wider sociological view is particularly ambiguous since extispicy has, thus far, been presented as the primary method of divination. Yet, as Maul points out, Babylonian expertise in astronomy, the compilation of star lists, and the calendar are well known to date to the third and early first millennia BC. He argues that there was no competition between the seers and the scribes who knew the cycles of the planets and when eclipses, lunar and solar, would take place, and who interpreted the meanings of the activities of the heavenly bodies. But our knowledge of these scribes is based on the reports uncovered from the libraries of the seventh century BC in Nineveh in Assyria and tablets from the Babylonian king Nabu-Nasir [213] (mid-eighth century BC), not earlier.

The micro-details of Babylonian astral divination are useful: the planets are written in the tablets that Maul discusses in the order of their favorable influences, the most benefic planet taking priority: Jupiter, Venus, Saturn, Mercury, and Mars. The hermeneutics, clearly given, include the rule that if the Moon eclipses a positive planet, it is a negative sign; but if it occults a baleful planet, it is an affirmative sign—an apodosis which seems understandable and logical. In a Neo-Assyrian era tablet (*ca* 1000–609 BC) cited with several "if…then" clauses, Venus is associated with revolt and famine (as the morning star) and childbirth. Different aspects of its appearance ostensibly determined whether a woman, and perhaps also the baby, would die during labor; whether it would be a difficult birth; or whether all would go well. Maul remarks that Venus is associated with "the forces of sexuality, lust, and love" and that the birth omens fall into that category. One may argue, however, that the childbirth omens relate to women and that Venus here represents females, since women are explicitly the subject of these omens [197–198].

The minutiae of astral divination regarding the different names of the planets when they are rising or setting before or after the Sun, or culminating, are all well done. It cannot be comprehensive. The same names were used for different constellations and planets, and what they represented; and the names of constellations in Sumerian were preserved. The constellations had geographical representations, such as cities and rivers: the Crab and Pisces (north and south are The Tails) are associated with the water levels of the Tigris and Euphrates, for example.

The discussion on the 360-day calendar that emerged in the third millennium BC is concise and standard, yet accessible to the non-specialist. Maul argues that the purpose of scanning the night sky was not to gather information regarding future events but to aid agriculture and to maintain a calendar based on the lunar months that is synchronized with the Moon.

A 13th month was added approximately every three years to keep the seasons in the same lunar months. (This view is taken for granted although it may also be argued that the purpose of intercalation was to keep the festivals, which have dates in the lunar calendar, in their seasons.) Most of the material in this chapter, such as the "astronomical diaries"—continual observations of the heavens and earthly events spanning some 700 years—is here well described and its chronology clarified (from the eighth century to the first century BC; the oldest extant tablet dates to 652 BC).

The philosophical differences between the two specialist sets of diviners is of interest. While the seer could instigate intercessory rituals and actions to ensure that a bad "instruction" was avoided, different kinds of acts were instigated by the scribe. These included the substitution of the king for a lay person during the period of a lunar eclipse, not to avert fate (which was predetermined by periodic astronomical cycles) but to negotiate ways to manipulate it [217–219].

Chapter 9, "New Teachings on the Cosmos", contains a welcome in-depth sociological overview on the co-existence of different guilds of diviners. It opens with the information that Ashurbanipal had an "advisory council" in which the scribes took priority over the seers. The head of all the diviners at court was the "chief scholar" (*ummânu*), who had mastered all the disciplines. The second string comprised the "healers" (*āšipu*) who interpreted terrestrial signs in order to identify and avert disasters, followed by the physicians, priests, and augurs (who divined by the direction of birds' flight), in that order [221–222]. They had to work together to make sure that the heavenly and unsolicited natural signs and terrestrial prognostications from solicited omens were in harmony; as in heaven, so on earth [224–228]. The explanations of the bureaucratic system of divination make fascinating reading.

Problems arise in this chapter with the description of the diviners' astronomical mores and procedures without pinning the narrative and the data to a chronology. One has to locate the references in the endnotes in specialist academic books and journals to find out the dates of some of the texts. Some single examples cited in the endnotes of Maul's book that are evidence of developments in astral divination in the history of Mesopotamian astronomy are far from readily accessible, yet this topic is aimed at the educated general reader.

Writing of the interaction between the different guilds of diviners at the Assyrian court in Nineveh, Maul states:

> The "healers" adopted from the "scribes" the doctrine that the 30° sections of the ecliptic—each of which, in keeping with the course of the sun, corresponded to one month—each possessed individual values. [224]

The statement requires clarification by contextualizing the time-periods of its terminology and mathematics, since most scholars regard the division of the ecliptic into equal sections of 30° as a later, mid-fifth-century innovation [Britton and Walker 1996, 49]. (The risk of anachronism is similar to that in Maul's comparison of the 12 canonical markings on the liver to the 12 divisions of the zodiac [55].)

A similar issue occurs in the example of an interesting "miniscule clay tablet from Achaemenid period Uruk" in which the 12 regions of the liver are each associated with a deity, a [lunisolar] month of the year, and a corresponding constellation [229]. Maul states:

> Each of the twelve sections on the liver is connected to not only one of the great deities of the ancient Near East but also to a month of the year and to a star that becomes visible again upon the eastern horizon at dawn at the beginning of that month (i.e., that rises heliacally). [229]

However, the text associates Orion (a constellation, not a star) with month 3 (Simanu). Since Orion rises heliacally in September, the link with the third month is unclear. (In contrast, in the tablet, months 1 and 2 are associated with the constellations of Aries and Taurus, respectively, which rise with the Sun in those months.) Maul's definition of the heliacal rising is problematic: it need not be associated with the beginning of a month, and it occurs just before sunrise, that is, in morning twilight or the very last of nighttime.

Maul also states that the seers perceived an image of the zodiac in the liver [230]. If he is referring to the Babylonian royal courts after the late fifth century, information about his dating is required. Moreover, when he moves onto the Late Babylonian and Seleucid era texts that assigned plants, trees, cities, minerals, and herbs to the zodiacal signs [231, 235], there is an intellectual gap that is not explained between these fourth-century BC texts, when the zodiacal signs were fixed, and texts using 12 constellations (not all zodiacal) from the Persian period. There is also very little mention of the birth and growth of Babylonian horoscopes from the late fifth century [235], although Maul's observations that scribes moved from the royal palace into temples in Babylon and Uruk are important [233].

A paragraph on *melothesia* (the correspondence between parts of the body and the zodiacal signs), which Maul speculates, correctly, must be a Babylonian innovation [232], though he adds that this cannot yet be substantiated by cuneiform sources, misses a paper that actually confirms his idea. It was published after the German edition of Maul's book came out in 2013 but before the translation under review appeared in 2018 [Wee 2015: see also Geller 2010; 2014]. It is unfortunate that this additional research was not incorporated in the present volume.

Maul's final remark at the end of the chapter, that classical Greece is traditionally yet incorrectly believed to be the intellectual soil of "observational and computational astronomy" [235], is very out-of-date. This chapter contains a lot of useful information, particularly on the pre-zodiacal history of astrology, nonetheless. It is interesting that not only do the texts described previously reveal the debt that astral divination owes to extispicy and other forms of terrestrial omen divination, particularly in the form and structure of its language (the protasis and apodosis), but Maul claims that there was a mutual exchange of concepts and deductive reasoning [235]. However, the discussion of the *dodecatemoria* omits any citations of this body of knowledge and research [see, e.g., Sachs 1952, 65–75; Neugebauer and Sachs 1952–1953; Brack-Bernsen and Steele 2004].[2]

Chapter 10, "At the Center of Power: Divination and Political Counseling", sees Maul back in his comfort zone of the seventh century BC, now cooking with gas on the history of early astral divination and politics at the royal court, and offering the reader some truly remarkable and fascinating case studies, including those compiled from tablets written by different scribes and officials related to the same events. This chapter opens with a discussion of the widely used protasis-apodosis formula, employed by all "scholars", that is, by those involved in observing and reporting astral and terrestrial phenomena and devising their interpretations. The bald "If p, then q" sentences had to be assessed and discussed by a committee of officials, Maul's "commission for future policy", who met monthly, probably around the time of the new Moon [241]. The statements always lacked context, and specific explanations may have been developed in retrospect when the prediction in question appeared to have been fulfilled [239].

Maul suggests that the texts involved matters of security and that discussions with the king could often take place in the open air, to avoid spies. (He gives a delightful example of a report of the chief scholar appraising a young king, Ashurbanipal, in a summerhouse by the riverbank [237–240].) Consequently, little documentation relating to predictions concerning state secrets exist. Another example relates to a tablet from 678 BC in which a scribe ("an

[2] Sachs' work does not appear in Maul's bibliography.

astrologer") describes a lunar eclipse with apologies for having to put his commentary in writing, rather than report orally.

Maul also gives the detailed example of a tablet written by a priest in May 657 BC who also watched the skies and was clearly privy to classified information. Based on an astral portent, the nature of the heliacal rising of Mars that year, he advised the king to declare war on an invading tribe [241–244]. The most absorbing illustration of politics at the royal court concerns no fewer than nine separate reports and interpretations of this very same astronomical event. One report linked the observation to a full Moon some 12 years earlier that was worryingly late by two or so days (hence a bad portent because an early or late full Moon is abnormal) and that also appeared in the sky with the conjunction of two malign planets, Mars and Saturn, which was never a good combination. Maul entertainingly speculates on the political discussions and the likelihood that second opinions were sought from the other groups of diviners before all the intelligence was assessed centrally [244–248].

He adds the historical note that the Assyrian king Sennacherib (705–680 BC) was the victim of a conspiracy by his scribes not to tell him any bad news because he had a hot temper. Consequently, he was not forewarned when he became terminally ill. Since then, there was a policy of separating the scribes to ensure that they could not collude to give a fraudulent report, and of questioning the veracity of their astronomical observations, as well as other methods of monitoring their performance. The king himself was also often expert enough to identify any attempt to pull the wool over his eyes [248–250]. By using the politics of divination, a king could employ the apparent blessings of the gods as divine propaganda [250–251]. This chapter is well written and on firmer ground; the historical, political, and sociological illustrations are enjoyable to read.

In the final few pages of chapter 11, "On Prognostication as Sense and Nonsense", Maul intimates that asking whether divination actually works is the wrong question [255]. Its importance, in his view, is that the layers of bureaucracy surrounding the multiple processes and methods of prognostication influenced policies from building projects to warfare and created a safety valve. Its function was, in effect, to make certain that every official action was questioned and examined each step of the way. In other words, it seems, the organization of scribes, scholars, priests, and all sky and terrestrial watchers prevented the king from abusing his power, thereby securing a pre-Greek style of proto-democracy, albeit with a highly complex and different form of bureaucracy [259–260].

The later history of astral divination after the invention of the zodiac and the emergence of horoscopes is not actually examined in this overview. Nor are other kinds of ancient Near Eastern divination explored, apart from extispicy and related forms of sacrificial offerings. It would have been helpful to have dates or time-scales placed consistently within the text, instead of the basic author-date citations in the endnotes. There are times when the information seems a little vague, and I found myself flicking to the back of the book to follow up a reference in the endnotes, expecting to find fuller details.

Aside from these observations, this is a readable introduction to a fascinating subject. The book is certainly of interest to anyone curious about the early history of divination techniques, their sociological and practical contexts, and the intellectual interactions between the interpreters of terrestrial omens and astronomical phenomena. All of these techniques and philosophical ideas were concerned with protecting a country's inhabitants, or an individual's concerns, either high-born or poor. Maul not only traces the links between ancient Near Eastern diviners and their skills, but he relates the longevity of these practices and their changing face beyond cuneiform culture in the later antique world. One looks forward to learning more about these important gaps in the history of knowledge, a super-nova research area thanks to the author, as more and more cuneiform tablets are deciphered.

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Syrische Astrologie und das syrische Medizinbuch by Stefanie Rudolf

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In her book entitled *Syrische Astrologie und das syrische Medizinbuch*, Stefanie Rudolf tackles a Syriac encyclopaedia known as the *Book of Medicines*, which was edited and translated into English for the first time by William Budge in 1913. Budge's edition was based on a reading of the manuscript BL 9360, which was, in Budge's estimation, copied in 1894 in the city of Alqosh from a 12th-century manuscript.

The *Book of Medicines* is a collection of heterogeneous medico-astrological texts. Budge pointed out the fact that they are actually grouped into three sections of distinct origin. The first, which deals with human anatomy, pathology, therapeutics and provides some prescriptions, is nothing more than the translation of a medical text by Galen. The second, which is the object of Stefanie Rudolf's study, is generally described as "astrological": it comprises more than 130 chapters on various subjects relating to iatromathematics, meteorology, astronomy, divination by numbers, the calendar, and even weights and measures. The third section, which contains 400 medical prescriptions, is, according to Budge, the work of "physicians" who were both ignorant and superstitious, but who were different from the authors/ translators of the first two sections.

The description of the manuscript proposed by Rudolf [116–124] confirms Budge's proposals by showing that the three sections have not traditionally circulated together and that it is, therefore, quite justified to study them independently. The section on Galen has already been well studied by scholars such as Siam Bhayro [2013 and 2015]. In the book that concerns us now, it is to Rudolf's merit that she has isolated and brought to light the more or less coherent set of chapters that make up the second section of Budge's edition and has provided the first German translation [201–289].

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Scholars interested in the knowledge recorded in those chapters are always embarrassed when asked to date their redaction and to contextualize them geographically. Indeed, this second part is itself composed of many chapters of various origins and dates: to illustrate this, let us note, for example, that the planets are systematically designated by means of an Arabic lexicon in some chapters, while in others they always have a Greek name, and in still others a name that is neither Greek nor Arabic, but which belongs to the oldest Syriac cultural heritage. A study of the history of those texts constituting the second part of the *Book of Medicines* was thus necessary and much awaited in order to provide a solution for researchers wishing to study the history of science as indicated in this compilation.

Rudolf presents a very general introduction to the late antique and medieval Syriac cultural and literary context [1–104]. There is a part focused on the analysis of the structure of the whole *Book of Medicines* [105–199]; an annotated German translation of its second part [201–288]; an appendix in the form of tables presenting in a synthetic way the subject of the chapters, the type of science concerned, the incipit of the text, and some elements of intertextuality [297–307]; a bibliography [309–342]; and indices [343–353].

In the very first part of her introduction [1–34], we note the author's interest in the important question of Babylonian heritage. One wonders what may have happened between the first century AD, when Mesopotamian copyists stopped transcribing their astronomical and astrological knowledge into cuneiform Akkadian, and the time when the first Syriac astronomical texts appeared. What became of the Babylonian heritage in the meantime? As much as current research has succeeded in establishing contacts between Greek and Syriac astronomical and astrological texts, it remains difficult to establish direct transmissions between the Akkadian and Syriac corpora.

Stefanie Rudolf, who is trained in Assyriology and Syriac, was, from this point of view, well armed to attempt an answer to this question. However Rudolf, instead of concentrating on the astral and meteorological sciences, which form the core of the second section of the *Book of Medicines* here translated, broadens the perspective of her introduction to medicine, and presents the cultural characteristics peculiar to Babylonian culture and to late ancient culture (Arabic, Syriac, Greek). But the relationship that this has with the text studied is not clear. Furthermore, while Rudolf's interest in the transmission of Babylonian knowledge to the Syriac astrological corpus is welcome, the reader would also have appreciated learning her thoughts on other possible sources of influence coming from India or from the Zoroastrians. It would have been very useful as well to have a distinction made between texts clearly written after the Arabization of the Near and Middle East and those written before.

In short, a fundamental reflection on the dating of texts is lacking. The reference to a remark by Furlani [53], according to which all the chapters are translated from an Arabic text, needs to be reconsidered and discussed on the basis of a precise and differentiated analysis of the texts that make up this set of chapters.

Several sections in this introduction are welcome and very informative, such as the one on Harran [25–29] and the one on techniques of divination [125–152]. The latter is undoubtedly the most interesting part and informs the reader precisely about all the links to be established between these chapters and the divinatory arts.

The description of the manuscripts is incomplete, however. The ms Paris BnF syr. 425, copied from the same model used by Budge, is not taken into account. Yet, it contains the entire second section as recorded by Françoise Briquel Chatonnet in her catalog *Manuscrits syriaques* [1997]. Readers may find the description of this manuscript online on the website of the Bibliothèque nationale de France [https://archivesetmanuscrits.bnf.fr/ark:/12148/cc1012501] and on the website of the Institut de recherche et d'histoire des textes [http://www.msscatalog.org/64913]. Rudolf has plainly confused this manuscript with Paris BnF syr. 325, which she mentions, and which contains only the third section of the *Book of Medicines*.

Since many of the chapters translated by Rudolf in her book are dedicated to astrology and astronomy, it is surprising that her introduction devotes so much importance to the history of medicine and less to the history of astrology and astronomy. Concerning the subjects of meteorology, geography, and alchemy also dealt with in the text, it would have been useful to refer the reader to the work of colleagues currently active in the field, such as Hidemi Takahashi (for meteorology), Matteo Martelli (for alchemy) and Olivier Defaux (for geography), some of whose articles have been conveniently collected in *Les sciences en syriaque* published in 2014. Finally, the reader would have appreciated having Rudolf's point of view on the possible points of contact between the various Syriac encyclopedias dealing with natural sciences, astronomy, and astrology. A more in-depth comparison with Theophilus of Edessa's encyclopedia and that of the *Causa causarum* would have been profitable [99]—it is a question of similarities between the *Causa causarum* and the *Book of Medicines* but without specifying the themes concerned.

In sum, there are some good elements in this introduction which deserve to be isolated to form a more direct and effective gateway to the reading of the texts translated in Rudolf's book.

The translation of the Syriac text is generally faithful to the text. One occasionally regrets, however, the persistent influence of Budge's interpretation. Consider the passage on comets [285], for example:

ܐܝܟ ܟܝܢܐ ܕܐܐܪܣ ܡܥܒܕܢܘܬܗܘܢ܆ ܘܡܥܒܕܝܢ ܩܪ̈ܒܐ ܘܚܣܡܐ ܠܗܠܝܢ

[Budge 1913, 1.550]

Rudolf translates this by

> Ihre Funktionsweise ist wie die Eigenschaft der Luft. Sie verursachen Kriege, Feindschaft und Ähnliches.

and Budge, by

> The operation of these is like unto the nature of the airs. And they cause wars, and bitter envy, and other such like things.

Now, given the explanation, formulated in the Syriac text, that the comet is a "cause of wars", it is obvious that the Syriac word « ܐܐܪܣ » (*''RS*) does not designate the plural of the word for "air", but rather that it is a typographical error in the copied text, which originally referred instead to the planet Mars, whose bellicose character is well known in astrology, and whose Greek name "Ares" is commonly used in Syriac in the form « ܐܪܣ » (*'RS*). In addition, the chapter on comets includes terms foreign to the Syriac language (« Buba », « Lakta »): the reader would surely appreciate learning about their origin. In the same chapter, a certain Andronicus is mentioned several times. It would have been useful for the reader to refer to the historiographical work of Muriel Debié, who devotes a section to the identification of this Andronicus [2015, 516–517], and who supposes that he came from the region of Ḥuzistan, which is mentioned several times in this chapter. In general, the annotations to the text would benefit by expansion.

Rudolf's book, which is based on her doctoral thesis, thus constitutes a praiseworthy effort towards the mastery of the corpus of astrological texts that make up the second part of the *Book of Medicines*, first published by Budge in 1913. We can only hope that Rudolf will continue her work by proposing a new critical edition of the translated texts as well as a commentary.

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World Soul – Anima Mundi: The Origins and Fortunes of a Fundamental Idea edited by Christoph Helmig

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The idea of a world soul, first meaningfully explored in Western philosophy in Plato's dialogue *Timaeus*, has been drawn on throughout its doctrinal history to explain the relationship between god and the cosmos with its ensouled life forms. It has played a fundamental role in accounts concerning the organization and nature of the physical universe and our human understanding thereof, and has thus featured in a range of cosmological, biological, and epistemological contexts. This collection of essays illustrates many such contexts, demonstrating that the world soul was a more or less continuous staple of ancient philosophical thought, at least until the time of the Neoplatonists. The volume follows its history chronologically, beginning with the world soul's early stirrings in Heraclitus' concept of universal λόγος, and ending with a glance at its *Nachleben* in Renaissance and early modern philosophy. Publishing a volume of topical discussions that illustrate this development is an unprecedented achievement in itself, and a welcome addition to the surveys already available.[1] The 14 contributions offer snapshots of the world soul's history, the overall aim being not to produce an exhaustive account but to contribute to discussions of its most pertinent aspects.

A brief yet sweeping introduction by the editor, Christoph Helmig, sets the scene by anchoring the idea of a world soul in Plato's *Timaeus* and by previewing its doctrinal path until early Christianity. Helmig flags several noteworthy stations along this path, including Aristotle's impactful criticism of the Timaean world soul, the attempts by Plutarch and Alcinous' *Didaskalikos* to align Timaean ideas with Plato's *Laws*, and Neoplatonic attempts to

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[1] E.g., Moreau 1939; Schlette 1993; Ziebritzki 1994. See also Wilberding 2021.

negotiate the relationship between the world soul, the hypostasis soul, and human soul.

The world soul's "pre-history" is illuminated by Christian Vassallo in the context of Heraclitus' λόγος. The entity that may be described as Heraclitus' "world soul" emerges as an intermediary force between the cosmos and the universal λόγος that participates in the latter's ordering function and aids in translating its meaning, thereby assuming an important epistemological role. An appendix to the chapter provides an edition with commentary and translation of Philodemus' *On Piety*, in which the author reports on a reference to the world soul by Chrysippus in the context of Heraclitean cosmology.

Vasallo stands alone in exploring the notion of a world soul before Plato. Part 2 of the volume is devoted to Plato himself and to [Aristotle]'s *De mundo*, a treatise probably dating from the turn of the first millennium. Philip Karfik returns to the much-disputed question concerning the Timaean world soul as the source of all, including disorderly, motion. Karfik argues that an additional cause of motion lies in the world soul's very own components. More specifically, its component "inequality"—which according to Karfik is a mixture of the ontologically disparate psychic components Difference and Dissimilarity (with Dissimilarity as the divisible equivalent of indivisible Difference mentioned at *Tim.* 35a)—is itself shown to be a source of motion. Against Harold Cherniss, Karfik thus identifies a source of motion in the Timaean cosmos that does not presuppose soul itself as its principle.

Franco Ferrari discusses parallels between the perfect being in Plato's *Sophist* and the perfect animal in the *Timaeus*. Ferrari suggests—controversially so, given that his argument leads him to associate intelligible being with both soul and motion—that the *Sophist's* perfect being is to be identified with the world of Forms, with soul being its essential attribute and performing its cognitive activity. Ferrari then draws a connection between this soul and the Timaean demiurge, interpreted here as "ensouling" the realm of intelligible Form in its creative and cognitive aspect. This demiurgic soul of intelligible being is, however, not to be identified with the world soul, which is a generated kind.

Federico M. Petrucci contributes a learned survey of the exegetical history of Timaeus' *divisio animae*, the division of the world soul's components that precedes its composition, described at *Tim.* 35b4–36b5. Petrucci identifies a number of programmatic points of exegesis concerning this passage that feature in Middle and Neoplatonic authors. Petrucci shows how these exegetes drew on select material, technical *nuclei* from manuals of musical theory, and repurposed it for their own discussions at various lengths, with differing pitch, emphasis, and levels of detail. Such technical nuclei might include the geometrical, harmonic, and arithmetical means, the distinction between musical intervals and ratios, and the quantification of the Platonic series of numbers featured in this passage into a musical system. Petrucci observes that exegetes would at times find themselves pressed to reconcile, or bolster, Plato's approach and terminology with recourse to musical theory in order to safeguard and reaffirm his authority in this discipline.

Johan C. Thom's study of the pseudo-Aristotelian *De mundo* and its focus on the relationship between god and the sensible cosmos rather establishes the notion of a world soul that is *not* to be found in this text. Its anonymous author offers—as an alternative to a world soul responsible for structuring and organizing the universe—a system of cosmic delegates to which god's providential δύναμις (power) is transferred. This scenario is similar to the fragmenting of the Platonic demiurge into a transcendent and immanent principle seen in Platonic and Neopythagorean authors of the early centuries AD, a point that may be of interest for dating the treatise.

Part 3 of the volume turns to the Old Academy, the Stoics, and the Middle Platonists. John Dillon explores the doctrine of the world soul in the *Epinomis* and the Old Academy. He associates the doctrine exhibited in the former work with Philip of Opus' position and, more controversially, with Plato's own perspective (as described in the *Laws*) as well as that of Polemon. At *Ep.* 985, the reference to a "god" who is distinct from the various demonic agents must, according to Dillon, denote a rational world soul immanent in the universe. Dillon's association of Plato with the idea of a world soul that acts as a first principle while assuming the role of an encosmic demiurge is an unorthodox one, as is readily acknowledged. He arrives at this view by re-examining the description of soul in book 10 of Plato's *Laws*, which, he argues, is intended to resemble that of the Timaean first principle or intelligible paradigm. Revisiting Aetius' report in Stobaeus' *Anthologia* and Cicero's *Acad.* 1.24–9, Dillon further claims an active demiurgic principle that resembles a rational world soul and shapes passive material also for Polemon.

Jean-Baptiste Gourinat offers a dense analysis of the Stoic notion of ἀπόσπασμα (detachment). In the context of Stoic psychology, the term refers to an individual soul, thus characterizing it, it would appear, as an autonomous portion detached from the world soul. This interpretation, however, clashes with other Stoic descriptions of the relationship between world soul and individual soul as one between a whole and its parts. Gourinat attempts to interpret the term in a manner that reconciles both scenarios by aligning the relationship between world soul and individual soul with the Stoic model of biological reproduction. Following his analysis, individual souls may be described as ἀποσπάσματα of the semen of the universe that originally contains also the world soul prior to this soul's own development. Since the universe is a continuum, the relationship between world soul and individual souls resembles that of a whole and its parts. Nevertheless, due to their rationality individual souls may be described as possessing autonomy from the world soul in a manner similar to the autonomy possessed by children in relation to their parents.

Andrea Ulacco analyzes the imperial Pseudopythagorica with a focus on [Timaeus Locrus'] *The Nature of the World and the Soul*, one of the earliest interpretations of Plato's *Timaeus*. While setting itself apart from other texts by its format as an epitome of the *Timaeus* and by presenting itself as the source of the dialogue's cosmology, it resembles other Pseudopythagorica, such as [Archytas], *On the Principles*, in reducing the principles from which the world soul derives to form and matter. In doing so, [Timaeus Locrus] arrives at a hylomorphic conception of soul as a *compositum*. This crucial exegetical step enables soul to cognize both composition and *composita*, a strategy aimed, as Ulacco plausibly suggests, at precluding Aristotle's criticism of the Timaean world soul's cognitive powers at *De anima* 409b3–410a15. The rapprochement of soul and matter emerges as a general point of interest in the Pseudopythagorica aimed at explaining divine immanence in the cosmos.

Carl O'Brien examines the relationship between the world soul and Fate in the translation and commentary of the approximately early fifth-century author Calcidius. Calcidius' world soul is integrated into a metaphysical structure that, in relevant aspects, combines Timaean doctrine with the Numenian hierarchy. A highest god, identified as the good, is followed by a secondary hypostasis represented by the demiurge, with soul as the third hypostasis. Calcidius associates the world soul with Fate as the agent responsible for dispensing god's providential power into the sensible world. Later in the commentary, however, he describes soul as obeying Fate, an apparent inconsistency that, O'Brien suggests, may be due to Calcidius' failure to distinguish between Fate as activity and Fate as essence. Discussing the well-known parallels between Calcidius, [Plutarch's] *On Fate*, and Nemesius' *On the Nature of Man*, O'Brien observes that the author's overall perspective aligns with a Middle Platonic rather than a Neoplatonic outlook. Calcidius is described as a "Christian" [211, 222], and although O'Brien notes in passing that this characterization may be in doubt, the extent of the controversy, while certainly not a primary focus of the contribution, is perhaps understated. The rather interesting relationship between Calcidius' translation and his commentary is addressed,[2] even if the subtle exegetical dynamic between these two components of his exegesis in the context of the world's createdness is perhaps somewhat more complex than a "standard Platonist interpretation" [217].

Opening part 4 of the volume, Damian Caluori elucidates Plotinus' cosmology by focusing on the Neoplatonist's association of the demiurge and his creative role with the world soul. While the world soul's creative agency is non-cognitive, soul does practice theoretical and practical thinking. It does *not* practice discursive thinking, which is required only for solving problems—yet no problems arise under the watch of a perfect craftsman, such as soul itself. When considering the relationship between the world soul and the hypostasis soul, Caluori argues that Plotinus conceives of the former as one among other individual souls: unlike the hypostasis soul, the world soul is individuated, like its subordinate counterparts, by focusing its practical thinking on the specific body of which it is in charge, the difference being that its thinking is taking place in the intelligible sphere. Plotinus thus removes the world soul from the physical sphere. Interestingly, Caluori notes that Plotinus' description of the world soul and its role within the physical universe is similar in many respects to the description of the cosmic impact of god's δύναμις in the pseudo-Aristotelian *On the Cosmos* (see the contribution by J. C. Thom for comparison). In the case of Plotinus' world soul, the subordinate cosmic agents that execute divine power are the rational souls.

Placing the world soul in the context of Plotinus' and Porphyry's embryological theories, James Wilberding explores its role in the creation and development of human embryos: more specifically, its relationship to the parents'

[2] Work on this topic has been done since Switalski's study from 1902, cited by O'Brien on several occasions. Calcidius has certainly taken "liberties" [215] with the translation. It may be useful, nevertheless, to provide some context for the rendering "substantia" (for the Greek «οὐσία»), which is singled out by O'Brien, who observes that the term's original connotation of "being" is lost in the Latin rendering. It may be of interest here that Calcidius uses the term "substantia" as denoting "the essential nature of a thing", often interchangeably with "natura", and to describe different ontological categories. Similar uses are found in Apuleius, Augustine, and Boethius. See Hoenig 2018, 171 and 171 n46.

and the embryo's soul. Plotinus' world soul, Wilberding argues, despite several passages in the *Enneads* that appear to ascribe to it a more extensive role, is responsible merely for external factors that affect the constitution of an individual soul's body, including region, climate, and the revolution of the heavenly bodies. It is a descending soul that plays an active role in the embryo's formation. Porphyry in his *Letter to Gaurus*, on the other hand, puts the mother's soul in charge of fetal development, a theory that has the additional advantage of accounting for maternal resemblance. Similar to Plotinus, he assigns a relatively limited role to the world soul, which merely ensures the descent of an individual soul into a suitable body at the moment of birth. Perhaps the most salient point of disagreement between Plotinus and Porphyry concerns the notion of a body's "suitability" as a receptacle for soul, with Porphyry emphasizing the receptacle's physiological fitness and Plotinus its ethical fitness.

Dirk Baltzly analyzes the nature and function of the world soul vis-à-vis hypercosmic souls and Nature in the Neoplatonist Proclus' commentary on Plato's *Timaeus*. For Proclus, the world soul primarily performs the role of an intermediary between Intellect and the cosmos. More specifically, Baltzly suggests that it may be placed between the ontologically prior hypercosmic souls and the posterior hypostasis Nature, itself the source of λόγοι that engender and animate physical objects. To mediate between the distinct ontological realms, the Proclean world soul consists of appropriately intermediate forms of Being, Sameness, and Difference. It is both monad and dyad, thus uniting in its own existence the opposing natures of the encosmic and the hypercosmic.

Marc-Antoine Gavray explores the mostly untrodden doctrinal path of the world soul after Proclus. Proclus remains an important point of reference for John Philoponus' *Against Proclus on the Eternity of the World* and *On the Soul*. Proclus' proofs for the world's eternal existence are grounded in the specific nature and function that he ascribes to the world soul, and it is here that Philoponus attacks. For instance, he rejects Proclus' conception of soul as the principle and cause of the world body's eternal motion, arguing that soul merely gives to it the *capacity* for movement which, however, remains to be actualized. From a methodological perspective, Gavray rejects the characterization of Philoponus as a Platonist, suggesting instead that the author's "Platonizing" vocabulary, his argumentative lines, and specific focus of his discussion arise merely in response to the Platonic material he intends to criticize. No dramatic shift occurred in Philoponus' thought that might have led him to abandon the topic of the world soul in his later treatises; discrediting Proclus simply was no longer a priority. In Philoponus' time (sixth century AD), the world soul exists on borrowed time, resurfacing only when it is doctrinally expedient, or necessary, to engage with it.

Johannes Zachhuber's contribution, which constitutes part 5 of the volume, offers an epilogue to the world soul's journey through antiquity with a snapshot of its *Nachleben* in Renaissance and early modern theology and science. The initial focus is on the 18th-century philosopher Salomon Maimon and his response to Kant's *Critique of Pure Reason*, which explores the world soul's potential as a teleological principle and agent of the laws of nature. Zachhuber attempts to re-establish the path by which soul made its way to Maimon, who associates it with the "Aristotelian School", *via* an association with Aristotle's theory of celestial heat as found in Themistius, and *via* Averroes, who defends soul's Platonic credentials against such an association. The link between the Platonic world soul and Aristotelian celestial heat acquired some significance also for Renaissance thinkers such as Girolamo Cardano and Francesco Buonamici—a possible influence on Maimon, as Zachhuber intriguingly suggests—for whom it takes on a decisive role in facilitating the generation and development of individual life.

This volume is a collection of in-depth, specialist inquiries conducted in English, Italian, and German. It does not offer, nor does it intend, a systematic approach to the doctrine of the world soul. Nevertheless, the choice and arrangement of the contributions result in an engaging narrative of the world soul's most important roles throughout the centuries—unceasingly working as a mediator between ontological realms—and of the dialogue between the various schools of thought that continuously shaped its doctrinal development.

It is advertised to historians of philosophy and specialists of ancient philosophy, as well as classicists and theologians. The last group, especially, might have enjoyed a discussion of St. Augustine's repeated (yet admittedly sporadic) engagement with the idea of a world soul until late in his career. Perhaps even a brief nod toward the doctrine's appeal to contemporary discussions of panentheism,[3] and to other more recent contexts that continue to negotiate the cosmic entanglement of the divine,[4] might engage a broader

[3] E.g., Cooper 2006. For those interested in discovering how Plato's *Timaeus* features in topical discussions, an excellent starting point is Baltzly 2010.

[4] The editor does acknowledge, albeit briefly, that the concept of a world soul is inspiring contemporary discussions, with reference to Scruton 2016 [1]. A further obvious

readership. The importance of illustrating the ongoing relevance of seemingly remote elements of ancient teaching and learning to our own human experience is eloquently reiterated by Baltzly at the close of his study on Proclus. For such a purpose, the world soul's historical narrative is a particularly useful example, given its fundamental role in defining human relationships with the cosmos.

That said, the volume's dogmatic range offers plenty of stimulating and thought-provoking material to specialist audiences across the disciplines, and successfully advertises the doctrine of the world soul as a topic of academic inquiry that deserves further attention. The volume's few and minor formal inaccuracies do not distract from its appeal.

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context that is not mentioned might be the conception of a world soul in the writings of Sergius Bulgakov, one of its most fervent modern-day defenders. See, for instance, Bulgakov 2002, 79–103.

Hellenistic Astronomy: The Science in Its Contexts edited by Alan C. Bowen and Francesca Rochberg

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One of the daunting challenges involved in reviewing a 750-page standard tome on a subject like astronomy is being able to evaluate all aspects of the volume, covering technical data as well as any possible impact of subject matter on other disciplines. The editors, mindful of their readership consisting of both "insiders" and "outsiders", have taken decisive steps towards making Hellenistic astronomy accessible and comprehensible, with an appropriate balance between complex graphs and arithmetic equations and more general topics, as well as a glossary of technical terminology. The present reviewer, an unrepentant "outsider", will attempt to focus on some key issues involving the connections between Babylonian and Greek astronomy in the period in question, as well as the impact of astronomy as a whole.

Without necessarily intending to do so, this volume highlights a basic difference between Greek and Babylonian approaches to astronomy but goes beyond the common view that Babylonians excelled in observation while Greeks excelled in theory. What becomes clear from several chapters is that Babylonians did not engage in an inner-Greek debate regarding the relationships between natural science (φυσική) and astronomy (ἀστρολογία), which persisted from Aristotle to Plotinus [chapters 4.2 and 14.2], involving arguments regarding the differences and relative importance of these disciplines. The lack of any Babylonian perspective on this issue reflects Francesca Rochberg's novel and provocative hypothesis that no one before

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the Greeks (including Babylonians) held an abstract notion of "nature" (φύσις), which was a uniquely Greek concept.[1] Whether one accepts Rochberg's viewpoint, it seems abundantly clear from the evidence presented in this volume that Babylonians did not have a corresponding notion of "natural science". Babylonians noted the movements of celestial bodies and interpreted the data for predictions (including astrology), but they did not engage with Greek questions of causation or why celestial bodies moved in a certain way, which were designed as explanations of nature.

The fact that Babylonian celestial observations were mostly adopted but not reproduced by Greek astronomy has an analogous parallel in the field of medicine. The Babylonian *Diagnostic Handbook* consists of a collection of roughly 15,000 anatomical symptoms organized from head to foot.[2] But as in astronomy, these observations were never reproduced by Greek medicine; however, enough similarities with prognostics in the Hippocratic corpus suggest that this work was known to Greek physicians [Labat 1951, xxxvii]. Instead, as Greek medicine developed, a theory of humors slowly replaced the importance of observing a myriad of external anatomical symptoms, which provided a relatively unified system of causation for disease based upon imbalances of bodily humors, which could also be conveniently related to primordial elements in natural science and zodiacal *melothesia* [357]. In effect, the tendency towards Greek medical theory reduced the dependence upon empirical data derived from extensive observation of symptoms.[3]

The impact of astronomy on the Hellenistic world should not be underestimated, despite the technical nature of the data and its intrinsic difficulty, which makes mathematical astronomy a topic unlikely to be widely understood by the general public. Nevertheless, the ancients relied upon combinations of celestial observation and mythology to sell the importance of astronomy to a wider audience, with constellations being described as graphic illustrations of characters well-known to the popular imagination. Beyond

[1] Francesca Rochberg points out that while Babylonians constructed a rigorous mathematical system for prediction, they were not interested in conceptual developments which depended upon a concept of "nature" [Rochberg 2016].

[2] For a convenient English translation, see Scurlock 2014, 13–272. A new edition and German translation by E. Schmidtchen will appear shortly (de Gruyter, Berlin).

[3] One of the volume's contributors, C. Montelle, remarks that mathematical astronomy relied on "mathematics to advance astronomical speculation so that the amount of empirical data...required for theorizing was reduced" [127]. This closely approximates the different approaches taken by Greek and Babylonian medicine.

this, however, the public did not need to follow abstruse astronomical calculations in order to appreciate the effects of astronomy on everyday life.

Two aspects of the popularity of astronomy come immediately to mind. First, there was the creation of more precise lunisolar calendar which was mathematically worked out rather than dependent upon the arbitrary decisions to intercalate months. Second, there was the rising use of astronomy for predictions, virtually replacing other, less accurate forms of divination such as oracles and the use of entrails, augury, and other subjective means. Moreover, astronomy influenced the healing disciplines in the form of astral medicine and astral magic [chapter 9.3], associating therapy and magical rituals with optimal times for effective applications. Perhaps most importantly, advances in astronomy changed perceptions of the cosmos, even in Mesopotamian and similar societies in which religion and theology dominated virtually every aspect of daily life, since the cosmos could no longer be seen to be guided by gods but by mathematically determined motion. The divine plan for the heavens could then be abandoned as a cosmology, and this realization may well have paved the way for Presocratic philosophy among Greek intellectuals.

One of the topics raised by many contributors in the volume under review concerns the increased interest in accurate time reckoning as a result of developments in mathematical astronomy. The ramifications of this widespread interest, from the second half of the first millennium BC onwards, involved the use of water clocks, sundials, and mathematical schemes for dividing daylight and nighttime hours into more precise divisions (usually of 12 hours), based upon mathematical schemes. Whichever system was invented or employed, the overall result was noticeable: more attention was being paid to time reckoning. One indication of this is that, at some point during this period, the idea of a seven-day week developed, although no one has as yet been able to explain how this came about. A chapter devoted to the Book of Jubilees (in which the week is the crucial structural motif) only refers to a 364-day year that is divisible by 52 weeks [534]; the astronomical context is not considered.

Another result of advanced astronomy is how the increased interest in time reckoning may have influenced vernacular language. The present reviewer once suggested that an important syntactical phenomenon within Aramaic had been largely overlooked: while pre-Achaemenid Aramaic from Mesopotamia generally followed Akkadian sentence structure, *Reichsaramäisch* showed a marked syntactical change, from aspect to tempus in verbal forms [Geller 2005]. The shift towards more time-associated action (tempus) rather than completed *vs* incomplete action (aspect) became standard in post-Persian period Aramaic, even within Eastern Aramaic of Mesopotamia, as well as influencing post-biblical Hebrew.[4] While previously attributing this change to the Indo-European influence of an Iranian/Aramaic *Sprachbund*, later reinforced by the use of Greek in the Levant, a new, unforeseen possibility may possibly be inferred from Hellenistic astronomy. Instead of being an entirely linguistic affair, the widespread shift to a tense system (past-present-future) may have been influenced by an increased interest in time reckoning in the Persian period, as a result of advances in astronomy.

Another issue arising from these studies is the general picture of astronomy in Egypt compared to Mesopotamia, in terms of the level of competence and advancement of the science, particularly during the Hellenistic period. With the rise of Alexandria's scholastic prominence, the center of gravity appears to shift towards its institutions, culminating in Ptolemy's *Almagest* and other works. At the same time, astronomy in pre-Ptolemaic Egypt was based on a very different cosmology and mythology which had little in common with its neighbors, nor is there evidence of observation or mapping the heavens [chapter 4.8]. While taking into account the spirited defense of Egyptian astral sciences as descending from Middle Egyptian origins [chapter 11.1], the lack of any solid evidence for a continuous Egyptian school curriculum, comparable with Mesopotamia's "stream of tradition", may partly explain the slower advances in Egyptian astronomy before the founding of Alexandria. The picture is further clouded by the penetration of Babylonian astronomy into Egyptian records [164], which raises interesting questions regarding *Wissenstransfer*.

In order to understand this, there are several relevant factors to consider. There is the crucial question regarding the "survival" of cuneiform writing and how long the script remained legible and understandable. There is a good deal of misunderstanding about this. First, the latest datable cuneiform tablet, from 75 AD, was an almanac [277], which means that the text was composed and not simply copied [Hunger and de Jong 2014, 182], hardly indicating the end of cuneiform writing. Second, there is abundant evidence of Akkadian genres and terminology appearing in later Aramaic texts, e.g.,

[4] The change from aspect to tempus did not affect Akkadian, which by the Achaemenid period had become a language of scholarship and literature, with Aramaic becoming colloquial.

in Mandaic astrology [489, chapter 13.4], as well as Mandaic magic [Drower 1946], and in medical passages in the Babylonian Talmud. The importance of this data is that Babylonian astronomical expertise may have been available for much longer than has presently been surmised.[5] Nevertheless, what is lacking is any anecdotal evidence for *Wissenstransfer*, describing some kind of putative forum or arena for the exchange of data and ideas between Babylonian, Greek, and Egyptian scholars. No account has come down to us of any face-to-face symposium or written correspondence or bilingual translations of astronomical literature which would explain how data crossed linguistic and geographical boundaries. Even the famous case of Berossus' writings in Greek on Babylonian astronomy turns out to be bogus [439], since it is highly unlikely that the high priest of the Marduk temple in Babylon would seek or find a Greek readership. It is much more likely that Berossus wrote in Aramaic or Akkadian and that his *oeuvres* were later translated into Greek, as happened with many Aramaic and Hebrew apocrypha and pseudepigrapha, their originals having been completely lost. On the other hand, the idea suggests that Aramaic could have served as an intermediary between Akkadian and Greek, considering that the alphabetic script of Aramaic may have been easier for Greeks and others to cope with, rather than the complexities of cuneiform script. With this in mind, Aramaic texts based upon Akkadian astronomy, e.g., those found in Qumran or in the Astronomical Book of 1 Enoch or the Mandaic *Asfar Malwasha* (*Book of the Zodiac*) [see chapter 13.4], render disappointing results. Aramaic astronomy references classical texts such as MUL.APIN or *Enūma Anu Enlil*, but not Babylonian mathematical astronomy.

This volume explains with admirable clarity that much of Ptolemy's work shows considerable awareness of all aspects of Babylonian astronomy [chapter 4.7], but it is also important to bear in mind that Ptolemy was born only 25 years after the last dated Babylonian astronomical almanac, mentioned above. In the absence of any narratives, we need to look for some kind of mechanism to explain *how* the complexities of Babylonian mathematical astronomy would have been known to Ptolemy, especially since cuneiform script and its sexagesimal numbers were integral to Babylonian astronomy [431], which made it inherently difficult to translate. One possible solution

[5] It is challenging to explain how a late author, Hephaestio of Thebes (*flor*. AD 415), included omens in his work which resemble celestial omens in *Enūma Anu Enlil*. See also Misiewicz 2016, 393.

presents itself. A group of some 20 tablets from Babylon comprise exemplars of Graeco-Babyloniaca, having cuneiform on the obverse and a Greek transliteration on the reverse. Since these can best be dated *via* Greek paleography, papyrologists have assigned these tablets to the first century BC, extending to 2nd century AD and perhaps even later.[6] Although usually assumed to be script-learning exercises, no convincing specific usage for the Graeco-Babyloniaca has as yet been proposed.

The intriguing feature of the Graeco-Babyloniaca tablets is that neither script is rudimentary, since both cuneiform and Greek scripts appear to be written by a scribe or scribes who were proficient and professional. One possible context for these exercises can be found in Babylonian astronomical diaries, which refer to royal decrees being written on leather, to be read out in public. Since leather was an unlikely medium for writing cuneiform, and since the diaries do not refer to translations, the most reasonable inference is that Akkadian was being phonetically transliterated on leather in Greek script, which had the advantage (over Aramaic) of preserving the vocalization of Akkadian. This, in fact, may well be the precise mechanism for *Wissenstransfer* which we are seeking, since a transliteration of technical Akkadian astronomy on leather might have made the texts accessible to Greek speakers. Astronomical and even astrological texts are not the Epic of Gilgamesh but employ a limited technical vocabulary, and it would thus be possible for a learned Chaldaean[7] within the Roman *oikoumene* to offer basic instructions on Babylonian astronomy, without having his colleagues grapple with the burdensome complexities of cuneiform script.

The present review has hardly expounded all of the considerable merits of this impressive tome, but some small quibbles could be mentioned in passing. The historical glossary provided by the editors is both useful and informative; but some important items are missing, such as the term "syzygy" (conjunction of the Sun and Moon [130]). The present reviewer was also puzzled by a repeatedly used expression, "save the phenomena" (e.g., page 92, but not found in the glossary), but fortunately one of the editors in private

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[6] This information was provided to the present writer by colleagues Herwig Maehler and Walter Cockle. The essential information for the Graeco-Babyloniaca can be found in Geller 1997.

[7] It would not be impossible to imagine that a Stoic philosopher like Diogenes of Babylon might have been partly responsible for bridging the gap between Greek and Babylonian science [615]. Other candidates have been suggested by Z. Misiewicz [2016, 351].

correspondence explained that this idiom "explains away the phenomena of planetary station and retrogradation". Finally, while attempts were made to cover all major sources of Hellenistic astronomy and astrology, one lapse is the absence of a chapter on astrology in the Syriac *Book of Medicine*, which contains a mixture of Greek and Indigenous late Babylonian astronomy [Rudolf 2018]. Despite these minor flaws, this volume has secured its place as a standard reference work on astronomy and astrology in a crucial period for knowledge transfer.

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Michel Scot: Liber particularis, Liber physonomie. Édition critique, introduction et notes by Oleg Voskoboynikov

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Michael Scot (d. *ca* 1235) has long been known as an important figure in medieval intellectual history. Translator (from Arabic) of scientific and philosophical texts, notably of al-Bitrūjī, Aristotle, and Averroes, he spent the last years of his life as an astrologer at the court of the Holy Roman emperor Frederick II (1220–1250) in Palermo. It is at the request of the emperor that Scot composed his major work, the *Liber introductorius*, a massive encyclopaedia in three parts dealing respectively with astrology and astronomy (the *Liber quatuor distinctionum*), cosmology (the *Liber particularis*), and physiognomy (the *Liber physonomie*). Totaling over 550,000 words—that is, by way of comparison, more than three times Ptolemy's *Almagest*—the *Liber introductorius* is one of the lengthiest scientific works produced in the Middle Ages. Another particular feature of the *Liber introductorius* is that it draws on a large number of sources, a good many of which are very rare, lost, or otherwise unidentified, thus making this trilogy markedly different from standard 12th- and 13th-century works dealing with the same subjects. The *Liber introductorius* thus appears as an important text in the history of medieval science, one whose critical edition has been called for by historians ever since the pioneering studies by Lynn Thorndike and Charles H. Haskins in the 1920s.

Oleg Voskoboynikov partly fulfills this desideratum by offering for the first time a critical edition of the second and third parts (the *Liber particularis* and *Liber physonomie*), which altogether represent about a quarter of the whole work. Besides the edition [63–385], the volume includes a bibliography [387–398], two indexes (names, places, and sources [401–405]; subjects

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[407–415]), and an engaging introduction [3–61], in which the author surveys the life and works of Scot, showing full mastery of the relevant primary and secondary literature and its wider historical and intellectual context.

There are good reasons for editing the *Liber particularis* and the *Liber physonomie* together insofar as both texts are found one after the other—and without the *Liber quatuor distinctionum*—in seven of the nine manuscripts that Voskoboynikov considers, all of which date from the 14th and 15th centuries [53–61]:

- Berlin, Staatsbibliothek Preussischer Kulturbesitz, lat. fol. 550;
- Budapest, Országos Széchényi Könyvtár, lat. 157;
- *London, Wellcome Institute, 507 (L);
- *Milan, Biblioteca Ambrosiana, L. 92 sup. (A);
- *Oxford, Bodleian Library, Canon. Misc. 555 (O);
- *Vatican, Biblioteca Apostolica Vaticana, Rossi 421 (R);
- Wrocław, Biblioteka Uniwersytecka, IV.F.21.

In the other two manuscripts,

- Paris, Bibliothèque nationale de France, n.a.l. 1401 (the earliest manuscript of any part of the *Liber introductorius*, copied *ca* 1279) and
- Escorial, Real Biblioteca del Monestario de San Lorenzo, f.III.8 (14th century),

the *Liber physonomie* is missing and the *Liber particularis* follows the *Liber quatuor distinctionum*. Another characteristic of these two manuscripts is that they preserve a shorter version of the *Liber particularis* (and of the *Liber quatuor distinctionum* for that matter), and a shorter version which differs considerably between the two manuscripts. Thus, we actually have three versions of the *Liber particularis*: two short versions represented by these two manuscripts of Paris and Escorial and the longer version contained in the seven manuscripts listed above.

To be complete, I take this opportunity to draw attention to two manuscripts unknown to the author:

- Escorial, Real Biblioteca del Monestario de San Lorenzo, e.III.15, a 14th-century manuscript containing the *Liber particularis* on f. 41ra–51va; and
- Bologna, Biblioteca Universitaria, 1598 (824), a 15th-century manuscript containing the *Liber physonomie* on f. 89r–114r.

Voskoboynikov edited *the Liber particularis* and the *Liber physonomie* on the basis of the four manuscripts marked with an asterisk above, all of which date from the 14th century. For the *Liber physonomie*, he also collated the version printed in Venice in 1477 by Jacopo da Fivizzano. The edition is clearly presented and easy to use, with chapter numbers added for convenience. The text is accompanied by two apparatuses, one reporting the variant readings and the other providing identification (when possible) of the citations found in the text, as well as, occasionally, other remarks by the editor. Since this volume essentially consists of an edition (without translation, commentary, and analysis of content and sources), there is little that can be discussed in a review, but I should like to draw attention to two points.

First, as fundamental as it is to evaluating Scot's contribution, the question of the relationships between the three versions of the *Liber particularis* is left unaddressed. Voskoboynikov is satisfied with briefly reporting the hypothesis of Gundula Grebner [2008], according to which the earliest version was the short version of the Paris MS, a version which was expanded into the long version, which in turn was abridged in the short version of the Escorial (f.III.8) MS. To this Voskoboynikov responds: "Mais un processus inverse reste aussi plausible" [55],[1] without further explanation. This would have called for more. If Grebner's hypothesis is correct, then the short version of the Paris MS gains special importance and the attribution of the long version to Scot becomes problematic, if not questionable. At the very least, the reader would have expected the author to engage with Grebner's hypothesis, to examine and compare the three versions, and to justify his choice of editing the long version.

Second, Voskoboynikov does not say how he edited the texts. MS O was chosen as the base manuscript [56]; but, for the rest, the reader is left to guess how the editor proceeded. For example, we do not know to what extent the base manuscript was trusted and what happened when it was not. The editor writes:

> Il n'y a que quelques cas où la lecture de R ou L m'a paru plus convaincante pour la reconstitution du sens.[2] [59]

but the cases in question are not detailed or referenced. We are not informed either about which variants were reported in the apparatus and which were ignored. Judging from the very small number of variants noted throughout

[1] "But a reverse process remains also plausible".

[2] "There are only a few cases where the reading of R or L seemed to me more convincing <than O> for reconstructing the meaning".

(an average of about seven variants per page for four to five witnesses collated!), it is clear that a selection was made. Closer inspection shows that the spelling variants were systematically ignored. This is not explained in the introduction and the reader has no way of knowing what other kinds of variants were silenced in the apparatus.

As problematic as these shortcomings might be in the context of an *édition critique*, this book nevertheless represents a considerable scholarly achievement and Oleg Voskoboynikov is to be congratulated for making these two long-awaited texts fully available.

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Mosaics of Knowledge: Representing Information in the Roman World by Andrew M. Riggsby

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With *Mosaics of Knowledge*, Andrew Riggsby has produced a very ambitious and thought-provoking book. Like Daryn Lehoux's *What Did the Romans Know?* [2012], Riggsby's new book reminds us that the Romans did not see science or technology as we do. However, where Lehoux focuses on a philosophical exploration of how the Romans made sense of the natural world, and why they saw such a different world from the one that we do, Riggsby explores how the Romans understood and used several types of information technology. Here I summarize and comment on what I consider to be the key contributions of each chapter. At the end of the review, I will give some general comments on the book as a whole.

In the introduction, Riggsby explains that he has set out to investigate conceptual developments in Roman information technologies. More specifically, he focuses on Latin and visual forms of information technology used in the period before AD 300. Though some may question Riggsby's choice to focus primarily on Latin documents—since Antonia Sarri and others have demonstrated that Greek documentary practices had a profound impact on the ways in which the Romans used written documents—his choice is a sound method of restricting the scope of his data and structuring his study. As Riggsby points out, many forms of information technology are specialized uses of writing, and therefore linguistically specific. With the possible exception of Roman wall-paintings, every form of technology that Riggsby

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considers is embedded in the Latin alphabet, the Latin language, and the ways in which the Romans used writing.

Riggsby is primarily interested in ordered and nested lists, tables, measurements, and maps. He also devotes attention to how Roman painters communicated a sense of perspective in landscape paintings. To explore these forms of technology, Riggsby spends a great deal of time working out definitions for terms like "list", "table", and "map". This devotion to definition is because Riggsby is trying to capture features of Roman practice that line up only approximately with any particular language's lexicon, and which were generally not theorized in antiquity. Riggsby's method of establishing his definitions and conducting his analysis of each type of technology involves evaluating its form and function along with the relationship between its function and form within Roman society. This is to say, he asks what functional features form a particular technology's identity and, based on that information, how and why the Romans made use of it. Riggsby augments his methodology by drawing on concepts from information and library science, cognitive psychology, and art theory. His use of these modern, scientific tools means that Riggsby does not directly engage with the more philosophical bent of Lehoux's scholarship; however, he does ask some of the same questions about how the Romans knew what they knew. This is particularly true in chapters 3 through 5.

In the first chapter, Riggsby explores the nature of ordered lists, indexed lists, tables of contents, and nested lists. Following Jack Goody's research [1977], Riggsby argues that lists are specialized technologies of writing, which depend on both discontinuity and physical placement within a document to establish a precise beginning and ending so that a person can read them in various ways.

An important type of list that the modern world takes for granted is the table of contents. Riggsby, by looking at five surviving examples of Roman tables of contents, shows that the Romans only generated tables of contents for multi-book works that did not have a particular internal structure of their own. As Riggsby points out, these works tended to be confined to technical and encyclopedic texts such as Pliny the Elder's *Natural History*. Riggsby further argues that Romans regarded the table of contents as a form of paratext or extraneous matter attached to the main body of an author's work. According to Riggsby, the Romans were suspicious of such material and tended to avoid it. However, I suspect the Roman attitude to paratextual material was more contextual than Riggsby makes it out to be since technical authors such as Vitruvius included a considerable amount of paratextual material in their work.

Another type of list that we tend to take for granted is alphabetic. Riggsby produces documentary evidence to show that while the Romans developed complex forms of alphabetization, they preferred to organize information in a list using topical categories such as geographic location or social order for intellectual and aesthetic appeal. They tended to reserve alphabetical order for utilitarian texts, such as educational or administrative documents, or for instances where such order allowed the author to assert himself as an intellectual authority.

The numbered list was by far the most common form of ordered list in the Roman world. However, Riggsby notes some interesting cultural restrictions on the ways in which the Romans used it. In administrative and legal documents, the numbered list was used only for the internal organization of the document itself. Nor did Romans use these numbered sections to cross reference, as modern scholars do with footnotes. Numbered sections were mentioned in a document or literary text to give authority as a technical specialist to the author. I would tend to agree with Riggsby that this cultural tendency stems from the absence of standardized texts produced by modern printing methods.

Lastly, the Romans seem to have used numbered lists to form nested lists, which is logical since nested lists are lists of lists; these were relatively common in antiquity. Riggsby focuses on five groups of lists that were three layers deep and therefore numbered for the sake of organization: military discharge certificates, Egyptian composite rolls, birth registers, Roman senatorial decrees, and the roster of Rome's grain dole. These collections of texts were almost exclusively official documents, and I think that Riggsby is correct when he argues that most were organized using the date or a sequential number assigned to the tabula or document collection, as well as numbers assigned to the individual documents included in the larger collection.

Nested lists are particularly important since they form part of the theoretical foundation for Riggsby's discussion of tables in chapter 2. This discussion builds on Riggsby's earlier article on the same subject and is one of the most structurally complex of the entire book [2018, 57–70]. This complexity is increased by the fact that some of the essential theoretical knowledge of cognitive psychology, which the reader needs to understand Riggsby's argument, comes near the end of the chapter.

For Riggsby, tables are a product of distributive cognition. Through the user's mental manipulation, tables redistribute information from lists into rows and columns that give a visible form to abstractions. By providing that visible form, they bring out structural or relational aspects of information, and allow the viewer to cut across categories of data. Though I recognize that the human brain has not changed much since Roman times, I am not sure that modern concepts such as this should be rigidly applied to ancient understandings of technology. Fortunately, Riggsby only uses his definition as a guide to look for signs of tabular thinking or structure in the form and function of ancient documents.

To demonstrate that the Romans understood the concept of tabular thinking, Riggsby quotes a passage from Varro's *On the Latin Language*, in which Varro explains to the reader how to "construct" a table that can be used to understand Latin grammatical forms. This table, as Riggsby points out, is a hypothetical construct that each reader has to build for themselves, and thus does not constitute proof that tables were common in the Roman world. Indeed, Riggsby can only point to one surviving indisputable example of a table from the Roman period: the Roman survey map called a *forma*. The *forma,* represented by a few bronze and marble fragments with numbered and lettered grid squares carved into them, were used to record the allocation of land to Roman veterans through the system known as centuriation. Through a close reading of numerous documents, Riggsby deduces that the Romans may have used tables to compile the records for the distribution of grain to veterans in the records of water distribution at Rome and in some military administrative documents. If he is correct about this, and I think that he is, then the *exempla* that he provides should be seen as widely scattered, showing neither a geographical localization nor clear evolution over time.

While I agree with Riggsby that the evidence shows that tables were not particularly prevalent in the Roman world, I find his explanation for why this was so to be less than complete. He first argues that tables are a specialized type of written document that require a cognitively complex understanding of representational conventions that only a few could appreciate. Therefore, only isolated individuals developed tabular thinking to solve particular localized problems at a particular time. Moreover, those individuals developed tables from what Riggsby calls living documents; texts that multiple users continuously augmented and rewrote. He further argues that this development was retarded in the Roman world because tables were more paratextual than lists, a contention that assumes that the Romans felt the need to embed all their written communicative practices in linear texts. Finally, he contends that the Romans had a *horror vacui* or the conscious avoidance of blank space in the structure of a written document.

Because of recent scholarship, I am not fully convinced by Riggsby's last two points. First, Antonia Sarri has cogently argued that the Romans made use of blank space to structure and annotate documents [2018, 111–112]. Her observations suggest to me that the problems with blank space that Riggsby has identified are more complex than he allows them to be. For example, some of the problems that he identifies may stem from the process of transcribing a text from a written document to an inscribed stone. Some of the problems may also stem from more than one person's working on a single "living" document over an extended period.

Second, as I indicated above, I think that the issue of paratextual texts needs more consideration. Looking at the types of tables that he has identified as having a tabular structure shows that they were all produced either by scribes, soldiers trained as scribes, or land surveyors. All three form a restrictive group of technical professionals who were given specialized training through a system of apprenticeship that was quite different from schooling in either the ancient or modern sense. While little research has been done on the apprenticeships used to train literate craftspeople such as doctors, architects, or surveyors, my work on the Roman *agrimensores* leads me to suspect that tables and tabular thinking were primarily developed and used by technical specialists through their systems of apprenticeship [Mattern 2013, 38–45; Haris-Mccoy 2017, 115–120; Morris 2019, 122].

While Riggsby does not state it in so many words, technical training and the ways in which it differed from general education in the Roman world plays an important part in his discussion of measurements in chapter 3. As he remarks at the start of this ground-breaking chapter, Roman technical writers imagined a world that perhaps lacked universal standards, but in which all measurement could nonetheless be brought under control by a massive system of conversion formulae. Riggsby further contends that this ambition to control things through quantification failed because what truly mattered was where, what, why, and how things were measured in the Roman world. In other words, measurement was a matter of the particular context in which it was carried out.

To demonstrate this point, Riggsby looks at several "dimensions" of measurement that include volume, weight, length or distance, the passage of time, and price. It is here that Riggsby, like Lehoux, is interested in Roman systems of knowing and the ways in which people in the Roman world established the "truth" of measurement.

To begin with, Riggsby argues that the Romans, rather than using metonymic units of measurement, frequently had recourse to proportional measurement. This meant that one person's unit of measurement did not need to be the same as anyone else's for a given procedure of measurement to work. This was important because people in the Roman world resisted the metonymic abstraction of units of measure. Such resistance was in part due to the fact that all units of measurement were derived from real things such as the human body. These units vary greatly from place to place, and the concrete model used to establish them often seems to have remained fixed in the minds of Roman measurers, in part perhaps because no particular standard foot was more authentically a foot than any other.

Furthermore, as Riggsby shows, the resistance to metonymic abstraction was also due to the absence of standardized units of measurement issued by the Roman administration. Riggsby does not provide a single concrete reason as to why Rome never regulated weights and measures across the empire. But one reason may have been the difficulty of establishing and enforcing a fixed, reproducible unit for each "dimension" of measurement that everyone in the empire would accept. The Roman authorities also liked to leave as much of the day-to-day work of administration to local civic governments as possible. However, while cities throughout the Roman world passed regulations to prevent people from tampering with their established systems of measurement, they also often let powerful private citizens either set the standards or provide the publicly available equipment used for weighing and measuring.

This tendency to localize and privatize metrology in antiquity meant that market forces had far less opportunity to regulate measurement than they do in the modern world. Instead of relying on a common set of conventions, mercantile agents negotiating in the marketplace would simply not assume that their units were the same as another person's. Nor did they presume that two measures which looked similar were necessarily equal in practice. As a consequence, people tended to negotiate the system of weights and measures used as part of a transaction. In essence, a large part of buying and selling came down to a question of "my scale and weights or yours?"

All of this meant that there was a preference for simplification in the units of measurement used, and a frequent though often covert recourse to rough approximations in the measurements made. According to Riggsby, Romans preferred to simplify calculations by using just a few common units such as the foot and mile, even when highly exacting theoretical systems of measurement existed. The one exception to this tendency was among technical professionals such as surveyors and architects, who may have made use of the full range of available metrological systems. However, even technical experts often rounded figures to the nearest half or whole number when providing information to include in a report or inscribe on a public monument. Part of the reason for this was that people in antiquity, like many people today, simply were not interested in exact measurements. Moreover, even if they did care, the average person in the Roman world lacked the time, tools, and necessary skills to check measurements down to the last digit.

In light of this, it is perhaps surprising to find rather exact measurements in some contexts. For example, some people recorded the life-span of a loved one down to the exact number of days that they lived. Since time was only inexactly measured in the Roman world, it is unlikely that most people truly had access to such detailed information. Riggsby explains this tendency to detail as an appeal to the authority of precise measurement or to what Riggsby terms "precisionism".

In his fourth chapter, Riggsby steps away from the usual areas of science and technology to look at the work of one particular group of craftspeople, Roman painters. He specifically focuses on how they communicated the concept of space in landscape paintings. Such a topic might suggest that the chapter is of more interest to art historians than historians of science, but he introduces some principles of color use and orientation that are important for his discussion of maps in chapter 5.

Riggsby devotes the first third of the chapter to a discussion of how space has been understood in paintings by art historians over the last three decades. However, most of the chapter is given over to the close examination of how space is presented in three sets of paintings dating to around 20 BC: a group of paintings originally from a columbarium found on the grounds of the Villa Doria Pamphilj in Rome, another group from the walls of the suburban villa found under the Villa Farnesina, also in Rome, and some stucco ceiling reliefs again from the "villa under the Farnesina".

Using these collections, Riggsby illustrates four features used by Roman artists to convey a sense of depth or distance in their paintings, none of which seem controversial to me: superposition, "atmospheric perspective", depth of relief, and distinctive perspectives in scale. Superposition, or stacking, involves layering elements in the picture so that they overlap, making the foremost figure appear closer to the viewer than those behind it. The concept of "atmospheric perspective" involves using color effects to articulate local spatial relations. When two figures overlap or nearly so in Roman paintings, the one in "front" is typically rendered in a dark red, while the one "behind" is in a less intense and usually bluer hue. Where color is not part of a presentation, such as in the Farnesina reliefs, the height of a relief carving is used to convey the same sense of depth.

As Riggsby explains it, distinctive perspectives in scale involves two concepts. First, it requires the viewer to understand that looking up at a picture equates to looking further into the distance. Second, drawing on that first principle, it also entails painting buildings and objects further up the wall smaller than those lower down so that they seem further away. As Riggsby admits, none of these tools provides mathematical perspective, but combined they do communicate the concept of three-dimensional space in a two-dimensional medium.

In many ways the fifth chapter of the book brings together some of the elements of chapters 3 and 4. Most of the chapter is given over to an analytic discussion of Roman maps, but Riggsby also considers the Romans' use of data graphics, textual illustrations, and architectural plans to put maps into the broader context of information technology.

He begins the discussion by noting that most forms of symbolic or conventionalized data graphics, such as the scatterplot, pie chart, bar graph, timeline, and musical staff notation, all evolved in the context of printing technology. Furthermore, Riggsby argues that it is unlikely that the Romans would have developed such tools since they were generally suspicious of reducing real-world situations to disembedded numbers, something that all the data graphics mentioned here do. As Riggsby rightly notes, the only tools that the Romans used that might be said to function like a data graphic are the faces of the sundial and the wind rose [155–157].

Having disposed of data graphics, Riggsby moves on to the rare instances in which textual illustrations are found in Latin literature. This discussion is one of the few weak points in the book. He observes that books in antiquity had to be copied by hand, and citing the evidence of Pliny the Elder, he argues that illustrations were hard to reproduce since they required technical specialists. This of course does not mean that Latin texts were never illustrated, but it does restrict the contexts in which illustrations were used.

As Riggsby points out, with the exception of an illustrated edition of Varro's lost lives of great men, illustrations primarily appear in utilitarian contexts. Prominent examples include the Corpus Agrimensorum Romanorum (Writings of the Roman land surveyors), Vitruvius' work on architecture, botanical literature, and possibly a series of sex manuals.

From this range of data, Riggsby deduces that illustrations were not particularly common in Latin literary texts, and that when illustrations were included they were schematic or geometrical in nature. Drawing on Pierre Gros' work on Vitruvius, he also argues that Roman concepts of discourse among the political elite influenced where, when, and how illustrations were used in Latin literature.

Riggsby's discussion of textual illustrations and their use would have benefitted from some engagement with Courtney Roby's recent study of mechanical diagrams in Greek technical literature [2016, 152–191]. Roby shows that there was a complicated relationship between diagrams and the written texts within which they were embedded, and that this relationship allowed technical literature to transcend a particular audience. Riggsby's third point—on influence—deserves further investigation. However, his first two arguments—that illustrations were uncommon and schematic—seem to me to be inconclusive at best. The only actual examples of illustrations in a Latin text that might be taken directly from the Roman period are preserved in the sixth-century manuscript of the Corpus Agrimensorum Romanorum. We only know about illustrations in other Latin works like Vitruvius' because they are either mentioned directly by the author or because other internal clues in the text suggest that an illustration was included in antiquity. Without such clues it is impossible to state whether or not illustrations were part of a text.

Where Riggsby's study of textual illustrations may be less than convincing, his examination of architectural plans is nothing less than outstanding. To begin with, he has compiled the most comprehensive catalog of surviving Roman architectural plans known to me. Using this catalog, which is situated at the end of the chapter, Riggsby distinguishes between three different types of plan. The first type, which he calls "part-oriented", focuses attention on the subcomponents of a structure through labeling. A second type, which he calls "building-oriented", presents structures as totalities. The third type, to which he does not give a specific name, models only particular components of a building.

The first and third types of plan seem to have been used as “blueprints”. Plans of the first type, which contained exact measurements and which were at least sometimes color-coded, may have also been used to advertise a patron’s euergetism. In such cases, the exact measurements can be seen as an example of the precisionism discussed in chapter 3.

The “building-oriented” plans focus on the built environment, illustrating man-made structures in the urban environment. They are largely iconic in their mode of representation, but there are also crucial symbolic/conventional features that give them the appearance of a floor plan. An interesting feature of these plans is that they seem to be drawn to scale, but this is deceptive. A comparison between the numerical lengths given on the plans shows that they do not correspond to the length of the sections of the building displayed. This means that the figures on the plans are not generally drawn to a uniform scale, no matter how neatly executed they appear.

Plans like these are not simply reproductions of what the drafter has seen. Nor are they simplifications or even composites of the kinds of things seen. These plans, regardless of how much observation and measurement went into their preparation, are necessarily works of imagination. Riggsby deduces that they were produced to document property ownership and water rights in and around the city of Rome. However, as his discussion of the *Forma Urbis Romae* shows, they could equally have been produced for propagandistic purposes.

Riggsby begins his discussion of maps proper by observing that scholars such as Kai Brodersen have ruled out the Romans’ use of such documents on the grounds that the surviving examples are either “one-dimensional” and/or not precisely to scale. He rightly feels that such a restrictive understanding of maps does more harm than good for two reasons. First, many modern maps are not precisely to scale, and yet they are considered maps. Second, this very narrow view of what counts as a cartographic representation of space stems from an unduly narrow take on what counts as space itself. As Riggsby shows in the case of landscape paintings in chapter 4, one needs to expand the definition to take in a different cultural view of mapping. For the purposes of his study, Riggsby defines a map as describing some physical space by establishing parallels between elements of the map and of reality. In other words, a map needs to “look like” the world in some sense, but it need not establish a systematic, mathematical projection between map and reality.

As with landscape paintings, it is important to understand that Roman maps created coherence by starting at the local level and building outward. Next, as part of that process, any attempt to attach distances or sizes to objects represented was necessarily an approximation in keeping with the discussion of measurements in chapter 3. As Riggsby points out, none of our complete representations gives a standard scale to convert represented length into actual distance. For this reason, what Roman maps did best was provide the viewer with a sense of proportional relationships.

To illustrate these points, Riggsby analyzes four examples of Roman cartography: the *Forma Urbis Romae,* the surveyor's *forma* (or map) from Orange, the Map of Agrippa, and the *Tabula Peutingeriana or* Peutinger map as it is commonly known. Riggsby's discussion of the *Forma Urbis Romae (FUR)* draws on his discussion of architectural plans earlier in the chapter. He persuasively argues that the *FUR* was a marble map of Rome made with a measurable scale of between 1 to 240 and 1 to 250. The scale varied in part because the carving techniques used did not allow for exact accuracy, and in part because the map was compiled from several different survey maps that were probably made at different periods. Riggsby speculates that the individual survey maps may be reflected in some of the "building-oriented" plans discussed above. However, like most other scholars, he feels that the *FUR* was constructed for propogandist purposes rather than as a record of Rome's urban infrastructure at any particular period.

Riggsby's discussion of the *forma* from Orange is somewhat more problematic. He demonstrates a sound grasp of centuriation, and clearly explains the system of coordinates used to locate individual units within the grid of *limits* or boundary roads that form the grid in the landscape. He also correctly deduces that a tabular reading of the grid locations depends on a geographic and, therefore a cartographic, reading of the document since the layout of the grid depends on the topographic features depicted on the plan. He also contends that the map has a compressed scale with a ratio of six to seven, suggesting that the map has been compressed along the top edge. A point that he overlooks is that the grid on the map has also been rotated some eight to ten degrees so that it appears to be oriented due north when in reality the colonial field system is oriented a little west of north. This may be an example of Roman approximation, but there are reasons to think that the slight change in alignment was deliberate.

To begin with, it is important to separate centuriation and Roman surveying. As Julian Dubouloz has demonstrated in his study of the *forma* from Orange, centuriation was a system of land management that depended upon surveying, and not a system of surveying in its own right [Dubouloz 2012]. I along with others have argued that Roman surveying was in fact a dynamic system that involved connecting points in the landscape with lines of sight to enclose and map zones of habitation using Euclidian mathematics [Chouquer 2010, 89–92; Morris 2019, 123–128]. This means that Roman surveyors did not necessarily have to centuriate land in order to map it. The largest known uncenturiated civic territory that we can document as being surveyed and mapped by Roman surveyors was probably about 60 kilometers (37 miles) across, though circumstantial evidence suggests that they enclosed and mapped much larger areas [Morris 2019, 125–126, 135–139].

An important factor in considering the surveyor's *forma*, which Riggsby seems to understand without fully explaining, is that they did not strictly reproduce the landscape as people experienced it. As both Courtney Roby and I have recently argued, the surveyor's *forma* was a document that depended upon mathematics to transpose an inexact correspondence between the imperfect state of a real-world object perceived by our senses and the abstract conception of that object which exists only in the mind [Roby 2014, 24–25; Morris 2019, 130–131]. In other words, the surveyor's *forma* represented aspects of the real world, but depicted them as part of a preconceived conceptual framework. Such a framework suggests that the foreshortening of the *forma* from Orange, along with the rotation of the centuriation grid's alignment, was done deliberately both to make the map easier to read and to fit the mapped landscape into a preconceived conception of the world.

Riggsby addresses the Romans' conception of the world and their attitudes to world geography by looking at the so-called Map of Agrippa and the Peutinger map. In treating the first of these two documents, he presents some of the testimonial evidence for its existence, and reviews the state of scholarship on it. He then uses a philological approach to the textual evidence in Pliny the Elder to argue that the Map of Agrippa was indeed a graphic depiction of the world accompanied by a written commentary and not just a textual description. While I agree with Riggsby's interpretation, I am not sure that his arguments are any more or less persuasive than those of other scholars who have used a similar method to examine the evidence for this lost artifact.

To negotiate the complex issues involved in interpreting the Peutinger map and its depiction of the Roman road system, Riggsby first argues that a description or depiction of a network of roads is cognitively distinctive and is more complex than its linear components are individually. He notes that experiments on types of diagrams have shown that those with multiple pathways among pairs of points are harder to process than those with only unique paths. He further contends that sets of lines are more like full maps than they are like individual lines. On this basis, the road network is less a practical guide and more a graphic illustration of the extensive and intensive reach of Roman power. While I think Riggsby is on to something here, proving this contention beyond dispute will take further engagement with recent work done by cognitive psychologists on the ways in which the brain encodes spatial information into memory through pattern processing to generate mental models of the environment.

Stepping beyond the issue of the road network on the Peutinger map, Riggsby observes that the document's creator goes to some cartographic lengths to center Rome and Italy in both the empire and the world. He further notes that the peculiar shape of this map is possible only if we imagine a mapmaker who already had a complex preconceived geographic vision of the world. As he further observes, the mapmaker compressed and expanded the various landmasses in idiosyncratic ways, but preserved their basic topological structure—including, importantly, the ways the coastlines, rivers, and mountain ranges are arranged relative to one another. Finally, Riggsby points out that pairs of sites that are north and south of each other in reality tend to remain so on the map. This suggests that the map is surprisingly regular in representing longitude.

While scholars have long recognized that the Romans could calculate latitude, and incorporated it into their cosmological thinking, their use of longitude is a very different matter. Scholars, including the author of this review, have long held that the Romans did not have an accurate method of calculating longitude [Morris 2019, 127–129]. However, if Riggsby is correct in arguing that the Peutinger map regularly presents longitude as well as latitudinal relationships properly, we will have to rethink our understanding of the Roman geographic consciousness and their use of cartography.

In a lengthy conclusion, Riggsby ties many of the threads of the disparate chapters together, as I have done here. He also argues that scholars should take a fresh look at Roman science with a more open-minded understanding of what constitutes science in the ancient world. To round things out, Riggsby provides an informed assessment of where scholars should go in the study of Roman science and the ways in which they can use *mosaics of knowledge* to get there.

By arguing for a more open-ended understanding of not just Roman cartography but Roman science, Riggsby more than justifies the publication of

Mosaics of Knowledge. However, the book goes well beyond that limited objective. It provides the first systematic look at how Romans used metrology. It also provides one of the first examinations of how Romans used tables and other forms of information technology.

The book has been well-produced by Oxford University Press. It is lavishly illustrated with 29 black-and-white photographs and eight color plates, all of which are of a higher quality than what I have come to expect from OUP. The typeface, if small, is neatly printed and of a high quality. Riggsby can take pride in an impressive work that should stimulate scholarly conversations in the years to come.

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Le De anima *alchimique du pseudo-Avicenne* by Sébastien Moureau

Micrologus Library 76: Alchemica Latina 1. 2 vols. Florence: SISMEL – Edizioni del Galluzzo, 2016. vol. 1: *Étude*. Pp. 451. vol. 2: *Édition critique et traduction annotée*. Pp. x + 451, x + 971. ISBN 978–88–8450–716–7. Paper €145.00

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"Sciant artifices alkimie species metallorum transmutari non posse".[1] Ibn Sīnā's (Lat. Avicenna's) famous and trenchant judgment on the impossibility of alchemical transmutation was at the center of a lively debate among Latin medieval thinkers, even more so since the section of Avicenna's *Kitāb al-Shifā'* (The Book of Healing) that it originally belonged to was transmitted as the fourth book of Aristotle's *Meteorologica* in the Latin world, with all the weight of authority that this implied. Nevertheless, the relationship between Avicenna's name and alchemy is much more nuanced: authentic works by Avicenna show that his position towards alchemy was possibly less strict than the famous Latin sentence may lead us to believe, and treatises of debated authenticity—like the *Risālat al-Iksīr* (Lat. *Avicenna ad Hasen regem epistola de re tecta*)—appear to accept the possibility of metallic transmutation, which implied the elimination of the *differentia specifica* of metals. What is certain is that Avicenna was considered an authority by the alchemists of the Arabo-Islamic world and that this fame, together with the pseudepigraphic works that carried it, extended to the Latin world, where pseudo-Avicennian alchemical treatises were translated, copied, summarized, and commented upon, and new treatises were composed under his name.

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1 "Practitioners of alchemy should know that the kinds of metals cannot be changed [into one another]".

Adapted and expanded from Moureau's doctoral thesis defended in 2010 at the Université Catholique de Louvain, this monograph extends over two substantial volumes for a total of more than 1,400 pages thoroughly annotated in more than 3,500 footnotes. Numbers apart, Moureau's praiseworthy effort aims to contribute to the study of the alchemical works of pseudo-Avicenna by presenting the first critical edition of an extensive, very complex, and deeply influential treatise, the *De anima*, and its first annotated French translation. Moureau's book rigorously achieves this and offers much more. The first volume is devoted to an extensive study that, in three chapters and one annex, positions the *De anima* in the context of the alchemical treatises that circulated under Avicenna's name, and of the penetration of Arabic alchemy into medieval Andalusia. It expounds the complex details of the composition and structure of *De anima*, presents a remarkably clear (given the complexity of the text) explanation of the alchemical doctrines underlying the treatise, identifies their sources, and provides a thorough description of the manuscript witnesses of this work and the criteria used for their assessment and a critical edition. Each of these sections deserves praise, since they all contribute to a significant advancement of our knowledge of the *De anima*, and, more generally, of the modes of transmission of Arabic alchemy in the medieval Latin world.

The close reading of the text implied by its critical edition has allowed Moureau to recognize that the *De anima* was not originally a single treatise but rather a compilation of three autonomous treatises characterized by formal and theoretical differences:

(1) the *Porta elementorum*, a dialogical exposition of the physical principles that pertain to alchemy;
(2) a text spanning from the first *Dictio* to the seventh and strongly influenced by Jabirian alchemy that constitutes the main portion of the *De anima*; and
(3) a text that presents significant lexical differences with the preceding text, often with erroneous or non-existent references, and is not transmitted in the extant versions of the *De anima* that are abridged.

Moureau raises a question about the composition of the work: Is the *De anima* a translation of an Arabic alchemical compilation (i.e., were the three parts already circulating together as a single work before their Latin translation) or is it a compilation of three autonomous Latin translations? He provides evidence that could support both hypotheses but concludes that, in the absence of a stringent argument, the question must be left open: it could also be the case that the *De anima* took its current shape at the same time as its contents were translated into Latin by a single translator/compiler.

The same scrupulous analysis of the internal and external evidence supports the author's efforts at dating and situating the composition of the *De anima*. In particular, Moureau brings to the attention of the reader the existence of a manuscript colophon (Cues, Bibliothek im St. Nikolaus Hospital, 299) that provides dates of composition and translation for the *De anima*: while the first date is bound to be fictional and actually fits well with the dates of the pseudepigraphic author, the second—1226 or 1235—could well be the genuine date of the translation of the work, But, as Moureau cautions, this date should be taken *cum grano salis.*

The second chapter delves into the sources of the *De anima* and is arranged in two sections, since the sources used in the treatise and the authorities that the text mentions explicitly do not overlap in many cases. Particularly praiseworthy is the exposition of the alchemical doctrines of the second part of the *De anima*: the formation of metals from sulphur and mercury; the existence of internal and external qualities of metals; the classification of matter into bodies, spirits, salts, stones, and other materials; and the many steps that the alchemist needs to follow in order to prepare the ingredients (bodies, spirits, elixir, and *fermentum*) for their alchemical marriage leading to the production of gold or silver.

The reader here is not only guided to the systematic appreciation of doctrinal points that are scattered and often intentionally left obscure by pseudo-Avicenna, but also offered an entry into theories that are shared by a large number of Arabic and Latin medieval alchemical treatises. It should not be forgotten that the *De anima* was one of the main channels of transmission of the alchemical ideas connected to the name of Jābir ibn Ḥayyān, ideas that proved very influential also in the Latin world.

The second part of this chapter surveys all the authorities mentioned by pseudo-Avicenna. The medieval Latin rendering of Arabic names and the influences of the Andalusian context in which this translation was produced result in a great deal of confusion and obscurity. In some cases, Moureau suggests only a possible identification or none at all. While Geber Abenhaen, Maurienus, and Aramuz are clearly identifiable with Jābir, Morienus, and Hermes, who were Zubaibar, Almortid, and Haelge?

The third chapter is devoted to an analysis of the manuscript tradition of the *De anima* that includes a critical assessment of the relationships between the seven complete Latin witnesses of the work, its 16th-century *editio princeps*, and the incomplete and indirect tradition. Moureau applies a (neo-)Lachmanian approach to the tradition of the *De anima* and, through painstaking collation of all the available manuscripts and the statistical study of their variants, manages to reconstruct a reliable *stemma codicum* that identifies three main families of manuscripts and allows for a certain degree of contamination in the tradition. Moureau underlines that the text of his edition represents the reconstruction of a translation in medieval Latin of an Arabic text: the Latin translation is often obscure, sometimes incomprehensible, and surely its language is a Latin of *mauvais qualité*, strongly influenced by the lexicon and syntax of the Arabic original(s). The situation is further complicated by the fact that the Arabic original(s) of this work is/are now lost, and that Latin renditions of Arabic words and entire phrases can sometimes be decoded only as a tentative exercise in retro-translation. Even a quick glance at the *apparatus criticus* of the edition easily conveys the inherent difficulties of this kind of textual tradition and is surely telling of the editor's painstaking, meticulous, and truly impressive critical effort, an effort that reflects his mastery of medieval Latin and Arabic.

A French translation faces the pages of the critical edition: its literality and unadorned style are intentional choices by Moureau, who aims at preserving the features of the original Latin, its numerous traces of Arabic syntax, and the "word-by-word" technique typical of these early Arabic-Latin translations. Where the Latin text and the French translation may be cryptic, the extensive explanatory footnotes provide guidance to the reader and are an incredibly rich source of information on the lexical, doctrinal, and chemical problems raised by, and connected to, the text.

The monograph has a further important point of strength: almost 100 pages of the first volume are devoted to a glossary that lists and explains rare words and *hapax legomena*, as well as common words that have a particular or technical meaning in the alchemical context of the *De anima*. It is, in particular, in the explanation of alchemical terms that another aspect of Moureau's expertise comes to the surface: apparently, he has tried to replicate in the laboratory some of the procedures described in the treatise in order to understand the nature of the ingredients utilized better and to provide a more insightful interpretation of the text. This attention to the materiality of the alchemical work and the historical usefulness of replications places Moureau's historical and philological effort in line with the most recent developments in the scholarly approach to alchemy and cognate subjects. Moureau's glossary—together with the aforementioned catalog of Arabo-Latin authorities in the second section of the work—will surely be used by scholars focusing on similar traditions as a precious tool for identifying the names of materials and substances obscured intentionally by the alchemists and unintentionally by the fluctuations that characterize medieval Latin translations from the Arabic language.

As I hope these few remarks may convey, Moureau's work is excellent. In concluding, I stress that this book offers a much needed and painstakingly accurate critical edition of one of the most influential, complex, and extensive medieval Arabo-Latin alchemical works, together with its first translation into a modern language. Moreover, as such, it stands as a model of the scrupulous and effective application of a sound method of textual and historical criticism to a very complex textual and doctrinal tradition. One should hope that more monographs of this level will appear in the near future: historians of alchemy, chemistry, and science in general will finally have at their disposal the reliable *corpus* of primary sources that has repeatedly been identified as one of the main *desiderata* in the field.

Anonymus Cantabrigiensis: Commentarium in Sophisticos Elenchos Aristotelis
edited by Sten Ebbesen

Scientia Danica. Series H: Humanistica 8.19. Copenhagen: Royal Danish Academy of Sciences and Letters, 2019. Pp. 408. ISBN 978–87–7304–424–7. Paper DKK 150.00

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The publication of the critical edition of this anonymous commentary on Aristotle's *Sophistical Refutations* is something to be celebrated for numerous reasons. Needless to say, it is of great value for scholars interested in the reception of this particular item of the *corpus Aristotelicum*, especially since the editor is responsible for much of our current knowledge within the field. But as Sten Ebbesen himself points out in his introduction to this volume (as well as in other contributions [see below]), the interest of many medieval commentaries on ancient sources—and this particular commentary is a great example—lies greatly in the discernment and acumen of their authors, even if their names remain unknown. "Mr. *Anonymus*", to quote Ebbesen,[1] "is a very important medieval philosopher", indeed. But before going into any examples of the acuity of this particular unknown medieval scholar, a few general remarks about the commentary and the present edition are in order.

As the acknowledgments makes clear, an edition of this magnitude implies many years of labor and many keen eyes and brains willing to engage in what is, inevitably, a collaborative effort, even in cases where a single person takes up the task of preparing a volume such as this. Ebbesen was first acquainted with the manuscript transmitting this commentary (Cambridge, St

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[1] The quotation is taken not from the present volume but from the introduction to Sten Ebbesen's *Festschrift* [Fink and Mora Márquez 2013, 2]. Ebbesen's words do not refer exclusively to Anonymus Cantabrigensis, but, more generally, to all valuable texts with no attribution of authorship.

John's College, MS D 12) in 1973, and has often pointed out the interest of its contents [Ebbesen and Iwakuma 1983, and Ebbesen 2011, 2014, and 2017]. Other scholars who have followed Ebbesen's lead in digging deeper into the contents of Anonymus Cantabrigiensis' commentary include Christopher Martin [2013], Jakob Leth Fink [2013], and Julie Brumberg-Chaumont [2017]. All those previous contributions leave their mark, in one form or another, in the present volume.

The edition also engages with a long list of scholars who studied aspects of that fascinating period ranging from the last decades of the 12th century to the first decades of the 13th, when the slow decline of Parisian schools gave way to the new type of organization represented by the University of Paris, where the *Sophistical Refutations* soon became mandatory reading in the faculty of arts. Ebbesen's arguments for identifying Anonymus Cantabrigiensis as a scholar active in Paris at the end of the 12th century, probably belonging to the school of *nominales*, are convincing; and so is his tackling of the difficulties arising from this characterization. In all likelihood, the author was a master well-versed in Aristotle, who had been teaching the *Sophistical Refutations* for many years, probably revising his notes over time. As Ebbesen points out, this might force some adjustments in the chronology of texts from the Parisian schools, although it should also be noted that, as usual, we are dealing here with overlapping timelines: the personal *curriculum vitae* of an author, and the overarching history of the institution(s) that he belonged to. In other words, a young witness to the decline of the Parisian schools might very well grow up to be a white-haired witness to the rise of the university—this exaggerated example is not Ebbesen's but my own and is meant simply to illustrate the point that something as apparently plain and concise as a date is in fact loaded with several trajectories at different stages of development. This is sometimes overlooked, and editions like this serve the purpose of reminding us that many of the difficulties that any editor must cope with derive precisely from this dynamic character of many commentary traditions.

Moreover, and given that our current inventory of 12th-century schools is reconstructed from sources like this one, it seems only fair to expect that the availability of new material may eventually derive from the revision of previous hypotheses regarding the dating and authorship of individual items. This is well reflected in the introduction to the present volume. Here Ebbesen's thorough knowledge of these sources is deployed to both ends: he aims not only to propose a date of composition of the present commentary (sometime between 1185 and 1205, perhaps with several stages of revision), but also to suggest corrections to the dating and attribution of other sources close in content or spirit to Anonymus Cantabrigiensis' text [17–24].

As usual, Ebbesen's introductory remarks and *ratio edendi* serve as a model for scholars working on the critical edition of similar sources. A special mention must be made of Ebbesen's attention to the influence of the Greek commentary tradition, many times overshadowed by the attention given to Latin translations. Section 6 of the introduction, which is devoted to the identification of material taken from Greek sources, is, among other things, a worthy reminder of this influence, which is also evident in the *apparatus*, furbished as it is with both Latin and Greek references.

Anonymus Cantabrigiensis' commentary stops short at *Soph. elen.* 20 177a35, leading Ebbesen to estimate that two quires of the manuscript are missing, nearly one third of the total work. Missing sections notwithstanding, this is quite a long commentary, prolix in its treatment of the source material and, as pointed out above, offering much food for thought. Given its length, many of the doctrinal points of interest of the commentary are only hinted at in the introduction. Some of them are dealt with elsewhere, however, either by Ebbesen himself or by different scholars—see the Bibliography [p. 224 below]—and will most likely continue to be by future researchers, now that the text has been made available in a proper critical edition.

A growing field of research that will in all likelihood benefit from this edition is, arguably, the medieval tradition of commentaries on the *Topics*, given the proximity of the two works. Their success in the period in which Anonymus Cantabrigiensis composed his text was quite disparate[2] and, in this respect, Ebbesen's caution regarding a mention by our anonymous author of an earlier commentary on the *Topics* of his own is reasonably judicious [90]: certainly, the author could be referring either to a commentary on Aristotle's *Topics* or on Boethius' *De differentiis topicis*. However, a quick survey of references to both works yields a strong contrast: merely 8 references to Boethius' *De differentiis topicis* against 34 to Aristotle's *Topics* are to be found in Anonymus Cantabrigiensis' text. This suggests that our author's commentary was on Aristotle's work.

[2] See, for instance, Ebbesen 1997, 338:

> To all appearances what happened was this: the exegesis of the *Elenchi* was developed first; when scholars began to deal with the *Topics*, they concentrated on the parts that resembled the *Elenchi*, and were especially alert to possible discrepancies between the *Topics* and the well-known *Elenchi*.

Not surprisingly, book 8 is more referenced in the text than the other seven books of Aristotle's *Topics*, which receive, however, their fair share of attention. One such instance can be found in the passage on *Soph. elen.* 5 167b31, which includes the following reference to Aristotle's *Topics*.

> …secundum methodos quas in Topicis ponit Aristoteles: si enim aliqua duo contraria sunt, et alia duo sunt contraria, si[ve] unum sub uno, reliquum oppositum sub reliquo opposito continebitur, cum neutrum secundum superabundantiam dicatur.[3] [94]

> …according to the methods which Aristotle presents in the *Topics*, namely: if there are two contrary [terms] and two other contrary [terms], if one [of the first] is contained under one [of the others], the remaining opposite [term] will be contained under the remaining opposite, when neither is predicated with respect to overabundance.

In the *apparatus*, Ebbesen identifies the reference as *Top.* 4.6 127b8–11. But other candidates could be mentioned as well, since the parallel attribution of contraries is found in several passages of book 4, as well as in books 1, 2, and 6, and in similar terms to the ones mentioned by Anonymus Cantabrigiensis. The choice of *Top.* 4.6 127b8–11 as a more likely reference than the others is certainly supported by the formula "unum sub uno, reliquum…sub reliquo", found in both cases. But the main purpose of the passage in *Top.* 4.6 127b8–11 is not to introduce that relation but rather to refer to it as a reason, or even as a τόπος itself (*eo quod contraria in contrariis generibus*), to support the claim that the attribution of the lower species to the higher genus, and *vice versa*, will render an inadequate argument. Such seems to be the general μέθοδος proposed by Aristotle in the *Topics*, to which the passage brought forward in the *apparatus* presents an example among many.

A more likely reference, then, could be *Top.* 4.4 124b4–5:

> nam si oppositum in opposito, et propositum in proposito erit.

> if the opposite is included in an opposite, the proposed [term] will also be included in the proposed [genus].

[3] The notion of *super<h>abundantia* was treated by Aristotle in an earlier passage [*Top.* 4.3 123b20–30]. The notion refers to opposites considered with respect to a middle term and not with respect to each other. The clause in the previous rule (or μέθοδος) indicates that it cannot be applied when the case involves this type of "overabundant" opposites.

Certainly, the turn of phrase is not the same, but it has the advantage of presenting four terms forming two pairs of opposites, as Anonymus Cantabrigiensis does. Moreover, the commentary on the *Topics* attributed to Robert Kilwardby explains this passage in this way:

> quattuor sint quorum primum similiter se habet ad secundum sicut se habet tertium ad quartum. Si primo dicitur de secundo sicut genus, et tertium dicitur de quarto sicut genus. [Ms. Firenze, Conv. Soppr. B.IV.1618, p. 120a]
>
> Let there be four terms of which the first is related to the second as the third is related to the fourth. If the first is predicated of the second as its genus, so the third is predicated of the fourth as its genus.

Notably, there are no references to opposition in this passage, but a few lines later Aristotle does in fact present τόποι that deal with opposites, stating that "if the pleasant is essentially good, the non-good will be non-pleasant" [*Top*. 4.4 124b7–12], and that "if the non-good is non-pleasant, the pleasant is good" [*Top*. 4.4 124b12–14]. The author of the commentary on the *Topics* in the Firenze manuscript adds a few lines later:

> Consequenter considerat in relative oppositis comparando due ad duo, et est consideratio talis: Considerandum cum sit aliquid generi relatione oppositum et aliquid specie, utrum oppositum generis sit opposite speciei; et si non, interimitur propositum.
>
> Then, he [*scil*. Aristotle] considers relative opposites by comparing two by two. And the consideration is of this sort:[4] It must be considered, when there is an opposite term related to a genus and another one to a species, whether the opposite of the genus is [the genus] of the opposite species. And if that is not the case, the position [of the adversary] is defeated.

In all these passages, the main goal seems to be to support the attribution of opposites (be it accidents, genera, species, or definitions) to opposite terms. The recurrent pattern (A:B :: C:D) seems to support Anonymus Cantabrigiensis' use of the plural ("methodos quas") since, in fact, there does not seem to be one single τόπος dealing with pairs of opposites in Aristotle, but rather several uses of this pattern, which Robert Kilwardby, in the second half of the 13th century, seems to have named "proportion of the double opposition".[5]

4 "Consideratio" is the term commonly used by the author of the commentary to refer to τόποι or *loci*.

5 See Robert Kilwardby, *Epistola ad Petrum de Confleto*:

> Si forma corrumpitur in pure nichil, ergo forme corruptio est annichilatio, ex quo sequitur, quod generatio est creatio, proprie accipiendo creationem; quia

As mentioned, close readings of both *Topics* and *Sophistical Refutations* centered in or including Anonymus Cantabrigiensis' commentary have been recently attempted, with a particular focus on the concern raised by some medieval scholars regarding the apparent discrepancies in Aristotle's classification of syllogisms. The peirastic syllogism ("temptativus", in Boethius' translation) seems to cause the more pressing exegetic challenges.[6] Anonymus Cantabrigiensis' solution to this conundrum is quite original, surpassing even, as Ebbesen has claimed elsewhere [2017], contemporary readings of Aristotle that fail to identify a problem there in the first place. Be that as it may, Anonymus Cantabrigiensis' treatment of the peirastic syllogism confirms Ebbesen's suggestion that commentaries on the *Topics* in the first half of the 13th century are in more than one way influenced by the tradition of commentaries on Aristotle's *Sophistical Refutations*. When the same question is raised in the parallel passages of both works, it is usually the commentary on the *Sophistical Refutations* that includes the more extended treatment of the problem.

When a medieval commentator is as perceptive a reader as Anonymus Cantabrigiensis, it could be said that he produces a true "companion" (in the modern, editorial sense of the word) to the work commented on. In that case, even if medievalists are likely to be the main target of this volume, curious readers of Aristotle would greatly benefit from this insightful take on the *Sophistical Refutations*. Or, to borrow a more eloquent case made by Ebbesen himself:

> For modern interpreters of Aristotle there are things to be learned from their medieval counterparts. We may not always be able to adopt their solutions of the problems raised by the text, but they can open our eyes to problems we have not seen, or make us realize that problems we have seen are even more complex than we thought. [Ebbesen 2017, 187]

> talis est proportio duplicis oppositionis, quod si oppositum de opposito et proportionatum de proportionato. [Ehrle 1920, 614–615]
>
> If a form is corrupted into pure nothing, then the corruption of a form is annihilation; from which it follows that generation is creation, understanding "creation" in its strict sense: since such is the proportion of the double opposition, namely, that if an opposite [is predicated] of an opposite, the proportionate [of the first is] also [predicated] of the proportionate [of the second].)

[6] Besides Fink 2013, Ebbesen himself deals with the issue in Ebbesen 2017 and briefly in Ebbesen 1997. A similar case has been made by Julie Brumberg-Chaumont [2017] regarding Anonymus Cantabrigiensis' treatment of the distinction of form and matter as it bears on the classification of fallacies.

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Brill's Companion to the Reception of Galen edited by Petros Bouras-Vallianatos and Barbara Zipser

Brill's Companions to Classical Reception 17. Leiden/Boston: Brill, 2019. ISBN 978–90–04–30221–1. Pp. xxv + 684, 11 color ill. Cloth €180.00/US$217.00

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With 31 chapters and over nearly 700 densely written pages, this bulky volume manages the difficult task of giving a comprehensive account of the afterlife of the Greek physician Galen (129–216 AD). Over the past few decades, his work has aroused much interest to the point that such a book has become increasingly desirable, if not necessary. Apart from the always useful synthesis of O. Temkin [1973] to which the editors refer in their introduction—one could also mention V. Nutton, [1982] and V. Boudon-Millot [2007, xci–ccxxxviii]—it was indeed until now very difficult to find information about the multiple facets of the evolution of Galen's corpus and ideas in one place. The book covers all historical periods, with a strong focus on the medieval reception. It brings together a wide range of renowned international experts in various linguistic areas (Greek, Latin, and Arabic, but also Syriac, Hebrew, Armenian, and even Chinese, Tibetan, Persian, and Urdu) who demonstrate an impressive command of the sources and make them accessible to all readers alike.

The volume follows a roughly chronological order that does not challenge the received views on the Western medical tradition. Less well-known subjects not included in the standard picture, such as Galen's Armenian or Asian reception, are gathered in the last part, not without surprise, since the Hebrew scientific writings also appear in it apart from the chapters on the Islamic tradition which do include a contribution on Maimonides. In any event, chapters in the collection need not be read in sequence, and the editors do propose an alternative order with three main thematic units:

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- textual transmission and dissemination (by far the most substantial unit),
- the impact of Galenic thought and medical practice,
- and the way Galen has been portrayed in non-medical contexts.

Each paper also includes an up-to-date bibliography which allows selective reading and comes in handy for using the book as a reference work. This *Companion* is indeed intended for scholars but also students and non-specialist readers. However, it is doubtful that all the papers reach such a large general audience: while there are some remarkable synthetical chapters (e.g., by Nutton, M. Green, P. Bouras-Vallianatos or A. Pietrobelli) on well-studied subjects, other chapters (e.g., by S. Bhayro, R. Alessi, and B. Zipser, or by A. Orengo and I. Tinti) on much more specialized topics present preliminary results of ongoing research However, it is also one of the most appealing features of the book to give readers an overview of our *current* understanding of the reception of Galen so that they can navigate through a rapidly evolving field of research.

The first part covers the reception of Galen in late antiquity and Byzantium. Pietrobelli [ch. 1] considers the "Galenic question" anew: paradoxically, the earliest reports on Galen (second and third centuries AD) portray him less as a physician than as a philosopher and exegete. Pietrobelli explores the testimonies of Pollux and Athenaeus of Naucratis, Alexander of Aphrodisias, and Eusebius of Caesarea (on the Christian Theodotian sect), as well as the possible use of Galen by Clement of Alexandria and Origen.

However, by the late sixth century, Galenism had already become a foremost medical doctrine. The next two chapters show how this was achieved. Bouras-Vallianatos [ch. 2] studies the use of Galen by Greek and Latin medical compilers between the fourth and seventh centuries (Oribasius, Aetius of Amida, Paul of Aegina, Alexander of Tralles, Theodore Priscianus, and Cassius Felix). He stresses that the project of transmitting, promoting, and abbreviating the medical knowledge of the time was open to a plurality of views and geared towards practical purposes. I. Garofalo [ch. 3] presents the constitution of the Alexandrian canon of Galen's works (late fifth to sixth centuries) and describes how his texts were selected, abbreviated, and organized, but also how they were commented on and used in teaching. Apart from a few innovations in anatomy, the aim was essentially that of preservation.

The next four chapters are centered on the Byzantine tradition. Bouras-Vallianatos [ch. 4] begins with medical writings in which Galen stands out as an authoritative figure. As in late antique textbooks, his teachings were systematized but also adapted to the Christian context and sometimes complemented (in sphygmology and uroscopy). Bouras-Vallianatos also highlights the irreverence of Symeon Seth, the originality of John Aktouarios, and the Italian connections of John Argyropoulos.

Zipser [ch. 5] goes on to discuss *iatrosophia*, an ill-defined genre of text with a practical potential (still in use in 20th-century Crete), ranging from collections of excerpts to medical codices. In them, Galen figures as an important source even if he is one among others and not necessarily a direct one.

P. Degni [ch. 6] focuses on the textual tradition and shows that it is not based on the Alexandrian canon and that it preserves Galen alongside other medical authors. Among the key manuscripts presented are those from Ioannikios and his colleague (12th century) or from the circle of John Argyropoulos (15th century).

D. Stathakopoulos [ch. 7] investigates non-medical texts in which Galen is pictured as a celebrity with unchallenged authority. But apart from the brief and critical survey of Photius (ninth century), active engagement with Galen's (essentially medical) texts begins only with Michael Psellus (11th century) and peaks in the 12th century in Anna Komnene's circle.

The second part is devoted to the medieval Islamic world. Bhayro [ch. 8] first turns to the Syriac textual tradition that has come under intense scrutiny in recent years. His study of the translations of Sergius of Resh ʿAina (sixth century), those of Ḥunayn ibn Isḥāq (ninth century), and the so-called Syriac Renaissance (12th century) challenges received ideas of the Syriac tradition and shows its intrinsic interest.

The next chapters almost all focus on individual authors. G. Cooper [ch. 9] presents a key moment of the *translatio studiorum*: Galen's Arabic translations by Ḥunayn (ninth century). As Cooper explains, however powerful Galen's supporters were in Baghdad, this lifelong undertaking does not belong to an official program. Ḥunayn's reader-centered translation techniques are described as involving expansion, explanation, and semantic shifting.

P. Koetschet [ch. 10] concentrates on al-Rāzi (9th–10th century), who had a good first-hand knowledge of Galen's work. The medical and philosophical criticisms that al-Rāzi addressed to Galen (on topics such as matter, teleology, or optics) are tied to his reaction to Muʿtazilite doctrines and form part of his personal scientific project—an important milestone in the Arabic reception of Galen from the 10th century onwards, as shown, for example, by al-Fārābī or Ibn Riḍwān.

G. Strohmaier [ch. 11] explains how Ibn Sīnā (10th century) relied heavily on Galen in his *Canon*, but contrasts Galen's authority with that of Aristotle, and challenges some of Galen's central assumptions, especially about the heart, in psychology, embryology, and physiology.

M. Forcada [ch. 12] gives numerous examples of direct engagement with Galen in a medical landscape dominated by Ibn Sīnā's *Canon* with Galenic commentaries written in such diverse settings as the 11th-century Aristotelian school of Baghdad (Ibn al-Ṭayyib) and Fatimid Egypt (Ibn Riḍwān) or 12th-century al-Andalus (Ibn Bājja and his students).

Y. T. Langermann [ch. 13] explains that Maimonides (12th century) had a very good knowledge of Galen, which he studied closely, summarized, and annotated. But while Maimonides accepted Galen's medical authority, he criticized, sometimes harshly, Galen's tendency to take a stand on every subject, as he does on Aristotelian logic or the Mosaic doctrine of miracle and creation.

N. Fancy [ch. 14] shows that although Ibn al-Nafīs [13th century] relied heavily on Galen and his anatomy, he felt free to criticize and correct him based on his own theories (especially in cardiovascular physiology). In his comments to Hippocrates as well, Ibn al-Nafīs dissociated himself from Galenic interpretations.

Alessi [ch. 15] looks at Ibn Abī Uṣaybiʿa's biographical encyclopedia and what it says about the vitality of Galenic scholarship in Damascus and Cairo at the end of the Ayyūbid period. Alessi also shows how important the encyclopedia is for the textual tradition since it contains not only a list of the treatises then available but also many firsthand fragments.

L. Chipman [ch. 16] focuses on pharmacology: Muslim theorists (such as Sābūr or al-Kindī) sought to specify and quantify the degrees of faculties to enhance the understanding of compound drugs. But these developments were without any real effect on pharmacological practice (as exemplified by the findings of the Cairo Genizah), which is mainly characterized by the integration of new *materia medica* coming from the East.

The third part is about the medieval West. With a strong emphasis on the long 12th century, the first three chapters, which describe Galen's return to Latinate Europe, both overlap and complement each other. Green [ch. 17] explains that until the 11th century the Latin Galen is mostly in bits and pieces and without much influence. She shows that the revitalization of his *oeuvre* was a slow process that unfolded quietly throughout the 12th century. It is marked by the work of Constantine the African at Monte Cassino (who is largely responsible for Galen's high repute in Europe) and by the great translation programs carried out in Toledo and Pisa (which ensured the availability of the texts).

Next, B. Long [ch. 18] introduces the Arabic-Latin translations. Coming from a tradition of Galenic synthesis, Constantine's works laid the terminological foundations for the time to come. But while Constantine passed over his Arabic sources (a tendency criticized by Stephen of Antioch), translators in Toledo such as Gerard of Cremona and Mark of Toledo, both working with the support of the church, no longer did so, thus conferring a normative status on the Arabic-Latin translations.

A. M. Urso [ch. 19] in turn presents the Greek-Latin translations. She shows the role of Burgundio of Pisa (12th century), whose translations, often based on manuscripts copied by Ioannikios, competed with those of Gerard of Cremona. She evokes the hazy figure of Stephen of Messina and the well-known William of Moerbeke (13th century), as well as the mediocre translations by Peter of Abano, and those of Niccolò da Reggio (14th century), which were numerous and reliable but too far removed from the Arabized Latin by then used in the universities to be successful.

After that, M. McVaugh [ch. 20] discusses how Galen's writings find their way into the curriculum of the universities in Paris, Montpellier, and Bologna (13th–14th centuries). Making a useful distinction between the existence of texts and translations and their actual accessibility and use, McVaugh presents the slow process of assimilation and selection of the texts translated at the end of the 12th century (the so-called "New Galen").

I. Ventura [ch. 21] gives a thorough account of the textual tradition of *On the Capacities of Simple Drugs*, which sums up all of Galenic pharmacology in the western Middle Ages. She identifies its various vectors of transmission, both indirect (the Arabic sources of Constantine's *Pantegni*, the doctrinal summaries in Ibn Sīnā or John of Saint-Amand, and the Arabic encyclopedias adapted into Latin) and direct (its Latin translations by Gerard of Cremona for the first section and by Niccolò da Reggio in its entirety).

The fourth part outlines the transformations of Galenism in Europe from the early modern period onwards. S. Fortuna [ch. 22] describes the rapidly evolving textual tradition of Galen in the first half of the 16th century. She notes that the first humanist translations (by Leoniceno, Kopp, and Linacre) did not immediately replace the medieval Arabic-Latin translations. Although not a bestseller, the very expensive Aldine edition published in 1525 and 1526 turned the tide: the availability of the Greek text led to many new translations that gradually improved and enriched Galen's complete works in Latin, and especially the Juntine edition published in Venice under Gadaldini's supervision.

C. Savino [ch. 23] examines the commentaries brilliantly forged in the 1560–1570s by Rasario, a prolific translator of Galen, which made their way into the Galenic corpus until they were exposed by philologists of the Corpus Medicorum Graecorum. She presents the techniques that he used to create a text in Latin which was later retroverted into Greek, from ancient commentaries and compilations.

Nutton [ch. 24] questions the supposed decline of Galenism at the end of the early modern period (1540–1640). Rather than describe medicine as emancipating itself from Galen, Nutton shows that the new medical ideas that emerged (in the work of Fracastoro, Vesalius, and Harvey, or even in Paracelsianism) aimed at a compromise within a general framework that long remained Galenic.

M. P. Donato [ch. 25] draws a picture of a Galenism disputed, refuted, and made obsolete, but whose influence persisted in the age of chemistry and mechanics (1650–1820). Galen was still edited (e.g., by Chartier) and especially commented on. But at the end of the 1740s Galenism as science was dead. However, Galen continued to act as a counter-model (as in physiology for Malpighi) and retained a certain authority in therapy, hygiene, and ethics.

P. Tassinari † [ch. 26] focuses on the great editorial projects of the 19th and 20th centuries, from Kühn to Daremberg to Diels. He shows a change not only in readership but also within academia: the study of Galen ceased to be the dominion of learned physicians and became pivotal in establishing philology as a major tool for the sciences of antiquity.

The fifth and last part is meant to bring together "chapters with diverse cultural settings" viewed over somewhat longer time-scales. C. Caballero-Navas [ch. 27] presents Galen's reception in medieval Hebrew science, which is fully in keeping with the Islamic tradition. She describes two aspects of the transmission of his *oeuvre*: the Hebrew translations from Arabic and Latin in northern Spain and southern France (12th–15th century), and the many quotations provided by the writings of Jewish scholars working from Arabic sources, such as Maimonides (12th century) or Falaquera (13th century).

Orengo and Tinti [ch. 28] discuss the Armenian tradition (5th–17th century). Despite a still fragmentary knowledge of the manuscripts and printed books, they note a certain number of references to Galen both in the original Armenian texts and in literature translated mostly from Arabic.

M. Martelli [ch. 29] outlines the relationship between alchemy and (Galenic) medicine in the late antique and medieval traditions in the Greek, Syriac, and Arabic languages. He shows that alchemists were well acquainted with medical thought and its tools (especially pharmacology) and that they sometimes drew inspiration and borrowed from Galen (as in a Syriac text of ps.-Zosimos or Jābir ibn Ḥayyān).

R. Yoeli-Tlalim [ch. 30] discusses the dissemination of Galenism to Tibet, India, and China, mainly through the mediation of Islamic medicine (or Jesuit doctors in the case of Ming China). As it remains of marginal influence, the reference to Galen is to be contextualized: his legendary role in the formation of Tibetan medicine in the seventh and eighth centuries shows the influence of Indian medicine in the 17th century, and the emphasis put on the Greek lineage of Unani medicine in India is best understood as a reaction to colonial medicine.

S. Lazaris [ch. 31] goes through the known medieval (mainly Byzantine) portraits of Galen in the manuscripts and frescoes in monasteries and churches. He emphasizes what their presence in a religious context says of the subordination of science to theology, and points out that, apart from a constant characterization as a respectable scholar, there was no iconography specific to Galen.

Overall, the contributions are all very knowledgeable and often excel at clarifying complicated or relatively unknown subjects. The volume covers a remarkable amount of ground and provides a fairly complete picture of how Galen was read, translated, received, transformed, or criticized in different times and contexts. However, some topics might have deserved better exposition or a more detailed treatment, such as the significance of Ravenna, the figure of al-Fārābī or that of al-Mājūsi, or the ancient forgeries of Galenic texts [see Petit, Swain, and Fischer 2020]. Moreover, the book does not avoid certain redundancies, such as between chapters 2 and 6, or 3 and 7, or in the central chapters (17 to 21). But again, this is not troublesome and allows for flexible reading. The most recent research is also considered. Galenic pharmacology is thus given due attention and, in particular, the treatise *Simple Drugs*, now being edited in Greek, Syriac, and Arabic.[1]

[1] See the contributions of Bhayro, Martelli, Ventura, and Chipman.

The volume highlights one of the strengths of Galenism, which accounts for its durability, i.e., its adaptability and ability to integrate new knowledge in different places and times, as with Christian anthropology [103], the Mesopotamian medical system [172], Mogul pharmacology [312], and even Vesalius' anatomical discoveries [475]. This raises the question of differentiating between cases in which the Galenic system undergoes mutations and adaptations and those in which hardly anything more than Galen's name is taken up or criticized—as is evident, for example, in an Armenian print [573], with certain Arab pharmacists [310], or the Arabic legend of Galen the alchemist [588] and that of his expatriation in Tibet [595]. It is also important to distinguish between fidelity to the letter of Galen's texts and adoption of great principles attached to his name or even unconscious integration of his ideas.[2] A more substantial introduction would indeed have been welcome to take stock of the theoretical bases of reception studies and to identify the different scenarios at issue in Galen's case better.

On many points, the individual chapters echo each other and offer exciting avenues. Criticism of Galen is well represented [cf. also Pietrobelli 2020], and it is interesting to note, for instance, that in quite a few cases Galen himself is used, or his own scientific attitude is emulated, to oppose Galenism—as with Alexander of Tralles [49], al-Rāzi [197], Ibn al-Nafīs [270], Vesalius [475], and Malpighi [496]. Although the book probably does not bring about a renewal of our understanding of Galen, it gives a good impression of how our perception of him was formed. For example, it is clear that the loss of Galenic philosophy, still accessible to Alexander of Aphrodisias [21] and already disappeared in Greek by the time of Metochites [154], is also a result of deciding to read Galen primarily as a physician, with which not everyone concurs [see, e.g., Falaquera [543]].

On the whole, the editors have done a very fine job; misprints are rare (e.g., "Pluto" [617 and 623], "Foes" [464]) and the indices are useful. The provided table of titles [xiii–xvii] would have been much more useful if alternative titles (especially the Arabic and medieval ones) had been included. Similarly, non-harmonization of proper names between papers (Averroes/Ibn Rushd; Giuntine/Juntine) and in the *index nominum* (translated names, in full form or not) may perplex readers unfamiliar with the sources. These remarks in no way detract from the numerous qualities of the book which is certainly going to become a reference work in Galenic studies and provide a valuable basis for further research.

[2] See Nutton's observations on pages 473 and 481.

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Le Physiologus *grec: 1. La réécriture de l'histoire naturelle antique* by Stavros Lazaris

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The Greek *Physiologus* is an early Christian collection of some 40 short chapters on animals (and a few plants and stones), each describing the appearance and the properties of the creature and disclosing its theological or moral sense. The text is the basis of a long and rich tradition of versions in various languages, currently known as bestiaries in Latin and in the European vernacular languages. This tradition has been studied since the 19th century and its bibliography is abundant. Its initial version, however, is still subject to debate and this recent book by Stavros Lazaris takes up the question in a fundamental way.

The preface by Arnaud Zucker [xiii–xxi] underlines the importance of this topic and the many open questions still persisting. He places the text in its early Christian environment and stresses its dissimilarity to classical Greek texts on animals. He also observes that this volume is the first of a two-set publication; the second is expected to treat the illustrations that accompany the Greek *Physiologus* in several of its manuscripts. Curiously enough, Zucker's preface is attributed to Lazaris in the running head; it is only signaled as being by Zucker in the table of contents. This is a printer's mistake that should have been detected in the proofs.

This book is organized in two parts: the first deals with the genesis of the work and its character as a work of Christian natural science; the second concerns the adaptation of pagan science to the Christian faith. In part 1, "Genèse et essor d'une oeuvre scientifique chrétienne", some much debated

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questions take on a new light. The work is anonymous and has no preface, but refers to an authority called *Physiologus* to introduce or to conclude the description of the animals. In spite of innumerable attempts, any identification of this "author" remains uncertain. Lazaris believes that the anonymous character and the absence of a prologue were deliberate, and that the work emerged from a collection of notes and drawings which had some circulation before being put into a proper structure. As to the date, which has varied between the years 130 and 390 in previous scholarship, Lazaris advances new arguments for an early date, the first half of the second century, in a context of primitive Christianity marked by the allegorical method of Philo of Alexandria. Concerning the place of origin, nearly all previous studies point to Alexandria, but Lazaris observes that no linguistic evidence confirms this. A Syrian origin, however, advanced by Max Wellmann, is no longer considered pertinent here. The sources of the text are both classical and Christian, and the author certainly had a sound knowledge of classical and religious literature. Biblical elements are numerous, but the fauna described in the chapters is not limited to animals occurring in the Bible. It is not a book on biblical animals, as has sometimes been written. A certain Aristotelian influence is noticeable, there are traces of a text on sympathies and antipathies attributed to Bolos of Mendes, and some analogies with the *Cyranides* and with the *Hieroglyphica* of Horapollo can be detected. A very helpful chart of the various influences is drawn on page 45.

The book then passes to more detailed and technical aspects: the versions and the manuscripts of the text. The Greek *Physiologus* is by no means a stable text. It evolved and changed depending on the copyists, the chronology, and the geography. No fewer than four *recensiones* have been distinguished, and some of them have sub-groups. There is an early "Christian" version in 48 chapters with five sub-versions and 23 manuscripts; a "Byzantine" version with 27 chapters is preserved in at least 31 manuscripts; a "pseudo-Basilean" version comprising 30 chapters is known by 11 manuscripts; and finally, a "late Byzantine" rhymed version with 48 chapters survives in only two manuscripts. Lazaris has drawn a table of the chapters present in the four *recensiones*, with detailed footnotes on the animals [53–65], which will be most useful for future research. The final section of part 1 deals with manuscripts and editions, and includes a table of about 100 manuscripts, grouped into eight categories. For several of them, Lazaris corrects the information on content or date, with respect to previous scholarship, thus providing a new list with up-to-date information.

Part 2, “La science païenne au service de la foi chrétienne”, contains the most original parts of the book. Its first section reflects on the content and the structure of the 48 chapters of the initial *Physiologus*, the majority of which (40) are devoted to animals both real and fantastic (a distinction without great value for the author and its public), and even hybrids. No real order of species by categories can be observed in the Greek texts, which is also the case in Latin and vernacular versions—the only exception being the Old French *Bestiaire* of Philippe de Thaon, as is stated in note 265; but here one ought to add the Latin version of the *Physiologus* known as *Dicta Chrysostomi*, which also distinguishes between beasts, birds, and fishes. A table of the chapters showing the animals and five various types of allegorical interpretation [89–99] provides a stimulating overview of the tendencies of the author of the *Physiologus*. In the accompanying commentary, Lazaris shows that the text develops chapters whose allegory is directed first against the Jews, then against heretics, and finally against the enterprises of the devil. This might be a sort of “fil rouge” for the text.

In the next section, on literary genres, Lazaris notes a certain proximity with the genres of paradoxography, fables, and gnostic texts, which provides further clues to the genetic background of the *Physiologus*. The following two sections build a sort of diptych. “L’oeuvre dans sa jeunesse” stresses that in the first centuries, the *Physiologus* was not a mere pseudo-scientific, low-level text for simple folk, as has sometimes been claimed, but a relatively elaborate text, using various modes of signification and requiring some subtlety from the public. Lazaris concludes:

> Quoi de plus intelligent qu’un tel ouvrage pour enseigner les préceptes de base du christianisme à un lectorat désireux de culture divertissante et destinée à une “grande consommation”? [115]

Thus, the intended audience was intellectual, probably the more educated Christians who were not ignorant of natural history:

> Le *Physiologus* est une “fable” chrétienne à visage scientifique faite pour un public curieux d’histoires merveilleuses. [118]

The second part of the diptych, “L’oeuvre à son âge adulte”, reflects on the later reception of the *Physiologus*. Interestingly, in the Byzantine context the work appears frequently in scientific manuscripts, and Lazaris suggests that it had some link with the schools, where it would have provided useful subjects for pupils. He notices that the work was present both in lay and monastic settings. He also devotes some attention to the illustration of the work, where the alleged author, the Φυσιολόγος, is sometimes portrayed seated in a luxurious chair and making a gesture of teaching, recalling the portraits of Aristotle in some codices. There is even an analogy with the portraits of evangelists.

On the whole, this book by Stavros Lazaris offers a fresh view of an old text, whose origin, nature, and function have been often debated from particular points of view. In this daring synthesis, which is also a new departure, Lazaris depicts a much wider context for this small work, whose destiny has been surprisingly vast.

Richard de Fournival et les sciences au XIIIe siècle edited by Joëlle Ducos and Christopher Lucken

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Edited by Joëlle Ducos and Christopher Lucken, *Richard de Fournival et les sciences au XIIIe siècle* focuses on one of the most fascinating intellectuals of the 13th century. Although Fournival studied in Paris and lived for some time in Rome, it was in Amiens that he spent most of his life. In some respects, Fournival may be compared with his English contemporary Robert Grosseteste. Both were polymaths interested in science, theology, and literature. Although less prolific than Grosseteste, Richard de Fournival wrote literary works in French—the most renowned being his *Bestiaire d'Amours*—and a number of scientific treatises. Some of these works are lost (e.g., his treatise on urines), while others such as his *De arte alchemica* are ascribed to him in the manuscript tradition, yet their attribution is still questioned.

Among his works, a rather short yet extremely consequential text plays a key role. This is the *Biblionomia*, an annotated list of manuscripts owned by Fournival and described by him as a garden of knowledge. The list is probably connected to the establishment of a library that Fournival made available to students at the cathedral school of Amiens, where he was chancellor of the cathedral later in his life. For contemporary historians, Fournival's *Biblionomia* is crucial for at least three main reasons. First, it documents what works were available and used in 13th-century France in a non-academic, learned environment. Second, through its description of manuscripts, works, and contents, the *Biblionomia* provides important data on the circulation of medieval manuscripts and also the authorship of the works that they presented. Third, its arrangement of manuscripts into a thematic structure gives us insight into how the sciences were thought to be internally organized and

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hierarchically connected. Accordingly, the *Biblionomia* is a central piece of information for the historical reconstruction of the 13th-century intellectual environment in France and, more generally, in Europe.

For this and other reasons, Ducos and Lucken's book is a brilliant contribution to scholarship. It provides a detailed picture of Fournival's attitude toward the sciences. Readers from different fields, moreover, can enjoy the cultural richness of medieval Amiens and reconstruct the intellectual profile of Fournival and the historical context in which he lived—a context made of theory and practice, wisdom and science, belief and experience.

True to its title, the volume is specifically centered on Fournival and the *sciences*. As Lucken recalls in his introductory chapter, "sciences" here means "modern sciences" in the restrictive sense of this term. Needless to say, medieval *scientia* was grounded in philosophy and, particularly, natural philosophy. Such thematic delimitation aims at justifying the editors' choice of focusing on some disciplines discussed by Fournival while leaving others aside. As a result, the volume has an impeccable unity of themes, methods, and research questions particularly appealing to intellectual historians and medieval philologists.

The first three chapters of the volume address the *Biblionomia* as a whole: the historical context governing its production (Lucken), its connections to medieval theories of knowledge (Mandosio), and its relationship with medieval encyclopedias (Draelans). In the first chapter, "Parcours et portrait d'un homme de savoir", Christopher Lucken gives an introduction to Fournival's intellectual work and historical context. The chapter is rich with details. Lucken starts by discussing Fournival's literary production and stressing the main lines of his reflections. Specific attention is given to the "sciences". Fournival's interest in medicine is examined in light of his work as a physician (following in his father's footsteps). Lucken also stresses the bond between dyeing and alchemy—the former being a central commercial activity in Amiens, the latter one of Fournival's central interests—as an eminent case in which practices and social context influenced the production of the *Biblionomia*. As a consequence, Lucken's contribution allows the reader to appreciate the historical concreteness of this text, from the role of its author as cathedral chancellor to the manifold socio-cultural implications governing its internal structure.

Jean-Marc Mandosio offers a fascinating contribution in the next chapter, "La *Biblionomia* de Richard de Fournival et la classification de savoirs au

XIIIe siècle", which examines how the *Biblionomia* is connected to the theories of articulation of knowledge elaborated in the High Middle Ages. This aspect is central to our understanding of how Fournival saw the organic structure of wisdom and science. Examining the main sections of the *Biblionomia* one by one, Mandosio points out that Fournival mostly follows the 12th-century system elaborated by Hugh of St Victor. In turn, while freshly translated works from both Arabic and Greek are widely attested in the *Biblionomia*, it seems that Fournival does not adhere to the tighter articulation of knowledge proposed by Gundissalinus and grounded in Avicenna's theory of subalternation. Similar to other medieval systems, Fournival's articulation ends with theology, which corresponds to the higher wisdom attainable by students consulting the library described in *Biblionomia*.

Mandosio's contribution is followed by a chapter authored by Isabelle Draelans and dedicated to the relationship between the *Biblionomia* and medieval encyclopedias: "La Biblionomia de Richard de Fournival, une bibliothèque d'encyclopédiste? Enquête comparative sur les textes et les manuscrits". Draelans' chapter addresses the question of intellectual bonds between Fournival and the authors of mediaeval encyclopedias (starting with Vincent of Beauvais and Thomas of Cantimpré) as well as philosophers like Robert Grosseteste and Albert the Great. This question is fundamental to our knowledge of the circulation of ideas and texts in medieval Europe. Draelans' detailed analysis shows that the interests and aims of the *Biblionomia* and the encyclopedists were not identical. While encyclopedists aimed to produce a handy yet complete account of knowledge that preachers could use easily, Fournival's aim was mostly focused on his personal and sometimes incidental interests. This difference is also reflected by a comparison between the sources used by the encyclopedists and the works mentioned by the *Biblionomia*, which shows some central discrepancies.

Following a thematic articulation, the next two chapters of the volume are dedicated to mathematics. In his contribution, "Arithmétiques et géométries au XIIIe siècle d'après la *Biblionomia*: des traductions arabo-latines à Jordanus de Nemore", Marc Moyon discusses the intellectual context in which the sections on arithmetic and geometry of the *Biblionomia* were written. Starting with Boethius, Moyon examines the most important novelties introduced in these disciplines during the High Middle Ages, focusing in particular on the Arabic-into-Latin translations by Gerard of Cremona and the relevance of Jordanus de Nemore. The latter plays a central role in Fournival's *Biblionomia*, and Mayon discusses the main contribution that Jordanus made in both arithmetic and geometry by using the freshly translated materials.

This chapter is followed by Laure Miolo's contribution, "Science des nombres, science des formes: arithmétique et géométrie dans les manuscrits de la *Biblionomia* de Richard de Fournival", which is centered again on arithmetic and geometry. Miolo's chapter, however, addresses another fundamental aspect of Fournival's collection: its role in spreading the works mentioned by the *Biblionomia* in Paris later in the Middle Ages. Miolo examines how Gerard of Abbeville's acquisition of parts of Fournival's collection directly impacted the study of arithmetical and geometrical works in Paris. The relevance of these works can be appreciated up to the later Middle Ages, as Miolo points out in her chapter.

The section on mathematics is followed by a set of three chapters dedicated to Fournival and medicine: its disciplinary context (Green), and the cases of uroscopy (Moulinier-Brogi) and horse medicine (Giese) as presented by the *Biblionomia*. Monica H. Green's chapter, "Richard de Fournival and the Reconfiguration of Learned Medicine in the Mid-13th Century", reassesses the role that Fournival had in the 13th-century renewal of medicine. After having recalled the seven *corpora* of medical texts mentioned by Fournival, Green examines Fournival's effort in acquiring and commissioning medical manuscripts containing texts which were recently translated from both Arabic and Greek. Green links Fournival's effort to the general reconfiguration of medieval medicine that would soon follow, particularly in consideration of the "new Galen", all of whose works are mentioned in the *Biblionomia*.

With the chapter by Laurence Moulienier-Brogi, "Richard de Fournival, la *Biblionomia* et la science des urines", the volume moves on to examine the case of uroscopy in Fournival's work. As Moulinier-Brogi recalls, the science of urines played a central role in medieval medicine; by the time Fournival wrote his *Biblionomia*, the discipline was already well-established in Europe. Moulinier-Brogi's learned contribution examines the works mentioned by Fournival in detail, pointing out the rarity of some of those titles and their influence on medieval medicine.

The last chapter of the section, "Works on Horse Medicine in the *Biblionomia* of Richard de Fournival in the Context of the High Medieval Tradition", is dedicated to horse medicine. Here, Martina Giese examines the manuscript tradition and possible identifications of the two titles on horse medicine mentioned by the *Biblionomia*: the *Liber de cirurgia equorum* and the *Liber de mulomedicina*. Giese reconstructs the connection of these works with the *Practica equorum* and the *Albertus-Vorlage* treatise, showing that the *Liber de mulomedicina* is an abridged version of the *Albertus-Vorlage*.

The second part of the volume widens the scope to include other scientific texts presumably authored by Fournival. Antoine Calvet's chapter, "Le *De arte alchemica* (inc.: Dixit Arturus explicator huius operis) est-il une oeuvre authentique de Richard de Fournival?", is dedicated to *De arte alchemica*, an alchemical treatise ascribed to Fournival in the manuscript tradition. Calvet's contribution is a remarkable piece of scholarship for the history of alchemy. *De arte alchemica* is a treatise focused on the alchemical transformation of arsenic, which is used in the transmutation of both silver and gold. Calvet shows how attribution to Fournival can be substantiated by historical and textual data. Admission that Fournival was the author of this alchemical text would be of the utmost relevance to tracing his intellectual profile and the role played by alchemy in the 13th century. Calvet's examination is accompanied by a critical edition of *De arte alchemica* and a French translation.

Calvet's chapter is followed by three contributions dedicated to the role of astronomy in Fournival's reflections and in relation to the *Nativitas* that he authored (see the chapter by Boudet and Lucken) and to the *Speculum astronomiae* (see the chapters by Weill-Parot and Burnett). The contribution by Jean-Patrice Boudet and Christopher Lucken, "In Search of an Astrological Identity Chart: Richard de Fournival's *Nativitas*", analyzes a special text: Fournival's *Nativitas*, his "astrological autobiography". The two authors reassess the attribution of the *Nativitas* to Fournival by considering the *status quaestionis* and the data provided by works directly related to Fournival and astronomy (the *Roman d'Abladane*, *De vetula*, and *Speculum astronomiae*). After convincingly arguing that the *Nativitas* was authored by Fournival, the authors stress the discrepancies between this text and the anonymous *Speculum astronomiae*, the attribution of which to Fournival seems difficult to maintain.

The next chapter of the volume, "La *Biblionomia* de Richard de Fournival, le *Speculum astronomiae*, et le secret" by Nicolas Weill-Parot, is centered on the "secret books" mentioned in the *Biblionomia* and about which many hypotheses have been proposed by scholars. Weill-Parot engages the problem of what these books might have been by examining the terms "occult" and "secret" in astrological and magical works that were included in manuscripts probably proceeding from Fournival's collection. The semantic field emerging from the textual analysis of these terms is quite close to the sense of a passage in the *Biblionomia* stating that a secret, although occult, can be unveiled. Weill-Parot's analysis of the *Speculum astronomiae*, however, shows that this text characterizes the terms negatively insofar as it affirms that what is occult cannot be unveiled. This discrepancy would seem to distance Fournival from the *Speculum astronomiae.*

The matter is taken up again in the last chapter of this section on astronomy. Charles Burnett, in "Richard de Fournival and the *Speculum astronomiae*", reassesses the hypothesis—proposed by Bruno Roy—that Fournival is the author of the *Speculum astronomiae* by comparing it with the *Biblionomia* and examining how both texts use translated sources. With much clarity, Burnett shows that some commonalities in sources, terminology, and concerns seem to point toward Fournival's authorship of the *Speculum*, even though, as Burnett remarks, further research is needed to clarify this point.

The last thematic section of the volume is dedicated to *De vetula*, a pseudo-Ovidian text ascribed to Fournival. In the first chapter of this section, "Le quadrivium dans le *De vetula* attribué à Richard de Fournival", Marie-Madeleine Huchet discusses the role of the four mathematical disciplines of the quadrivium (arithmetic, geometry, music, and astronomy) in *De vetula*. She examines how *De vetula* connects astronomy with the other disciplines of the quadrivium and its hierarchical structure as presented in the text.

In the second and last chapter of this section, "An Astrological Path to Wisdom. Richard de Fournival, Roger Bacon and the Attribution of the Pseudo-Ovidian *De vetula*", Cecilia Panti challenges the attribution of *De vetula* to Fournival. Through a detailed analysis of the work and the use of it made by Roger Bacon, Panti argues convincingly in favor of a closer relationship between the author of *De vetula* and Bacon—a relationship whose closeness borders identity, since the author might be Bacon himself, as Panti suggests. Panti's hypothesis is very consequential since it would explain some non-perspicuous aspects of Bacon's reflections and historical context.

Ducos closes the volume with a short conclusion in which the relevance of Fournival's contribution to the history of ideas is summarized and contrasted with that of other intellectuals and "polymaths" from the 13th century, such as Robert Grosseteste and Vincent of Beauvais.

Rich in perspective in all its chapters, the volume is a remarkable contribution to the intellectual history of the 13th century—especially as regards the historical reconstruction of Fournival's thought and attitude toward the sciences. The studies included in the volume allow readers to establish sets of meaningful connections with other main characters of the 13th century, such as Grosseteste, Albert the Great, and Roger Bacon. However, while the volume focuses on Fournival's connections to the scientific debate of his time, one main question appears to be left aside: What role did philosophy play in Fournival's reflections, purchase of manuscripts, and overall consideration of science? By restricting the richness of *scientiae* to a consideration of "modern sciences", the volume misses an aspect that appears to be central to the reconstruction and assessment of Richard de Fournival's contribution and his intellectual context.

Galen: A Thinking Doctor in Imperial Rome by Vivian Nutton

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The popularity that ancient medicine and Galenic studies in particular now enjoy in anglophone scholarship is owing in no small part to the author of the monograph under review. Through his textual critical and analytic work over the past 50 years, Nutton has made the life, writings, and thought of the second-century AD Greek doctor Galen of Pergamum (d. *ca* 216) more accessible to generations of students and scholars. As Nutton admits in the introduction [1], the present book has the apologetic aim of defending his career-long interest in Galen against critics who might view Galen's obsolete medical theories and practices as evidence of a lack of intellectual worth. Nutton's biography of Galen claims to differ from past surveys in English of Galen's life and literary output, such as Mattern's highly readable *The Prince of Medicine: Galen in the Roman Empire* [2013], by "put[ting] Galen into context as medical practitioner in the Roman Empire" [3]. It emerges from the book that "context" means the resources, obstacles, and opportunities which doctors, especially from elite backgrounds such as Galen's, encountered in Rome, including indigenous and imported drugs available in the city's markets; a large, diverse patient pool exposed to poor sanitation and occupational hazards; and sectarian rivalries between doctors and philosophers for authority over matters of health.

The biography is divided into six chapters, with an introduction and conclusion. The first two chapters, "Galen the Greek" and "Galen the Roman", trace chronologically Galen's upbringing in Asia Minor, his travels around the Mediterranean to study with famous practitioners and to collect rare *materia medica*, and his success with the intelligentsia and aristocracy in Rome. This couple of chapters clearly communicates that Galen's considerable personal wealth, which allowed him the freedom to pursue an unusually lengthy

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education after his father's untimely death, is behind his exceptional command of past and contemporary medical and philosophical theory as well as his technical proficiency. The next three chapters of the book—"Galen the Observer", "Galen the Thinker", and "Galen the Doctor"—are structured around key traits of Galen that help to explain his long-lived impact on learned medicine in the Middle East and Europe. For example, Nutton connects Galen's prognostic skills, which earned him the reputation as a "wonder-worker" in Rome [98], with his observation of minute details of his patients' sickrooms, such as the color of their sputum and food leftovers, that can be read as signs about the course of their disease.

As a researcher and teacher of Galen and his thought, I am unsure after reading Nutton's biography who his target readership is. While the synoptic overview of Galen's work as a healer and theorist suggests a novice reader, similar to the user of Nutton's other survey and now standard university textbook *Ancient Medicine* [2004, 2012], its abundant details, which derive from the author's almost unparalleled familiarity with the Galenic Corpus, may overwhelm a neophyte to the field. For example, an undergraduate student who is assigned Nutton's biography of Galen for a course on premodern medical history may struggle to discern the takeaway of the list of the various printings of the Aldine Galen [143]. These details, however, are a treat to the more seasoned student of Galen who is already conversant with Nutton's general and specialized explanations of the Pergamene doctor. From his extensive and close reading of the writings attributed to Galen (genuine and pseudonymous), Nutton is able to extract interesting asides, such as Galen's description of the waters around his hometown Pergamum [55], missed theoretical opportunities, such as Galen's use and then abandonment of the metaphor of "seeds of a disease" [90], and inconsistencies, such as Galen's confusion of the sex of a patient whom he treated for love sickness when retelling the story in a later work [122]. Many of these remarks invite further research, and Nutton's generous footnotes with full citations to the primary sources provide a starting point.

Nutton's approach to explicating Galen's context primarily consists in letting Galen speak for himself through quotations, summaries, and paraphrases of his writings. Occasional reference is made to contemporary medical figures, such as the author of the pseudo-Galenic pharmacological tract *Properties of Centaury* [35], to provide a point of comparison to Galen's theories or methods. Nonetheless, a broader engagement with contemporary Latin and Greek authors outside of medicine and philosophy would have provided richer texture to Nutton's narration of Galen's navigation of the political and social realities of life in the imperial capital. Furthermore, the undue influence of Galen's own rhetoric may underlie unhelpful speculations about, for instance, Galen's "always angry and emotional mother" driving him to move away from Pergamum for most of his medical education [69].

The book is undeniably well researched, as it is based on Nutton's command of Galen's original Greek versions and their Latin translations as well as past and current secondary scholarship on the corpus as a whole. The weakest section of the biography is the summary of Galen's *nachleben* in the premodern Middle East. Although this reviewer is sympathetic to the difficult task of making Galen's reception accessible to a mixed-level readership, the material in this part of the book tends to be oversimplistic. For example, *pace* Nutton [138], with regard to the translation of the Galenic Corpus into Arabic, Gutas [1998, 143] has demonstrated that there was no straightforward progression from a literal (*verbum a verbo*) to freer (*ad sensum*) style of translation during the "Greco-Arabic" translation movement (8th to 10th centuries). Moreover, Nutton gives the impression that the famous translator of Galen, Ḥunayn ibn Isḥāq (d. 873/7), an Arab Christian from Iraq, rendered almost all of Galen into Syriac and Arabic with the assistance of only two family members [138], when his workshop of translators consisted of several other bilingual Christians and even pagan individuals. Minor errors include the attribution of a tract *On the Eye* to Ḥunayn—he wrote, in fact, two ophthalmological compositions, *Ten Treatises on the Eye* and *Questions Concerning the Eye*—and mistakes and frequent inconsistencies in the transcription of Arabic titles and person names: for example, « Kitāb al-Ḥāwī » instead of the correct « al-Kitāb al-Ḥāwī » by al-Rāzī [135], which is sometimes spelled without the diacritics (i.e., « al-Razi » [138]).

To reiterate, this learned biography offers newcomers to ancient medicine an elaborate, if at times dense, sketch of what made Galen an enduring presence in medicine for almost two millennia. On the other hand, it offers the professional Galenist a fascinating *potpourri* of side stories and elusive details. The addition of an appendix with the standard abbreviations, Latin, and English titles, and editions and translations of the Galenic corpus serves to facilitate research into a field which has long benefited from the contributions of the author under review.

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Aestimatio focuses on the history of science from antiquity to the early modern period. This chronological span is complemented by a geo-cultural one that takes into account cultures in Eurasia and Africa, recognizing that the spread of the traditions of knowledge and of ideas is a unifying characteristic of the chronological and geo-cultural scope of premodern science in the Old World.

In *Aestimatio*, we take science broadly to be the goals, methods, knowledge, and practices in what is presented as science in the historical sources. Accordingly, this new series of *Aestimatio* aims to make fundamental texts and ideas in the history of science accessible to readers today through the publication of original research. It will also include assessments of books recently published that allow reviewers to engage critically with the methods and results of current research. On occasion, there will be guest-edited thematic issues and supplementary volumes.

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