Talmudic Metrology II

The Mile as a Measure of Time

Abstract

In the Talmud, the mile, which is basically a unit of length, is also often used to represent a lapse of time, corresponding theoretically to the time needed to cover this distance. This length is subject to important discussions and controversies between the rabbis. Nearly all the Rishonim (Rabbis from the 10th until the 15thcentury) have evaluated this time to be 22.5 minutes, but Maimonides has considered the span of time to be 24 minutes. R' Joseph Karo in his Shulhan Arukh and Rema in his remarks have followed R' Israel Isserlein and adopted a span of 18 minutes. During the 17th century (R' Yom Tob Lipman Heller and R' Jacob Reicher), the 18th century (R' Nathanel Weil and the Gaon of Vilna) and the 19th century (R' Moses Sofer), the value of 22.5 minutes was still used. Nowadays the value of 18 minutes seems to be generally accepted. The present paper aims to reexamine the problem on the basis of the available data concerning the length of the mile and of the analysis of the Talmudic passage. It will prove that the span of time of 18 minutes is the only acceptable measurement. The development of the paper will allow us also to examine the apparent contradiction between the position of Maimonides in his commentary to Mishna Berahot I: 1 and his position in Mishna Pesahim IX: 2 and Hilkhot Korban Pessah V: 9 and to give a definitive solution to this old problem.

Talmudic Metrology II

The Mile as a Measure of Time

1. Examination of the passage in B. Pesahim 93b-94a[1]

Mishna. What is "a journey afar off"? From Modiim and beyond, and the same distance on all sides of [Jerusalem]: This is Rabbi Akiba's opinion. Rabbi Eliezer said: from the threshold of the temple court and without. Said Rabbi Jose to him: For that reason the ה is dotted in order to teach: Not that it is actually far away, but [when one is] beyond the threshold of the temple court and without [he is regarded as being "afar off"].

Gemara. Ulla said: From Modiim to Jerusalem is fifteen miles. He holds as Rabbah bar Bar Hanah said in Rabbi Johanan's name: What is an [average] man's journey in a day? Ten parasangs: five miles from daybreak until sunrise, [and] five miles from sunset until the stars appear. This leaves thirty: fifteen from morning to midday and fifteen from midday to evening [i.e. sunset]. Ulla is consistent with his view, for Ulla said: What is a "journey afar off"? Any place whence a man is unable to enter [Jerusalem] at the time of slaughtering.[2] The Master said: "Five miles from daybreak until sunrise." Whence do we know this? - Because it is written, And when the morning arose [i.e. at daybreak] then the angels hastened Lot, saying etc.;[3] and it is written," The sun was out upon the earth when Lot arrived at Zoar";[4] while Rabbi Hanina said: "I myself saw that place and it is five miles [from Sodom]."

The [above] text [stated]: "Ulla said, what is a "journey afar off"? Any place from where a man is unable to enter [Jerusalem] at the time of slaughtering." But Rab Judah maintained: Any place whence one is unable to enter [Jerusalem] at the time of eating. Rabbah said to Ulla: On your view there is difficulty, and on Rab Judah's view there is a difficulty. On your view there is a difficulty, for you say, "Any place whence a man is unable to enter at the time of slaughtering": yet surely a man unclean through a reptile is unable to enter [the temple] at the time of slaughtering, yet you say, one slaughters and sprinkles on behalf of a person unclean through a reptile?[5] On Rab Judah's view there is a difficulty, for he says, "Any place whence one is unable to enter at the time of eating": but surely he who is unclean through a reptile is able to enter at the time of eating, yet he says, one may not slaughter and sprinkle on behalf of a man unclean through a reptile?[6] Said he to him: neither on my view, nor on Rab Judah's view, is there a difficulty. On my view there is no difficulty: "A journey afar off" [is stated] in reference to a clean person, but "a journey afar off" is not [stated] in reference to an unclean person. On Rab Judah's view there is no difficulty: When one is unclean through a reptile, the Divine Law relegated him [to the second Passover], for it is written, "If any man shall be unclean by reason of a dead body." Does this not refer [even] to one whose seventh day falls on the eve of Passover? Yet even so, the Divine Law said: Let him be relegated [to the second]. Our Rabbis taught: if he was standing beyond Modiim and is able to enter by horses and mules, you might think that he is culpable. Therefore it is stated "and is not in a journey" whereas this man was in a journey. If he was standing on the hither side of Modiim, but

could not enter on account of the camels and wagons which held him up, you might think that he is not culpable. Therefore it is stated "and is not in a journey," and lo, he was not on a journey. Rava said: "The world is six thousands parasangs and the thickness of the heaven [*Rakia*] is one thousand parasangs." The first one [of these statements] is a tradition while the other [is based] on reason. [Thus] he agrees with Rabbah bar Bar Hannah's dictum in Rabbi Johanan's name: What is an average man's journey in a day? Ten parasangs: from daybreak until the first sparkling of the rising sun five miles, and from sunset until the stars appear five miles; hence the thickness of the heaven is one sixth of the day ['s journey]. An objection is raised: Rabbi Judah said: The thickness of the sky is one tenth of the day's journey. The proof is this: what is an [average] man's journey in a day? Ten parasangs; and from daybreak until the rising sun four miles, [and] from sunset until the stars appear four miles. Hence, the thickness of the sky is one tenth of the day ['s journey]. The refutation of Rava and the refutation of Ulla are indeed refutations! Shall we say that this is [also] a refutation of Rabbi Johanan? He can answer you: I spoke only of [an average man's journey] in a [complete day], and it was the Rabbis [Rava and Ulla][7] who erred by calculating [the distance for] pre-dawn and after nightfall. Shall we say that this is a refutation of Rabbi Hanina [who confirmed that the distance walked by Lot is five miles]? No, "and the angels hastened"[8] is different.[9]

1.   The location of Modiim.

 The above passage raises the question of the distance between Modiim and Jerusalem. Anyone who is beyond Modiim on the eve of Passover at sunrise[10] can be considered as someone being a long way away.[11] He is then exempt from coming to Jerusalem to sacrifice the Paschal lamb. He is allowed to postpone the sacrifice until the next month (Pessah Sheni).
From the Talmud it appears clearly that the time necessary to walk from Modiim to Jerusalem is six hours. So what is the distance between Modiim and Jerusalem? The Talmud brings the opinion of Ulla that the distance between Modiim and Jerusalem is 15 miles. Probably due to the fact that Ulla traveled often and was therefore reliable, and also due to the fact that this data can be verified,[12] it has generally been accepted that the distance between Modiim and Jerusalem is 15 miles, despite the fact that the other part of the statement of Ulla was refuted.[13]
Modiim is also mentioned in B. Hagiga 25b, where Rashi writes that Modiim is a town distant from Jerusalem by 15 miles, as it is mentioned in B. Pesahim.[14] It is also mentioned in B. Kiddushin 66a.
In Kaftor Vaferah, Modiim is mentioned as follows:[15]

למערב בית שאן כמו שעה היא מודיעית הנזכרת במסכת קידושין פרק האומר גבי אמו של ינאי המלך, דאמרינן אמו נשבית במודיעית. ואין זה מודיעים הנזכר סמוך לירושלם, שהרי מודיעית לחוד ומודיעים לחוד, וקורין לה מידעה, ואמרינן פרק מי שהיה טמא, אמר עולא מן המודיעין ולירושלם חמישה עשר מילין הויא, והוא קרוב למהלך חצי יום, כי היום כלו הוא מהלך מ' מיל.

Modiim is identified there[16] with the Arab village of Middah. Modiim is also mentioned by A. Neubauer,[17] at the place called el-Medyeh, east of Lod. According to him, the locality of Modiim mentioned in the Talmud can be identified with the town of the Maccabim. As the place is situated on a hill, it is compatible with a passage in the book of the Maccabaei according to which the monument built by Simon the Hasmonean could be seen by the sailors on the Mediterranean Sea.[18] Modiim was already mentioned to be east of Lod (Diaspalis) by the early Christian writer Eusebius,[19] and it was located east of Lydda on the Madaba map.[20]

Today, it is accepted that Modiim, mentioned in Pesahim and in B. Kiddushin, is the historical town of the Maccabim situated near to the Arab village of el-Midieh, about 10 km east of Lod.[21] The historical site of Modiim is represented on the new road atlas of Israel (scale 1: 100000): 28, J 17, east of Maccabim Junction. The straight distance between Modiim and Jerusalem is about 28 km[22] and the true distance, taking into account the deviations of the roads, is about 30 to 31 km or more. This corresponds to a distance of about 20 Roman miles.[23] At a speed of 18m a mile,[24] it takes six hours to travel this distance.

The conclusion is therefore that the distance between Modiim and Jerusalem is 20 Roman miles, and people walking on the eve of Passover walk 20 miles in six hours at the speed of one mile in 18 m.

Therefore, when Rabbi Judah says that the thickness of the heaven is one tenth of a day's journey, he adopts the solution offered by column C of the explanatory table that follows. This table presents all the possibilities of covering 40 miles in a day, according to all the possible interpretations, i.e., covering 40 miles between sunrise and sunset, between daybreak and night or even in a complete day of 24 hours, walking before daybreak and after the beginning of night. Each column represents another possibility for a division of the day. In each column, we have also calculated the ratio of dawn to day (counted from sunrise to sunset) and the ratio of dawn to day (counted from daybreak to night). This table will allow us to elucidate the different interpretations of the Talmudic passage. According to column C, the day's journey between sunrise at 6 a.m. and sunset at 6 p.m. is 40 miles and the distance covered during dawn or twilight is four miles. The thickness of the heaven, which means the length of twilight, is one tenth of the day's journey. In other words, the length of twilight and dawn is $(1/10)*12\ h = 1.2\ h = 72\ m$. On the other hand, when Rava said that the thickness of heaven is one sixth of the day's journey, he thought that the length of twilight or dawn was $(1/6)*12\ h = 2\ h$.

2.   The standard analysis of the Talmudic passage

1.   The position of Rabbi Judah

It appears from the text of the Gemara that the Amoraim, including Rabbi Johanan and Rabbi Hanina, no longer knew the distance between Modiim and Jerusalem,[25] probably

because of the political situation,[26] the limitations on their movement and the difficulty Jews faced in visiting Jerusalem.[27]

Ulla considered the distance between Modiim and Jerusalem to be 15 miles.[28] This supports the dictum of Rabbah bar Bar Hannah that the day's journey is 30 miles, and the length of each dawn and twilight is five miles. Therefore the distance walked from daybreak until the end of twilight is 40 miles. The opinion of Rabbah bar Bar Hannah corresponds to column B of our table, in which the thickness of heaven is one sixth of the day's journey and the length of dawn and twilight is two hours. The dictum of Rava is parallel to that of Rabbah bar Bar Hannah, but it is refuted because Rabbi Judah[29] said that the thickness of the heaven is one tenth of the day's journey, and consequently the length of dawn and twilight is 1.2 h, not 2h.

Rabbenu Hananel and Rashi, followed by nearly all the Rabbis, have for an incomprehensible reason, explained the opinion of Rabbi Judah according to column D of our table. The reason was probably because they thought that 40 miles a day is a fixed quantity that could not be overstepped. Another reason is perhaps that they could not imagine a difference of 33.3 percent between the speed of Rabbi Judah's and Ulla's walkers and preferred a difference of 6.67 percent. But in doing so, the ratio of the length of dawn to the length of the day is denatured. The figure to compare to 1/6, with respect to a day of 12 hours (we are near the equinox) is not 1/10, as required, but 1/8, corresponding to 4/32. The length of dawn is not 1.2 h, as required by Rabbi Judah, but 1.5 h.

2   The distance between Modiim and Jerusalem

According to the generally accepted conclusion that Rabbi Judah's opinion is given by column D, the distance covered by the walkers during a six hour walk is 16 miles, and the distance between both towns should be considered 16 miles. This is exactly the way Rashi and R' Hananel explain the refutation of Ulla. The refutation of Ulla results from the fact that the travelers walk four miles during twilight (corresponding to a fraction of 1/10), not five miles during twilight (corresponding to a fraction of 1/6). Consequently, the distance covered in six hours, between 6 a.m. and noon, is 16 miles, not 15 miles. Rashi does not conclude whether the distance is actually 16 miles or if it still is 15 miles but the travelers must cover an additional mile. This problem has preoccupied many commentators. R' David Corinaldi, in his commentary to the Mishna, Beit David (Amsterdam, 1738) has suggested that in both manuscripts of Maimonides, the commentary on the Mishna and the big composition, the Hibbur, the distance was 16 miles, but it was then corrupted to 15.[30] Rabbi David Pardo,[31] in his commentary on the Mishna, Shoshanim le-David (Venice 1752), cites the former opinion irreverently[32] and notes that he should have rather left the problem unsolved than written such a thing in a book and falsely accused the scribe or the editor. Rabbi Pardo suggests that 15 miles is the distance to Jerusalem, but there is another mile until the entrance of the azarah, so the true distance is 15+1=16 miles.[33] Therefore, he thinks that although Rabbah bar Bar Hannah and Rava were refuted, the proposition of Ulla, which can always be checked, is true. Strangely, the Talmud does not mention Rabbah bar Bar Hannah, but writes that

Rava and Ulla were refuted even when, according to our texts, Ulla has spoken only about the distance from Modiim to Jerusalem.

Rabbi Pardo mentions that the great authority of the preceding generation, Rabbi Moses Zacuto,[34] arrived at the same conclusion in his own commentary on the Mishna. It is likely that this was also the thought process of Rashi, who writes in Mishna Hagiga III: 5 that Modiim is 15 miles distant from Jerusalem. As far as Maimonides is concerned, the problem is even more complex because he also seems to accept the rejected opinion of Rabbah bar Bar Hannah that the distance covered in a day of 12 h is 30 miles. Therefore, he identifies a mile with 2/5 hour or 24 m.[35]

Case:	A	B	C	D	E	F
From dawn until sunrise, in miles	5	5	4	4	3	3.75
From sunrise until sunset, in miles	40	30	40	32	30	30
From sunset until end of astronomical twilight, in miles	5	5	4	4	3	3.75
From begin of astronomical dawn until end of astronomical twilight, in miles	50	40	48	40	36	37.5
Complete day time + prolongations before the beginning of dawn and after the end of twilight, in miles	--	--	--	--	40	40
Fraction $\dfrac{twilight}{day(short)}$	$\dfrac{1}{8}$	$\dfrac{1}{6}$	$\dfrac{1}{10}$	$\dfrac{1}{8}$	$\dfrac{1}{10}$	$\dfrac{1}{8}$
Fraction $\dfrac{twilight}{day(long)}$	$\dfrac{1}{10}$	$\dfrac{1}{8}$	$\dfrac{1}{12}$	$\dfrac{1}{10}$	$\dfrac{1}{12}$	$\dfrac{1}{10}$
Duration of a mile, in minutes	18	24	18	22.5	24	24
Duration of astronomical twilight, in minutes	90	120	72	90	72	90

Table 1 Different possibilities for day division

Day (short) = day between sunrise and sunset.
Day (long) = day between the beginning of astronomical dawn and the end of astronomical twilight.

3. The position of Rabbi Johanan.

The Talmud considers that the refutation of the dictum of Rava and of Rabbi Johanan's pupil, Ulla, does not imply the refutation of Rabbi Johanan's opinion. Rabbi Johanan can say in his defense that he was not understood correctly by his pupils. Rashi understands that Rabbi Johanan simply said that one day's journey is 40 miles and that the repartition was the responsibility of Rabbah bar Bar Hannah (and Ulla). Rava does not seem to have been the pupil of Rabbi Johanan and does not seem to be concerned by this discussion. This explanation of Rashi does not fit perfectly with the Talmudic text and does not explain why the words דקא חשבן דקדמא וחשוכא.... were attributed to Rabbi Johanan on a subject that he had even not considered. He should have simply said that he had taught them only about the 40 miles a day.

Secondly, how does Rashi[36] know that Rabbi Johanan's opinion is the same as that of Rabbi Judah?[37] If this were the case, Rabbi Johanan could have simply answered that he shares the position of Rabbi Judah and was misunderstood by his pupils. I assume that Rabbi Johanan had not only taught that a day's journey is 40 miles, but he probably also said that people are used to walking five miles before sunrise and after sunset and that the distance that an average walker covers in six hours, between 6 a.m. and noon, is 15 miles. He may also have endorsed the dictum of Ulla about the distance between Jerusalem and Modiim. Rabbah bar Bar Hannah and Ulla did not invent the five miles by themselves and therefore the explanation of Rashi seems too complicated. Their mistake was, in the words of Rabbi Johanan, to have considered that the five miles are covered after daybreak and before the end of twilight. That means that the opinion of Rabbi Johanan cannot agree with that of Rabbi Judah because Rabbi Johanan considers that the day's journey, between sunrise and sunset, is 30 miles. For more precision about Rabbi Johanan's position, let us examine columns E and F of our table. Column E solves the problem: it satisfies the condition of 1/10 imposed by R' Judah and it gives a length of dawn and twilight of 3 * 24 = 72 m or (1/10)*12 = 1.2 h.

If we accept that the fraction 1/10 is to be considered relative to the length of the complete day, dawn and twilight included, but night excluded, as Rashi and nearly all the Rabbis[38] have done, then column F can also work. Now, if we accept column F, then column A can also enter into the consideration. But column A has one disadvantage: the length of dawn and twilight is five miles and such a distance is excluded by the answer attributed to Rabbi Johanan. The conclusion is that, contrary to what Rashi and R' Hananel explain, the position of Rabbi Johanan seems to be independent of that of Rabbi Judah and can correspond to column E and, possibly, in the frame of the standard exegesis, to column F. Regarding the distance between Modiim and Jerusalem, the position of the main commentaries is not clear. In explaining the refutation of Ulla, Rashi and R' Hananel state clearly that the average walker covers 16 miles in six hours, not 15 miles, and therefore the distance between Modiim and Jerusalem must be 16 miles, not 15 miles. This does not prevent Rashi from writing in B. Hagiga III: 5 that Modiim is 15 miles away from Jerusalem. On the other hand, some other commentators, including Maimonides, have adopted 15 miles as the distance from Modiim to Jerusalem.

4. The position of Rabbi Hanina.

Until now, the discussion centered on the ratio of dawn to day and indirectly the length of dawn. For example, in columns C and E of our table, the length of dawn is 1.2 h, and in columns D and F the length of dawn is 1.5 h although the corresponding numbers of miles are not equal. Nevertheless, Rava was refuted on the basis of the inequality of the ratio of dawn to day as 1/6 being different from 1/10, i.e., because of the inequality of the length of dawn and twilight (two hours as opposed to 1.2 hours), and not because of the discordance between five and four miles.

Now the Talmud asks whether the physical distance of five miles can still be in accordance with Rabbi Judah, when we know that Rabbi Johanan has explicitly refuted the possibility of dawn corresponding to five miles. Therefore, it answers that Lot was pushed by the angels and covered five miles at an abnormal speed.

5. The discussion between Ulla and Rav Judah.[39]

Ulla says a man is considered to be on a "journey afar off" if he cannot arrive at the time of the slaughtering. Rav Judah, on the contrary, says that is the case only if he cannot reach Jerusalem in time to eat the Paschal lamb.

Maimonides apparently understood that the man must be there at the beginning of these moments. According to Ulla, whom he follows, the man must leave Modiim at 6 a.m. and he will then be in Jerusalem at noon, which is the theoretical time to begin the slaughtering. On the contrary, according to Rav Judah, the man should leave Modiim at noon and reach Jerusalem at 6 p.m. This time is approximately sunset, the beginning of Ben ha-shemashot, which lasts about 20 minutes[40] and can be considered the beginning of the night. This corresponds to the beginning of the eating period. The time when we decide if a man is on a "journey afar off" is then for Ulla at 6 a.m. and for Rav Judah at noon.

Rashi followed by Tossafot[41] and Nahmanides,[42] understands that the important moment is not the beginning time but the ending time of slaughtering or of eating. Therefore, for both, Ulla and Rav Judah, the man leaves Modiim at noon[43] and must be in Jerusalem at 6 p.m., which corresponds to sunset and therefore to the end of the slaughtering time. We know that if someone enters the tchum Sabbath at the beginning of Sabbath, he is allowed to continue on to the town.[44] Therefore, if a man leaves Modiim a little later than noon and arrives at 6 p.m. (the beginning of Sabbath twilight) at the entrance of the tchum Sabbath of Jerusalem, he will be able to participate in eating the Paschal goat. Therefore it seems that the moment when we decide if one is on a "journey afar off" is at noon according to Ulla and a mile later according to Rav Judah.

6. The definition of the day according to Tossafot.

It is well known that Tossafot were puzzled by the contradiction between the dictum of Rabbi Judah in Pesahim 94a saying that the dawn and twilight last four miles and the dictum of Rabbi Judah in Sabbath 34b, saying that Sabbath twilight lasts 0.75 miles. R' Tam solved the problem by saying that the Sabbath's twilight is situated at the end of astronomical twilight.[45] This little Tossafot of 12 lines in both Pesahim and Sabbath had

an exceptionally resounding impact in rabbinical literature and in the Jewish Halakha and Maaseh (theoretical and practical conduct). It is also at the origin of the extension of the halakhik day (at least לחומרא) from daybreak until the end of astronomical twilight[46] and of the creation, ex nihilo, of a new way of counting temporary hours, *the long temporary hours,* that were never known or even imagined before. This position of R' Tam is actually founded on an old-fashioned and incorrect cosmographical system,[47] which has been precisely described by R' Hananel ad locum[48] and of which a good schematic representation is made in B. Pesahim, ed. Steinzalts, ad locum. According to this cosmographical system, the sun turns from east to west during the day, and in the opposite direction above an opaque surface during the night. In order to explain the dawn and twilight, which have diminishing light while the sun has disappeared, the system imagines that the sun, for example at sunset, enters an opaque pipe and crosses the heaven from its day trajectory to its night trajectory. Light diminishes with the progression of the sun in the pipe, and finally when the sun finishes crossing the thickness of heaven; it gets back to its window and begins its night trajectory. At this moment, which in modern terminology is the end of astronomical twilight, there is no more direct or indirect light coming from the sun and all the stars, even the littlest, are now visible. According to this system, night happens only when the sun is behind the opaque vault and the four miles of dawn and the four miles of twilight belong to the day. Similarly, at daybreak the sun enters a pipe and crosses the heaven until sunrise. Day begins four miles before sunrise, at daybreak, and ends four miles after sunset, at the end of astronomical twilight. It must also be observed that in many instances, in Tossafot and even in Rashi, it speaks of a dawn of five miles. In other words, not only has the incorrect distance of 15 miles from Modiim to Jerusalem been generally accepted, but the refuted opinion of Rava and Rabbah bar Bar Hannah (and Ulla) still survives, incomprehensibly, in many passages of Tossafot,[49] Rashi,[50] and the German[51]and Italian[52] Rishonim. This provokes some confusion, the mile being estimated there to be 22.5 m or 24 m. We also observe that both the former values of 22.5 or 24 m are 18 m if they are expressed in long temporary hours. This is misleading and increases confusion.[53] According to column D of our table, which was considered generally the definitive solution, the long temporary hour on the day of the equinox is 40/32 = 1.25 h = 1 h 15 m short temporary hours (equal to the equinoctial hours on the day of equinox) and sunrise occurs at (4/40) * 12 = 1.2 h = 1h 12 m long temporary hour. According to column B, which, despite the Talmudic refutation, still remains the basis of some Tossafot, the long temporary hour is (40/30) = 1.33 h= 1 h 20 m short temporary hours, and sunrise occurs at (5/40) * 12 h = 1.5 h long temporary hour.

As far as the problem of the discussion between Ulla and Rav Judah is concerned, Tossafot considers that the time of slaughtering lasts until the beginning of the night (end of astronomical twilight).[54] On the contrary, in B. Zevahim 56a and in B. Menahot 20a, Tossafot considers that the time of slaughtering ends with sunset and therefore it is at noon that we decide whether the person is in Modiim and is obliged to leave for Jerusalem or whether he is beyond it and must report for the second Passover. According to Rav Judah, things are more complex because the beginning of the festival is four[55] miles after sunset and Ben ha Shemashot begins 3.25 miles after sunset. Furthermore, someone arriving at this moment at the beginning of the tchum is authorized to continue on his way until the town.[56] Therefore, logically, according to Rav

Judah, the important moment in Modiim should be 4.25 miles after noon. It is needless to put the emphasis on the simplicity and the genuineness of Maimonides' interpretation and on the complexity of the solution of Tossafot.

3. The correct exegesis in the frame of the standard analysis.

In the time of the Mishna, the situation was clear. Rabbi Akiba and Rabbi Judah were perfectly aware of the true distance of 20 miles between Modiim and Jerusalem, and they knew that this distance is hardly covered in six hours. They also knew the division of the day is four miles during dawn, 20 miles in the morning, 20 miles in the afternoon and four miles during twilight. Furthermore, the test moment for leaving Modiim is necessarily at 6 a.m. and the theoretical time of arrival is noon. This allows normal walkers to arrive at about 14 h,[57] still in time for the slaughtering of the Paschal lamb. In the Gemara, all of these elements were forgotten. Nevertheless, as was already pointed out, it was possible to get the exact solution of the problem without knowing, a priori, the distance between Modiim and Jerusalem. The correct interpretation[58] of the ratio 1/10 must lead to column C, implying that the distance between Modiim and Jerusalem is 20 miles and that one mile corresponds to a time of 18 minutes. When the Talmud refuted the opinion of Rava, it was because of the contradiction of the ratio of dawn to day of 1 to 6 instead of 1 to 10 and consequently the faulty estimation of the length of dawn as two hours instead of 1.2 hours. When the Talmud refuted the opinion of Ulla, it was because, according to Rabbi Judah, the distance between Modiim and Jerusalem is actually 20 miles (3.33 miles/hour * 6 hours) and not 15 miles as he stated. As far as Rabbi Johanan is concerned, the classical exegesis assumed that he could not propose an independent position, but could only follow the position of Rabbi Judah as expressed in column C.[59] Therefore, the length of dawn is 1.2 h at the equinox. And the length of dawn in Jerusalem, with latitude of 31.8° from the equator, is 1 h 20 m; it is 19 h 20 m at the end of the astronomical twilight and the depression of the sun is then 15.25°.
Owing to our knowledge that the distance between Modiim and Jerusalem is 20 miles, we know the true meaning of the Mishna, and we can see how the Gemara tried to uncover the true meaning of the Mishna. Apparently, and this is our thesis, the Gemara found the true meaning of the Mishna but the standard commentators did not. An important conclusion is that the speed of the traveler of Rabbi Judah is a theoretical speed of about five km/h. [60] A normal man will need about eight hours to cover the distance.[61]
Therefore, there is no place for an afternoon traveler (Rashi), neither for a criterion depending on an arrival at the time of eating (Rav Judah) nor for a practical journey of 40 miles per day. This distance is the extrapolation of the maximum speed of the traveler of Rabbi Judah, walking 12 h without any rest or any break for eating, at the speed of 1 mile in 18 m! This is a theoretical distance, not a practical one.
This can be demonstrated by the following consideration. According to the Mishna Maasser Sheni, V: 2, Lod is at a day's distance from Jerusalem. The straight distance between the old town of Lod and Jerusalem is about 37 km,[62] while the straight distance between Jerusalem and Modiim is 28 km. The corresponding road distances must then be about 40-41 and 30-31 km, or even more. It is clear that the time to reach Modiim cannot be six hours if we need a day to reach Lod,[63] which is about 10 km northwest of Modiim.

4.   Back to the exegesis of the passage of B. Pesahim.

It appears that the position of Rabbi Johanan is different than the position of Rabbi Judah. Rabbi Johanan's position corresponds to column E (eventually column F) and Rabbi Judah could not refute it. Therefore, the idea of identifying Rabbi Johanan with Rabbi Judah seems farfetched. The traveler of Rabbi Judah walks 20 miles in six hours, or one mile in 18 m, at the rate of about 4.9 km/h, without fatigue, during six or even twelve hours, without taking a break for eating or for relieving oneself. On the other hand, the traveler of Rabbi Johanan covers a distance of 15 miles in six hours, or one mile in 24 m, at the rate of 3.7 km/h. It is reported that Herodotus[64] asserted in the antiquity that a normal walking rate is 20 stadia per hour and 200 stadia per day because a man cannot maintain this rate for more than 10 hours. With eight stadia per mile, the covered distance of 20 stadia per hour is equal to 2.5 miles per hour or 15 miles in six hours and the 200 stadia per day is equal to 25 Roman miles per day. It was also agreed in Germany that a normal walker covers a distance of 25 Roman miles per day.[65] The traveler of Ulla and Rabbi Johanan walks slightly faster than these historic average travelers, as he covers 30 miles in a day instead of 25 miles. So the traveler of Rabbi Judah is a fast walker while that of Rabbi Johanan seems to be an average walker. Now in the text of the Gemara, the walker of Rabbi Judah is also called an average walker. We have therefore a good case for deleting the word "average" from Rabbi Judah's Braita.[66] Deleting the word average from this Braita would mean that Rabbi Judah is dealing with quick walkers while Rabbi Johanan deals with an average walker.

The Gemara has rejected the opinion of Rava because his duration of dawn and twilight is two hours instead of 1.2 hours; the objection was raised only on the basis of the difference of the ratio of dawn to day. The Gemara has rejected the statement of Ulla about the distance of 15 miles between Modiim and Jerusalem because it contradicts the distance implied by the Braita of Rabbi Judah, according to which the distance is 3.33 miles/hour * 6 hours = 20 miles. Finally, the Gemara has not rejected the opinion of Rabbi Johanan because his division of the day is compatible with that of Rabbi Judah. Apparently the Gemara was aware of the difference in speed between the walkers and did not see a fundamental objection to the existence of two types of walkers, quick walkers and average walkers. It is probably because Rabbi Johanan considered the speed of Rabbi Judah's walker exceptional that he reformulated the division of the day. As far as Rabbi Johanan was not concerned with the distance between Modiim and Jerusalem and would not try to deduce it, he was not rejected.

What about the time necessary to cover a mile? We now have a span of time of 18 m (or 22.5 m according to Rashi, Tossafot and R' Hananel), corresponding to a quick walker and a span of time of 24 m corresponding to an average walker. Most of the Rabbis have followed the opinion of Rabbi Judah, the Tana, because they considered that, except possibly for the problem of the physical distance between Modiim and Jerusalem, the position of Ulla and Rabbah bar Bar Hanna was taken as a whole, and it was rejected. We can also note that most of the measurements expressed in miles were expressed by Rabbi Judah. The repartition of the day is generally presented according to the Braita of Rabbi Judah and the beginning of Sabbath is expressed in miles according to the opinion

of Rabbi Judah. It is therefore normal that the mile is evaluated according to Rabbi Judah, at the rate of 1 mile in 18 m or 3.33 miles per hour, even if his walker's speed is quick, not average.

In conclusion, according to what seems to be the true exegesis of the Talmudic passage, the mile as a unit of time is derived from the schedule of the eve of Passover. The Talmud has clearly decided in favor of Rabbi Judah, either for the distance between Modiim and Jerusalem, which is 20 Roman miles, or for the span of time corresponding to a mile which is 18 m, even though it corresponds to a quick walker. The fact that Rabbi Johanan felt obliged to propose another schedule, based on an average walker, has provoked some confusion. It must be concluded and remembered that the time schedule of Rabbi Johanan has no far-reaching consequences; the distance between Modiim and Jerusalem, the length of the mile as Halakhik[67] unit of time are deduced from Rabbi Judah's schedule and not from Rabbi Johanan's.

    2. The metrology of Maimonides.

        1. The mile as a unit of time.

The opinion of Maimonides has fascinated generations of scholars, probably because of the rationality of his structure. To whom more than him does the following dictum of Samuel apply: אילמלי ראיתו, נמוקו עמו..... גיטין ס"ז.

Maimonides believes that one mile corresponds to 24 m, that the distance between Modiim and Jerusalem is 15 miles and that this distance is covered in six hours. At first glance, this completely contradicts the Gemara!

Furthermore, he writes in his commentary on Mishna Berahot I: 1 that the length of dawn is 1.2 h. This last passage has been completely misunderstood by the standard commentators and by modern scholars, who could not reconcile this advice with the former data. The Gaon of Vilna has been especially puzzled by the problem, in his commentary on Shulhan Aruch,[68] he could not explain why Maimonides rules that a mile is 24 m, in contradiction with the conclusion of B. Pesahim. He even contemplated the possibility of a different reading of Maimonides in the Gemara according which Ulla would not have been rejected. But in his commentary on Berahot,[69] ad locum, he wrote that in Berahot also, Maimonides deals with the situation in Israel[70] at the equinox and the 72 m correspond to four miles at the rate of 18 m per mile. He offers no satisfactory solution explaining the different rulings of Maimonides. The only way to propose a solution allowing the following data: 1 mile = 24 m, and Modiim – Jerusalem = 15 miles is to connect the ruling of Maimonides with the opinion of Rabbi Johanan that we described above. We must admit that Maimonides has ruled according to Rabbi Johanan, who was not refuted. We then have the possibility of considering columns E or F of our table. We see immediately that column E offers a solution: 30 miles in 12 hours correspond to 24 m for one mile, and a length of three miles for dawn corresponds to 72 m, as is written in the commentary on Berahot.[71]

        2. The thickness of the atmosphere.

In his commentary on Berahot I: 1, Maimonides writes that the length of twilight is 72 m, and he adds, in anodyne precision, that the thickness of the atmosphere is 51 miles. In his commentary ad locum, Tossafot Yom Tov mentions that R' Solomon Delmedigo, in his book Elim, corrects that figure to 52 miles and says that according to his own data the true value is 44 miles. The ancients thought that the upper surface of the atmosphere was a reflecting surface and they explained the end of twilight as the moment when the last ray sent by the sun, after reflection on this reflecting surface, reached the considered place of the earth. After this moment the depression of the sun has reached such a value that no ray coming from the sun reaches any more, after reflection, the eyes of the observer standing on the considered place of the earth. The darkness has reached its maximum, and this moment corresponds to the end of the astronomical twilight.

We established the following theory in order to check the values of Maimonides and Delmedigo. In the meantime, we have taken knowledge of the English[72] and Hebrew[73] translations of the manuscript of the Book of Dawn, which inspired Maimonides, and which was already known by Delmedigo in a Latin version. It appears that this book chooses a depression of $19°$[74] at daybreak and at the end of twilight and calculates a thickness of the atmosphere of 51.8 miles. The value of 51 miles of Maimonides would then be a truncation of the exact number and the 52 miles of Delmedigo, a correct rounding off. If we examine the situation according to column E of our table, which we supposed was the opinion of Maimonides, we deduce from the formulas that for a depression of 15.25° at equinox, the thickness of the atmosphere is 33.086 miles.[75] This solution is not acceptable, despite the good correspondence between three miles in Pesahim and 72 m in Berahot.

But if we consider column F, we will find a satisfactory solution. The 3.75 miles represent 1.5 h. We check that at 19 h 30 m in Jerusalem, 1.5 h after sunset, the solar depression is exactly 19° and the thickness of the atmosphere is then 51.808 miles. The data in Berahot cannot apply anymore to Israel; it concerns the equator where the time at the end of twilight is 19h 16m. All the elements allow us to say with certitude that Maimonides, in his commentary to Mishna Berakhot I: 1 is dealing with the situation at the equator at the equinox.

The question is then: why did Maimonides speak about the duration of twilight as 72 m and not as 76 m? There is only one possible answer. Maimonides begins twilight at 18h 04 m, when the depression of sun is 1°,[76] corresponding to apparent sunset, when the sun disappears completely at the horizon. This depression is slightly different from the modern correct depression of 0.85° at apparent sunset.

In conclusion, we have shown how Maimonides could give a definitive ruling in Gemara Pesahim in accordance with the scientific achievements of his time. He surely attributed his interpretation of Pesahim to Rabbi Johanan. The concordance with the results of the Book of Dawn was, for Maimonides, the best proof of the correctness of his conclusions.[77] This conviction was further confirmed by the fact that Maimonides believes night falls 20 m after apparent sunset. He could consider this moment as the beginning of the night of Rabbi Jose, following by two minutes[78] the beginning of the night of Rabbi Judah, which occurs 24*(3/4) = 18 m after apparent sunset.
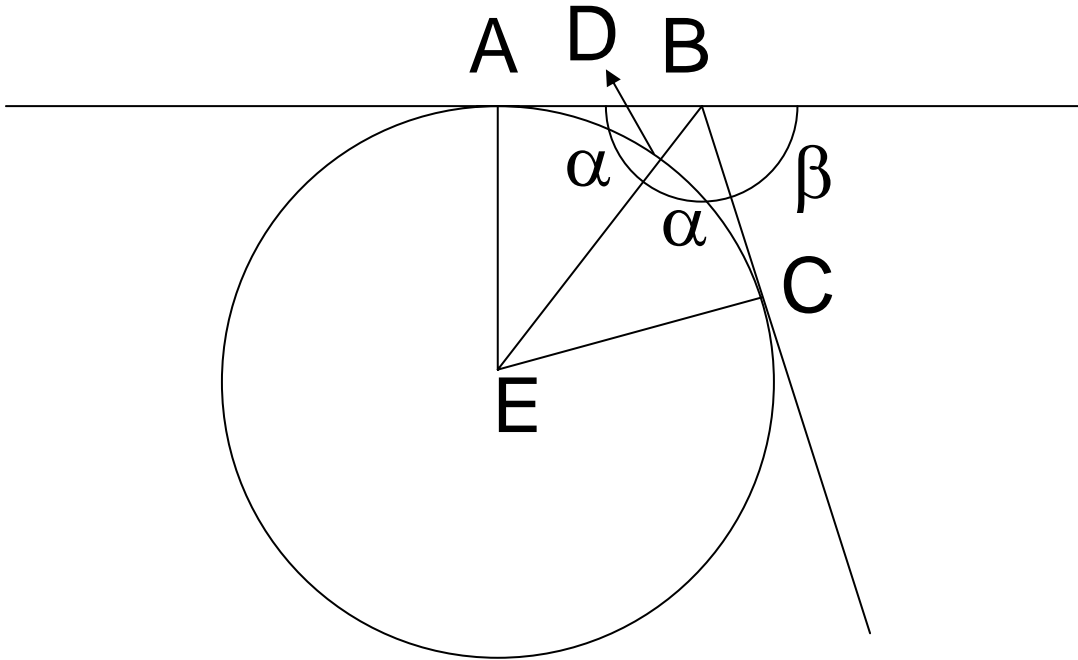
Figure 1 Representation of the situation at the end of the astronomical twilight, when the sun is at the infinite.

E is the center of the earth.
A is the position of the observer on earth.
CB is the last ray emanating from the sun. After reflection on the dioptric surface in B, it gives the ray BA, the last ray reaching the observer.
β is the depression of the sun, r is the radius of the earth and is worth
$\dfrac{24000}{2\pi} = 3819{,}7186$ miles, h is the thickness of the atmosphere.

$$\sin \alpha = \cos \frac{\beta}{2} = \frac{r}{r+h}$$

$$h = r\left(\frac{1}{\cos \dfrac{\beta}{2}} - 1 \right)$$

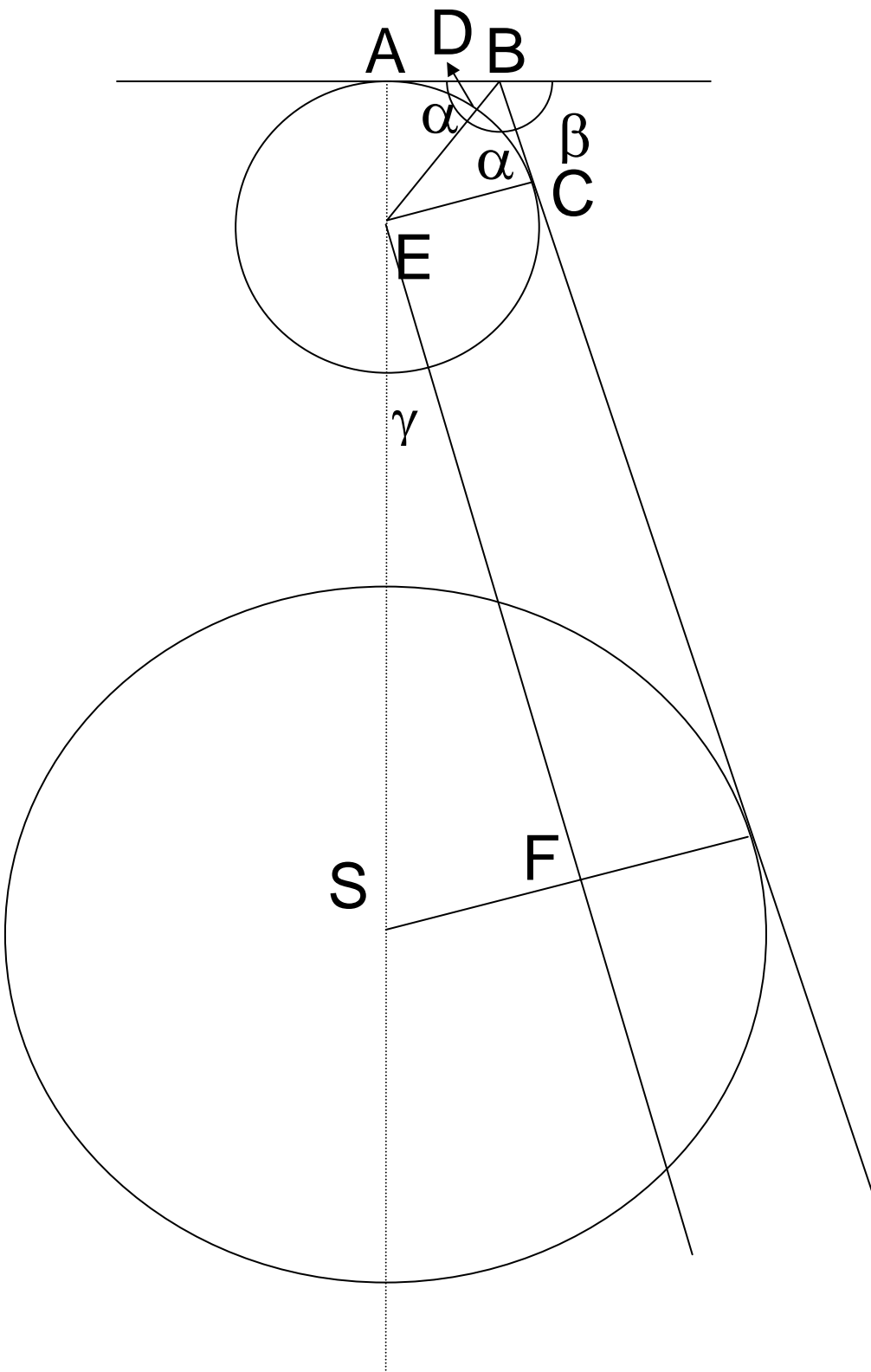$r = EA = EC$
$h = DB$ is the thickness of the atmosphere.

Figure 2 Representation of the situation at the end of astronomical twilight. The sun is at a finite distance.

R is the radius of the sun, d=ES is the distance between the sun and the earth. δ is the depression of the sun. In ancient astronomy, r=1, R=5.5 and d=1110. γ is a measure of the distance of the sun.

E is the center of the earth, A is the position of the observer and S is the center of the sun.

$$\sin\alpha = \cos\frac{\beta}{2} = \frac{r}{r+h}$$

$$\sin\gamma = \frac{R-r}{d}$$

$$\delta = \beta + \gamma$$

$$h = r\left(\frac{1}{\cos\left(\dfrac{\delta-\gamma}{2}\right)} - 1\right)$$

$$\sin\gamma = \frac{5.5-1}{1110},$$

$$\gamma = .2323^0 = 0^0 13'56''$$

If δ=19°, h=51.808 miles.
If δ=15.25°, h=33.0386 miles.

We also see that four and five centuries before Delmedigo and Hanover, Maimonides was able to transpose a phenomenon from one place of the earth to another or from one season to the other by conservation of the solar depression. Similarly, we have shown in another paper[79] that the beginning of the night of Maimonides (apparition of three stars, theoretical end of Sabbath) in Jerusalem at the equinox is at 6 h 24 m true time, twenty minutes after apparent sunset, when the solar depression is 5.1°. It is interesting to note that Maimonides divides the religious day (time for prayers[80] or time for eating leaven on the eve of Passover[81]) on the basis of short temporary hours, but for moments connected to an astronomical phenomenon, he fixed them on the basis of a solar depression. In so doing, he was an exceptional precursor. He was actually so discrete in doing so that it was never recognized by former scholars, so that Delmedigo and Hanover appeared to be the precursors.

3. The exegesis of the passage of B. Pesahim according to Maimonides.

Maimonides has ruled that a mile represents a span of time of 24 m,[82] that a long distance from Jerusalem is 15 miles[83] and that a man can possibly cover a distance of 40 miles in a day.[84] In his silence we may assume that Rabbi Abraham ben David (Rabad) agrees with these rulings. In order to justify the two first ruling of Maimonides, the Gra writes that Maimonides probably had another reading of B. Pesahim.

We can assume that Maimonides did not have the word "average" in the Braita of Rabbi Judah. It should be noted that, according to the exegesis of Maimonides, the type of walker involved is completely irrelevant to Rabbi Judah's argument, founded on the proportion of dawn to day and consequently on setting the duration of dawn and twilight at 72 m.[85] Indeed, the objection raised against Rava and Ulla by the introduction of Rabbi Judah's Braita was only against his length of twilight of two hours.[86] It is normal that only the part of the statement of Rabbah bar Bar Hanna that an average person walks five miles during twilight conflicted with Rabbi Judah's statement that even a quick walker does not walk more than four miles during twilight. On the other hand, the Gemara was aware of the difference of speed of the walkers and didn't see any contradiction between the 20 miles in half a day of Rabbi Judah and the 15 miles of Ulla. Therefore, the objection was raised only against the difference of the ratio of twilight to day between Ulla and Rabbah bar Bar Hanna and Rabbi Judah.

Under these conditions, it is not more certain at all, according to Maimonides, that the Gemara took a position on the distance between Modiim and Jerusalem. Therefore, the objection raised against Ulla was only about the length of twilight. The Talmud was aware that the walker of Rabbi Judah is a quick walker and that of Ulla, a slow walker. Maimonides ruled according to Rabbi Johanan, because he was not rejected, and he accepted consequently the statement of Ulla, which he considered a corollary of the statement of Rabbi Johanan, i.e. that an average walker covers 15 miles in six hours.[87] This position was only possible because Maimonides ignored the true distance between Modiim and Jerusalem,[88] and the true length of a Roman mile. Now in a case of emergency, when we evidently deal with a quick walker, he ruled according to Rabbi Judah and adopted a rate of 40 miles per day.

As we have seen above, Maimonides understood Rabbi Johanan according to column F of our table and therefore, he must have understood Rabbi Judah according to column D. That means that, contrary to the assumption of Kaftor Vaferah, the mourner of Maimonides covers the 40 miles in 15 hours, not in 12 hours, at a rate of 1 mile in 22.5 m instead of 30 miles in 12 hours at a rate of 1 mile in 24 m on the eve of Passover.

There remains, however, one difficulty: why does Maimonides characterize the walk of his traveler on the eve of Passover, in Hilkhot Korban Pessah, as a slow walk and not an average walk, as he did in his commentary to Pesahim? He was probably aware that his average walker is, indeed, very slow.[89] Therefore it is not impossible that the 40 miles in a day of his mourner are nevertheless covered in 12 hours, because with the mile of Maimonides, this remains an acceptable speed. It is also possible, even likely, that Maimonides changed his mind with respect to the characterization of the traveler of the eve of Passover, which he had considered average in his commentary of the Mishna Pesahim. He could probably verify that 40 miles of about 900 m per day correspond to 36 km per day and fit with an average walker, while the 30 miles per day of Rabbi Johanan correspond to a slow walker. It is likely that Maimonides ruled according to Rabbi Johanan because the speed of one mile in 24 m fits perfectly his theories of the duration of the astronomical twilight (see above) and of the apparition of the three first middle stars marking the beginning of the night, as well as the Talmudic exposition of Ben ha Shemashot.[90] He considered these three middle stars, which become visible at the equinox, 20 m after apparent sunset, as the night of Rabbi Jose, which begins 2 m after

the night of Rabbi Judah. The latter begins ¾ mile or 18 m after apparent sunset and this confirms the choice of 1 mile in 24 m.

We could even consider explaining the rulings of Maimonides with our present text, without any change, with the word "average" in the statement of Rabbi Judah. The simple fact that Rabbi Johanan was not contradicted by the Braita of Rabbi Judah implies that the Talmud considers the possibility of travelers walking at different speeds and even a contradiction between Rabbis about average speed. Maimonides ruled according to Rabbi Johanan for the general cases, but he adopted the quicker speed of Rabbi Judah's traveler in the case of the mourner in a hurry.

In conclusion, Maimonides has ruled according to Rabbi Johanan, who was not rejected by the Braita of Rabbi Judah, and he has accepted a Halakhik mile of 24 m, although it corresponds to a slow walker. He was perfectly aware of it and he has clearly expressed it in Hilkhot Korban Pessah. In Hilkhot Evel, he considered an average walker at the speed of 40 miles per day.[91]

3. Astronomical evidence about the duration of the mile.

B. Rosh Hashanah 25a writes about the last sighting of the old crescent of the moon on the morning of the 29th day of Elul,

ר' חייא חזיא לסיהרא דהווי קאי בצפרא דעשרים ותשעה, שקל קלא, פתק ביה, אמר לאורתא בעינן לקידושיך ואת קיימת הכא, זיל איכסי, אזיל ואיכסי

Apparently Rabbi sent Rabbi Hiya to sanctify the new moon on the evening following the 29th day, so that the former month would be defective[92] and the new month would begin on the 30th day, even though they still saw the old crescent of the moon at the end of the night of the 29th day.

Y. Rosh Hashanah II: 5,58a writes concurrently:

ר' חייא הילך לאורו של ישן ארבעת מיל. ר' אבין משרי עליה צררין ואמר לה לא תבהית בני מריך ברמשא אנן בעינן תיתחמי מיכא ואת מיתחמי מיכא, מיד איתבלא מן קומיה

The second sentence is related to another period, probably in the time of R' Johanan. The first sentence is relative to R' Hiya and it probably refers to the case considered in B. Rosh Hashanah 25a, although this is not certain. It can also refer (especially if the reading of four miles is correct) to another case when R' Hiya found at the last sighting of the old moon, that he could walk four miles, or 72m, during its light. It was too far from conjunction[93] and he probably did not sanctify the new moon on the 30st of Elul but on the following day, the 31st of Elul. In Midrash Tanhuma (Buber edition) Parashat Bo n°8, both events the latter and this of B. Rosh Hashanah are connected:

מעשה בר' חייא הגדול שעלה הירח ערב ראש השנה והלכו הבהמין לאורו מהלך ג' מילין, ראה אותו ר' חייא נטל צרורות ועפר והיה זורק בו, אמר למחר אנו מבקשים לחדשך ועלית לך עכשיו, מיד נבלע במקומו...

In Yalkut Shimoni, chap. 191 (Bo) the reading is slightly different:

מעשה ברבי חייא הגדול שעלה הירח ערב ראש השנה והלכו הספנין לאורו מהלך ג' מילין. ראה אותו רבי חייא, נטל צרורות ועפר והיה זורק בה, א"ל למחר אנו מבקשין לקדשך ועלית לך עכשיו, מיד נבלע במקומו

Rabbi Hiya and principally Rabbi decided to proclaim the 30th day of Elul to be the first day of Rosh Hashanah. It was indeed an empirical rule to have Elul and Adar (before Nissan) defective in order not to confuse the Diaspora[94] and to help them fix the holidays with confidence. Therefore, they had to manipulate the length of the summer months and introduce enough full months to ensure that Elul would be defective and to avoid the visibility of the old lunar crescent on the morning of the 29th of Elul.

Of course, the visibility of the old crescent on the morning of the eve of Rosh Hashanah would be a rather unpleasant situation.[95] It was the result of the lack of one, or even two, supplementary full months in the summer.

In Tishri, the span of time between the last visibility of the old moon and the true conjunction and between the true conjunction and the first visibility of the new moon is a minimum of about 19 hours and a maximum of about 77.5 hours.[96] The span of time between the last visibility of the old crescent and the first visibility of the new crescent is at least 38 hours and at most 155 hours. Therefore, in the case of the visibility of the old moon on the morning of the eve of Rosh Hashanah,[97] we are sure that the new moon will not be visible in the beginning of the evening belonging to the 2nd of Tishri and it will be visible, at the earliest, in the beginning of the evening belonging to the 3rd of Tishri. Normally, the Talmud accepts a first visibility of the new moon on the day following the Neomenia.[98]

We can now show that using a mile of 24 m (or 22.5 m) in place of a mile of 18 m seriously worsens the situation in which the calendar committee of the Sanhedrin had placed itself. If we consider a mile of 18 m, the situation on the morning of the 29th of Elul was the following: the old crescent was seen during 54 m. If we assume that the old moon became invisible at sunrise, we can deduce that the moon rose at about 54 m before sunrise and the elongation between moon and sun was about 13.5°. Therefore the true conjunction of Tishri occurred about 27 hours later,[99] during the morning of the 1st of Tishri, and the first visibility of the new moon of Tishri was at least 46 hours later than the last visibility i.e. at the earliest in the beginning of the evening belonging to the 3rd of Tishri.

If we consider now a mile of 24 m, the old crescent was seen during 72 m, and the elongation between the moon and the sun in the morning of the 29th of Elul was still 18°! The true conjunction occurred about 36 hours later, at the end of the day of the 1st of Tishri. Therefore, a mile of 24 m instead of a mile of 18m worsens the situation and moves the conjunction back by nine hours. With a mile of 22.5 m, the worsening would be slightly less important. Therefore the most likely span of time represented by a mile is 18 m. Similarly, in the Gemara Y. Rosh Hashanah II: 5 mentioned above, we must consider whether to correct the reading of four miles to three miles or to assign this passage to another case where Rabbi Hiya resolved to fix Rosh Hashanah on the 30th of Elul but was forced to postpone its sanctification to the 31st of Elul.[100]

4. The position of R' Israel Isserlein.

R' Israel Isserlein (1390-1460 C.E.) was a pupil of Maharil. He is considered the primus inter pares among his colleagues R' Jacob Weill and R' Joseph Colon, and is celebrated for his Responsa Terumat ha-Deshen. In his responsum I: 167, he writes that a mile represents 18 m.[101] R' Joseph Karo has adopted this ruling in Orah Haym 459: 2,[102] but the Gra and R' Jacob Reicher have sharply challenged this position. According to them, R' Isserlein counts his temporary hours from daybreak to night.[103] He then uses long temporary hours (the Gra considers that counting long temporary hours from daybreak until night is a big mistake, contrary to astronomy[104]) and therefore the distance covered in 12 equinoctial hours is 32 miles, and the time corresponding to one mile is 22.5 m. The 18 m mentioned by R' Isserlein are actually expressed in long temporary time; they represent (40/32)*18 = 22.5 m equinoctial time. We find that R' Jacob Weil has a very similar position. In his responsum 193, devoted to the eve of Passover, he writes that a mile is 18 m.[105]

Actually, R' Joseph Karo would then have misunderstood the ruling of R' Isserlein. Nowadays such misunderstanding can still be found in the book Jewish Chrononomy by Leo Levi, pp 17-18 (Hebrew text). Let us examine the position of R' Isserlein in detail. If we combine several of his responsa, he gives enough information to solve the problem. In responsum I: 1, we learn that he was not accustomed to temporary hours and he apparently believed that all the hours in the Talmud are equinoctial hours. He remembers that in his youth, in learning a Tossafot in Berahot[106] he discovered temporary hours. In his responsum 121 dealing with the schedule of the eve of Passover, he considers the case when Passover occurs very late (nowadays Passover can fall as late as April 25) and he mentions that the end of the 4th hour is still three hours before noon. In Vienna (near his town of Neustadt), latitude 48°, we observe that on the eve of this late Passover sunrise is at 4 h 58 m, noon is at 11 h 59 m and sunset is at 18 h 59 m. The duration of the morning is indeed 7h 01 m. At the end of the fourth hour, we are at 9 a.m., three hours before noon.[107] It appears here that he counts the hours from sunrise. In his responsum 109, dealing with the early reading of the Megila on the eve of Purim, he considers the case when Purim occurs very late (nowadays Purim can fall until March 26). On the eve of this late Purim sunrise is at 5 h 51 m, noon is at 12 h 06 m and sunset is at 18 h 20 m. The duration of the afternoon is 6 h 14 m and Pelag ha Minha is then 4 h 59 m after noon i.e. 4h 59m true time. The repetition of this responsum by his pupil in Leket Yosher mentions that this moment is just before the clock of Neustadt rings 5 p.m. It is then evident that R' Isserlein uses equinoctial hours and counts the hours of the day from sunset. Most likely, he did not follow R' Tam about the times of Sabbath and considered the beginning of the night 0.75 miles after sunset and therefore he probably called sunrise Alot ha-Shahar and sunset Tseit ha-Kohavim. The former rabbis did not correctly understand R' Isserlein (he was indeed not very clear) and did not check the times indicated in these two responsa. Now the question is whether R' Joseph Karo adopted the duration of 18m for a mile with full knowledge of the facts.[108] It is likely that he was not aware of the former results and he understood Alot ha-Shahar and Tseit ha-Kohavim according to the standard understanding of the Talmud B. Pesahim 94a. But, while all the other Rabbis understood Terumat ha-Deshen according to column D of our table, the 18 m being 18 long minutes or 22.5 equinoctial minutes, in accordance with their own comprehension of Pesahim, R'

Karo (followed by Rema and Levush) understood Terumat ha-Deshen according to column C, the 18m being 18m equinoctial. In any case, there is enough evidences in Terumat ha-Deshen that all his hours (even on the eve of Passover, when according to the plain explanation of the Mishna Pesahim I: 1 the hours are temporary hours) are equinoctial hours and that he is not accustomed to temporary hours.

5. Conclusion.

According to what was considered the definitive exegesis of the Talmudic passage of B. Pesahim, the Halakhik mile represents a span of time of 18 m, which corresponds to the time used by a quick walker to cover that distance. According to the definitive exegesis of the interpretation of the passage by Maimonides, the Halakhik mile represents a span of time of 24 m; this corresponds to the time used by a slow walker to cover the distance. In both exegeses, the Halakhik mile does not correspond to an average walk.

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[1] Departing from the Soncino translation, with many improvements, most of them by R' Y.G. Weiss.

[2] I.e.,so far that if a man started walking at sunrise, he could not reach it by midday (Maimonides) or according to Rashi, so far that if a man started walking at midday, which is the earliest time for sacrificing the Passover-offering, he could not reach it by sunset, which is the latest time allowed.

[3] Genesis XIX : 15.

[4] Ibid. 23

[5] B. Pesahim 90b.

[6] Ibid.

[7] This is the explanation of Rashi. Rabbi Johanan did not know actually Rava. I prefer Rabbah bar Bar Hannah and Ulla.

[8] Genesis XIX : 15.

[9] From daybreak until sunrise, one normally walks four miles, but hastened by the angels, they walked five miles.

[10] This is the opinion of Maimonides. According to Rashi, the traveler begins his walk at noon and must reach Jerusalem before sunset, at about 18h.

[11] See Num 9:10.

[12] See the commentary on the Mishna: Shoshanim le David by R' David Pardo. He uses exactly the same expression.

[13] The opinion of Ulla according to which a traveler can walk 30 miles from sunrise until sunset, five miles during astronomical dawn and five miles during astronomical twilight was generally rejected, but the distance of 15 miles between Modiim and Jerusalem was accepted.

[14] According to the conclusions of Rashi and Tossafot, one can walk 16 miles in six hours. Nevertheless they accept that the distance is only 15 miles. Therefore Tossafot suggests that there was a border to cross between the two towns where the traveler lost time.

[15] Kaftor Vaferah was written in Palestine by R' Estori ben Moses ha-Parhi from Florenza (Perah); Andalusia, south of Spain 1280-1355. He was the scion of a prestigious Provencal family: grandson of R' Nathan from Trinquetaille (the teacher of Nahmanides) and great grandson of R' Meir from Trinquetaille (the most important pupil of R' Abraham ben David of Posquière). He was the pupil of R' Jacob ben Machir in Montpellier and later, after he left France during the expulsion of the Jews in 1306 for Perpignan and Barcelona, he was the pupil of R' Asher ben Yehiel (Rosh) in Toledo. In 1313, he was in Egypt on his way to Palestine.

[16] See chapter 11, paragraph beginning with נחזור לבית שאן: He makes the distinction between Modiit, or Har Modiit (mentioned in B. Kidushin 66a), which he situates at one hour's walk west of Beit Shean, and Modiim (considered in B. Pesahim 93b) which is near to Jerusalem and is called Middah with a guttural Ayin : מידע. R' Y. G. Weiss wants to understand that Middah refers to Modiit, west of Beit Shean and not to Modiim near to Jerusalem. I am less certain of this. A careful reading brings me to think that both remarks, first about the denomination of Middah and second about the dictum of Ulla, refer to Modiim. This seems to also be the understanding of R' Joseph Schwartz, who understood that Modiim of Pesahim is called Middan.

[17] La Geographie du Talmud, p 99.

[18] I Macc. XII: 29.

[19] Eusebius (260-339) wrote the Onomasticon in around 324. It contains place names mentioned in the Bible and Gospels, which he arranged alphabetically by books of the Bible, following the Septuagint spelling of the names. He identifies them with places existing in his time and sometimes adds their distance from the nearest city. At the end of the fourth century the Onomasticon was translated into Latin by Jerome (Hieronimus).

[20] Mosaic map discovered in 1884, representing the biblical holy land and neighboring regions.

[21] See Pinhas Neeman in Encyclopedia Talmudit, Modiim and Prof. Zeev Vilnai in his book Lidiat Israel, Midiah. See also Kaftor Vaferah, Beit Hamidrash Lahalaha Behityashvut, p 62, remark 129.

[22] Hanokh Albeck, in his commentary on the Mishna Pesahim IX: 2 notes that Modiim is at a distance from Jerusalem of 28 km north west.

[23] The length of a mil was always considered to be 1478m. In the last edition of the French encyclopedia Larousse, the length of the mil is 1481.5 m or 1481.75 meters.

[24] This corresponds to a velocity of a little less than 5 km per hour.

[25] R' Y. G. Weiss suggests that they were not more aware of the exact location of Modiim. Rabbi Judah and Rabbi Akiba knew the town of Modiim near Lod, but the Amoraim thought it was another town nearer to Jerusalem, as R' Estori ha Parhi suggests in his book, Kaftor vaferah.

[26] Tossafot B. Pesahim 93b, רב יהודה says, in a first answer, that the way was blocked up. This can mean that there was a border to cross on the way or that the route had to change.

[27] Nevertheless, we know that Rabbi Hanina bar Hama, his colleague Rabbi Joshua ben Levi and Rabbi Johanan, Rabbi Hanina's pupil, visited Jerusalem. Y. Masher Sheni 3: 3.

[28] Because of a bad estimate of the distance, resulting from political reasons that prevented him from traveling this distance. It is also possible that the exact location was forgotten and Ulla placed Modiim in the wrong place. So, either he had an erroneous estimate of the distance between the two places or he had a correct evaluation of the distance between a false location of Modiim and Jerusalem. It is also possible that he didn't know the location of Modiim and he evaluated the distance by multiplying the speed of an average walker, which he evaluated to be 2.5 miles per hour, according to the statement of Rabbi Johanan, by six hours.

[29] Rabbi Judah bar Illai is a Tana of the fourth generation. His father was a pupil of Rabbi Eliezer and was close to Rabban Gamliel from Yavneh. Rabbi Judah was the pupil of his father, of Rabbi Tarfon and mainly of Rabbi Akiba. He was the colleague of Rabbi Meir, Rabbi Nehemiah and Rabbi Simeon. Among his pupils was also Rabbi Judah the Prince.

[30] This is a strange explanation when we know that Maimonides mentions a few times that a mile corresponds to 24 m.

[31] He is one of the great authorities of the eighteenth century, who originated in Venice. He was rabbi in Spalato (Split) in Dalmatia and then in Saraj (Sarajevo) in Bosnia. Finally he was head of the tribunal of Jerusalem. He wrote important books in all fields of Jewish scholarship, especially on the Tossephta.

[32] Because of his irreverence toward other contemporary authors, he came under criticism, and in the second volume of his commentary on the Mishna, he was obliged to apologize in the introduction of his book in order to receive an imprimatur.

[33] This seems far-fetched because there is no need for the man to go to the Temple. He must only arrive in Jerusalem in time.

[34] Rabbi Moses ben Mordehai Zacuto (1620-1697) wrote notes on the Mishna in his book Kol ha Remez (Amsterdam, 1714).

[35] Commentary on the Mishna Pesahim III: 2 and IX: 2. In both cases he considers that walking one mile in 24 m represents average speed. In Hilkhot Korban Pessah V: 9 he considers it a slow walk.

[36] And Rabbi Hananel.

[37] Rashi probably assumes that Rabbi Johanan, an Amora, does not contradict a Tana.

[38] All the Rishonim, with the exception of R' Israel Isserlein, shared this opinion. Later authorities like R' Yom Tov Lipman Heller and R' Jacob Reicher in the 17th century, R' Elijah of Vilna in the 18th century and R' Moses Schreiber in the 19th century also shared this opinion.

[39] Rav Judah bar Ezekiel was a Babylonian Amora of the third century. He was the pupil of Rav and Samuel. He died in 299 C.E.

[40] See Hilkhot Terumot VII: 2 and Hilkhot Kiddush ha Hodesh XIV: 6.

[41] Ad locum

[42] Num. IX: 10

[43] The position of Rashi was probably influenced by Y. Pesahim ad locum.

[44] Maimon. Hilkhot Shabbat XXVII: 9.

[45] Tossafot, B. Sabbath 34a and B. Pesahim 64a.

[46] This is also the conclusion of B. Berahot 2b.

[47] Because the Gemara Pesahim is based on incorrect scientific bases, R' Moses Al Ashkar considered in his responsum 96 that this Gemara is refuted and that we don't take it into consideration concerning the contradiction between it and B. Sabbath 34a. On the contrary, his elder colleague R' David ibn Zimra, in his responsum 1353 (or 282 according another numbering) writes that the discussion between the sages of Israel and the nations was about the representation of the scheme of sunset but not about the length of twilight (ben ha Shemashot). In other words, the incorrectness of the cosmographical explanations does not affect the relevance of the passage.

[48] We find also a good description of this system in the commentary ad locum of R' Eleazar of Metz, pupil of R' Tam.

[49] B. Berahot 2b, B. Pesahim 11b, B. Sanhedrin 41b, B. Aboda Zara 34a and B. Menahot 20b.

[50] B. Berahot 2b.

[51] B. Sabbath , Mordehai 293; Rosh on B. Taanit I: 12; Sefer ha Yashar Sabbath 34.

[52] Tossafot Rid: Rabbi Isayah Di Trani the Elder, south of Italy, 13th century.

[53] The Novellae of Rashba on B. Berahot speaks of a mile of 18 m even when Rashba considers 32 miles covered in 12 hours. The mile is then 22.5 m equinoctial and 18 temporary minutes.

[54] B. Pesahim 93b, first Tossafot.

[55] Tossafot B. Menahot 20b mention the 15 mile distance between Modiim and Jerusalem and a length of dawn of four miles. Tson Kodashim corrects this to five miles.

[56] See Maimonides, Hilkhot Sabbath XXVII, 9.

[57] See the end of this paragraph.

[58] As far as the reading in B. Pesahim 94a is 1/6 according to Rava. There is a variant reading of 1/8, but it is marginal. All the classical commentators had the reading 1/6 in the ratio expressed according to Rava.

[59] This is of course a difficulty for this reasoning. The Talmud says that Rabbi Johanan has not been rejected and therefore Rabbi Judah could not destroy his position (column E or F), and we want him to abandon his position and accept the position of Rabbi Judah.

[60] 1 mile in 18 m is 3.33 miles per hour or 4.938 km/h.

[61] In a book still in manuscript, R' Raphael from Hanover mentions that the normal velocity of a traveler is one German league or Deutche Meile (Parsah Guermanit) in two hours. A German league is five Roman miles and therefore the normal time to cover 20 Roman miles is eight hours. On the other hand I found in Weiss (1985) p 363 remark 10 the following additional elements: R' Jacob Emden (Sefer Mor u Ketsia, Kuntras yshuv Erets Israel) writes that a day's journey is five German leagues, one German League in two hours, during 10 hours corresponding to 25 Roman miles per day. He considered that the five German leagues are equal to 10 Talmudic Parsah and therefore his cubit was equal to 46.3 cm. The rate of one German league per hour appears also in the printed book of R' Joseph Delmedigo. R' Yair Bachrah, in Sefer Hut ha Shani 97, writes also that the normal velocity of the walker is one German league in two hours but the distance covered in a day is, according to him, six German leagues (44.45 km). He considers a man walking during 12 hours. He considers therefore that 6 German leagues = 30 Roman miles = 40 Talmudic miles and therefore 1 cubit = .56 cm. In the book Minhat Baruch, R' Baruch Krinik also writes that the day's journey is about five German leagues (37.04 km).

[62] See the encyclopedia for Talmudic Geography by Pinkhas Neeman.

[63] R' Y.G. Weiss let me remark that Lod was the boundary of the Jewish Palestine in the time of the Mishna as we see in Mishna Gitin I: 1. Therefore it was one of the boundaries for Maaser Sheni, although it was less than a day's walk. It was already pointed out by Kaftor Vaferah that the four distances given in the Mishna Maaser Sheni are not equal. In fact, Lod is about 40km from Jerusalem and I think that this corresponds to about one day's walk from Jerusalem. See remark 62 above.

[64] See Herodotus Book 4 art 101. This source is also quoted by Borenstein (who says that this data is based on a 10-hour walking day. He quotes no source for this precision). However in Book 5 Art 53, Herodotus says that the Parsah is 30 stadia and a day's journey can be taken as 150 stadia. I thank R' Y.G. Weiss for this information.

[65] See Remark 58.

[66] R' Y.G. Weiss has proposed the following explanation: the word "average" could have been transferred there by a scribe who faultily deleted the term from the first quotation by Rabba Bar Bar Hanna of Rabbi Johanan (p 93b) and placed it in Rabbi Judah's Braita. But the scribe did not delete the word "average" from the second quotation by Rabba Bar Bar Hanna of Rabbi Johanan (p 94a). This explanation is valid for the text of the printed edition (Vilna), but in the extant manuscripts, Vatican 134, Vatican 125 and Columbia X 893 – 141 T), there is no omission. R' Y.G. Weiss also justifies this way the Gemara confronting Rabbi Hanina's statement with the Braita of Rabbi Judah. It would be strange that the Talmud did not realize from the very start that Lot might have been walking at an extraordinary speed. But since Rabbi Judah is also dealing with a maximum speed, the question could be valid and the Talmud goes on to say that with the prompting of the angels, this speed could been increased even more.

[67] By Halakhik mile, we mean the mile that emerges from the Talmudic discussion and represents the definitive span of time to which the Talmud refers.

[68] Orah Hayim 459.

[69] R' Jacob Weiss has forwarded me a scan of the introduction to the commentary of the Gra to Mishlei, edited by the Gra's pupil R' Menahem Mendel of Hassalovitz in Shklov, 1798. I want to express him my gratitude. In this introduction the editor expounds a teaching that he received from the Gra and which deals precisely with the commentary of Maimonides on Mishna Berahot I: 1. According to it the 72m of twilight correspond to 4 miles of 18m and is based on the principle of 40 miles in 12 equinoctial hours and of a

dawn and twilight of 4 miles or 72m. The Gra, however, does not explain the ruling of Maimonides in Hilkhot Korban Pessah according which the walker of the eve of Pessah walks 15 miles in 6 hours at the rate of 1 mile in 24m.The text of the introduction to the commentary of Mishlei and the text of the commentary to the Mishna Berahot I: 1 in Shenot Eliahu (edited in Lemberg in 1799) are very alike. It is unanimously accepted that the introduction of R' Menahem Mendel to Mishlei was transplanted into the commentary of Shenot Eliyahu. Moreover the commentary Shenot Eliyahu is not constituted by marginal autographic notes by the Gra but it is a compilation of what the disciples heard from him (introduction to shenot Eliyahu by R' Hayim of Wolozin). Similarly it is likely that the same introduction or, according to R' Abba Kleinerman, the text of Shenot Eliahu was then transplanted into the commentary of the Gra on Shulhan Arukh Orah Hayim 459.5 (Sefer Meginei Erets, Shklov, 1803) after the autographic margin notes of the Gra. We observe indeed that there is no unity in this text: there is a completely different explanation of Maimonides in the second passage than in the first. In the first passage the Gra concludes that a mile is 22.5m while in the second passage the mile is rather 24m. See variant reading by R' Abba Kleinermanp. 91of the Vilna edition, just after הגהות יעבץ. I thank R' Jacob Weill for all these informations.

[70] R' Joseph Solomon Delmedigo, in Sefer Elim, has understood that in Mishna Berakhot I: 1, Maimonides deals with the situation at the equator and at the equinox. Similarly, R' David Hoffman (Melamed le-Hoïl I: p. 32 $ ד) has understood that Maimonides deals in his commentary on Mishna Berahot I: 1, with the situation at the equator at the equinox. R' Hoffman considers that the end of twilight corresponds to a solar depression of 18° in accordance with the modern definition of the astronomical twilight. Nevertheless neither of them could reconcile the inconsistencies between the different rulings of Maimonides.

[71] This solution was already proposed by R' Yehiel Schlesinger (1923). R' Y.G. Weiss wrote me that R' Jonah Landsofer (1678-1712) had already proposed this solution: כנפי יונה יו"ד ס' ס"ט ד"ה נמצא מוכח. He champions this solution: Maimonides can argue, he says, that the ratios twilight / day considered in B. Pesahim 94a refer to the equator and not to Israel, as generally understood. However this seems farfetched because the ratio 1/6 of Rava refers certainly to Israel at the equinox (Lot).

[72] Goldstein (1985).

[73] Katz (1986) and Katz and Weiss (1997).

[74] The book mentions the extant values of 18° and 19°, but it works with the value of 19°.

[75] These miles are neither Roman miles nor Talmudic miles. These miles are those used in Arab geodesy. When Maimonides writes that the equator of the earth measures 24,000 miles, he uses the same miles. This mile is about 1.67 km.

[76] Eng. Tuvia Katz to wrote me that he was not completely sure of the correctness of this interpretation. I was asking myself if Maimonides was not hesitating between the two values 18° and 19°. But now it appears that column F of our table satisfies the requirements of the Gemara Pesahim and must without a doubt represent the solution that Maimonides attributed to R' Johanan. It is now certain that Maimonides believed that the end of astronomical twilight corresponds to a solar depression of 19°. Therefore it is now certain that Maimonides considered in Berakhot, at the equator, an astronomical twilight beginning at 18h 04m and ending at 19h 56m and lasting 72m. This important result allowed me to demonstrate that the epoch of Maimonides in Hilkhot Kiddush ha Hodesh is, at the equinoxes, 20 minutes after **apparent** sunset, when the solar depression is 1°, and that Maimonides demonstrates a remarkable coherence all through his work, astronomical and not astronomical, in the definition of the beginning of the night, the beginning and the length of ben ha Shemashot. See "The Equation of Time in Ancient Jewish Astronomy" BDD 16.

[77] Of course he was obliged to accept a mile of 24m in order to get an acceptable span of time for .75 mile corresponding to Ben ha Shemashot, the Halakhik twilight. This obliges him to accept that the traveler of the eve of Passover walks very slowly. While in his commentary on Mishna Pesahim IX: 2 he writes that a man can walk the distance of 15 miles between Modiim and Jerusalem, at a middle speed between 6 a.m. and noon, in Hilkhot Korban Pessah V: 9 he writes that the man can walk this distance **slowly**. In Hilkhot Evel VII: 4, he agrees that it is possible to walk 40 miles in one day (if one walks faster). The mile of Maimonides is the halakhik mile of 2,000 cubits.

[78] About two minutes corresponding to 2m = 20m – 18m the difference between 20m and .75 mile i.e. 18m.

[79] The Equation of Time in Ancient Jewish Astronomy; BDD 16, Tamuz 5765. University of Bar Ilan.

[80] Hilkhot Tefila III, Hilkhot Shema I: 11.

[81] Hilkhot Hamets u Matsah I: 8 and 9.

[82] See his Commentary on the Mishna Pesahim, III: 2 and IX: 2. See his Hibur, Hilkhot Hamets u Matsah V: 13, where he mentions the time necessary to walk a mile without more precision.

[83] See Hibbur, Hilkhot Korban Pessah V: 13.

[84] See Hibbur, Hilkhot Evel VII: 4.

[85] $(1/10)*12h = 1.2\ h = 72\ m.$

[86] $(1/6)*12h = 2\ h.$

[87] Maimonides has necessarily understood תיובתא דעולא as the rejection of the common opinion of Ulla and Rabbah Bar Bar Hanna about the length of dawn and twilight of two hours (1/6 of 12 hours or 5 miles * 24 m) according to the proposed answer of Rabbi Johanan, but without taking a definitive position on the distance between Modiim and Jerusalem.

[88] In ruling according to Rabbi Johanan and Ulla, he arbitrated in favor of Ulla the contradiction about the distance between Modiim and Jerusalem.

[89] If we consider that the mile of Maimonides is equal to 900m then a rate of 1 mile in 24 m corresponds to the very slow rate of 2.25 km/h. Even with a mile of 1,100m (according to R' Y.G. Weiss) this is not more than 2.75 km/h. Note that the quick speed, according to Rabbi Judah, would be only 2.4 km/h.

[90] See B. Sabbath 34a. Of course there is a difficulty at this level, as the ¾ mile of Ben ha Shemashot was defined by Rabbi Judah and should be considered according to Rabbi Judah's advice.

[91] It seems that these 40 miles in a day must be understood in a day of 12 hours and not 15 hours. Indeed with a mile of 900 m, 40 miles per day represents 36 km per day, practically the distance of 37 km covered by an average walker, as has always been considered. But in doing so, he interprets the fraction dawn/day of 1/10 according to Rabbi Judah, in a different way than the same fraction for Rabbi Johanan: 3.75/(3.75+30+3.75). Kaftor Vaferah seems to have understood Maimonides in the same way. The traveler on the eve of Passover covers the 15 miles between Modiim and Jerusalem in six hours at a slow speed, but he says that an average walker covers 40 miles in a day and walks the distance between Jerusalem and the rock of Azazel, in three hours. Necessarily, he considers a distance of 10 miles according to Rabbi Judah in B. Yoma 67a, and a span of time of 18 m for a mile. R' Joseph Schwartz has followed this interpretation of Kaftor Vaferah because the 40 miles per day corresponds very well with 37 km per day, which he considered the accepted daily walk of an average walker (five German leagues per day). Therefore, he considers that the distance between Modiim and Jerusalem of 15 miles, or about 14 km, is covered by an average walker in 4.5 hours. The Hatam Sofer ruled in Orah Haym 89 for a mile of 22.5 m. Nevertheless, at the end of his statement he finally accepts the value of 18 m for one mile on the basis of the statement of Kaftor Vaferah which he considered experimental testimony. He actually committed two mistakes: first, Kaftor Vaferah does not affirm to have found this place, but at the rate of one mile in 18m, he says that it must take three hours to cover this distance of 10 miles at an average speed; second, the Hilkhatic mile is not deduced from an average and practical walk, but from the walk of the eve of Passover. Therefore the Hilkhatic mile must be fixed according to his first speculations and correspond to 22.5 m as stated in the beginning of his explanation.

[92] A Jewish month has either 29 days (defective month) or 30 days (full month)

[93] The moment when the sun and the moon have the same longitude and the sun occults the moon is the new moon.

[94] See B. Rosh Hashanah 19b and Y. Sanhedrin I: 2. See also Ajdler (1966) p 673 remark 2.

[95] The true lunar months are shorter in the summer than in the winter. In the summer, especially in June and July, the sun is near its apogee, so its velocity is minimal and the moon faster recaptures the sun. Therefore, there are more defective months in summer, see Ajdler (1966), p701. In this case they had foreseen too many defective months and therefore the old moon was seen too late in Elul.

[96] See Ajdler (1966) pp 206-208.

[97] Even in our calculated calendar it is not completely impossible to see the old moon on the morning of the 29th of Elul. See Ajdler (1966) p 668, remark 4.

[98] See remark 90.

[99] The rate of variation of the elongation is about .5° per hour.

[100] See B. Erahim 9a: it was accepted that the new moon became visible one day after the Neomenia, but not more. See Ajdler (1996) pp 221-224.

[101] "as we proved it from the 40 miles walk of an average man during an average day representing 12 hours."

[102] He refers explicitly to this ruling of Terumat ha-Deshen in Beit Yosseef Orah Hayim 459.

[103] In his responsum I: 1, he writes that Pelag ha Minha is 1.25 h before the apparition of the stars. In his responsum I: 123, in the remark, it writes that the day's journey is 10 parsah in a day of 12 hours. His pupil R' Joseph from Muenster in Leket Yosher specifies that these 10 parsah are covered in a middle day, from daybreak until night, which represents 12 hours.

[104] In other words the Gra considers also a mile of 22.5m and a walk of 32 miles in 12 equinoctial hours but he does not accept the principle of long temporary hours, although this principle was accepted by Tossafot (ד"ה אחד אומר, in B; Pesahim 11b and in B; Sanhedrin 41b). According to Gra, the temporary hours must coincide with the equinoctial hours at the equinox.

[105] "as we can deduce it from Tossafot B. Pesahim 11b, ד"ה אחד אומר, and from B; Pesahim 94a where we have seen that an average man walks 40 miles in a day corresponding to 12 hours." Indisputably R' Jacob Weil considers long temporary hours and the 18m mentioned by R' Jacob Weil are in fact 22.5 equinoctial minutes. We see also that although the rulings of R' Isserlein and Weil are very similar in their expression and conclude both to a mile of 18 m, it appears that they differ: the mile of R' Isserlein is 18 equinoctial minutes while the mile of R' Jacob Weil is 22.5 m.

[106] The editor could not give a reference. There are actually many other Tossafot which cannot be understood without the use of the concept of temporary hours.

[107] R' Isserlein is thus very lenient and accepts to eat bread until the beginning of two equinoctial hours before noon. Today this leniency is not accepted. Today there are two ways of calculating the schedule of the eve of Passover:
  1. According to the principle of short temporary hours (Maimonides, Gra, Levush).
  2. According to the principle of the long temporary hours (Tossafot, German and Spanish Rishonim). It is nevertheless incorrect to ascribe this system to R' Isserlein and even to Magen Avraham, as people are accustomed to do. Indeed, the latter does not take position on this issue except in O.H 58 where he uses the long temporary hours for the calculation of the limit of the reading of Shema.

[108] See Kosover (1989) p 19 and Benish (1996) t I, p 113.