Early and Late New Moon Sightings in Maimonides' Teaching

Two quotations in Maimonides' Hilkhot Kiddush ha-Hodesh, namely section 2 of chapter V and sections 7 and 8 of chapter VII have always puzzled commentators and scholars who could not give a satisfactory explanation to these sections. Both quotations are related to the issue of the new moon sighting at the beginning of the Jewish months.
In the first quotation Maimonides dealt with the span of time around the first day of the month during which the first sighting of the new lunar crescent is theoretically possible. He wrote that the first new moon sighting can occur on the first day of the month, on the day before or on the day later. In fact it seems that the span of time during which the first moon sighting can occur is wider and extends to more than these three days. On the one hand it also seems that the classical understanding of the preposition ב in the expression או אחריו ביום is in contradiction with similar expressions used by Maimonides. On the other hand, by contrast with the former exegetes' understanding, it seems that Maimonides considered all the months of the year and not exclusively the months of Tishri. This new approach allows giving a satisfactory understanding to this section.
In the second quotation Maimonides dealt with the rules of postponement of the first day of Rosh ha-Shanah, the true conjunction and the moment of the first visibility of the new lunar crescent of Tishri. We analyze in depth the consequences of the rules of the postponement on the first visibility of the moon and we show that indeed the rules of postponement reduce the average span of time between the first day of Tishri and the first moon sighting. This should be the astronomical reason of the existence of the rules of postponement besides the religious reasons mentioned in B. Rosh ha-Shanah. We must accept however that we cannot fully understand Maimonides' text without three emendations. This is perhaps too much to be likely. Perhaps there is really no acceptable solution for the difficulties of the second quotation.
In an appendix we examine two parallel quotations of ibn Ezra in his commentary on Leviticus XXIII and in his Sefer ha-Ibbur. Slight mistakes are pointed out.
According to Maimonides' interpretation the creators of the Jewish calendar were concerned about the good agreement between the fixed and automatic calendar and the celestial phenomenon of the first moon sighting. It must remain in close correspondence with the fixed calendar and the Neomenia of the different months. A lack of correspondence would question the legitimacy of the Jewish calendar.

Early and Late New moon Sightings in Maimonides' Teaching

I. True and mean conjunction.

The mean conjunction is based on the mean movements of sun and moon.
But in consequence of the eccentricity of the orbits the sun may be 1.92° on either side of its mean place and the moon 6.3°. Moreover there are periodic perturbations in the moon's longitude. However at a new or full moon the elongation D is equal to 0° or 180° and the perturbations reduce the moon's maximum deviation from 6.3° to 5.41°.
The relative positions of the two bodies may therefore vary 1.92° + 5.41° = 7.33° from their mean value near the conjunction or opposition.
As the hourly variation of the elongation has an average value of 0.51°, the maximum time interval between the mean new or full moon and the true new or full moon will be 7.33° / 0.51° ~ 14.3 hours.
The exact relations giving the longitude of the sun and moon are:[1]

$\Lambda_{0true} = \Lambda_{0mean} + 1.919460 \sin M + 0.020094 \sin 2M + \ldots\ldots\ldots\ldots$

$\Lambda_{(true} = \Lambda_{(mean} + 6.288750 \sin M'$	equation of the center
$+ 1.274018 \sin (2D - M')$	evection
$+ 0.658309 \sin 2D$	variation
$+ 0.213616 \sin 2M'$	equation of the center
$- 0.185596 \sin M$	annual equation
$- 0.114336 \sin 2F$	reduction to the ecliptic
$+ \ldots\ldots\ldots\ldots$	

Where $M = \Lambda_{0mean} - \Lambda_{0perigee}$ = sun's anomaly
$M' = \Lambda_{(mean} - \Lambda_{(perigee}$ = moon's anomaly
$D = \Lambda_{(mean} - \Lambda_{0mean}$ = mean elongation
$F = \Lambda_{(mean} - \Lambda_{(ascending\ node}$ = moon's argument of latitude.

By deriving the functions Λ_{0true} and $\Lambda_{(true}$ with regard to the time we get the solar and lunar velocity in longitude i.e. the hourly variation of the sun's and the moon's longitude. Subtracting the first from the second, we get the hourly variation of the elongation.[2]

In fact we are able to give a more precise estimation of this variation in function of the moment in the year. Indeed, at the time of Maimonides, the solar apogee corresponded to a longitude of about 86.75°, around the summer solstice, and the solar perigee was then at

[1] Meeus, J., Astronomical Formulae for Calculators, Willman-Bell, Richmond, USA, 1982, pp. 79-81 and 147-149.
Meeus, J., Astronomical Algotithms, Willman-Bell, Richmond, USA, 1991, pp. 151-153 and 307-309.
Danjon, A, Astronomie Générale, Paris 1986, p. 296.
[2] For the detail of these calculations, see Ajdler, J.J., Hilkhot Kiddush ha-Hodesh al-pi ha-Rambam, Jerusalem 1996, (H.K.H 1996) pp.200-201.

a longitude of 266.75°, around the winter solstice. The movement of these two points is very slow. According to Maimonides' data the increase of longitude of the apogee and perigee since the epoch of Maimonides is 830 years * 365.2422 * 0.15" = 45472" = 12.63°. Therefore the conclusions resulting from Maimonides' values remain approximately correct today although they will certainly evolve in the far future. We can thus consider that in the beginning of Nissan M ~ 90°, of Tamuz M ~180°, of Tishri M ~ 270° and of Tevet M ~ 0°. Therefore if call the longitude of the mean conjunction Λ_{conj} then:

- In Tishri $\Lambda_{0true} = \Lambda_{conj} - 1.92°$
  $\Lambda_{(true\ max} = \Lambda_{conj} + 5.41°$
  $\Lambda_{(true\ min} = \Lambda_{conj} - 4.95°$
  The relative positions of the true sun and moon at the moment of the mean conjunction varies thus between 3.03° and – 7.33°
  The hourly variation of the elongation varies between 0.4534 °/h and 0.5939°/h with an average value of 0.4534°/h.
  The true conjunction can precede the mean conjunction by maximum: 7.33/0.4534 = 16.17h
  The true conjunction can follow the mean conjunction by maximum: 3.03/0.4534 = 6.68h.

- in Nissan $\Lambda_{0true} = \Lambda_{conj} + 1.92°$
  $\Lambda_{(true\ max} = \Lambda_{conj} + 4.95°$
  $\Lambda_{(true\ min} = \Lambda_{conj} - 5.41°$
  The relative positions of the true sun and moon at the moment of the mean conjunction varies thus between 7.33° and – 3.03°
  The hourly variation of the elongation varies between 0.4534 °/h and 0.5939°/h with an average value of 0.4534°/h.
  The true conjunction can precede the mean conjunction by maximum: 3.03/0.4534 = 6.68h
  The true conjunction can follow the mean conjunction by maximum: 7.33/0.4534 = 16.17h

- In Tamuz and Tevet
  $\Lambda_{0true} = \Lambda_{conj}$
  $\Lambda_{(true\ max} = \Lambda_{conj} + 5.18°$
  $\Lambda_{(true\ min} = \Lambda_{conj} - 5.18°$
  The relative positions of the true sun and moon at the moment of the mean conjunction varies thus between 5.18° and – 5.18°
  The hourly variation of the elongation varies between 0.45 °/h and 0.59°/h with an average value of 0.51°
  The true conjunction can precede or follow the mean conjunction by maximum 5.18/0.45 = 11.51h.

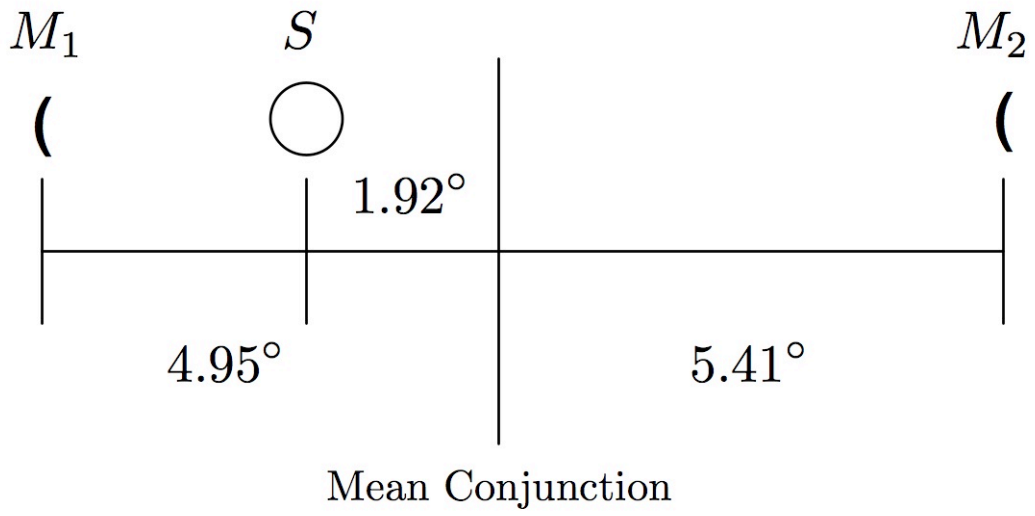

Figure 1: Positions in longitude of the sun and moon at the mean conjunction of Tishri.

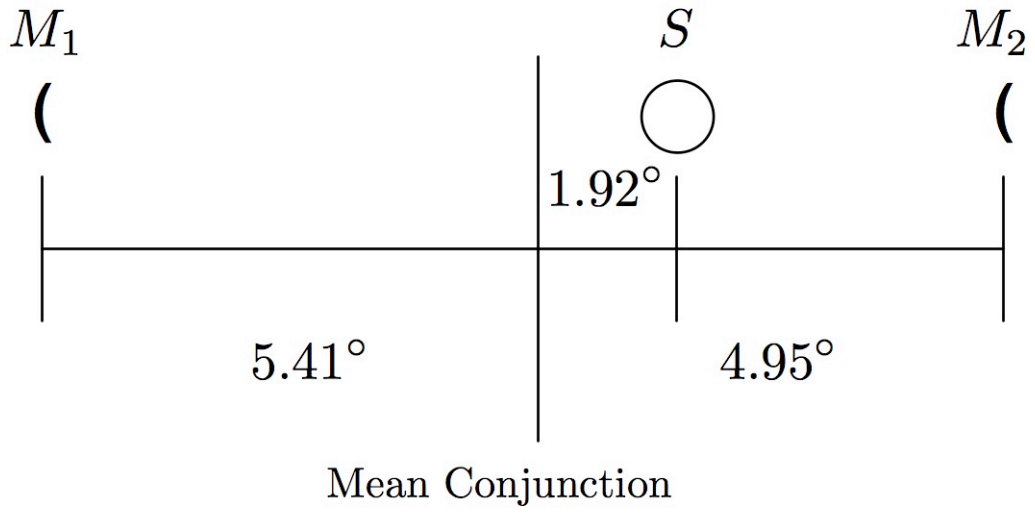

Figure 2: Positions in longitude of the sun and moon at the mean conjunction of Nissan.

II. Early and late first sighting of the new moon.[3]

This chapter is based on Maimonides' criterion of visibility defined in Hikhot Kiddush ha-Hodesh 17; 15-21, on the associated tables[4] that we calculated and on the computer calculations[5] that we established.

[3] This problem was examined in detail in (H.K.H 1996) pp. 200-220 on the basis of Maimonides' criterion of visibility. **By contrast with all the other aspects of astronomy, the study of the visibility of the new moon did not interest western astronomers and no decisive progress was made. Maimonides' criterion remains a good approach of the problem. But even if this was not the case it would be anachronistic to try explaining Maimonides' text by a modern criterion unknown to him.**

[4] See (H.K.H 1996) pp. 112-113. These tables rest on Maimonides' simplified theory of the movements of sun and moon, developed in the chapters 12 – 17 of H.K.H.

1. In Tishri.

The first moon sighting in Jerusalem can occur, in theory, when the elongation is included between the extreme values $\lambda_{1min} = 10.9°$ and $\lambda_{1max} = 21.83°$[6]

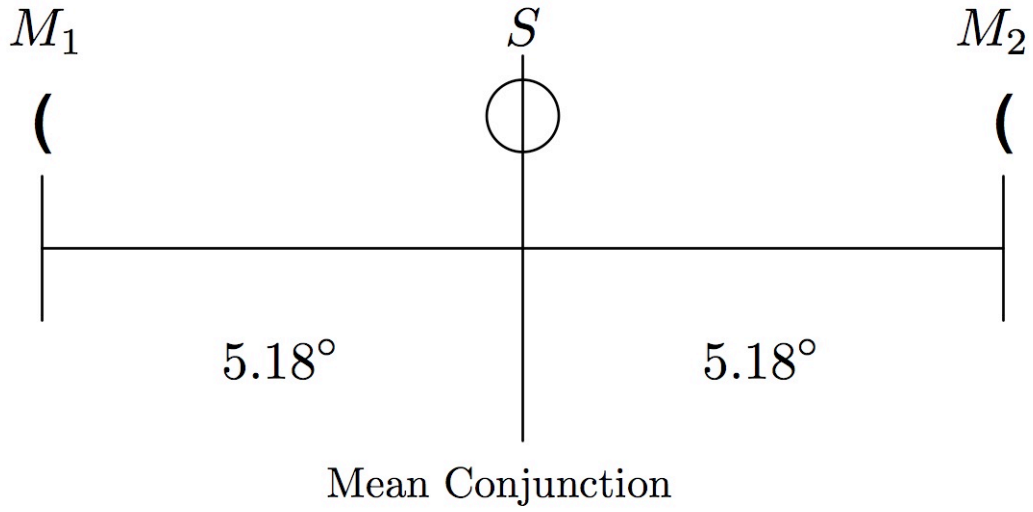

Figure 3: Positions in longitude of the sun and moon at the mean conjunction of Tevet and Tamuz.

where $\lambda_1 = \Lambda_{(true} - \Lambda_{0true.}$
These limits correspond to spans of time between the true conjunction and the first visibility of $T_{min} = 10.9 / 0.5939 = 18.35h$ and $T_{max} = 21.83 / 0.4534 = 48.15h$

2. In Nissan.

The first moon sighting can occur, in theory, when the elongation is included between $\lambda_{1min} = 10.2°$ and $\lambda_{1max} = 11.12°$.[7]
These limits correspond to spans of time between the true conjunction and the first visibility of $T_{min} = 10.2° / 0.5939 = 17.17h$ and $T_{max} = 11.12° / 0.4534 = 24.53h$

3. In Tevet.

The first moon sighting can occur, in theory, when the elongation is included between the extreme values $\lambda_{1min} = 9.43°$ and $\lambda_{1max} = 13.4°$[8]

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[5] See (H.K.H 1996) pp. 490-497. These calculations rest on the exact theory i.e. what Maimonides considered as the exact theory of the movements of sun and moon according to the model of Ptolemy improved by al-Battani.
[6] See (H.K.H 1996) p. 493. Compare these values with the values 10.75° and 21.42° deduced from the parameters of the simplified theory of Maimonides, p. 113. We can appreciate the quality of Maimonides' simplified theory.
[7] See (H.K.H 1996) p. 490. Compare these values with the values 10.17° and 10.91° deduced from the parameters of the simplified theory of Maimonides p. 112.
[8] See (H.K.H 1996) p. 495.

These limits correspond to spans of time between the true conjunction and the first visibility of $T_{min} = 9.43° / 0.5954 = 15.84h$ and $T_{max} = 13.4) / 0.4549 = 29.46h$

III. The span of time between the mean conjunction and the first moon sighting.

The spans of time between the mean conjunction and the theoretical first moon sighting are included between the following limits:

1. In Tishri: $T_{min} = (10.9 – 7.33) / 0.5939 = 6.01h$
   $T_{max} = (21.83 + 3.03) / 0.4534 = 54.83h$

2. In Nissan: $T_{min} = (10.2 – 3.03) / 0.5939 = 12.07h$
   $T_{max} = (11.12 + 7.33) / 0.4534 = 40.69h$

3. In Tevet $T_{min} = (9.43 – 5.18) / 0.5954 = 7.14h$
   $T_{max} = (13.4 + 5.18) / 0.4549 = 40.84h$

Thus if T is the span of time between the mean conjunction and the moment of observation of the new moon:

- If $T < T_{min}$: the visibility is impossible.
- If $T > T_{max}$: the visibility is theoretically certain.
- If $T_{min} < T < T_{max}$ the visibility is theoretically possible and must be checked.

Anyhow, whether certain or possible, it is always possible that the moment T follows moonset. In this case even if the theoretical visibility is possible, the practical visibility will become possible only on the next evening.

IV. The span of time between the mean conjunction and the Molad.

In the twelfth century the Molad occurred about 57m after the mean conjunction according to the data of Maimonides and Al-Battani. According to modern data this difference was only about 49 minutes or 0.82 hour.[9] Today this difference is about 2 hours and it will increase with time.

V. The span of time between the Molad and the first moon sighting.

The spans of time between the mean conjunction and the theoretical first moon sighting are included between the following limits:[10]

1. In Tishri: $T_{min} = 6.01h – 0.82h = 5.19h$
   $T_{max} = 54.83h – 0.82h = 54.01h$

2. In Nissan: $T_{min} = 12.07h – 0.82m = 11.25h$
   $T_{max} = 40.69h – 0.82h = 39.87h$

[9] See Hilkhot Kiddush ha-Hodesh al-pi ha-Rambam , Ajdler, J.J. pp. 176-178.
[10] The distance between the Molad and the astronomical mean conjunction is variable. The following formulas were exact in the 12th and 13th centuries. They should be slightly adapted for our time.

3. In Tevet $T_{min} = 7.14h - 0.82h = 6.32h$
$T_{max} = 40.84h - 0.82h = 40.02h$

Thus if T is span of time between the mean conjunction and the moment of observation of the new moon:

- If $T < T_{min}$: the visibility is impossible.
- If $T > T_{max}$: the visibility is theoretically certain.
- If $T_{min} < T < T_{max}$ the visibility is theoretically possible and must be checked.

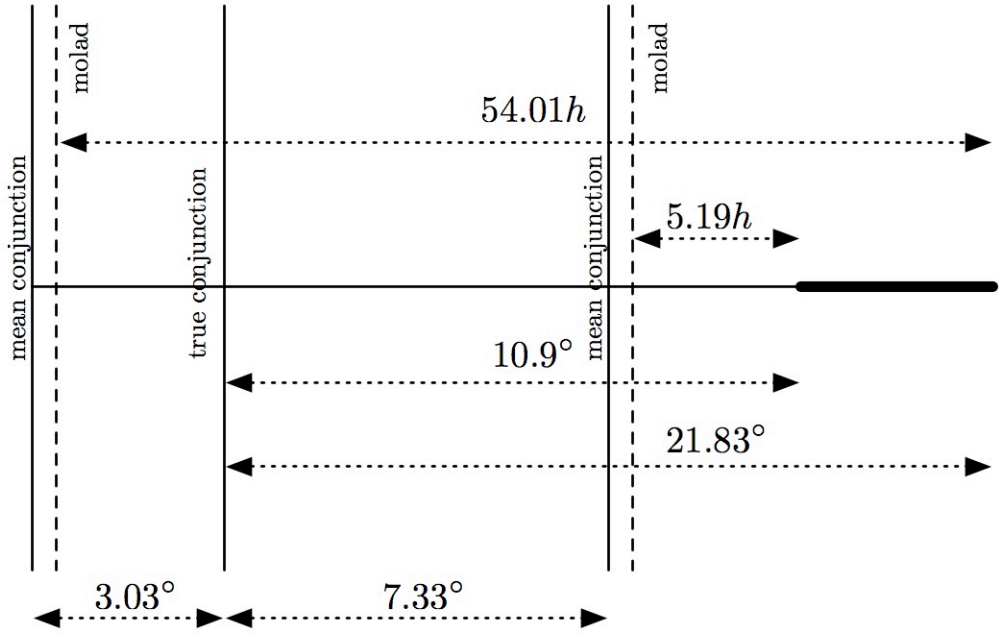

Figure 4: The limits of the first theoretical visibility of the moon in Tishri. All the horizontal distances represent angular elongations between sun and moon. The first vision occurs between (10.9° - 7.33°) / 0.5939 = 6.01 h after the mean conjunction or 5.19 h after the molad and (21.83° + 3.03°) / 0.4534 = 54.83 h after the mean conjunction or 54.01 h after the molad. Of course if the theoretical visibility becomes possible just after the moonset, then the delay for the first vision is increased by 24 h.

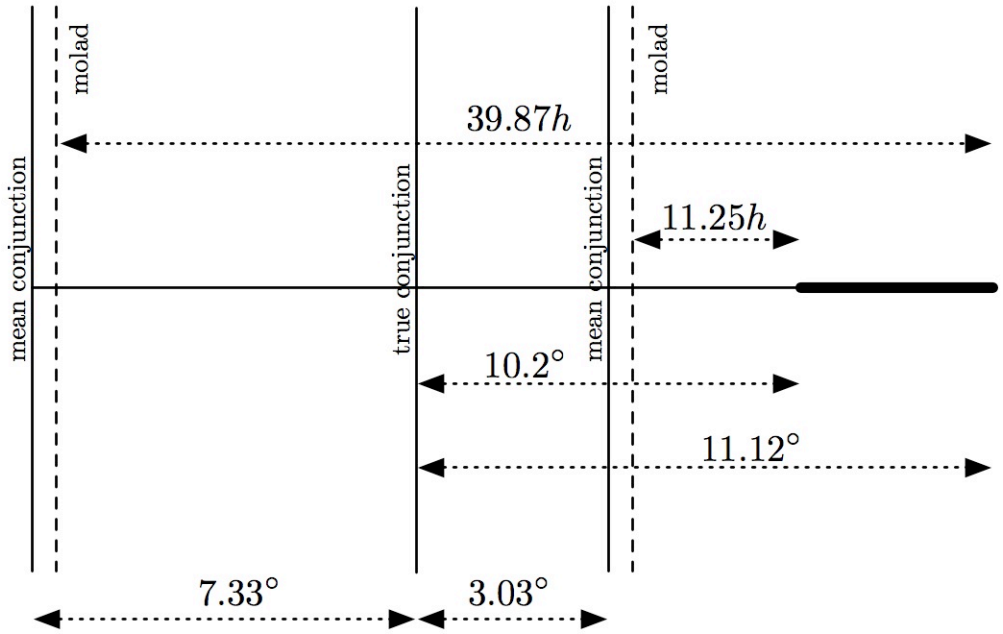

Figure 5: The limits of the first theoretical visibility of the moon in Nissan. All the horizontal distances represent angular elongations between sun and moon. The first vision occurs between (10.2° - 3.03°) / 0.5939 = 12.07 h after the mean conjunction or 11.25 h after the molad and (11.12° + 7.33°) / 0.4534 = 40.69 h after the mean conjunction or 39.87 h after the molad. Of course if the theoretical visibility becomes possible just after the moonset, then the delay for the first vision is increased by 24 h.

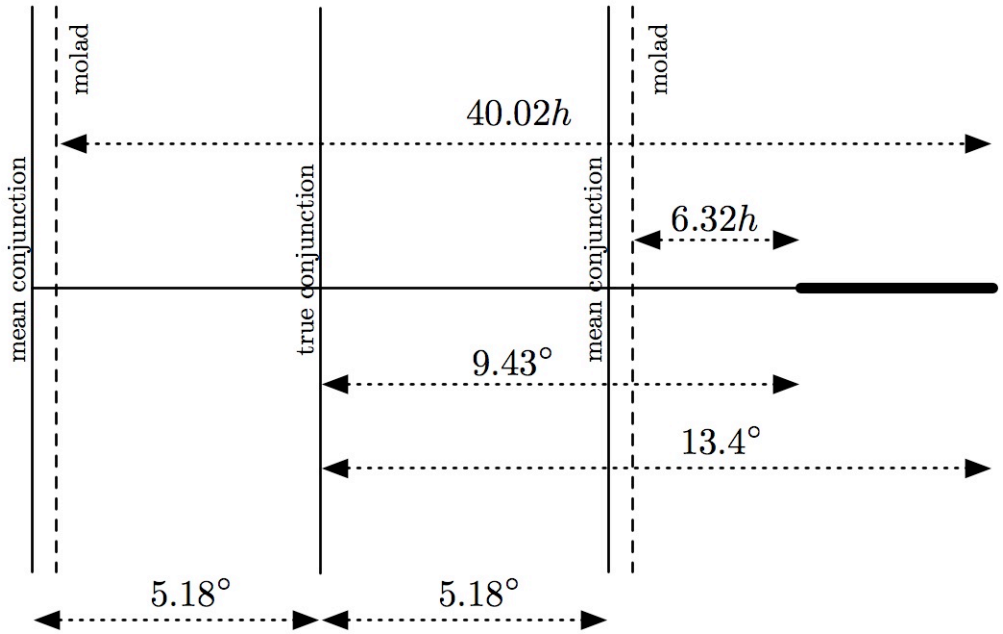

Figure 6: The limits of the first theoretical visibility of the moon in Tevet. All the horizontal distances represent angular elongations between sun and moon. The first vision occurs between (9.43° - 5.18°) / 0.5954 = 7.14 h after the mean conjunction or 6.32 h after the molad and (13.4° + 5.18°) / 0.4549 = 40.84 h after the mean conjunction or 40.02 h after the molad. Of course if the theoretical visibility becomes possible just after the moonset, then the delay for the first vision is increased by 24 h.

Anyhow, whether certain or possible, it is always possible that the moment T follows moonset. In this case even if the theoretical visibility is possible, the practical visibility will become possible only on the next evening.

VI. In the fixed Jewish calendar the first moon sighting can precede the first day of Tishri and of the other months.

Tishri.

1. At the beginning of any year, if the molad is included between 3 – 18 and 3 – 18 – 885, 5 – 18 and 5 – 18 – 885 or 0 – 18 and 0 – 18 – 885 the first day of Tishri will be Thursday, Saturday or Monday. The earliest first visibility of the new moon could theoretically be the day before. For example on the third assumption, the first day of Tishri is Monday but the visibility could be possible on Saturday evening (beginning of Sunday).

   Max [(0).75 + 5.19/24] = (1)
   Max [(0).784143 + 5.19/24] = (1). Corresponding to a Molad 0 – 18 – 885
   But Max [(0).784182 + 5.19/24] = (2). Corresponding to a Molad 0 – 18 – 886

In these formulas Max [x] is the smallest integer greater than x. Thus Max [x] = Int [x] + 1

In this type of reasoning we work with a standard day of 24h beginning and ending at 6 pm without taking into account the seasonal effects. In Tishri and Nissan the seasonal effects are limited but this would not be the case in Tamuz or Tevet. At the beginning of the month the moon sets slightly after the sun. If the moment of the first vision (20 minutes after sunset) is later than moonset, then the new crescent will not be seen any more on this evening, even if the criterion of visibility is already satisfied. The first moon sighting will be delayed to the next evening.
The former cases of visibility of the new moon one day before Tishri 1 are limit cases theoretically possible but practically extremely rare.

2. At the beginning of an ordinary year, if the molad is included between 3 – 9 – 204 and 3 – 18 – 885 the first day of Tishri will be Thursday but the earliest possible first visibility could be already possible on Tuesday evening (the beginning of Wednesday).

   Max [(3).38287 + 5.19 / 24] = (4). Corresponding to a Molad 3 – 9 – 204
   Max [(3).784143 + 5.19/24] = (4). Corresponding to a Molad 3 – 18 – 885

But Max [(3).784182 + 5.19/24] = (5). Corresponding to a Molad 3 – 18 – 886

Again, if the molad is near to the end of the area of molad considered i.e. near to 3 – 18 – 885, the condition of visibility could be satisfied only after moonset and the earliest first visibility would then be delayed until (5), on Wednesday evening.

Nissan.

If the molad of the ordinary year n is on *Gatrad* or later, then 1 Tishri of that year is on Thursday. Now 1 Nissan of the preceding year n – 1 is 1 Tishri – 177 days and therefore 1 Nissan is on Tuesday.

If molad Tishri is 3 – 9 – 204
6 months – 2 – 4 – 438

Molad Nissan 1 – 4 – 846

If molad Nissan is included between 1 – 4 – 846 and 1 – 12 – 809, the earliest possible first moon sighting will be on Sunday evening (the beginning of Monday) because:

Max [(1).19926 + 11.25 / 24] = (2). Corresponding to a Molad 1 – 4 – 846
Max [(1).53121 + 11.25 / 24] = (2). Corresponding to a Molad 1 – 12 – 809
But Max [(1).53125 + 11.25 / 24] = (3). Corresponding to a Molad 1 – 12 – 810

Again, if the molad is near to the end of the area of molad considered i.e. near to 1 – 12 – 809, the condition of visibility could be satisfied only after moonset and the earliest possible first visibility would then be delayed until (3), on Monday evening.

Tevet.

If the molad of the ordinary year n is on *Gatrad* or later, then 1 Tishri of that year is on Thursday. Now if the preceding year n – 1 is also an ordinary year, then 1 Tevet of this preceding year is 1 Tishri –265days and therefore 1 Tevet is on Friday.

If molad Tishri is 3 – 9 – 204
9 months – 6 – 18 – 657

Molad Tevet 3 – 14 – 627

If molad Tevet is included between 3 – 14 – 627 and 3 – 17 – 734, the earliest possible first moon sighting could be on Tuesday evening (the beginning of Wednesday) because:

Max [(3).607523 + 6.32 / 24] = (4). Corresponding to a Molad 3 – 14 – 627
Max [(3).73665 + 6.32 / 24] = (4). Corresponding to a Molad 3 – 17 – 734
But Max [(3).73669 + 6.32 / 24] = (5). Corresponding to a Molad 3 – 17 – 735

Again, if the molad is near to the end of the area of molad considered i.e. near to 3 – 17 – 734, the condition of visibility could be satisfied only after moonset and the first visibility would then be delayed until (5), on Wednesday evening.
We see thus that on all these restrictive conditions, there is theoretically a possibility that the new moon could already be seen two days before 1 Tevet, on Tuesday evening, beginning of Wednesday, two days before Friday 1 Tevet.

VII. In the fixed Jewish calendar the first moon sighting follows generally the first day of Tishri and of the other months.

1. In an ordinary year if the molad falls before *Gatrad* between 2 – 18 and 2 – 9 – 203 the first day of Tishri is Tuesday and the first visibility could be delayed until Thursday evening, the beginning of Friday Tishri 4.

   Max [(2).75 + 54.01 / 24] = (6) Corresponding to a Molad 2 – 18
   Max [(3).38283 + 54.01 / 24] = (6) Corresponding to a Molad 2 – 9 – 203

2. If the molad of Tishri is included between (4).75 and (5).74996 the first day of Tishri is Thursday but the first visibility could be delayed until Saturday evening (beginning of Sunday Tishri 4).

   Max [(4).75 + 54.01 / 24] = (8)
   Max [(5).74996 + 54.01 / 24] = (8).

The same happens if the molad is included between 6.75 and (0).74996 and between (1).75 and (2).74996: the first visibility could be delayed until the evening beginning Tishri 4.
Furthermore if the molad is near to the end of the area of molad considered i.e. near to 0 – 17 – 1079, the condition of visibility could be satisfied only after moonset and the earliest possible first visibility would then be delayed to the next evening, at the beginning of Tishri 5.

VIII. Early and late new moon sighting during the period 4000 – 6000.

The beginning of this span of time has a proleptic[11] character. Furthermore, the Jewish calendar **at the time of its introduction** was probably slightly different than our modern calendar.
With this reservation we checked the practical situation during 2000 years of the Jewish calendar thanks to the visibility program Kiddush 2009 Ver.7 constructed by R' Eytan Tsikouni[12]

1. Early moon sighting in Tishri.

[11] A theoretical calendar before its real historical use is said proleptic. According to a tradition mentioned in a responsum of R. Hai Gaon, reported by R' Abraham bar Hiyya (died after 1136 C.E.) in his book ספר העיבור Filipowski, London 1851, p. 97 the Jewish calendar was introduced in 4118 - 4119. See however Stern, S., Calendar and Community, Oxford, 2001. Dates anterior to this year would then belong to the proleptic Jewish calendar.
[12] Hazon40@netvision.net.il.

It appears that an early moon sighting on the evening at the beginning of 29 Elul is very rare. The condition of visibility, one day before the first day of Tishri is satisfied in only a few years among those were the postponement of *Gatrad* was used. This is probably related to the fact that Tishri follows a defective month of 29 days.
We found an early visibility one day before 1 Tishri in the years 4683[13], 5275,[14] 5373, 5796, 5894 and 5965 thus 6 times in 2000 years but only one time between 4000 and 5000.[15] In each case the early visibility was not limited to Tishri but it extended also to some months following Tishri and, or some months preceding Tishri.
However, we did not find a case of early visibility of the new moon before the beginning of Tishri connected to a molad on Tuesday, Thursday or Saturday at noon or after.

2. Early moon sighting in Nissan.

It appears that an early moon sighting on the evening at the beginning of 29 Adar is very rare. The condition of visibility, one day before the first day of Nissan is satisfied in only a few years among those were the postponement of *Gatrad* was used on the next Tishri. This is probably related to the fact that Nissan follows a defective month of 29 days.
We found an early visibility one day before 1 Nissan in the years 4208, 4357, 4455, 4553, 4800, 5047 and 5145, thus 7 times in 2000 years. In each case the early visibility was not

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[13]See note 15.

[14] This case was already discovered by R' Raphael ha-Levi from Hanover. See his book in manuscript, תכונת השמים (הארוך), in the Bodleian library: OX 2062 (cat. Neubauer), OX Mich 603 and OX Mich 847 (old n°). This book is now available on the web site: http://www.ajdler.com/jjajdler/hanover/. See p. 137.

[15] Therefore the scholars thought that this occurrence was really exceptional and unique. The case of the year 4683 is really interesting because it is the only historical case of an early visibility of the moon one day before the *keviyah*. It was at the summit of the dispute of the calendar between Ben Meir and Sa'adia Gaon. The Babylonian kept Thursday 26 September as the first day of Rosh ha-Shanah while the Palestinians fixed it on Tuesday 24 September 922. The new moon was seen, in Egypt, in Palestine and probably also in Babylonia, on Tuesday evening 24 September 922. The followers of ben Meir considered this apparition as a support to Ben Meir's decision. See *Korot Heshbon ha-Ibbur*, T.H. Jaffe, Tel Aviv 1931 p. 196. See also *Divrei Yemei ha-Ibbur ha-Aharonim*, Y.Bornstein, Hatekufah, vol 16, Elul 1922, pp. 246-249 where the text of a letter found in the Cairo Genizah is given. This letter was sent by R' Sa'adia Gaon to his disciples in Egypt and we learn from it that they were surprised and bewildered by this early moon sighting and followed the majority in keeping Rosh ha-Shanah on Tuesday-Wednesday. As R' Sa'adia Gaon did not raise any objection or doubt about this vision, it is likely that the moon was also seen in Babylonia. **Reference to the Cairo Geniza documents: Cambridge University LibraryT-S 6 Ja 1.**
I thank Professor Yaacov Choueka for providing me this information about this letter of R. Sa'adia Gaon.
For more information about the Geniza documents, see the Friedberg project website: http://www.genizah.org.
R' Tsvi Hirsh Jaffe (1853-1927) wrote (see reference above) that he checked the visibility of the moon in Tishri during the period 4600-4700 A.M. in all the years where Rosh ha-Shanah had been postponed by two days and did not find another early moon's vision one day before the *yom ha-keviyah*. R' Raphael ha-Levi from Hanover (1685-1779) examined the period 4000-5000 A.M. and he found only this year 4683, where the first vision of the moon occurred one day before Tishri 1. By contrast with Jaffe, Hanover was unaware of the historical background and he found this year after a systematic check of the whole period. This is the occasion to pay a special tribute to these exceptional scholars and more particularly to Hanover. It appears that he was really an exceptional skilled and tireless calculator (manual calculations). See his book *Klalei Sod ha-Ibbur* in manuscript in the Bodleian Library in Oxford: Ox 2290 (Cat. Neubauer); OX Mich 58 and OX Mich 345 (old n°) This book is now available on the web site: http://www.ajdler.com/jjajdler/hanover/.

limited to Nissan but it extended also to some months following Nissan and, or some months preceding Nissan.

3. Early moon sighting in other months.

We found early visibility of the new moon, one day before the first day of the month in a greater amount of ordinary years depending on a molad Tishri at *Gatrad* or later. This could also occur in the preceding year. Such occurrence remains a rare event as the probability to meet a year making use of the postponement *Gatrad* is only 3.31%.[16] However we could not find any practical case of visibility two days before the first day of Tevet of an ordinary year. But this could perhaps exceptionally be possible in an area west of Israel.
In the case of molad Tishri on Tuesday, Thursday or Saturday at noon or later, we did not meet early visibility before Tishri 1. However we met more frequent cases of early moon sightings before the beginning of one or other month.

4. Late moon sighting in Tishri.

We did not find a case of a theoretical late moon sighting delayed until the evening beginning Tishri 5.

IX. The effect of the postponements on the early and late moon sightings.

Let us compare the present situation of our calendar in Tishri with a fictitious calendar without any postponement. In this fictitious calendar the first day of Tishri would always be on the day of the molad. Thus a molad included between (5) – 0 – 0 until (5) – 23 – 1079 would correspond to 1 Tishri on Thursday. If the molad is at the end of this interval then the visibility can be delayed until Sunday evening, beginning of Monday 5 Tishri. Max [5.99996 + 54.01 / 24] = Max [8.25] = 9.
The postponements adopted in the Jewish calendar diminish the maximum delay counted from the end of the first day of Tishri, until the first moon sighting, from three days to two days.

X. Hilkhot Kiddush ha-Hodesh V: 2.

ודבר זה הלכה למשה מסיני הוא, שבזמן שיש סנהדרין, קובעין על פי הראיה, ובזמן שאין שם סנהדרין, קובעין על חשבון זה שאנו מחשבין בו היום ואין נזקקין לראיה אלא פעמים שיהיה יום שקובעין בו בחשבון זה הוא יום הראיה **או קודם לו ביום או אחריו ביום**. וזה שיהיה **לאחר הראיה ביום פלא הוא, ובארצות שהן למערב ארץ ישראל**.

It is an halakhah le-Moshe mi-Sinaï that in times when there is a Sanhedrin, the fixing of the month is based on visual observation while in times when no Sanhedrin exists, the fixing of the month is based on calculations such as we are using today and no attention is paid to observation of the new crescent. Rather the day of the Neomenia, established by calculation, might well coincide with the day of the first moon sighting. But it might

[16] Hilkhot Kiddush ha-Hodesh al-pi ha-Rambam, J.J. Ajdler, pp. 686-691.

sometimes be the day before it or the day after it. The latter case, however, when the calculated Neomenia happens to be the day after the sighting of the new moon, occurs only rarely and then only in the countries west of Palestine.

The second part of this section is related to the early and late moon sighting one day before or after the *yom ha-ke'viah.* This problem has puzzled all the commentators, beginning with R' Obadiah ben David (14th century). All the commentators, including R' T. H. Jaffe[17] and R' Raphael ha-Levi[18] from Hanover examined this section only with regard to the situation in Tishri. This exegesis presents many difficulties.

- It is true that Tishri plays a major role in the Jewish calendar but this section does not consider a specific month like Tishri but seems to have a more general implication and refers to all the months at the time of the calendar by observation.

- We saw above that the visibility can occur, one day before the beginning of the *yom ha-ke'viah*. Although this is a rare event, even exceptional, it does not justify the expression used by Maimonides which means in fact that this early sighting, one day before *yom ha-ke'viah*, is virtually impossible and if it were to occur, this could happen only in a region west of Israel.

- If we understand that this section restricts itself to the examination of the only month of Tishri then, as we noted above, the first vision can be delayed until Tishri 4, two days after the end of Tishri 1 or even, at least theoretically until Tishri 5, three days after the end of Tishri 1. Maimonides' text limiting the delay of the first moon sighting to one day after *yom ha-kevi'ah* is thus difficult. Furthermore, if this were the understanding of this text, it would contradict two other quotations of Hilkhot Kiddush ha-Hodesh.

1. In Chapter VII:8, Maimonides writes that it is possible that *yom ha-kevi'ah* is on Thursday and that the first visibility occurs only on Saturday (Friday evening), thus two days and not one day later.
2. In chapter XI:16, Rambam defined his epoch on Wednesday evening, beginning of Thursday Tishri 3. This epoch corresponded to the first visibility of the moon but it was not on Tishri 2.

- Finally we must observe that Maimonides used a special wording to which we must pay a special attention: או קודם לו ביום או אחריו ביום. Understanding that it represents the day before or after, would contradict the use made by Maimonides of this wording in other quotations. It seems that Maimonides used this preposition ב in the sense of an interval. This expression would then represent here an interval of time separating the *yom ha-kevi'ah* from the day of the moon sighting, the *yom ha-re'iyah*.[19] We should understand this text as it was written

[17] Korot Heshbon ha-Ibbur, pp. 196-197 and note.
[18] Klalei Sod ha-Ibbur in manuscript in the Bodleian Library; see above.
[19] This point was noted by the late professor Ernest Wiesenberg in Addenda et Corrigenda to treatise VIII (Yale Judaica Series Vol XI) Yale Judaica Series Vol XIV.

each time בהפרש יום , with one day *difference* with the meaning that the *yom ha-re'iyah* can precede the *yom ha-kevi'ah* with one day interval or follow it by the same interval.
The same understanding appears indisputably in the following quotations

1. Chapter 7; 2:

קודם חצי היום, אפילו **ב**חלק אחד.....

2. Chapter 8; 2:

יתר על זה **ב**שעות.....פחות מזה **ב**שעות

3. Chapter 9; 3:

קודם מולד ניסן **ב**שבעה ימים ותשע שעות .....

4. Chapter 10; 3:

קודם מולד ניסן **ב** ט' שעות ו תרמ"ב.....

5. Chapter 10; 7:

בכמו שני ימים קודם שתי התקופות.....

6. Chapter 11; 11:

אפילו **ב**חלק אחד.....

11. Chapter 11; 17:

בכמו ששה או שבעה ימים

12. Chapter 12 ; 2 :

או קודם שקיעת החמה **ב**שעה או אחר שקיעת החמה **ב**שעה

13. Chapter 14 ; 6 :

הוא אמצע הירח לאחר שקיעת החמה **ב**כמו שליש שעה

In all these quotations the preposition ב is used in the sense of an interval of time rather than a precise moment as in the sentences : בחצות הלילה or וביום השבת.[20]
The text of this section H.K.H 5; 2 would thus mean the following: או קודם לו בהפרש יום או אחריו בהפרש יום. Maimonides considered in general the first moon sighting of any month and stated that the first sighting can occur even two days before the beginning of *yom ha-kevi'ah*, corresponding thus to the sighting of the crescent L_1 at the beginning of the day before the day of interval in the beginning of the month of Tevet. The sighting could also be delayed until two days after the end of *yom ha-kevi'ah* corresponding to the sighting of the crescent L_5 at the beginning of the day after the day of interval. The day of interval would thus be the day between the end of *yom ha-re'iyah* and the beginning of *yom ha-kevi'ah* or the day between the end of yom *ha-kevi'ah* and the beginning of *yom ha-re'iyah.* If we refer to fig. 7 we see that this exegesis would fit perfectly for the moon sightings before the *yom ha-kevi'ah*. Maimonides would ascertain that the sighting of crescent L_1, which happens on a *yom ha-re'iyah* separated from the *yom ha-kevi'ah* by one day interval, is virtually impossible and were it to happen, this would occur only in an area west to Israel. This statement would refer to the moon sighting at the beginning of Tevet which is indeed virtually impossible.
By contrast this exegesis would still be difficult for the moon sightings occurring after *yom ha-kevi'ah*. We have seen on fig. 7 that the moon sighting can be delayed until the evening beginning Tishri 4 (crescent L_6), corresponding to two days interval and

[20] As already mentioned, the use of the preposition ב in this sense is not in current use. It is not mentioned in the dictionaries like Gur and Ibn Shoshan. It is Maimonides' own particular way of writing.

theoretically even until the evening beginning Tishri 5 with three days interval (crescent L_7).
This problem seems unsolvable with the current reading. However, MS Sassoon 1132 reads: או קודם לו או אחריו ביום omitting the first ביום present in the other manuscripts and the printed texts.[21] Thus Maimonides would give no limitation to the delay of the first visibility after *yon ha-kevi'ah*, the limitation to one day interval would only relate to early visibility before *yom ha-kevi'ah*.
This reading[22] is in agreement with the physical reality but it is provided by only one MS. This seems the only acceptable exegesis of this *halakha* and it must be ascribed to the credit of the late professor R' Ephraïm Judah Wiesenberg.

In conclusion this section V: 2 presents two important difficulties.

1. או קודם לו ביום is difficult in any case, whether we limit the scope of this section to the months of Tishri or to all the months of the year. A satisfactory solution was never proposed. The reading of MS Sassoon 1032 discovered by the late Prof. Wiesenberg and still unknown by the scientific community, gives a satisfactory solution to the problem.[23]
2. וזה שיהיה לאחר הראייה ביום פלא הוא, ובארצות שהן למערב ארץ ישראל. .
   The classical understanding was enunciated at best by R' Raphael ha-Levi of Hanover:[24] the moon sighting one day before the *yom ha-kevi'ah* is possible but exceptional. In the areas west to Israel it could be less exceptional. However this exegesis is far-fetched with regard to Maimonides' phraseology and it does not fit with the significance that Maimonides gives to temporal words introduced by the preposition ב. Hence the solution to understand this last sentence is to extend the scope of this section to all the months of the year. The exegesis of the passage is

[21] This reading was mentioned by the late professor Ernest Wiesenberg in Addenda et Corrigenda to treatise VIII (Yale Judaica Series Vol XI) Yale Judaica Series Vol XIV, **p. 586 lines 22-24.**
[22] This variant reading is not mentioned in the new edition of the Yad by Shabtaï Fraenkel.
[23] **I have got the following objection: the preposition ב can indeed refer to time intervals, but if the interval is one day, this still means that the event occurs one day later, not two days later. The author claims that "the day of interval would thus be the day between the end of *yom ha-re'iyah* and the beginning of *yom ha-kevi'ah*". However the "end of *yom ha-re'iyah* " is incorrect and unjustified in the context of Maimonides' arguments. In short the interval of ביום runs from the moment of visibility to the beginning of the first day of the month, thus only 24 hours interval. I don't think that this argumentation resists a careful analysis of the text: אלא פעמים שיהיה יום שקובעין בו בחשבון זה הוא יום הראייה או קודם לו [ביום] או אחריו ביום.**
The text is very precise and thanks to a strict application of the rules of the syntax, it does not suffer any doubt; the interval of one day is to count after the day of the vision and not, as it was argued, after the instant of the vision. If Maimonides was referring to the moment of vision he would have written:
.אלא פעמים שיהיה יום שקובעין בו בחשבון זה הוא יום הראייה או קודם לה [ביום] או אחריה ביום.
One can then ask why Maimonides, in the following sentence, seems to refer to the moment of the first vision. In fact Maimonides refers to the last of the three cases of the former sentence and in the repetition of the sentence he cuts it short but the complete text should indeed be:
.וזה שיהיה לאחר [יום] הראייה ביום פלא הוא ובארצות שהן למערב ארץ ישראל
In a word, the present objection gives us the opportunity to show that the proposed explanation is genuine and fits the text.
[24] In his manuscript כללי סוד העיבור **in the Bodleian Library in Oxford: Ox 2290 (Cat. Neubauer); OX Mich 58 and OX Mich 345 (old n°).This book is now available on the web site:** http://www.ajdler.com/jjajdler/hanover/.

then that *an early moon sighting can occur before yom ha-kevi'ah, theoretically even two days before at the beginning of the month of Tevet of an ordinary year. But this is practically impossible and if this were to happen it would certainly be in an area west to Israel*.

XI. Hilkhot Kiddush ha-Hodesh VII: 7and 8.

ומפני מה אין קובעין בחשבון זה בימי אד"ו , לפי שהחשבון הזה הוא לקבוץ הירח והשמש בהלוכם האמצעי, לא במקום האמיתי, כמו שהודענו. לפיכך עשו יום קביעה ויום דחיה, **כדי לפגוע ביום קבוץ אמתי**. כיצד, בשלישי קובעין, ברביעי דוחין, בחמישי קובעין, בששי דוחין, בשבת קובעין, באחד בשבת דוחין, בשני קובעין.

And why does this method of calendaric calculation eliminate 1, 4 and 6 from being the day of the Neomenia? Because this method reckons with conjunction of the moon and the sun based upon their mean motion and not upon their true motion. Therefore the Neomenia may fall on 2, 3, 5 and 7 while 1, 4 and 6 are days of postponement.

ועיקר שאר ארבע הדחיות האלו הוא זה העיקר שאמרנו, שהחשבון הוא במהלך אמצעי, וראיה לדבר, שהמולד יהיה **בליל** שלישי וידחה לחמישי, פעמים רבות לא יראה הירח בליל חמישי ולא בליל ששי, מכלל שלא נתקבצו השמש והירח קבוץ אמתי אלא **בחמישי**.

At the root of all those four postponements lies the reason just stated, namely that our computations are based upon the mean motion. And the following is proof of this statement: when the Molad occurs during the night of Tuesday – yet the Neomenia is postponed until Thursday – it frequently happens that the new crescent will not be visible either on the night of Thursday or even on the night of Friday. Hence we must realize that the sun and the moon did not enter in conjunction except on Thursday.

The sections VII, 7 and 8 are probably the most difficult sections of the whole treatise of Hilkhot Kiddush ha-Hodesh. Besides the problem of their general meaning which is not obvious, the text presents some textual difficulties which appear unexplainable without emendation of the text. Now even after such an emendation the internal signification of these two sections remains difficult because Maimonides proceeds more by allusion than by an elaborated explanation.

The main objections were already raised by R' Isaac Israeli of Toledo in the fourteenth century in *Yessod Olam*.[25] The problem was also discussed by R' Jonathan in *Sefer Yeshuah be-Israel*.[26] The latter argued that R' Obadiah ben David, in his classical commentary adapted freely the text of Maimonides: וראיה לדבר שהמולד היה ביום שלישי instead of בליל שלישי in order to escape the difficulties resulting from this reading. This thesis does not seem likely; in such a case the author would certainly have made a remark. It seems rather that this reading was at his disposal. Anyhow we have no manuscript sustaining this reading.

[25] Ma'amar IV, chapter 9, p. 17c.
[26] Frankfurt-am Main 1720, p. 22a and 49b.

When we read the first sentence of section VII, 7 we could understand that the postponements were introduced in order to bind the calendar to the true movement of the sun and moon instead of their mean movement. But it cannot, in any way, mean that the aim of the Jewish calendar and its postponements is to bind the Neomenia of Tishri, the *yom ha-ke'viah* of Tishri to the day of the true conjunction.
If we refer to fig. 4 and we consider an average variation of the elongation moon-sun of 0.51 °/h, we see that in Tishri the true conjunction can precede the mean conjunction by about 7.33 / 0.51 = 14.37 hours and it can follow the mean conjunction by about 3.03 / 0.51 = 5.94 hours. On an average the true conjunction of Tishri precedes the mean conjunction by 4.22 hours.[27] In Nissan the situation is opposite and on an average the true conjunction follows the mean conjunction by 4.22 hours. We can conclude that the true lunar months from Tishri until Nissan have a total length of about 8 hours more than the same number of mean lunations. Similarly the true lunar months from Nissan until Tishri have a total length of about 8 hours less than the same amount of mean lunations. This phenomenon is of course related to another observation that the shortest true months occur in June-July when the sun is near to its apogee and its velocity minimal. The shortest months occur when additionally the moon is near to its perigee and its velocity maximal. Similarly the longest true lunar months occur in December-January, when the sun is near to its perigee and its velocity is maximal. The longest months occur when additionally the moon is near to its apogee and its velocity is minimal.[28]
In conclusion if we wanted to bind the calendar and the Neomenia to the true conjunctions instead of the mean conjunctions, we should rather advance the Neomenia in Tishri by some rules and not delay them by rules of postponement.

Therefore the rules of postponements discussed by Maimonides in these two sections seem rather linked to another problem, the delay of the first possible moon sighting in Tishri. The meaning of the first sentence of section VII, 7 must then be that the postponements were introduced in order to agree with the visibility of the new crescent which is linked to the true conjunction and not to the mean conjunction.
If we refer to fig. 4 we see that in Tishri the first visibility of the moon occurs between 6.01 h and 54.83 h after the mean conjunction and on an average 30.42 hours after the mean conjunction.
If we refer to fig. 5 we see that in Nissan the first visibility of the moon occurs between 12.07 h and 40.69 h after the mean conjunction, and on an average 26.38 hours after the mean conjunction. If we name "apparent lunar months", the months counted from a first lunar sighting until the following, we can conclude that the apparent lunar months from Tishri until Nissan have a total length of about 4 hours less than the same number of mean lunations. Similarly the apparent lunar months from Nissan until Tishri have a total length of about 4 hours more than the same number of mean lunations.[29]

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[27] The considerations of Gandz in Sanctification of the New Crescent, Yale Judaica Series XI, p. 93, that in the beginning of tishri (September) the true conjunction is frequently more than two days later that the mean conjunction is completely erroneous.
[28] See Hilkhot Kiddush ha-Hodesh al-pi ha-Rambam, J.J. Ajdler, p. 791.
[29] This phenomenon corresponds to the remark of Gandz in Sanctification of the New Crescent, Yale Judaica Series XI, p. 93, ascribed to J.K. Fotheringham, ERE, 3, 62, that the mean interval between [true] conjunction and phasis is at its minimum near the vernal equinox in March and at its maximum near the autumnal equinox in September, so that the lunar months [the apparent lunar months based on the first

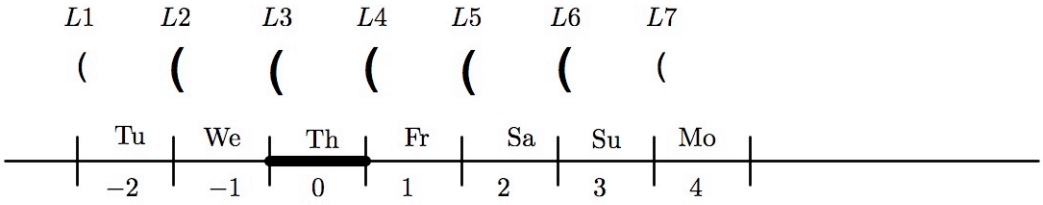

Figure 7: The first theoretical moon sighting at the beginning of Tishri. Tishri 1 is on Thursday when the molad is included between 3 – 18 and 5 – 17 – 1079. In an ordinary year the area of the molad is extended to the area between 3 – 9 – 204 and 5- 17 – 1079. L4 and L5 are the most frequent cases. L3 is less frequent, L6 is still less frequent. L2 is rare and could happen when the Molad is slightly after Gatrad in an ordinary year. L1 and L7 are theoretically possible but seem practically impossible.

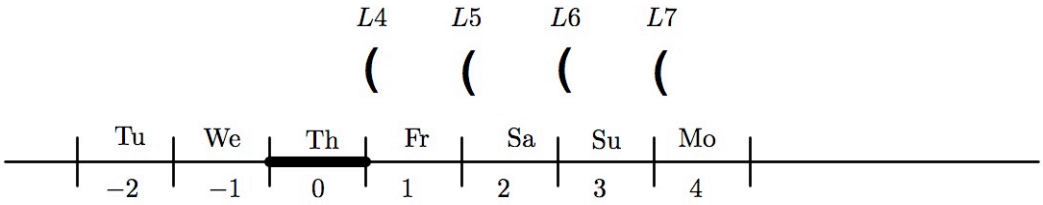

Figure 8: Theoretical calendar without postponement. In this calendar Tishri 1 is on Thursday if the Molad is included between 5 – 0 – 0 and 5 – 23 – 1079. The first moon sighting can be delayed until Tishri 5.

In conclusion, on an average, the span of time in Tishri between the mean conjunction and the first moon sighting is maximal and amounts to about 30.42 hours. This seems the most likely astronomical reason for justifying the postponements introduced in the Jewish calendar in Tishri in order to reducing the average span of time between the end of the *yom ha-ke'viyah* and the first moon sighting, the *yom ha-re'iyah*.
If we refer now to the fig. 7, 8 and 9: we see that in calendar without postponement the maximum span of time between the end of the *yom ha-ke'viyah* and the first moon sighting is three days. We note also that this *yom ha-ke'viyah* precedes always the first

visibility] from March to August are on an average about 8 hours longer than those from September to February. These considerations are in complete agreement with the present conclusions. However the remark of Gandz is unintelligible because of a lack of precision and an incorrect and confusing precedent statement.

moon sighting. By contrast, in the modern calendar with postponements

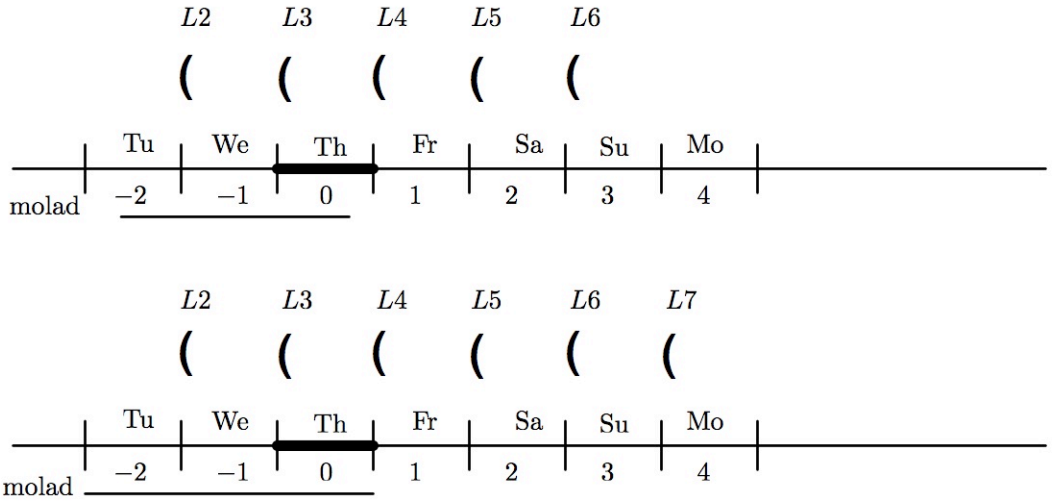

Figure 9: Comparison between a calendar with postponements and a theoretical calendar without postponements for a similar area of the molad. We have omitted L1 and L7 in our calendar with postponements because these situations are practically impossible and were not met in the period 4000 – 6000 AM.

the maximum span of time between the end of *yom ha-ke' viyah* and the latest first moon sighting is now only two days. We excluded the case of the first visibility delayed until the evening beginning Tishri 5 corresponding to a delay of three days between the end of *yom ha-kevi'ah* and the first sighting, which seems practically impossible.
In conclusion, as we can deduce from the fig. 7, 8 and 9, the result of the reduction of the average span of time between the end of *yom ha-ke'viyah* and the first moon sighting is:

- A better centering of the *yom ha-ke'viyah* with regard to the width of the area of the possible first moon sightings.
- The reduction of the maximum span of time between the end of the *yom ha-ke'viyah* and the latest first moon sighting.
- However this better centering is reached at the cost of the possibility of an early visibility of the new moon before the *yom ha-ke'viyah* in rare circumstances.

We can of course ask ourselves if it is such an achievement to have reduced the maximum distance between the end of *yom ha-ke'viyah* and the first sighting from 3 to 2 days at the cost of a possible moon sighting one day before *yom ha-ke'viyah* and also at the cost of many complications of the rules of the calendar.
I think that there is still one element that was never taken into consideration. We know that in exceptionally favorable circumstances, near to the summer solstice, it is possible to see the old and the new moon at a distance of about 38.75 hours (two days and one night). Thus seeing the old and new moon at about 60 hours interval (three days and two nights) seems much more possible. In the calendar without postponement the *yom ha-ke'viah* of Thursday can correspond to a molad of (5) – 23 – 1079 , the true conjunction could then be on (6) – 5 and the latest old moon could perhaps still be seen on
Int [(6).21 – 24 / 24] + 0.5 = (5).5 corresponding to Thursday morning and certainly on
Int [(6).21 – 48 / 24] + 0.5 = (4).5 thus on Wednesday morning.

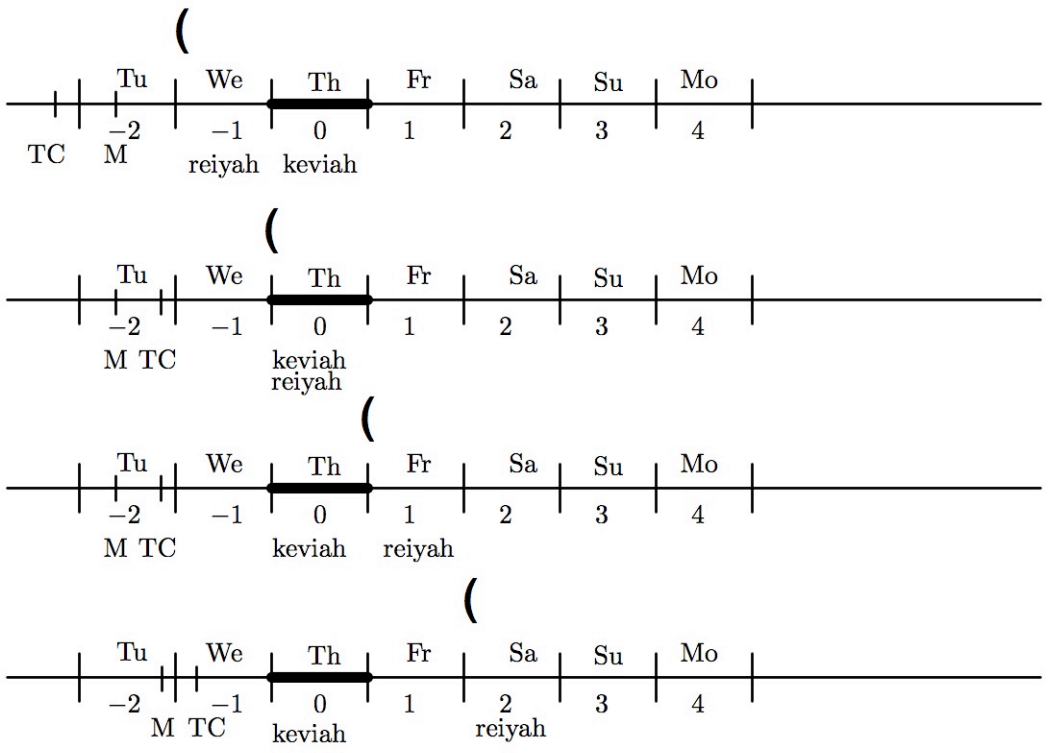

Figure 10: In our present calendar, visibility of the new moon in an ordinary year, yom ha-keviyah and yom ha-reiyah when the Molad is on Tuesday after *Gatrad*. Different situations correspond to a Molad on Tuesday between 3 – 9 – 204 and 3 – 17 – 1079. TC is the true conjunction and M is the Molad.

In the case of the calendar with postponements the latest molad corresponding to the *yom ha-ke'viah* of Thursday is (5) – 17 – 1079, the true conjunction could be about (5) – 23 and therefore the last visibility of the old moon will be each time a day before.
In other words there is another important result of the introduction of the postponements in the Jewish calendar: the postponements eliminate the risk of the sighting of the old moon on the morning of the *yom ha-ke'viah* and diminish the risk of the sighting of the old moon on the morning of the eve of the *yom ha-ke'viah.*
The sighting of the old moon on the morning of the eve of the *yom ha-ke'viah* is very embarrassing and must be avoided.[30] The sighting of the old moon on the morning of the *yom ha-ke'viah* would be disastrous; it would prove the inefficiency of the fixed calendar and its incapacity to clone the movement of the moon.
All these elements must be taken into account when appreciating the result of the introduction of the postponements. It is likely that Maimonides had these considerations in mind. Indeed he wrote in Chapter 18; 6:
.....ונמצא בחדש אחרון אפשר שיראה הירח בליל כ"ה בו או כ"ו, ואין לך דבר שחוק והפסד יותר מזה.

[30] See B. Rosh ha-Shanah 25a and Y. Rosh ha-Shanah II, 5. The late sighting of the old moon on the morning of Elul 29, the day before the *yom ha-ke'viah* embarrassed considerably Rabbi Hiyya who was in charge with the sanctification of the year.

This concern applies also to the fixed calendar which aims at replicating the lunar calendar. It must fit the best with the movement of the moon and have the first moon sighting the nearest possible to the *yom ha-ke'viah*, otherwise it would be a comedy and a mockery.

However the text of the sections VII, 7 and 8, which should deal with these problems and allude to them is problematic. Furthermore there are certainly textual corruptions.
The first problem is raised by the demonstrative example of Maimonides when the Molad is during the night of the third day, during the night from Monday to Tuesday when the *yom ha ke'viah* is postponed to Thursday because of *Gatrad*.
If we follow the general reading: שהמולד יהיה בליל שלישי, that the molad is at the end of the night at 3 – 11 – 1079, then the true conjunction could still be on Tuesday and the latest first visibility will occur at the latest 54 hours after the molad:
Max [(3),4999 + 54 / 24] = Max [(5).75] = (6).
The first visibility will thus occur at the latest on Thursday evening.
According to the reading of R' Obadiah ben David : שהמולד יהיה ביום שלישי, the molad could be at the end of Tuesday, the true conjunction could be on Wednesday and the first moon sighting could be delayed until Friday evening: Max [(3),9999 + 54 / 24] = Max [(6).75] = (7). The reading of R' Obadiah ben David solves the difficulty. But we do not know if this reading was based on a manuscript or if it was his correction of the text.

The second important problem is raised by the quotation:כדי לפגוע ביום קבוץ האמתי.
R' Raphael ha-Levi Hanover[31] was apparently not disturbed by the quotation: כדי לפגוע ביום קיבוץ אמיתי; he understood that the *yom ha-ke'viah* cannot be before the true conjunction. In his little book still in manuscript,[32] he wrote:

סעיף א'....וראוי להיות יום הקביעה מכל החדשים, או ביום קיבוץ האמיתי או ביום אחר קיבוץ אמיתי, אבל לא קודם לו.....

סעיף י''ד. דחיית כל י"ח כמו שאמרנו בכלל ח', ולא כמו שכתבו בעלי המעברים והמפרשים שטעם דחיית י"ח משום דאמרינן בגמרא דראש השנה דף כ' ע"ב נולד קודם חצות וכו', וזה מוכח ממאמר הזה עצמו, דאמר שם, נולד קודם חצות בידוע שנראה סמוך לשקיעת החמה וא"כ יהיה יום הראיה למחר[33] ואנו קיבלנו, אם נולד קודם חצות קובעין בו ביום אלא הטעם **כדי לפגוע ביום קיבוץ אמיתי**. ובעבור שאפשר שקיבוץ אמיתי מאוחר לאמצעי רק בשש שעות ולא יותר, לפיכך דוחין ראש חדש על למחרת. אבל אם נולד קודם חצות בודאי יהיה קיבוץ בו ביום וקובעין בו ביום.

He understood thus the quotation according to its literal sense without any objection and wanted to institute a great principle in the Jewish calendar that the *yom ha-ke'viah* of all[34] the months of the year may not fall before the true conjunction. It seems exact that in Tishri this principle is generally verified as a consequence of the postponements but this is not necessarily the case in other months. For example if the Molad of Nissan preceding

[31] Simon Weltch in his commentary נאוה קדש Berlin 1786 followed the theory of his teacher's (R' Berich Bernstein of Hanover) teacher (R' Raphael Hanover).
[32] כללי סוד העיבור. Book still in manuscript in theBodleian Library. See above 15.
[33] In exceptional cases the earliest first visibility can occur 5.19 hours after the molad.
[34] If he had not written all the months but only the months of Tishri, his principle would be exact.

an ordinary year is 3 – 13 – 641, Tishri 1 of the following year will be a Thursday and the preceding Nissan 1 will be a Tuesday. In Nissan the true conjunction can follow the mean conjunction by 7.33 / 0.4534 = 16.20 h and the molad by 16.20 – 0.83 = 15.37 h = 15 – 399. Hence the true conjunction can be on 4 – 4 – 1040 while Nissan 1 will be a Tuesday. It appears that although often verified, this principle is not universal. In Tishri, it is a consequence of the postponements י"ח and אד"ו. But this is, at least according to my humble opinion, rather a consequence but not an aim.
Anyhow if this was the profound signification of the postponements to which Maimonides wanted to make allusion, it makes no sense that he felt obliged to invoke the first visibility of the moon on Friday evening after its invisibility on Wednesday evening and Thursday evening. And this only in order to explain that *yom ha-ke'viah* was fixed on Thursday after the true conjunction of Wednesday. Further the postponement י"ח on all the days of the week would be sufficient to fulfill Hanover's requirement. The postponement אד"ו would not have an astronomical or calendaric Justification. By contrast Maimonides, in these two sections begins his exposition with the postponement אד"ו and applies to it, his reasoning. Only later he mentions the other postponements and refers to the same reason.

It seems thus more likely that Maimonides had never in mind the principle proposed by Hanover but had rather in mind the fact that the postponements must delay the *yom ha-ke'viyah* and reduce the average distance between the end of the *yom ha-ke'viah* and the first moon sighting in order to achieve the different purposes exposed above. The postponements allow to achieve the best correspondence with the apparent lunar calendar and guarantee the legitimacy of the calendar. Otherwise it would be a comedy and a mockery or according to Maimonides' quotation:[35]
ואין לך דבר שחוק והפסד יותר מזה. This understanding requires however emending the text

ומפני מה אין קובעין בחשבון זה בימי אד"ו , לפי שהחשבון הזה הוא לקבוץ הירח והשמש בהלוכם האמצעי, לא במקום האמיתי, כמו שהודענו. לפיכך עשו יום קביעה ויום דחיה, **כדי לפגוע ביום הראיה הבא אחרי יום קיבוץ האמיתי.** כיצד בשלישי קובעין, ברביעי דוחין, בחמישי קובעין, בששי דוחין, בשבת קובעין, אחד בשבת דוחין, בשני קובעין

ועיקר שאר ארבע הדחיות האלו הוא זה העיקר שאמרנו, שהחשבון הוא במהלך אמצעי, וראיה לדבר, שהמולד יהיה **ביום** שלישי וידחה לחמישי, פעמים רבות לא יראה הירח בליל חמישי ולא בליל ששי, מכלל שלא נתקבצו השמש והירח קבוץ אמתי אלא **ברביעי**.

The second and the third emendations are classical emendations. The second corresponded perhaps to the text of R' Obadiah ben David, the third was already considered by R' Isaac Israeli and R' Jonathan the author of *Yeshuah ba-Israel*. The first emendation is the most problematic because it is not classical. Originally[36] I had simply replaced *yom kibbutz amiti* by *yom ha-re'iyah* but I did not justify the fact that at the end of section 8 the text comes back to the *yom kibbutz amiti*. The proposed emendation supposes the omission of three words because of the similitude of the two *yom*. The copier would have confused them and omitted the three words between. The meaning of

[35] H.K.H 18; 6.
[36] Hilkhot Kiddush ha-Hodesh al-pi ha-Rambam, J.J. Ajdler, p. 227.

this section would then be that the reason of the postponements is that the calendar is constructed on the mean movements of sun and moon and not on their true movements. However the first visibility of the moon depends on the true movements and on the true conjunction which it always follows. The postponements aim at the diminution of the interval between the *yom ha-ke'viah* and the *yom ha-re'iyah* which follows the true conjunction and is astronomically linked to it. Maimonides demonstrated then by an example that the *yom ha-ke'viah* on Thursday differs from the *yom kibuts amiti* on Wednesday, the *yom kibuts emtsaï* on Tuesday and the *yom ha-re'iyah* on Saturday. The aim of the postponement would be to reduce the interval between the *yom ha- ke'viah* and the *yom ha-re'iyah.*, But the aim of the postponement is not to make coincide or to bring together *yom ha-ke'viah* with *yom kibuts amiti*. Indeed let us refer to fig 10 representing the different possible situations for the beginning of an ordinary year when the Molad falls on Tuesday after *Gatrad*. We see that the result of the postponement is certainly not to bring together the *yom ha-ke'viah* and the *yom kibuts amiti* but rather to get the best centered position of *yom ha-ke'viah* with regard of *yom ha-re'iyah* and the shortest average interval between them.
However we must admit that the three proposed emendations have a forced character. None of them is supported by the reading of a manuscript. Especially the first emendation implies that the scribe skipped a few words. It is certainly far-fetched. Furthermore the reconstructed text is not satisfactory at philological level and therefore it lacks genuineness. In fact it is not certain at all that the problem has a solution.
Finally, the length of the necessary development proves that this section remains difficult and its meaning uncertain.

XII. Conclusion.

We have devoted the present paper to the analysis of two difficult quotations in Maimonides' Hilkhot Kiddush ha-Hodesh. This led us to make a thorough study of the span of time between the astronomical data governing the moon sighting: the mean conjunction, the Molad, the true conjunction and the resulting day adopted for the Neomenia. In the case of the second quotation the examination was restricted to the month of Tishri.
The first commentator, R' Obadiah ben David had already recognized these difficulties and all the subsequent commentators dealt with this problem.
The solutions proposed in this paper are perhaps not particularly innovative. In fact the solution proposed for the first quotation is certainly innovative but it is not original. It is however practically unknown. The solution proposed to solve the difficulties of the second quotation is perhaps questionable. In this last case, the problem could even have no solution at all.
The interest and the originality of the paper lie more in the treatment of the subject. The presentation of the problem on clear basis and its precise and mathematical formulation allow a profound understanding of the different possible situations. The commentators wrote indeed imprecise and even incorrect considerations about the spans of time between *molad emtsaï*, *molad amiti* and *re'iyah*. The article proves that the proposed solutions are the only possible. Even if the reconstruction of H.K.H 7; 8-9 was not

accepted because of a lack of genuineness, we will at least have reached a full understanding of the difficulty of the subject.

Appendix: Two quotations from R' Abraham ibn Ezra.

1. Commentary on Lev. XXIII:

והעיבור בנוי על המהלך התיכון, ע"כ אמרו פעמים שבא בארוכה ובקצרה. ואין הקביעות רודף אחר ראית הלבנה בירושלים או בקצה מזרח או במערב כלל, והעד מקום מחברת התיכונה, כי הנה היא על ירושלים. ועוד שראינו פעמים **רבות** הלבנה בחדש ניסן בליל שני. וכן היתה נראית בכל העולם וקביעות החדש היה ליל שלישי. וכן אירע לשלשה חדשים קודם ניסן. וזה נתקן בשנת גטר"ד בעבור הדחיה. גם פעמים היה הקביעות בתשרי יום חמישי ולא נראית הלבנה בליל שבת, והיה האויר זך וזה יקרה **בכל** שנה שהמולד קרוב מחצי היום.....

2. Sefer ha-Ibbur p.11b:

כי הנה נראתה הלבנה בטרם ראש חדש ניסן בבבל גם בירושלים גם במערב יום אחד וכן יקרה פעמים **רבות** ובשנת גטר"ד תמצאנו בשבט ובאדר ובניסן ובאייר.

These two quotations deal with the same problems of early and late moon sighting at the beginning of the Jewish months. Problematic words were printed in bold characters.
In the first quotation ibn Ezra, writes that the *yom ha-ke'viyah* is not fixed according to the first moon's visibility because in many circumstances, the first moon sighting was one day before the *ke'viyah* of Nissan. He adds that it was an easy vision, visible anywhere and not only in Israel. He specifies also that such a situation happens often in a year presenting the postponement *Gatrad*. He ends by saying that we can also have the situation of a late first sighting of the moon with *yom ha-ke'viyah* of Tishri on Thursday and the first visibility on Friday evening (Saturday). This happens when the molad is slightly before noon.
The second quotation of *Sefer ha-Ibbur* is equivalent to the first part of the first quotation.

When the molad Tishri of an ordinary year is on (3) – 9 – 204 or later then the molad of the former Nissan is on (1) – 4 – 846 or later. The *ke'viah* of Tishri is on Thursday and the *ke'viah* of Nissan is on Tuesday. The first visibility of the moon occurs between 10.78 hours and 39.86 hours after the molad.
The first visibility of Nissan will thus be:
Max {[(1) – 4 – 846] + [10 – 842]} = Max [(1) – 15 – 608] = (2)
There is thus a possibility of an early moon sighting on Sunday evening, beginning of Monday, one day before the *yom ha-ke'viah*.
However we have seen that this situation is extremely rare and ibn Ezra's appreciation that this happens often is certainly erroneous.

The second case considered by ibn Ezra is exactly Maimonides' example in Hilkhot Kiddush ha-Hodesh VII, 8. When it happens the molad is slightly before noon but it is incorrect to write that it happens each time when the molad is slightly before noon.