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An Astronomical Table by Shabbetai Donnolo and the Jewish Calendar in Tenth-Century Italy

The astronomical table published for the first time in this article appears in a single—the most ancient—manuscript of Shabbetai Donnolo's *Sefer Ḥaḵmoni*. It contains the planetary ephemerides for the period of one lunar month corresponding approximately to September 946 CE. This table provides not only important evidence of Donnolo's astronomical knowledge, but also unique evidence about the Jewish calendar as it was reckoned in tenth-century Italy.

Shabbetai Donnolo and the *Sefer Ḥaḵmoni*

Shabbetai ben Abraham Donnolo was born in Oria, one of the most important outposts of Byzantine Apulia, around the year 912/13. In 925, after Oria had been conquered by the Arab armies led by Ja'far ibn 'Ubayd, the emir and army chief of the Fatimid caliph 'Ubayd Allāh al-Mahdī, the twelve-year-old Shabbetai was deported and subsequently ransomed by his family in Taranto, an important Apulian seaport under Arab control. For the rest of his life he probably remained in Byzantine southern Italy, spending most of his time in Rossano (near

Calabria), where he was on good terms with the Byzantine authorities and with St. Nilus, one of the leading authorities of medieval Christian monasticism. It was in Rossano, probably not long after the fall of Oria in 925, that he plunged himself into the study of the celestial bodies under the guidance of a Babylonian (Iraqi) teacher. Also famous as a physician, he was allegedly one of the four doctors—a Latin Christian, a Greek Christian, a Jew, and a Muslim—who founded the medical school of Salerno. The date of his death is unknown, but the year 982 is mentioned in a passage of his *Sefer Ḥakmoni* and thus can be regarded as the *terminus post quem*.

The literary production of Shabbetai Donnolo ranges from pharmacopoeia through human pathology to astrology and astronomy, although not all works can be attributed to him with certainty.[1] His most important work is *Sefer Ḥaḵmoni*,[2] completed in 946.[3] This work is well known for its discussion of the problem of the creation of man in God's likeness in Genesis 1:26[4] and for its commentary on *Sefer Yeṣirah*.[5]

The astronomical table and text published in this article come from the introductory section of *Sefer Ḥaḵmoni*, which opens with a poem set as a long acrostic bearing the author's name and his main biographical data. A long biographical section follows, wherein Donnolo gives a general account of the events following the fall of Oria, the deportation of the Jews from the city, and the beginning of his intellectual and professional career.[6] It is at this point that Donnolo introduces his astronomical table.

The Manuscripts

The introductory section of *Sefer Ḥaḵmoni*, from which our astronomical table and text are taken, is attested in five complete and four incomplete manuscripts, as follows (with the sigla employed in this article):

1 His astrological and astronomical works include *Sefer ha-Mazzalot* (Book of the Constellations), a commentary on the *Baraita de-Šemu'el,* of which only a long fragment is extant as a citation in Joseph ben Simeon Qara's commentary on the book of Job. The text was first published by Samuel David Luzzatto ("Miḵtav gimmel," *Kerem Ḥemed* 7 (1843): 60–67) and then by Zacharias Frankel ("Der Commentar des R. Joseph Kara zu Job," *Monatsschrift für Geschichte und Wissenschaft des Judentums* 5 (1856): 223–29; 6 (1857): 270–74; 7 (1858): 255–63, 345–58). Some passages were translated into English by J. Starr, *The Jews in the Byzantine Empire (641–1024)* (Athens, 1939), 157–59; see also I. Twersky, *Rabad of Posquières. A Twelfth-century Talmudist* (Cambridge, MA, 1962), 258 and 279 n. 38). The *Baraita de-mazzalot* has been attributed to Donnolo by Gad B. Sarfatti ("Mavo la-baraita de-mazzalot," *Bar-Ilan University Annual* 3 [1965]: 56–82, esp. pp. 80–82), based on an analysis of quotations attributed to Donnolo in later works such as *Midrash Leqaḥ Ṭov* (ed. S. Buber, 7 and 12–13) and *Sefer Raziel*; but see A. Sharf, *The Universe of Shabbetai Donnolo* (Warminster, 1976), 187.

2 The work is also known in the manuscript tradition as *Sefer Taḥkemoni.* A number of manuscripts (ס, בא, בב, and ד—see list of manuscripts and sigla) include in the title צפנת פענח ("who reveals secrets" [Gen. 41:45]). Certainly as a consequence of scribal misreading or miscopying, the work was also transmitted under the title מחכמוני (in מ). There is no certain interpretation צפנת פענח of the two names, which are both mentioned in the Bible: "And this is the number of the mighty men whom David had: Jashobeam, a son of Ḥaḵmoni" (1 Chron. 11:11); "these are the names of the mighty men whom David had: the son of Taḥkemoni who sat in the seat" (2 Sam. 23:8).

3 This date appears in the introductory section of the work and also corresponds to the date of the astronomical table. The passage dated 982 appears to be a later addition, probably by the author himself.

4 First published by A. Jellinek, *Der Mensch als Gottes Ebenbild. Von dem Arzte und Astronomen Rabbi Shabtai Donolo (Geb. 913)—Nach einer Handschrift der Kaiserlichen Bibliothek in Paris* (Leipzig, 1854), then reprinted by S. Muntner, *Rabbi Shabetai Donnolo, 913–985*, 2 vols. (Jerusalem, 1949), 1:214–38.

5 First published by David Castelli, *Il commento di Shabbatai Donnolo sul Libro della Creazione* (Florence, 1880), 30–88 (Hebrew section), together with the complete text of

א Florence, Biblioteca Medicea-Laurenziana MS 44.14
(1391, Sephardi cursive and Ashkenazi semi-cursive scripts. Paper)

בא Parma, Biblioteca Palatina MS 2123
(fourteenth century, Sephardi semi-cursive script. Parchment)

בב Parma, Biblioteca Palatina MS 2425
(1433, Ashkenazi semi-cursive script. Parchment)
Copied from MS Parma 2123. Not included as an independent textual witness.

גא Oxford, Bodleian Library MS Heb.e.26
(eleventh-twelfth century, proto-Italian square scripts. Parchment. See further below)

ד Oxford, Bodleian Library MS Opp. Add. Qu. 89
(1845, Italian cursive script. Sheets of a modern exercise book)
Copied from MS Parma 2123. Not included as an independent textual witness.

מ Moscow, Russian State Library MS Guenzburg 302/3
(sixteenth-seventeenth century, Italian and Ashkenazi scripts. Paper)

נ New York, Jewish Theological Seminary MS 2141
(fourteenth-fifteenth century, Italian cursive script. Paper and parchment)

ס Jerusalem, Schocken Institute for Jewish Research of the Jewish Theological Seminary MS 13161
(seventeenth century, Oriental cursive script. Paper)

פא Paris, Bibliothèque nationale de France MS heb. 767
(fourteenth-fifteenth century, Ashkenazi script. Paper and parchment)

פב Paris, Bibliothèque nationale de France MS heb. 770
(various fifteenth-century hands and scripts, section of *Sefer Ḥaḵmoni* in Italian semi-square script. Paper and parchment)

The astronomical table itself is attested in only one of these manuscripts, MS Oxford (גא). This manuscript is by far the oldest

and holds the highest position in the stemma codicum. It is made up of eight parchment folios measuring ca. 17×20 cm and written in two different proto-Italian square scripts (ff. 1a–5a and ff. 5b–8b). It was dated by Neubauer to the eleventh–twelfth centuries, in chronological proximity to Donnolo's lifetime.[7] A *terminus post quem* is provided by the Hebrew year 4742 (= 982 CE) mentioned on folio 4a, line 9.[8] The Cairo Geniza provenance of this manuscript provides a *terminus ante*

Sefer Ḥaḵmoni and a long introduction. Castelli's edition was republished by Goldman in *Sefer Yeṣirah ha-meyuḥas le-'Avraham 'avinu* (Warsaw, 1884), 121–48, and in an anastatic copy by Lewin-Epstein, *Sefer Yeṣirah* (Jerusalem, 1962), 148–67. It is important to note, however, that the text published by Goldman and Lewin-Epstein is not identical to Castelli's: many passages were modified on the basis of the variant readings of the Castelli edition, but also on what appears to be a series of linguistic conjectures totally unrelated to any manuscript evidence. There is no mention of this editorial intervention in the two letters written by Castelli and Buber in the preface to the text.

6 This introductory section was first published by A. Geiger, "Haqdamat sefer ha-taḥkemoni," *Melo Ḥofnaim* (Berlin, 1840), pp. 28–33; other parts of the text were published by Jellinek, *Der Mensch*, pp. 245–250 and S. D. Luzzatto, "Iggeret 15," *Kerem Ḥemed* 8 (1854): 97b–102. The first poem was also published by J. (Ḥ.) Schirmann, *Mivḥar ha-širah ha-'ivrit be-'Italya* (Berlin, 1934), 15–16; idem, "Gli albori della poesia ebraica in Italia," *La Rassegna Mensile di Israel* 35 (1969): 187–210, esp. pp. 196–97. The Hebrew text with an English translation appeared in Sharf, *The Universe*, pp. 7–8 and 159–60.

7 See: A. Neubauer and A. E. Cowley, *Catalogue of the Hebrew Manuscripts in the Bodleian Library* 2 (Oxford, 1906), No. 2762; A. Neubauer, "Un chapitre inédit de Sabbetai Donnolo," *Revue des études juives* 22 (1891): 213–18.

8 "David did not pronounce those verses to teach the generations that lived after him and before us, people of good name, but also for the inane, witless and wisdom-less generations of our time in the year 4742 from the Creation of the world, the eleventh year of the 250th cycle."

quem of the first half of the thirteenth century, when the chamber of the synagogue in Fustat was walled up.[9]

Folios 1a–2b contain the last words of Donnolo's introductory poem to *Sefer Ḥakmoni* and the autobiographical section (see above). Folios 3a–3b contain our astronomical table, followed by a poetical composition unattested in any other manuscript. This poem is made up of nineteen Biblical quotations, all of them taken from the book of Proverbs; like the initial poem (see above), it is set as an acrostic of Donnolo's name, this time with an extra qualitative (שבתי בר אברהם קונה חכמה). Folios 3b–6b contain a further introduction to *Sefer Ḥakmoni*, not attested in any other manuscript. Then follows the first part of Donnolo's commentary on Genesis 1:26 (ff. 6b–8b).

This manuscript was almost certainly part of a longer codex containing the entire text of *Sefer Ḥakmoni*. Numerous paleographic analogies have been found, in fact, with two other Cairo Geniza fragments that contain other parts of *Sefer Ḥakmoni*: MS Cambridge, University Library T-S. K 21.43; and a fragment published by Alexander Scheiber.[10] The authenticity of this manuscript and its astronomical table can thus hardly be doubted.

Donnolo's Description of the Table

As stated, the astronomical table is attested only in the earliest manuscript of *Sefer Ḥakmoni*, MS Oxford. It was presumably omitted in later manuscripts because of its technical complexity and the scribes' lack of interest in preserving it. However, Donnolo's description of the table, which appears in the main text, did survive more or less intact in all the manuscripts, except for some errors and changes that were due, again, to its technical complexity, but also perhaps to the scribes' inability to relate this text to the astronomical table that it described (because the table had not been preserved).

Below is a transcription of Donnolo's description of the table, as it appears in MS Oxford. The layout of the text in this manuscript is unusual, representing perhaps an attempt to separate and classify the various elements of the table. For the original layout, the reader should refer to the facsimile (Figure 1). The layout in this transcription reflects a measure of interpretation which we hope is accurate:

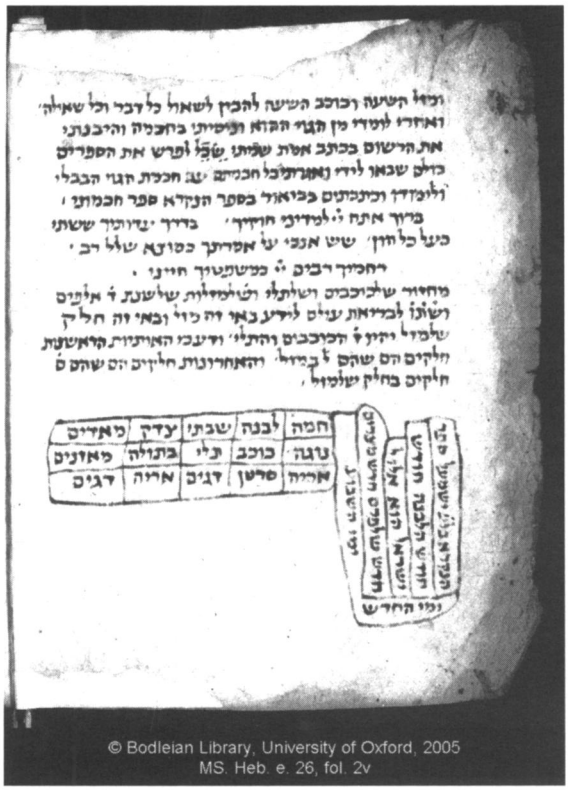

Figure 1: Donolo's description of the table

מחזור שלכוכבים ושלתלי ושלמזלות שלשנת[a] ד' אלפים ושתו[b] לבריאת עולם
לידע באיזה מזל ובאי זה חלק שלמזל יהיו ז'[c] הכוכבים והתלי. ודע כי האותיות
הראשנות חלקים הם שהם ל'[d] במזל. והאחרונות חלקים הם שהם ס' חלקים
בחלק שלמזל.

ימי החדש:

הנקרא ב..[e] ישמעל ספר חדש הלבנה חדש ישראל הוא אלול
חדש שלפרס
חדש מצרים
ימי השבוע[f]
חמה לבנה שבתי צדק מאדים נוגה כוכב תלי
בתולה מאזנים אריה סרטן דגים אריה דגים[g]

Notes on the text[11]

[a] בא omits שנת. [b] These letters have superscribed dots to indicate that they are numbers. [c] מ omits 'ז'. [d] באס read ששים, נ reads ס, מ reads ששה; all these are obviously erroneous. [e] Two letters partially erased, illegible. Other MSS read בלשון ("in the language"). [f] בא reads ימי החדש. פב omits the whole passage from ימי החדש until this point, perhaps because of homoioteleuton. [g] So also פב, but in other MSS the sequence of zodiacal signs is different, as follows:

ס בתולה מזנים אריה סרטן דגים אריה דלי
נ בתולה מאזנים אריה סרטן דגים דלי
א בתולה מאזנים אריה סרטן דגים
בא טלה שור תאומים סרטן אריה בתולה מאזנים עקרב קשת גדי דלי דגים. ובספר אשר העתקתי ממנו
אין בו מן המזלות כי אם שבעה והן בתולה מאזנים אריה סרטן דגים גדי דלי
מ טלה שור תאומי' סרטן אריה בתולה מאזני' עקרב קשת גדי דלי דגים

Translation

Table [lit. "cycle"] of the stars [i.e., planets], lunar node, and zodiacal signs for the year 4706 from the Creation of the World, in order to know in which zodiacal sign and in which part thereof will be[12] the seven stars [i.e., planets] and the lunar node. Note that the first letters

are the parts that are 30 in one zodiacal sign, and the last (letters) are the parts that are 60 in one part of zodiacal sign.

9 See: S. C. Reif, *A Jewish Archive from Old Cairo. The History of Cambridge University's Genizah Collection* (Sabon, 2000), 1–22; idem, *A Guide to the Taylor-Schechter Genizah Collection* (Cambridge, 1973), 1–3; S. D. Goitein, *A Mediterranean Society: The Jewish Communities of the World as Portrayed in the Documents of the Cairo Geniza*, 6 vols. (Berkeley and Los Angeles, 1967–1993), 1:29; P. E. Kahle, *The Cairo Genizah* (London, 1947).

10 The scribal techniques employed for ruling and pricking the vellum are the same in all three. With the exception of the first five folios of the Oxford manuscript, all three display the same script. The three fragments have exactly the same folio size and approximately the same number of lines on each. Finally, there is an exact proportion between the quantity of text contained in the extant folios and what was in all probability contained in the missing folios. On the latter, see Alexander Scheiber, "Qeṭaʿ ḥadaš mi-peruš naʿaśeh ʾadam be-ṣalmenu le-rabbi Šabbetai Donnolo," *Sinai* 30 (1952): 62–64. Scheiber did not provide any bibliographical information about his manuscript, which he claimed to have found in Kaufmann Geniza Collection of Budapest. Despite all our efforts to recover the original manuscript and searches in Budapest and at the Institute for Microfilmed Hebrew Manuscripts at the National Library in Jerusalem, no information on this manuscript has turned up. We would like to take this opportunity to express sincere gratitude to Kinga Devenyi of the library of the Hungarian Academy of Sciences, Budapest, Dr. Anna Somfai of the Warburg Institute, London, and Dr. Benjamin Richler, former director of the Institute of Microfilmed Hebrew Manuscripts of the Jerusalem Jewish and National University Library, for their help and generous support. The few codicological details provided by Scheiber match the Oxford and Cambridge manuscripts which we have directly examined.

11 These notes refer only to significant textual variations. A full critical apparatus to *Sefer Ḥakhmoni* will appear in Piergabriele Mancuso's doctoral dissertation.

12 We take the imperfect יהיו to be a future tense. This implies that the table was redacted before the date of these ephemerides, i.e., before September 946 CE.

Days of the month:

That called in the ... of Ishmael "Safar,"[13] a lunar month, this is the Jewish month of Elul.

Persian month.

Egyptian month.

Days of the week.

Sun, Moon, Saturn, Jupiter, Mars, Venus, Mercury, lunar node.

Virgo, Libra, Leo, Cancer, Pisces, Leo, Pisces.

This passage represents reasonably well the astronomical table as we have it. As indicated in this passage, the first section of Donnolo's table is calendrical. The first four columns of the table, as we shall see, indicate the days of the month according to four different calendars: Islamic/lunar/Jewish (treated as all one and the same), Julian (not mentioned, however, in Donnolo's description here), Persian, and Egyptian. The fifth column indicates the day of the week. The last eight columns are astronomical and provide the true longitudes of the sun, moon, Saturn, Jupiter, Mars, Venus, Mercury, and lunar node respectively. As stated in this passage, longitudes are expressed in relation to the zodiacal signs, which are divided (as per standard usage) into 30 degrees, and each degree into 60 minutes.[14]

The last line of this passage is a string of seven zodiacal signs in disorder, with repetitions. This string at first sight is incomprehensible, which explains why it has become corrupted in the manuscript tradition. Its purpose, however, is probably to indicate in which zodiacal sign the sun, moon, planets, and lunar node are positioned at the beginning of the table. This is necessary because the table itself does not indicate this (zodiacal signs are mentioned in the table only where there is a change, i.e., whenever the celestial body enters a new sign). At the beginning of the table, the celestial bodies are in the following signs:

- Sun: Virgo
- Moon: Libra
- Saturn: Leo
- Jupiter: Cancer
- Mars: Capricorn
- Venus: Leo
- Mercury: Leo
- Lunar node: Pisces

The last line of our text corresponds to this sequence, but with a few exceptions:
Table: Virgo—Libra—Leo—Cancer—Capricorn—Leo—Leo—Pisces
Text: Virgo—Libra—Leo—Cancer—Pisces—Leo—Pisces

Capricorn (for Mars) in the table has become "Pisces" in the text (the words for Capricorn and Pisces, גדי and דגים, seem to have been confused by metathesis), and the two Leos (for Venus and Mercury) have been merged into one.

These errors are more likely scribal, i.e., the result of faulty transmission. Yet this erroneous text in MS Oxford appears to have become the basis of all subsequent manuscript versions. In later manuscripts, indeed, this text was either preserved intact (פב), or the end of the sequence (after the first Pisces) was altered, perhaps in an attempt to eliminate the apparently unnecessary repetition of Leo and Pisces. Most interesting is בא, which reports that its master copy had a sequence of the same kind as other contemporary manuscripts (for

13 *Sic* (and so henceforth in this article), although the correct transliteration of the Arabic name should have been צפר, i.e., *Ṣafar*.

14 A "zodiacal sign" or מזל should be defined, in this context, as a 30° section of the ecliptic (or zodiac), with the first section counted from the vernal equinox. This term is not to be confused with zodiacal constellations, although they bear the same names.

example ג), but substitutes a list of the twelve signs of the zodiac in the correct order (both these versions appear in בא in the main text). Clearly, the scribe was baffled by the sequence of his master copy, which is understandable considering that the table itself was presumably not available for him to refer to. The twelve signs of the zodiac are also attested in a much later manuscript, מ.

The Astronomical Table: Text and Translation

A few editorial remarks. The astronomical data in the last eight columns of the table are fairly well preserved, except for a few blatant errors that can be reasonably corrected and some lacunae that can be reasonably restored. The transcription of the table as in the manuscript (Figure 2, p. 41) assumes our corrections and restorations (the latter are indicated in round brackets); the original, uncorrected manuscript readings are indicated in the notes. The translation follows our emended text.

The alignment of rows is completely disrupted in the manuscript (with a certain effect, also, on the columns); indeed, this is the manuscript's main flaw. In the transcription below, we have re-aligned the rows as they should originally have been in the table. For the reader's convenience, we have also added a row of headers; this row is not in the original table, but it is based on Donnolo's descriptive text cited above.

The table comprises 29 rows, corresponding to the 29 days of the lunar month of (Islamic) Safar or (Jewish) Elul, which in 946 CE, according to this text, began at the end of August. Columns 2–4 (Julian, Persian, and Egyptian calendars) have 30 rows, the first or last of which are superfluous in the table. We do not have a clear explanation for this excessive row, but it should be noted that the Persian and Egyptian months, as well as the Julian month of September, are all 30-day months.

Cols. 2–3 have been re-aligned on the basis that August 31, 946, is known to have been a Monday and to have corresponded to the fifth

of the Persian month (Shahrivar) as it was reckoned in that period.[15] This alignment also fits the astronomical data. The alignment of col. 4 remains uncertain, because the Egyptian month (Pachons) should have been conterminous with the Persian month, and thus the Egyptian starting date in this table should also have been the fifth (= August 31). The alignment we are proposing entails a one-day discrepancy between the Egyptian calendar (as we know it) and the other calendars, which remains unaccountable except as an error on the author's part.

Normal practice, in medieval astronomical texts, is to reckon zodiacal signs from 0° to 29° 59'. In the absence of any Hebrew alphabetical character for zero, the zero in this table has simply been omitted: thus for any position at 0°, only the minutes are given (for example in the first line, the position of Moon is indicated as נא for 0° 51').[16] However, presumably because of the zero problem, the author occasionally uses an alternative count from 1° to 30° 59' (thus the Sun in line 24, for example, is indicated as [Virgo] 30° 12'). Both counts are effectively the same, except that 30° of one sign (according to the latter count) is equivalent to 0° of the sign that follows (according to the former count): for example, 30° (Aries) = 0° (Taurus). Thus, the same position will be allocated (in this example) to either Aries or Taurus, depending on which counting system happens to be used. The use of both counts in this table leads therefore to some inconsistency, though only in a limited number of cases.[17]

15 See F. de Blois, "The Persian Calendar," *Iran* 34 (1996): 39–54.

16 In later Hebrew sources, e.g., Abraham Ibn Ezra's *Sefer ha-Mispar* (early twelfth century), the circular symbol O is proposed for representing zero: see T. Lévy, "Abraham ibn Ezra et les mathématiques: Remarques bibliographiques et historiques," in P. J. Tomson, ed., *Abraham ibn Ezra, savant universel* (Brussels, 2000), 60–75, esp. pp. 74–75.

17 We are grateful to the anonymous *Aleph* reader for pointing this out to us, as well as for making other important suggestions elsewhere in the article.

ספר אלול חדש הלבנה	(אוגוסט - ספטמבר)	חדש פרס	חדש מצרים	ימי השבוע	חמה	לבנה	שבתאי	צדק	מאדים	נוגה	כוכב	תלי
	ל		ג									
א	לא	ה	ד	ב	ז יט	נא	ז נט	יד ט	א יג	כ ה	כח לו	ב כד
ב	א	ו	ה	ג	ח יח	יב יד	ח ו	יד יט	א	כא יט	ל יד	ב כא
ג	ב	ז	ו	ד	ט יח	כד יג	ח יג	יד כח	מז	כב יג	א יב[a]	ב כ
ד	ג	ח	ז	ה	י יז	עקרב ז	ח כ[b]	יד לח	לה	כג מז	ג ל	ב יט
ה	ד	ט	ח	ו	יא יז	יט ד	ח כז	יד מז	כג[c]	כה א	ה י	ב יב
ו	ה	י	ט	ז	יב יו	קשת א כח	ח לד	יד נז	(י) דלי[d]	כו יה	ו יד	ב ט
ז	ו	יא	י	א	יג יה	יג יג	ח מא	יה ו	כט נח[e]	כז כט	ח ז	ב ו
ח	ז	יב	יא	ב	יד יד	כו יא	ח מח	יה יו	כט מה	כח מד	י כב	ב ב
ט	ח	יג	יב	ג	יה יג	גדי ט[f] מג	ח נו	יה כה	כט לג[g]	כט לה	יב ו	א נה
י	ט	יד	יג	ד	יו יג	כא ח	ט ב	יה לה	כט יט	בתולה א ג	יג מט	א נב
יא	י	יה	יד	ה	יז יג	דלי ד יה	ט ח	יה מג	כט יה	ב כז	יה כג	א מט
יב	יא	יו	יה	ו	יח יג	יז כב	ט יד	יה נב	כט י	ג מא	יז ז	א מו
יג	יב	יז	יו	ז	יט יג	לב ט[h]	ט כ	יו א	כט ה	ד יה	יח כב	א מג
יד	יג	יח	יז	א	כ יב	יג לו דגים	ט כו	יו י	כט	ו ט	כ לו	א מ

Notes on the table

[a] The zodiacal sign בתולה should have been indicated. [b] MS ב [c] MS לג
[d] Although there is no trace of (י), the letter may have been omitted because of its small size (similarly to our conjecture for the Moon, line 18). The sign דלי is sequentially in the right position, but it should have appeared in the next line. [e] MS יח [f] MS א [g] MS יג
[h] So the MS, but this is clearly impossible. The text should read either לב (with ט being superfluous), i.e., 0° 32', or כט ל, i.e., 30° 29'. The latter is preferable because it accounts

ספר אלול חדש הלבנה	(אוגוסט - ספטמבר)	חדש פרס	חדש מצרים	ימי השבוע	חמה	לבנה	שבתאי	צדק	מאדים	נוגה	כוכב	תלי
יה	יד	יט	יח	ב	כא יב	כו מג	ט לג	יז כ	כח נו	ז כד	כב לא	א לז[i]
יו	יה	כ	יט	ג	כב יב	טלה יא יה	ט לט	יז ל	כח נא	ח לח	כד יג	א לד
יז	יו	כא	כ	ד	כג יב	כה יג	ט מו	יז מ	כח מו	ט יג	כה יד	א לא
יח	יז	כב	כא	ה	כד יב	(י) כח[j]	ט נב	יז מח	כח מא	יא ה	כז לו	א כח
יט	יח	כג	כב	ו	כה יב	כה ג	ט נח[k]	יז נו	כח לו	יב כג	כט יז	א כה
כ	יט	כד	כג	ז	כו יב	ט יט[j]	י ח[l]	יז ג	כח לב	יג לז	מאזנים נט	א כא
כא	כ	כה	כד	א	כז יב	כג כח	י (?)	יז י	כח ל	יד נד	ב כב	א יח
כב	כא	כו	כה	ב	כח יב	סרטן ז יז	י (?)	יז יז(ז)	כח כח	יו כח	ד כה	א יה
כג	כב	כז	כו	ג	כט יב	כא ז	י כב	יז כד	כח כו	יז כד	ו ח	א יב
כד	כג	כח	כז	ד	ל יב	אריה ד נז	י כח	יז לב	כח כד	יט יה	ז נא	א ט
כה	כד	כט	כח	ה	מאזנים א יב[m]	יח מו	י לד	יז לט	כח כב	כ יג	ט לה	א ה
כו	כה	ל	כט	ו	ב יב[m]	בתולה א ג	י מ	יז מו	כח כ	כב א	יא יו	א ב[n]
כז	כו	א	ל	ז	ג יג	יד	י מו	יז נד	כח יח	כג י	יב יו[o]	נט
כח	כז	ב	א	א	ד יג	כו לז	י נב	יח א	כח יו	כד יט	יד לח	נו
כט	כח	ג	ב	ב	ה יד	מאזנים ט יד	י נח	יח ח	כח יד	כה כט	יו לט	(?)
		ד										

for all the characters in the text, and also because the sign דגים (in the next line) is then out of place by only one position (it should appear before יג לו in the same line). [i] MS יז [j] The zodiacal signs שור (in line 18) and תאומים (in line 20) should have been indicated. [k] MS נא corrected over into נח [l] Read maybe ה [m] MS כב [n] There follows a line of illegible letters. [o] Maybe יז

Translation

Safar Elul Lunar month	(Aug.-Sept.)	Persian month	Egyptian month	Weekday	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury	Lunar node
	30		3									
1	31	5	4	2	7° 19'	0° 51'	7° 59'	14° 9'	1° 13'	20° 5'	28° 36'	2° 24'
2	1	6	5	3	8° 18'	12° 14'	8° 6'	14° 19'	1°	21° 19'	30° 14'	2° 21'
3	2	7	6	4	9° 18'	24° 13'	8° 13'	14° 28'	0° 47'	22° 13'	(Virgo) 1° 12'	2° 20'
4	3	8	7	5	10° 17'	Scorpio 7°	8° 20'	14° 38'	0° 35'	23° 47'	3° 30'	2° 19'
5	4	9	8	6	11° 17'	19° 4'	8° 27'	14° 47'	0° 23'	25° 1'	5° 10'	2° 12'
6	5	10	9	7	12° 16'	Sagittarius 1° 28'	8° 34'	14° 57'	0° (10')	26° 15'	6° 14'	2° 9'
7	6	11	10	1	13° 15'	13° 13'	8° 41'	15° 6'	Aquarius 29° 58'	27° 29'	8° 7'	2° 6'
8	7	12	11	2	14° 14'	26° 11'	8° 48'	15° 16'	29° 45'	28° 44'	10° 22'	2° 2'
9	8	13	12	3	15° 13'	Capricorn 9° 43'	8° 56'	15° 25'	29° 33'	29° 35'	12° 6'	1° 55'
10	9	14	13	4	16° 13'	21° 8'	9° 2'	15° 35'	29° 19'	Virgo 1° 3'	13° 49'	1° 52'
11	10	15	14	5	17° 13'	Aquarius 4° 15'	9° 8'	15° 43'	29° 15'	2° 27'	15° 23'	1° 49'
12	11	16	15	6	18° 13'	17° 22'	9° 14'	15° 52'	29° 10'	3° 41'	17° 7'	1° 46'
13	12	17	16	7	19° 13'	30° 29'	9° 20'	16° 1'	29° 5'	4° 15'	18° 22'	1° 43'
14	13	18	17	1	20° 12'	Pisces 13° 36'	9° 26'	16° 10'	29°	6° 9'	20° 36'	1° 40'
15	14	19	18	2	21° 12'	26° 43'	9° 33'	16° 20'	28° 56'	7° 24'	22° 31'	1° 37'
16	15	20	19	3	22° 12'	Aries 11° 15'	9° 39'	16° 30'	28° 51'	8° 38'	24° 13'	1° 34'
17	16	21	20	4	23° 12'	25° 13'	9° 46'	16° 40'	28° 46'	9° 13'	25° 14'	1° 31'
18	17	22	21	5	24° 12'	(Taurus) (10°) 28'	9° 52'	16° 48'	28° 41'	11° 5'	27° 36'	1° 28'
19	18	23	22	6	25° 12'	25° 3'	9° 58'	16° 56'	28° 36'	12° 23'	29° 17'	1° 25'
20	19	24	23	7	26° 12'	(Gemini) 9° 19'	10° 8'	17° 3'	28° 32'	13° 37'	Libra 0° 59'	1° 21'
21	20	25	24	1	27° 12'	23° 28'	10° (?)	17° 10'	28° 30'	14° 54'	2° 22'	1° 18'

22	21	26	25	2	28° 12'	Cancer 7° 17'	10° (?)	17° 1(7')	28° 28'	16° 28'	4° 25'	1° 15'
23	22	27	26	3	29° 12'	21° 7'	10° 22'	17° 24'	28° 26'	17° 24'	6° 8'	1° 12'
24	23	28	27	4	30° 12'	Leo 4° 57'	10° 28'	17° 32'	28° 24'	19° 15'	7° 51'	1° 9'
25	24	29	28	5	Libra 1° 12'	18° 46'	10° 34'	17° 39'	28° 22'	20° 13'	9° 35'	1° 5'
26	25	30	29	6	2° 12'	Virgo 1° 3'	10° 40'	17° 46'	28° 20'	22° 1'	11° 16'	1° 2'
27	26	1	30	7	3° 13'	14°	10° 46'	17° 54'	28° 18'	23° 10'	12° 16'	0° 59'
28	27	2	1	1	4° 13'	26° 37'	10° 52'	18° 1'	28° 16'	24° 19'	14° 38'	0° 56'
29	28	3	2	2	5° 14'	Libra 9° 14'	10° 58'	18° 8'	28° 14'	25° 29'	16° 39'	(?)
		4										

Note on the table

Saturn, Jupiter, and the lunar node are in the signs of Leo, Cancer, and Pisces respectively.

Analysis: Astronomical Data

Some of the astronomical data in the table conform to a standard Ptolemaic computation, but others deviate from it completely. In Table 1, we compare Donnolo's data to those computed according to Ptolemy's Almagest (meridian of Alexandria, at noon), for three sample dates:[18]

18 For the computation of the positions of the sun, moon, planets, and lunar node according to Ptolemy's Almagest, we have relied on Raymond Mercier's Kairos program (http://www.raymondm.co.uk), as well as on the assistance of Dr. Mercier himself. In this table the notation of the Ptolemaic data follows Donnolo's usage, i.e., longitudes are expressed in relation to the zodiacal signs.

Table 1. Donnolo and *Almagest* (Alexandria)

946 CE	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury	Lunar node
	Virgo	Libra	Leo	Cancer	Pisces	Leo	Leo	Pisces
Donnolo Aug 31	7° 19'	0° 51'	7° 59'	14° 9'	1° 13'	20° 5'	28° 36'	2° 24'
Almagest Aug 31	7° 15'	0°	7° 59'	14° 8'	1° 30'	17° 33'	28° 30'	2° 23'
		Pisces			Aquarius	Virgo	Virgo	
Donnolo Sept 14	21° 12'	26° 43'	9° 33'	16° 20'	28° 56'	7° 24'	22° 31'	1° 37'
Almagest Sept 14	21° 7'	25° 55'	9° 33'	16° 20'	28° 31'	4° 52'	22° 22'	1° 39'
	Libra	Libra					Libra	
Donnolo Sept 28	5° 14'	9° 14'	10° 58'	18° 8'	28° 14'	25° 29'	16° 39'	0° 53'?
Almagest Sept 28	5° 9'	8° 52'	10° 56'	18° 7'	28°	22° 21'	16° 16'	0° 54'

Saturn, Jupiter, and the lunar node are almost exactly the same, but other bodies are discrepant. The most significant discrepancy is Venus, excessive throughout Donnolo's table by about 2° 30'–3° (equivalent to about two days); this is a gross error that we cannot explain. Other discrepancies are milder, though not insignificant: the Sun tends to be excessive by 5 minutes, Mercury by maximum 23 minutes, the Moon by maximum 51 minutes. Mars is deficient on August 31 and excessive on the other dates.

The tendency of Donnolo's data to be excessive (albeit not consistently) suggests a meridian to the west of Alexandria. Donnolo spent most of his life in Rossano, as well as some time in Taranto, and may thus have assumed a southern Italian meridian. This meridian is likely to have been calculated on the basis of data available in Ptolemy's *Handy Tables*, which give a longitude of 39° 50' for Reggio di Calabria

(a little west, but mainly south, of Rossano) and 42° 10' for Brindisi (east of Taranto), while the meridian of Alexandria is given as 60° 30'.[19] This produces, overall, a difference in longitude between Alexandria and southern Italy of about 18°–20°. In Table 2 below, we have used again a Ptolemaic computation, but assumed—purely as a working hypothesis—a southern Italian meridian of 19° west of Alexandria (again, at noon).[20]

19 E. S. and M. H. Kennedy, *Geographical Coordinates of Localities from Islamic Sources* (Frankfurt a.M., 1987), 17 (Alexandria), 81 (Brindisi), and 285 (Reggio di Calabria). Arabic sources from Donnolo's period (e.g., al-Battani), which may not have been accessible to him, do not give Italian longitudes. Modern values are 16°39' E for Rossano, 17°15' E for Taranto, and 29°54' E for Alexandria, thus a difference of longitudes of around 13°. Here, too, the assistance of the anonymous *Aleph* reader must be acknowledged.

20 Since 15 degrees corresponds to 1 hour, the 19° difference in terrestrial longitude corresponds to 1 hour 16 minutes; in other words, the set of computations for noon in southern Italy (in Table 2) corresponds to a time in Alexandria 1 hour 16 minutes later than the previous set (in Table 1).

Table 2. Donnolo and *Almagest* (southern Italy)

946 CE	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury	Lunar node
	Virgo	Libra	Leo	Cancer	Pisces	Leo	Leo	Pisces
Donnolo Aug 31	7° 19'	0° 51'	7° 59'	14° 9'	1° 13'	20° 5'	28° 36'	2° 24'
Almagest Aug 31	7° 18'	0° 44'	8°	14° 9'	1° 29'	17° 37'	28° 36'	2° 23'
		Pisces			Aquarius	Virgo	Virgo	
Donnolo Sept 14	21° 12'	26° 43'	9° 33'	16° 20'	28° 56'	7° 24'	22° 31'	1° 37'
Almagest Sept 14	21° 10'	26° 39'	9° 34'	16° 20'	28° 30'	4° 57'	22° 28'	1° 39'
	Libra	Libra					Libra	
Donnolo Sept 28	5° 14'	9° 14'	10° 58'	18° 8'	28° 14'	25° 29'	16° 39'	0° 53'?
Almagest 28 Sept	5° 12'	9° 31'	10° 57'	18° 8'	28°	22° 25'	16° 21'	0° 54'

Overall, the results are much closer than in Table 1: the discrepancies of the Sun, Mercury, and the Moon, in particular, are significantly reduced. This suggests that Donnolo may have calculated his data on the basis of his own meridian. It should be emphasized, however, that we do not know whether the table was calculated by Donnolo himself or borrowed *in toto* from some other source.

The extent of Donnolo's dependence on Ptolemy deserves, however, further probing. In Table 3, below, we present a full comparison of Donnolo's Moon data with Ptolemaic data for both Alexandria and southern Italy:

Table 3. Moon Data

Date (Aug/ Sept 946)	Zodiacal sign	Donnolo	*Almagest* Alexandria	*Almagest* southern Italy (19° west)
31	Virgo	0° 51'	0°	0° 44'
1	Libra	12° 14'	12° 28'	13° 7'
2		24° 13'	24° 35'	25° 13'
3	Scorpio	7°	6° 29'	7° 7'
4		19° 4'	18° 22'	19°
5	Sagittarius	1° 28'	0° 31'	1° 10'
6		13° 13'	13° 3'	13° 43'
7		26° 11'	25° 25'	26° 21'
8	Capricorn	9° 43'	8° 7'	8° 46'
9		21° 8'	20° 25'	21° 4'
10	Aquarius	4° 15'	2° 54'	3° 34'
11		17° 22'	15° 42'	16° 23'
12		Pisces 0° 29'	Aquarius 28° 50'	Aquarius 29° 32'
13	Pisces	13° 36'	12° 15'	12° 58'
14		26° 43'	25° 55'	26° 39'
15	Aries	11° 15'	9° 52'	10° 36'
16		25° 13'	24° 10'	24° 56'
17	Taurus	(10°) 28'	8° 52'	9° 39'
18		25° 3'	23° 51'	24° 38'
19	Gemini	9° 19'	8° 43'	9° 30'
20		23° 28'	23° 6'	23° 51'
21	Cancer	7° 17'	6° 57'	7° 40'
22		21° 7'	20° 39'	21° 22'
23	Leo	4° 57'	4° 24'	5° 7'
24		18° 46'	17° 58'	18° 40'
25	Virgo	1° 3'	1° 8'	1° 49'
26		14°	13° 56'	14° 36'
27		26° 37'	26° 29'	27° 8'
28	Libra	9° 14'	8° 52'	9° 31'

In the "*Almagest* Alexandria" and "*Almagest* southern Italy" columns, figures in bold indicate the closest matches to Donnolo's figures. We note that closest matches are more common in the "southern Italy" column, which would confirm again that Donnolo may have been using this meridian.

But far more importantly, this table reveals a high level of inconsistency between Donnolo's Moon data and those of the *Almagest* (for both meridians). For September 1, 2, and 25, Donnolo's figures are deficient from the *Almagest*; for September 3, 6–7, 19–23, and 26–28, Donnolo's figures lie between *Almagest* Alexandria and southern Italy; for other dates, they are excessive from both *Almagest* columns, sometimes by 0.5°–1° or more (these high excesses are indicated in the "Donnolo" column in bold).

This leads us to the conclusion that Donnolo's Moon data bear no relation to those of Ptolemy's *Almagest*, and that for the Moon at least—probably also for Venus and Mars—Donnolo would have been using an entirely different (and unknown) scheme.

Astrology: The Lunar Node

The meaning of *teli* ("lunar node") and its inclusion among the celestial bodies may require a brief explanation. The astrological term *teli* has a range of senses, but it refers primarily to the celestial Dragon.[21] This imaginary notion has early origins in the astrological tradition.[22] Donnolo defines it elsewhere as "like a king over the two luminaries, the five planets, and everything that takes place in the world, whether good or bad," to which are attached "all the planets in the seven firmaments, both above and below, as well as the two luminaries and the twelve constellations."[23] The Dragon is traditionally conceived as a creature lying either along the *axis mundi* (about which the celestial sphere revolves)[24] or, alternatively, along the ecliptic, with its head and

tail positioned at the two lunar nodes (the two points—themselves, of course, not imaginary—where the Moon crosses the ecliptic). In our text, however, *teli* has the more restrictive, derivative sense of "ascending lunar node."

The inclusion of the lunar node in our table of ephemerides follows an astrological tradition which was fully developed in Arab-Muslim astrology and partly accepted by the Byzantine astrologers, according to which the two lunar nodes—like the five planets and the two luminaries—were endowed with astrological meanings and believed to exert influence over human life.[25] Just like the planets and the luminaries, the position of the lunar nodes was needed for astrological purposes such as the compilation of birth charts—hence its inclusion in this table.[26]

21 The etymology of this term is unclear; but see Sharf, *The Universe*, p. 40.

22 It is probably of Arabic origin (in Arabic astrological texts it is called *jawzahr*), but was quickly adopted by the Western astrological tradition, as well as by the Jews, as is clearly attested by the ninth-century *Seder tanna'im we-'amora'im* (ed. S. D. Luzzatto, *Kerem Ḥemed* 4 [1839]: 187), the *Baraita de-Šemu'el* (ed. J. D. Eisenstein, *'Oṣar ha-midrašim* [New York, 1915], 1:542), and the commentaries on *Sefer Yeṣirah* by Saadia Gaon, Dunash ibn Tamim, and Judah ben Barzilai. See: A. Sharf, " 'Tli' and 'Jawzahr' in the Macrocosm of Shabbetai Donnolo," in idem, *Jews and Other Minorities in Byzantium* (Jerusalem, 1995), 178–89, esp. pp. 180–87; idem, *The Universe*, pp. 33–51.

23 See Castelli, *Il commento*, p. 79.

24 So Donnolo in *Sefer ha-Mazzalot;* see Luzzatto, "Miḳtav gimmel," p. 62.

25 For examples in the Cairo Geniza of the lunar node (*jawzahr*) being treated as a planet in an astrological context, see, for example, B. R. Goldstein and D. Pingree, "Astrological Almanacs from the Cairo Geniza," *Journal of Near Eastern Studies* 38 (1979): 153–75, 231–56. On the Dragon and the inclusion of the lunar nodes in

Analysis: Chronology and Calendar

Donnolo's dating of the table (in his descriptive text) to the year 4706 from the Creation confirms that the author was using the era from the Creation according to the Palestinian custom. It is evident from the astronomical data in the table that the year was 945/6 CE, which according to the Palestinian custom was reckoned as 4706 from the Creation; whereas according to the Babylonian custom, the year would have been reckoned as 4705. There is evidence that the Palestinian era—which has become normative today—was adopted in Babylonia by the early eleventh century (R. Hai Gaon's period).[27] Our text indicates that it was used in Italy in the mid-tenth century.

Most important are the calendrical implications of this table, as the table provides exact dates for the Jewish and Muslim month of Elul/Safar in 946 CE. We know that the month of September 946 CE corresponded roughly to the Muslim month Safar. Donnolo identifies the equivalent Jewish month as "Elul." According to the rabbinic calendar computation, however, this month should have been Tishri. This suggests that the Jewish calendar of Donnolo differed from the contemporary rabbinic calendar.

The reference to "Elul" in the descriptive text cited above cannot be explained away as a mere mistake. Indeed, the lunar month in this table is hollow (29 days), which is a standard characteristic of Elul in the rabbinic calendar; the month of Tishri, by contrast, is always full (30 days). If Donnolo was following the rabbinic calendar and meant to refer to Tishri (but erroneously wrote "Elul"), his month would have been not hollow but full—unless he was committing a double error. Such gross errors, however, are unlikely in a sophisticated work of this nature. It seems evident, therefore, that the reference to Elul is not an error: the Jewish calendar that Donnolo knew and followed was simply different and retarded by one month in relation to the rabbinic calendar.

A one-month retardation of this kind is easy to explain. According to the rabbinic calendar, Passover (15 Nisan) in 946 CE occurred on

March 21, thus relatively early in the solar year. The Jews of Italy (more precisely: the Jews who set Donnolo's calendar) may have felt that this was too early, possibly even a breach of the rule of the equinox that stipulated that Passover could not occur before the spring equinox.[28] Therefore, they postponed the festival by one month, by intercalating a second month of Adar (which the rabbis did only the following year). As a result, Elul occurred one month later, at the time of the rabbinic month of Tishri.

The beginning of the month is also problematic. According to the rabbinic calendar, at least in this period, the month would normally begin on the day of the mean conjunction (the *molad*).[29] The rabbinic *molad* of the month which Donnolo calls "Elul" occurred on Saturday,

the group of the celestial bodies in Arabic astrology, see A. Caiozzo, *Images du ciel d'Orient au Moyen Age* (Paris, 2003), 213–28.

26 In this guise, *teli* appears also in *Sefer ha-mazzalot* (Luzzatto, "Miḳtav gimmel," p. 62) and in *Baraita de-mazzalot*, ed. S. A. Wertheimer, *Batei midrašot* (Jerusalem, 1955), 2:34–35.

27 See S. Stern, *Calendar and Community. A History of the Jewish Calendar, 2nd Century BCE–Tenth Century CE* (Oxford, 2001), 272–73.

28 This is to assume that they followed the rule of the equinox, which by this period was well established among Christians (for the date of Easter) and probably also among most Jews (Stern, *Calendar and Community*, pp. 50–53, 66–70, 167–70, and 198–99). This explanation would depend on when the spring equinox was deemed to occur, which we cannot be certain of; but it may well have been on or after 21 March (ibid., 199–200). The Christians themselves celebrated Easter in 946 CE on Sunday, March 22, but Donnolo's calendar makers may have disagreed with their calculation. Whatever the exact reason why they postponed Passover (and hence the subsequent months of the year), it was clearly due to the earliness of Passover according to the rabbinic (and Christian) computation.

29 Ibid., pp. 183–84, 191–92.

August 29, at about 2:00 p.m., thus two days before the beginning of Donnolo's month.[30] According to the rabbinic calendar, however, in certain circumstances the beginning of the month can be postponed one or two days after the day of the *molad*. As it happens, the rabbinic month of Tishri in 946 CE began on Monday, August 31, two days after the *molad*: it was postponed by two days because of the lateness of the *molad* on Saturday (occurring in the afternoon, at 2:00 p.m.: this is the postponement of *molad zaqen*), and then because of the rule that 1 Tishri (Rosh Hashanah) can never occur on a Sunday. But since Donnolo reckoned this month as Elul, there would have been no reason for him to postpone it from Sunday to Monday; for there is no rule preventing Elul from beginning on Sunday. Thus if Donnolo's calendar had followed the principles of the rabbinic calendar (with the only exception that it was one month off), his month should have begun on Sunday. It seems clear, therefore, that in Donnolo's calendar the months did not begin at the conjunction, nor did they follow the rules of the rabbinic calendar.

If, instead, Donnolo's months were based on observation of the new moon crescent, this month should have begun one day later, on Tuesday, September 1: indeed, the new moon crescent was not visible (in Italy or anywhere else) before Monday night (when, in the Jewish calendar, the new 24-hour period begins). This rules out a calendar based on new moon observation. Donnolo's calendar could not have been Karaite, nor was it tied to the Muslim calendar, since both these calendars were based on new moon observation.[31]

In short, Donnolo's month of Elul did not begin at the first sighting of the new moon (as in the Karaite and Muslim calendars), because then it would have begun on Tuesday; nor it did begin at the conjunction or conform to the principles of the rabbinic calendar, because then it would have begun on Saturday or Sunday. We are left to conclude that Donnolo's Jewish month, beginning on Monday, was either imprecise, or followed some scheme that differed from that of the rabbinic

calendar. The beginning of the month was thus another way in which Donnolo's calendar differed from the rabbinic calendar.

The discovery of this "different" Jewish calendar raises the question of how normative the rabbinic calendar would have been in European communities of the mid-tenth century CE. In the early 920s, R. Saadia Gaon (then in Baghdad) claimed that the Babylonian rabbinic calendar (known as the לוח ארבעה שערים, "four parts table") was followed by "all Jews in the East, West, North, and the islands,"[32] but this was evidently incorrect. A late tenth-century Muslim source informs us that in Spain, the rabbinic calendar was introduced by R. Ḥisdai ibn Shaprut in the 960s or 970s, although, previously, calendar dates for a few years in advance had been regularly sent out to Spain from Baghdad (presumably, from the seat of the Geonim).[33] This account, whether or

30 Similarly, as is evident from the astronomical data in this table, the month did not begin on the day of the true conjunction: according to this table, at noon on 1 Elul = August 31, the sun and moon were at a distance of over 22°. True conjunction (when the longitudes of the sun and moon are equal) would have occurred two days earlier, on Saturday, August 29.

31 Although Donnolo equates the Jewish Elul with the Muslim Safar, the latter is likely to have begun one day later, on Monday night; the equation between these months should thus be interpreted as only approximate. If, alternatively, Donnolo's equation of Elul with Safar is interpreted as exact (and thus the Jewish and Muslim months were conterminous), he would have erred in predicting (assuming that this table was drawn up before the beginning of this month) that the new moon would be visible on Sunday night and hence that the Jewish and Muslim month of Elul-Safar would begin then. This error is possible but less likely.

32 I. Levi, E. Adler, and J. Broyde, "Nouveaux fragments relatifs à Ben Méir," *Revue des études juives* 41 (1900): 224–32, esp. pp. 225–26. See Stern, *Calendar and Community*, pp. 266, 270.

33 The source is Ibn Djoldjol, *apud* Abu Usaybia in his *History of the Physicians*, cited in

not it is entirely believed, conveys the impression of a late diffusion of the rabbinic calendar in western Europe.

Donnolo's table provides evidence of a local, independent Jewish calendar that differed from the rabbinic calendar and that would have been used by Jews in southern Italy in the mid-tenth century. Calendar diversity is well attested in the Jewish Diaspora communities of late Antiquity.[34] This text reveals that it persisted in Europe until as late as the tenth century.

French translation by S. Munk, "De la philosophie chez les Juifs," *Archives Israélites* 9 (1848): 169–84, 325–36, 419–33, esp. pp. 325–26 (and hence in the English translation in idem, *Philosophy and Philosophical Authors of the Jews*, trans. I. Kalisch [Cincinnati, 1881], 41); Hebrew translation by Ḥ. Y. Bornstein, "Divrei yemei ha-ʿibbur ha-ʾaḥaronim," part 2, *Ha-Tequfah* 16 (1922): 228–92, esp. pp. 286–87.

34 Stern, *Calendar and Community*, pp. 65–98, 143–54.

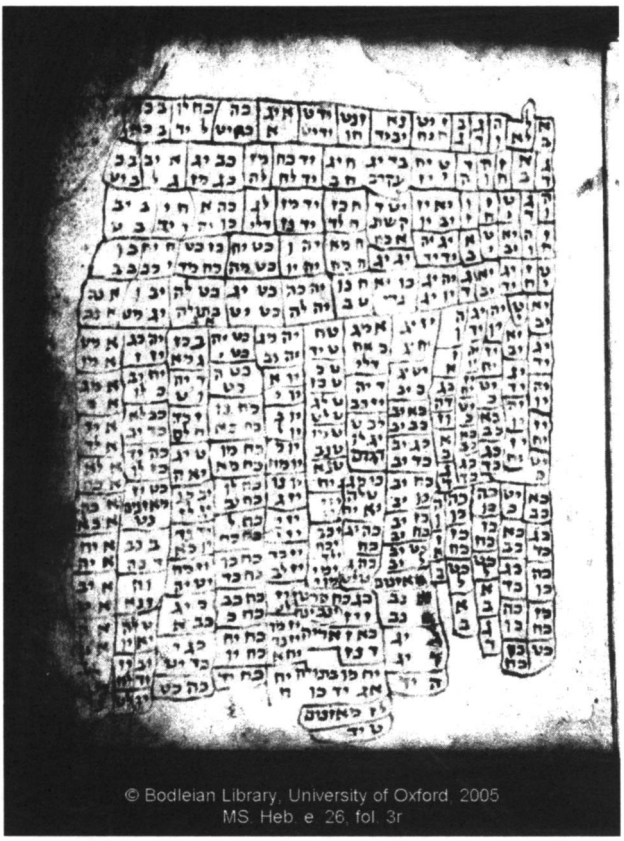

Figure 2: Donolo's astronomical table