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The Zoroastrian Persian Calendar in a Medieval Hebrew Treatise on The Jewish Calendar by Abraham bar Ḥiyya[1]

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Abstract
This article exposes an analysis of the Zoroastrian Persian calendar in a 12th century Hebrew book on the Jewish calendar (*Sefer ha-'Ibbūr*). The Hebrew treatise was composed by the polymath Abraham bar Ḥiyya, probably in Northern France. Bar Ḥiyya depicts the structure of the Zoroastrian Persian calendar, its months and some of its festivals. He then expounds on calendrical algorithms which enable to convert between Persian and Jewish dates. Although one finds the names of some Persian months and festivals in earlier Jewish sources, Abraham bar Ḥiyya's text not only elaborates in greater detail on these matters, but for the first time in Hebrew literature, one encounters conversion algorithms between the two calendars.

Keywords: calendrical algorithms, the Jewish fixed calendar, The Zoroastrian Persian calendar

1. I wish to thank François de Blois, Malachi Beit-Arie, Judith Olszowy-Schlanger, Israel Sandman, Shaul Shaked, and Sacha Stern, for their precious advice. This article is based on my recent research of the section on the Zoroastrian Persian calendar in Abraham Bar Ḥiyya's calendrical treatise *Sefer ha-'Ibbūr*, and several questions still remain open. Comments and corrections from the readers will be most welcome. *Sefer ha-'Ibbūr* was first edited and published by Filipowski in London in 1851. His edition is based on two (at best) mediocre manuscripts. A complete critical edition and English translation of *Sefer ha-'Ibbūr*, based on 23 manuscripts and the 1851 printed edition, accompanied by a commentary, is being currently prepared at University College London by my colleague Dr Israel Sandman and myself. This is part of our postdoctoral research project on early 12th century Hebrew monographs on the Jewish calendar, directed by Prof. Sacha Stern and funded by the AHRC (Arts and Humanity Research Council, UK).

The Zoroastrian Persian calendar[1]

In contrast to the old Persian calendar, the Zoroastrian Persian calendar was non-lunar and fixed. It was introduced under the Achaemenid rule in the century following Cambyses' reign (c. 525 BCE). The Babylonian calendar was in use throughout the entire Achaemenid period, and the Persian rulers determined when to intercalate the year. However, the new Zoroastrian Persian calendar was predictable and stable, and thus it could serve many political, administrative and economic functions, while bearing a unique Persian identity.

The Zoroastrian Persian year has 365 days, distributed over 12 months of 30 days each and another five additional days (‘the epagomenai’, or ‘the little month’), also known as the five Gatha days, Andargāh, or ‘the stolen five days’. The names of the months, in their modern form, are: Farwardīn, Urdībihišt, Xurdāδ, Tir, Murdāδ, Šahrīwar, Mihr, Ābān, Āδar, Day, Bahman and Isfandārmaδ. The months and the days of the months are named after Zoroastrian divinities, but the Zoroastrian Persian calendar was probably instituted and diffused through Achamaenid rulers rather than Zoroastrian priests. Since the Persian year is about ¼ of a day shorter than the tropical year, festivals will drift throughout the seasons, about 1 day in 4 years. The Zoroastrian Persian calendar was modelled on the Egyptian calendar, the only fixed calendar that existed in earlier Antiquity, with the difference that 1 Farwardīn (the 1st Zoroastrian Persian month) corresponds to 1 Choiak/Akhet (the 4th Egyptian month).[2]

The calendar continued to be in use, without any further alteration, for about a thousand years, until the Sasanian calendar reform, around 500 CE. The reform constituted in moving the epagomenai from the end of the 12th month (Isfandārmaδ) to the end of the 8th month (Ābān), probably with the intention of (at least temporarily) correcting the drift in seasons, bringing the religious New Year (Nawrōz) celebrations

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1. In this section I shall focus the main characteristics of the Zoroastrian Persian calendar and the changes it underwent. Further details, especially citations from primary sources concerning some of the festivals, are provided in the commentary alongside the English translation of the Hebrew text. For a thorough history and analysis of the various stages of the Persian calendar, its festivals as well as social and etymological aspects see de Blois, “The Persian calendar”, Boyce, “On the Calendar of Zoroastrian Feasts”, ead, “Further on the calendar of Zoroastrian Feasts”, and Stern, *Calendars in Antiquity*, pp. 167-191. The materials in this section are based on these works.
2. Blois, ‘The Persian Calendar’, p. 48.

during the epagomenai back to the vernal equinox, its traditional time of celebration. This did not mean the transferal of the beginning of the civil year, which always seems to occur on 1 Farwardīn, but shifting the religious Nawrōz festival to 1 Āδar.[1] Yazdgerd III, the last Sasanian ruler, introduced the final changes to this new reformed Sasanian calendar. The year 632 was chosen as the beginning of a new era, and this last imperial Persian calendar is known as the Yazdgerdi calendar.[2] Years are counted according to his reign, from 16 June 632, or the era of his death, from 11 June 652 (= 1 Farwardīn 21).[3]

In the year when the shift was decided upon, the 12th month was followed immediately by Farwardīn, i.e. the Gatha days were removed from their original position, and instead, they were inserted in the following year between the 8th and 9th months. This meant that the new 1 Farwardīn was the old 6 Farwardīn. A portion of the Zoroastrian clergy resisted the Sasanian reform and continued to celebrate Nawrōz according to the old calendar, i.e. on 6 Farwardīn. Others accepted the new Nawrōz on 1 Āδar, while a third faction did not object to the new calendar, as a calendar, but still insisted on having their New Year on the day that was called 1 Farwardīn. The three options were eventually reconciled by accepting them all and this explains why Nawrōz was celebrated three times every year: "little Nawrōz" on 1 Farwardīn, then "great Nawrōz" on 6 Farwardīn (=1 Farwardīn old style) and finally the "Nawrōz of the Magians", the official religious New Year, on 1 Āδar.[4]

The Zoroastrian Persian calendar underwent further changes. In 1006/7 the epagomenai were moved (back) to the end of the year (i.e. after the 12th month) as we learn from Kūšyār ben Labbān Al-Jīlī[5] as well as his contemporary, Al-Bīrūnī (in his *Al-Qānūn Al-Masʿūdī*, written in 1030),[6] but the latter treats the moving of the epagomenai as irrelevant since Zoroastrians in Eastern Iran rejected it. In 1079, a new

1. The religious tradition of commemorating the departed spirits at the end of the 12th Iranian month was so firmly established that the shift was met with resistance. The uncertainty about the date of this festival ended in 10-day celebration i.e. for the last five days of the twelfth month and for the next following five epagomenai.
2. It is this stage of the Zoroastrian Persian calendar that is presented in *Sefer ha-ʿIbbūr*.
3. The old-fashion calendar, however, remained in use in other parts of the Achaemenid Empire: in Armenia, Sogdiana and Choresmia.
4. Blois, ‘The Persian Calendar’, pp. 47-8.
5. Ibid, p. 41.
6. Ibid, p. 39.

solar calendar was introduced in the eastern provinces of the Muslim world by the Seljuk ruler Jalāl ad-Dīn Malik-Šāh, and it was named after him - the Jalāli calendar. He fixed the beginning of the year to the spring equinox and retained the traditional Zoroastrian Persian twelve months of 30 days each as well as the epagomenai (at the end of the year), but he added a sixth 'stolen' day at regular intervals and thus rendered the year equally long as in the Julian calendar. The Jalāli calendar was an agricultural one, and it never played a significant role in official time-keeping. It detached the traditional New Year's festival once and for all from the Zoroastrian calendar and fixed it permanently to the vernal equinox, and with this, the Zoroastrian calendar ceased to be of practical interest to Iranian Muslims.

The Fixed Jewish calendar[1]

The rabbinic calendar was originally based on the appearance of the new moon, which involved a procedure of observation, as described in the Babylonian Talmud within tractate Rōš Ha-Šānā. Later, the Jewish calendar became a calculated scheme, based on the mean conjunction (mean mōlā<u>d</u>),[2] which approximates the true conjunction (the true mōlā<u>d</u>). The fixed Jewish calendar, also known as the present-day rabbinic calendar, is lunar, and the days of the month correspond, *grosso modo*, to the phases of the moon. The variable length of each lunation, a-priori any value within the rough interval [29d 6.5h, 29d 20h], impedes the creation of a mathematical scheme that perfectly reflects astronomical reality. However, the chosen mean lunation value for the synodic month, 29d 12h 793p,[3] is a good approximation.[4]

The calculation of the new moon is based on this value of lunation and the epoch is 2d 5h 204p, or BaHaRaD, in Hebrew alpha-numerical

1. I shall focus here solely on calendrical elements which are necessary for understanding the algorithms in this article, and further details will be provided later *chemin faisant*. For a comprehensive analysis of the Jewish calendars from antiquity until the Middle Ages with their intricate, non-linear, evolution from solar into a lunar and fixed arithmetical scheme see Stern, 'Calendar and Community'.
2. Mōlā<u>d</u> literally means 'birth', referring to the birth of the new moon.
3. d := days h := hours p := parts, and i := instants, whereas there are 1080 parts in an hour and 76 instants in each part. The first day of the week is Sunday. For the calculation of the mōlā<u>d</u>, the day starts at 6pm of the previous evening, e.g. Monday starts on Sunday at 6pm.
4. 29d 12h 793p is equivalent to the standard Babylonian value (expressed in sexagesimal notation) 29; 31, 50, 8, 20 d. For further details on this value and variants in medieval Hebrew, Arabic and Latin literatures, including the 'phantom' value 29; 31, 50, 8, 9, 20 see Goldstein, "Ancient and Medieval Values for the Mean Synodic Month".

notation. The latter value marks the mōlā<u>d</u> of Tišrī in year 1 of Creation, i.e. the time of the first mōlā<u>d</u> in Jewish chronology. This epoch corresponds to Sunday, 6 October 3761 BCE, 23 hours, 11 minutes, and 20 seconds.[1] Any subsequent mōlā<u>d</u> can be reckoned by adding the right number of lunations to this epoch. However, this is not a straightforward numerical task. Most people are prone to arithmetical error, especially when lengthy calculations are involved. Since the only information that really matters is when the mōlā<u>d</u> falls within the week, the operation of casting out 7s, or seeking the smallest non-negative number equivalent to the given number modulo 7, becomes a useful tool in the reckoning of the Jewish calendar.[2] Throughout the Middle Ages, many an algorithm were devised to facilitate the process of casting out 7s and also enable the detection of errors in the outcome (sanity tests).[3]

The months in the Jewish calendar are: Tišrī, Marḥešwān, Kislēw, Ṭēbē<u>t</u>, Šə<u>b</u>āṭ, ’Ă<u>d</u>ār, Nīsān, Iyār, Sīwān, Tammūz, Ā<u>b</u>, ’Ĕlūl. The number of days in each month alternates in a constant pattern between 30 and 29 with the exception of the months of Marḥešwān and Kislēw, which are variable: they consist of 29 and 30 days, respectively, in an orderly year (šānā kəsidrāh), 29 days in a defective year (šānā ḥāserāh) and 30 days in a complete year (šānā šəlemāh). This results in six types of year, with 353, 354 or 355 days in a plain (non-intercalated) year or 383, 384, 385 days in an intercalated year. This flexibility enables the application of the fundamental rules of postponement and it also balances the discrepancy between a mere alternation of 30 and 29 days and the multiple of the length of the mean synodic month, which is just over 29.5 days.

Given the approximate 11-day surplus of a solar year over 12 lunations, every two or three years, a 13th month with 30 days (first ’Ă<u>d</u>ār) is added to, or intercalated into, the lunar year, right before the

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1. Sometimes the mōlā<u>d</u> of the following year, year 2 of Creation, is used. It is the ‘neater’ figure of 6d 14h 0p or WeYaD ('ו'י'ד), which probably means that this was the original epoch to have been in use. See details in Stern (2001), p.192.
2. Casting out 19s is useful for the determination of a year’s position within the 19-year cycle, and casting out 28s for the position within the great 28-year solar cycle. We will see examples of casting out 7s but also multiples of 29d 12h 793p.
3. Numerous sanity tests are adduced by Abraham bar Ḥiyya, some derive from earlier Hebrew sources which have not survived. The currently prepared edition of *Sefer ha-‘Ibbūr* includes a thorough analysis of these procedures.

month of ’Ădār (which becomes second ’Ădār, or Ve-Ădār) in order to keep in sync with the tropical year of 365¼ days in the Julian calendar. Intercalation thus ensures that Jewish holidays are celebrated in the biblically prescribed season and do not drift through the seasons. The pattern of intercalation is constant; within the 19-year cycle (adopted from the Babylonian calendar) one intercalates years 3, 6, 8, 11, 14, 17 and 19. The Jewish New Year, Rōš Ha-Šānā, is celebrated on 1 Tišrī. A-priori, 1 Tišrī should coincide with the day in which the mōlād of Tišrī occurs. However, 1 Tišrī must be postponed to the following day if its mōlād is old (mōlād zāqen), i.e. if it occurs at 18 hours (midday) or later.[1] Another postponement rule is that *Rōš Ha-Šānā* cannot be celebrated on Sunday, Wednesday or Friday (Hebrew mnemonic: *Lo ADU Rōš*).[2]

Abraham bar Ḥiyya (ca. 1165 – ca. 1136) and his *Sefer ha-‘Ibbūr*

Immersed in Arabic science and culture, Abraham bar Ḥiyya is considered ‘the father of medieval Hebrew mathematics’ because he was the first to have coined hundreds of mathematical (and other scientific) Hebrew terms during the Hebrew Renaissance of the 12th century, during which Hebrew became a scientific *lingua franca* among Jews in the Iberian peninsula, Northern France, and other areas under Christian rule. Bar Ḥiyya’s vast contribution to medieval Hebrew science and philosophy goes far beyond his linguistic creation. His

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1. This is based on an astronomical explanation found in the Talmud that if mōlād occurs before midday, then the moon will be seen close to sunset, but if the mōlād does not occur before midday, then it will not be seen close to sunset (Babylonian Talmud, tractate Rōš Ha-Šānā, page 20b). This explanation, however, is astronomically incorrect since the new moon can only be visible at least 18 hours after conjunction.

2. This could result in a 2-day postponement. ‘Lo’ means ‘no’, ‘ADU’ is a vocalized form of the alphanumerical presentation of the numbers 1-4-6 א'ד'ו', the numbering of ‘forbidden’ days for the celebration of *Rōš Ha-Šānā* in the Jewish week, and ‘Rōš’ stands for *Rōš Ha-Šānā*. This rule derives from religious motives: if *Rōš Ha-Šānā* were to fall on Wednesday or Friday, then the Day of Atonement, *Yōm Kīppūr*, celebrated on 10 Tišrī, would fall on Friday or Sunday, respectively, i.e. on a day adjacent to the Sabbath, and thus will create a chain of two holy days. This could mean that deceased people would not be buried within the 24 hours, as prescribed by Jewish law. This would also imply that people would not be allowed to cook for two whole days, making life difficult. As for the prohibition of *Rōš Ha-Šānā* to fall on Sunday, the reason behind it is to avoid that the Day of the Willow on 21 Tišrī (part of the festival of Tabernacles) would fall on the Sabbath and then people would not be able to perform the precept of holding the willow, because it is considered as toil, thus prohibited on the Sabbath.

prolific writings include tracts on astronomy, mathematics, calendar reckoning, astrology, philosophy and exegesis.[1]

Bar Ḥiyya's extensive calendrical treatise *Sefer ha-'Ibbūr* was written in the Jewish year 4883 (=1122/3 CE), probably in Northern France. It is not only a book that merely teaches how to reckon the Jewish calendar and its structure. *Sefer ha-'Ibbūr* embodies many other facets: philological, exegetical and polemical. It also includes sections on terrestrial geography, cosmology and astronomy. It is divided into three discourses, and each discourse is subdivided into ten chapters. The first discourse focuses on terrestrial geography, cosmology, the Ptolemaic models for lunar and solar motions, a linguistic analysis of the term 'day', its components and the dispute among the nations regarding on when it should begin. Further themes include the cyclical dominion of planets over the hours, equinoxes and solstices.

In the second discourse we find the kernel of the Jewish calendar: the length of the lunar month, the calculation of any mōlāḏ and ways to check one's outcome. Bar Ḥiyya elaborates on various ways in which different nations delineate the lunar month, starting at different lunar phases. Bar Ḥiyya analyses the discrepancy between a lunar and solar year and shows how this difference is calibrated within the 19-year cycle. He describes how to fix the first day of Tišrī, the rules of postponement, and the four-gate scheme, which allows one to know the type of year at hand only from the time of the mōlāḏ. Bar Ḥiyya provides practical information regarding the dates of Jewish holidays and the pericopes, i.e. the weekly portions of the Torah that are to be read on each week of the year, in the various types of year.

The third discourse presents the notion of the solar year and its various measures used by different nations, accompanied by lengthy discussions of the notion of *təqūp̄ā* (season or measure of solar year) and two measures of the solar year used within the Jewish calendar: the first is called the *təqūp̄ā* of Rabbi. Samuel, a Talmudic figure to whom this measure of 365¼ days was attributed, the same measure of the Julian year. It is used only for few ritual customs, e.g. the day of prayer for rain outside the land of Israel. However, for the purposes of reckoning of the Jewish calendar, the relevant solar year directly derives

1. On his scientific work and linguistic contribution see, for example, Sarfatti, 'Mathematical Terminology', pp. 61-129.

from the division of the number of lunations in a 19-year cycle, 235, by the average lunation of 29d 12h 793p, yielding an average solar year length of 365d 5h 997p 48i, which is called here the *təqūp̱ā* of Rav ʾĀdā. Further chapters in the third discourse include polemics regarding the month in which the world was created (Tišrī or Nīsān), sabbatical and jubilee cycles and various eras used in Jewish chronology, for example the Seleucid Era (or: 'Era of Contracts') and the Era of Destruction of the Second Temple (starting in 70 CE). The last two chapters of the third and last discourse are dedicated to non-Jewish calendars: Muslim, Greek, Egyptian, Zoroastrian Persian, and Christian.

The transmission of the Zoroastrian Persian calendar in the manuscripts of *Sefer ha-'Ibbūr*

Out of the surviving copies of Bar Ḥiyya's *Sefer ha-'Ibbūr* only fourteen include the discussion of the Zoroastrian Persian calendar, one of which only partially – the subsequent notebook(s) are lost. In other cases it seems to have been the scribe's choice not to copy the lengthy and intricate text in its entirety, and instead, skip themes that are not directly pertinent to the reckoning of the Jewish calendar. In this article I focus on the transmission of the Zoroastrian Persian calendar via manuscript 5512 in the collection of the Library of the Jewish Theological Seminary of America (JTS) in New York. Following the description of the Egyptian calendar, the analysis of the Persian calendar begins 11 lines from the bottom of folio 41r, and continues up to the end of the 15th line on folio 42v.[1] This manuscript was written on parchment, in semi-cursive Italian hand, and it dates from the end of the 13th century or the beginning of the 14th century.[2] It is a fair copy, which testifies a good scribal practice in spite of a few lexical and numerical errors, which I point to in my English translation of the text.

1. The photo of folio 41v is shown in this article.
2. As has been pointed out to me by Malachi Beit-Arie.

English Translation of the Hebrew text[1]

[41a] *“Those who count 365 complete days, according to the sun, without anything additional, are the remnant of Persia and those of the remnant of Media*[2] *who follow their custom. They count their months thirty days each, except for one month, which is their eighth month, for which they count 35 days. These are the names of their months: the first is the month of Farwardīn.*[3] *Its first day is their beginning of the year [literally, ‘the head of the year’, i.e. New Year], which they call ‘the Day of Nawrōz’, which means ‘the renewed day’. The second month is Urdībihišt. The third month is Xurdāδ. The fourth month is Tir. The fifth month is Murdāδ. The sixth month is Šahrīwar. The seventh month is Mihr. The 16th day thereof is Mihragān to Persia and its meaning is ‘the day of joy’.*[4] *The eighth month is Ābān. It always consists of 35 days. In the language of Persia they call the [26th]*[5] *until the 35th day of the month Andargāh, which means ‘the day of addition’ [i.e. each of the epagomenail].*[6] *The ninth month is Āδar and they call its first day ‘the day of the ride of the thin-bearded*[7] *one’.*[8] *On this day*[9] *a man with a*

1. My translation herewith is of the section on the Persian calendar within manuscript number 5512, folios 41-42, from the collection in the Jewish Theological Seminary of America (JTS).
2. The reference is probably to (non-Muslim) remnants of the old religion.
3. The forms of the names of the month are early New Persian. However, in the case of the month of Farwardīn, we find several slightly variants, such as אפרוסרין [’AFRWSRYN], unknown pronunciation] and אפרוזרין [’AFRWZRYN], but all the variants start with an [’A]. As has been pointed out to me by François de Blois, both Farwardīn and Ifrawardīn are probably both possible continuations of Middle Persian Frawardīn. The former is however much more common.
4. The Avestan origin Miθrahe of the month name Mihr means ‘of the God Mithra’. Al-Bīrūnī elaborates on the reasons for joy associated with this day, as we shall see later.
5. The text erroneously says 25th. The 10 days are of the Frawardigan, the five Gatha days, together with the last five days of the preceding month.
6. “In-between Gathas”, one of the Persian designations for the epagomenai.
7. The reference is perhaps to someone with just beard stubs, possibly a boy who has just reached puberty.
8. In JTS 5512 we find the erroneous form רביבת התולדקן, which is graphically similar to the correct רכיבת הזולדקן. The scribe clearly did not understand the Hebrew expression he is was copying.
9. In JTS 5512 and most other manuscripts we find והם [and they], which results in the grammatically inadequate ‘and they, on that day’. In JTS 2564 [Ashkenazi script, 15th or 16th century] we find ויהיה [he will be] and in JTS 2500 (Ashkenazi script, 15th or 16th century) we find ויהי [there will be], which perfectly suits the following participle רוכב [riding]. However, these are probably later corrections which are not connected to the Urtext. The transcription of the Hebrew והם into Arabic or Persian yield (وهم), which in both language can mean

small beard or no beard at all will be riding on a big horse before [their eyes] and they are walking in front of it, laughing[1] *and disgracing themselves with their idols*[2] *and it is a great festival for them. The tenth month is Day. The eleventh is Bahman. The twelfth is Isfandārmaδ.*[3] *They count according to the Kingdom of Yazdgerd, the last of their kings [i.e. the last Sasanian king, Yazdgerd the Third]. The beginning of his reign* ***[41b]*** *was about nine years and ten months after the Ishmaelite Kingdom.*[4] *The beginning of the year in the Kingdom of Persia is the beginning of the month of Farwardīn, which fell on Tuesday, 22 of Sīwān in the year 4392 from the Creation of the World, which is the third year of the 232nd cycle.*[5] *That day was [16]*[6] *of [June]*[7] *in the calculation of the Greeks, which is called Tammūz, [i.e. July] in the language of the Greeks, in the year 943 to the reign of Alexander, which is the Era of Contracts [i.e. the Seleucid Era, which starts in 311 BCE]. Here we [start] counting according to the Persians two years*

'imagination' or 'fancy'. So perhaps this is a non-translated term which is part of the description of the thinly-bearded (or beardless) man on the horse in the source that Bar Ḥiyya used, but this option seems less likely. In any case, this issue is far from clear at this point.

1. משחקין could also mean playing a musical instrument, making fun, mocking or scorning.

2. מקלקלין can also mean 'sinning'. In some manuscripts we find the variant מקללין לתועבותם, which means 'cursing/reviling in their abomination'. Another variant is מקלסין לתועבותם, which could mean both 'deriding/mocking their abomination' or precisely the opposite 'blessing their abomination', 'abomination' possibly referring to idolatrous practice. In the Bible, the Hebrew root ק.ל.ס. originally had a negative meaning, (e.g. Ezekiel 22:4). However, within Rabbinic literature, the same root acquired a positive meaning, possibly by the influence of the Greek word καλόϛ (fair, beautiful, respectable). The root ק.ל.ס. is found in ms. JTS 2596 (Oriental script, 17-8 century), and may have been deliberately chosen to show the two opposing perceptions of idolatry, depending on whether one is idolatrous or not.

3. The names of the Persian months in the Hebrew text are imperfect but are still easily recognizable and seem to be directly related to an Arabic source. We find many variants in the Hebrew transliteration, many are due to scribal misreading of graphically similar Hebrew letters, such as ד [=D] and ר [=R] and some cases of metathesis. We see cases of confusion due, perhaps, to phonetic proximity (e.g. ז [Z] and ס [S] or ג' [J] and י [Y], although the precise pronunciation is not known). This type of confusion may indicate that some texts were read out to the scribe. We also find some attempts to vocalize the names of the months, albeit wrongly. Also, the ending ماه מאה [māh] sometimes appears as a separate word following the name of the month (as it should) but at times it is attached to the name of the month or part of it e.g. ארדי השתמאה i.e. Urdī [bi]hištmāh..

4. If we calculate retroactively 9 years and 10 months from 22.6.632 we will obtain 22.10.622, which is supposed to be the beginning of Hijra Era, according to our Hebrew source. The discrepancy is about 3 months, since 1 Muḥ arram 1 fell on 16 July 622.

5. 4392=231x19+3

6. In JTS 5512 and most other manuscripts the day of the month, 16, is missing.

7. The Hebrew erroneously says יולייו, i.e. July.

before this year, in order to start in the beginning of a lunar cycle, which is in the year 4390 to the Creation of the World. It is the beginning of the 232nd cycle. In that year, the beginning of cycle, the month of Farwardīn, the first [literally, 'head'] of the months of the Persians, fell on the first day of the week [i.e. Sunday] and the first of the month of Tammūz. The mōlā<u>d</u> of Tišrī that year occurred on 12 hours 489 parts on the 7th day [Sabbath i.e. Saturday]. The distance [i.e. interval] between the beginning of the month of Farwardīn and the mōlā<u>d</u> of Tišrī, inclusive of the [first] day of the month, is [267][1] *days, 11 hours and 591 parts. That year the day of Rōš Ha-Šānā [literally, 'the head of the year', i.e. the Jewish New Year], which is the beginning of the month of Tišrī, occurred that year on Saturday, on the 9th day of the month of Tir, the fourth of the months of Persia. When you wish to know on which weekday the Persian New Year falls and on which day of the lunar month, you count [literally, 'know'] how many cycles and years which do not complete a cycle [have elapsed] from the Creation of the World and subtract 231 cycles. Retain the remainder of the cycles with the years which have not completed a cycle, if there are any. For each of these cycles take 4 days 16 hours and 595 parts, the excess of the lunar cycle over 19 years of Persia.*[2] *Retain the sum of cycles, days and parts. If there are intercalated years which have not completed a cycle, take for each intercalated year 18 days 21 hours and 589 parts, by which an intercalated year exceeds a Persian year.*[3] *Add everything to the remainders of the cycles and retain it. Then take 10 days, 15 hours and [204]*[4] *parts for each plain year which have elapsed in the incomplete cycle*[5] *and you will know how much will go into the remainders of the simple years. Subtract it from the remainders of the cycles and the intercalated years you have [literally, 'have in your hand']. What remains to you is the excess of the calibrated years in the lunar cycle over the years of Persia that you have. If there is no intercalated year among the years which have not completed a cycle you know the excess of the plain years [in the lunar cycle over the years of Persia]. Subtract is from the excess of the cycles and you will be left*

1. The text erroneously says 'ת'ש'ס'ז [767].
2. 4d 16h 595p=235x(29d 12h 793p)-19x365d
3. 18d 21h 589p=13x(29d 12h 793p)-365d
4. JTS 5512 erroneously says 'כ'ד [24], graphically similar to the correct 'ר'ד [204].
5. 10d 15h 204p=365-12x(29d 12h 793p)

*with the calibrated excess. If you do not have years which have not completed a cycle, then the total from the remainder of the cycles is the calibrated excess. When the calibrated excess becomes known to you subtract it from 267 days, 11 hours and 591 parts, which is the distance between [1] Tišrī and [1] Farwardīn in the first year [i.e. the Jewish year 4390]. What remains [literally, 'remains in your hand'] is the calibrated distance between the mōlā*d̲ *of Tišrī and the Persian New Year [1 Farwardīn] which you seek.*[1] *From this distance cast out 29 days 12 hours and 793 parts, which is the measure of a lunar month,*[2] *and you will know how many [lunar] months there are. Retain the remainder which has not completed a [lunar] month and it is the distance between the beginning of the month of Farwardīn and the mōlā*d̲ *of the [Jewish] month in which it falls. Count from Tišrī the number of months you have removed from the distance and the month in which the calculation ends, add to the remaining distance the hours and the parts in the mōlā*d̲ *of the following month and you will come up with [the number of] complete days between the mōlā*d̲ *of that month and the beginning of the month Farwardīn. If you wish to know on which weekday the beginning of the month of Farwardīn falls, cast out 7s from the distance. Count the remainder from the day of the mōlā*d̲ *of the month and you will come up with the day of the beginning of the month of Farwardīn that year. You can know the weekday by a different method: revert the cycles from which you counted years [to years], 19 years to each cycle. Add to them the years which have not completed a cycle and subtract 7s from them.*[3] *What remains is 7 or less than 7, is the weekday of the beginning of the month of Farwardīn that year and it is the sign of the year.*[4] *If you wish to know on which weekday the*

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1. In short we could say that all these steps that yield the calibrated distance between 1 Tišrī and 1 Farwardīn in a specific Jewish year boil down to: 267d 11h 591p – [(C-231)(4d 16h 595p) + I(18d 21h 589p) – P(10d 15h 204p)], whereas C is the number of complete cycles in the sought Jewish year, I is the number of intercalated year, any integer between 0 and 6. Seven intercalated years would imply a complete cycle given that the 7^{th} intercalation occurs in the last year of the cycle. P is the number of plain years, any integer between 0 and 12.
2. This is an example of casting out non-integer figures.
3. I.e. cast out 7s as long as the result is non-negative.
4. The intention here is probably(?) to count the number of Persian years until now, and then add one weekday for every year. 1 Farwardīn -2 (= the Jewish year 4390, the year of comparison between the two calendars) falls on Sunday (=1 in the Jewish week). After one Persian year, 1 Farwardīn will fall on Monday (2), since $365 \equiv 1 \pmod 7$, the following year it will fall on Tuesday (3) etc.

beginning of another Persian month will fall, you know how many complete months there are between it and Farwardīn. Take two days for each month.[1] *If they include the month of Ābān, which is the eighth month, do not take anything for it.*[2] ***[42a]*** *Add these days together and add to them the sign of the year.*[3] *Cast out 7s from everything and what remains is the day of the beginning of the Persian month you seek. If you wish to know which day of the lunar month it is, take 2 days for every month and 7 days for the eighth month of Ābān, if included. Add everything together and retain it. Go to the parallel lunar months and begin with the month in which Farwardīn enters. Take two days for every full [lunar] month*[4] *and one day for every defective month.*[5] *Add everything up and remove it from the sum of the months of Persia that you have. Add the remainder to the days that have elapsed in the month in which Farwardīn entered and you will come up with the [number of] days that have elapsed in the lunar month for the Persian month you seek. I give [literally, 'bring to'] you an example of all these calculation so you will understand them and your method of calculation will not become erroneous. I begin with the calculation of the Persians which we have been discussing:*[6] *if you wish to know on which day the beginning of Farwardīn, the beginning of the year of the Persians, will fall in the year 4883 to the World according to our reckoning, it is the year 19 in the 257th cycle, remove from it 231 cycles and you will be left with [25]*[7] *full cycles and 18 complete years in the 257th cycle, from which six are intercalated years and 12 are plain. Take 4 days, 16 hours and 595 parts for each cycle and you will come up with 117 days, 5 hours and 835 parts. For the six intercalated years that have elapsed in the cycle take 18 days, 21 hours and 589 parts. For the six [intercalated] years there will be 113 days, 9 hours and 294 parts. Add [literally, 'lend'] them to the remainders of the cycles, the days of the*

1. 30≡2 (mod 7)
2. 35≡0 (mod 7)
3. I.e. the weekday on which the beginning of the month of Farwardīn falls that year, any number between 1 and 7.
4. 30≡2 (mod 7)
5. 29≡1 (mod 7)
6. The Persian calendar is the last of four non-Jewish calendar to be discussed in this chapter. The other three are Muslim, Greek and Egyptian. Towards the end of the chapter numerical examples for all four calendars are provided, and this is the first one.
7. JTS 5512 erroneously says 'ר'ל'ה [235].

two remainders, 230 days, 15 hours and 49 parts. Then take 10 days, 15 hours and 204 parts for the 12 plain years that have elapsed in the cycle. You will come up with 127 days, 14 hours and 288 parts. Cast out this remainder from the remainders of the cycles and the intercalated years, and you will be left with [103][1] days, [841][2] parts and it is the calibrated remainder which remained from the reckoning of [the length of] our years over the years of Persia until the year which we reckon. Subtract it from 267 days, 11 hours and 591 parts, which was the distance between [1] Farwardīn in the first year of Persia and the mōlāḏ of Tišrī. 164 days, 10 hours and 830 parts will remain as the calibrated distance, which is the distance between Farwardīn in that year and the mōlāḏ of Tišrī. When you subtract this distance by the measure of a lunar month [i.e. 29 days, 12 hours and 793 parts], you will come up that for five months, you have 147 days, 15 hours and 725 parts. You will be left with 16 days, 19 hours and 105 parts, which is the distance between Farwardīn and the mōlāḏ of the sixth month after Tišrī, which is [ʻĂdār] I and its mōlāḏ in that year is 975 parts and 4 hours from the second day. Add the hours and the parts to the distance and it will be 17 days from the mōlāḏ of the month. Start to count from Monday, on which the mōlāḏ falls, the first day of the month [literally, 'the day on which the month has been fixed']. Your calculation will end on Wednesday [the fourth day] and it is the first day of the month of Farwardīn, and you will see [literally, 'it becomes visible to you'] that the month of Farwardīn falls on Wednesday the 16^{th} of the month of ʻĂdār I. If you wish to check the weekday by another method, add the cycles whose [number of] years which you have calculated in 25 cycles, and there are 475 years. Add to it the years that have elapsed in the cycle, 19, together with the year according to which you are calculating, it will all be 494 years. Cast out 7s and you will be left with 4, which is the first day of the month of Farwardīn in that year. If you seek the beginning of another month of Persia, for example the month of Day, which is the tenth of their months, you know that 9 months of the year have elapsed from the year until the beginning of the tenth month. It is fitting to take 2 days for every one of their months. However, because the eighth month of Ābān was among them, for which you take

1. JTS 5512 erroneously says 'ק'נ' [150], graphically close to the correct value 'ק'ג' [103].
2. In JTS 5512 we find the false value 'ת'ת'מ'ה' [845].

nothing, you will be left with eight months for which you take 2 days per month and you will come up with 16 days. Add 4 to it, which is the sign of the year, because the month of Farwardīn enters on the 4th [day] in that year, and everything will amount to twenty days. Cast out 7s and you will be left with 6, which is the day of the beginning of the month of Day. If you wish [literally, 'come'] to know on which day of the lunar month it will fall, add to the distance you have for eight months of Persia, 16, the distance of the month of Ābān, 7, all will amount to 23 days, the excess of the months of Persia [over Jewish years]. Also, come and count according to the remainders of nine lunar months, starting from 'Ădār I, in which Farwardīn falls, Tišrī will be the ninth month. Take 2 days for every full month and one day for every defective month ***[42b]*** *and you will come up with 14 days, the remainder of lunar months over 4 weeks, for every month. Remove them from the excesses of the months of Persia and 9 days will be left in your hand. Add it to 17, the distance between Farwardīn and 'Ădār I in this year, it will be 26, the distance between the month of Day, the tenth of the months of Persia and Marḥešwān, which is the tenth month after 'Ădār I. The beginning of the month of Marḥešwān in the coming next year will be Monday and its 26th day will be Friday, which is the first day of the month of Day, of the months of Persia. If you wish to know on which day of the months of Persia Rōš Ha-Šānā occurred in the year 883 [i.e. 4883], according to which you reckon, please take the distance, 164 days, and do not be concerned about the hours and parts in it since they are of the coming year. Remove this distance retroactively [i.e. backwards] from the months of Persia, 30 days for each month, and 35 days to the eighth month. Remove retroactively 155 days for five months because they include the eighth month, which consists of 35 days. You will be left with 9 days. Remove them retroactively from the sixth month and it is the seventh [month] in the aligned calculation. Six Persian months and 21 days which elapsed from the seventh month until the day of the mōlād of Tišrī will be left. The day of the mōlād will be the 22nd of the month of Mihr, the seventh of Persian months. If you wish to calculate by another method which is shorter*[1] *[literally 'closer'] than this one, subtract the calibrated distance, 164 days, from the measure of the*

1. ואם תרצה לחשוב על דרך אחרת אשר היא קרובה מזו The term יותר קרוב usually means 'more accurate' but since both methods here yield the same accurate result, I believe that Bar Ḥiyya was pointing out to the second method being shorter.

Persian year, 365 days, and you will be left with [201][1] *days, which elapsed from the beginning of the month of Farwardīn until the day of the mōlāḏ of Tišrī. Distribute [literally 'divide'] them over the months of Persia,30 days for each month, it will be six months and 21 days. The day of the mōlāḏ will be the 22nd of the seventh month. The day of the mōlāḏ will be Sunday [literally, 'the first day']. Because Rōš Ha-Šānā is fixed on Monday,*[2] *it will fall on the 23rd of the seventh month of Persia."*

1. JTS erroneously says 'כ'א' [21] instead of the graphically close 'ר'א' [201].
2. Because the molad falls on Sunday, one of the 'forbidden' days.

Additional Comments to the Hebrew text

[16 Mihr] The translation of the feast of Mihragān is given in the Hebrew as 'day of joy'. An explanation for the sources of joy is found in Al-Bīrūnī's *al-ʾĀθār-ul-Bākiya:*

> "On the 16th [day], or Mihr-Rōz, there is a feast of great importance, called Mihragān. The name of the day is identical with that of the month. It means 'the love of the spirit'. According to others, Mihr is the name of the sun, who is said to have for the first time appeared to the world on this day; that therefore this day was called Mihr. This is indicated by the custom of the Kisras [i.e. Sasanian kings] of crowning themselves on this day with a crown on which was worked an image of the sun and of the wheel on which he rotates. On this day the Persians hold a fair. People maintain that the special veneration in which this day is held is to be traced to the joy of mankind when they heard of [King] Frēdūn's coming forward, after Kābī had attacked Alδaḥāk Bēvarasp [Frēdūn's archenemy], expelled him and called upon people to do homage to Frēdūn..." *(Al-Bīrūnī, pp. 207-8)* [1]

[26-35 Ābān] In Al-Bīrūnī's *al-ʾĀθār-ul-Bākiya* we also find an explanation why there are ten additional days and not only five:

> "Regarding these days there has been among the Persians a controversy. According to some they are the last five days of the month Ābān, according to others they are the Andargāh, i.e. the five Epagomenai which are added between Ābān and Āδar-Māh. When the controversy and dispute increased, they adopted all (ten) days in order to establish the matter on a firm basis, as this is one of the chief institutes of their religion, and because they wished to be careful, since they were unable to ascertain the real facts of the case. So they called the first five days the first Farwardajān, and the following five days the second Farwardajān; the latter, however, is more important than the former*..." (Al-Bīrūnī, pp. 210-1)*

[1 Āδar] In the Hebrew text we also find the description of some sort of a parade which takes place on the 1st of Āδar (the religious Nawrōz),

1. On the importance of this festival (second only to the celebrations of New Year) and further details on the pleasures of the king and his people associated with this feast, see Kohut, "The Talmudic Records of Persian and Babylonian Festivals Critically Illustrated", pp. 189-90.

which involves a thinly-bearded or beardless man riding a horse, and people walking in front of him possibly engaged in some kind of abomination, probably idolatry. In the Arabic medieval literature we find the account of the historian Al-Masʿūdī, in his *Murūju δ-δahab* (Prairies of Gold), written in 943, gives a different account on what happens during the feast on 1 Āδar:

> "…a man was riding a mule, a custom practised only in Iraq and Persia. The inhabitants of Syria, The Arabian Peninsula, Egypt and Yemen were not aware of it. During numerous days, people were eating nuts, garlic, fatty meat and warming foods, and they were drinking drinks that were fitting to warm and combat the cold. The Kausaj appeared as the enemy of the cold. People were throwing cold water at him, and far from not sensing any pain, he shouted in the Persian language: 'germā, germā' i.e 'hot, hot'. These days were for the Persians an occasion of public joy. It would nevertheless fall in many other periods and seasons of the year…" (Al-Masʿūdī, pp. 495-6)[1]

The description here seems to suggest that the festival occurs at winter solstice, or around the coldest time of the year, and this assumes that 1 Farwardīn falls around the vernal equinox, which was the case at the establishment of the Zoroastrian Persian calendar and after the Sasanian reform, but definitely not in the 10th century, when the Arabic text was written, when 1 Āδar receded to November. Along similar lines, Al-Bīrūnī describes the feast of the Ride of Alkausaj, a thinly bearded or beardless man, which fell on the beginning of spring at the time of the Sasanian kings, who used to ride about, fanning himself with a fan to express his rejoicing at the end of the cold season and the coming of the warm season. He tells us that this custom was still kept in Persia for fun.[2]

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1. This is my own translation from the French.
2. Al-Bīrūnī, p. 211. The section on the first day of Āδar is missing in Sachau's edition of ʾ *Āθār-ul-Bākiya*, it is one of the lacunae in his manuscripts, but in his translation he has filled the gap with a rendering of the briefer description of this festival in Al-Bīrūnī's Al-*Qānūn Al-Masʿ ūdī*, a gap filled by Khalidov. François de Blois has kindly shared with me his own translation of this passage. It has a similar, but non-identical account to Al-Masʿūdī's. There is a specific mention to the aggravation of the cold weather after abandoning intercalation. The Kausaj debases himself by wearing shabby clothes. He rides on an ass and smears his body with fatty substances to ward off the cold. People make jokes about him and splatter water on him and pelt him with ice and snow and in this way he would acquire financial gain from the rich

Boyce claims that since non-Zoroastrians did not keep Zoroastrian purity laws, they were considered by Zoroastrians to be ritually unclean thus they were not allowed to be present in the ceremonies therefore the accounts by Muslim authors are second-hand at best. Furthermore, the crucial element of devoutness was missing from their accounts since they were not told that every Zoroastrian celebration is accompanied by acts of worship, with the sacrifice of offerings.[1] Interestingly, the Hebrew text does allude to idolatrous practice during the 1st of Āδar. This seems to suggest that Bar Ḥiyya's source was not a text Al-Bīrūnī or Al-Masʿūdī. I shall return to this point at the conclusion of the article.

[The Yazdgerd era] The epoch of the Yazdgerd Era, 1 Farwardīn year 1, falls on 22 Sīwān 4392, in the third year of the 232nd cycle. For convenience reasons, Bar Ḥiyya suggests to compare the two calendars in regard to the first year of the 19-year cycle, i.e. in the Jewish year 4390.[2] The mōlā<u>d</u> of Tišrī 4390 fell on 7d 12h 489p, and therefore there is no need to postpone 1 Tišrī. I designate by Δ(A,B) as the interval [A,B], or the distance between dates A and B, whereas A precedes B. We read that Δ(1 Tišrī 4390, 1 Farwardīn -2) = 267d 11h 591p, taking into account that the mōlā<u>d</u> of Tišrī starts at 12h 489p. Bar Ḥiyya does not explain how he obtained that result but he could have, for example, counted retroactively 730 days (=2 Persian years) from 22 Sīwān 4392 (an equivalence he knew through the Julian calendar), taking into account the type of Jewish years at hand (4392 - plain and complete, 4391 - plain and orderly, 4390 - intercalated and complete) and then calculated the distance between the obtained date and 12 hours and 489 parts into 1 Tišrī, the time of the mōlā<u>d</u>. Or, he may have used the Julian calendar directly. Also, the calendrical equation 1 Tišrī 4390 = 4 Tir -2 can be obtained by retroactive calculation of 267 days from 1 Farwardīn -2 through the Persian months.

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among them. One also reads that these customs were still practised in the time of Al-Bīrūnī, in Shiraz and other Persian towns, on account of the tax income which it guarantees to the ruler.

1. Boyce 'Further'. pp. 21-2.

2. Although the fixed rabbinic calendar with the 19-year cycle did not exist in the 7th century CE, it was applied retroactively in a purely mathematical way, i.e. independent of calendrical reality. The rabbinic fixed calendar did not evolve into a fixed scheme (in the way we know it today) before the 9th century CE at the earliest.

[Calculating the weekday and day of the Lunar month on which Nawrōz falls] The underlying principle in the various conversion algorithms is the determination of the distance between 1 Tišrī and 1 Farwardīn in a given (Jewish) year by gradual calibration, which takes into account the various length of months (in the Persian and Jewish calendar) and years (in the Jewish calendar) as well as the distance between these dates in the epoch (the Jewish year 4390). After this distance has been established, one needs to make internal adjustments within that year, according to the aim of the calculation.

Conclusion

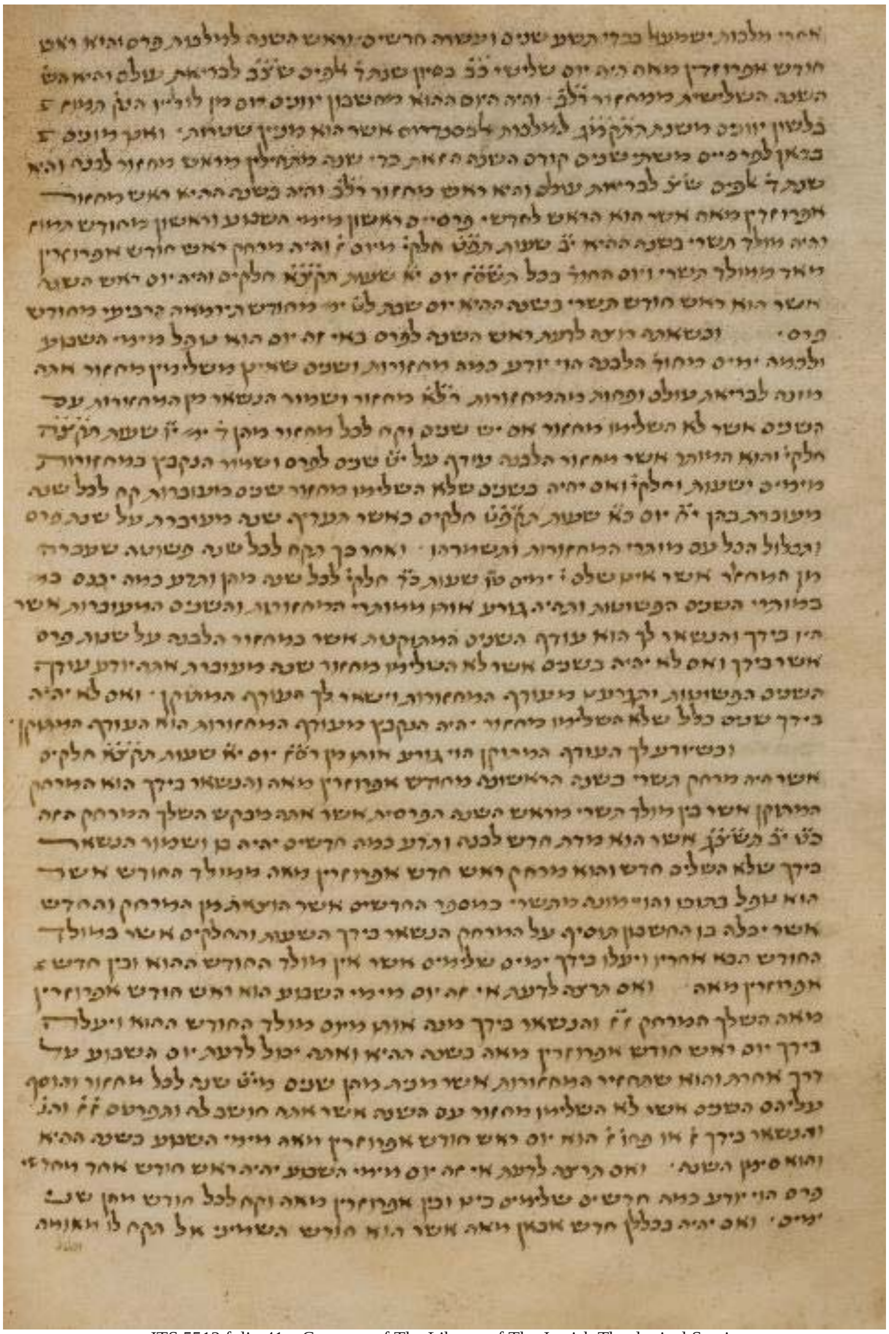
The identification of the source Bar Ḥiyya used in his composition of the section on the Zoroastrian Persian calendar in *Sefer ha-ʻIbbūr* remains an open question. At least we can be almost certain that he used an Arabic source. We know that Bar Ḥiyya knew Arabic - he often used it to coin new Hebrew scientific words by calque or semi-phonetic matching (feasible due to the relative proximity of Arabic and Hebrew) - but there is no evidence for Bar Ḥiyya's knowledge of the Persian language. The use of an Arabic text is also suggested by the way in which Persian month names were transliterated into Hebrew but which one was it? The allusion to idolatry in our Hebrew source also seems to suggest a different text than Al-Masʿūdī or Al-Bīrūnī. The latter's *Qānūn Al-Masʿūdī* mentions the return of epagomeani to follow the 12th month (at least in a remote country), calendrical information Bar Ḥiyya was not aware of. For the same reason Kūšyār ben Labbān Al-Jīlī must be ruled out, too, since Bar Ḥiyya does not mention the Jalāli calendar.

There are succinct allusions to the Persian calendar in earlier Jewish sources, for example in the Talmud, which include some names of Persian months names and festivals.[1] Yet, *Sefer ha-ʻIbbūr* not only elaborates on several Persian festivals but it also presents a novel facet in Hebrew literature – a discussion of conversion algorithms between the Zoroastrian Persian and the Jewish calendars. In his calendrical

1. For example, the festival of Mihragān is mentioned in the Palestinian Talmud, tractate Avodah Zara, I., p. 39c, and is called מתירקנה [MTYRQNH, unknown pronunciation]. In the Babylonian Talmud, tractate Avodah Zara, we find מוהרנקי [MWHRNQY] and מוהרסנקי [MWHRSNQY] (Munich 95). Sacha Stern has also pointed out to me other variants in the Babylonian Talmud: מוהרקני (JTS Rab. 15) and מוהרקי [MWHRQY] (Paris 1337). For further details, see Kohut, "The Talmudic Records of Persian and Babylonian Festivals Critically Illustrated", pp. 183-90.

work, Bar Ḥiyya clearly aimed at presenting a comprehensive work on the Jewish calendar and also touch upon non-Jewish calendars, with special emphasis on the calendrical interface between them. Whether the discussion of the Zoroastrian Persian calendar and the conversion algorithms could have had any practical application for the Jewish readers is not evident, but at least we could say that the analysis of the Persian and other calendars within a book on the Jewish calendar seems to have been part of a general calendrical education (possibly following the tradition of zīj books)[1] with the mathematical parts serving at least as an intellectual exercise.

1. As has been suggested to me by François de Blois.



JTS 5512 folio 41v, Courtesy of The Library of The Jewish Theological Seminary

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