The Origins of the 247-year Calendar Cycle

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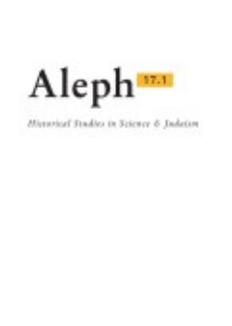
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The Origins of the 247-year Calendar Cycle
Many medieval and early modern Jewish calendars were based on the assumption that the calendar repeats itself exactly after 247 years. Although this cycle—known as the *ʿIggul of R. Naḥshon Gaon*—is discussed in many sources, both medieval and modern, its origins remain a mystery. The present article sheds light on the early history of the reiterative Jewish calendar by looking at the oldest 247-year cycles identified to date. Textsf rom the Cairo Genizah demonstrate that the 247-year cycle originated in Babylonia in the middle of the tenth century and was produced by Josiah b. Mevorakh (ibn) al-ʿĀqūlī, previously known from Judeo-Persian calendar treatises. In contrast, a large body of manuscript evidence shows that the attribution of the cycle to R. Naḥshon Gaon (874–882 CE) is not attested before the twelfth century and may be unhistorical. The 247-year cycle may have been proposed as an alternative Jewish calendar that would eliminate the need for calculation and prevent calendar divergence. But at least from the early twelfth century the cycle was seen as a means of setting the standard calendar, even though it is not fully compatible with the latter.

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The Origins of the 247-year Calendar Cycle

Many medieval and early modern Jewish calendars were based on the assumption that the calendar repeats itself exactly after 247 years. This cycle—best known as the *ʿiggul* of R. Naḥshon Gaon—is not fully compatible with the standard Jewish calendar but diverges in a few years every century. A convenient if imprecise method of calendation, the 247-year cycle spread to all corners of the Jewish world; its origins are virtually unknown, however.[1] Below I attempt to shed light on the history of the reiterative Jewish calendar by examining the earliest 247-year calendar cycles identified thus far.

 A calendar is considered reiterative or cyclical if it repeats itself

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[1] On the 247-year cycle, see Sacha Stern, *Calendar and Community: A History of the Jewish Calendar, 2nd cent. BCE–10th cent. CE* (Oxford: Oxford University Press, 2001), p. 193; Raḥamim Sar-Shalom, *Gates to the Hebrew Calendar* (Netanya: R. Sar-Shalom, 1984) (Heb.), p. 51; Yosef Tobi, *The Jews of Yemen: Studies in Their History and Culture* (Leiden: Brill, 1999), pp. 211–226; Hayyim Yehiel Bornstein, דברי ימי העבור האחרונים, חלק א׳ ("The Later History of Calendar," part 1), *Ha-Tequfah* 14–15 (1934, 3rd edition): 321–372, on pp. 354–358; idem, מחלקת רב סעדיה גאון ובן מאיר (*The Dispute of Rav Saadia Gaon and Ben Meir*) (Warsaw, 1904), pp. 141–144; Eran Raviv, "Mathematical Studies in the Hebrew Calendar," Ph.D. thesis, Bar Ilan University, 2015, pp. 53–111 (Heb.).

exactly after a certain number of years; i.e., any two dates that many years apart fall on the same day of the week. The standard Jewish calendar in use today takes just under 700,000 years to repeat exactly.[2] This cycle is obviously impractical, because it is too long to be used in calendar reckoning. Of more practical significance is the period of 247 years, after which the standard calendar repeats itself, except for several years (between two and seventeen) that do not exactly coincide with the corresponding year 247 years earlier.[3]

The non-cyclical nature of the Jewish calendar means that it cannot be set once and for all but must be calculated on a regular basis. The reckoning is based on the 19-year cycle of intercalations, the calculation of the astronomical new moon (*molad*), and a set of additional rules.[4] Three variables must be set on this basis. The first is the day of the week on which Rosh Hashanah falls. This generally corresponds to the day of the week of the *molad* of Tishri, but is postponed if the calculated *molad* falls on Sunday, Wednesday, or Friday. Rosh Hashanah is also postponed if the *molad* of Tishri occurs after 18 hours of the 24-hour day that begins at 6 p.m. (this rule is known as *molad zaqen*). The second variable is the length of the months Marḥeshvan and Kislev. In the Jewish calendar months have a fixed length of either 29 or 30 days, in alternation. The exception is the two months of Marḥeshvan and Kislev, which have 30 days in some years and 29 days in others. There are three possible combinations: *ḥaserim* ("defective"), when both have 29 days, *ke-sidran* ("regular"), when Marḥeshvan has 29 days and Kislev 30 days; and *shelemim* ("full"), when both have 30 days. The third variable is the inclusion or not of an additional 30-day intercalary month, which is a function of the 19-year cycle in which twelve years have twelve months and seven years are intercalated and have thirteen months.

The permutations of these three variables determine the course of the year. Because of various ritual constraints, only fourteen such combinations are allowed; setting the calendar for a particular year ultimately means establishing which of the fourteen types (also called "characters") applies to it. The type of a year is represented by a mnemonic capturing the three variables: the day of the week on which Rosh Hashanah falls; whether the year is defective, regular, or full; and the day of the week on which Passover begins, which derives from the day of the week of Rosh Hashanah, the length of the variable months, and whether or not the year is intercalated. An example of such sign is בחג where the first letter represents the day of the week of Rosh Hashanah (here ב, Monday); the second, the length of the variable months (here ח for חסרים "defective"); and the third, the day of the week of Passover (here ג, Tuesday). The middle letter of the sign can be ח for חסרים, when Marḥeshvan and Kislev are 29 days long, כ for כסדרן when Marḥeshvan has 29 days and Kislev 30; and ש for שלמים when both have 30 days. In Oriental manuscripts the letter מ for מעוברת is added to indicate intercalated years. For example, גכמז denotes a year that begins on a Tuesday (ג), is regular (כ for כסדרן), is intercalated (מ for מעוברת), and Passover begins on a Saturday (ז). In manuscripts from other geo-cultural areas the mnemonic is more likely to be simply גכז.

Reiterative calendars based on the 247-year cycle assert that the character of a year is always the same as that of a year 247 years before or after it, so that once a correct sequence of 247 symbols is established it can be used indefinitely without any changes. As mentioned above, this claim is not quite accurate for the standard Jewish calendar. If a sequence of 247 year-types compatible with

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2   The recurrence period of the Jewish calendar is 689,472 years (see, e.g., Sar-Shalom, *Gates to the Hebrew Calendar*, p. 52).

3   On the accuracy of the 247-year cycle, see Raviv, "Mathematical Studies," pp. 57–62.

4   For a detailed explanation of the workings of the Jewish calendar, see Sar-Shalom, *Gates*, esp. pp. 52, 131–140; for the history of the calculated Jewish calendar see Stern, *Calendar and Community*, pp. 155–275.

the standard calendar is re-used for the next 247 years, there will be deviations in between two and seventeen cases. Such deviations always come in clusters of two to three years, conditioned by the Rosh Hashanah postponements and the permissible combinations of Marḥeshvan and Kislev.

Depending on their provenance, reiterative Jewish calendars are written down as sequences of 247 year-type signs laid out in various ways. In a substantial group of manuscripts, the cycle is referred to as the *'iggul* of R. Naḥshon Gaon (gaon of Sura from 874 to 882 CE) and formatted as a table of nineteen columns by thirteen rows. In this table, each column represents a year in the 19-year cycle of intercalations; each row, one such 19-year cycle (247 = 13 × 19). Each cell of the table contains the mnemonic for the calendar type of the relevant year. It is in this form and under this title that the 247-year cycle is best known in the secondary literature on the subject, where R. Naḥshon Gaon's connection to the cycle is generally taken as historically valid, thus tracing its origin to the ninth century.[5] However, this early date is not confirmed by any other known textual evidence. The 247-year cycle is not mentioned in the correspondence relating to the Saadia–Ben Meir dispute (921–922 CE),[6] and is also absent from al-Bīrūnī's comprehensive and well-informed section on the Jewish calendar in his *Chronology of the Ancient Nations,* completed in 1000 CE.[7]

An examination of more than 200 manuscripts reveals that the earliest text that explicitly mentions R. Naḥshon Gaon in association with the 247-year cycle refers to a calendar starting in 1198/9 CE (Oxford, Bodl. Canon. Or. 1, fol. 81r). The earliest unattributed calendar that has the format usually associated with the *'iggul* of R. Naḥshon Gaon (i.e., a nineteen-by-thirteen table) covers the period 1123/4–1369/70 CE (Moscow State Library, Guenzburg 481, fol. 102r).[8] The earliest such calendar implied by the sources must have started in 1104/5 CE.[9] Moreover, contrary to what might be expected of a cycle devised in

the ninth century, none of these *'iggulim* "of R. Naḥshon Gaon" contain calendrical information that predates 1006/7 CE.[10]

Taken together, this evidence clearly calls for a re-evaluation of the current thinking on the origins and history of the reiterative Jewish calendar. I will do so by looking at a group of manuscripts in which the 247-year cycle is not attributed to R. Naḥshon Gaon and is not

5 For references, see n. 1 above. Raviv, "Mathematical Studies" is a notable exception; see below, n. 10.

6 Personal communication from Sacha Stern and Marina Rustow, who are currently in the process of compiling and editing the entire corpus of texts related to the dispute. On this project see Marina Rustow and Sacha Stern, "The Jewish Calendar Controversy of 921–22: Reconstructing the Manuscripts and their Transmission History," in *Time, Astronomy, and Calendars in the Jewish Tradition*, ed. Sacha Stern and Charles Burnett (Leiden: Brill, 2014), pp. 79–95. On the Saadia–Ben Meir calendar dispute, see also Stern, *Calendar and Community,* pp. 256–275; Bornstein, מחלקת רב סעדיה גאון ובן מאיר.

7 See Abū Rayḥān al-Bīrūnī, *The Chronology of Ancient Nations* 7; trans. C. Edward Sachau (London: W.H. Allen, 1879), pp. 141–175. A new annotated translation of *The Chronology of Ancient Nations* is in preparation by François de Blois, whom I thank for drawing my attention to al-Bīrūnī's silence on the 247-year cycle.

8 The earliest fragmentary table of a similar format (Manchester, Rylands B 4471), which may or may not have covered the entire 247 years, takes 1048/9 CE as its starting point.

9 This is inferred from a marginal note in Munich, Bayerische Staatsbibliothek, Cod. Hebr. 128, fol. 28r, which speaks of 19-year cycle 270 as the beginning of a next iteration of the 247-year cycle, indicating that its previous iteration started thirteen cycles earlier, at the beginning of 19-year cycle 257, i.e., 1104/5 CE.

10 In a similar vein, Raviv ("Mathematical Studies," pp. 55–56 and 86) concludes that the attribution of the 247-year cycle to R. Naḥshon Gaon is anachronistic and that the cycle was not in use before the second half of the eleventh or start of the twelfth century.

presented in tabular form. The method of creating a reiterative calendar to be discussed here was previously known from only a handful of Judeo-Persian treatises on the Jewish calendar.[11] It is attributed to Josiah b. Mevorakh al-ʿĀqūlī (or ibn al-ʿĀqūlī) and is dubbed in Judeo-Persian sources *dūlābī*, "waterwheel-like," suggested by its ever-repeating nature. Recently I was fortunate to discover a number of Cairo Genizah fragments related to Josiah b. Mevorakh's calendar, including actual calendars, statements of the system's use, and a critique of the 247-year cycle. Unlike previously known calendars of Josiah b. Mevorakh, this new material is in Judeo-Arabic. In addition, Josiah b. Mevorakh's cycle has been discovered in a Byzantine manuscript on the Jewish calendar, in Hebrew. These largely unstudied sources furnish important evidence about the creation, spread, and practical use of the deviant calendar cycle.

The Structure of Josiah b. Mevorakh al-ʿĀqūlī's Calendar

Josiah b. Mevorakh al-ʿĀqūlī's work on the calendar consists of an introduction followed by fourteen chapters, one on each of the fourteen types of the Jewish year. To make it clear how this calendar works, here is the introduction, followed by the beginning of the chapter on year-type בחג, as found in T-S 10K20.2.

<div dir="rtl">

בשׁ רוֹ
קאל יאשיהו בן מבורך בן אלעאקולי רצֹי
אללה ענה אדא ארדת תערף רווס אל
שהור ואלאעיאד פכד סני אלאסכנדר
מע אלמטלובה ואסקט מנהא אלף סנה
ומא יתבקי אסקטה רֹמֹז רֹמֹז ואלדי
יבקי מעֹ[ר] בעד דלך אטלבה עלי הדה
אלאלואה אלתֹ[י] בין [י]דיך אדא וגדתה תקרא

</div>

<div dir="rtl">

תחת אללוח תגֹד אלשהור ואלאעיאד צחיחה
כמא תשתהי אן שא אללה תעאלי

</div>

<div dir="rtl">

טֹו מֹב סֹטֹ פֹו צֹג קֹיֹגֹ קֹכ קֹמֹ
קֹסֹד קֹצֹא קֹפֹד רֹיֹא רֹיֹח רֹלֹח

</div>

<div dir="rtl">

חסרין פשוטה סימן בֹחֹג טֹו
תשרי סוכה ושמיני בֹ צום גדליה אלֹד כפורים
זֹ ערבה אֹ מרחשון גֹד כסלו הֹ ....

</div>

In the name of God

Said Josiah b. Mevorakh b. al-ʿĀqūlī, may God be pleased with him: if you want to know the beginnings of months and the festivals, take the years of Alexander including the required (year), deduct from them 1000 years, and cast out 247s from what remains. What is left after this, look it up in the tables that you have before you, and when you find it, read what is under the table and you will find the correct months and festivals as you wanted, so God will.

15, 42, 69, 86, 93, 113, 120, 140, 164, 191, 184,[12] 211, 218, 238

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11   Elkan N. Adler, "The Persian Jews: Their Books and Their Ritual," *The Jewish Quarterly Review* 10/4 (1898): 584–625, on p. 623; Tobi, *The Jews of Yemen*, pp. 215–216; Tobi, "The Dispute over the 247-year Cycle in Yemen," in *Studies in Judaism and Islam presented to Shelomo Dov Goitein*, ed. Shelomo Morag, Issachar Ben-Ami, and Norman A. Stillman (Jerusalem: Magnes Press, 1981), pp. 193–228, esp. pp. 196–198, 206–207 (Heb.). Raviv ("Mathematical Studies," pp. 88–102) analyses Judeo-Persian 247-year calendars but also comments on one Genizah fragment related to R. Josiah b. Mevorakh's cycle.

12   This number is out of order here and in other related manuscripts.

defective, plain, sign בחג, 15[13]

Tishri, Sukkot and Shemini ('Aṣeret): Monday; fast of Gedaliah: Wednesday; (day of) Atonement: Wednesday; (day of the) Willow:[14] Sunday; Marḥeshvan: Tuesday and Wednesday; Kislev: Thursday …

As is apparent from this excerpt, each chapter of Josiah b. Mevorakh al-ʿĀqūlī's calendar has three parts: (1) a set of numbers, (2) the character of the year described in that chapter, and (3) a fuller description of the calendar, including the beginning of months, the festivals, and the fast days. The list of numbers at the beginning of each chapter identifies which years will have the character described in the chapter, indicated by their position in the 247-year cycle. This position is calculated as the remainder after subtracting 1000 from the Seleucid-Era date (SE) and casting out 247s (for the purposes of this calendar, if the SE date minus 1000 is a multiple of 247, the remainder is not 0 but 247).

In order to apply Josiah b. Mevorakh al-ʿĀqūlī's calendar to any given year, you take that year's SE date and determine its remainder by following the algorithm described above. You then look for it in the lists of numbers in each of the fourteen chapters. The chapter whose list contains that remainder will describe the correct course of the year in question. Take, for example, year 1262 SE. Its remainder in Josiah b. Mevorakh al-ʿĀqūlī's algorithm can be calculated as (1262-1000) modulo 247, or 15. The number 15 can be found in the list of remainders for a defective and plain (not intercalated) year with the character בחג (see text above). This means that in 1262 SE, the month of Tishri starts on a Monday, the first day of Sukkot as well as Shemini ʿAṣeret fall on a Monday, the Fast of Gedaliah on a Wednesday, the Day of Atonement on a Wednesday, and so on.

Manuscripts of Josiah b. Mevorakh al-ʿĀqūlī's Calendar and Related Texts

1. Genizah fragments[15]

Cambridge, T-S 6K2.1: two leaves; a critique of the 247-year cycle in the hand of Joseph b. Jacob ha-Bavli, a scholar active in Egypt in the late twelfth and early thirteenth centuries;[16] cf. Cambridge, T-S NS 98.40, T-S Misc.25.29, T-S AS 144.164 and Cambridge, T-S AS 144.111.

Cambridge, T-S 10K20.2 and T-S K19.12: three non-consecutive leaves (one folio and one bifolio), paleographically datable to the thirteenth–fourteenth century, with the introduction and a description of five year-types.

Cambridge, T-S K2.8: fourteen bifolios containing an introduction and a description of thirteen of the fourteen year-types. The layout of the lists of remainders suggests that the fragment was written at the end of the thirteenth century, around 1296/7 CE.

Cambridge, T-S K2.41: eight bifolios with a description of eight year-types, tentatively datable on paleographic grounds to the thirteenth–fourteenth century. T-S K2.41 is clearly related to JTS ENA 3329 and ENA 1640.5 (see below), as shown by numerous common features, such as irregularities in the ordering of remainders, scribal mistakes, the representation of 15 as הי as opposed to טו in other copies, etc.

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13   This number is intended to represent the count of numbers above, and should be 14.

14   I.e., the seventh day of Sukkot (Hoshanah Rabbah).

15   I thank Dr. Amir Ashur of Tel Aviv University for helping me assess the handwriting of Genizah documents.

16   See Alexander Scheiber, "Materialien zur Wirksamkeit des Joseph ben Jakob Habavli als Schriftsteller und Kopist," *Acta Orientalia Academiae Scientiarum Hungaricae* 23 (1970): 115–130.

Cambridge, T-S Ar.2.12: one folio with writing in different directions and by two different hands: Hand 1: remainder lists for the last two year-types, without fuller descriptions of the course of the year; probably the original text of this fragment. Hand 2: a draft of an introduction to a work on calendar describing inter alia how the remainders for each year-type were established. Additional passages copied here in the same hand include a calendar for the years 1492–1494 SE (1180/1–1182/3 CE).

Cambridge, T-S NS 98.2 and T-S AS 144.118: three folios (one folio and one non-continuous bifolio) beautifully written in a square script and paleographically datable to the thirteenth–fourteenth century. The author describes the history of the Jewish calendar and testifies to the popularity of Josiah b. Mevorakh al-ʿĀqūlī's scheme.

Cambridge, T-S NS 98.40, T-S Misc.25.29, and T-S AS 144.164: four non-consecutive leaves (two folios and one bifolio), paleographically datable to the second half of the twelfth or first half of the thirteenth century. The fragments contain a description of three year-types and a critique of the 247-year cycle; cf. Cambridge, T-S 6K2.1 and Cambridge, T-S AS 144.111.

Cambridge, T-S NS 98.95: one badly rubbed folio containing a description of one year-type.

Cambridge, T-S NS 312.94: one folio with holes, paleographically datable to the thirteenth–fourteenth century; contains the introduction to Josiah b. Mevorakh al-ʿĀqūlī's calendar.

Cambridge, T-S AS 144.32: one bifolio, rubbed and badly stained, partially illegible. It is tentatively datable on paleographic grounds to the thirteenth century and contains a description of two year-types.

Cambridge, T-S AS 144.46 and T-S AS 144.166: two leaves containing descriptions of four year-types; paleographically datable to the twelfth–fourteenth century.

Cambridge, T-S AS 144.111: one leaf that contains the description of three year-types, a critique of the 247-year cycle and a note in a second hand establishing remainders for some of the years in the 19-year cycle 258 (1123/4–1142/3 CE); cf. Cambridge, T-S NS 98.40, T-S Misc.25.29, T-S AS 144.164 and Cambridge, T-S 6K2.1.

Cambridge, T-S AS 144.228, T-S AS 144.286 and T-S AS 203.216: three fragments of one folio. They contain the introduction to Josiah b. Mevorakh's calendar, an explanation of the algorithm using 1443 SE (1131/2 CE) as an example, and a description of two year-types.

Manchester, Rylands B 3390 and Rylands B 5508: remains of three badly torn leaves (one folio and one bifolio) containing a partial description of two year-types, paleographically datable to the eleventh to thirteenth centuries.

New York, JTS ENA 1640.5 and ENA 3329: fourteen leaves containing a description of all fourteen year-types but not the introduction, paleographically datable to the thirteenth–fourteenth century. This copy is clearly related to T-S K2.41 (see above).

2. Judeo-Persian manuscripts

London, BL Or. 2451: a Bible in a Persian hand copied in Qum by Samuel b. Aaron b. Yehosef and dated in the colophon to 1482/3 CE. Fols. 363v–375v contain Josiah b. Mevorakh al-ʿĀqūlī's calendar. The arrangement of remainders in this manuscript indicates that at least the calendar section was copied from a *Vorlage* penned around 1330/31

CE.[17] The calendar of remainders here is identical (including the scribal mistakes) to that in Oxford, Bodl. Heb. e.60, also copied in Qum by Samuel b. Aaron b. Yehosef.

London, BL Or. 9884: a Bible in a Persian hand copied in 1468/9 CE. Fols. 308r–314r contain Josiah b. Mevorakh al-ʿĀqūlī's calendar.

London, BL Or. 10576: a prayer book for the entire year according to the Persian rite, copied in the sixteenth or seventeenth century. Fols. 153r–158v contain the 247-year cycle attributed to Josiah b. Mevorakh al-ʿĀqūlī. The calendar is said to start after 1494 SE (1182/3 CE) and must have been copied from an earlier *Vorlage*. The cycle has an unusual shape in that it is presented not as lists of the remainders for each year-type but as a numbered sequence of 247 year-types. Compare London, BL Or. 10702.

London, BL Or. 10702: an incomplete prayer book for the entire year according to the Persian rite, copied in the fifteenth century. On fol. 30r there are traces of Josiah b. Mevorakh al-ʿĀqūlī's calendar, in the form of a continuous sequence of 247 year-types, of which only 218–241 have survived. Compare London, BL Or. 10576.

Oxford, Bodl. Heb. e.60: a Bible in a Persian script, copied in Qum by Samuel b. Aaron b. Yehosef and dated 1484/5 CE. Josiah b. Mevorakh al-ʿĀqūlī's cycle is on fols. 450r–461v. The calendar of remainders in this MS is identical to that in London, BL Or. 2451 and was probably copied from the same *Vorlage*.

ונטר״ת מנהם יופ אייאם אלקביעה [א]לדי הם בֹן[גֹהֹ]ז והם יֹד סנה לא תצי... שי...אר? והם בֹשֹה בֹשֹמֹ בֹחֹמֹה

3. Manuscripts from other geo-cultural areas

Oxford, Bodl. Poc. 368: a fifteenth century astronomical and calendrical miscellany copied in a number of Byzantine hands. Fol. 219r contains

a calendar scheme identical to Josiah b. Mevorakh's cycle but not attributed to any authority.

The Origins of Josiah b. Mevorakh al-ʿĀqūlī's System

The instructions provided in the introduction to Josiah b. Mevorakh al-ʿĀqūlī's cycle of remainders explain how this calendar should be used, but say nothing about how it was assembled. We do not possess a description of the work process employed by Josiah b. Mevorakh himself, but a later scholar claiming to have followed the same method as Josiah b. Mevorakh, by then deceased,[18] describes it as follows:[19]

> I looked in each of them at the days of the week on which (Rosh Hashanah) is set, which are Monday, Tuesday, Thursday and Saturday. There are fourteen (types of) years, not .... These are זשג, החמא, הכז, השמג, השא, גכמז, גכה, בחג, בחמה, בשמז, בשה, זשמג,[20] זחא, and זחמג. I counted how many times each of these fourteen signs occurs in each 19-year cycle, added them up,

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17 For an explication of this date, see below, the section on the distribution and use of Josiah b. Mevorakh's calendar.

18 T-S Ar.2.12: וקד סלכת פי אל[מ]ן גמוע מא סלכה פיה זֹל. The fragment, which appears to be an autograph draft, contains calendrical information for 1180/1–1182/3 CE and was most probably written around these dates.

19 T-S Ar. 2.12r:
ונטר״ת מנהם יופ אייאם אלקביעה [א]לדי הם בֹן[גֹהֹ]ז והם יֹד סנה לא תצי... שי...אר? והם בֹשֹה בֹשֹמֹ בֹחֹמֹה
בֹחֹג גֹכֹה גֹכֹמֹ[ז] הֹשֹא הֹשֹמֹגֹ הֹכֹז הֹחֹמֹא זֹשֹגֹ זֹשֹמֹגֹ זֹחֹא זֹחֹמֹגֹ פעדדת כם פי כל מחזור מן הדה אליֹד
עלאמה וגמעתהם ופצלתהם פכאן פי אליֹג מחזור מא עלאמתה בֹשֹה כט סנה עמלת להא כֹט ודלך אנני
נטרת כל סנה מא תאריכהא ללשטרות אסקטת אלף גמלה ואלבקיה רֹמֹז רֹמֹז רֹמֹז ומא פצל געלתהא סימן

20 This is a mistake; the expected sign is זשמה.

and itemized them. Thus, in thirteen 19-year cycles there are twenty-nine years of the type בשה, I made for it twenty-nine (symbols). That is, for each year I looked at its Seleucid date, subtracted 1000 from the total, and cast out 247s from what remained, and what was left over I made into a symbol.

The process is straightforward: amass calendrical data for thirteen 19-year cycles, group together years with the same year-type, and for each group note down ordinal numbers of the years that belong to it, counting in 247-year cycles with an epoch in 1001 SE.

The question is how the initial set of calendrical data for 247 years was compiled: was it based on the standard *molad* calculation or on some other set of rules not involving the *molad*? Fixed, non-empirical calendars that do not depend on the calculation of the *molad* have been recently discovered in the Cairo Genizah.[21] These schemes operate with rabbinic calendrical concepts but follow their own rules for determining the character of a year. Importantly, sequences of year-types produced by these rules do not form cycles of 247 years but much shorter cycles, which differ crucially from the standard Jewish calendar. By contrast, the sequence of year-types generated by Josiah b. Mevorakh al-ʿĀqūlī's method is very close to the standard calendar. This is not likely to be a coincidence, because the standard Jewish calendar is not in any obvious way reducible to a combination of shorter sequences and is thus not easy to reproduce following structural considerations alone. Hence it seems likely that the sequence of 247 year-types underlying Josiah b. Mevorakh's cycle was initially based on the standard *molad* calculation.[22]

Operating with relative positions of years within a 247-year cycle instead of their SE or AM dates means that Josiah b. Mevorakh's calendar applies not to a particular 247-year interval[23] but to any stretch of 247 consecutive years from 1001 SE on. The resultant lack of dates in copies of Josiah b. Mevorakh al-ʿĀqūlī's calendar creates difficulties for dating this system. The epoch of 1001 SE (689/90 CE), determined

as the first year when the algorithm described in the introduction becomes usable, is not helpful in dating the system, because it is clearly too early. Indeed, the above considerations show that the 247-year cycle cannot pre-date the *molad* calculation, which in all likelihood has been known since the ninth century but not before.[24] Instead, this epoch was probably chosen in order to simplify calculations, since for a thousand years the operation of taking away 1000 produced a number that can be more easily cast out by 247 than the full SE date. The downside of choosing such an epoch is that 247-year cycles calculated from it are not synchronized with the 19-year intercalation cycle, but start in year four of the 19-year cycle if counted from the year of Creation, as was the rule in Palestine and as is common today, or in year three of the 19-year cycle if counted from Adam's epoch, as was common in Babylonia. Using the count from Creation, 1001 SE is 4450 AM, 19-year cycle 235, year four.

Earlier attempts to date the cycle of remainders proved inconclusive. In London, BL Or. 10576, one of the Judeo-Persian manuscripts, Josiah b. Mevorakh al-ʿĀqūlī's calendar is said to start after 1494 SE (1182/3

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21 See Sacha Stern, "A Primitive Rabbinic Calendar Text from the Cairo Genizah," *Journal of Jewish Studies* 67/1 (2016): 68–90.

22 It is particularly telling that pairs of consecutive year-types precluded in the standard calendar by the *molad* calculation alone never appear in the 247-year cycle. For examples of such prohibited sequences, see Sherrard Beaumont Burnaby, *Elements of the Jewish and Muhammadan Calendars with Rules and Tables and Explanatory Notes on the Julian and Gregorian Calendars* (London: George Bell and Sons, 1901), pp. 108, 115.

23 As is the case with the ʿiggul of R. Naḥshon which, although it is said to repeat itself exactly, is always formulated for a particular thirteen cycles of nineteen years, e.g., 19-year cycles 258–270.

24 It is first attested in al-Khwārizmī's treatise on the Jewish calendar of 823/4 CE. See Stern, *Calendar and Community*, pp. 200–210.

CE). This starting point, together with the honorific "of blessed memory" appended to Josiah's name, led Tobi to deduce that Josiah b. Mevorakh lived in the first half of the twelfth century or earlier.[25] A *terminus post quem* of 1000 CE was inferred by Adler from the fact that "this chronologist is unknown to Albīrūnī,"[26] an opinion challenged by Steinschneider for whom "the ignorance of Albiruni is no proof for the time of Joschia!"[27] New evidence from the Cairo Genizah allows dating this sage and his calendar with far more precision.

The methodology for dating a cycle of remainders depends on the fact that the 247-year cycle is not a true cycle from the perspective of the standard calendar. Because the sequence of year-types does not recur exactly, for any given sequence it is possible to establish one and only one 247-year period during which this sequence corresponds to the standard calendar. In the next (or previous) iteration of the cycle, most remainders will produce correct results but some will deviate from the *molad* calculation. By analyzing all preserved cycles of remainders and establishing the 247-year interval to which each calendar pertains, it might be possible to establish the original sequence as it was fixed by Josiah b. Mevorakh al-ʿĀqūlī, on the assumption that it was based on the *molad* calculation. The period covered by the original sequence can help us date the system and its author.

Starting from 1001 SE, the earliest date when the described algorithm is applicable, the first four iterations of the 247-year cycle are:

- first iteration: 1001–1247 SE (689/90–935/6 CE)
- second iteration: 1248–1494 SE (936/7–1182/3 CE)
- third iteration: 1495–1741 SE (1183/4–1429/30 CE)
- fourth iteration: 1742–1988 SE (1430/31–1676/7 CE)

This takes us to the second half of the seventeenth century which, according to the catalogues, is an adequate *terminus ad quem* for the latest known manuscript containing the cycle of remainders.

As mentioned above, two consecutive 247-year sequences differ from one another in between two and seventeen years. Table 1 lists all years in which the four iterations of the 247-year cycle listed above are not identical. Cells with a grey background indicate deviations from the first iteration of 1001–1247 SE.

Table 1

Remainder	1st iteration SE date	Year-type	2nd iteration SE date	Year-type	3rd iteration SE date	Year-type	4th iteration SE date	Year-type
6	1006	זשג	1253	זשג	1500	זשג	1747	זחא
7	1007	הכז	1254	הכז	1501	הכז	1748	גכה
8	1008	בחה	1255	בחה	1502	בחה	1749	זשה
49	1049	זשה	1296	זחג	1543	זחג	1790	זחג
50	1050	זחא	1297	השא	1544	השא	1791	השא
53	1053	זשג	1300	זחא	1547	זחא	1794	זחא
54	1054	החא	1301	גכז	1548	גכז	1795	גכז
55	1055	גכה	1302	בשה	1549	בשה	1796	בשה
65	1065	בשז	1312	בשז	1559	בחה	1806	בחה

25 Tobi, *The Jews of Yemen*, p. 215. Raviv, "Mathematical Studies," p. 89 accepts this dating.

26 Adler, "The Persian Jews," p. 623.

27 Moritz Steinschneider, "An Introduction to the Arabic Literature of the Jews," *Jewish Quarterly Review* 12/2 (1900): 195–212, on p. 201.

66	1066	בחג	1313	בחג	1560	זשג	1807	זשג
69	1069	בשה	1316	בשה	1563	בחג	1810	בחג
70	1070	זחא	1317	זחא	1564	השא	1811	השא
94	1094	השא	1341	הכז	1588	הכז	1835	הכז
95	1095	גכז	1342	בשז	1589	בשז	1836	בשז
147	1147	זשה	1394	זשה	1641	זשה	1888	זחג
148	1148	זחא	1395	זחא	1642	זחא	1889	השא
151	1151	זשג	1398	זשג	1645	זשג	1892	זחא
152	1152	החא	1399	החא	1646	החא	1893	גכז
153	1153	גכה	1400	גכה	1647	גכה	1894	בשה
172	1172	השא	1419	השא	1666	הכז	1913	הכז
173	1173	גכה	1420	גכה	1667	בשה	1914	בשה
192	1192	השא	1439	השא	1686	השא	1933	הכז
193	1193	גכז	1440	גכז	1687	גכז	1934	בשז
233	1233	השג	1480	החא	1727	החא	1974	החא
234	1234	הכז	1481	גכה	1728	גכה	1975	גכה
235	1235	בחג	1482	זשג	1729	זשג	1976	זשג
238	1238	בשה	1485	בחג	1732	בחג	1979	בחג
239	1239	זחג	1486	השג	1733	השג	1980	השג

Table 2 presents data for the same years of possible calendar divergence as found in various manuscripts of Josiah b. Mevorakh al-ʿĀqūlī's calendar. Not all preserved copies of this calendar are complete, and some have description of only one or two year-types. The following notation is used in Table 2:

Data

- Year-type: the remainder is in the list for this given year-type.
- {Year-type}: the remainder is not in the list for this given year-type, even though the relevant year-type is represented in the manuscript. The absence of a remainder marked in this fashion is not due to a scribal error or a hole in the manuscript and is therefore significant (the difference between scribal errors and significant variations is explained below). This notation is used for incomplete manuscripts where not all year-types have been preserved, which makes it necessary to draw conclusions from silence.
- Empty cell: (a) in incomplete manuscripts, the remainder data are missing because the relevant year-type has not survived; (b) in complete manuscripts, a remainder is not assigned to any year-type due to a scribal mistake; (c) a lacuna in the manuscript.
- For each year-type, the numbers 1 to 4 indicate in which iterations of the 247-year cycle it is correct. For year-types given in curly braces, it indicates iterations in which it is correct for the remainder to be missing from the list; e.g.: 'remainder 8: בחה 1–3' means that in iterations 1–3 it is correct for remainder 8 to be on the list of remainders for the year-type בחה; 'remainder 65: {בחה} 1–2' means that in iterations 1–2 it is correct for remainder 65 to be missing from the list of remainders in the year-type בחה.

Manuscripts

- Classmark A+classmark B: Genizah fragments join and are part of the same copy
- Related manuscripts that contain identical or very similar lists of remainders are grouped together and represented by a single column.
- London, BL Or. 10702 is excluded from the table because it is too fragmentary and inconclusive.

Remainder	T–S NS 98.40+T–S Misc.25.29+T–S AS 144.164[28]	T–S AS 203.216+T–S AS 144.228+T–S AS 144.286[29]	T–S AS 144.111[30]	T–S AS 144.32[31]	T–S AS 144.46+T–S AS 144.166[32]	T–S Ar.2.12, T–S NS 98.95[33]	Rylands B 5508+Rylands B 3990[34]
6			זחא} 1–3				
7				הכז 1–3			
8	בחה 1–3				בחה 1–3		
49						זחג 2–4	זחג? 2–4
50			זחא 1				
53		זשג? 1	זחא} 1				
54	החא 1		גכז} 1				

ENA 3329+ENA 1640.5, T–S K2.41[35]	T–S 10K20.2+T–S K19.12[36]	T–S K2.8[37]	Ox. Bodl. Poc. 368	Lon. BL Or. 10576	Lon. BL Or. 2451, Ox. Bodl. Heb. e.60	Lon. BL Or. 9884[38]
זשג 1–3	זחא} 1–3		זשג 1–3	זשג 1–3		זחא 4
הכז[39] 1–3	הכז 1–3	הכז[40] 1–3	הכז 1–3	הכז 1–3		גכה 4
בחה 1–3	זשה} 1–3	בחה 1–3	בחה 1–3	בחה 1–3	בחה 1–3	זשה 4
זחג 2–4	זשה} 2–4	זחג 2–4	זחג 2–4	זחג 2–4	זחג 2–4	זחג 2–4
	זחא} 2–4	השא 2–4	השא 2–4	השא 2–4	השא 2–4	השא 2–4
זחא 2–4	זחא 2–4	זחא 2–4	זחא 2–4	זחא 2–4	זחא 2–4	זחא 2–4
גכז 2–4		גכז 2–4	גכז 2–4	גכז 2–4	גכז 2–4	גכז 2–4

28 Three year-types are preserved: בחג, בחה and החא.

29 Two year-types are preserved: בשה and זשג (the latter is extremely fragmentary).

30 Three year-types are preserved: השא, גכז and זחא.

31 Two year-types are preserved: הכז and בחג.

32 Four year-types are preserved: בחה, בשו, בחג and השג.

33 T-S Ar.2.12 preserves remainders for the year-types זחא (only some remainders survive) and זחג and T-S NS 98.95 for the year-type זחג only. Unlike other manuscripts grouped together in one column, these two cannot be shown to be related and are placed together only for considerations of space.

34 Two year-types are partially preserved: זחג and בשו.

35 ENA 3329+ENA 1640.5 is complete. In T-S K2.41 only eight year-types are preserved; missing are: זחא, גכה, זשה, זשג, השא, גכז.

36 Five year-types are preserved: בחג, זשה, השג, זחא, הכז.

37 The year-type זשג is missing.

38 Remainders for זחז are corrupt in the manuscript and are given as identical to those of זחא apart from two years.

39 In ENA 3329+ENA 1640.5 remainder 7 is also given in גכה, where it is listed out of order (cf. T-S K2.8).

40 Remainder 7 is also given in גכה (cf. ENA 3329+ENA 1640.5).

41 In both fragments the remainder given in בשה is 58, and 55 is not assigned to any year-type. This is a clear scribal mistake based on the similarity of the Hebrew numerals נח and נה. The same is also the case in T-S K2.8.

42 By scribal error the remainder given in בשה is 58, and 55 is not assigned to any year-type. Cf. ENA 3329+ENA 1640.5 and T-S K2.41.

Remainder	T–S NS 98.40+T–S Misc.25.29+T–S AS 144.164[28]	T–S AS 203.216+T–S AS 144.228+T–S AS 144.286[29]	T–S AS 144.111[30]	T–S AS 144.32[31]	T–S AS 144.46+T–S AS 144.166[32]	T–S Ar.2.12, T–S NS 98.95[33]	Rylands B 5508+Rylands B 3990[34]
55		{בשה} 1					
65	{בחה} 1–2				בשז 1–2		בשז 1–2
66	בחג 1–2			בחג 1–2	בחג 1–2		
69	{בחג} 1–2	בשה 1–2		{בחג} 1–2	{בחג} 1–2		
70			זחא 1–2				
94			השא 1	הכז 2–4			
95			גכז 1		{בשז} 1		בשז 2–4
147						{זחג} 1–3	
148			זחא 1–3				
151		{זחא} 1–3					
152	החא 1–3	{גכז} 1–3					
153		{בשה} 1–3					

Remainder	ENA 3329+ENA 1640.5, T–S K2.41[35]	T–S 10K20.2+T–S K19.12[36]	T–S K2.8[37]	Ox. Bodl. Poc. 368	Lon. BL Or. 10576	Lon. BL Or. 2451, Ox. Bodl. Heb. e.60	Lon. BL Or. 9884[38]
55	בשה 2–4[41]		בשה 2–4[42]	בשה 2–4	בשה 2–4	בשה 2–4	בשה 2–4
65	בחה 3–4[43]		בחה 3–4[44]	בחה 3–4	בחה 3–4	בחה 3–4	בחה 3–4
66	זשג 3–4	{בחג} 3–4		זשג 3–4	זשג 3–4	זשג 3–4	זשג 3–4
69	בחג 3–4	בחג 3–4	בחג 3–4	בחג 3–4	בחג 3–4	בחג 3–4	בחג 3–4
70	השא 3–4	{זחא} 3–4	השא 3–4	השא 3–4	השא 3–4	השא 3–4	השא 3–4[45]
94	הכז 2–4	הכז 2–4	הכז 2–4	הכז 2–4	הכז 2–4	הכז 2–4	הכז 2–4
95	בשז 2–4		בשז 2–4	בשז 2–4	בשז 2–4	בשז 2–4	בשז 2–4
147	זשה 1–3	זשה 1–3	זשה 1–3	זשה 1–3[46]	זשה 1–3	זשה 1–3	זשה 1–3
148	זחא 1–3	זחא 1–3	זחא 1–3	זחא 1–3	זחא 1–3	זחא 1–3	זחא 1–3
151	זשג 1–3	{זחא} 1–3		זשג 1–3	זשג 1–3	זשג 1–3	זשג 1–3
152	החא 1–3		החא 1–3	החא 1–3	החא 1–3	החא 1–3	החא 1–3
153	גכה 1–3		גכה 1–3[47]	גכה 1–3	גכה 1–3	גכה 1–3	גכה 1–3

43 Both fragments give here בחג, the symbol for a plain defective year beginning on Monday, whereas what is expected is בחה, representing an intercalated year.

44 The remainder given in בחה is 68, and 65 is not assigned to any year-type. This is a clear scribal mistake based on the similarity of the Hebrew numerals סח and סה. Cf. remainder 55 in this manuscript as well as in ENA 3329+ENA 1640.5 and T-S K2.41.

45 Remainder 70 is also given in זחא, but the list of remainders for this year-type is corrupt in the manuscript.

46 The remainder given in זשה is 146, and remainder 147 is not assigned to any year-type. This is a scribal mistake based on the graphic similarity of the Hebrew numerals קמו and קמז.

47 The remainder given in גכה is 123, and remainder 153 is not assigned to any year-type. This is a scribal mistake based on the graphic similarity of the Hebrew numerals קכג and קנג. Similar confusion occurred in this manuscript between Hebrew numerals כח and נח and קכו and קנו.

Remainder	T–S NS 98.40+T–S Misc.25.29+T–S AS 144.164[28]	T–S AS 203.216+T–S AS 144.228+T–S AS 144.286[29]	T–S AS 144.111[30]	T–S AS 144.32[31]	T–S AS 144.46+T–S AS 144.166[32]	T–S Ar.2.12, T–S NS 98.95[33]	Rylands B 5508+Rylands B 3990[34]	ENA 3329+ENA 1640.5, T–S K2.41[35]	T–S 10K20.2+T–S K19.12[36]	T–S K2.8[37]	Ox. Bodl. Poc. 368	Lon. BL Or. 10576	Lon. BL Or. 2451, Ox. Bodl. Heb. e.60	Lon. BL Or. 9884[38]
172			השא 1–2	{הכז} 1–2				השא 1–2	{הכז} 1–2	השא 1–2	השא 1–2	הכז 3–4	השא 1–2	הכז 3–4
173								גהה 1–2		גהה	גהה 1–2	בשה 3–4	בשה 3–4	בשה 3–4
192			השא 1–3	{הכז} 1–3				השא 1–3	{הכז} 1–3	השא 1–3	השא 1–3	השא 1–3	השא 1–3	השא 1–3
193			גכז 1–3		{בשז} 1–3		{בשז} 1–3	גכז 1–3		גכז 1–3	גכז 1–3	גכז[48] 1–3	גכז 1–3	גכז 1–3
233	{החא} 1				השג 1			החא 2–4	{השג} 2–4	החא 2–4	החא 2–4	החא 2–4	החא 2–4	החא 2–4
234				הכז 1				גהה 2–4	{הכז} 2–4	גהה 2–4	גהה 2–4	גהה 2–4	גהה 2–4	גהה 2–4
235	בחג 1			בחג 1	{בחג} 2–4				{בחג} 2–4		זשג 2–4	זשג 2–4	זשג 2–4	זשג 2–4
238		בשה 1		בחג 2–4	בחג 2–4			בחג 2–4	בחג 2–4	בחג 2–4	בחג 2–4	בחג 2–4	בחג 2–4	בחג 2–4
239					השג 2–4	{זחג} 2–4	{זחג} 2–4	השג 2–4	השג 2–4	השג 2–4	השג 2–4	השג 2–4	השג 2–4	השג 2–4

48 London, BL Or. 10576, fol. 155r reads here גכמה, where מ stands for מעוברת, intercalated. This is a clear scribal mistake, since the character of an orderly intercalated year starting on Tuesday is גכז, not גכה. Other mistakes in the day of the week of Passover are found in this manuscript.

A comparison of Table 2 with Table 1 reveals that lists of remainders presented in different manuscripts show significant differences that cannot be dismissed as scribal mistakes. Admittedly, most copies of this calendar are ridden with scribal errors because copying sets of numbers is an arduous task in which the copyist is not aided by the context. In most cases, however, scribal mistakes can be distinguished from significant variations. Indeed, mistakes usually apply to single years and generate random results, assigning remainders to year-types that are incorrect in any iteration of the 247-year cycle. On the contrary, iteration-related deviations show up in groups of two to three consecutive years[49] and produce remainders that are incorrect in one iteration of the cycle but correct in another.

Three fragmentary copies of the calendar contain a version of Josiah b. Mevorakh's cycle that is particularly early. These are T-S NS 98.40+ T-S Misc.25.29+T-S AS 144.164, T-S AS 203.216+T-S AS 144.228+T-S AS 144.286, and T-S AS 144.111. The following remainders are decisive for dating the version:

233	{החא} 1		
235	בחג 1		
238		בשה 1	

Remainder	T-S NS 98.40+T-S Misc.25.29+T-S AS 144.164: החא and בחג, בחה	T-S AS 203.216+T-S AS 144.228+T-S AS 144.286: זשג and בשה	T-S AS 144.111: זחא and גכז, השא
50			זחא 1
53		1 זשג?	{זחא} 1
54	החא 1		
55		{בשה} 1	
94			השא 1
95			גכז 1

It is immediately obvious that the remainders in these copies refer to the first iteration of Josiah b. Mevorakh's calendar, i.e., 1001–1247 SE (689/90–935/6 CE). As I argued above, Josiah b. Mevorakh's cycle of remainders must have been originally put together using the standard *molad* calculation, which makes a birth date in the seventh century very unlikely.[50] More probable is that it was constructed around the end of this 247-year period or the beginning of the next one, using calendrical records for the near past in combination with data calculated retrospectively for more remote years, or by retrospective calculation alone.[51]

The most likely *terminus post quem* for the creation of Josiah b. Mevorakh's calendar is the Saadia–Ben Meir dispute of 921–922 CE,

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49 As was mentioned above, this follows from the rules of postponements and the allowed lengths of the variable months Marḥeshvan and Kislev.

50 On the *molad* calculation see Stern, *Calendar and Community*, pp. 200–210.

51 Raviv ("Mathematical Studies," pp. 88 and 102) maintains that R. Josiah b. Mevorakh calculated a calendar for 247 years starting from 1494 SE (1182/3 CE) and recycled it back twice to 1001 SE. This conclusion is based on a limited corpus consisting of London, BL Or. 10576, Oxford, Bodl. Heb. e.60, London, BL Or. 9884 and T-S 10K20.2, all of which reflect the third iteration of the 247-year cycle of remainders (see Table 2). In view of Genizah fragments that have earlier iterations of the 247-year cycle, Raviv's conclusion is untenable. Additional evidence against Raviv's analysis is provided by the blessing of the dead (*raḍiya Allāhu ʿanhu* or *z"l*) attached to Josiah b. Mevorakh's name in all surviving copies of his cycle in which the name has been preserved, including T-S AS 144.111 datable to ca. 1123/4 CE.

when methods of calendation were discussed in fine detail but the 247-year cycle was not mentioned.[52] It can be conjectured that Josiah b. Mevorakh's calendar of remainders was devised in the aftermath of the dispute as a means of preventing future calendar dissidence by eliminating the need for calculation, an alternative to using the so-called Four Gates table advocated by the protagonists of the dispute. The decade of 980s may be suggested as the cycle's *terminus ante quem*. Inasmuch as the second iteration of Josiah b. Mevorakh's cycle diverges from the first in 984/5–985/6 CE and then in 988/9–990/1 CE (cf. remainders 49–50 and 53–55 in Table 1), in this decade calendrical data for the previous 247 years would deviate from the standard calendar, so it is not likely to have been used as the basis for a calendar cycle. Taken together, the two *termini* indicate that the calendar of remainders was conceived in the middle of the tenth century. This dating fits well with the scheme's omission by al-Bīrūnī,[53] as news of the method may not have reached him in Gurgan, on the Caspian Sea, before his book was completed in 1000 CE.

Josiah b. Mevorakh al-ʿĀqūlī: A Tentative Identification

Josiah b. Mevorakh al-ʿĀqūlī (or ibn al-ʿĀqūlī) must have been a scholar of Babylonian descent.[54] His *nisba* al-ʿĀqūlī may refer to ʿĀqūlā, a pre-Islamic (Syriac) name of Kūfa,[55] or to Dayr al-ʿĀqūl, a town on the Tigris southeast of Baghdad.[56] His Babylonian allegiance is shown by the fact that his calendar fixes the year 923 CE, one of those affected by the calendar dispute, as בחג in line with the Babylonians and contrary to the Palestinians, who fixed it as זשג.

Josiah b. Mevorakh (ibn) al-ʿĀqūlī is not a well-known personality, but he may be mentioned in manuscripts other than copies of his calendar. Genizah fragment T-S Ar.1b.5 contains a translation and commentary on Song of Songs and Lamentations by "*shaykh* Abū ʿAlī R. Josiah ben R. Mevorakh ben R. Isaac known as ibn al-ʿĀqūlī al-Kātib, may God prolong his existence," copied in the year 400 of the Arabs (1009 CE).[57] A list of books in Mosseri I,106.1 mentions a commentary on the weekly Torah portion *Haʾazinu* by Ben al-ʿĀqūlī (recto, line 25). A thirteenth-century copy of Maimonides' *Guide of the Perplexed* (Oxford, Bodl. Hunt. 162) preserves a textual variant where Ibn al-ʿĀqūlī is mentioned together with authorities of the tenth and early eleventh centuries who are said to have written against the eternity of the world, namely, Hayye Gaon (gaon of Pumbedita, d. 1038 CE), Aharon ibn Sarjado (gaon of Pumbedita in 942–960), Ibn Janāḥ (ca. 990–1050), Ibn al-ʿĀqūlī, Ben Ḥofnī ha-Kohen (gaon of Sura, d.

52 Sacha Stern and Marina Rustow, personal communication. See also n. 6 on p. 99.
53 See Abū Rayḥān al-Bīrūnī, *The Chronology of Ancient Nations* 7, pp. 141–175.
54 See also Tobi, *The Jews of Yemen*, p. 215.
55 Moshe Gil, *In the Kingdom of Ishmael: Studies in Jewish History in Islamic Lands in the Early Middle Ages; Texts from the Cairo Genizah: Letters of Jewish Merchants* (Tel Aviv: Tel Aviv University, 1997) (Heb.), vol. 1, pp. 507–508.
56 In his monumental dictionary of Islamic traditionists entitled *al-Ansāb* and arranged by the scholars' *nisbas*, ʿAbd al-Karīm ibn Muḥammad al-Samʿānī (1113–1166 CE) derives the *nisba* al-ʿĀqūlī from Dayr al-ʿĀqul only. See ʿAbd al-Karīm ibn Muḥammad al-Samʿānī, *al-Ansāb* no. 1662 and no. 2652 (Hyderabad: Osmania Oriental Publications Bureau, 1978), vol. 5, pp. 441–442, vol. 9, pp. 149–150. On Dayr al-ʿĀqūl, see A. A. Dari, "Dayr al-ʿĀḳul," *Encyclopaedia of Islam*[2] (Leiden: Brill, 1965), vol. 2, p. 196.
57 T-S Ar.1b.5r:
לישועתך קויתי ייי כתאן]ב[אלרזיה ואלנחיב. באלנטם ואלשרח ואלתרתיב. והו תפסיר איכה מן]מא[פן]ס[רה ותרגמה ותרה ונטמה אלשיך אבו עלי מֹרב יאשיה בן מֹרב מבורך בן מֹרב יצחק אלמשהור באבן אלעאקולי אלכֹתאֹב אטאל אללה בקאה אללה בקאה אשהרה סנה ת׳ לתאריך אלערב.

d. 1013), Dosa (gaon of Sura, ca. 935–1017), and his father Saadia Gaon (gaon of Sura, 882–942).[58]

Judging by his name, the author of the commentary in T-S Ar.1b.5 is likely to be the same person who composed the calendar of remainders, which means that Josiah b. Mevorakh was still alive in 1009 CE. If this identification is correct, it supports dating the calendar of remainders to the middle of the tenth century.

Critique and Modifications of the System

Most manuscripts of the earliest possible version of Josiah b. Mevorakh al-ʿĀqūlī's treatise include the calendar of remainders as part of a critique of the 247-year cycle. These are manuscripts T-S NS 98.40+ T-S Misc. 25.29+T-S AS 144.164 and T-S AS 144.111. The same critique also survived in T-S 6K2.1, where it was copied without the calendar. It was composed by Joseph bar ʾĀraḥ otherwise known from early twelfth-century business letters,[59] who set out to explain why Josiah b. Mevorakh's reiterative scheme fails to correspond to the standard calendar calculation in certain years. Joseph bar ʾĀraḥ's argument is as follows. For the 247-year calendar cycle to work, the calculated *molad* of Tishri of year N must equal that of year N+247. This, however, is not the case in the standard *molad* calculation procedure: the *molad* of Tishri of year N+247 is 905 parts (*ḥalaqim*) earlier than that of year N. This has implications for *moladot* that are close to various calendrical limits, such as a *molad zaqen* (one that occurs after 18 hours of the 24-hour day that begins at 6 p.m., i.e. after 12 noon). If the *molad* of year N falls after noon, Rosh Hashanah is postponed to the next permissible day. If the *molad* of year N falls less than 905 parts after noon, the *molad* of year N+247, being 905 parts earlier, will fall before noon, it will not be a *molad zaqen*, Rosh Hashanah will not be postponed, and the type of year N+247 will not be the same as that

of year N. Thus, a plain (*peshuṭah*, i.e., not intercalated) year with the *molad* of Tishri at 18 hours and 904 parts on Saturday will be set as בח, but 247 years later the year-type will be זש, because then the *molad* of Tishri will occur at 17 hours and 1079 parts.[60] On the other hand, if the *molad* of Tishri of year N is later than that, the *molad* in year N+247 will also be a *molad zaqen* and the two years will be fixed the same. For example, a plain year with the *molad* of Tishri at 18 hours and 905 parts on Saturday will remain בח in the next cycle, because then the *molad* will be on Saturday at precisely 18 hours. But in the following cycle it will become זש, because the *molad* will be at 17 hours and 175 parts.[61]

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58   Oxford, Bodl. Hunt. 162, fol. 66v, a marginal note in the hand of the main scribe that gives an alternative version of the final phrase of part I of the *Guide*, to be inserted after the words אלעאלם קדם מן יקולונה מא פי אלאפלאספה מע אלכ׳רוֹץ ארגّ דלך ובעד:

נ״א וארדّ עליהם ולסת אזעם אני וחדי מן דון ג׳ירי תגّרדת ללרד עליהם בל קבלי איצّא מתל רבנו האיי ואהרון בן סרגّאדו ואבן גّנאח ואבן אלעאקולי ובן חפני הכהן ור׳ דוסא ואלאדה רבנו סעדיה גאון זכרם כולם

... לברכה

The note was first published by Salomon Munk, *Notice sur Rabbi Saadia Gaon et sa version Arabe d'Isaïe* (Paris: Imprimerie de Cosson, 1858), p. 13. Munk erroneously cites the manuscript as Uri 359 (now Oxford, Bodl. Hunt. 267), whereas the correct number in the catalogue Uri is 309 (now Oxford, Bodl. Hunt. 162). The note was discussed or republished by M. Steinschneider, S. Poznanski, and A. Harkavy, in all cases on the basis of Munk's original publication and citing the erroneous catalogue number (see Moritz Steinschneider, *Die Arabische Literatur der Juden* (Frankfurt a. M.: Kauffmann, 1902), pp. 269–270; Samuel Poznanski, רב דוסא ברב סעדיה גאון (*R. Dosa be-Rav Saadia Gaon*) (Berditchev: Scheftel, 1906), p. 25; Abraham Harkavy, זכרון לראשונים וגם לאחרונים. חלק ראשון: זכרון לראשונים. מחברת שלישית: זכרון הגאון רב שמואל בן חפני וספריו (*On the Rishonim and the Aḥaronim. Part I: On the Rishonim. Vol. III: On R. Samuel ben Ḥofni Gaon and His Books*) (St. Petersburg, 1880), p. 17. I thank Rahel Fronda from the Bodleian Library, Oxford for her help with the manuscripts.

59   T-S 13J20.8 and T-S 12.329.

60   T-S NS 98.40, fol. 1v: יّנٍתّק̇ל מּן פּבּח אّلّي פُّشّ אّد יّכّוّن אّלّמّوّ יّזّהّתּּתּّرّّوّّعّّטّ פّّאّّنّّה מّّתّّ̊אّّלّّه מّّתّّל יّّוّّ̊زّّ̇וّّ̊עّّ̇ד

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Joseph bar ʾĀraḥ's exposition makes it clear that the remainder lists must be updated if one wishes to continue using Josiah b. Mevorakh's cycle beyond its first iteration without deviating from the standard calendar. To underpin his argument, Joseph includes a version of Josiah b. Mevorakh's calendar in which all the necessary changes have been made for it to apply to the second iteration (1248–1494 SE, 936/7–1182/3 CE). To draw attention to these changes, he does not simply replace old numbers with new ones but keeps the calendar in its original form and graphically indicates those that are no longer valid, adding the new ones outside the main text. In T-S AS 144.111, the remainders 50 in זחא, 94 in השא, and 95 in גכז are enclosed in a rectangle; the remainder 54 is introduced at the end of the list in גכז with a special insertion sign.[62] In T-S NS 98.40+T-S Misc. 25.29+T-S AS 144.164, the remainders 235 in בחג and 54 in החא are enclosed in a rectangle, and new remainders are noted below the main list: 238 in בחג and 233 in החא.[63] Corrections in a similar format are also found in T-S AS 203.216+T-S AS 144.228+T-S AS 144.286, which may or may not have come from a copy of Joseph bar ʾĀraḥ's critique: remainder 238 in בשה and remainder 53 in זשג are circled, but the updated numbers have not survived, because of the fragment's poor state of preservation. It is interesting that the corrections in Joseph bar ʾĀraḥ's work cover the entire 247 years of the cycle, including years that were long past when the critique was composed at the start of the twelfth century. This gives a clear indication that the purpose of revising the cycle was not to extend its usability but to demonstrate that it is not properly reiterative within the framework of the standard *molad* calculation.

The copies of Josiah b. Mevorakh's cycle included in the critique share a number of conspicuous features of wording and layout, in addition to the graphic indications of the changes. First, in all of them the chapters on the different year-types are listed in the same order as they occur at the beginning of an iteration; i.e. בשה is described first because it corresponds to remainder 1, followed by זשג, which is the year-type

for remainder 2, etc. Most other manuscripts group the year-types by the day of the week of Rosh Hashanah, starting with all year-types that begin on a Monday, followed by all types that begin on a Tuesday, those that begin on a Thursday, and finally the types that begin on a Saturday. Second, all copies refer to the seventh day of Passover with the rare Judaeo-Arabic term כֹס "diminishing."[64] Two other manuscripts of the cycle (T-S AS 144.32 and T-S AS 144.46+T-S AS 144.166) exhibit the same features and are clearly related to Joseph bar ʾĀraḥ's update. Here Joseph's marginal corrections are integrated into the main text, but outdated remainders are not always successfully removed. Thus, in T-S AS 144.32, the framed remainder 234 (1st iteration) appears on the main list in הכז alongside remainder 94 (2nd–4th iterations) and both 235 (1st iteration) and 238 (2nd–4th iterations) are given in בחג, whereas in T-S AS 144.46+T-S AS 144.166 both 233 (1st iteration) and 239 (2nd–4th iterations) are listed in השג.[65]

These two manuscripts represent a shift of perspective: from this time on the updated cycle is no longer copied to demonstrate that it is faulty but rather in order to be used. Notably, it is only at this stage that the cycle appears to have become popular: we do not possess a single

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61 T-S NS 98.40, fol. 1v: והו מתלא יֹוֹיֹֹה פאנה יתבת עלי פבח פי אלדור אלאכר איצא אד יכון אלמולד
פיה יֹוֹ ופי מ[א] בעדה פֹזֹש אד יצי[ר] [א]למולד יֹוֹהֹקֹעֹה

62 Remainder 50 was probably added to the list of השא but only the insertion sign survives. Remainder 53 may have been added in זחא but the area where this correction would have been made is badly stained.

63 For a summary of year-types expected in various iterations of the 247-year cycle see Table 1.

64 The same term is also used by Saadia Gaon in his prayer book (see Israel Davidson, Simcha Assaf, and B. Issachar Joel, *Siddur Rav Saadia Gaon*, 2nd ed. (Jerusalem: Meḳiṣe Nirdamim, 1963), p. 58 and p. 135, line 17).

65 Cf. Table 1.

pre-critique copy (i.e., before the first half of the twelfth century) of Josiah b. Mevorakh's calendar, whereas post-critique versions from the thirteenth–fourteenth century abound.

As it was used, the reiterative calendar was brought in tune with the standard calendar. Joseph bar ʾAraḥ's scientific method of checking and correcting a full iteration from remainder 1 to remainder 247 did not strike roots. Instead, a pattern of updating remainder lists in some years only is evident in manuscripts of Josiah b. Mevorakh's calendar that do not belong to the critique. ENA 3329+ENA 1640.5, T-S K2.41, T-S 10K20.2+T-S K19.12, and T-S K2.8 update remainders for the third iteration (1183/4–1429/30 CE) but stop before remainders 172–173, which are left the same as in previous iterations. London, BL Or. 9884 corrects remainders 6–8 to the fourth iteration (1430/31–1676/7 CE), but fails to do so for remainders 147–148, 151–153 and 192–193. In fact, of all extant manuscripts of Josiah b. Mevorakh's calendar, only London, BL Or. 10576 contains remainders that pertain to only a single iteration of the 247-year cycle—the third (1183/4–1429/30 CE). But it is difficult to say whether it was freshly calculated, or simply updated as far as 1354/5–1355/6 (remainders 172–173)—the last required in the third iteration, but not in 1435/6–1437/8 CE (remainders 6–8)—the first update in the fourth iteration.[66]

This gradual modification of the scheme probably indicates that whoever copied and corrected the cycle of remainders did not think of it in terms of 247-year cycles but as a convenient tool to determine the calendar for the coming years, at best a few decades. It may be conjectured that corrections were made in a haphazard manner by users of the calendar who checked and if necessary corrected in their copy only those years that were relatively close to their time.[67] When such corrected versions were copied again, user corrections were integrated into the main text and became part of the updated lists of remainders, much in the same way as in T-S AS 144.32 and T-S AS 144.46+T-S AS 144.166 for the corrections introduced by Joseph bar ʾAraḥ.

The process of updating the cycle of remainders began no later than the beginning of the twelfth century and continued at least until the middle of the fifteenth century: the latest attested corrections to the scheme, incorporated in the main text of London, BL Or. 9984, pertain to 1435/6–1437/8 CE (iteration 4, remainders 6–8). That the next set of corrections necessary for 1576/7–1577/8 CE (iteration 4, remainders 147–148) are not attested may be conditioned by the extant manuscripts, most of which were copied before the 16th century.

Both Joseph bar ʾAraḥ's critique that highlights the 247-year cycle's divergence from the standard calendar and the corrections made to remedy this clearly indicate that Josiah b. Mevorakh's scheme was not seen by its users as an alternative calendar. Instead, it was perceived as an easy means of reckoning the standard calendar and was thus not permitted (at least in theory) to differ from it. Notably, neither the critique nor the necessary corrections dissuaded everybody from relying on Josiah b. Mevorakh's cycle. Thus, the author of T-S Ar.2.12 expects one to "find it correct without a shadow of a doubt,"[68] whereas T-S Ar.29.31+T-S Ar.29.3v presents calculations to support an argument that although the 247-year cycle is not a true cycle, mistakes produced by it are few and in many cases will happen in such a distant future (not until some 10,000 years later) that it remains a perfectly usable calendar.

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66   Rylands B 5508+Rylands B 3990 may have been another such copy, but it is mutilated and not a reliable witness. All preserved data in this copy refer to the second iteration of the cycle.

67   A fourteenth-century source from Yemen reports that the 247-year cycles in circulation at that time were checked in 1647 SE (1335/6 CE) for at least as far as 1667 SE (1355/6 CE) (Tobi, *The Jews of Yemen*, pp. 215–216; idem, "The Dispute over the 247-year Cycle," p. 211).

68   T-S Ar.2.12: יגדה צחיח בלא שך ולא ריב.

The Distribution and Use of Josiah b. Mevorakh al-ʿĀqūlī's calendar

The relatively large number of Oriental manuscripts of Josiah b. Mevorakh's calendar and the gradual updating of the cycle by its users reflect the popularity of this method of calendation. The same is confirmed by a contemporary witness whose voice is preserved in T-S NS 98.2:[69]

> We saw that people often rely on the calendar of R. Josiah b. Mevorakh of blessed memory because it is simple and easy to grasp. We intentionally collated many versions of it and found them significantly different and there is not among them a correct one.

The manuscripts themselves furnish evidence of having been used in practice. T-S K19.12v contains corrections in a second hand to the description of a year-type. A hand different from that of the main scribe left a comment on year-type הכז in T-S K2.41: "this is our blessed year."[70] T-S AS 144.111 contains an added note intended to make using the cycle even more straightforward by establishing remainders for some of the years in the 19-year cycle 258 (1123/4–1142/3 CE). But most revealing is a marginal note in London, BL Or. 2451: "I calculated using this cycle as it is written [here] year 5495 is cycle 58."[71] Then in thicker characters it continues: "year 5503 is cycle 66."[72] This note correctly states that years 5495 AM (1734/5 CE) and 5503 AM (1742/3 CE) correspond to remainders 58 and 66 in Josiah b. Mevorakh's cycle. The cycle of remainders does not differ from the standard calculation for either year.

In addition, two fifteenth-century manuscripts (London, BL Or. 2451 and Oxford, Bodl. Heb. e.60) inherited from their common *Vorlage*[73] an arrangement that shows active engagement with the calendar of remainders in order to make it easier to use. In these manuscripts, the remainders for a number of year-types are given not from low to high, but starting at some point between 148 and 175 and then going full

circle. The starting numbers probably correspond to the next year of that type that will be encountered and must have been moved to the top of the lists to make them more prominent. This arrangement reflects the period when the author of the *Vorlage* was writing. The relevant calendar sections are ordered so as to allow using the treatise as a continuous text, even if only for a small number of years. Take for example, remainders 151, 152, and 153. In iterations 1–3, remainder 151 belongs to the year-type זשג, remainder 152 to the year-type החא, and remainder 153 to the year-type גכה. In most copies of Josiah b. Mevorakh's cycle, the sections on זשג, החא, and גכה are in different parts of the calendar, because year-types are ordered by day of the week of Rosh Hashanah. But in London, BL Or. 2451 and Oxford, Bodl. Heb. e.60 the section on זשג is directly followed by that on החא and then by that on גכה. In this way, a user who has established that his year corresponds to remainder 151 could find the relevant section, i.e., זשג, bookmark it in the manuscript, live through that year following the directions on זשג, and by the end of the year arrive exactly at the place in the manuscript where a description of his next year (remainder 152, year-type החא) begins.[74] This arrangement does not work equally well in all iterations of the 247-year cycle and best

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69 T-S NS 98.2, fol. 2:

ונצרנא כתרה אעתמאד אלנאס עלי עבור לרבינו יאשיהו בן מבורך זֹל לאנה סהל קריב אלמאכד פעמדנא

קאבלנא מנה נסך כתירה פוגﬞ[ד]נאהא מכתלפה כלף עטים וליס מנה צחיח.

70 T-S K2.41, plate 3r: הדה סנתנא אלמבארכה.

71 London, BL Or. 2451, fol. 369v: נח הוא מחזור שנת התצה שכתוב כמו חשבתי מחזור בזה. The term מחזור "cycle" is used here to indicate a remainder.

72 London, BL Or. 2451, fol. 369v: סוֹ מחזור התקג שנת.

73 On the relation between these two manuscripts, see the description of manuscripts above.

74 A similar arrangement is found in copies of Joseph bar ʾĀraḥ's critique, where year-types are listed in the same order as they occur at the beginning of an iteration.

fits 1642–1669 SE (1330/31–1357/8 CE), implying that it was elaborated sometime around 1330 CE.

Knowledge of Josiah b. Mevorakh's calendar of remainders or at least the association of Josiah b. Mevorakh's name with the 247-year cycle appears to have been geographically widespread. Oriental manuscripts containing the scheme and its critique come from Egypt and Persia. In addition, fourteenth-century Yemenite sources attribute the 247-year cycle to Josiah b. Mevorakh and claim that the Jews of Yemen rely heavily on his calendar.[75] It is not entirely clear, however, if the 247-year cycle actually circulated in Yemen as a cycle of remainders. To the best of my knowledge, no Yemenite manuscripts preserve a cycle of remainders, and Josiah b. Mevorakh is always mentioned together with other authorities, such as R. Naḥshon Gaon and R. Samuel b. Joseph ha-Kohen,[76] which is not the case in cycles of remainders preserved in Genizah fragments or in Judeo-Persian manuscripts. It is not impossible that Josiah b. Mevorakh was known to have composed a calendar treatise based on the 247-year cycle so that his name became associated with the idea of such a cycle, whatever the actual form.

Outside the Oriental geocultural area, two Ashkenazi manuscripts mention R. Josiah as one of the authorities for the 247-year cycle:[77]

> R. Hayye and his father R. Sherira Gaon, and the geonim R. Naḥshon and R. Josiah understood the principle regarding the end of this calculation and said that at the end of 247 years, which are written down as thirteen cycles of nineteen years, the calculation will always return to what it was in the beginning without any addition or deficit with regard to defective, full, and regular (years) and the fixing of festivals. The arrangement of all this is a sign for the whole congregation of Israel.

At present, there is no evidence to connect Hayye Gaon and Sherira Gaon with the 247-year cycle, and their names may have been

adduced here to make the statement more authoritative. R. Naḥshon is the standard authority for this cycle, although the history of this attribution is yet to be studied. Here R. Josiah is said to be one of the Geonim; indeed, Josiah b. Aharon was a Palestinian gaon ca. 1011–1025 CE.[78] However, considering that Josiah b. Aharon Gaon is not known to have supported the 247-year cycle, whereas a work on this cycle by

75 See, e.g., an anonymous 'Ibbur ha-Šanim, composed in 1329 CE, as edited in Tobi, "The Dispute over the 247-year Cycle," p. 207 on the basis of MS 1236 in Ben-Zvi Institute, Jerusalem:

ומחזור גדול והו י"ג מחזור מן מחאזיר אלעיבור אלד"י כל מחזור י"ט סנה והו מנסוב לר' יאשיה בר מבורך, והו עגול דר' נחשון.

A statement to the same effect is found in 'Ibbur ha-Šanim by R. Maʿūḍa b. Solomon al-Lidānī, as edited in Tobi, "The Dispute over the 247-year Cycle," p. 210 on the basis of New York, JTS 4463, fol. 98r–100r:

וכאן אכת'ר אעתמאד אלנאס עלי עיבור יאשיה בירב מבורך ועלי עבור שמואל בר יוסף כהן לאנהא עיבורות סהלה וליס יד'כר פיהא מולד ולא דחייה בל קד הי מוצ'ועה ברבאטאת מערופה מת'ל בש"ה בח"ג זש"ג זח"א הכ"ז גכ"ז ומת"ל בשמ"ז החמ"א גכמ"ז פי אלמעוברות.

76 It is not clear who R. Samuel b. Joseph ha-Kohen was and in what way he was associated with the 247-year cycle. Tobi (*The Jews of Yemen*, p. 219) suggests that the reference may be to a tenth-century Palestinian gaon of that name. On R. Samuel b. Joseph ha-Kohen Gaon, see Moshe Gil, *Palestine during the First Muslim Period* (Tel Aviv: Tel Aviv University, 1983), vol. 1, p. 542 (Heb.).

77 These are Oxford, Bodl. Opp. 614, a fourteenth-century Ashkenazi miscellany, and Cincinnati, HUC 436, a fifteenth-century Ashkenazi prayer book for the whole year. The text, nearly identical in both manuscripts, is cited here according Oxford, Bodl. Opp. 614, fol. 50v:

רב האיי ורב שרירא גאון אביו וובני נחשון. ור' יאשיה גאונים עמדו על עיקר סוף זה החשבון והם אמרו כי לסוף רמ"ז שנים כמו שהן מצויינין לי"ג מחזו' שהן של י"ט שנים חוזר החשבון חלילה בחסירין ובשלימין וכסדרן ובקביעות המועדים כבראשונה בלי חסירות ויתרות וסדר כל זה סימן לכל עדת ישראל.

78 See Gil, *Palestine*, vol. 1, pp. 543–545.

Josiah b. Mevorakh al-ʿĀqūlī was in circulation at least in the Orient, the latter must be intended.

Josiah b. Mevorakh's cycle of remainders makes another non-Oriental appearance in a fifteenth-century manuscript copied in a number of Byzantine hands, which contains Isaac Israeli's *magnum opus* on the calendar, *Yesod ʿOlam,* and a number of other astronomical and calendrical treatises (Oxford, Bodl. Poc. 368). Among them is a short, one-page section on a reiterative calendar, written in Hebrew, and introduced as follows:[79]

> To know the character of the year with ease, count the years of Alexander up to the year that you are in, including your year, and discard the thousand. Cast out 247s from what is left and look for the number that remains among the 247 numbers in the fourteen tables, and you will find what you need with God's help. For example, the year 5202 from Creation is year [1]753 of Alexander. Remove the thousand and what remains is 753. Cast out 247s from 753, and what remains is 12. We searched for 12 in the fourteen gates and found it in the gate זשג. Do the same with all of them.

Then follow fourteen tables of remainders for the fourteen types of the Jewish year, but the longer descriptions of the course of the year are lacking. Although the name of Josiah b. Mevorakh does not appear in this text, it is obvious that the method described is based on his composition. First, this fifteenth-century Byzantine calendar instructs one to start with the year from Creation and to convert it to a Seleucid date, the era used in Josiah b. Mevorakh's calendar. Secondly, it applies the same algorithm to work out the remainders, with the same epoch of 1001 SE. The remainders presented are identical to those in Josiah b. Mevorakh's work (allowing for scribal mistakes) and reflect the stage in the development of the cycle when remainders were updated for the third iteration up to but not including remainders 172–173 (1354/5–

1355/6 CE), which are left the same as in the previous iteration. The same situation is found in ENA 3329+ENA 1640.5, T-S K2.41, T-S 10K20.2+T-S K19.12, and T-S K2.8. The examples illustrating the method in Oxford, Bodl. Poc. 368 are for the years 5202 AM (1441/2 CE, 4th iteration, remainder 12) and 5224 AM (1463/4 CE, 4th iteration, remainder 34), meaning that the remainders were outdated at the time of copying but would not produce any mistakes until 1576/7 CE (4th fourth iteration, remainder 147), when the first aberration would occur, more than a century after the date of the last example given.

A final comment on the spread of Josiah b. Mevorakh's cycle of remainders concerns an Italian version of the reiterative 247-year calendar. Prayer books of the Italian rite frequently contain a calendar for thirteen 19-year cycles that does not refer to any dates but operates with cycles numbered 1–13 and years numbered 1–247. The calendar is formatted as a sequence of 247 year-types, and users are provided with an algorithm for determining their place within the sequence that, depending on the version, has an epoch of either 4998 AM (1237/8 CE) or 5017 AM (1256/7 CE). For example,[80]

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79   Oxford, Bodl. Poc. 368, fol. 219r:

לדעת קביעות השנה בנקל חשוב שנות אלסכנדר עד השנה אשר אתה בה ובשנתך והשלך מהם האלף והנותר השליכם רֹמֹ רֹמֹ ביֹד שערים ביֹד שערים ותמצא חפצך בעה. המשל שנת הֹרֹב היא שנת תֹשֹׁנֹג לאלסכנדר השלך האלף ישארו תֹשֹׁנֹג התֹשֹׁנֹג השלך התֹשֹׁנֹג רֹמֹ רֹמֹ ישארו יֹב בקשנו יֹב ביֹד שערי׳ מצאנוה בשער זֹשֹׁג וכן תעשה לכלם.

Note that רמו is written where רמז is expected. The mistake of writing a *vav* in place of a *zayin* runs through the entire passage under consideration. Additional examples include לו for לז, קמו for קמז, קצו for קצז (cf. n. 46 above).

80   JNUL Heb. 38°4281, fol. 298r:

הרוצה לידע קביעות ראשי חדשים ומועדים וצומות וקריאת פרשיות והפסקות שלכל שנה ושנה יחשוב שנות הפרט שעל חמשת אלפים שנה ויוסיף עליהן גֹ שנים ויכללם יחד ויוציאם רֹמֹ רֹמֹ והנמצא בידו הוא החשבון שעומד בו וימצאהו באילו יֹג מחזורים שלפנינו.

He who wants to know for each year how to fix the New Moons, the festivals, the fasts, the reading of the weekly portions and their divisions, should count the years above 5000, and add to them three years. He should add them all up and cast out 247s. What he retains is the number (of the year) in which he is in, and he will find it in the thirteen cycles before us.

This procedure is undeniably reminiscent of the Oriental algorithm of Josiah b. Mevorakh. The Italian "thirteen cycles" are not attributed to any authority, operate with a different era and epoch, and are formatted differently from most copies of Josiah b. Mevorakh's cycle. Still, the Italian and the Oriental methods of creating a perpetual calendar independent of dates are so similar that it is hard to imagine that the more recent Italian cycle was devised independently of its Oriental predecessor.

Concluding Remarks

In this article I have identified and examined the oldest traceable reiterative Jewish calendars. Evidence from the Cairo Genizah shows that the original 247-year cycle was conceptualized as a cycle of remainders and drawn up in the middle of the tenth century. It predates the earliest cycles that are structured as tables of nineteen columns by thirteen rows, commonly entitled the ʿiggul of R. Naḥshon Gaon, by more than a hundred years. The attribution of the 247-year cycle of remainders to a Babylonian scholar, Josiah b. Mevorakh (ibn) al-ʿĀqūlī, appears to be historical; given that he was contemporary with the earliest cycle and not a high-ranking authority, his name would not add weight to the scheme and he would be an unlikely pseudo-author. The cycle of remainders may have been proposed in the aftermath of the Saadia–Ben Meir dispute of 921–922 CE as an alternative for the standard calendar that could avert future calendar arguments caused by differences in the calendar calculation procedures employed in Babylonia and Palestine. However, users of the 247-year cycle clearly regarded it as a means of reckoning the standard calendar and strove to keep the cycle in line with the standard calculation by updating the remainders. The reiterative method was subjected to rigorous criticism in the early twelfth century, but continued to be widely used in the Orient at least until the middle of the eighteenth century, with knowledge of it spreading to other geocultural areas, including Byzantium, Italy, and Ashkenaz.

Focusing on the origins of the 247-year cycle, this article leaves open a number of important questions related to Jewish calendar cycles in medieval manuscripts, which will be dealt with in greater detail in subsequent research. These include a study of the calendar tables known as the ʿiggul of R. Naḥshon Gaon and of the Italian "thirteen cycles"; the history of the cycle's attribution to R. Naḥshon Gaon; and the controversy surrounding the inclusion of the 247-year cycle in printed editions of the Arbaʿah Ṭurim of Jacob b. Asher, one of the most influential rabbinic law codes ever written.