Tosafot (d.h. Litekufot) on b. Rosh Hashanah 8a, translated & explained

The division into paragraphs of the Hebrew text of this Tosafot comment is my own – Motti Yarchinai.

1) **לתקופות** כר"א דאמר בתשרי נברא העולם. ומונין מולד הלבנה והתקופה מאחד בתשרי ורבי יהושע מונה מניסן ויש נפקותא מרובה בדבר במה שקודם מנין של זה למנין של זה חצי שנה

2) והא דקיימא לן פרק כיצד מעברין (עירובין ד' נו. ושם) דאין תקופת ניסן נופלת אלא בארבעה רבעי היום אם בתחילת היום וכו' היינו משום דהתם כולהו כר' יהושע דתניא בברייתא כוותיה דשמואל סבר כר' יהושע דלר"א בכ"ה באלול נברא העולם ולר' יהושע בכ"ה באדר היינו דכשנברא אדם בששי קדש החדש

3) וזה טעם למחשבי העבור לאחר שצרפו כל השעות והקפה של כל מחזורים שמסירין ז"ט תרמ"ב פי' ז' ימים תשע שעות תרמ"ב חלקים דרגילים לומר לפי שהיתה הלבנה נזופה ע"י שקטרגה ונהגה נזיפה בעצמה ז"ט תרמ"ב

4) ולא מצינו טעם זה בכל מקום אלא זהו הטעם לפי שהמונה מבריאת העולם לא מונה ר"ה עד יום ששי שנברא אדם הראשון ובשעה תשיעית נצטווה כדאמר פרק אחד דיני ממונות (סנהדרין ד' לח:) ומסתמא אז קדש החדש ומשקדש החדש ע"כ היה המולד ו' שעות קודם דשית שעי מכסי סיהרא ונמצא המולד בתחילת שעה ט"ו דהיא שעה שלישית של יום וסימן וי"ד פי' ביום ו' בסוף שעה י"ד היה המולד מאחר שלא היה ר"ה עד יום ו' שקידש אדם הראשון החדש נמצא שנברא העולם בכ"ה באלול ואותה שנה של תוהו שמונין משום דיום אחד בשנה חשוב שנה

5) וכשתדקדק על מולד ניסן של תוהו שלפני תשרי של יישוב שבו נברא אדם תמצא מולד ניסן ברביעי בתשע שעות תרמ"ב חלקים שאתה צריך להשליך ב' ד' תל"ח [ממולד תשרי ש]לאחריו [פי'] ב' ימים ד' שעות תל"ח חלקים ו[כן ל]מולד תשרי של תוהו שלפניו שנמצא ב' ה' ר"ד

6) ולתקופה מניסן של תוהו מונין שהיתה התקופה בתחילת ליל ארבעה ונמצאת תקופת תשרי של יישוב של אחריו ביום ד' ט"ו שעות כדאמרינן בפרק כיצד מעברין אין בין תקופה לתקופה אלא תשעים ואחד יום וז' שעות ומחצה נמצא דשתי תקופות ט"ו שעות ונמצא דקדמה תקופת תשרי למולד א' כ"ג פי' יום אחד כ"ג שעות ונמצא דקדמה תקופת ניסן את המולד ז' ט' תרמ"ב דל חצי ~~(שעה)~~ עודפת התקופה על המולד ה' י' תרמ"ב פי' ה' ימים י' שעות תרמ"ב חלקים וכשתצרף ה' י' תרמ"ב עם א' כ"ג עולה ז' ט' תרמ"ב

7) והרי עכשיו נוהגין למנות מתשרי של תוהו שנות העולם כדפי' דיום אחד בשנה חשוב שנה ותקופת ניסן מונין [מ]מולד תשרי ב' ה' ר"ד וזקוקים להסיר ז' ט' תרמ"ב

8) ודבר תימה הוא במה נחלקו ר"א ור' יהושע דתניא לקמן (דף יב.) מונין לתקופה מניסן ולמולדות מתשרי והלא היו יכולים לברר הדבר דכ"ד שעות מיכסי סיהרא בין חדתא לעתיקא כדאיתא בסוף פ"ק דערכין (דף ט: ושם) והם מרחיקין המולד זה מזה ב' ד' תל"ח כולי האי אין ראוי לטעות דאיך יטעו בו שני ימים.

The above Hebrew text of the Tosafot is repeated below, alongside my translation.
The red coloured, bracketed insertions were added by me.

Abstract

This document contains the Hebrew text and my English translation of the Tosafot (d.h. "Litekufot") on TB Rosh Hashanah, 8a. The translation is preceded by an explanation of some aspects of the structure of the Jewish calendar. An understanding of these is necessary to understand this Tosafot comment. The translation is followed by a critical discussion of the Tosafot comment.

The Talmud (Hulin 60b) tells of a Jewish legend about the creation of the Sun and the Moon, to explain why the Bible, in the account of their creation, first refers to them collectively as the two great luminaries, then, in the same verse, refers to the larger and the smaller of the two. The legend relates that the Moon, being jealous of the Sun, argued with God that one light was sufficient for the world, whereupon God, in a rebuke of the Moon, diminished her in size.

In a comprehensive study of the Jewish calendar published in 1901, S. B. Burnaby cites two secondary sources for a different version of the above legend. In that version, God shut up the Moon in darkness and did not permit it to shine for a period of 47 hours after it was first created.

I first discussed this legend mentioned by Burnaby in another of my articles on this website entitled: *Discoveries while searching for a source for the Sun's creation at zero hours*. This legend purports to explain a seeming inconsistency between the biblical account of creation and a fundamental assumption of traditional Jewish chronology, upon which the epoch of the Jewish calendar is founded.

In the biblical creation story, the Sun and Moon were created together on the fourth day of creation. (By Shmuel's tekufah calculations, that was Wednesday, Shmuelian Day Number (SDN) 353, at 15:00 hours, Jewish Mean Time.)

But in traditional Jewish chronology, the Moon's first conjunction with the Sun (the first New Moon after creation) took place on the sixth day of creation (SDN 355, at 14:00 hours), when the creation of Adam was completed. By that time, the Moon was just under two days old (47 hours). The legend mentioned by Burnaby is a piece of folklore that purports to explain this apparent anomaly.

The primary source for this legend mentioned by Burnaby is unknown to me, but this Tosafot (on Rosh Hashanah 8a) is possibly the main evidence for its existence. Burnaby says:

> "Of course Scaliger places no faith in this folklore. ... And it is hardly necessary to say that no Jewish scholar treats the myth ... with any more respect."

That statement mirrors a similar one in this Tosafot comment, which mentions a similar legend, which he too dismisses. It uses different values and I explain the difference in this article.

Rejecting this legend as the explanation, this Tosafist explains the tekufah and molad system in use today, the calculations for them, and how their respective epochs were obtained.

The translation and accompanying explanations that I provide here make very clear what is otherwise a very difficult and obscure Tosafot comment.

Background Information

- Times of week are expressed as **w,hh:pppp** (**w**eekday 1 to 7 (Sun to Sat), 00 to 23 **h**rs, 0000 to 1079 **p**arts).
- A time span is expressed in the same units, but the notation is: days,hh,pppp. (1 hour = 1080 parts.)
- All times are expressed in Jewish Mean Time (JMT), which (everywhere) = (your local) civil time + 6 hours.
- All tekufot discussed here are Shmuelian tekufot (Shmuelian equinoxes, solstices and seasons).
- For more details about these terms and the information presented in this section, please see the companion document "Global Glossary and Notes". First appearances here of terms explained in the glossary are shown in red.

To understand this Tosafot, one must know the following facts about the Jewish calendar.

Moladot: The calendar is structured around moladot, which are mean New Moons (**lunar conjunctions**) that occur at fixed intervals. That interval is a **calendric lunation**. The calendric moladot and lunations model the real, astronomical ones, but, since the Moon's orbit is elliptical, not circular, it does not move at a uniform speed, so real lunations vary in length, but the length of a calendric lunation is constant. That length (about 29.53 days) is the Jewish calendar's estimate of the *mean* length of a real, synodic lunation (a full cycle of lunar phases from one New Moon to the next). So the calendric moladot and lunations correspond only approximately with the real ones that they model.

The calendar's lunations also correspond with its months. This correspondence too is approximate because a calendric lunation is exactly 29.5d, 44 min and 1p, whereas a calendar month must have a whole number of days – either 30 or 29, usually occurring in alternation. They occur in a ratio (53% to 47%) that makes the above value the calendar's mean month length (29.53 days). A month always begins on the day of a calendric molad or within the next 3 days.

Metonic Cycle: From around the mid-4th century CE, the Jewish calendar started regulating the occurrence of its leap years with a scheme first used in 432 BCE by the Greek astronomer Meton in a reformation of the Greek luni-solar calendar. Announcing that **19** solar years is almost equal in length to **235** lunations, Meton introduced a scheme based on this by which 7 years in every 19 are leap years of 13 months, so **19** years have **235** months (19×12+7). This makes the calendar's mean year-length about the same as a solar year, which keeps its lunar months recurring in the same seasons. The leap years are spaced at intervals of 2 or 3 years, spreading them as evenly as possible throughout the 19-year cycle, known ever since as the Metonic Cycle. In the Jewish calendar's implementation of this scheme, the leap years are years 3, 6, 8, 11, 14, 17 and 19 of each Metonic cycle. Year Y is a leap year if the remainder of (7Y+1)/19 is < 7.

Length of Solar Year: Several centuries before the Jewish calendar started using the Metonic cycle, a more accurate year length than Meton's had been discovered (about 146 BCE) by the Greek astronomer, **Hipparchus**. The values found by Hipparchus for both the synodic lunation and the solar year are the mean month length and the mean year length of the present-day Jewish calendar.

Jewish tradition attributes to **Rav Adda bar Ahava** the proposal that Hipparchus's year length be adopted by the Jewish calendar. Rav Adda's proposal was eventually implemented about a century later, as a result of the calendar reforms of the mid fourth century, which Jewish tradition attributes to Hillel II. But an alternative value for the seasonal year was proposed by Rav Adda's contemporary, Shmuel Yarchinai, and was used for other purposes.

Shmuelian Tekufot: Shmuel Yarchinai, a 3rd century rabbi and astronomer of the Talmud, devised a system of approximate, calendric seasons based on a less accurate (slightly longer) year-length of 365¼ days – the mean year-length of the Julian calendar, which was the older version of the Gregorian (our present civil) calendar. His system was adopted for the purpose of regulating the occurrence of two seasonal, liturgical observances – sh'elah and Birkat Hachama. Being seasonal, they have no fixed dates in the Jewish calendar, whose months are lunar. Shmuel's method ensured that those two observances were linked to consistent dates in the Julian solar calendar, which by then had been in widespread use for over two centuries and was the civil calendar for the Jews of those times. For its calendric convenience, Shmuel's system was retained for the regulation of those two observances even after Hipparchus's year length was adopted for the fixed Jewish calendar.

Quantities: There are 1080 parts (*halakim*) in an hour. A full cycle of seasons is called a Tropical year and the modern estimate of its mean length (**T**) is about 365.24219 days (so 19T ≈ 6939.60167d). A calendric lunation (**L**) (the calendar's mean month length) is 29.5d, 793p. 235**L** is a Jewish Metonic cycle (**M**), and its length is 6939d, 16h, 595p (≈6939.689622 days), about 2 hours longer than 19**T**. The calendar's mean year-length is **M**/19 (about 365.2468222 days), which is slightly longer than **T**. A Shmuelian year (**S**) is even longer (365.25 days), and 19**S** = 6939.75 days, which is longer than **M** by **1 hour, 485 parts**. To understand this Tosafot, it is important to remember this last quantity – the difference between 19 Shmuelian years and a Metonic cycle of the Jewish calendar.

Table and Diagram: Refer to the following Table and Time Line Diagram in the preliminary explanation and translation of Tosafot below. They are especially relevant to paragraphs 5 and 6 of the Tosafot and to the explanation below of how certain tekufot may be calculated from the moladot of the matching months when calculating in increments of nineteen years or a multiple thereof.

The table shows moladot and Shmuelian tekufot for Tishrei and Nisan of Jewish years 1, 2, 20, 21 and 5758. Dates are labelled by their **Shmuelian Day Number (SDN)**. This is a continuous day count which I have modelled on the Julian Day Number and named in honour of Shmuel Yarchinai. SDN 1 is the Jewish calendar's first day – Monday, Tishrei 1 of year 1, the day of Molad Tohu. (The previous day is the theoretical date, Sunday, SDN zero, and SDN −12 in the top row is a theoretical date, 13 days before the beginning of the calendar.)

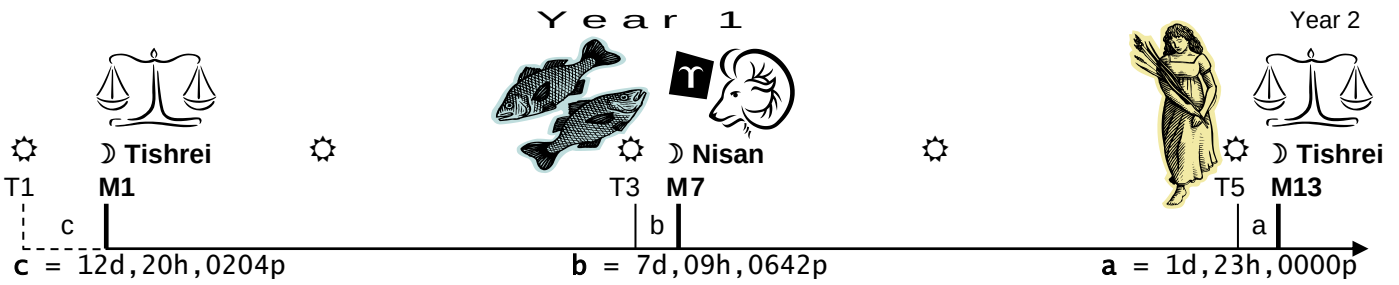
This day count makes date arithmetic much simpler. The corresponding dates shown here are those of the present-day calendar extended backwards to year 1.

Epochs and Derived Values of Moladot and Shmuelian Tekufot of Tishrei and Nisan

Year, Month	Event	SDN	Time (JMT)	Proleptic Date (Y,M,D)
1, Tishrei תשרי של תוהו	(a) Molad ("Molad Tohu") (b) Tekufah (c) Molad minus Tekufah	1 −12	Mon,05:0204 Tue,09:0000 12d,20,0204	1, Tishrei 1 0, Elul 17
1, Nisan	(a) Molad (b) Tekufah (c) Molad minus Tekufah	178 171	Wed,09:0642 Wed,00:0000 7d,09,0642	1, Adar 29 1, Adar 22
2, Tishrei תשרי של יישוב	(a) Molad ("Molad VYD") (b) Tekufah (c) Molad minus Tekufah	355 353	Fri,14:0000 Wed,15:0000 1d,23,0000	1, Elul 29 1, Elul 27
(1 + 19 =) 20, Tishrei	(a) Molad (b) (a) + 1hr, 485p (c) Tekufah (d) b minus Tekufah	6940 6940 6928	Wed,21:0799 Wed,23:0204 Fri,03:0000 12d,20,0204	19, Elul 29 19, Elul 29 19, Elul 17
(1 + 19 =) 20, Nisan	(a) Molad (b) (a) + 1hr, 485p (c) Tekufah (d) b minus Tekufah	7118 7118 7110	Sat,02:0157 Sat,03:0642 Fri,18:0000 7d,09,0642	20, Nisan 1 20, Nisan 1 20, Adar 22
(2 + 19 =) 21, Tishrei	(a) Molad (b) (a) + 1hr, 485p (c) Tekufah (d) b minus Tekufah	7295 7295 7293	Mon,06:0595 Mon,08:0000 Sat,09:0000 1d,23,0000	21, Tishrei 1 21, Tishrei 1 20, Elul 28
5758 (Cycle 304, Yr 1) Tishrei	(a) Molad (b) (a) + 303(1h, 485p) (c) Tekufah (d) b minus Tekufah	2102727 2102745 2102732	Thu,04:0129 Mon,11:0204 Tue,15:0000 12d,20,0204	5758, Tishrei 1 5758, Tishrei 19 5770, Tishrei 6

Rows 1 to 3 of the table contain three alternative epochs (mathematical commencements) that can be used for calculations of moladot and tekufot. Rows 4 to 6 show the corresponding moladot and tekufot 19 years later at the beginning of the 2nd Metonic cycle of the calendar, as counted, respectively, from those three epochs. Row 7 shows the molad of Tishrei and tekufat Tishrei (the Shmuelian September equinox) of year 5758, year 1 of the current cycle (cycle 304), counting from Tishrei of year 1. (By that count, next year, 5770, is year 13 of Metonic cycle 304.)

Time Line Diagram



M1 = SDN 1, 05:0204, **T3** = SDN 171, 00:0000, **M7** = SDN 178, 09:0642, **T5** = SDN 353, 15:0000, **M13** = SDN 355, 14:0000

*Interval **T1** to **T5** = 365, 06,0000, Interval **M1** to **M13** = 354,08,0876, Difference (**D**) = 10,21,0204, **D/2** = 5,10,0642, **D/2 + a = b***

Preliminary Explanation of Tosafot

The Chazon Ish (Rosh Hashanah, ch 138) commenting on this Tosafot, correctly (though not for the right reason[1]) connects it to a method for calculating the Shmuelian tekufot used by calendar computists of old. He explains that they used certain shortcuts to simplify the arithmetic and to avoid having to deal with very large numbers. This applies to the calculation of both moladot and tekufot. In both cases, the calculation is based on the fact that we are calculating the day and time at which a certain length of time has elapsed from a known commencement date and time, which is the epoch (the starting point) for the calculation. The time elapsed from that epoch is some multiple of a certain fixed time quantity.

When calculating moladot, we calculate *calendric* (not real) moladot, which occur at constant intervals of 29.5d, 793p. That interval is a calendric lunation (**L**), and it is the calendar's mean month-length. The first molad of year 1 (Molad Tohu) is the epoch of our molad calculations. It is calculated to have occurred on a Monday, at 05:0204 (ב,ה:ר"ד), and that Monday is day 1 of the calendar. From that epoch, the molad of any subsequent month, **n** months later, can be found by adding to the day and time of Molad Tohu the time quantity (n × L). The procedure for doing so can be further simplified as explained below.

Similarly, when calculating tekufot, we are calculating the occurrence of a *nominal* (not a real) equinox or solstice, i.e. the beginning of one of Shmuel's approximate, calendric seasons. Unlike the real seasons, Shmuel's calendric seasons are all of equal length – exactly one quarter of the length of a Julian calendar year, which is 365¼ days. Therefore, the Shmuelian equinoxes and solstices occur at constant intervals of 91 days plus 7.5 hours from one to the next.

The epoch of our Shmuelian tekufah calculations is the first Shmuelian March equinox (tekufat Nisan) of the Jewish calendar. It is calculated (by Shmuel's method) to have occurred at zero hours (Jewish Mean Time) on Wednesday, Adar 22 of year 1. (18:00 on Tuesday, March 25 of year −3759, Julian.) From that epoch, any subsequent tekufat Nisan, **n** years later, can be found by adding to that epoch an amount of time equal to **n** × 365.25 days.

The above is the principle on which the molad and tekufah calculations of the calendar operate, but there is an important difference between the two. The calendric moladot are tied to the months – a month always begins on the day of a molad or within the next three days. A tekufah, on the other hand, is related to the seasons of the solar year and has no connection with the months, which are lunar. This difference affects the calculation methods as follows:

A molad occurrence is traditionally expressed only as a time of week (given as weekday and time of day). This suffices to fully identify the day; there is no need to specify which week that weekday belongs to. Since the months are tied to the moladot, there is no ambiguity as to which day it is; it is either the first of the month or within the preceding three days.

This allows molad arithmetic to be greatly simplified as follows. As mentioned above, we add the quantity n × **L** to Molad Tohu to obtain the molad of some subsequent month, n months later. Since moladot are expressed only as a time of week, all whole weeks in the sum may be discarded. This does not affect the result because a time of week plus or minus n whole weeks is the same time of week, n weeks later or earlier. Therefore: instead of using the whole quantity L, we use L − 4 weeks, which is 1.5 days, and 793 parts. We also remove as many whole weeks as possible from the product nL. And when that result is added to Molad Tohu, if the sum exceeds one week, we reduce it by one week, leaving us with the time of week of the desired molad. This simplifies the arithmetic by reducing the quantities used in the various stages of the calculation. (The traditional method consists of slightly different procedures, but the result is the same and we are concerned here with the principle of the method, not with its procedural details.)

This kind of simplification cannot be used in calculations of tekufot. There is no correlation between the tekufot and the lunar dates; the tekufot are related to the solar year and therefore only to dates in a solar calendar. For example, tekufat Nisan always falls on consistent dates (March 25 or 26) in the Julian calendar, because it is a solar calendar and its mean year length is the same as a Shmuelian year, but it does not fall on consistent dates in Nisan, and often does not even fall in Nisan. So, to calculate a tekufah from an earlier, known one, all of the days in the intervening time span must be counted.

Nevertheless, since 19 solar years ≈ 235 lunations (see "Metonic cycle", above), the calendar computists could use a different shortcut for calculating tekufot. *Some* tekufot can be obtained from the molad values of matching months, e.g. tekufat Nisan from molad Nisan, or tekufat Tishrei from molad Tishrei. Starting from the known values of a matching epochal molad and tekufah (say, molad Nisan and tekufat Nisan), the occurrence of the same tekufah in year Y, exactly 19**n** years later (n ≥ 1), can be obtained from the molad of the same month in year Y, as explained below (and as shown in the table).

Remember at this point (see "quantities", above) that the mean length of a Jewish year is slightly longer than a tropical year (T), and that a Shmuelian year (**S**) (365¼ days) is even longer, so that 19**S** exceeds **M** (a Jewish Metonic cycle of 19 years) by **1hr, 485p**. Therefore, if we calculate tekufot and moladot from

matching epochs (say, from molad Nisan and tekufat Nisan of year 1) and we find that in year Y, exactly 19**n** years later, the molad of the same month (molad Nisan in our example) occurs on day d, at time t, then the same tekufah in year Y (tekufat Nisan in our example) will succeed day d, time t by **n** × (1hr, 485p). However, this result (R) for the tekufah occurrence in year Y needs to be adjusted because the epochal tekufah (T_1) and the epochal molad (M_1) did not coincide, rather T_1 preceded M_1. So we must deduct from R the time quantity ($M_1 - T_1$), i.e. the amount of time by which T_1 preceded M_1. (See table, above.)

The amount that must be deducted depends on the epoch used for the calculation, as follows:

(a) Tishrei of year 2 1d, 23h, 0000p
(b) Nisan of year 1 7d, 09h, 0642p
(c) Tishrei of year 1 12d, 20h, 0204p

Note that the difference between adjustments (a) & (b) and the difference between adjustments (b) & (c) are the same: **5d, 10h, 642p**, a quantity which Tosafot calls חצי עודפת התקופה על המולד, i.e. **D**/2 where **D** = the amount (10,21,204) by which a Shmuelian year (**S**) (365,06,0000) exceeds 12**L**, i.e. 12 calendric lunations (354,08,0876). If a tekufah (T_1) and a molad (M_1) coincided, then 6 months (2 seasons) later, T_3 would succeed M_7 by D/2, and after another 6 months, T_5 would succeed M_{13} by D. Hence, there are differing gaps between the tekufah and molad at (a), (b) & (c).[2]

Before the age of computing machines, a computer was a person who was adept with numbers and who made a living by performing complex or large-scale calculations. These human computers were trained in the methods to be followed but not necessarily in the theory behind those methods. However, an arithmetic procedure is far easier to remember and follow if the person performing it can attribute some reason to it that can be remembered easily.

Therefore, it was common, this Tosafot says, for the computists whose job it was to perform calculations for producers of Jewish calendars to attribute this adjustment to a variation of the legend told about the Moon in the Talmud (Hulin 60b). In that legend, the Sun and Moon were originally created equal to one another, then the Moon was diminished in size for being jealous of the Sun. In the variation of this legend told by the computists, the Moon hid herself in shame at this for an initial period before she began to shine or orbit the Earth. This explained why the epochal molad occurs some time after the day of the epochal tekufah, which is when the Sun and the Moon were believed to have been created.

Our tosafist gives no credence to the story told by the computists and proceeds to explain the real reason for the adjustment they performed. He mentions only the adjustment amount (b) because it corresponds to the epoch traditionally used for tekufah calculations. He explains the reason for it by working backwards, mathematically, from what the adjustment would have been if the epoch (a) was used. He uses (a) as the starting point for his explanation because that is when the world was created according to R. Eliezer, which became the accepted view.

As the Tosafot point out in paragraph 7, by their time the years of the Jewish calendar were being counted from Molad Tohu and the calendar computists were using molad Tishrei of year 1 and tekufat Nisan of year 1 as the mathematical epochs for their molad and tekufah calculations. Consequently, the legend they told to explain their arithmetic adjustment had the Moon hiding herself for 7d, 9h, 642p, the amount of time by which molad Nisan of year 1 succeeded tekufat Nisan of year 1.

But if any of them were in the habit of reckoning from the supposed week of creation, i.e. from molad Tishrei and tekufat Tishrei of (what we now call) year 2 (both of which occurred during the last week of what we now call year 1), they would have subtracted adjustment-amount (a) to correct their results and if they explained this procedure with a legend like the one mentioned above, it would have differed from the version mentioned in this Tosafot. They would have undoubtedly said that the Moon hid herself for 47 hours ending at molad VYD, i.e. the amount of time by which molad Tishrei of year 2 succeeded tekufat Tishrei of year 2.

Our Molad Epoch and Tekufah Epoch

Our tosafist's explanation of the arithmetic procedures performed by the computists also sheds light on another important aspect of our calendar calculations. From this tosafot, we may derive an understanding of how the epoch of the calendric tekufot was fixed. The day and time of that epoch is very important, because, as demonstrated above, from it all succeeding calendric tekufot are calculated.

We will presently demonstrate the procedure implied in this Tosafot by which that epoch was arrived at, but we must preface that explanation by pointing out that the debate between Rabbi Eliezer and Rabbi Yehoshua that is the Talmudic context for this Tosafot comment concludes (on page 12a) with a dichotomous resolution: For our year count we adopt the view of Rabbi Eliezer, but for our tekufah calculations we adopt the view of Rabbi Yehoshua. Hence, the epoch of our molad calculations is molad Tishrei, while the epoch of our tekufot is tekufat Nisan.

Four dates will be of relevance in the following explanation. All are in year 1 and all are proleptic – that is, they are given assuming the present-day calendar's dates, structure and rules extended all the way back to the beginning of year 1. They are: Wednesday Adar 22, Thursday Nisan 1, Wednesday Elul 27 and Friday Elul 29. In the date arithmetic that follows, all of them will be indicated by their Shmuelian Day Numbers (SDN) which was explained above, just prior to the table.

1. In the creation story, Adam was made on day 6 (Friday) of the week of creation. Let the first molad after creation (M13 on the timeline diagram) be called **Molad VYD**. This is a mnemonic formed from the Hebrew numerals for the time-of-week of its occurrence, 6,14:0000. That day and time was probably derived from some calculated molad (or possibly a real one observed during a solar eclipse) around the time of Hillel II in the middle of the fourth century CE. From it they deducted **nL** where **L** = the molad interval (29d, 12h, 793p) and **n** = the number of months thought to have elapsed from the day Adam was made, based on the chronological data in the Bible. The result was Molad VYD. A legend in support of that calculation has Adam witnessing the first appearance of a waxing lunar crescent at 20:0000 on that Friday. The preceding molad is assumed to have occurred six hours earlier at 14:0000.

Jewish chronology counts the first month of Adam's life as month 1 of a new year. It numbers Adam's first year as year 2 because the preceding days of creation must be counted as part of some year, so it counts those days as belonging to the last week of year 1. Since, by that chronology, most of year 1 (all but its last week) precedes creation, it is regarded as largely theoretical – just a mathematical construct. It is therefore called the **Year of *Tohu*,** from the word *tohu* in the creation story describing the amorphous state of the world at the beginning of its creation. From that name, the (theoretical) molad of Tishrei at the beginning of year 1 (M1 on the timeline diagram) is called **Molad Tohu**.

From Molad VYD, molad arithmetic gives us the time-of-week of Molad Tohu. It is 6,14:0000 minus 12L, which is 2,05:0204. That Monday is **SDN 1**. The length of a common year is 354 days, plus or minus 0 or 1 day. If it commences on a Monday and ends on a Friday, it must have 50 weeks and 5 days, so the Friday of Molad VYD was **SDN 355**. Similar molad arithmetic (Friday, SDN 355, at 14:0000 minus 6L) gives us, for molad Nisan of year 1, Wednesday, **SDN 178**, at 09:0642. This is M7 on the timeline diagram.

2. Tekufat Tishrei of year 2 (T5)
(a) In the creation story, the Sun, Moon and stars were created on day 4. So, if day 6 was Friday, SDN 355, then the Sun was created at some time on Wednesday, **SDN 353**. This is T5 on the timeline diagram. We know the day of T5, but we have yet to determine the time.

(b) We assume that at T5, the heavenly bodies were placed relative to one another such that the Moon was about 2 days away from her first conjunction with the Sun, and the Sun appeared from Earth to be at the September equinoctial point on the ecliptic. Therefore, SDN 353 will be the day of tekufat Tishrei of year 2.

3. Tekufat Nisan of year 1 (T3)
(a) The (theoretical) tekufah two seasons (6 months) prior to T5 is tekufat Nisan of year 1. (T3 on the timeline diagram.)

(b) T3 will be the epochal tekufah for all subsequent Shmuelian tekufah calculations.

(c) Therefore, T3 is deemed to have occurred on a Wednesday at zero hours.[3]

4. Two Shmuelian seasons = (365.25 days / 2) = 26 weeks, 15 hrs. Therefore, if T3 is zero hours on a Wednesday, T5 = 15:00 on a Wednesday. We know which day that is; it is the day given in point 2, SDN 353. Now we also know the time of T5.

5. From point 4 we see that T3 precedes T5 by exactly 26 weeks, 15 hours. Therefore the day of T3 is T5 minus 182 days. SDN 353 − 182 = **SDN 171**.

6. We have already calculated (in point 1) the molad Nisan of year 1 as Wednesday, SDN 178, at 09:0642. Therefore, T3 (tekufat Nisan, Wednesday, SDN 171 at 00:0000) precedes molad Nisan by 7 days, 9h, 0642p. Thus we arrive at the epoch of the tekufot.[4]

Translation of Tosafot

1) **לתקופות** כר"א דאמר בתשרי נברא העולם. ומונין מולד הלבנה והתקופה מאחד בתשרי ורבי יהושע מונה מניסן ויש נפקותא מרובה בדבר במה שקודם מנין של זה למנין של זה חצי שנה

1) For tekufot: This is according to Rabbi Eliezer, who said that the world was created at Tishrei time [near the Autumnal equinox]. Accordingly, the mathematical beginning of our molad and tekufah calculations is the 1st of Tishrei. Rabbi Yehoshua [on the other hand] would regard [the preceding] Nisan [near the Spring equinox] as the mathematical commencement of those calculations. The fact that one of these two epochs precedes the other by half a year creates a significant difference in the matter [of the calculations of the tekufot, as we shall explain].

2) והא דקיימא לן פרק כיצד מעברין (עירובין ד' נו. ושם) דאין תקופת ניסן נופלת אלא בארבעה רבעי היום אם בתחילת היום וכו' היינו משום דהתם כולהו כר' יהושע דתניא בברייתא כוותיה דשמואל סבר כר' יהושע דלר"א בכ"ה באלול נברא העולם ולר' יהושע בכ"ה באדר היינו דכשנברא אדם בששי קדש החדש

2) The principle established in chapter *Keitzad Meabrin* (Eruvin 56a) that [the Shmuelian] tekufat Nisan only occurs at [the beginning of one of] the four quarters of the day [i.e. at 00:00, 06:00, 12:00 or 18:00 hours], is from the perspective of Rabbi Yehoshua's view. Indeed, the entire discussion there is conducted from that perspective and the Beraita's teaching presumes that Shmuel follows Rabbi Yehoshua's view. On Rabbi Eliezer's view, the creation of the world commenced on 25th Elul [five days before 1st Tishrei]. On Rabbi Yehoshua's view, the creation of the world commenced on 25th Adar [five days before 1st Nisan]. This is why when Adam was created on day six, he sanctified [that day as the first of] the month.

3) וזה טעם למחשבי העבור לאחר שצרפו כל השעות והקפה של כל מחזורים שמסירין ז"ט תרמ"ב פי' ז' ימים תשע שעות תרמ"ב חלקים דרגילים לומר לפי שהיתה הלבנה נזופה ע"י שקטרגה ונהגה נזיפה בעצמה ז"ט תרמ"ב *

3) For this reason, it has become common practice for calendar computists [when calculating the tekufot] to deduct 7d, 9h, 642p from the sum of all the cycles and multiples of cycles being counted and their accumulated [excess] hours. They are wont to attribute this deduction to the Moon having been reprimanded for her accusation [against the Sun], saying that she underwent a self-imposed reproach [hiding herself] for a period of 7 days, 9 hours, 642 parts [which is the amount of time by which the molad of Nisan of year 1 succeeded tekufat Nisan of that year].

4) ולא מצינו טעם זה בכל מקום אלא זהו הטעם לפי שהמונה מבריאת העולם לא מונה ר"ה עד יום ששי שנברא אדם הראשון ובשעה תשיעית נצטווה כדאמר פרק אחד דיני ממונות (סנהדרין ד' לח:) ומסתמא אז קדש החדש ומשקדש החדש ע"כ היה המולד ו' שעות קודם דשית שעי מכסי סיהרא ונמצא המולד בתחילת שעה ט"ו דהיא שעה שלישית של יום וסימן וי"ד פי' ביום ו' בסוף שעה י"ד היה המולד מאחר שלא היה ר"ה עד יום ו' שקידש אדם הראשון החדש נמצא שנברא העולם בכ"ה באלול ואותה שנה של תוהו שמונין משום דיום אחד בשנה חֲשׁוֹב שנה

4) But we do not find that reason given anywhere. Rather, this is the reason for the above deduction: In our numbering of the years from creation, the first Rosh Hashanah after creation is reckoned as having occurred on the sixth day of creation, when Adam was created. As mentioned in chapter *Echad Dinei Mamonut* (Sanhedrin 38b), he was enjoined [against eating from the tree of knowledge] in the 9th hour [of daytime] on that day [commencing at 20:0000] and presumably it was at that time that he [saw the first appearance of the waxing crescent Moon and] sanctified [that day as the first of] the [new] month. If so, the molad [of that new month] must have occurred six hours before that time, because for [at least the first] six hours [after conjunction] the [waxing crescent] Moon is not visible. So we find that that molad must have occurred at the beginning of the 15th hour [of that 24-hour day], which is the third hour of daytime. That molad is notated as VYD (6,14:0000), meaning that it occurred on weekday 6 [Friday], at the end of the 14th hour. For [the first] Rosh Hashanah [post creation] was not until day 6, when Adam sanctified [that day as the first of] the [new] month. Thus, [day 1 of] the creation of the world [five days earlier] occurred on 25th Elul of [the preceding year, which is largely theoretical as most of it predated the creation of the world which occurred in its last week, so it is therefore known as] the year of Tohu. Our year count commences with that year as year 1 because [even] a single day [preceding the first Rosh Hashanah following creation] must be accounted as [belonging to] a year [so the first five days of creation are accounted as belonging to the last week of year 1].

In the previous paragraph, the author lays the foundation for our year count in which the last week of year 1 is considered the week of creation and Friday of that week, when Adam was created, was the day of molad Tishrei of year 2. He also specifies when, on that Friday, the molad Tishrei is computed to have occurred, according to the molad calculation of the present-day Jewish calendar. Now, he shows how, from that molad, the moladot of Nisan and Tishrei of the previous year (year 1) may be derived.

5) וכשתדקדק על מולד ניסן של תוהו שלפני תשרי של יישוב שבו נברא אדם תמצא מולד ניסן ברביעי בתשע שעות תרמ"ב חלקים שאתה צריך להשליך ב' ד' תל"ח [ממולד תשרי ש]לאחריו [פי'] ב' ימים ד' שעות תל"ח חלקים ו[כן ל]מולד תשרי של תוהו שלפניו שנמצא ב' ה' ר"ד

5) Let us now focus our attention on the [theoretical] molad of Nisan, six months before the Tishrei of population on [the first day of] which Adam was created. The molad of Nisan [of that year 1] was Wednesday [29th Adar] at 09:0642. This is found as follows: [The excess (**E**) of 12 calendric lunations above 50 whole weeks is 4 days, 8 hours and 876 parts. Therefore, halving those quantities, six lunations exceeds 25 whole weeks by half of **E**, and this amount (**E/2**) which is] 2 days, 4 hours, 438 parts must be subtracted from the molad of the following Tishrei, [Molad VYD, i.e. from weekday 6 at 14:0000, to obtain the molad of the previous Nisan]. And [by the same method] we find that the molad of Tishrei of Tohu [i.e. of year 1] which precedes that Nisan is [on weekday 2, at 05:0204 and is therefore notated as Molad] BHRD.

Having shown how we arrive at the epoch of our molad calculations, the author now shows how we do the same for the epoch of the Shmuelian tekufot.

6) ולתקופה מניסן של תוהו מונין שהיתה התקופה בתחילת ליל ארבעה ונמצאת תקופת תשרי של יישוב של אחריו ביום ד' ט"ו שעות כדאמרינן בפרק כיצד מעברין אין בין תקופה לתקופה אלא תשעים ואחד יום וז' שעות ומחצה נמצא דשתי תקופות ט"ו שעות ונמצא דקדמה תקופת תשרי למולד א' כ"ג פי' יום אחד כ"ג שעות ונמצא דקדמה תקופת ניסן את המולד ז' ט' תרמ"ב דל חצי ~~(שעה)~~ עודפת התקופה על המולד ה' י' תרמ"ב פי' ה' ימים י' שעות תרמ"ב חלקים וכשתצרף ה' י' תרמ"ב עם א' כ"ג עולה ז' ט' תרמ"ב

6) Now the mathematical beginning of our [Shmuelian] tekufah calculations is from [the theoretical] Nisan of Tohu [i.e. of year 1, and that tekufat Nisan occurs] at the beginning of the night [i.e. at zero hours] on Wednesday [22nd Adar]. As stated in chapter *Keitzad Meabrin* [ibid], the period between one [Shmuelian] tekufah (i.e. equinox or solstice) and the next is [a constant] 91 days [which equals 13 weeks] and 7½ hours. Therefore, [the excess of] two [Shmuelian] seasons [above 26 whole weeks] is 15 hours. Thus, we find that the tekufah of the following Tishrei of Population occurs on Wednesday, [Elul 27] at 15:00, which precedes the molad of that Tishrei by **1 day, 23 hours**. [Let us call this quantity **a**.] And [by the following method, working backwards from Molad VYD] we find that tekufat Nisan [of year 1] preceded the molad [of that Nisan] by [**b**, which is] **7 days, 9 hours, 642 parts**. [This **b** is made up of two components as follows:] Take half of the difference (**D**) between a Shmuelian solar year (365¼ days) and twelve calendric lunations, [D = 365,06,0000 − 354,08,0876 = 10,21,0204, so **D/2**, which is the difference between two seasons and six lunations is] 5,10,0642. Add [**D/2** to **a**,] 5,10,0642 + 1,23,0000, and you get [**b**,] **7,09,0642**, [the amount] which must be subtracted [from molad Nisan of year 1 to obtain tekufat Nisan of year 1].

7) והרי עכשיו נוהגין למנות מתשרי של תוהו שנות העולם כדפי' דיום אחד בשנה חֲשׁוּב שנה ותקופת ניסן מונין [מ]מולד תשרי ב' ה' ר"ד וזקוקים להסיר ז' ט' תרמ"ב *

7) The way we number our years nowadays, year 1 of the calendar is the year commencing with the [theoretical] Molad Tohu (BHRD), [which is the epoch] from which our moladot are calculated. As explained above, this is because [even] one day [before the first Rosh Hashanah post creation] must be counted as [part of] a [whole] year. And our tekufot are counted from Nisan [of year 1]. And [to obtain the tekufah epoch,] we must subtract 7d, 9h, 642p [from molad Nisan of year 1].

The reasoning behind the next paragraph is puzzling.

8) ודבר תימה הוא במה נחלקו ר"א ור' יהושע דתניא לקמן (דף יב.) מונין לתקופה מניסן ולמולדות מתשרי והלא היו יכולים לברר הדבר דכ"ד שעות מיכסי סיהרא בין חדתא לעתיקא כדאיתא בסוף פ"ק דערכין (דף ט: ושם) והם מרחיקין המולד זה מזה ב' ד' תל"ח כולי האי אין ראוי לטעות דאיך יטעו בו שני ימים.

8) It is a strange thing that Rabbi Eliezer and Rabbi Yehoshua were in dispute [as to whether the world was created at the Autumnal or Spring equinox, which is why] as stated later (on page 12a), the epoch of our tekufah calculations is from Nisan [of year 1] and the epoch of our molad calculations is from [the previous] Tishrei. They could have resolved the question empirically. As stated at the end of chapter one of Arakhin (9b, ff), the Moon is invisible for a period of 24 hours between the last appearance of the old moon's waning crescent and the first appearance of the new moon's waxing crescent, whereas their respective molad epochs differ by [the excess of six calendric lunations above 25 whole weeks, which is] 2 days, 4 hours, 438 parts [i.e. half of the excess of 12 calendric lunations above 50 whole weeks]. It is not possible to be mistaken by such a large amount as two days.

* Since our tosafist prefaces this comment by saying that this whole discussion is from the viewpoint of Rabbi Eliezer, I am wondering if paragraphs 3 and 7 should perhaps be amended to read as follows.

(In paragraph 3, the quantity mentioned in the ***insertion*** and the ***amended*** quantity at the end are explained in paragraph 6 of this Tosafot. (7d, 9h, 642p − 5d, 10h, 642p = 1d, 23h, 0p.)

3) וזה טעם למחשבי העבור לאחר שצרפו כל השעות והקפה של כל מחזורים שמסירין ז"ט תרמ"ב פי' ז' ימים תשע שעות תרמ"ב חלקים ***(ולא ה' י' תרמ"ב, שהיא חצי עודפת התקופה על המולד)*** דרגילים לומר לפי שהיתה הלבנה נזופה ע"י שקטרגה ונהגה נזיפה בעצמה ***א' כ"ג***

7) והרי עכשיו נוהגין למנות מתשרי של תוהו שנות העולם כדפי' דיום אחד בשנה חשוב שנה, ותקופו**ת מ**ניסן מונין **ומולדות מ**מולד תשרי, ב' ה' ר"ד, וזקוקים להסיר ז' ט' תרמ"ב

Discussion

Some aspects of this Tosafot are troubling. Its author seems to make no distinction between the molad system by which the present-day calendar regulates the commencements and lengths of its months and the observation system of its predecessor, based on the first appearance after each real lunar conjunction of the waxing lunar crescent. The author freely mixes the molad values of the present system with assumptions of practices belonging to the old system.

But we must first ask ourselves why our tosafist makes such assumptions at all. He has Adam, at barely a few hours old, witnessing the first appearance of the waxing crescent moon and, on the basis of that sighting, without ever having experienced even a single cycle of lunar phases before, designating that day as Rosh Chodesh. Moreover, in the words of Tosafot, he sanctifies it as such, when there is nothing to say that he had been commanded by God to follow any observances in relation to the keeping of a calendar. Why should we assume that Adam's actions played any role at all in the Jewish calendar, thousands of years later, counting that day as the day of molad Tishrei of Jewish year two?

Aside from that question, this Tosafot has Adam observing, in broad daylight at two hours after noon, a waxing crescent moon that is only six hours old – a physical impossibility on both counts. Six hours after conjunction is too soon for first visibility of the Moon, and a crescent Moon on its first day of visibility is too close to the Sun to be seen in the daytime, especially when the Sun is so high in the sky.

The Tosafot may not have been astronomers, but were they also ignorant of what the Rambam has to say about when the waxing crescent moon first becomes visible? This is not possible until the Moon has reached an elongation of at least 9°, and even then, only if the vertical separation (the latitude difference) between the Sun and Moon is at least 14°. (http://www.astronomycafe.net/qadir/q947.html and http://www.astronomycafe.net/qadir/q729.html)

Mean elongation increases at about ½° per hour. Assuming the same rate of increase for *true* elongation (over an angular distance of only 9° the difference in time would be negligible), the Moon must be at least 18 hours old to be visible. Even if we are very generous in our estimation of the Moon's speed and assume that the Moon was then at perigee (its closest proximity to Earth), when its motion is fastest, six hours would not be sufficient for visibility.

In any case, the molad values that led our tosafist to this assumption are the mean moladot of our present, fixed calendar, and our tosafist has Adam designating that day as Rosh Chodesh as per the observation system of the old calendar. Experts on the history of the Jewish calendar are in almost universal agreement that our calendric Molad system with Molad Tohu or Molad VYD as its mathematical epoch is based on backward calculation from a true molad (possibly around the time of Hillel II in the middle of the fourth century), which was either determined by calculation or actually observed (in a solar eclipse). By repeated subtraction from that molad of the molad interval (the value adopted by the Jewish calendar as the mean length of a synodic lunation) all the way back to the reckoned year of creation, we arrived at the calendar epoch in use today.

In confusing this system and its mean molad values with the older observation system based on the real moladot, our tosafist seems to have fallen into the same trap that Rashi fell into in his commentary on the rule given by R. Zera in TB Rosh Hashanah 20b. That Rashi is discussed by W. M. Feldman on p. 192 of *Rabbinical Mathematics and Astronomy* as follows:

> "Talmudic authority for this dechiyah *[dechiyat YaCH]* is claimed from the following rule given by R. Zera: "The time of a conjunction is calculated: if it is found to be before 12 o'clock, then one can be certain that the crescent would be visible at about the time of sunset, but if it occurs after 12 o'clock, it is equally certain that the new moon would not be visible at about sunset."
>
> "Notwithstanding, however, the apparently complete parallelism between R. Zera's rule and the *dechiyat YaCH*, it is practically certain that the similarity between the two is apparent rather than real, and is brought about by the word חצות, which means "half" or "middle" i.e. 12 o'clock. For, as the Calendar Council fixed a new month by the time of a *true* conjunction, the quoted passage cannot refer to a *mean* conjunction. On the other

hand, if it refers to a true conjunction, then for visibility there must be a minimum true elongation of 9° (see p. 170), and therefore חצות cannot signify 12 o'clock *noon* – as Rashi translates it – since we must have an interval of 18 hours to produce an elongation of 9°. The conclusion, therefore, seems inevitable that the word חצות must be translated as 12 o'clock *midnight*, which would make the interval between the conjunction and sunset exactly 18 hours – just long enough to increase the elongation to 9° "

It is possible that our tosafist refers to the minimum *mean* elongation compatible with visibility, which is 2½°, as Feldman points out on the same page and on pp. 144 and 165, and which accords with Rambam (*Kiddush Hachodesh* 15:3). And this would be compatible with his use of the mean molad values of the present-day calendar. But this elongation would be attained in only five hours from the molad, not the six hours mentioned by our tosafist, and, in any case, this approach is inconsistent with his assumption of Adam engaging in the practices of the old calendar's method of *kiddush haChodesh* by observation, not to mention the objection raised above to that assumption because of the impossibility of such an observation in those circumstances.

It may occur to the reader to (partially) counter that objection by pointing out that our molad and tekufah times are specified in Jerusalem time, whereas Adam was somewhere further east, and that at 14:00 Jerusalem (civil) time (20:00, JMT) it would have been later in the day for him. I have considered this, but for this to be of any use as a counter argument, Adam would have to have been somewhere in China. And it does not alleviate the objection that a six-hour old Moon would not yet be visible even at a location where the Sun was then setting.

The final paragraph of this Tosafot is the surest sign that the author's understanding of the subject differs greatly from the way others (including Rambam) understood these matters and from the way we generally understand them nowadays. Our tosafist's contention that the molad values adopted for use in the present-day calendar can somehow be of use in resolving, empirically, the dispute between Rabbi Eliezer and Rabbi Yehoshua, defies understanding and does not accord with the way this system is commonly understood. The Chazon Ish also finds this contention problematic.

That paragraph is also, in my view, further evidence of the author's failure to properly differentiate between the fixed arithmetic system of the present calendar and the observation system of that calendar's predecessor. It makes no difference to our present calendar's molad system and its values whether we side with Rabbi Eliezer or with Rabbi Yehoshua in their debate as to when the world was created.

This applies even to Shmuel's tekufah system, which on the face of it appears more consistent with Rabbi Yehoshua's view (and this is certainly how this tosafist saw it, as evidenced by his words in paragraph 2). However, Shmuel's system can be understood as being quite compatible with Rabbi Eliezer's view, as I have argued in my article, Myths and Maths of the Blessing of the Sun. In brief, that argument is as follows: To regard the March equinox (tekufat Nisan) as the nominal "birthday" of the Sun, and therefore the notional commencement of the seasons, is not inconsistent with a belief that the Sun was actually created on the last Wednesday in Elul.

Finally, it is perhaps time to deal with "the elephant in the room" – the great unanswered question: Why does the epochal molad occur some time after the matching tekufah – any such pair, take your pick. For example, assume that the Sun and the Moon were created on the last Wednesday of year 1 (Shmuelian Day Number 353). Tekufat Tishrei of year 2 fell on that day at 15:00 (JMT). Yet the Moon's first (mean) conjunction with the Sun (molad Tishrei of year 2) did not occur until Friday (SDN 355) at 14:0000, exactly 47 hours later.

Our tosafist quite properly dismisses the legend told by the calendar computists that purported to account for this. He explains the legend as having arisen from a simplistic explanation of convenience created to account for a certain arithmetic procedure that the computists habitually performed and to help them remember it. (A modern day parallel to this would be the procedural explanation that is given to young children being taught how to perform a long subtraction like 725 − 481, proceeding from right to left by columns. The instructions go: "Eight (in the subtrahend) cannot be subtracted from two (in the minuend), so we "borrow" 1 from the 7 in the next column," etc.)

But, having dismissed this legend, our tosafist does not find it necessary to seek an alternative answer to the question just raised. And that is no surprise, for indeed it needs none.

It may appeal to our sense of order and symmetry to assume that the Sun, when first created, was placed at one of the two equinoctial points on the ecliptic, and that the Moon, when first created, was placed at conjunction with the Sun, i.e. at New Moon position, but nothing compels such assumptions. In fact, quite the contrary is clear from *Pirkei de Rabbi Eliezer*, in the words of both the author and the major commentary to it. (See my article, Discoveries while searching for a source for the Sun's creation at zero hours.)

Furthermore, such assumptions are based on a major misunderstanding of the nature of the molad system of our calendar and the Shmuelian tekufah system. Neither are meant to be taken as a reflection of astronomical or historical reality. They are approximations created for calendric convenience. This is especially so with regard to the Shmuelian tekufot, which, while possibly being fairly close approximations to the real astronomical tekufot in Shmuel's time, are nowadays (only 17 centuries after Shmuel) 18 days later than the real tekufot, and in Jewish year 1, 39 centuries before Shmuel's time, they preceded the real tekufot by 25 days.

Remember, in relation to what follows next, that traditional Jewish chronology accords a purely theoretical status to most of Jewish year 1 – that is, all but its last week, the week of creation. I should now observe here that Wednesday Adar 22 of that year, which, by our present calendar, is the date of its first tekufat Nisan (the epoch of the Shmuelian tekufot), also precedes the creation according to R. Yehoshua. Our tosafist (in paragraph 2) says, as do others, that on R. Yehoshua's view, the first day (Sunday) of the week of creation was Adar 25th. Clearly a calendar constructed according to R. Yehoshua would be different from our present calendar. But, I repeat, neither our calendric moladot nor Shmuel's tekufot are meant to be taken as representing astronomical reality or the historical reality assumed by traditional Jewish chronology from its interpretation of the biblical account of creation and other biblical chronological data.[5, 6]

And this may also be taken as negating any compulsion to assume, as some read into our Birkat Hachama observance, that the Sun was created at zero hours of the day. Abbaye himself, in his dictum in TB Berachot 59b, often cited as the source for this belief, does not say this. He merely explains that our Birkat Hachama cycle comes about because every 28 years the Shmuelian tekufat Nisan reoccurs at the same time of week (zero hours on Wednesday) as it did at the beginning of the first such cycle – i.e. at tekufat Nisan of year 1. The notion that this implies a belief that the Sun was created at that time of day is an assumption by later commentaries who adduced no foundation for it, and, as evidenced in *Pirkei de Rabbi Eliezer*, it is by no means a universally held belief.

Nor, it should be noted, does Abbaye say that the Sun was created on the date of the first Shmuelian tekufat Nisan. If he believed that to have been the case, it is unlikely that he would have omitted to mention so significant a factor as this and one so relevant to that context.

A comment on Abbaye's statement that may more legitimately be made about the significance of that time of week, is that it calls to mind the biblical account of creation – in particular, the account of the creation of the Sun on the fourth day. And it does so in contrast to the pagan celebrations of the Sun's "birthday" at that time of year (the northern spring equinox) with rites honouring the Sun and other forces of nature as powers in their own right.

Judaism, in celebrating only special birthdays of the Sun (when it occurs at that special time of week), turns that celebration into an act of worship and into a testament that the world has but one God and that the Sun is His creation.

Endnotes

1. It is correctly explained by Rambam (Maimonides) in *MT*, *Kiddush Hachodesh* ch 9. (See also note 2.)

2. The *Chazon Ish* (ibid) in the first paragraph of point 1, constructs the following, mathematically fallacious explanation for the deduction of 7d, 9h, 642p explained by this Tosafot. The seven intercalary months that we insert into every 19-year Metonic cycle are intended to increase the calendar's mean year length to that of a solar year, thus compensating for the shortfall in the length of 12 calendric **L**unations (12**L**) compared to the length of a tropical year (**T**). The Jewish calendar assumes that 19T = 235L, i.e. that T = 235L/19, so the shortfall is 7/19 of **L**.) Since year 1 is largely theoretical, as most of it predates the creation of the world which took place in its last week, he contends that the first Metonic cycle of the calendar consisted of only 18 "real" years instead of the usual 19 years. Nevertheless, it still contains seven intercalary months. Therefore, he writes, the seven intercalations of Metonic cycle 1 overcompensate for that shortfall in cycle 1. This is why, he erroneously states, tekufat Tishrei of year 20 precedes molad Tishrei of that year.

   The fallacy in this reasoning is that it does not take into account that when we create a theoretical year 1 as a mathematical construct (to account for the days of creation preceding Tishrei of year 2), just as we assume, mathematically, twelve full, calendric lunations preceding molad Tishrei of year 2, we also assume, mathematically, four Shmuelian seasons preceding tekufat Tishrei of year 2. In other words, Metonic cycle 1 commenced with year 1, not year 2.

   In a further (minor) arithmetic inaccuracy, he states that the overcompensation amounts to the difference (**D**) between a Shmuelian year and 12L, which is 10d, 21h, 204p, whereas, assuming that there was any substance to his argument, it would be 7L − 18(7L/19), which is about 10d, 21h, 121p. He goes on to say that when calculating tekufat Tishrei of year 20 from molad Tishrei of that year, we must

subtract an adjustment (**A**), which consists of two components: the amount of the overcompensation, **D**, plus the gap (**G**) of 47 hours by which tekufat Tishrei of year 2 preceded molad Tishrei of year 2. Together, D + G come to 12d, 20h, 204p. He says that by using, as the epoch of our tekufah calculations, tekufat Nisan of year 1 rather than tekufat Tishrei of year 1, this is the equivalent of subtracting **D/2**, which accounts for part of **A** and the rest of the adjustment – **D/2** plus **G**, which is 7d, 9h, 642p – is achieved by manually subtracting that amount.

He thus arrives at the same outcome as does Tosafot (and Rambam *MT*, *Kiddush Hachodesh* ch 9), but the reasoning behind it is wrong.

3. The reasoning behind this step in the procedure is, logically, somewhat shaky. The choice of day is, of course, based on the creation story in which the Sun was created on day four. The time may be based on the general assumption that the Sun was created at the very beginning of day four, or possibly, the time zero hours was chosen for mathematical convenience, since this would be the epoch from which all other tekufot are calculated.

   However, it is clear from point 2 in this procedure, that it does not assume the Sun to have been created on this day (the day of T3). In this particular context it is difficult to argue that, since, as a rule (TB RH 12a), we take that view (i.e. R. Yehoshua's view) for purposes of calculating the tekufot, we adopt that belief here. That argument would then leave us with no basis for what was said in point 2, which in turn is the basis for the value (SDN 353) of the minuend of the subtraction in point 5, which gives us the day (SDN 171) of the first tekufat Nisan.

4. The astute reader will not have failed to notice what appears to be an inconsistency between this date of the tekufah epoch and its supposed conformance with Rabbi Yehoshua's view that the world was created in Nisan (which, as our tosafist explains, means that Nisan was the first month of Adam's life). The Wednesday of Tekufat Nisan (T3) is, in our proleptic calendar, SDN 171 (Adar 22), eight days before Nisan 1. This is, however, not the difficulty it initially appears to be. The apparent inconsistency can be reconciled, though at the expense, somewhat, of the dichotomous nature of the resolution (TB RH 12a) of the debate between R. Eliezer and R. Yehoshua. The difficulty in the answer is similar in nature to the difficulty raised in endnote 3.

5. If one wishes to construct a scenario for the creation of the Sun and Moon that accords with those traditions, one can comfortably assume the following. (Several of the traditional commentaries offer one or more variations of the following scenario. The points of difference between their theories are the times of the events, the initial positions within the zodiac at which the Sun and Moon are assumed to have been placed and whether there was some initial delay before the system was set in motion.)

   The Sun and Moon were created near the end of Elul on the last Wednesday of year 1. The Sun was placed in a position relative to the Earth and the stars such that it appeared from Earth to be not far from (but not exactly at) the September equinoctial point on the ecliptic. The Shmuelian tekufat Tishrei of year 2 occurred at 15:00 (JMT) on that day. Assume also, if you like, that the Sun was created at zero hours, JMT, on that day, Jerusalem time. If so, the Sun's creation preceded that tekufat Tishrei by 15 hours. Alternatively, you may choose to assume that it was created at the time of the Shmuelian tekufat Tishrei. Either way, the real astronomical September equinox occurred well after the creation of the Sun, because, as mentioned above, the Shmuelian tekufot were then 25 days earlier than the astronomical equinoxes.

   Assume also that the Moon was placed in a position relative to the Earth and Sun such that its first conjunction with the Sun occurred about two days later, around 14:00 on Friday, which is the molad Tishrei of year 2. Remember, that molad is not a real, astronomical conjunction; it is a calculated, *mean* conjunction of the present calendar's system of fixed-length, calendric lunations, and it did not necessarily coincide with the real molad. But, by that system, tekufat Tishrei of year 2 preceded molad Tishrei by 47 hours.

   On the principle that יום אחד בשנה חשוב שנה – i.e. that even one day preceding that Tishrei must be accounted as belonging to a year, we count the year commencing with that Tishrei (תשרי של יישוב) as year 2 and the preceding days of creation as belonging to the last week of year 1, and we count our years from (the theoretical beginning of) year 1, i.e. from Molad Tohu.

   But we count the Shmuelian tekufot as commencing from tekufat Nisan of year 1, firstly, because the March equinox was widely regarded (in the northern hemisphere) as the Sun's "birthday" and as the notional beginning of the cycle of seasons, and secondly, because of the mathematical convenience that (by the construction of Shmuel's tekufah system) that tekufah occurred at zero hours, and fortuitously – or by design (see my theory in section 7 of Myths and Maths of the Blessing of the Sun) – it was a Wednesday.

6. After writing the above, I was gratified to see that several of my conclusions appear to be supported by the Gaon R. Eliyahu of Vilna in his *Biur haGRA* on *Shulchan Aruch*, *Orach Chayim*, 581:1, quoting RaN.