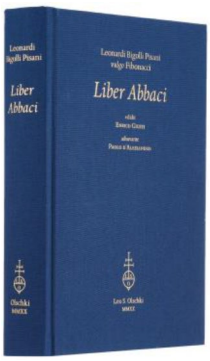
Review

Liber Abbaci

Leonardi Bigolli Pisani vulgo Fibonacci Edited by Enrico Giusti with the assistance of Paolo d'Alessandro

Reviewed by Stefano Gattei



Leo S. Olschki, 2020,
cxviii+824 pp., € 300

The *Liber Abbaci*, one of the most important books of mathematics of the Middle Ages, had a huge impact on Western mathematics, disseminating the Hindu number system and method of algebra throughout Europe. We know very little about its author, Leonardo Pisano, better known as Fibonacci. We do know that he flourished between 1220 and 1235, when he wrote most of his known works, but we know neither when he was born nor when he died; we do not even know his actual name. Apart from the information we draw from his own writings—which seem to be contradictory at times and difficult to interpret—we know of only two period documents that refer to him. The first, a notary deed dated August 28, 1226, mentions the name of his father, Guglielmo (and not Bonaccio, as is often asserted[1]), and the appellation "bigollo," a term of uncertain origin that had fallen into disuse by the sixteenth century, which was often used to refer to Leonardo. The second document is a resolution of the Municipality of Pisa (it is undated, but it was added to documents referring to the years 1233–1241), and it allows us to set a *terminus post quem* for Leonardo's death. Both documents use the *cognomen* Bigollo to complement the name Leonardo, and so we may assume he was called this by his fellow citizens; later on, when "bigollo" fell into disuse, Leonardo was consistently referred to as Pisano (as did, for instance, Luca Pacioli, Rafael Bombelli, Muzio Oddi and Bernardino Baldi, in manuscripts as well as in print). It was not until the beginning of the eighteenth century, when a group of scholars rediscovered his writings, that the name Fibonacci, by which Leonardo is known today, began to appear.

Besides the dedication and autobiographical prologue, the *Liber Abbaci* is divided into fifteen chapters, grouped into four major thematic areas. The first part (chapters 1–7) is dedicated to the positional writing of numbers and the rules of arithmetic operations. The second (chapters 8–11) deals with various problems directly related to trade. Chapter 12 (by far the longest chapter in the book, representing about a third of the entire work) is dedicated to a variety of miscellaneous problems and methods, among which are problems of some theoretical interest. Finally, chapters 13–15 present the more advanced part of the work: the double false position method, calculations with square and cube roots, and algebra.[2]

Chapter 1 is an introduction to Hindu–Arabic figures (particularly the writing and reading of numbers), whose main advantage over other recording methods, especially Roman numerals, lies in the possibility of writing and reading arbitrarily large numbers. The so-called indigitation is also presented, namely, the representation of numbers from 1 to 9999 with the two hands: the units and the tens with the left hand, the hundreds and thousands with the right; there follow addition and multiplication tables. Chapters 2–4 present the arithmetic of integers: multiplication

[1] *Leonardus filius Bonaccii* (abbreviated *fi. Bonaccii*, leading to "Leonardus Fibonacci," that is, Leonardo, son of Bonaccio) is found in most manuscript copies of the *Liber Abbaci*.

[2] In what follows, I shall adopt Giusti's convention and refer to chapter x, section y of the *Liber Abbaci* as $(x.y)$. The editor's internal division of chapters into sections appears to have the sole end of setting the stage for an electronic (or, most appropriately in this case, digital) edition, which is already underway: see Paolo Galluzzi and Paolo Mancarella's foreword, p. XI.

https://doi.org/10.1007/s00283-022-10174-1

(chapter 2), addition (chapter 3), and subtraction (chapter 4); notably, multiplication precedes addition, which is probably related to Leonardo's specific multiplication technique, in which the required additions (of units, tens, hundreds, thousands, etc.; Leonardo extends his calculations to eight-digit numbers) are made directly during the calculation and not at the end, as became customary later. Chapter 5 deals with the division of integers, which preliminarily requires the introduction of fractions. In addition to "standard" fractions, Leonardo introduces "graded," or compound, fractions (*fractiones in gradibus*), that is, sums of fractions in a compact notation, in which successive fractions have denominators that are multiples of the previous ones.[3] Such fractions, particularly suitable for denoting the successive submultiples of a given magnitude, would remain in use until the second half of the eighteenth century. Chapters 6–7 deal with the arithmetic of fractions and mixed numbers (namely, those comprising an integer and one or more fractions): multiplication (chapter 6) and other operations (chapter 7). Chapter 7 also treats the ancient problem of the decomposition of a fraction m/n into a sum of unit fractions, that is, those with numerator 1. Leonardo addresses the general case by elaborating a series of strategies according to the mutual relations between m and n. Chapters 8–11 concern commercial operations: purchases and sales (chapter 8), barter (chapter 9), companies (chapter 10), and money alloying (chapter 11). Chapter 12 deals with what we may refer to as "recreational mathematics," but it includes problems that are solved by appealing to important theoretical methods such as the rule of false position, which Leonardo calls the "rule of the trees" (*regula arborum*), because it is at first used to solve problems concerning the height of trees. This is where, in a section titled "How many pairs of rabbits are generated by one pair in one year?" (*Quot paria coniculorum in uno anno ex uno pario generentur,* 12.996-1000), the famous problem of the rabbits is to be found, along with the well-known chessboard problem (12.1240-1259) and that of the sum of a progression of ratio 7 (12.1264-1268). The last three chapters concern "higher" mathematics: the method of the double false position, or *elchataym* (chapter 13); the extraction of square and cube roots and the arithmetic of binomials (chapter 14); and algebra (chapter 15).

The renewed interest in Leonardo's work during the last decades of the eighteenth century led to the publication of extended parts of the *Liber Abbaci*. As early as 1754, the Jesuit Francesco Antonio Zaccaria described some manuscripts in the Biblioteca Magliabechiana (now part of the Biblioteca Nazionale Centrale) of Florence, and published the dedication to Michael Scot[4] and the autobiographical prologue. It was not until the nineteenth century, however, that Leonardo's mathematical works were published in full. Between 1854 and 1862, the Italian historian of mathematics Baldassarre Boncompagni (founder of the celebrated *Bullettino di bibliografia e di storia delle scienze matematiche e fisiche*, 1868–1887) published the entire corpus of his works: the *Liber Quadratorum*, the *Flos*, and the *Epistola ad Magistrum Theodorum*, in 1854; and Leonardo's two major works, the *Liber Abbaci* and the *Practica Geometriae*, in 1857 and 1862, respectively. Boncompagni based his edition of the *Liber Abbaci* on a single codex of the fourteenth century (Florence, Biblioteca Nazionale Centrale, Conv. Soppr. C.1.2616; it is referred to as **F** in Giusti's edition), the only extant complete manuscript, and adhered to it faithfully, preserving its scribal errors and only occasionally calling attention to the most evident ones.

> "The undeniable merits of this new edition notwithstanding, Giusti's approach to the text of the *Liber Abbaci* betrays a poor understanding of the nature of the philologist's work."

The need for a critical edition grew considerably throughout the twentieth century, but none was produced, and the Boncompagni edition remained the standard

[3]The notation is connected to the use of the abacus as a computational tool: "graded fractions" are the numbers and positions of beads on the abacus. For instance, $\frac{a}{b}\frac{c}{d}\frac{e}{f}$ means $\frac{a}{b\cdot d\cdot f}+\frac{c}{d\cdot f}+\frac{e}{f}$. Leonardo uses compound fractions to express decimals as well. In (12.1279), the expression $\frac{1}{10}\frac{8}{10}\frac{4}{10}\frac{6}{10}\frac{3}{10}\frac{5}{10}\frac{9}{10}\frac{2}{10}\frac{4}{10}\frac{2}{10}28$ equals 28.2429536481.

[4]Michael Scot (ca. 1175–ca. 1235) was a Scottish scholar and mathematician whose translations of Aristotle from Arabic and Hebrew into Latin are a landmark in the reception of that philosopher in Western Europe. He was famous in the European Middle Ages as an astrologer and soon acquired a popular reputation as a wizard. He is first recorded at Toledo in 1217, where he finished translating the treatise of al-Biṭrūjī (Alpetragius) on the sphere and translated Aristotle's *Historia animalium* from Hebrew or Arabic. He also translated, perhaps at this time, Aristotle's *De caelo,* and he was probably responsible for the translations of the *De anima* and the commentary by Averroes that is found in the same manuscripts. After 1227 he was at the Sicilian court of the Holy Roman Emperor, Frederick II, and was mentioned as recently deceased in a poem written early in 1236. His works are mainly undated, but those on natural philosophy seem to predominate in his earlier, Spanish, period, and those on astrology in his later, Sicilian, period. He wrote three treatises on astrology, and several alchemical works were ascribed to him; and he served as Frederick II's science adviser and court astrologer. Regrettably, Giusti's edition of the *Liber Abbaci* lacks any information about Michael Scot, nor does it hint that any attempts were made to inquire as to whether there are any traces of the *Liber Abbaci* in Michael Scot's own output.

reference for more than a century and a half. Laurence E. Sigler's posthumous English translation of the book corrected most errors, but offered an unreliable translation that often strays from the original text.[5] More recently, Giuseppe Germano and Nicoletta Rozza published a critical edition of the dedication, table of contents, prologue, and chapters 1–4 of the *Liber Abbaci*, which, however, shows a number of significant deficiencies in the mathematical understanding of Leonardo's text.[6]

The new edition of the *Liber Abbaci*, by Enrico Giusti (University of Florence) with the assistance of Paolo d'Alessandro (University of Rome 3) is meant to fill a significant gap, providing scholars with a reliable text, both from the philological and the mathematical points of view.[7] Of the nineteen known witnesses of the *Liber Abbaci*,[8] nine contain all (or most) of the work, while the other ten contain only (part of) the last few chapters (a twentieth manuscript copy, of chapters 14–15, which belonged to Boncompagni, is now in private hands and was only partially available to the editor).

Among the partial witnesses, codex **L** (Florence, Biblioteca Medicea Laurenziana, Gaddi 36; fourteenth century) is particularly interesting, for it likely presents an earlier version of chapter 12. According to what we find in several manuscripts, after the first version of 1202, the *Liber Abbaci* was revised in 1228,[9] upon the request of Michael Scot, to whom the second version of the *Liber Abbaci* is dedicated. Leonardo took the opportunity offered by Scot's request for a copy of his work to revise it as he deemed necessary, after more than a quarter of a century since its first appearance. As we read in the dedication:

(1.2)

Scripsistis mihi domine mi et magister Michael Scotte, summe philosophe, ut librum de numero quem dudum composui vobis transcriberem; unde vestre obsecundans postulationi, ipsum subtiliori perscrutans indagine, ad vestrum honorem et aliorum multorum utilitatem correxi. In cuius correctione quedam necessaria addidi et quedam superflua resecavi.

You, my lord master Michael Scot, the best of philosophers, asked me to make a copy for you of the book on numbers I wrote some time ago. In complying with your request, I examined the work with greater attention, and corrected it, in your honor and to the advantage of many others. In this revision, I added some things that I deemed necessary, and cut out others that I deemed unnecessary.

In 2017, Giusti published the first version of chapter 12, as he found it in **L**.[10] The codex includes chapters 13–15 as well, but whereas the text of these latter chapters does not differ from the one transmitted by other known codices (apart from the usual scribal errors), the text of chapter 12 is substantially different. Most notably, it is considerably shorter than that in other copies, and the missing passages do not concern entire parts, which could have been caused by the loss of one or more quires, but are scattered throughout the chapter; also, the missing parts include at times whole problems, but more frequently they concern alternative solutions of a given problem (particularly interesting is the absence of the computation of the sum of the squares of integers, a result that is included in the 1228 version of the *Liber Abbaci*, with explicit reference to the *Liber quadratorum*, which was written during the interval between the two versions of the *Liber Abbaci*). In other instances (even if less frequently), there are passages in **L** that we no longer find in the 1228 version, such as an entire part dedicated to geometry.

In the present full edition of the *Liber Abbaci*, Giusti refers to all the surviving manuscripts—with the sole exception of chapter 12 of **L**, and possibly of **W** (Vatican City, Biblioteca Apostolica Vaticana, Vat. Lat. 4606; fourteenth century), although we are not told much about the latter—to a single archetype, ω, which differs from the original manuscript because, according to the editor, all the witnesses show a series of errors that cannot be reasonably ascribed to the author (Introduction, §7). Also, he groups the manuscripts into families: subarchetypes α (§8) and φ (§11); a group of six copies stemmatically close to α, only partially collated (§9); and other witnesses, among which it seems impossible to identify direct or indirect relationships (§§10–11). Quite surprisingly, no *stemma codicum* is offered.

Of these nineteen witnesses, the editor discarded those manuscripts that are too fragmentary and excluded four *codices descripti* (that is, direct copies of other manuscripts, already taken into account); he also discarded other witnesses that present only the last two chapters. Accordingly, Giusti's edition is based on six codices for chapters 1–11, five for chapter 12, and six for chapters 13–15; other manuscripts, however discarded—such as **J** (Florence, Biblioteca Nazionale Centrale, Conv. Soppr. C.7.2645; fourteenth century) and **W**—are occasionally referred to in the apparatus.

[5] *Fibonacci's Liber Abaci: A Translation into Modern English of Leonardo Pisano's Book of Calculation*, New York: Springer, 2002. A welcome complement to the new edition of the *Liber Abbaci* would be a new, reliable translation into English, which would make Leonardo's gem available to scholars around the world.

[6] Leonardo Pisano detto il Fibonacci, *Liber Abaci – Il libro del calcolo*, Naples: Loffredo, 2019.

[7] For the sake of simplicity, in what follows I refer to this edition just as Giusti's.

[8] Their full description is in the Introduction, §6. Regrettably, nothing is said about their localization (that is, where copies were actually produced). From the plates in the introduction, it is possible to say that most of them are by Italian hands, which would imply that the circulation of the *Liber Abbaci* was restricted to Italy (which is surprising, given the huge impact the work eventually had). It would have been interesting to inquire about the reasons for that.

[9] This date remains uncertain, though, and the chronology based on it must be considered with caution.

[10] "The Twelfth Chapter of Fibonacci's *Liber Abaci* in its 1202 Version," *Bollettino di storia delle scienze matematiche*, XXXVII, 1, 2017, pp. 9–216.

Boncompagni's 1862 edition of the *Practica Geometriae* has also been taken into account for corrections in chapter 14. The text is followed by an extensive Appendix Critica (pp. 691–822), containing all variants that are not included in the apparatus.[11]

Enrico Giusti's work, assisted by Paolo d'Alessandro, is a remarkable and lavishly produced edition (the hardback volume comes in just short of a thousand pages printed on elegant India paper and includes several beautiful color plates), which is bound to remain the standard reference edition of the *Liber Abbaci* for years to come, and required reading for anyone interested in Fibonacci, his work, and the meeting of Western science with Eastern mathematical practice.

That said, however, a number of remarks are in order. I shall gather them in four groups.

(1) *Exclusion of some witnesses*

The editor's decision to collate **CDEKO** only in part, since these manuscripts include only the last few chapters of the *Liber Abbaci* (p. XCIV), is quite problematic: whereas **D** and **E** are later copies (fifteenth to seventeenth centuries) and may be traced back to **C**, and **K** is a later copy (sixteenth century), the discard of **C** (Paris, Bibliothèque Mazarine, ms. 3637; fourteenth century) is apparently inexplicable (although it includes only chapters 14–15, it is one of the earliest copies). The same could be said about **W**, which is used only occasionally: a complete collation could have provided interesting elements for the edition and, generally, the transmission of the text.

(2) *The archetype*

According to the editor, the archetype of the manuscript tradition differs from the autograph, as "all the witnesses show a series of omissions and errors that cannot reasonably be attributed to the author" (p. LXXXIII). This is questionable, for the following reason. Leonardo clearly says that he revised the first (1202) version of the *Liber Abbaci*. Revisions did not consist in the rewriting of the whole work, but in more or less substantial modifications of the original manuscript, whose status was gradually altered.[12] Accordingly, in the case of the *Liber Abbaci*, such a revision (which, we may plausibly argue, took place sometime around 1228) did not consist in the rewriting of the entire manuscript but, rather, in more or less substantial modifications (additions or deletions) of some of its parts. That this copy, revised by the author, is the *direct* source of the entire manuscript tradition—and hence the very archetype, without any different intermediary copy—is strongly suggested by the fact that some portions of the text are, in the various witnesses, either in the body of the text or in the margins, or else omitted. The most significant marginal addition of the second version is the dedication to Michael Scot (1.2–6), which appears in the margin of the first folio of **G** (see also the relevant plate), is omitted by **A**, and moved after section 10 in **B**. In other words, there was a redactional state in which the dedication was absent (first redaction). The dedication was then added in the margin of the first redaction (second redaction), and it is precisely this textual arrangement that is reflected by some of the witnesses.

The editor did notice the presence of such marginal additions or variants:

> His explanation, however, is questionable; a different, and more plausible, explanation is possible. It is not a matter of omissions that were later recovered, but of supplementary material and corrections introduced by the author when revising his work. Manuscripts omitting the marginal additions reflect the status of the text prior to its revision; manuscripts that bear the text in the margins reproduce the status of their model; and those that incorporate the text carried out the correction. In the case of chapter 12, the revision process was so radical that the entire chapter was thoroughly rewritten.
>
> If that is the case, there is no need for an archetype (ω) different from the original autograph.

(3) *Errors shared by the whole manuscript tradition*

If the archetype is the author's own copy, then errors shared by the entire manuscript tradition—in fact, very few, given the length of the work—should be accounted for either as author's errors or as errors due to a first transcription of the text Leonardo had someone prepare (a "clean" copy of the manuscript), which he then further corrected to produce a second redaction of the text. Accordingly, some errors shared by the entire manuscript tradition—especially those that are hardly explained as mechanical errors—should not be corrected, but rather noted in the apparatus, since they are likely to be the author's own errors. Some others may well be scribal errors, of course—such as omissions by homoeoteleuton[13]—but that cannot be taken for granted in all instances.

The hypothesis of author's errors or of incomplete redactions cannot be ruled out. In (8.199), for instance, we read: "exibunt libre $\frac{1}{2}\ \frac{2}{8}\ \frac{14}{20}\ \frac{11}{12}\ \frac{15}{20}$ 21 bononinorum."

[11]Such an appendix is utterly redundant, and of little use. Nor is it always clear by what criteria items belong either to the apparatus or to the Appendix Critica. On p. 232, for instance, we read in the apparatus: "(147m) *om.* **V** … (148m) *om.* **V**"; and, in the Appendix Critica, p. 757: "(516m) *om.* **V** … (517m) *om.* **V**." Why are omissions of marginals in **V**—a witness the editor explicitly numbers among those on which he based his work, and which is constantly used throughout the edition—at times noted in the apparatus and at times in the Appendix Critica? Or to offer but another example, why are trivial mistakes such as "residuumque] residuum que **S** *corr.* $\mathbf{S}^{2}$" (12.1279) noted in the apparatus, rather than listed, if at all, in the Appendix Critica? An index of technical terms would have been much more appreciated.

[12]See, for example, *Aristoteles Latinus*, Vol. X 2.1: *Meteorologica, Translatio Guillelmi de Morbeka*, edited by Gudrun Vuillemin-Diem, Bruxelles: Brepols, 2008, Part II, chapter 7 ("Vier getrennte Überlieferungszweige: kein 'Archetyp'").

[13]See, for example, (15.411): "et multiplica radicem radicis 5 censuum et radicis 500 denariorum <in se, et proveniunt radix 5 censuum et radix 500 denariorum>, que equantur censui] in se—denariorum *om. codd*" (as presented in the introduction, p. LXXXV).

According to the apparatus, **AFRS** report "exibunt libre [*vac*.] bononinorum," and all others "exibunt libre bononinorum" (with no blank space). According to the editor (p. LXXXIV), the blank space signals an omission. However, a more natural explanation would be that Leonardo actually left a blank space while waiting to compute the series of graded fractions: indeed, the blank space is included in **AFRS** (or rather, in their model) and omitted by all other copies.[14]

This is an example of the editor's additions. Conversely, to offer an example of the editor's deletions: (9.2) "Regula universalis in baractis mercium" (text), "*post* mercium] Primum de pipere ad linum ω" (apparatus). The editor explains his deletion by saying "There's no pepper/linen bartering problem in chapter 9" (p. LXXXIV). But it is rather difficult to account for the addition of "Primum de pipere ad linum": why would one add these words (what is more, to the very title of the section) if nothing in the text would cause such an addition? It seems more plausible to suggest that the author actually deleted a part of the text on pepper/linen, and then forgot to change the title accordingly.

The editor's heavy—but invisible—hand is particularly evident in case of numbers or diagrams, which are consistently corrected or supplied without ever taking into account the very possibility that they are author's errors or incomplete redactions. It is hard to make sense of statements such as, "With respect to mathematics, I checked all the calculations and corrected errors every time this was possible without interfering with the text."[15] How can it be possible to correct errors without touching the text? The only plausible explanation is that Giusti does not regard numbers or diagrams as parts of the text (which is altogether bizarre, in the edition of a mathematical work).[16]

Such liberty in the amendment of the mathematical parts of the text does not consider the unavoidable presence, in such complex works as the *Liber Abbaci*, of the author's own errors,[17] which, naturally, must not be corrected, but merely noted in the apparatus. In at least four instances, Giusti supplements the text, in the margin, with complex diagrams that are totally absent from any witnesses: (7.101m), (8.194m), (8.211m), and (9.85m).

(4) *Critical apparatus*

If the hypothesis of author's errors is rejected—or else is accepted, but the editor thinks that all such errors should be corrected—the corrections should be clearly noted in the text and in the apparatus, especially in the case of deletions and additions. For example: (14.25) "in cruce" (text), "in cruce] eum in cruce ω" (apparatus). This way of noting the editor's deletion is questionable: whenever an editor decides to delete parts of text transmitted by the entire manuscript tradition, he must preserve such parts in the text and mark the deletion using square brackets, noting the deletion in the apparatus by *delevi*. It should read: "[eum] in cruce" (text) and "eum *delevi*" (apparatus).

Whereas the editor deals with all deletions in the same way—namely, he deletes the relevant portion of text and notes his intervention in the apparatus, as if it were a replacement—integrations are dealt with in two different ways. In the case of words, the integration is marked in the text with <…>, without any apparatus. For instance: (7.46) "et relinques <multiplicare per 10 propter> comunitatem" (text; no corresponding apparatus).

When dealing with figures, by contrast, integrations are not marked in the text, but are noted in the apparatus (not as integrations, though, but as replacements). For example: (9.60) "$\frac{1}{4}\frac{17}{20}$" (text), "$\frac{1}{4}\frac{17}{20}$] $\frac{17}{20}$ ω" (apparatus); it should read: "<$\frac{1}{4}$> $\frac{17}{20}$" (text), "$\frac{1}{4}$ *addidi*" (apparatus). Such unequal treatment of words and figures has no basis whatsoever.

The same holds for replacements, which should be clearly noted in the apparatus. For example: (3.39) "decenis" (text), "decenis] unitatibus ω" (apparatus). It is unclear who is actually responsible for the correction *decenis*: is it Giusti, or (for instance) Boncompagni, or else an anonymous revisor of a manuscript? Shall I assume it is always Giusti? In the latter case, it should at least be noted by saying that all corrections that are not otherwise attributed are the editor's. For the sake of clarity (as customary), it should read, "decenis" (text), "decenis *scripsi*] unitatibus ω" (apparatus).

What has been remarked above—namely, that the editor's deletions and additions are both noted in the apparatus as replacements—completely conflates different kinds of errors. The same holds for individual variants. To give but one example: (6.30) "alios numeros" (text), "alios numeros] alios **R**" (apparatus); it should read: "alios numeros" (text), "numeros *om*. **R**" (apparatus).

The undeniable merits of this new edition notwithstanding, Giusti's approach to the text of the *Liber Abbaci* betrays

[14]The problem of authorial blank spaces is well known for Moerbeke's translations: see Proclus, *Commentaire sur le Parménide de Platon. Traduction de Guillaume de Moerbeke*, Tome I: *Livres I à IV*, édition critique par Carlos Steel, Leuven: University Press and Leiden: E. J. Brill, 1982, p. 49*-53*. The blank spaces left by Moerbeke are at times reproduced by copyists, at times simply omitted: see, for example, *ibidem*, pp. 20.38, 30.52, 91.14, etc. Just as Moerbeke left blank spaces when he did not know how to translate a given Greek term, or sentence, so Leonardo might have left a blank space, to be filled later with the correct computation.

[15]Introduction, p. CIII. As a matter of fact, rather than a critical edition of the *Liber Abbaci*, Giusti provided what Gerolamo Saccheri would have called *Leonardus Pisanus (vulgo Fibonacci) ab omni nævo vindicatus*.

[16]This very idea is reflected by Giusti's assessment of Boncompagni's edition: "The text is substantially correct; its mathematics much less so" (p. LXXVI).

[17]In antiquity and the Middle Ages, the author's control over the text was extremely difficult (the material conditions under which authors worked need to be taken into account as well), so that ponderous scientific works, involving a huge quantity of figures and diagrams, necessarily included a more or less substantial number of author's errors. Not even the invention of printing managed to avoid such errors. See, for example, Nicolas Copernic, *De revolutionibus orbium cœlestium / Des révolutions des orbes célestes*, édition critique, traduction et notes par Michel-Pierre Lerner, Alain-Philippe Segonds et Jean-Pierre Verdet, Paris: Les Belles Lettres, 2015, vol. II, pp. 73 (k), 112 (i), 132 (u), 220 (h), 230 (b), 255 (a) (e), etc.

a poor understanding of the nature of the philologist's work, which requires specific technical skills, the awareness of the variety of textual traditions, and the ability to deal with them. Philology, just like mathematics, cannot be improvised.

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