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A Catalan Astronomical Manuscript of the Fifteenth Century: Newberry Library Ayer MS 746

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The Newberry Library is the most outstanding collection of original source materials available to medievalists in the state of Illinois. In its large manuscript collection, the Newberry owns a fifteenth-century Volume, Ayer MS 746, that contains several previously unidentified astronomical texts, as well as medical recipes and birth records added by the manuscript's owners. Virtually all of this material is written in Catalan. Paul Saenger of the Northwestern University Library first brought this manuscript to my attention when he asked me to examine several incipits and explicits needed for his catalogue of the Newberry's medieval manuscripts. From that first cursory examination, I have gone on to study the manuscript in detail, investigating both the value and sources of the astronomical texts that it includes and the particular codicological and paleographical features that it displays.1 This paper summarizes the still very preliminary results of my investigations.

Generally speaking there is nothing terribly remarkable about either the contents or construction of Ayer MS 746. As a sort of astronomical miscellany in the vernacular, it is simply one more testimony to the well-known flowering of astronomical studies in fourteenth and fifteenth century Aragon.2 As a manuscript book, it is an ordinary looking Volume of manual size, and very probably a typical product of the Barcelona booktrade of the period. Nonetheless, Ayer MS 746 can contribute in a very material way to our knowledge of late medieval scientific and technical literature, considered as written tools that

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were used, rather than simply read, for concrete purposes in the lives of those who possessed them. This material fact of use, combined with the explicit evidence of ownership that the manuscript happily contains, makes Ayer MS 746 an excellent object of investigation for that "archaeology" of the book proposed by L.M.J. Delaissé.3 The following remarks attempt to pursue a deliberately holistic description of the manuscript's texts, construction, and use in order to emphasize its status as a cultural artifact that offers material testimony to those social, cultural, political, economic, or technological forces of fifteenth century Aragon that helped produce it.

The manuscript's physical construction offers several salient features. First, it is a small Volume, of true manual size (approximately 11 1/2 by 17 centimeters), comprising 109 parchment leaves in eleven quires, plus the front and back endpapers pasted down to the boards. The latter are apparently original, wooden, and covered in leather (now badly decayed) with bosses on the front and back arranged in a quincunx, and a hinge (half of which is lost) that opens from the top, in a common Southern European fashion. The binding has obviously been repaired in modern times (as a new strip of cloth in the spine shows) with the result that the manuscript no longer opens easily; the binding was probably looser originally, in order to allow free consultation of the numerous tables and diagrams in the texts. There are many wormholes in the endpapers, and some (but not all) of these continue into the boards and outer quires.

In its paleographical features, the manuscript shows a range of hands. The main astronomical texts and their

accompanying diagrams (items 4, 6-10, 13, and 14 in Appendix A) all use a kind of cursiva formata that Zacarías García Villada calls "cursive Gothic"4 (see Illustration 1). The first line of these

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texts is written over or above the top ruling, a common fifteenth century feature. The rulings for these texts are, in most eases, only faintly visible, if at all; their accompanying tables have red rulings that disappear into the binding. These main texts offer the most elaborate decoration of any in the manuscript. They use red and purple or blue and red capitals, red and blue paragraph symbols, red rubrics, numbers, or reference letters, and red and yellow touches. Some texts or portions of texts have no rubrics, paragraph symbols, or capitals, and hence less decoration. The Canons of Jacob Poel (item 10) are unusual, however, for their complete lack of yellow touches.

Four separate tables (items 5, 11, 17, and 19) use a very small Gothic bookhand (see Illustration 2). The sides of the leaves bearing these four tables appear noticeably smoother than other leaves, suggesting that they received extra rubbing in order to prepare them for the detailed material of these charts. The rulings for these tables use regular ink, are not especially neat, and do not enter into the binding, which suggests that they were added after the manuscript was bound. The other tables and diagrams (items 3, 12, 15-16, and 18) use various cursive hands. Their rulings also use regular ink (with the exception of item 16) and do not enter the binding. Their decoration is limited to now faint ochre touches, although items 16 and 19 also employ red ink for numerals and rubrics.

There is a group of birth records dated 1438-1456 and various medicinal recipes that use a personal cursive hand (items 23 and 24; see Illustration 4), while other records dated 1490-1501 in Italy show a more humanistic type of cursive script (items 20 and 22). The angle of writing in these recipes and records indicates that they were probably added after the manuscript was bound.

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The changes of hand between the main astronomical texts and the various other tables suggests that these are later additions to the manuscript, although a single scribe was, of course, capable of employing several different hands, particularly for specialized purposes such as tables or diagrams. Moreover, the fact that the rulings of those other tables do not enter the binding, that their decoration is markedly inferior, and that their arrangement in the manuscript seems limited to the disposition of the main texts argues in favor of their later addition, as I will show in more detail immediately below. Before examining that question, however, one initial conclusion is fairly obvious: Ayer MS 746 is a commercially produced book, confected and finished by a bookseller who presumably already had or recognized a strong potential market for such a work. This Volume disseminates received astronomical lore; none of its contents is original. It fulfills a kind of "popularizing" function that testifies to the breadth and strength of vernacular scientific culture in fifteenth century Aragon, and to the contribution of the booktrade in sustaining that culture.

If we turn now to the disposition of the various texts and tables in the manuscript, it will be easier to examine this aspect by considering it in conjunction with the nature and contents of the texts themselves. I will present these in the order of their inclusion in the manuscript, as I understand it.

Five texts or charts clearly comprise the main and necessarily original material in the manuscript. These all employ the same cursiva formata script and display the other features noted above. These are the treatises (with appended charts and paragraphs) on the use and construction of the astrolabe (items 4 and 6-8; ff. 2r-33r and 34r-48r), brief directions for

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constructing an equatorial sundial (item 9; ff. 48v-50v), Canons and Tables of Jacob Poel (items 10 and 13; ff. 51r-70r and 73v-98r), and tables for calculating the Aureus Numerus to determine the date of Easter (item 14; ff. 98v-99v). In addition, the wind rose on the front endpaper and unidentified diagram on the back endpaper also employ the same hand and therefore appear to belong to the original material in the manuscript. If we assume that the manuscript originally included only these items, the following folios would have been left blank: lr-lv, 33v, 70v-73r, and 100r-109v. As we shall see, most of these blank sections were filled with later additions, probably in two stages, in order to complement or extend the miscellaneous texts originally copied into the manuscript.

Taken in order, these original texts begin with a treatise on construction and use of the astrolabe, based on the work (now lost) of the famous Messahalah (d. ca. 815), a Jewish astrologer employed by the caliphs of Baghdad.5 Messahalah's works, which reached Spain in the tenth century, provided the basis for many later texts, and the Catalan treatise in Ayer MS 746 is probably a translation of one of these.6 The Catalan text bears strong resemblances to the

Latin version of Messahalah printed by Robert Gunther in his edition of Chaucer's famous astrolabe treatise.7 A "Messahalah" astrolabe treatise was a typical companion piece in medieval collections of astronomical works. Although it reverses the order of the two parts, the Catalan text of Ayer MS 746 preserves the characteristic incipit of each section, just as does the treatise of Andalo di Negro, published in Venice in 1475.8 Nonetheless, the rubrics attribute each part to the "great astrologer Ptolemy," as commonly occurs in many medieval astronomical texts.9 The star tables accompanying the text are typical of those attached to Messahalah's work, which usually list stellar positions

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by signs of the zodiac and measure them from both the ecliptic and celestial equator, the latter being the older and easier system, better suited for application to astrology.10 In the section on use, Chapter 40 concerning the "revolutions of the years of the world" (ff. 32r-33r) pertains specifically to astrological doctrine.11 The text is obviously a product of Moslem Spain, and not completely revised for use by non-Moslems; it includes a chapter on locating the quibla, or direction of prayer to Mecca, and another entitled "On finding the years of the Christians and their months." The height of the pole star is given as 400, which corresponds approximately to the latitude in contemporary tables for Toledo or Valencia, both centers of astronomical science.

The sundial instructions describe a very simple instrument of the equatorial type, capable of assembly in a short time. The instructions describe alignment of the instrument according to the latitude of Barcelona.

The longest text in the manuscript is the Canons and Tables of Jacob ben David ben Yomtob. Also known as Jacob Poel or Jacob Bonjorn, and by various other Latin and vernacular versions of his name, he was a Jewish astronomer of Perpignan in the mid-fourteenth century, and came from a distinguished scientific family; his father was a famous maker of instruments and his son was also an astronomer, who caused some controversy when he converted to Christianity in the face of the rising anti-Semitic sentiment current in later fourteenth-century Aragon.12 Jacob calculated his Tables for use at the latitude of Perpignan, beginning in the year 1361, as he explains in the Canons, or instructions for use of the Tables. The first of the tables gives this "root year" or radix at the top (see Illustration 3). The Canons have an interesting Prologue on the superior status of mathematics

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among the arts and sciences. The Tables form a sort of perpetual calendar for predicting eclipses of the sun and moon, based on a cycle of 31 solar years. They become very popular, and were glossed or commented upon by later astronomers, such as Abraham Zacuto of Salamanca. Jacob apparently wrote his work in Hebrew originally, and the Jewish Theological Seminary in New York possesses a manuscript of this version.13 There are also Latin and Catalan translations.14 The Catalan version in Ayer Ms 746 differs significantly from the other known vernacular translation, which suggests that the Ayer text might have been made specifically for this book. Its basis was probably a Latin text of Jacob's work, since the rubrics are in Latin. Use of Jacob's Tables requires a fairly developed knowledge of mathematics, and they are really the only material in the manuscript whose technical sophistication has any claim to historical importance. The creation of perpetual calendars or almanacs such as Jacob's was a long-standing tradition among the Hispano-arabs, and increased in the later Middle Ages,15 gradually replacing the production of more specialized technical treatises. However, these later almanacs also became increasingly simple, requiring less and less mathematical knowledge, where Jacob's Canons and Tables obviously require rather more than the rudiments. The potential buyer for such a work necessarily had that more advanced knowledge, and perhaps even an especial interest in Jacob's Tables themselves.

Finally, the tables for computing the Aureus Numerus are very simple in form and have rubrics entirely in Latin. They bear no explanatory notations, which implies the reader's prior knowledge of their use.

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Now that we have considered the nature of the main texts in the manuscript, we should recall that it would not be difficult to imagine a buyer for such a work in early fifteenth century Aragon, given the flourishing state of all the astronomical and geographical sciences in the kingdom at that time. The bookseller who produced this work for this buyer was able to draw on various products of Arabic, Jewish, and Christian science, a diversity emblematic of a cultural heterogeneity in Spanish society that was quickly disappearing.16 Access to these diverse products was still common among the conversos (converts from Judaism, often forced, or their descendants), who monopolized the Barcelona bookbinding trade of the period, and commonly provided works for Christian and non-Christian clients alike.17 Ayer MS 746 may be one of their products. The Canons and Tables of Jacob Poel would appear to be the centerpiece, as it were, of this artwork, with the other texts as complementary embellishments. It is interesting to note that the various main texts in the

manuscript resisted the common adaptation of geographical or celestial reference points for use in the place where they would be used:18 as we have seen, these texts give latitudes for points as diverse as Toledo, Barcelona, and Perpignan. This suggests that the bookseller who produced the Volume was either unable to make, or uninterested in making, such changes.

If we turn now to the other texts or tables in the manuscript, we find that they serve to continue the miscellaneous and apparently popularizing function of the main materials in the manuscript. Because of the variations in script, decoration, and disposition in the manuscript, it seems likely that these other texts or tables were added in two stages. The first stage would comprise the four tables that use the Gothic script. These four tables all appear on

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the verso of leaves in those sections not filled by the main texts. The first table obviously occupies the only blank page in its entire section, but the other three appear in sections of more than one blank page. This suggests that these tables were all copied into the manuscript when several blank openings were still available, and placed on the first page (i.e. left-hand side) of each opening. The contents of these four tables extend the miscellaneous character of the manuscript by offering a chart of astrological "elections" or favorable signs for particular activities, from a royal audience to bloodletting to hunting (item 5; f. 33v; see Illustration 2); a list of the hours and minutes of "midday" by latitude (item 11; f. 70v); a list of eclipse extent by "digits" (item 17; f. 101v); and a list of the "proportion of increase over twelve hours of the longest day, by latitude" (item 19; f. 102v). Tables of such material are common in medieval astrological and astronomical manuals,19 but here they have no specific relation to any of the main texts in the manuscript; the second and fourth offer tabular summaries of calculations described in the treatise on use of the astrolabe. The third obviously concerns eclipses, but not calculation of their dates.

The second stage of additions would comprise the various tables that occupy the second page (i.e. right-hand side) of the openings left blank after the copying of the main texts in the manuscript and of the four charts in Gothic script into the first pages of their openings. These also offer both astrological and astronomical lore: diagrams and notes on the mechanics and limits of eclipses (item 12; ff. 71r-73r); a chart of combinations of the elements in the signs of the zodiac (item 15: f. 100r); and a diagram showing the difference between the true and visible horizons (item 18; f. 102r). The latter is noteworthy as a graphic representation of a point explicitly mentioned in Jacob's text (f. 57r), although

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it is so simple that it hardly requires illustration. Similarly, the notes on eclipse limits treat a topic discussed by Jacob (ff. 65v and 68r). These notes refer to limits for the third "revolution," which is perhaps the 31-year cycle of Jacob's system, since that is the term that he uses; if so, these notes would give figures for the period 1423-1454, and thus may be contemporary data added to facilitate use of the Tables during those years.

A final anomalous table (item 16), representing a possible "third stage" of additions to the manuscript, fills the opening formed by folios 100v and 101r. The two charts of this table list the influence of each astrological sign over each hour of the night and day. They have red rubrics and numerals, faded ochre touches on letters, and a light purple ruling that almost enters the binding at the bottom. The fact that one of the four tables in Gothic script follows, and one of the others in a cursive hand precedes, this table makes speculation about the relative chronology of their addition into the manuscript difficult.

What do these additional tables reveal about the use of the manuscript and its main texts? A few of them obviously complement those texts, but the rest instead extend the manuscript's miscellaneous character, and especially its status as a reference manual of precalculated data. It thus reflects the trend in the later medieval astronomical literature of Spain toward perpetual almanacs requiring no calculations for use, and away from more specialized works. In fact, the presence of so much miscellaneous material in the manuscript serves to attenuate whatever central or primary status that the Canons and Tables of Jacob Poel might have had originally. We might surmise that these less sophisticated additions reflect more general interests in subsequent users of the manuscript, who therefore had them

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copied into it. The addition of explicitly astrological materials represents a special orientation toward that application of astronomical knowledge, which flourished in late medieval Aragon.20

In attempting to understand the value and use of this manuscript, we are fortunate to know who its owners were at the end of the fifteenth century, because they left two generations of their birth records in its final leaves. They were the

family of a certain Bartholomew of Besalú. Besalú is a town in northern Catalonia new the city of Girona; it was an established, if minor trade center in the Middle Ages, and home to several distinguished figures in history.21 A toponymic surname such as "of Besalú" is typical of an emigrant from the place named, and Bartholomew probably no longer lived in Besalú or its district; his sons apparently came from Barcelona. The oldest records appear on the last folio of the manuscript (109r), and list the births of Bartholomew's children, notably his sons Francis and Raphael (born in 1446 and 1449 respectively). These entries give the children's godparents, but no place of birth, perhaps because they were recorded in the birthplace itself, which obviated the need to indicate any location. Still, it is not certain that they are contemporary; they could have been added much later, simply as a means of keeping records after the fact. The cursive document hand used in all these entries is very similar in all of them, although some changes in ink or writing angle are noticeable.

The next to last leaves of the manuscript (ff. 105v-108v) offer a selection of medicinal recipes for maladies ranging from headaches to impotence to epilepsy. These reveal many different personal cursive hands and are grouped into distinct sections. This use of the manuscript for private or domestic records suggests, I would argue, a decreased interest in its use as a work of applied astronomical science.

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It may, of course, have been the only book available to the family for recording personal or domestic information, even while they still used its scientific texts.

Moving further backwards into the manuscript we find on folios 103v-105v the birth records for the children of Francis and Raphael themselves, covering the years 1490-1501. Each brother's records show a different cursive script of a more humanistic type, and various changes in ink or writing angle are evident throughout their entries. These records obviously postdate the recipes and earlier records, and their incorporation backwards into the manuscript does suggest a desire to keep this material as separate as possible from the astronomical texts and tables in the Volume. Perhaps the most important feature of these records is their indication of Florence and Venice as the birthplaces of the children, and of Venice as the final resting place of Francis, who died sometime between 1494 and 1500. This specification of the birthplace perhaps reflects the family's perception of its temporary or extraordinary residence in foreign territory, a sentiment not inconsistent with the loyalty to their homeland that these Catalan merchants are known to have displayed.22 Francis and Raphael are but two of the many Catalan merchants active in Italy during the fifteenth century. Francis was trading there by 1474, when records from Naples describe him buying and selling grain for export.23 By 1482 the Aragonese Crown owed the two brothers substantial sums.24 Their presence in Northern Italy undoubtedly resulted from their commercial affairs, in which they evidently prospered, and attained important social standing: the godparents of their children include the Florentine banker Giuliano Gondi,25 and members of such distinguished families as Frescobaldi, Pazzi, and Strozzi. Finally, we might note one other possible result of the manuscript's use by the brothers or

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someone after them. Between folio 103r (left blank) and folio 102v (which bears one of the four charts in Gothic script) is the stub of folio 107, the only half sheet in the entire manuscript. All the quires in the manuscript have full sheets, usually ten (the seventh quire has twelve, the tenth eight), so it is unlikely that folio 107 is a deliberate singleton, especially since it was left blank. It is possible that the leaf following folio 102v bore some diagram or table removed for separate use, or that it too was blank and removed for some other purpose. If the manuscript's original binding was looser, cutting out the leaf would not have been difficult.

The recipes and birth records left by Francis and Raphael of Besalú in Ayer MS 746 are chronologically the last clues concerning the use of the manuscript. There is one inscription in an elegant sixteenth century hand a diagram with the word "Ripa" on folio 1r. It would appear that use of the astronomical material in the manuscript ended with Francis and Raphael, if in fact they used it at all. Complete disuse of the manuscript is especially probable if it remained in Italy after 1501; there are several reasons for this. First, the text that is perhaps the most important in the manuscript, the Canons and Tables of Jacob Poel, is designed for use at the latitude of Perpignan, and an owner without the considerable mathematical skill needed to adapt the Tables would find them useless elsewhere. Second, virtually all the material in the manuscript is written in Catalan, which ceased to be a literary and scientific language in the sixteenth century, owing to some complex and still imperfectly understood changes in Catalan society and culture. The disuse of Ayer MS 746 testifies to this decline, known among Spanish historians as the "Decadence," in Catalan vernacular culture.26 A work written entirely in Catalan would necessarily have found only a limited readership outside of Catalonia, and a continually

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decreasing one there as well. Moreover, it is possible that, if the children of Francis and Raphael of Besalú remained in Italy, speaking largely Italian, they would have found the texts in the manuscript increasingly unintelligible. A hint of their linguistic and cultural assimilation appears in the Italianate names such as Lodivica, Johan Batista Paulo, and Francesco Benedetto given to the children of Raphael in the records. These Italianate names are even more notable when we consider the tendency in these records to create Catalan forms for the names of the Italian godparents. Finally, the patently "medieval" character of the manuscript's scripts and contents would have limited even further its appeal in the humanist culture of Northern Italy. In short, circumstances of geography, language, and culture, probably all conspired to restrict very sharply the possible use of Ayer MS 746 in sixteenth century Italy.

Understanding the mutual relationship of composition and use is one of the chief lessons available to us from the study of Ayer MS 746 as a written artifact. It reveals how directly the creation of medieval manuscript book depended upon specific material circumstanees, sueh as the availability of particular texts, their offering by particular book-sellers, and the existence of particular buyers willing and able to acquire and use them in a book. Subsequent use of the manuscript obviously depended upon the degree to which its codicological and textual composition could match changes in the circumstances of use. Some tension between the manuscript's composition and use was inevitable, and would affect each aspect in diverse ways; the most extreme results would be destruction of the manuscript on the one hand, or its complete disuse on the other. Ayer MS 746 shows, I believe, some initial efforts to change its composition in response to changes in use, but an eventual cessation of use

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altogether, My remarks in this paper probably carry speculation about the history of the manuscript as far as we dare take it and perhaps beyond. More investigation of every area discussed above is obviously necessary. But I still hope that my comments and suggestions will serve to remind us of the valuable insights that the "archaeology" of manuscript books perhaps the most numerous artifacts available to us from. those centuries can offer concerning the "structures of everyday life" in the Middle Ages.

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APPENDIX A
The Contents of Ayer MS 746

1. (inside front board endpaper) Wind rose.

2. (inside front board endpaper) Medicinal recipe using red wine.

3.c(lr) Diagram labelled "Ripa."

4. (2r-33v) Treatise on use of the astrolabe. Incipit: Açi comença lo tractat del stralau del gran strolech Tholomeu. Rubrica del present libre... (list of chapter titles follows). Explicit: Et abtant ha compliment lo tractat del stralau. A deus gracias.

5. (33v) Astrological table of "elections."

6. (34r-44r) Treatise on construction of the astrolabe. Incipit: Açi comença la pratica de fer l'astralau del gran stroleg Tholomeu per set clims. Explicit: Et abtant es complida la pratica de fer l'estralau. A Deus gracias.

7. (44v-45v) Three separate further paragraphs on using the astrolabe.

8. (46r-48r) Charts illustrating construction of the astrolabe.

9. (48v-50v) Brief treatise on constructing an equatorial sundial. Incipit: Si volem fer hun instrument per lo qual sapiam quina hora es del dia per la ombre del sol en qualsevulla die del any et en qualsevulla orizon... Explicit: Et sera aquesta linia de necessari linia del mig jorn, ço es que en qualsevol dia del any, con la ombra de la columpna caura sobra aquesta linia, sera mig jorn. One illustrative diagram

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follows in the lower half of 50v.

10. (51r-70r) The Canons of Jacob Poel. Incipit: Dix Jacob, fill de David, fill d'en Bonjorn: per tal com la sciençia matematical entre les altres sciençies es singular en fortitud de la verificaçio que perve en los seus quisits... Explicit: Et aquella es la lugor perfeta fort continua que de la influencia influent de part sua ha sclarit tota cosa scura, aixi com diu lo propheta "el la terra ha illuminada de la sua gloria." Senyor ver Deus, converteixnos, iliumina les tues faç et serem sans. Et est phinitum.

11. (70v) Table showing the length of "midday" by latitude.

12. (71r-73r) Diagrams and notes explaining eclipses, with some rubrics in Latin.

13. (73v-98r) The Tables of Jacob Poel.

14. (98v-99v) Tables for calculating the Aureus numerus in Latin.

15. (100r) Chart of combination of four elements in the twelve zodiacal signs.

16. (100v-101r) Chart showing influence of each zodiacal sign over each hour of night and day.

17. (101v) Table of extent of eclipses in "digits" in Latin.

18. (102r) Diagram illustrating difference between true and visible horizon.

19. (102v) Table showing "proportion of increase over twelve hours of the longest day for each latitude."

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(103r blank)

20. (103v) Birth records for children of Rafel de Besalú, for years 1497-1501.

(104r blank)

21. (104v) Birth records for children of Francesch de Besalú, for years 1490-1500.

22. (105r) Birth records for children of Rafel de Besalú, for years 1490-1495.

23. (105v-108v) Medicinal recipes.

24. (109r) Birth records for children of Berthomeu de Besalú, father of Francesch and Rafel, for years 1438-1456.

(109v blank)

25. (Inside back board endpaper) Astronomical diagram and notes.

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