

Bircas HaChamah and Calendar Mathematics: Precision, Simplicity and Conflict

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Introduction

One of the more infrequent cyclical religious Jewish observances, occurring only once every 28 years, is *Bircas HaChamah* (BH—“Blessing for the Sun”). The last time BH was recited was Wednesday, April 8, 1981 (4th of *Nissan*, 5741), and the next time will be Wednesday, April 8, 2009 (*erev Pesach*, 5769). The fact that *Bircas HaChamah* is always recited on a Wednesday (and for our era, on April 8) is the result of three preconditions:

1. The vernal equinox (VE, used interchangeably with *Tekufas Nissan*—TN) in year 1 of Creation occurred at sunset on Tuesday, 6:00 p.m. (Wednesday starts at sunset on Tuesday),¹
2. The solar year is exactly 365 days and 6 hours,
3. The four *tekufos* of the year, i.e.,
 - VE,
 - Summer solstice (SS)—also called *Tekufas Tamuz*,
 - Autumnal equinox (AE)—also called *Tekufas Tishrei* (TT),
 - Winter solstice (WS)—also called *Tekufas Teves*
 are each exactly 91 days and 7.5 hours apart.²

¹ The word equinox literally means equal night, i.e., when the length of day and night are the same. In fact, this is not exactly correct. The equinox is at the time when the sun is crossing the celestial equator. At that time, day and night are almost, but not exactly, equal at all latitudes, and so we call it the equinox (see <<http://www.nmm.ac.uk/server/show/conWebDoc.3843>>). For purposes of the Jewish calendar, by convention, at the equinox the day goes from 6 p.m. to 6 p.m.

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Based on 2, a solar year is exactly 52 weeks and 1¼ days long. In 28 years, the accumulation of the yearly excess 1¼ days is 35 days, or exactly five weeks. Thus, VE occurs every 28 years at exactly the same time of the week that it was during year 1 of Creation. Since the VE currently occurs every 28 years at 6:00 p.m. (sunset) on Tuesday, April 7, we recite the prayers for BH the next time the sun rises, i.e., the morning of Wednesday, April 8.

Talmudic and post-Talmudic support for BH is based on a model of the Sun's orbit advocated by Shmuel (2nd-3rd century *amora*). This paper reviews Shmuel's statements concerning the solar year, and Rambam's and Ibn Ezra's comments on the inaccuracy of his model. We demonstrate that BH and another prayer-related practice whose starting date is determined by Shmuel's solar model openly contradict the requirements on which they are premised, and pose a problem that may not be easily resolved.³

History of the Jewish Calendar

The Jewish calendar as we know it today is reported to have been first implemented in the middle of the 4th Century CE.⁴ The most

² Depending on when the year is considered to start, this condition may not be necessary. We will discuss this in more detail later in the paper (e.g., footnote 64).

³ We will at times discuss a *gemara* in a footnote prior to mentioning it in the body of the paper. When we then discuss the same material in the body of the paper we will also reference the prior footnote so that the reader can return to it.

⁴ See, for example, Rambam *Kiddush HaChodesh* (KH) 5:3 ומאימתי התחילו כל ישראל לחשב בחשבון זה, מסוף חכמי תלמוד בעת שחרבה ארץ ישראל, ולא נשאר שם בית דין קבוע; אבל בימי חכמי משנה, וכן בימי חכמי תלמוד עד ימי אביי ורבא—על קביעת ארץ ישראל היו סומכין

Abaye was born at the close of the 3rd century and died in 339. Rava lived from 270 to 350. There is discussion in the literature as to whether some parts of the fixed calendar system were in place prior to the mid-4th century, e.g., Ajdler "Rav Safra and the Second Festival Day: Lessons about the Evolution of the Jewish Calendar," *Tradition*, Winter 2004, 38(4): 3-28. There are also those who insist that while the rudiments of the fixed system may have been in place in the 4th century, the totality of the system we have today was in place no earlier than the

important characteristics of our fixed calendar are:⁵ the specification of when the year begins; that it primarily consists of alternating 29- and 30-day months; the specification of which years are leap years (i.e., they have an extra *Adar*). Up until the introduction of the fixed calendar any month could be either 29 days (if witnesses came to the *Sanbedrin* and testified that they had seen the new moon on the night after the 29th) or 30 days. The determination of when to have a leap year depended on several factors of which the most important was that the first day of *Pesach* (15th of *Nissan*) could be no earlier than the first day of spring (VE).⁶ If calculations showed that without any changes *Pesach* would start too early, an extra *Adar* was added. However, even in times when *Pesach* would have started after the onset of spring, there were secondary and tertiary reasons for adding another *Adar*, e.g., the crops had not grown sufficiently and it would not have been possible to bring the *Korban Omer* on the second night of *Pesach*;⁷ the winter was long and difficult and the conditions of the

10th century. See Loewinger, Bar Ilan University 'דף שבועי מספר רמח' תשנח ואתחנן, פרשת ואתחנן, <<http://www.biu.ac.il/JH/Parasha/veethcha/lev.html>>.

⁵ For a concise but rigorous description of the Jewish Lunar System, its underlying assumptions and its mathematical nomenclature, see Epstein, Dickman, and Wilamowsky, "A 5765 Anomaly," *Tradition*, Fall 2004, 38(3):40-59.

⁶ Rambam KH 4:2. על שלושה סימנין מעברין את השנה—על התקופה, ועל האביב, ועל פירות האילן. כיצד—בית דין מחשבין, ויודעין: אם תהיה תקופת ניסן בשישה עשר בניסן, או אחר זמן זה—מעברין אותה השנה, ויעשו אותו ניסן אדר שני, כדי שיהיה הפסח בזמן האביב; ועל סימן זה סומכין ומעברין, ואין חוששין לסמן אחר.

⁷ Rambam KH 4:3. וכן אם ראו בית דין שעדיין לא הגיע האביב, אלא עדיין אפל הוא, ולא צמחו פירות האילן, שדרכן לצמוח בזמן הפסח—סומכין על שני סימנין אלו, ומעברין את השנה; ואף על פי שהתקופה קודם לשישה עשר בניסן, הרי הן מעברין, כדי שיהיה האביב מצוי להקריב ממנו עומר התנופה בשישה עשר בניסן, וכדי שיהיו הפירות צומחין כדרך כל זמן האביב.

Rambam starts by saying that only the absence of both אביב and פירות justifies declaring a leap year. He concludes by saying that the reason for this is the need of the *Omer* sacrifice and fruit as befits spring. ערוך רשי ד"ה אביב says that Rambam agrees with Rashi's second explanation that *aviv* refers to the *Omer*. Thus, in a period where there is no Temple and therefore no *Omer*, an extra month is not added

roads would have prevented people from being *oleh regel*; ovens were not in condition to broil the *Korban Pesach*, etc.⁸

Since the non-primary reasons for inserting an extra *Adar* are related to the *Omer*, being *oleh regel*, and eating the *Korban Pesach*, these considerations would have been limited to periods in time when these actions were mandatory. From an historical and practical perspective, all of these three activities ceased a short time after the destruction of the Second Temple when, after the Bar Kochba revolt of 132-135 CE, Emperor Hadrian totally destroyed *Yerushalayim*, rebuilt it, and renamed it Aelia Capitolina, and banned Jews from going there. This ban stayed in effect until 438 CE when Empress Eudocia permitted Jews to once again live there. As a result, with respect to the Jewish calendar, we have three periods with different rules for adding leap years:⁹

on the status of the fruit crop alone. *Aruch L'Ner's* explanation is supported by a statement of Shmuel (*Chullin* 95b): כולהו שני דרב הוה כתב ליה רבי יוחנן לקדם רבינו שבבבל כי נח נפשיה הוה כתב לשמואל לקדם חבירינו שבבבל אמר לא ידע לי מידי דרביה אנא כתב שדר ליה עיבורא דשיתין שני אמר השתא ידע חושבנא בעלמא ידע. The *Gemara* implies that Shmuel, because of his mathematical expertise, was able in *Bavel* to determine many years in advance whether the *Bais Din* in *Eretz Yisrael* would declare a leap year. Since Shmuel lived after the destruction of the Temple, there was no *Omer* in his lifetime. If the absence of the *Omer* is sufficient on its own to eliminate this second category of reason from causing a leap year, then we understand Shmuel's predictive ability based solely on his knowledge of when VE occurs. If, however, the absence of fruit on its own could cause the need for a leap year, then it would be impossible for Shmuel to make any long-range predictions about leap years. We discuss *Chullin* 95b in depth in a later section.

⁸ See Rambam KH 4:5.

⁹ Rambam never specifically says that in the post-Temple period the non-primary reasons were not applicable. Perhaps this is implied in the following *halachah*: קי"ה י: מראין לי הדברים, שעל חשבון תקופה זו היו סומכין לעניין עיבור השנה בעת שבית דין הגדול מצוי, שהן מעברין מפני הזמן, או מפני הצורך—לפי שחשבון זה, הוא האמת יותר מן הראשון... Rambam says that a certain calculation was employed during the time that the calendar was determined by *בית דין הגדול*. Note that in KH 5:3 (cited in footnote 4, Rambam said that a calendar system based on "sighting" remained in

<u>Time Period</u>	<u>Adar Added</u>
Before 70 CE.	For primary, secondary, and tertiary reasons.
70 CE–mid-4 th Century. ¹⁰	If <i>Pesach</i> would begin before spring.
After mid-4 th Century.	Fixed 7 in 19 years.

Whereas spring starting before the 15th of the month even without a second *Adar* did not preclude *Bais Din* from adding it prior to 70 CE, it did from 70 CE to the mid-4th Century. A 3rd-century astronomically knowledgeable person could thus know well in advance without receiving direct information from *Eretz Yisrael* as to whether a year would have a second *Adar*. This person, however, would still not know the precise date of any day in the year without being told from *Eretz Yisrael* because he could not predict for any month when witnesses would testify that they first saw the new moon.¹¹

effect as long as there was a **בית דין קבוע** in *Eretz Yisrael*. We suggest that this latter court of law is not the **בית דין הגדול** of KH 10:6 which employed both primary and non-primary reasons for instituting a leap year, but rather a post-Temple court that only considered the primary reason of the start of spring. (With respect to the accuracy of our wording of KH 10:6 see Loewinger “על השמינית” footnotes 64 and 65 for the following variant readings based on a manuscript dating to the last decade of the 16th century (available at <<http://www.daat.ac.il/daat/v1/alhashminit/alhashminit04.pdf>>.) **נראין לי הדברים, שעל חשבון תקופה זו היום סומכין לעניין עיבור השנה בשעה שאין בית דין הגדול מצוי, שאין מעברין מפני הזמן, או מפני הצורך—לפי שחשבון זה, הוא האמת יותר מן הראשון** Note how the boldly highlighted words change the meaning of the text.)

¹⁰ With the possible exception of 70 CE to 135 CE which was after the destruction of the Second Temple, but before Jews were banned from *Yerushalayim*.

¹¹ We will discuss later how a 3rd-century person could be certain whether a second *Adar* would be added even though he could not know for sure which day was the 15th of the month.

Tekufas Shmuel

The assertion that a year has exactly 365 days and 6 hours and that all successive *tekufos* are 91 days and 7.5 hours apart is known in Post-Talmudic literature as *Tekufas Shmuel*.

עירובין נו. אמר שמואל אין תקופת ניסן נופלת אלא בארבעה רבעי היום או בתחלת היום או בתחלת הלילה או בחצי היום או בחצי הלילה ואין תקופת תמוז נופלת אלא או באחת ומחצה או בשבע ומחצה בין ביום ובין בלילה ואין תקופת תשרי נופלת אלא או בשלש שעות או בתשע שעות בין ביום ובין בלילה ואין תקופת טבת נופלת אלא או בארבע ומחצה או בעשר ומחצה בין ביום ובין בלילה ואין בין תקופה לתקופה אלא תשעים ואחד יום ושבע שעות ומחצה ואין תקופה מושכת מחברתה אלא חצי שעה.

It is not clear from the *gemara* with respect to which, if any *halachos*, Shmuel made this statement. Today, we use Shmuel's solar model in two halachic matters:

1) Determining when to do BH based on the VE:

ברכות נט: תנו רבנן הרואה חמה בתקופתה לבנה בגבורתה וכוכבים במסילותם ומזלות כסדרן אומר ברוך עושה בראשית ואימת הוי? אמר אביי כל כ"ח שנין והדר מחזור ונפלה תקופת ניסן בשבתאי באורתא דתלת נגהי ארבע.

רמבם ברכות י"ה—הרואה את החמה ביום תקופת ניסן של תחילת המחזור של שמונה ועשרים, שהתקופה בתחילת ליל רביעי—כשרואה אותה ביום רביעי בבוקר, מברך עושה בראשית...¹²

¹² There is in fact disagreement with the concept of BH as expressed by Abaye's interpretation of the *beraisa* and how we practice it. The *Tosefta* says: **ברכות ו:** וי את החמה ואת הלבנה ואת הכוכבים ואת המזלות כסדרן אומר ברוך... עושה בראשית... This appears to be dealing with the same issue as the *beraisa* but uses the word *כסדרן* with respect to the sun rather than *בתקופתה*. The *Yerushalmi's* phraseology (also found in *כג:ה*) is: **ברכות ט:ב**... הרואה את החמה בתקופתה ואת הלבנה בתקופתה (ויקרא רבה ואת הרקיע בטיהרו. אומר ברוך עושה בראשית. אמר רב חונה הדא דתימר בימות הגשמים בלבד לאחר שלשה ימים. הה"ד (איוב לז) ועתה לא ראו אור וגו' *Yerushalmi* does not relate *חמה בתקופתה* with TN but to when the sun is not visible for at least 3 days and then reappears (similar to what happened at Creation when there was no sun for the first three days). See

שו"ע או"ח רכט:א—הרואה חמה בתקופתה והוא מכ"ח לכ"ח שנה
והתקופה בתחלת ליל ד' כשרואה אותה ביום ד' בבקר אומר...

As mentioned in the Introduction, the conditions for saying the prayer are currently met on April 7 and BH is recited the morning of April 8. Although the solar calendar date for reciting BH is publicized and well known, it is not mentioned in major *poskim* up to and including *Aruch HaShulchan* and *משנה ברורה* who lived at the start of the 20th century. *Aruch HaShulchan* does say that BH will next be recited on Wednesday morning in תרנז (1897) but gives no specific date in the Hebrew (lunar) or solar Calendar for the recitation. *חתם סופר* does comment that in תקעג (1813) BH is recited on the 7th of *Nissan*. Similarly, *מערכת חנוכה* (right after *שדי חמד* and *כף החיים* או"ח רכט:ז) both say that BH was recited in תרנז on the 5th of *Nissan*.

2) *שמונה עשרה* in ותן טל ומטר

who attempts to reconcile *Yerushalmi's* explanation with Abaye's explanation and what we practice. The authoritativeness of the text in *Bavli* is also in question. גליון השם says that ערוך did not have our text with Abaye, and interprets the *beraissa* to mean exactly the same as the *Yerushalmi*. הגאות מיימון also cites the *Aruch* as to what the *Gemara* is referring. מאירי (*Berachos* 59a) first offers Abaye's explanation of the *beraissa* without attributing it to him or the *gemara* and then offers a *יש מפרשים* that בתקופתה means כהירותה (presumably like the *Yerushalmi*). See also Solomon Gandz ("The Benediction Over the Luminaries and the Stars," *The Jewish Quarterly Review*, vol. 44, no. 4, April 1954, pp. 305-325) who argues that Abaye's statement is a later addition to the *Gemara*. One of his proofs is Saadiah Gaon's *Siddur* (p. 90) which makes no mention of BH related to *Tekufas Nissan* but offers a third explanation for חמה בתקופתה — ועל השמש ביום — תקופת תמוז מברכין ג"כ עושה בראשית *Tekufas Tamuz* (SS) not VE. Gandz argues that if Saadiah Gaon had our *Gemara* text with Abaye, he never would have said this. He furthermore suggests that Saadiah Gaon understood בתקופתה to mean "at its strength" or maximum point. This is represented at the time of the SS when the day is at its maximum. We will discuss this issue in more detail later in the paper.

תענית י ...א"ר אלעזר הלכה כרבן גמליאל תניא חנניה אומר ובגולה עד ששים בתקופה אמר רב הונא בר חייא אמר שמואל הלכה כחנניה.¹³

רמבם הלכות תפילה ב:טז משבעה ימים במרחשוון, שואלין את הגשמים בברכת השנים, כל זמן שמזכיר הגשם. במה דברים אמורים, בארץ ישראל; אבל בשנער ובסוריה ובמצריים ומקומות הסמוכין לאלו והדומין להן, שואלין את הגשמים ביום שישים אחר תקופת תשרי.

¹⁴**בית יוסף אורח חיים קיז** וכתב בהגהות מיימון פ"ב וק"ל דיום תקופה מתחיל נמצא כשעברו נ"ח ימים מן התקופה שואלין בתפילת ערבית שהיא תחילת נ"ט. וכתב הר"ד אבודרהם ויום ס' יבוא בכב "מניבי"מברי אם היה אותו פיבריי"ר מכ"ח יום אבל אם היה ¹⁵פיבריי"ר מכ"ט יום תהיה השאלה בכ"ג גוביי"מברי ...

Avudraham identifies November 22/23 as the 60th day of the *tekufah*. Since a "Jewish" day starts at sunset and **ותן טל ומטר** is begun at

¹³ Although we start **ותן טל ומטר** based on *Tekufas Shmuel, Taanis* 10a continues: איני והא בעו מיניה משמואל מאימת מדכרינן ותן טל ומטר אמר להו מכי מעיילי ציבי לבי טבות רישבא דילמא אידי ואידי חד שיעורא הוא *The Gemara* questions Shmuel's affirmation of Chananya when he offers a starting point of **טבות רישבא** (see commentators on meaning of the term)? *The Gemara* answers that **טבות רישבא** is identical to the 60th day after the *tekufah*. If so, why did he offer an alternate way of saying it? We will address this later.

¹⁴ This quote is from the new **מפעל הטור השלם** edition of Tur. Older editions of Tur have additional words. We will discuss these other versions in the next section.

¹⁵ Avudraham means if the February following November has 29 days. His reference to the following February as being "this year" can be explained 2 ways:

- February of the next solar calendar year is part of the Jewish year starting the previous *Tishrei*. Hence, it is "this year" in our lunar terminology
- In Avudraham's time, many countries did not start the new solar year January 1 (as we do today) but at VE. Since February occurs before VE, it is in the same solar year as the previous November (**תשבץ**).

מעריב, he must mean¹⁶ that the recitation starts at sunset on November 21/22. We currently start at sunset on December 4/5.¹⁷ In the next section we explain why the dates have changed.¹⁸

Although no solar calendar date for reciting BH is explicitly mentioned in the *poskim*, if BH and ותן טל ומטר are both based on Shmuel, the former can be extrapolated from the latter. To demonstrate how this can be done, we pick an arbitrary year in the time of Avudraham (14th century), 1337, which is exactly $24 \times 28 = 672$ years prior to 2009. Based on all of the above, we know the following about the year 1337:

- BH was recited—Reason: It is a multiple of 28 less than 2009,
- ותן טל ומטר started on November 22nd eve—Reason: 1338 was not a leap year.
- *Tekufas Tishrei* was sometime between sunset on September 23rd and sunset on September 24th—Reason: ותן טל ומטר starts on the 60th day after TT (see bolded dates on a calendar of year 1337 at the end of this paper),
- VE was sometime between 3 a.m. March 25th and 3 a.m. March 26th—Reason: 182 days and 15 hours (half a year) before TT (see italicized dates on calendar).
- March 25, 1337 was a Tuesday—See 1337 calendar.
- VE was 6:00 p.m. March 25, 1337—Reason: 1337 is a BH year,

¹⁶ There are some who read this to mean at sunset the nights of November 22/23 (e.g., <<http://www.judaic.org/halakhos/talumatar.pdf>>). As is evident from the computations which we give in the next paragraph, this cannot be correct.

¹⁷ Thus, Avudraham would call this December 5/6.

¹⁸ Avudraham (13th-14th Century) lived in Seville, Spain. Seville had for centuries been under Islamic rule but not long before Avudraham's time, came under the control of Catholic monarchs. Islam uses a lunar calendar that makes no adjustments to reconcile lunar and solar years, and we cannot say how Jews living in Islamic lands yearly identified the starting date of ותן טל ומטר (i.e., the Jewish calendar date and Islamic calendar date of 60 days after TT would change from year to year). We are not familiar with any earlier *posek* linking the start of ותן טל ומטר to a solar calendar day. Perhaps it was Avudraham's living under Catholic rule that influenced him to give a solar date that would make it easier for everyone to know when the recitation of the prayer begins.

- TT was 9:00 a.m. September 24th—Reason: 182 days and 15 hours after VE.

Thus, using *Tekufas Shmuel* we can extrapolate that had Avudraham given a secular date for BH it would have been the morning of March 26.

According to Shmuel, VE and TT are 6 hours later with each passing year (with the exception of a secular leap year where 1 day is deducted). Using this, Table 1 generates the list of solar dates and times of VE and TT for 1337, as well as the starting date for ותן טל ומטר for the four-year period 1335-1338. These dates must subsequently also be identical for every successive four-year period ad infinitum. Table 1 shows these starting times for the current parallel four-year period 2007-2010. In the next section we discuss why the dates we use today for BH and ותן טל ומטר are so different from these numbers.

Although we derived the date of VE by extrapolating backwards from Avudraham's dating of ותן טל ומטר, the calculation was most likely done in the reverse order. Rambam and Ibn Ezra offer detailed instructions on how to calculate VE for any Jewish year (age of the

Table 1

<u>Year</u>	<u>Vernal Equinox</u>	<u>Tekufas Tishrei</u>	<u>Start of ותן טל ומטר</u>
1335, 2007	26-March 6:00 a.m.	24-September 9:00 p.m. ¹⁹	23-November ²⁰
1336, 2008	25-March Noon	24-September 3:00 a.m.	22-November
1337, 2009	25-March 6:00 p.m. ²¹	24-September 9:00 a.m.	22-November
1338, 2010	26-March Midnight	24-September 3:00 p.m.	22-November

¹⁹ Since the Jewish day starts at 6:00 p.m. we call this September 25. Thus except for a year preceding a solar leap year, e.g., 1335 and 2007, Shmuel's TT is September 24. This is the reason for Avudraham's relating the start of ותן טל ומטר to a leap year.

²⁰ All dates in this column mean the prayer is started at *Maariv* on the day before.

²¹ I.e., March 26. Thus, with the exception of a leap year, VE is always on March 26.

World—Anno Mundi—AM) assuming only that at Creation VE preceded the *molad* of *Nissan* by about 7.4 days.²² Rambam KH 9:9-11 details an elegant algorithm that gives the exact date in the Jewish calendar for VE. His algorithm includes a variety of divisions, multiplications, and additions, including one variable that changes with the passing of time. Rambam gives the value of the variable for his era but does not give a rule for how it changes with time. He offers an example for the year 4930 (1170 CE)²³ and shows that VE according to *Tekufas Shmuel* is on the 8th of *Nissan*. Ibn Ezra's method for calculating the Jewish date of the VE involves intensive mathematical calculations which keep track of the difference between VE and *molad Nissan* since Creation. Ibn Ezra applies his methodology to calculate the onset of spring for the year 4918 (1158 CE).²⁴

For historical background information, Shmuel was born in 165 CE, died in 257 CE, and lived outside of *Eretz Yisrael* (in *Bavel*). Since calendrical issues in the pre-fixed calendar era were exclusively under the full control of the Rabbis in *Eretz Yisrael*,²⁵ Shmuel as a Diaspora resident would have no say in its determination. In one interesting correspondence between Shmuel and R. Yochanan (an *Eretz Yisrael Amora*) we find

חולין צה:כולהו שני דרב הוה כתב ליה רבי יוחנן לקדם רבינו שבבבל כי
נח נפשיה הוה כתב לשמואל לקדם חבירינו שבבבל אמר לא ידע לי מיד

²² To be more precise: 7 days, 9 hours and 642 *Chalokim* (1080 *Chalokim*= 1 Hour).

²³ See <<http://www.Hakirah.org/Vol 6 Epstein Appendix.pdf>> for a discussion of how these calculations can help shed light on when Rambam wrote *Mishneh Torah*.

²⁴ There is one other possible halachic application of *tekufos*. רמ"א, יו"ד says it is a custom not to drink water at the time of any *tekufah* because historically at each of the four *tekufos* bad things associated with water happened. This issue is mentioned and rejected by Ibn Ezra in *Sefer HaIbbur* with the following comment: וכבר שאלו חכמי קרוואן לרבינו האי ז"ל למה נהגו שלא לשתות מים בשעת התקופה? והשיב ניהוש בעלמא הוא... ויש מן הגאונים שאמר על התקופה כי לא ניהוש ביעקב ולא קסם אבל הקדמונים תקנו אלא הדברים להפחיד שייראו מהשם ולא יוסיפו הרשעים לרשוע וישונו מדרכם למען יצילם השם מהארבעה תקופות...

²⁵ KH 5:1.

דרביה אנה כתב שדר ליה עיבורא דשיתין שני אמר השתא חושבנא
בעלמא ידע.

Note that Shmuel did not send a full 60-year calendar to R. Yochanan but rather only a list of which years would be regular/leap. As mentioned previously, this ability would be within the grasp of any 3rd-century astronomically sophisticated scholar. R. Yochanan's reason for rejecting Shmuel's display of erudition is not clear. Was it because Shmuel simply showed that he was a good astronomer but not that he merited the title *Rav*? If so, why did R. Yochanan phrase his dismissal in terms of חושבנא, mathematics, rather than astronomy? In the next section we discuss this *gemara* in greater depth.

Julian and Gregorian Calendars: Length of the Year

The Julian calendar was introduced in 45 BCE, more than 200 years before the birth of Shmuel, and it, too, was based on a 365-day-and-6-hour year. The Julian calendar was a solar calendar and differed from the Gregorian calendar in use today in that it always added an extra day, February 29, every 4 years. Since the four seasons of the year are solar related, one of the objectives of a solar calendar is to create a system where each season begins on or about the same date every year. Because a solar year is, in fact, very close to 365 days 5 hours 48 minutes and 45 seconds, the Julian calendar overstated the length of a year and, as a result, over time the cumulative effect of the approximately 11.25 extra minutes per year was to add an extra day in about every 128 years.²⁶ Thus, the start of spring moved earlier and earlier on the Julian calendar date. By 1582 CE, the VE, which in 45 BCE when the Julian calendar was first instituted occurred on or about²⁷ March 25th, had now moved earlier by almost 13 days and occurred around March 11.

²⁶ I.e., $128 * 11.25 = 1440$ minutes = 1 day.

²⁷ See, for example, <<http://www.geocities.com/calendopaedia/julian.htm>>. The dating of VE in 45 BCE as the 25th of March is consistent with our extrapolation of Avudraham's calculations in the previous section of VE being on March 25/26. Elkin "Birkath Hachamah: Blessing of the Sun," *Proceedings of the Association of Orthodox Jewish Scientists*, VI (1980), p. 96 writes: "When Julius Caesar, in Talmudic days, adjusted the calendar, he set up the Vernal Equinox on March 25th. But,

since it started at 6 p.m. of that day, in the Jewish calendar it was considered the equivalent of March 26th.” Elkin offers no source for this assertion. Others suggest that the VE of the early Julian period was either March 24 or March 25. In actuality, no assertions about the exact date people in the ancient world considered the VE to fall can be stated with certainty. Even though it may be possible by calculation to precisely determine when VE occurred in ancient times, the results of these calculations need not match up with the historical reports of when VE allegedly occurred then, for the following several reasons:

- March 25th cited for VE of 45 BCE is the Mean VE. Actual VE in that year was on March 23rd. In 1582 when they reset the calendar they set VE at the actual VE of 325 (see discussion of Gregorian calendar later in this section). The Mean VE was preferred for calendar purposes by Sosigenes (Julius Caesar’s calendar expert). The nearly 2-day difference between the Mean and actual VE is also cited in Rambam:

קידוש החודש י:ז וחשבון שתי התקופות האלו שביארנו דרכם, הכול בקירוב הוא, ובמהלך השמש האמצעי, לא במקומה האמיתי; אבל במקום השמש האמיתי תהיה תקופת ניסן בזמנים אלו, בכמו שני ימים קודם שתי התקופות שיוצאין בחשבון זה, בין בחשבון מי שמחשב רביע יום גמור, בין למי שמחשב לפחות מרביע יום.

Rambam cannot be referring to how much time VE had moved from Shmuel’s times to his, because in the almost 900 years between them (3rd century to 12th century) the actual VE would have moved $900/128=7$ days.

- What was called March 25 in 45 BCE is not the same as March 25 in the retrojected Julian calendar. This is because from 45 BCE to about 4 CE, the actual calendar of the Romans was irregular and did not yet conform exactly to the rules of the Julian calendar. Thus for the actual VE of 45 BCE: Julian (retrojected) 23 March = Roman 25 March.
- When the ancients were talking about the actual VE, their way of calculating it was far less precise than ours. Thus, what we reckon today as the actual VE is not necessarily the same as the ancient reckoning.

When discussing VE, it is therefore important to look at the values given in ancient sources, regardless of whether they are consistent with projections based on modern astronomical data, and to keep in mind that not all references to VE refer to the same astronomical event. In this paper we will begin our discussion with the assumption that VE occurred originally on March 25/26. We will on occasion use the dif-

To halt this “drift”, the Julian calendar was dropped the day after Thursday October 4, 1582 and replaced by the Gregorian calendar.²⁸ The rules for the new and old calendars are identical with the one exception that centurial years (i.e., divisible by 100) are all leap years in the Julian (i.e., they are divisible by 4) but are not in the Gregorian unless also divisible by 400 (e.g., 1900 is not a leap year; 2000 is). This “correction” brings the average length of a solar calendar year to 365 days, 5 hours, 49 minutes and 12 seconds.²⁹ While this is still more than the actual solar year, the difference is small enough so that a change of one day does not occur for over 3200 years.³⁰

In addition to “tweaking” the calendar model, the first day of the Gregorian calendar was declared to be Friday October 15, instead of October 5. By dropping 10 days VE was pushed to March 21 which is what it was in 325 CE at the time of the Council of Nicaea.³¹ That Council had established the doctrines of the Catholic Church and had severed the observance of Easter from its dependence on the Jewish

ferent VE’s to explain discrepancies between what we know to be true and what we find in ancient texts. (For the sake of completeness we offer the following definitions of Actual and Mean VE:

Actual VE: When the actual sun, moving non-uniformly along the ecliptic, is at the first point of Aries

Mean VE: When an imaginary sun moving uniformly, at the annual speed of the true sun along the ecliptic, is at the first point of Aries.)

²⁸ The new calendar was not accepted throughout the world at the same time. It was initially accepted in Italy, Poland, Portugal, and Spain. Shortly afterward it was adopted by other Catholic countries. However, Protestant countries were reluctant to change, and Greek Orthodox countries didn’t change until the 1900s. Below is a partial list of some of the countries that adopted it at a later time:

Britain, the British Empire, and the eastern part of the USA: 1752; Alaska: 1867; Russia: 1917; Greece: 1923.

²⁹ To see this, note that in 400 years there are 97 leap years (3 centurial years are not divisible by 400). An average year is then $(400 \times 365 + 97) / 400$ days.

³⁰ The Gregorian year overstates the true year by about 27 seconds. Thus in 3200 years the calendar overstates reality by 27×3200 seconds = 1 day.

³¹ In the 1257 years (i.e., 1582-325) since the Council, the Julian calendar overstated the true year by about 9.8 days (i.e., $1257 / 128$).

calendar.³² Thus, starting in 1582, Julian dates were 10 days behind their Gregorian counterparts. This difference remains constant until a centurial year which is not divisible by 400. At these centurial points the differential between the two calendars increases by 1 (i.e., the Julian calendar adds a day, the Gregorian does not). At present, the Julian calendar is 13 days behind the Gregorian calendar and has been so since 1900 CE.³³

In the previous section we cited Avudraham that וְתַן טַל וּמָטָר starts on November 22/23 and extrapolated that VE occurs every 28 years at 6:00 p.m. on March 25. Avudraham lived before the Gregorian calendar and his dates are Julian. Adjusting for the current 13-day difference in the two calendars, we get the *Maariv* of the night of December 4/5 as the start of וְתַן טַל וּמָטָר and April 7 for VE on the Gregorian calendar for a BH year.

While our current practice for both וְתַן טַל וּמָטָר and BH are completely consistent with Avudraham's dating system according to *Tekufas Shmuel*, the question, however, is whether these dates in fact represent what they allege, i.e., is December 4/5 60 days after the actual TT and is April 7 the day of VE in a BH year³⁴? With respect to VE, Table 2 lists the Hebrew dates³⁵ of the last 10 and next 10 BH recitals. April 8th both for the last time BH was said in 1981 and for the next time it will be said in 2009 are pre-*Pesach*. Interestingly enough, every date we have found cited in earlier works concerning

³² Easter commemorates the Last Supper which is the *Pesach Seder*. Until 325, Easter was celebrated based on the Jewish calendar.

³³ I.e., between 1582 and today there have been 3 centurial years satisfying this condition: 1700, 1800, and 1900. 1600 and 2000 were leap years in both calendar systems and did not affect the time differential between them.

³⁴ We note that there are other religious groups that observe their holidays based on the Julian calendar despite its inaccuracy and refuse to accept the Gregorian changes. For example, the Orthodox churches of Jerusalem, Russia, Serbia, Georgia and the Greek Old Calendarists celebrate the Nativity on 25 December in the Julian calendar, which is 7 January in the Gregorian calendar until 2100.

³⁵ We used a date-converter available at: <http://www.hebcal.com/converter/?gd=6&gm=4&gy=1729&g2h=Compute+Hebrew+Date&hd=16&hm=Nisan&hy=5517>.

the recitation of BH are all before *Pesach*.³⁶ However, of the 20 dates cited in the Table, 6 are after the start of *Pesach* and 4 of them are after the end of *Pesach*. All of these violate the requirement that *Pesach* start after the onset of spring (VE). If Shmuel is correct, then our Jewish calendar is ill designed and violates a basic tenet of what Rambam says is a required ³⁷הלכה למשה מסיני for a fixed calendar.

Table 2

Last 10 BH Years	Year in 19-Year Cycle	Date of BH	Next 10 BH Years	Year in 19-Year Cycle	Date of BH
1729	17	<i>Nissan 7</i>	2009	12	<i>Nissan 14</i>
1757	7	<i>Nissan 16</i>	2037	2	<i>Nissan 23</i>
1785	16	<i>Nissan 26</i>	2065	11	<i>Nissan 2</i>
1813	6	<i>Nissan 7</i>	2093	1	<i>Nissan 12</i>
1841	15	<i>Nissan 16</i>	2121	10	<i>Nissan 21</i>
1869	5	<i>Nissan 26</i>	2149	19	<i>Nissan 2</i>
1897	14	<i>Nissan 5</i>	2177	9	<i>Nissan 11</i>
1925	4	<i>Nissan 14</i>	2205	18	<i>Nissan 19</i>
1953	13	<i>Nissan 23</i>	2233	8	<i>Adar II 29</i>
1981	3	<i>Nissan 4</i>	2261	17	<i>Nissan 9</i>

Based on this as well as other clear physical evidence of the inaccuracy of Shmuel's (Julian calendar's) position that a year is exactly 365.25 days, we question whether Shmuel originally thought that his calculations were exact. Rambam's first presentation of Shmuel's view that a solar year is exactly 365¼ days gives the impression that this is a legitimate scientific possibility held by both Jewish as well as gentile scholars:

³⁶ See previous section and citations from Chasam Sofer (1762–1839), Sdei Chemed (1832–1909), and Kaf HaChaim (1870–1939). Chasam Sofer comments only on BH of 1813, but is silent on BH of 1785 (when he was 23) which fell after *Pesach*. Similarly, Sdei Chemed comments only on BH of 1897 but is silent on BH of 1869 (when he was 37) which also fell after *Pesach*. *Aruch HaShulchan* (1829–1907), on the other hand, did not mention a date for any BH.

³⁷ KH 5:2.

הלכות קידוש החודש ט:א שנת החמה—יש מחכמי ישראל שהוא אומר
שהיא שלוש מאות חמישה ושישים יום ורביע יום, שהוא שש שעות; ויש
מהן שהוא אומר שהיא פחות מרביע היום. וכן חכמי יוון ופרס, יש ביניהן
מחלוקת בדבר זה.

However, Rambam later states clearly that Shmuel's position is incorrect:

י:ו מראין לי הדברים, שעל חשבון תקופה זו היו סומכין לעניין עיבור
השנה בעת שבית דין הגדול מצוי, שהן מעברין מפני הזמן, או מפני
הצורך—לפי שחשבון זה, הוא האמת יותר מן הראשון, והוא קרוב
מדברים שנתבארו באצטגנינות, יותר מן החשבון הראשון שהייתה בו
שנת החמה שלוש מאות וחמישה ושישים יום ורביע יום.³⁸

Rambam here recognizes that Shmuel's viewpoint is wrong but never says whether Shmuel himself knew that what he said was inaccurate. If Shmuel was the great astronomical observer that he professed to be, i.e.,

ברכות נח: ואמר שמואל נהירין לי שבילי דשמיא כשבילי דנהרדעא לבר
מכוכבא דשביט דלא ידענא מאיניהו.

it would seem that he should have known that what he said was imprecise. He was born more than 200 years after the introduction of the Julian calendar in 45 BCE, and by the middle of his life the discrepancy between whatever the VE had been in 45 BCE and what it was in his time was about 2 days.

Ibn Ezra emphatically rejects Shmuel's model and says Shmuel knew it was inaccurate:

ספר העבורו—אל תשים לבך אל תקופת שמואל שאומר כי התוספות
רביעית יום בלי תוספות ומגרעת כי איננה תקופת אמת כלל, ויתכן
ששמואל ידע זה ותקן זה בדרך קרוב לאנשי דורו כי אין יכולת בידי
האדם להבין חלקים ראשונים ואף כי שניים, ואני ידעתי כי כל חכם
שיראה דבר זה יתמה על אלה הדברים שדיברתי על תקופת שמואל
או ילעג, ואני אומר לו תמה ממך איך לא היו לך עינים לראות והלא
אמרה כתוב על פי שנים עדים או על פי שלשה עדים יקום דבר ואני אתן
לך שבעה עדים.

³⁸ See footnote 9 for a discussion of the exact wording of this *halachah*.

One of Ibn Ezra's proofs is the fact that by his time, 1158, *Tekufas Shmuel's* estimate of VE is contradicted by direct observation:³⁹

והנה לנו בשת עולם ונהיה בחשבונינו לעג וקלס לסביבותינו כי הקל
שבקלים יראה כי כבר השתו היום והלילה בקרוב מי"א יום

i.e., simple reality shows spring started 11 days earlier than Shmuel's model dictates.⁴⁰

³⁹ Ibn Ezra makes it clear that he expected his "smart" contemporaries to reject his assertions. He is not clear on which assertion(s) he had in mind, i.e.,

- Shmuel's model for the solar year is wrong;
- Shmuel knew his model was wrong.

Most of Ibn Ezra's subsequent "evidence" about the incorrectness of Shmuel's model deals with the fact that by Ibn Ezra's time projections from *Tekufas Shmuel* were so far off that it was obvious they were wrong. These proofs would not, however, have been available to Shmuel in his own time when the differences were much smaller. The one argument that Ibn Ezra offers that addresses Shmuel's awareness of the inaccuracy deals not with the assertion that the year is exactly $365\frac{1}{4}$ days but with him saying all seasons are of equal length. והעד החמישי שחלק התקופות בחלקים שוים וזה כנגד גלגלה רק כנגד גלגל המזלות לא יתכן כי הנה יש בין תקופת ניסן לתקופת תמוז יותר מצ"ג יום ותקופת תשרי לתקופת טבת פחות מפ"ט יום.

This inaccuracy (which we will discuss in detail in a later section) would have been evident in Shmuel's time as well. We are thus left with Ibn Ezra proving that Shmuel was aware that the seasons were of different length but not showing that he was aware of the inaccuracy of his $365\frac{1}{4}$ -day year. Ibn Ezra also offers the following words for those who insist that Shmuel could not have erred in any of his pronouncements based on his acclaimed astronomical knowledge: ואם טען טוען אנה נמצא חכם משמואל שאמר נהירן לי שבילי דרקיעא כשבילי דנהרדעא הנה תשובה לפניו שלא ידע סוד נולד קודם הצות ועוד אפרשנו גם דברים רבים בברייתא שלא באמת...

⁴⁰ Some of Ibn Ezra's other six proofs are very creative. While the proof we listed here is clear, it is interesting that based upon our estimate of a one-day error in the Julian Calendar for each 128 years, by Ibn Ezra's time the Julian calendar should overstate spring by almost $9\frac{1}{2}$ (i.e., $(1158+46)/128$) days. Ibn Ezra's insistence on an approximately 11-day discrepancy most probably represents the 2-day difference we alluded to in footnote 28 between the mean VE (that Shmuel's calculations yield) and the actual VE (as noted by observation). Ibn Ezra, in his

If Ibn Ezra is correct and Shmuel used $365\frac{1}{4}$ days only as an approximation for the sake of simplicity and for his time period (when the discrepancy between the real and the approximate was small) then he could very well have been implying that everyone could use the Julian Calendar, or something very similar to it to know when VE occurred. This would have required no calculations of any kind since the dating scheme behind the Julian calendar was based on the same underlying principle of a $365\frac{1}{4}$ -day year. Unlike the methodology of Rambam and Ibn Ezra, it would not even be necessary to know the Jewish year in order determine VE.⁴¹ Just as everyone today knows when to say BH and start *ומטר טל ותן* based on the Gregorian date, it is possible that Shmuel was saying that spring begins on March 25th, or some other specified date. Shmuel's pronouncement, as we explained previously, would not tell anyone in the Diaspora exactly when a specific day in the Jewish calendar occurred, but it would offer everyone a simple way of knowing whether a particular Jewish year would be a regular or leap. For example, without loss of generality, suppose Shmuel targeted March 25th on the Julian calendar as the start of spring. Then, if not adding a leap year meant that the 15th of *Nissan* preceded March 25th, a second *Adar* would be added.⁴²

fourth proof suggests that knowledge of when spring begins can be determined by: *כי כל משכיל יוכל לראות זה בכלי הנחשת גם בצל אחר שידע כמה רחב ארצו ובנטות השמש לסוף דרום או צפון יוכל לדעתו בצל והנה יוכל לדעת היום שישתוו היום עם הלילה והנה השמש נוטה מסוף צפון ועוד לא באה תקופת תמוז יום לשמואל קרוב מט' יום*. Thus while Ibn Ezra has the VE occurring 11 days early, he has the Summer Solstice occurring only 9 days early. We explain this discrepancy in a later section.

⁴¹ Unlike today, the impression from the *Mishnah* and *Gemara* (e.g., *Avodah Zarah* 9a, *Gittin* 79b) is that regular dating in Talmudic times was not based on the age of the world since Creation (*Anno Mundi/AM*). In fact, the *beraisa* mentioned in *A"Z* 9a is the only known tannaic work that specifically dates an event from Creation. It appears that dating from Creation did not come into widespread use in Spain until the 12th century (see, e.g., Soncino *Avodah Zarah* 9b footnote b2). Thus, while in the days of Rambam and Ibn Ezra, AM may have begun to be commonly used, it was not in the public domain in Talmudic times.

⁴² In most situations, the application of this rule is easy and direct. This technique, however, may be problematic when VE occurs very close to

Although we have offered the possibility that Shmuel's intentions were to target March 25th on the Julian calendar as the start of spring, as it was in 45 BCE,⁴³ this would mean that his projections about leap years in his time were inaccurate because by then the VE would really occur on the Julian calendar two days earlier.⁴⁴ Such a discrepancy would never lead to an error of mistakenly omitting a necessary leap year but could lead to an error in adding an unnecessary leap year.⁴⁵ A simple analysis of the effects of being off by 2 days in the calculation of VE shows that in 60 years (the length of the calendar he sent R. Yochanan) this "error" would lead to the addition of an unnecessary leap year about 6 times. Rather than assume that Shmuel would accept an error rate of about 10%, we prefer to think that Shmuel was aware of the discrepancy and compensated for the 2-day drift by des-

what would be the start of *Pesach* if a second *Adar* was not added—i.e., in a case where if the regularly scheduled *Adar* had 29 days, the 15th of *Nissan* would come out a day before the VE, but if *Adar* had 30 days VE would be on the 15th. In the first case a second *Adar* is required, but in the second case it is not. Since Shmuel could not tell in advance the exact date of any day, how would he handle this situation? The answer is that based on his knowledge of astronomy, Shmuel knew in advance the *molad* of the month and whether it were possible for first visibility to occur on the night of the 30th and make *Adar* a 29-day month. If calculations showed that a sighting on the night of the 30th was possible, since the decision to add an extra *Adar* must be made no later than *Adar* 29, *Bais Din* in *Eretz Yisrael* would be forced to make it a leap year and could not afford to wait to see if "sighting" witnesses in fact did not show up making the extra month unnecessary. (See KH 4:14. It is of interest that this *halachah* is in fact attributed to Shmuel: סנהדרין יב: גופא אמר שמואל אין מעברין את השנה ביום שלשים של אדר הואיל (וראוי לקובעו ניסן).) Thus, in the case of a possible 29- or 30- day *Adar*, *Bais Din* would always have to make its decision based on the 29-day possibility (See ראש השנה יט: for a dispute as to how much flexibility there is in the number of days that there are in *Adar*.)

⁴³ See footnote 27. More generally we could say Shmuel was targeting whatever day VE was considered to have occurred in 45 BCE.

⁴⁴ I.e., $(250+44)/128 = 2.3$.

⁴⁵ E.g., if without an extra *Adar*, *Pesach* would start on March 24th, we would declare a leap year when in fact spring begins March 23rd and no extra month is required.

ignating March 23rd, not March 25th, as the date of the equinox.⁴⁶ His intention could then have been that this date be pushed back one day every 128 years to correct for the Julian inexactness. In this way Shmuel's methodology would always remain applicable. In some ways this is similar to what we do today with BH and ותן טל ומטר.⁴⁷

The idea that Shmuel could be referring to the use of the Julian calendar date⁴⁸ is not unreasonable. As cited previously, Avudraham, who lived two centuries before the introduction of the Gregorian calendar, gave Julian dates for starting ותן טל ומטר.⁴⁹ Even earlier, in

⁴⁶ If the Mean VE in 45 BCE was March 25th, the actual VE occurred two days earlier on March 23rd. If so, Shmuel could well have targeted March 21st as the defining date in his time.

⁴⁷ The cases are similar in terms of the action done (changing the date) but are diametrically opposite in terms of the purpose of the change. In the case of ותן טל ומטר, the Gregorian change of dates is meant to maintain the same Julian calendar date and ignore the *tekufah* drift. In the case of Shmuel, the change is meant to maintain the *tekufah* date where it really belongs.

⁴⁸ Whether the Julian calendar was actually regularly used in *Bavel*, where Shmuel lived, is irrelevant. If necessary, he could easily have replicated it.

⁴⁹ The quote of Avudraham cited in the previous section is in *Bais Yosef* who died in 1575, seven years before the Gregorian calendar was introduced. Thus we understand that the words in parentheses in most older editions of the Tur— בית יוסף אורה חיים קיז וכתב הר"ד אבודרהם ויום ט' יבוא בכב' 'מניבי"מברי (ג' דיעצמ') אם היה אותו פיברי"ר מכ"ה יום אבל אם היה פיברי"ר מכ"ט יום תהיה השאלה בכ"ג נובי"מברי (ד' דיעצמ')—are neither from *Bais Yosef* nor Avudraham. They are clearly later additions meant to transform the original Julian dates to their Gregorian equivalents. The text we have just given is from an 1861 Warsaw Poland edition of Tur. Poland, as mentioned in footnote 29, accepted the Gregorian calendar almost immediately. Because many 20th century editions of Tur are copies of this edition, the dates in parentheses remained the same. In reality, as explained previously, after 1900 the Gregorian dates would have switched to December 4/5. We must point out, however, that whoever inserted the December 3/4 update either misunderstood Avudraham or used different nomenclature. As explained previously, when Avudraham says November 22, he means the night preceding that date. When updated to compensate for Julian/Gregorian differences, this correctly leads to our current practice of beginning ותן

1158, we find Ibn Ezra in *Sefer HaIbbur* freely using Julian dates and knowledgeable about what the Julian calendar is supposed to do and what it actually does:

ודע כי חשבון הגוים שהשמש לא תכנס בטלה עד עבור שתי שליטות
 חדש מארסו היה אמת בימים קדמונים רק היום הוא שקר כי ביום י"ד
 לחדש מארסו תכנס בטלה ואחר ק"ל⁵⁰ שנה מן היום הזה תכנס ביום י"ג
 לחדש מארסו

We therefore feel comfortable in suggesting that Shmuel, like Ibn Ezra and Avudraham, was simply announcing that a modified Julian calendar could be used in his time by people in the Diaspora to determine which lunar years would have a second *Adar*. Our explanation also gives new meaning to R. Yochanan's response to Shmuel sending him a list of leap years for the next 60 years in *Chullin* 95b:

כתב שדר ליה עיבורא דשיתין שני אמר השתא חושבנא בעלמא ידע.

Note that Shmuel did not send R. Yochanan a full 60 year calendar but merely a list of which of the following 60 years would have a

טל ומטר on the night of December 4. In Avudraham's nomenclature in modern times the starting date is December 5/6 while in the 1861 Poland edition it would be December 4/5. See *Encyclopedia Judaica* 5:47 which correctly gives the December 5/6 dates. See footnote 16.

⁵⁰ Ibn Ezra does not mean that the change literally would take place in 130 years, but, rather, that by the time 130 years passed, the start of spring would certainly be one day earlier. Projecting Ibn Ezra's numbers out for several centuries from the 1158 date in which he was writing gives the start of spring in:

<u>Year</u>	<u>Start of Spring</u>
1288	March 13
1418	March 12
1548	March 11.

This is completely consistent with the Gregorian change in 1582 which added 10 days to fix the start of spring on March 21. Ibn Ezra's familiarity with the Julian calendar is not surprising. Like Avudraham, he had substantial contact with people from Catholic countries. He was born in Tudela (under Muslim rule) but left Spain and wandered for nearly three decades through many places including Italy, France and England where he taught Jews of Christian Europe who were unacquainted with Arabic.

2nd *Adar*. Why did Shmuel pick the number 60? Sixty and its decimal multiples are frequently used in the *Gemara* in a non-literal manner to denote a large number.⁵¹ If that is what 60 means here, i.e., a calendar for many years, then it would be consistent with Rashi's interpretation of the next *gemara* which records Shmuel's response to R. Yochanan's rejection of his calendars:

כתב שדר ליה תליסר גמלי ספקי⁵² טריפתא אמר אית לי רב בבבל איזיל
איחזייה.
רשי: תריסר גמלי. לאו דווקא.

In the same way 13 camels are not to be taken literally, so 60 years is not meant literally. However, Rashi does not say the 60-year calendar was an exaggeration. We suggest that 60 here is literal. The *Gemara's* story occurs between the deaths of Rav, 247 CE, and Shmuel, 254 CE. Thus, the 60-year calendar ended somewhere between 307 and 314 CE. The later date is 359 years from the start of the Julian calendar. In this time, the Julian calendar had lost almost 3 full days.⁵³ Thus Shmuel limited his calendar to his era when the discrepancy was only 2 days and no errors could occur if one followed his advice. We finally suggest that R. Yochanan's response to the calendars was that Shmuel was simply showing his mathematical (not astrological or rabbinical) skills of working out in advance which of the following 60 years would be leap years. The rest of what he said is obvious and flows directly from the Julian calendar.

All of the above is consistent with and supports Ibn Ezra's contention that Shmuel was aware of the limitations of his methodology and only meant his calculations to be "quick and dirty" approxima-

⁵¹ E.g.: ב"ק צב: אמר ליה רבא לרבה בר מרי מנא הא מילתא דאמרי אינשי שיתין תכלי מטייה לככא דקל חבריה שמע ולא אכל

רשי ד"ה שיתין...ולאו דוקא הוא
שבת צ: מאי ציפורת כרמים...והתים ליה בשיתין גושפנקי...
רשי ד"ה שיתין. לאו דוקא אלא מכסיהו כסויין הרבה...

⁵² Rashi offers two possibilities as to what this refers: ספק טריפות or ספיקי טריפות. Rashi's second interpretation is interesting because Shmuel's actions now dovetail with the last *mishnah* in the third chapter of *Pirkei Avo*: רב אלעזר בן חסמא אומר קנין ופתחי נדה הן הן גופי הלכות רב אלעזר בן חסמא אומר קנין ופתחי נדה הן הן גופי הלכות. Shmuel did exactly what R. Eliezer prescribed, but in reverse order and R. Yochanan appropriately called him on it.

⁵³ I.e., $(314+45)/128 = 2.8$.

tions for his time. If so, then just as Shmuel did not mean for his technique to be used to project VE times for 200 years past his time, so can we not use his methodology to determine actual VE times for periods of time 200 years or more before him. Any attempt to work backwards from the VE of Shmuel's time to VE at the time of Creation cannot yield correct actual results for the time of Creation. Shmuel was not working forwards in time from Creation to his time by knowing when VE occurred at Creation, but rather knew the VE of his time from the astronomical indicators of his own time.⁵⁴ Although Rambam and Ibn Ezra use the time of Creation as the starting point for their calculations of Shmuel's *tekufas*, they use it only as a device to simplify things so that it not be necessary to use some other year to be our base of calculation. Whatever date the VE occurred in the time of Shmuel, in the more than 1750 years since his death his calculations currently overstate VE by more than 13 days (i.e., 1750/128).⁵⁵ By the same account, in the more than 4000 years between Creation and Shmuel, Shmuel's calculations yield an error of more than 31 days (i.e., 4000/128). Had Shmuel really assumed that at Creation *Tekufas Nisan* preceded the *molad* of *Nissan* by 7.4 days as required by Rambam's and Ibn Ezra's calculations, then Shmuel's projection of VE in his time would have been off by 31 days and in our time by 45 days.

Our entire discussion thus far is primarily based on citations from Ibn Ezra, Rambam, and Avudraham concerning the VE, BH, or the start of *ותן טל ומטר*. Unfortunately, none of these *rishonim* talk about all of these issues jointly and fully in any detail. Ibn Ezra discusses VE in great detail but never mentions anything about when he felt was the proper time to start *ותן טל ומטר*. Since he summarily dismisses Shmuel as wrong and insists that Shmuel himself knew it, we see no reason to assume that he used *Tekufas Shmuel* to determine TT and

⁵⁴ Using perhaps the types of tests discussed in Ibn Ezra (see, e.g., footnote 40).

⁵⁵ As we show in the next section, the actual VE currently occurs on March 20/21. Our April 8th date for BH means that VE occurs on April 7th and overstates VE by at least 17 days. How the 13-day difference grew to 17 days is discussed in the next paragraph and partially in the next section. Similarly, TT currently occurs on September 22/23. Thus *ותן טל ומטר* should begin 60 days later on November 20/21. This means that our starting date of the night of December 4/5 is more than 13 days off. This discrepancy will, as well, be explained later.

which date was 60 days later. Absent evidence to the contrary, it is logical to assume that he did not practice BH as we do and probably used the best approximation of the true TT in his time to determine the start of ותן טל ומטר. Since in his time the Julian calendar overstated all of the *tekufos* by a considerable amount, it is reasonable to think that he started ותן טל ומטר before the Julian November 15.

Rambam discusses VE, BH, and ותן טל ומטר and says that *Tekufas Shmuel* is wrong. Despite his recognition that it is wrong, Rambam still insists in *Hilchos Berachos* that *Tekufas Shmuel* be used with respect to BH. The fact of the matter is that once Rambam concludes that BH is meant to memorialize a recurring *Tekufas Nissan* that takes place every 28th year at 6:00 p.m. on Tuesday, he has no choice but to calculate its recitation based on *Tekufas Shmuel*⁵⁶ (since according to

⁵⁶ As mentioned previously in footnote 12, it is by no means clear that this BH is the intention of the *Gemara* in *Berachos*. The earliest source for our BH practice is Abaye (*Berachos* 59a). Abaye lived 100 years after Shmuel, and Shmuel himself never mentions BH nor offers an operational starting time of ותן טל ומטר in term of TT (i.e., he says מכי מעיילי (ציבי לבי טבות רישבא). As also cited in footnote 12, there is evidence that our BH was not universally practiced (if at all) by the 9th century and there is also evidence that earlier Talmudic texts did not have Abaye's statement in the *Gemara*. Further support for both of these contentions are:

- ריף in *Berachos* who quotes the *beraissa* about a blessing on the sun but does not cite Abaye nor explain when the *berachah* is recited. רבינו יונה on *Rif* does explain it with respect to the 28-year cycle but never mentions that this is what Abaye said in the *gemara*,
- ראש in *Berachos* explains the *beraissa* in terms of the 28-year cycle but never mentions Abaye or that it is in the *gemara*,
- רבינו בחיי בראשית א:יד ד"ה והיו לאותות... ועוד שהם אותות writes רבינו בחיי בראשית א:יד ד"ה והיו לאותות... ועוד שהם אותות... לישאל בקריאת שמע של בקר שמצותה עם הנץ החמה... גם בחיוב ברכת השמש בתקופת תמוז שחייב אדם לברך ברוך עושה בראשית וכן דרשו רז"ל בברכות פרק הרואה תנו רבנן הרואה חמה בתקופתה ולבנה בטהרתה... וכוכבים במשמרותם ומזלות בעתם אומר ברוך עושה בראשית... R. Bechaya concurs with Saadiah Gaon that the *gemara* is referring to the start of summer and he makes no mention of Abaye in this *gemara*. (Note he also changes many of the words in the *beraissa*). Chavel's edition of R. Bechaya offers the following comment on the words בתקופת תמוז :

the correct solar model⁵⁷ the astronomical replication of the time and day of *Tekufas Nisan* as it was by Creation would take thousands of years). The question nevertheless remains as to why we would care to create what seems to be a “legal fiction” to support such a BH ritual? With respect to the starting day for *ותן טל ומטר*, all Rambam mentioned in *Hilchos Tefillah* is that it is to begin 60 days after TT. Does he mean the accurate TT or the TT based on *Tekufas Shmuel*? Rambam sheds no light on this. On the one hand it would seem that he would not want to cause an open and apparent contradiction⁵⁸ between BH and *ותן טל ומטר*. On the other hand the contradiction is inherent anyway because, as Ibn Ezra demonstrated, according to *Tekufas Shmuel Pesach* sometimes starts before the onset of spring in violation of *Hilchos Kiddush HaChodesh*. We have no evidence as to what Rambam meant to do in practice and without evidence to the contrary we assume he started *ותן טל ומטר* based on the real TT.

The *Rishon* who ultimately supplies all of the missing links of data is Avudraham. While he says nothing about VE, BH or *Tekufas Shmuel*, his precise dating of *ותן טל ומטר* based on the Julian calendar is considerably more than 60 days after the actual TT. The only justification for such a dating requires using *Tekufas Shmuel*. This link is further supported by our previous calculations showing that VE at

ברור שטעות סופר היא וצ"ל בתקופת ניסן כמבואר בגמרא ברכות נט ב ברם בד"ר מצאתי כן.

He offers a possible explanation (which he says he likes) for how the error crept into our text based on a book on BH written by R. Shalom Muskvit: "ברכת כי לפני המדפיסים היה כתוב 'השמש בתקופת תמוז' והוא נוטריקין 'תחילת מחזור' ולא הבינו הכוונה ועשו מאות ח"ת אשורית וזו ויצא: 'תמוז' או 'אפשר לומר שהיה כתוב בדברי רבינו בתקופת בהפסק בין פ"א לתי"ו והמדפיס טעה והשב שזה ב' תיבות בר"ת: 'בתקופת תמוז' ובאמת היא תיבת 'בתקופתה'..." He concludes that ultimately R. Muskvit found it difficult to accept these answers because the word תמוז also appears in מדרש תלפיות and other sources.

⁵⁷ The same is true even if we use R. Adda's more accurate but still wrong solar year.

⁵⁸ We will in a later section define more precisely what it means to have an “open and apparent contradiction.”

the beginning of each 28-year cycle is Tuesday 6:00 p.m..⁵⁹ The association is finally confirmed by בית יוסף who cites Avudraham for ותן טל ומטר and also supports our practice of BH according to Shmuel.

⁵⁹ One interesting point concerning Avudraham's calculations is in order. Our direct application of *Tekufas Shmuel* to Avudraham's November 22/23 dates resulted in a VE of March 25/26. This is completely consistent with the presumptive VE circa 45 BCE which we have previously stated was March 25/26, since according to the $365\frac{1}{4}$ -day solar-year model the Julian dates for VE should never change. It is not consistent with VE in the time of Shmuel which was March 23/24 (i.e., two days earlier). The fact of the matter, however, is that Avudraham did not calculate March 25/26 from working backwards from the start of ותן טל ומטר nor from knowing the time of VE in 45 BCE. He presumably used Ibn Ezra's straightforward methodology (or something similar) based on,

- a) the time difference between a lunar regular year and solar year,
- b) the time difference between a lunar leap year and solar year,
- c) the time difference between *Molad Nissan* and *Tekufas Nissan* at Creation,
- d) the number of lunar regular years since Creation,
- e) the number of lunar leap years since Creation,
- f) calculating $a) * d) + b) * e) + c)$,

to determine by how many days *Tekufas Nissan* differed from *Molad Nissan* in his time. Since by his lunar calendar he knew exactly on which day *Molad Nissan* fell, he adjusted for the difference he had calculated and looked up the date on the Julian calendar. This turned out to be March 25/26. He then would have worked forwards to get the date for starting ותן טל ומטר.

Note that a key parameter in these calculations is the age of the world (Anno Mundi, i.e., $d) + e)$ which we know based on a *beraisa* in *Avodah Zarah* 9a. If for some reason this number turned out to be wrong, then the discrepancy between *Tekufas Nissan* and *Molad Nissan* changes and the Julian (and Gregorian) dates for VE would change. To see this, suppose, for example, the current year is 5767 rather than 5768. In 2010 VE would then be 6:00 p.m. on a Tuesday (i.e., it is 5769, a BH year). But March 25 (April 7) in 2010 is Wednesday, not Tuesday. Thus the calculations would yield a VE of March 24 (Tuesday) and BH would be said on Wednesday March 25 (April 7), one day in April earlier than now. The chart below lists the Julian (Gregorian) dates of Tuesdays that would be candidates for *Tekufas Shmuel* at the start of a 28-year cycle for years 2008 through 2014.

We conclude this section by summarizing our understanding of Shmuel as presented thus far. We agree with Ibn Ezra that Shmuel knew his *tekufah* was imprecise and only meant it to be used without modification for about 60 years. In his time, his methodology allowed for a simple, correct way of determining leap years. At the same time, with respect to the starting date of *ותן טל ומטר* in the Diaspora, we note that Shmuel in *Taanis* 10a offers an alternate means of determining when to start the prayer that was not predicated on the knowledge of when *TT* started. Shmuel's recommendations would presumably have resulted both in the correct recitation of *ותן טל ומטר* as well as the correct decision on adding an extra *Adar*. With respect to BH there is no evidence that Shmuel, nor anyone else in Talmudic times, practiced it as we do today. If Shmuel knew that his model of the sun's orbit was in error, then he knew that in reality the sun would not return to its original place at Creation every 28 years at the same time on the same day of the week. The only statement in the *Gemara* that supports our practice of BH is Abaye who lived 100 years after Shmuel, and we have Talmudic and post-Talmudic sources that interpret the *beraissa* differently than Abaye. Finally, we have no sources corroborating that BH was practiced the way Abaye de-

Year	Gregorian Tuesday	Julian Counterpart
2008	April 8	March 26
2009	April 7	March 25
2010	April 6	March 24
2011	April 5	March 23
2012	April 3 or 10	March 21 or March 28
2013	April 2 or 9	March 20 or March 29
2014	April 8	March 26

Thus if the current year were really 5766, BH would be said on the Gregorian April 6, 2011 which is the equivalent to the Julian March 24th, and the Julian VE would be March 23rd exactly as it was in Shmuel's era. We conclude this discussion by referring the reader to "A Y2K Solution to the Chronology Problem" in *Hakirah* Volume 3, Summer 2006, where we argued from a variety of *gemaras* that the *amora'im* knew that our calendar is missing 166 years and that we are currently really in year 5934. If this is correct, then BH would next be in 5937 (i.e., 5936 is divisible by 28), 3 years from now, 2011, and we would be observing it exactly the way VE actually was in Shmuel's time.

scribes it up to and through the period of the *Geonim*. Although we have *rishonim* stating our *halachah* of BH (e.g., Rambam, R. Yonah, Rosh), we also have those who disagree (e.g., *Aruch*, R. Bechaya).⁶⁰ Since Avudraham does not mention BH we have no definitive statement by him on his position concerning its observance. However, the fact that his date for *ותן טל ומטר* results in a VE that is consistent with our BH leads us to believe that by his time the BH issue was settled to be done in the manner we do it today. Thus, *Tekufas Shmuel* was not being used for leap years⁶¹ but was being used for BH and *ותן טל ומטר*. The interconnection of these two led to several inaccuracies that echo even today with respect to the dating of the VE and the recitation of *ותן טל ומטר*.

We end this section by noting the irony of the *Gemara* in *Taanis* presenting a dispute between Rav and Shmuel over a single day difference in the start of *ותן טל ומטר*, i.e.,

דף י. א"ר אלעזר הלכה כרבן גמליאל תניא חנניה אומר ובגולה עד ששים בתקופה... איבעיא להו יום ששים כלפני ששים או כלאחר ששים ת"ש רב אמר יום ששים כלאחר ששים ושמואל אמר יום ששים כלפני ששים א"ר נחמן בר יצחק וסימנך עילאי בעו מיא תתאי לא בעו מיא אמר רב פפא הלכתא יום ששים כלאחר ששים:

and yet today we have no difficulty following Avudraham and knowingly starting the recitation of *ותן טל ומטר* more than 10 days late. The view of Rambam in *Peirush HaMishnayos*, *Taanis* 10a, and Rosh is that the 60-day post-TT start of *ותן טל ומטר* is only relevant to the envi-

⁶⁰ See footnote 12.

⁶¹ I.e., R. Adda's calculations were used in the fixed calendar. We cannot say with any degree of certainty the underlying cause of the dispute between the two sides on BH (e.g., did they simply have different texts in *Berachos*?), but we would surmise that during the period of the *Rishonim* the question of correctness of Shmuel's *tekufah* was possibly unresolved. Although Ibn Ezra rejects it outright and belittles those who support it, his language implies that it did have supporters and that Ibn Ezra's position was considered (at least by some) to be unacceptable. If so, we could see the two sides on BH deciding where they stood based on whether they thought Shmuel was correct (pro), or not (con). If our assumption is correct, by the 14th century those supporting using Shmuel's assertion at face value regardless of the evidence to the contrary had won the battle.

rons of *Bavel* and places of similar climate and water needs (see *Bais Yosef, Orach Chaim* 117). In other geographic and climatic areas their opinion is that the start of *ותן טל ומטר* should be adjusted to local needs. Despite the position of Rambam and the best efforts of Rosh to get the starting time of *ותן טל ומטר* revised to reflect the country in which it was being recited, the *Bavli's* 60-day waiting period remained normative *halachah*. What is most interesting is that they were lobbying for *ותן טל ומטר* to start even earlier in European countries (i.e., immediately after *Succos* or at the start of *Mar Cheshvan*, just like in *Eretz Yisrael*) because they need the water as soon as possible. The end result was that not only did they not get what they wanted, but we in practice do it considerably later than even the 60 days the *Gemara* suggested. Although, as explained previously, we have no direct evidence which calendar date Rambam and Rosh actually started saying this prayer, considering the position they supported it seems very unlikely that they would have consented to a practice that in effect starts the prayer even later than the *Gemara's* proposed date.

Julian and Gregorian Calendars: Length of the Seasons

In Shmuel's 365¼ days solar model, all of the seasons are of equal duration: 91 days 7½ hours. Ibn Ezra already cites the inaccuracy of this latter assertion:

והעד החמישי שחלק התקופות בחלקים שוים וזה כנגד גלגלה רק כנגד
גלגל המזלות לא יתכן כי הנה יש בין תקופת ניסן לתקופת תמוז יותר
מצ"ג יום ותקופת תשרי לתקופת טבת פחות מפ"ט יום.⁶²

Table 3 lists the starting dates of the four *tekufos* for the years 2002–2014. The design of the Gregorian calendar is such that each season currently starts on one of two dates, i.e.,

Tekufas Nisan - March 20/21, Summer Solstice - June 20/21,
Tekufas Tishrei - September 22/23, Winter Solstice - December 21/22.

Table 4 lists the numbers of days in each month in the Gregorian (and Julian) calendar(s) and the average number of days in each season. Combining these values with the numbers from Table 3 we see that not only do the lengths of the same seasons fluctuate from year

⁶² See footnote 39.

Table 3

Starting Dates for Each Season 2002–2014

Year	Equinox March		Solstice June		Equinox Sept.		Solstice Dec.	
2002	20	19:16	21	13:24	23	04:55	22	01:14
2003	21	01:00	21	19:10	23	10:47	22	07:04
2004	20	06:49	21	00:57	22	16:30	21	12:42
2005	20	12:33	21	06:46	22	22:23	21	18:35
2006	20	18:26	21	12:26	23	04:03	22	00:22
2007	21	00:07	21	18:06	23	09:51	22	06:08
2008	20	05:48	20	23:59	22	15:44	21	12:04
2009	20	11:44	21	05:45	22	21:18	21	17:47
2010	20	17:32	21	11:28	23	03:09	21	23:38
2011	20	23:21	21	17:16	23	09:04	22	05:30
2012	20	05:14	20	23:09	22	14:49	21	11:11
2013	20	11:02	21	05:04	22	20:44	21	17:11
2014	20	16:57	21	10:51	23	02:29	21	23:03

to year,⁶³ but, more importantly, summer is longer than winter by more than 4½ days. Since it is obvious that the seasons are not of equal duration, why does Shmuel say they are the same? Ibn Ezra suggested that Shmuel said that the length of the year was 365.25 days to simplify the calculations for his era in time and we showed how he could have used this simplification to correctly predict leap years for the next 60 years. A similar explanation that Shmuel meant the equal-season length characteristic for his own time as well does not seem to work. Since he started his presentation with *Tekufas Nisan* we feel comfortable assuming that this was when he started his seasonal calendar.⁶⁴ If so, the uneven sized seasons have no effect on *Tekufas Nisan*. However, they do have an effect on the other *tekufos* of his time.⁶⁵ For example, if Shmuel meant for his model to be used

⁶³ The durations of each season for these years range within a 15-minute time span.

⁶⁴ See also *יוצר* of *פרשת החדש* מוסף which says with respect to *Tekufas Nisan*: ...לארבע תקופות ועד ראש לארבע תקופות.

The starting point for solar calendars differed from society to society. Ibn Ezra describes three different approaches as to what determines the start of a new solar year: דע כי שנת השמש תתחלק לשלשה חלקים החלק האחד מעת היות השמש החלק ראשון ממקום מחברת השנים גלגלים הגבוהים ואז ישתוה היום עם הלילה וזאת היא שנת תלמי וחכמי ישמעאל והחלק השני כנגד נקודה בגלגל השמש שמוצקו רחוק ממוצק הארץ וזאת היא שנת פרס גם יש מחכמי ישמעאל מונים כן והחלק השלישי הוא מאת התחברות השמש אם כוכב אחד ממחנה המזלות וזאת היא קרובה לחכמי הודו. The first of these corresponds to the Vernal Equinox and the second to start of summer. See footnote 12 where we discussed the possibility that the prayer mentioned in *Berachos* 59b refers to a prayer said yearly at the start of summer.

⁶⁵ From a purely mathematical perspective, for a solar calendar that has equal-length seasons, the cumulative sum of the absolute number of days the *tekufos* deviate from their true occurrence depends on the starting date of the calendar as follows:

<u>Starting Calendar at</u>	<u>Average Cumulative Deviation from Actual</u>
Vernal Equinox	9.0
Summer Solstice	5.6
Autumnal Equinox	9.2
Winter Solstice	6.2

This means that if Shmuel started his solar calendar at VE the other *tekufos* on average precede or follow their true occurrence by a cumula-

to determine when to start reciting⁶⁶ ותן טל ומטר then by projecting *Tekufas Tishrei* (Autumnal Equinox) almost 4 days too early (i.e., 182 days, 15 hours vs. $186.4 = 92.75 + 93.65$ days) he would end up starting the recitation of the prayer almost 4 days early. There must therefore be something other than what we have previously discussed that involves the *tekufos* that Shmuel was addressing.

Table 4

Number of Days in Months and Seasons for Julian and Gregorian Calendars

<u>Month</u>	<u>Days</u>	<u>Season</u>	<u>Month</u>	<u>Days</u>	<u>Season</u>
January	31	<u>Winter</u>	July	31	<u>Summer</u>
February	28 or 29	88.99 days	August	31	93.65 days
March	31		September	30	
April	30	<u>Spring</u>	October	31	<u>Fall</u>
May	31	92.75 days	November	30	89.85 days
June	30		December	31	

Although we have previously mentioned all of the halachic applications involving *tekufos*, there is one additional place where *tekufos* have an halachic relevance:

סנהדרין יא: תנו רבנן על שלשה דברים מעברין את השנה על האביב ועל פירות האילן ועל התקופה...
רשי ד"ה ועל התקופה. בין על תקופת תמוז שמתעקבת ונמשכת שאין תקופת תשרי נופלת עד עבור החג מעברין...
יב: אמר רב יהודה **אמר שמואל** אין מעברין את השנה אלא א"כ היתה תקופה חסירה רובה של חודש וכמה רובה של חודש ששה עשר יום דברי רבי יהודה **יג.** רבי יוסי אומר אחד ועשרים יום ושניהם מקרא אחד דרשו (שמות לד) חג האסיף תקופת השנה מר סבר כוליה חג בעינן בתקופה

tive 9 days. Thus, his assumption fits best for a calendar that begins at the onset of summer, and is close to the worst if it starts at the onset of spring. This would seem to imply that the accuracy of the fit of the other *tekufos* were not really of concern to Shmuel.

⁶⁶ As we pointed out previously, this seems unlikely being that in *Taanis* 10a Shmuel offers a different way of identifying the starting point of the prayer.

חדשה ומר סבר מקצת חג בעינן בתקופה חדשה... ר' יוסי אומר מחשבין ששה עשר לפני הפסח מעברין ששה עשר לפני החג אין מעברין. **רשי ד"ה ר"י.** אם צריך להשלים כ"א יום מחודש תשרי על תקופת תמוז שתקופת תשרי נופלת בכ"ב מעברין ומוסיפין חודש אחד... **ד"ה ששה עשר לפני הפסח מעברין.** אם תקופה שלפני הפסח דהיינו תקופת טבת חסירה ששה עשר בניסן ותקופה נופלת בשבעה עשר, מעברין את השנה שכשאתה מונה משבעה עשר בניסן צ"א יום לתקופת ניסן וצ"א יום לשל תמוז הרי הם כלים בכ"א בתשרי ותקופה נופלת בכ"ב...

The *Gemara* asserts that just as *Pesach* must be in spring so must *Succos* be, either partially or wholly, in fall. The former view is that of R. Yossi who says that it is sufficient even if only the last day of *Chol HaMoed Succos*, i.e., 21st of *Tishrei*, is in fall. The *Gemara* then asserts that this condition is met if the first day in spring is no later than the 16th of *Nissan*. Rashi's explanation (given above) of this passage is based on each *tekufah* (season) being 91 days.⁶⁷ As discussed previously, there is still an additional 15 hours to be dealt with (i.e., each *tekufah* is 91 days and 7.5 hours). *Tosfos* complete the argument by saying that if *Tekufas Nissan* (VE) is on the 16th at 6:00 a.m. or noon (i.e., the *tekufah* of *Nissan* according to Shmuel can only be 6:00 p.m., midnight, 6:00 a.m. and noon), a leap year is still necessary because the extra 15 hours will carry *Tekufas Tishrei* into the 22nd of *Tishrei*. Halachically we decide according to R. Yossi, and since we require that spring starts no later than the 15th of *Nissan*, the *Tishrei tekufah* requirement is always met with at least about 1 day to spare.

The problem with the *Gemara's* entire presentation in *Sanhedrin*, as explained by Rashi and *Tosfos*, is that it assumes that the combined elapsed time for spring and summer is less than 183 days. As we have shown, the two combined seasons take more than 186 days. Hence, in reality, *Tekufas Nissan* starting even as early as the 14th of *Nissan* will make *Tekufas Tishrei* occur after *Chol HaMoed Succos*. How, then, do we justify ignoring the TT requirement and deciding that no leap month is required as long as spring starts no later than what would be *Nissan* 15? We will next demonstrate how Shmuel might have offered the equal-seasons model to address this problem.

⁶⁷ I.e., spring and summer combined are 182 days and span days in the months of *Nissan* (14), *Iyar* (29), *Sivan* (30), *Tamuz* (29), *Av* (30), *Elul* (29), and *Tishrei* (21).

In a previous section we noted that at the beginning of the Julian calendar circa 45 BCE, VE occurred March 25/26, but by Shmuel's time it came earlier by more than 2 days. We suggested that to account for the 2-day discrepancy Shmuel probably did not mean for March 25/26 on the Julian calendar to be used in determining leap years, but rather the actual VE of March 23/24. However, to meet R. Yossi's requirement that *Succos* occur at least partially in fall, it is possible that Shmuel nominally kept VE at the Julian March 25/26 and offered an equal-season model that understated the true number of days between *Tekufas Nissan* and *Tekufas Tishrei*, to counter the 2-day drift in VE. In effect, by leaving VE at March 25/26 it was really *Nissan* 14, not *Nissan* 16, that Shmuel was using for the cut-off for the start of spring. While partially remedying the problem, this approach still leaves us about 2 days off of the 4 day shortfall due to the varying lengths of the different seasons. Note, however, that Rambam⁶⁸ KH 10:7 says that the actual VE precedes the mean VE by 2 days. Thus, if Shmuel was doing his calculations based on the actual VE and he used the Julian calendar's 45 BCE estimate of the mean VE, his assumption of seasons of equal duration would yield the correct answer, i.e., the 4-day differential is made up by overstating the start of VE by 2 days and overstating the timing of the actual VE by using the mean VE which occurs 2 days later. This would mean that it was really the timing of *Succos*, not *Pesach*, that drives the need for a leap year.⁶⁹

In summary, we are suggesting that just as Shmuel's comment about the length of the year was related to leap years, so was his comment about seasons being of equal size. Although Shmuel never said why he was offering his solar-calendar system, our explanations

⁶⁸ See footnote 27.

⁶⁹ Loewinger (see footnote 4) makes the argument that the actual VE was being used when the fixed Jewish calendar was first introduced in the 350s. He tries to prove this by showing that if we extrapolate our current calculation of *molad* and *tekufab*—both of which currently do not match with reality—back in time, the last time they both matched reality was in the mid-4th century. The 2 values are both correct only if we assume it was the actual, not the mean, VE that was used at that time. Thus, 100 years before the introduction of the fixed calendar we already find possible evidence of Shmuel using this same actual VE in his calculations.

fit in directly with other quotes directly attributable to Shmuel, and in both cases Shmuel's statements are accurate enough to be used. We thus have no evidence that Shmuel did not know the realities of the solar year nor have evidence that use of his shortcuts ever yielded incorrect results.

Today Shmuel's model is used for BH and *ותן טל ומטר*, but for our fixed lunar calendar we use a model attributed to R. Adda. This calendar is based on the length of a solar year being about 365 days, 5 hours 55 minutes and 25 seconds.⁷⁰ Rambam KH 10:2 says that in this model as well we assume seasons of equal length.⁷¹ Knowing that the calendar is based on two fundamental premises (i.e., an inaccurate length of a solar year, and equal-length seasons) which do not comport with reality, how (why) was it originally adopted? We must emphasize that this problem does not exist today since R. Adda's estimate of VE overstates the length of solar year by one day every 216 years.⁷² Thus, in the approximately 1600 years since the introduction of the fixed calendar (assuming it was adopted in mid-4th century), VE based on the lunar calendar has gained over 7 days (i.e., 1600/216). This significant drift is attested to by the fact that the earliest starting date currently for *Pesach* is March 26 (will happen in 5773

⁷⁰ This number is deduced from the fact that the Jewish calendar purportedly equalizes the solar and lunar orbital systems every 19 years. In 19 solar years there are 12 years with 12 months and 7 years with 13 months, for a total of $12 \cdot 12 + 7 \cdot 13 = 235$ months. We know each lunar month averages $29\frac{1}{2}$ days and 793 *chalakim* (.03059 of a day). Thus, 19 lunar years has 6939.69 days (i.e., $235 \cdot 29.53059$). Dividing this by 19, gives 365 days 5 hours, 55 minutes and 25 seconds per solar year. This is a better estimate than Shmuel's $365\frac{1}{4}$ days, but is still about 6 minutes and 40 seconds longer than the true length of a solar year (i.e., 365 days, 5 hours, 48 minutes and 45 seconds). It, thus, results in a slower drift than Shmuel's model (1 day per 128 years), but the lunar calendar still gains approximately one day over the solar year every 216 years.

⁷¹ This assumption is also evident from the fact that the calendar is based on the premise of setting the cut-off date for the insertion of a leap year such that spring start no later than the 15th of *Nissan* (Rambam KH 4:2). Were the model not assuming equal-length seasons, then as previously explained, the cut-off for a leap year would have to be several days before *Nissan* 15 in order not to conflict with R. Yossi's requirement that TT occur before the 22nd of *Tisbri*.

⁷² See previous footnote.

AM—2013) and VE that year will be March 20. Thus, both *Pesach/Succos* in this era are starting/ending, as required, considerably after the start of spring/fall. This, however, would have been a problem in the first 500 years of the fixed-calendar era when an initial cushion of 4 days did not yet exist.⁷³ We address this problem in the next section.

The Role of Numerical Approximations and Simplifications

The underlying motivation behind our presentation thus far has been the need to have rules, laws, and prayers that are related to physical issues be consistent with reality. We find it intuitively unacceptable for a rule or law to be knowingly premised on an inaccurate calculation or evaluation. In this vein, we have demonstrated that everything Shmuel actually said can be shown to possess this desirable consistency, but much of what we practice today concerning BH and ותן טל ומטר does not. We must, however, point out there are examples of well-known documented imprecise values being used to determine legal issues. In this section we review two types of such imprecisions and see how they apply to the issues we have been discussing.

Perhaps the most prominent example of using a known inaccuracy is:

עירובין יג: משנה... כל שיש בהיקפו שלשה טפחים יש בו רוחב טפח:
רמבם פירש המשניות—צריך אתה לדעת שיחס קוטר העיגול להקפו בלתי ידוע ואי אפשר לדבר עליו לעולם בדיוק ואין זה חיסרון ידיעה מצדנו כמו שחושבים הסכלים... והקירוב שמשמשים בו אנשי המדע הוא יחס אחד לשלשה ושביעית... וכיון שזה לא יושג לגמרי אלא בקירוב תפשו הם בחשבון גדול ואמרו כל שיש בהיקפו שלשה טפחים יש בו רוחב טפח והסתפקו בזה בכל המדידות שהוצרכו להן בכל התורה.⁷⁴

⁷³ Our problem in the present era is actually the reverse issue, i.e., *Pesach* starting after the first month of spring, in possible violation of the requirement that it be in the first month of spring (i.e., **חדש האביב**). For example, in 5757 (1997) *Pesach* started April 22 and in 5765 (2005) it started April 24. For a discussion of this see Merzbach **תזוזת חג הפסח** לקראת הקיץ, בד"ד 18 ניסן תשסו.

⁷⁴ See also *Tosfos Yom Tov*.

Rambam suggests that the *Mishnah* knows that π does not equal 3 but allows its use as a simplifying approximation. This idea is further reinforced by:

גמרא יד...הא תו למה לי? סיפא איצטריכא ליה כל שיש בהיקפו ג' טפחים יש בו רחב טפה מנא הני מילי? א"ר יוחנן אמר קרא (מלכים א ז) ויעש את הים מוצק עשר באמה משפתו עד שפתו עגול סביב וחמש באמה קומתו וקו שלשים באמה יסוב אתו סביב.

It is not common for the *Gemara* to ask for the Biblical derivation of something which is a physical factual matter. Why, then, does the *Gemara* do it here? ה'יזקוני, like Rambam, answers that the *Gemara* knew the circumference of a circle is not 3 times the diameter and therefore wants to know how we know that for halachic purposes we may use $\pi=3$. It then brings a verse where this relationship is explicitly accepted.

The case of using an approximation for π is not unreasonable and may not even be counterintuitive since, as Rambam said, any number, larger or smaller, that we use is an approximation. No single approximation of π can be used to err on the side of caution because sometimes an over-approximation will guarantee compliance while at other times it will be an under-approximation. Thus, if a single approximation is to be used, a “quick and dirty” 3, perhaps, makes no more or less sense than using 22/7.

A second type of “accepted” imprecision is demonstrated in the *Gemara* in *Sanhedrin* 13a, that we previously discussed. In this case, numbers that we are not certain are correct are used to determine whether there is a need to add a leap month. As Rashi explained, R. Yossi assumed seasons of equal length to determine when a leap year was warranted. However, even assuming that his premise is valid, the *Gemara's* analysis may not yield accurate results. When the lunar months were determined by “sighting” and not by a fixed calendar, there was never any certainty as to how long any month would last (i.e., 29 or 30 days). Thus, Rashi's calculation that *Nissan* 16/17 will result in the following *Tishrei* 21 being after/before *Tekufas Tishrei*, cannot be stated with certainty. The concept of continually alternating months of 29 and 30 days is derived from the average length of a month being a little more than 29½ days. In reality, the lengths of months fluctuate but do not necessarily alternate. It is not uncommon under the sighting system to have 3 consecutive months of 29 days or 3 consecutive months of 30 days and ultimately average to a

little more than $29\frac{1}{2}$. Rashi's argument is then based on the average length of a month, and the possibility that in reality there is a chance that the actual results may be different, is of no concern. We could of course err on the side of caution and whenever in doubt as to whether the last day of *Succos* will be in fall, add a leap month. R. Yossi chooses not to do this but, rather, is willing to rely on an average-length month.

The question we posed at the end of the last section was how our fixed lunar calendar was used in its initial period being that it could at times violate R. Yossi's requirement that fall start before the end of *Succos*. We begin our answer by noting, as mentioned previously, that the length of each season is not constant from year to year.⁷⁵ Here too, for simplification purposes, it seems reasonable that we could accept using the average length of each season in our calculations. This approximation, although on a smaller scale, is analogous to the one used by R. Yossi in *Sanhedrin* 13a of using the average-sized month in his leap year calculations. If both in R. Yossi's situation and in our calendar we are already accepting calculations based on averages rather than exact numbers, can we use Rambam's justification of $\pi = 3$ to take the approximations one step further and use an additional simplifying assumption of equal-length seasons?⁷⁶

Questions like this arise in many different halachic situations, and, in general, the answer is that approximations can be used as long as they do not lead to results that are clearly wrong. For example, the *molad* is used in the construction of a lunar calendar to determine when the month of *Tisbri* starts. The *molad* is an approximation of

⁷⁵ See footnote 63.

⁷⁶ From Rambam's presentation in the 9th and 10th chapters of KH it appears that he understood that Shmuel's and R. Adda's models were both approximations and were never taken to be exact. This is most clearly illustrated by י:ה מראין לי הדברים, שעל חשבון תקופה זו היו סומכין לעניין עיבור השנה בעת שבית דין הגדול מצוי, ...לפי שחשבון זה, הוא האמת יותר מן הראשון, והוא קרוב מדברים שנתבארו באצטגנינות, יותר מן החשבון הראשון שהיתה בו שנת החמה שלוש מאות וחמישה ושישים יום ורביע יום. By saying that R. Adda's model is more precise than Shmuel's he is recognizing that both are only approximations and that R. Adda's is closer to the true value (much like $22/7$ is closer to the real value of π than 3).

the time of conjunction which in turn is related to the time of first possible visibility of the new moon. Because the *molad* is only an average value, projections based on it to determine the time of first possible visibility of the new moon can be wrong. It is, thus, possible that based on the *molad*, a new month is declared in a situation where it is impossible to see the new moon. Even though people expect to see the new moon on the first night of a new month they do not consider not seeing the moon the first night a contradiction to it being a new month (e.g., perhaps it was visible but they did not see it). However, it is absolutely imperative that the old moon never be visible once a new month is declared.⁷⁷ If the *molad* could possibly lead to such a situation, it could not be used because it would be causing an open and irreparable contradiction.⁷⁸

With this rule in mind, it is possible that in the early days of the fixed calendar (or in R. Yossi's time in *Sanbedrin* 13a) a situation where fall actually started after the end of *Succos* occurred. That, however, might not have been a problem because the actual TT would be within a few days of the end of *Succos* and an open contradiction that TT definitely occurred after *Succos* might not be apparent. What would present a problem is the constant drift that we have previously discussed in the relationship between our solar and lunar calendars ultimately causing *Pesach* to start in the summer. Since everyone knows that *Pesach* must be in spring, this situation could not be allowed. The issue of what to do about this drift is extensively discussed in the literature, and suggestions on how to remedy the situation have been proposed.⁷⁹

The idea of balancing the use of approximations when possible and exact numbers when necessary, is evident throughout all of *Hilchos Kiddush HaChodesh*. Rambam introduces the details of the fixed calendar with the following:

קידוש החודש ו:א בזמן שעושין על הראייה, היו מחשבין ויודעין שעה שיתקבץ בה הירח עם החמה בדקדוק הרבה, כדרך שהאצטגנינין עושין, כדי לידע אם ייראה הירח או לא ייראה. ותחילת אותו החשבון, הוא החשבון שמחשבין בקירוב ויודעין שעת קיבוצם בלא דקדוק; ושעת קיבוצם בלא דקדוק אלא במהלכם האמצעי, הוא הנקרא מולד. ועיקרי

⁷⁷ See ערכין ט. and *Tosfos* there.

⁷⁸ See *Tradition*, "A 5765 Anomaly".

⁷⁹ See for example Merzbach תשסז ניסן 18 בד"ד 18 ניסן תשסז Merzbach.

החשבון שמחשבין בזמן שאין שם בית דין שיקבעו על הראייה, והוא
חשבון שאנו מחשבין היום—הוא הנקרא עיבור; ואלו הן:

In this *balachab*, Rambam differentiates between the astronomical precision used in developing our fixed lunar calendar and the one used when the calendar was determined by visual lunar sightings. The former is driven by the average time between conjunctions, while the latter uses the averages for its initial values but then goes on to refine the numbers using very precise measurements. The reason that the “sighting” system requires more precision is that ultimately witnesses will come to testify about sightings and we have to know if what they are saying is possible. If the average time between conjunctions does not tell us conclusively that the moon cannot be seen then we must turn to the more precise numbers for the correct answer. We would never want to accept witnesses in a situation where precision shows that what they are saying cannot be correct. Since in the fixed-calendar system no one is coming to testify about anything, the average numbers are sufficient for decision making. In Chapters 9 and 10 of KH, when Rambam discusses the two possible models of a solar year, he says:

י:ה מראין לי הדברים, שעל חשבון תקופה זו היו סומכין לעניין עיבור
השנה בעת שבית דין הגדול מצוי, שהן מעברין מפני הזמן, או מפני
הצורך—לפי שחשבון זה, הוא האמת יותר מן הראשון, והוא קרוב
מדברים שנתבארו באצטגנינות, יותר מן החשבון הראשון שהייתה בו
שנת החמה שלוש מאות וחמישה ושישים יום ורביע יום.

Rambam makes no claim that R. Adda’s model (what Rambam calls “this *tekufah*”) is precise. He is well aware that this model is also imprecise and merely says that it is a closer approximation than Shmuel’s model. What we are then left with is that with respect to *tekufah*, even when the sighting system was used precision was not required. The averages could be used because, as we explained, there is nothing contradictory that will occur that can cause evident contradictions.⁸⁰

⁸⁰ As explained previously, the repeated use of R. Adda’s “solar” year over a 216 year period will also result in a one day misalignment of the solar and lunar calendars. Thus, while R. Adda’s approximation could safely be used for an extended period of time ultimately some correc-

Can these approximations and rounding answers explain and justify the problems raised in this paper concerning the inaccuracies related to the reciting of ותן טל ומטר and BH? With respect to ותן טל ומטר it is definitely clear that we currently start reciting it much later than the mandated 60 days after TT. However, to present an open contradiction to the public, three pieces of information are necessary:

- Knowledge that the prayer is supposed to start 60 days after TT,
- The date of TT,
- The date 60 days after TT.

Because our lives today revolve around the Gregorian calendar, and we are all aware of the daily date and when each season starts, the 2nd and 3rd pieces of information are in the public domain. This may well not have been the case in Avudraham's times,⁸¹ or for many years afterwards. Thus, while the open contradiction of the 2nd and 3rd points did not represent a problem when starting dates for ותן טל ומטר were introduced by Avudraham (or earlier), it would represent a problem today. The only thing today that might prevent the open contradiction is the lack of knowledge on the part of the public of the 60-day waiting requirement. We are, however, uncomfortable justifying a prayer based on the ignorance of the worshippers.

In an earlier chapter we cited Rambam in *Hilchos Berachos* that ותן טל ומטר is begun 60 days after TT but noted that Rambam did not offer specifics on how this day is identified. However, in KH he describes in great specificity how to calculate the *tekufos* according to Shmuel (chapter 9) and R. Adda (chapter 10). Since the only *halachos* to which the knowledge of the *tekufos* are relevant are ותן טל ומטר and BH, and we have no reason to believe Rambam was just engaging in KH in hypothetical exercises, we must conclude that Rambam's calculations in KH were meant to be applied to these two *halachos*. As Rambam mentions the 28-year cycle (Shmuel) with respect to BH, it

tions would have to be made by the *Bais Din Hagadol* to make sure that no apparent contradiction is evident.

⁸¹ As cited previously, Ibn Ezra (who lived about 200 years before Avudraham) felt he proved Shmuel wrong but knew he had an uphill battle to convince others that he was right. It seemed that most of the *Chachamim* of his time were not "tuned in" to the start of the seasons and certainly did not feel it an "open contradiction".

is apparent that he meant the calculations of Chapter 9 to be used for this prayer. The absence of any mention of the 28-year cycle with respect to ותן טל ומטר and the fact that Rambam stresses the greater precision of R. Adda's model, similarly implies that it is the calculations of chapter 10 that are to be used for ותן טל ומטר. The discrepancy between the actual *tekufah* based on the sun's true orbit and an approximation based on R. Adda's model is about 60% of the discrepancy based on an approximation using Shmuel's model. For example, in the almost 1400 years between 45 BCE⁸² and Avudraham, Shmuel's model adds 11 days to the *tekufah* (1400/128) while R. Adda's adds only 6.5 days (1400/216). Thus, had Rambam lived in the 14th century he would have started ותן טל ומטר sometime between November 16 and November 18 rather than Avudraham's suggested November 21/22. Moreover, as time progressed beyond the 14th century, Rambam's calculation would continue to move the date back, although at a slower than actual rate.

As we stated above, it is now abundantly clear to all that a starting date of December 4/5 for ותן טל ומטר is clearly more than 60 days beyond the start of fall. Although Rambam's calculations would lead to a smaller discrepancy, unfortunately by our time period his starting time would also be substantially off (i.e., 8 days rather than 14 days). Can this situation be corrected without resorting to complicated calculation (Rambam's calculations are certainly more complex than Avudraham's)? Interestingly enough, an easy solution is available that is both highly accurate and consistent with the words of Avudraham. As noted in the chart at the beginning of the previous section, TT in the current era is on September 21/22 and November 22/23 is roughly 60 days later. If we delete the Gregorian dates added later to *Bais Yosef*, we can observe Avudraham's November 22/23 starting dates with little concern about open contradiction.⁸³

⁸² If they had properly calculated VE to be March 25/26 in 45 BCE.

⁸³ As explained previously, Avudraham's November 22/23 means starting with *Maariv* on November 21/22. Although based on the opinion that the 60 days includes the day of TT and the day of recital, November 22/23 would be one day off. Nevertheless, there are other opinions and most people only remember that fall starts somewhere around September 21.

With respect to BH the open contradiction is also presently inescapable. If originally BH was recited based on the type of calculations Ibn Ezra presents (and we previously outlined), then even in the times of *risbonim* where the practice is first mentioned, the prayer was openly inconsistent with reality. While the people of that time period may have been unaware of when spring starts based on general knowledge considerations, they could not assert that BH commemorates the date of VE (the start of spring) at the time of Creation, and still, at times, offer the prayer after the start of *Pesach*. The contradiction would have been immediately apparent to everyone because it is common knowledge that spring starts before *Pesach*.

***Bircas HaChamah*: What Does it Represent? A Fresh Look**

Before we can begin to discuss a solution to the BH problem, it is important that we first understand what BH is intended to commemorate. We began this paper with a brief discussion of BH and the Talmudic and *risbonim* sources for its recitation. Rambam *Berachos* 10:18 says:

הרואה את החמה ביום תקופת ניסן של תחילת המחזור של שמונה
ועשרים, שהתקופה בתחילת ליל רביעי—כשרואה אותה ביום רביעי
בבוקר, מברך עושה בראשית.

The text of the *berachah*, עושה בראשית, and the specification of the timing of the recitation imply that BH commemorates an event that took place at the time of Creation, Tuesday 6:00 p.m. Rambam, however, does not say what event this is. The conventional understanding, as expressed for example by Bleich,⁸⁴ is:

“BH, however, is pronounced only when the sun's return to its original position takes place on the same day of the week and at the same hour of the day as the original Creation. Creation of the sun took place at the beginning of the fourth day of the week. The sun was created in the position which it occupies at the time of the vernal equinox.”

⁸⁴ “*Bircas Hachammah*, Blessing of the Sun: Renewal of the Creation: a Halachic Analysis and Anthology,” 1981, p. 59.

This formulation ties the commemoration into two sun-related characteristics that happened during the week of Creation:

- 1) The installation of the sun into its celestial position at 6:00 p.m. on Tuesday;
- 2) The installation of the sun at Creation at the VE point of its orbit.

The first characteristic is accepted by all early commentators and is based on the understanding that when the Torah says the sun and moon were installed in the heavens on the 4th day of Creation, it means at the start of the 4th day, i.e., Tuesday, 6:00 p.m. There is, however, neither mention in the Torah nor a universally accepted *mesorah* to the *chachamim* as to the position of the sun in its orbit when it was installed. The position of the sun's orbit at its installation depends on a Tannaic (*Rosh Hashanah* 9a) and an Amoraic dispute. The Tannaic dispute revolves around the question of whether the world was created in *Tishrei* (R. Eliezer) or *Nissan* (R. Yehoshua). According to the former view, the sun's orbital position was somewhere around *Tekufas Tishrei* (start of fall) and not related to VE at all. However, even according to the latter view, there is a dispute based on the models of Shmuel and R. Adda as to whether the sun was installed at VE or a week after VE.⁸⁵ These assumptions are explicitly spelled out by Rambam in the 9th chapter of KH where he tells how to calculate VE for any year according to Shmuel. His analysis is based on *molad Nissan* of year 1 being 9 hours and 642 *chalakim* after Tuesday 6:00 p.m. in the week of Creation,⁸⁶ and the first VE preceding the *molad* by 7 days 9 hours and 642 *chalakim*, i.e.:

⁸⁵ See Ibn Ezra (*Sefer Halbbur*, pp. 5-6) that Shmuel's model is based on R. Yehoshua that the world was created in *Nissan* but that the timing in *Nissan* of both VE and *Molad Nissan* must yield the same TT and *Molad Tishrei* as it does for R. Eliezer. This assumption answers the question asked by *Tosfos*, לתקופות ד"ה ה. ר"ה, as to why the dispute between R. Eliezer and R. Yehoshua cannot be resolved by observing when the new moon becomes visible.

⁸⁶ According to R. Yehoshua, the world was created one half year earlier than it was according to R. Eliezer. According to both R. Yehoshua and R. Eliezer we consider a year as starting in *Tishrei*. Thus, according to R. Yehoshua, the first half of year 1 (i.e., *Tishrei* to *Nissan*) did not exist. According to R. Eliezer, Adam was created on Friday the first of *Tishrei*,

החדש ט:ז דרך חשבון התקופה, כך הוא: תדע תחילה כמה מחזורין שלמים משנת היצירה עד מחזור שתרצה, ... ותגרע מן הכול שבעה ימים ותשע שעות ושש מאות ושניים וארבעים חלקים; והשאר תוסיף אותו על מולד ניסן של שנה ראשונה מן המחזור, ... ז אם תרצה לידע באיזה יום מימי השבוע ובאיזו שעה תהיה התקופה—קח שנים גמורים שעברו משנת היצירה עד שנה שתרצה, ... ולמה מוסיפין שלושה, לפי שתקופה ראשונה של שנת היצירה הייתה בתחילת ליל רביעי.

In the 10th chapter of KH, Rambam offers similar calculations for determining VE according to R. Adda. While he keeps *molad Nissan* at the same day and point in time, 9 hours and 642 *chalakim* after Tuesday 6:00 p.m., he puts VE at exactly 6:00 p.m. on that Tuesday (i.e., 9 hours and 642 *chalakim* before the *molad*):

ג תקופת ניסן לפי חשבון זה, הייתה בשנה ראשונה של יצירה קודם מולד ניסן בתשע שעות ושש מאות ושניים וארבעים חלקים סימן להם ט' תרמ"ב. וכן היא לעולם בכל שנה ראשונה של כל מחזור, קודם מולד ניסן בתשע שעות ושש מאות ושניים וארבעים חלקים.

Thus, in Shmuel's model both R. Eliezer and R. Yehoshua agree that VE was on Tuesday 6 p.m. *not* during the week of Creation. When we say BH commemorates an act that took place with respect to the sun at the time (week) of Creation, we cannot therefore be referring to the sun, according to Shmuel, being installed at the VE (as Bleich says), because it was not. Neither can we say that in targeting 6:00 p.m. on the week of Creation in *Nissan* we are using R. Adda's assumption, because it makes absolutely no sense to choose a starting point of one *amora* based on one model, and the commemoration of that point in time based on a conflicting model offered by a different *amora* with whom he does not agree.

Hence BH can commemorate either the sun's installation Tuesday 6:00 p.m. in the week of Creation (according to R. Yehoshua), or the first VE taking place (virtually) at 6:00 p.m. Tuesday (not in the week of Creation), but not both. If it is the former, why is BH placed at VE and not one week later?⁸⁷ If it is the latter, then the closeness

but Creation started 5 days earlier on the 25th of *Elul*. Thus, according to him, 349 days of year 1 did not exist.

⁸⁷ It seems plausible that had Adam been created earlier in the week of Creation he would have done BH Wednesday morning of the week of

of VE to Creation does not seem to be the major reason for the commemoration but rather the fact that VE is an important point in the sun's orbit.⁸⁸ This approach resembles the way Saadiah Gaon interpreted *Berachos* 59b⁸⁹ with *Tekufas Nissan* replacing *Tekufas Tamuz* as the most significant point in the sun's orbit. Why then is BH not recited every year (like Saadiah Gaon's prayer) instead of being limited to once every 28 years based on a model that Rambam says is inaccurate?

Conclusion

This paper has discussed *Tekufas Shmuel* in detail and many aspects of the Jewish calendar in a passing manner. We have placed the most emphasis on Shmuel because it is he who is usually put forth as someone whose solar/lunar model is clearly wrong. On the one hand, Shmuel proudly proclaims his astronomical knowledge:

ברכות נח: ...ואמר שמואל נהירין לי שבילי דשמיא כשבילי דנהרדעא
לבר מכוכבא דשביט דלא ידענא מאי ניהו.

On the other hand, he seems unaware of elementary rules in calendar construction:

ראש השנה כ: ...אמר שמואל יכילנא לתקוני לכולה גולה אמר ליה אבא
אבוה דרבי שמלאי לשמואל ידע מר האי מילתא דתניא בסוד העיבור נולד
קודם חצות או נולד אחר חצות א"ל לא אמר ליה מדהא לא ידע מר איכא
מילי אחרנייתא דלא ידע מר.

We have shown that Shmuel may very well have been an expert in astronomy and thoroughly understood the need for leap years to balance the solar/lunar differences. His statements throughout *Sbas* are astronomically correct for his era and he never claimed that they would work for all time without corrections. Over time, the need to establish a simple starting date for **ותן טל ומטר**, and the desire to have a BH blessing commemorating the renewal of the sun, appears to

Creation, in the last few days of *Adar*, and not been concerned that the virtual VE was one week earlier.

⁸⁸ E.g., the length of the day continues to increase and day starts to dominate night.

⁸⁹ See footnotes 12 and 56.

have led to a resurgence of Shmuel's model. The problem we face is that while his model offers easily derived prayer dates, it also leads to results that are openly at odds with season-related facts that are common knowledge in today's society. ❧

Calendar⁹⁰ for year 1337

January

Su	Mo	Tu	We	Th	Fr	Sa
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

February

Su	Mo	Tu	We	Th	Fr	Sa
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	

March

Su	Mo	Tu	We	Th	Fr	Sa
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

April

Su	Mo	Tu	We	Th	Fr	Sa
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

May

Su	Mo	Tu	We	Th	Fr	Sa
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

June

Su	Mo	Tu	We	Th	Fr	Sa
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

July

Su	Mo	Tu	We	Th	Fr	Sa
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

August

Su	Mo	Tu	We	Th	Fr	Sa
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

September

Su	Mo	Tu	We	Th	Fr	Sa
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

October

Su	Mo	Tu	We	Th	Fr	Sa
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

November

Su	Mo	Tu	We	Th	Fr	Sa
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

December

Su	Mo	Tu	We	Th	Fr	Sa
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

⁹⁰ Available at <http://www.timeanddate.com/calendar/index.html?year=1700&country=16>.