'*SHANA MEUBERET*' and the 'THEORY of OTHERS'

Ari Belenkiy

Department of Mathematics, Bar-Ilan University, Ramat Gan, Israel

Abstract.

The Talmudic calendar system known as the 'theory of others' is recovered from oblivion. This system is mentioned no less than five times in four Talmudic tractates, but still is grossly misunderstood in literature on the subject. The reason is a change in the meaning of the notion 'shana meuberet.' Its modern (probably Gaonic) meaning as a 13-month (intercalary) year quietly suppressed its former Talmudic meaning of a 355-day (leap) year.

The 'theory of others' is known in the medieval literature as the *Epact* system. The Catholic Church used the 19-year-cycle version of the latter for determination of Pascha from the Council at Nicea up to the Gregorian reform. A new interpretation of the 'theory of others' gives an answer to the question raised by Otto Neugebauer about the relationship between the calendars of the 4th century Alexandrian Church and the local Jewish community. It also sheds new light upon the so-called *Sardica* Document. A stated conjecture is that the 'theory of others' was an *emergency* system for the time of persecutions, designed around the time of the Bar-Kochba revolt. It remained the basis for the Jewish calendar from the end of Mishnaic period up to 359 CE.

Introduction

The contemporary Jewish calendar has a 19-year intercalation cycle and is based on the *Molad* (calendar conjunction). The implementation of the modern Molad system in Jewish practice was credited by Hai Gaon (in a 992 letter) to the 4th century sage Hillel bar Yehuda Nasi (known also as Hillel II). We know practically nothing about what calendar was in use before the 4th century. Therefore Saadia Gaon c. 927 claimed that *'the Jewish calendar was given at Mount Sinai'* (and as such was - and always will be - the same). The

constancy of the calendar later turned into a powerful myth, repeated by different rabbinical authorities through the centuries to modern times.

This claim sought support from the famous Baraita from the Mishnaic period cited in the Talmudic tractate B. *Rosh Hashana 25a* and ascribed to Rabban Gamliel of Yavne (d. 116). The Baraita explicitly quotes the Babylonian-Ptolemaic value of the mean lunar month equal to 29.5 days, 44 minutes and 1 part, which is also the basis for the present-day calendar *Molad* system. The Baraita was the subject of detailed scrutiny in Jewish literature. Chayim Zelig Slonimsky and Chayim Yehiel Bornstein, classical scholars of the Jewish calendar, showed that the Baraita suffered multiple emendations and was completed no earlier than the end of the 8th cent. CE.[1]

This discovery, together with the fact that Rabban Gamliel used natural phenomena (like the ripeness of fruits, B. Sanhedrin 11b) to determine the proper time for intercalation and interrogated witnesses to determine the beginning of every month, questions the fact that Rabbanim stuck to the Molad system in the Mishnaic period, yet leaves room for the possibility that other, different calendar systems could have been tried at the same time. Here we describe one such system, known in the Talmud as the 'theory of others.' This theory was grossly misunderstood in the literature and, as a consequence, its historical role has been underestimated.

1. CRUCIAL FACT

A decisive proof that a fixed calendar was on the agenda no later than the second half of the 2nd century comes from a dispute, recorded in the Talmudic tractates *Rosh Hashana* 19b and *Arachin* 9b, between an *anonymous* Tanna (Rabbi Nathan or Rabbi Meir?) and Rabban

Simon ben Gamliel about the length of the additional month intercalated in the Jewish intercalary year:

"What do we intercalate? Thirty days. Rabban Shimon said a 'month' [29 days]."

If it was an empirical calendar, then the beginning of any month (intercalary in particular) had to be decided by accepting the testimony of two witnesses. The dispute marks a complete break with that practice. The only way to handle this fact is to recognize that in the mid-2nd century in place of an empirical calendar a fixed calendar was sought, or that there was a transition from one fixed calendar system to another.

Another immediate corollary is even more striking. The fact that the Jewish leader of his time, Rabban Shimon ben Gamliel, argued for a 29-day intercalary month unequivocally proves that the present-day Molad system (with its 30-day intercalary months) was not considered the best in the Mishnaic period.

A last remark: It is impossible to construct a viable cyclic system by always intercalating a 29-day month. This means that the subject of discussion was not a general rule, but rather a particular situation. We will come back to this point later.

2. 'THEORY OF OTHERS'

In four tractates and in five places the Talmud[2] mentions the following passage:

"And others say: from Atzeret to Atzeret and from Rosh Hashana to Rosh Hashana - 4 days only, though in a shana meuberet [lit: pregnant year] - 5 days."

This statement is known as the 'theory of others,' authorized by one of the 'others' - either by the dissident scholar Elisha ben Abuya (fl. c.120-50), Rabbi Nathan (fl. c.150-90), or Rabbi Meir (fl. 130-90). The first 'cut the roots' - stopped observing Jewish law - and was excommunicated at the time of Rabban Gamliel. The second sage was a student of the

first and was third in authority in the era of Rabban Simon ben Gamliel. The third sage came from Babylonia and was second in authority in the era of Rabban Simon ben Gamliel. The latter two were expelled from the Talmudic Academy in Usha.[3]

Starting with Rashi (1040-1105), 'shana meuberet' in that passage was taken to mean an intercalary year of 13 months and the 'theory of the others' was then understood[4] as meaning two things:

1) the regular Jewish calendar year (of 12 lunar months) must contain 4 days *on top of* a whole number of weeks; the only reasonable number is 354 days.

2) the Jewish intercalary year (of 13 months) must contain 5 days *on top of* a whole number of weeks; the only reasonable conjecture leads to 383 days.

3. 'SHANA MEUBERET' IN THE 'THEORY OF OTHERS'

Logical as it sounds, the above explanation encounters serious difficulties. The 383 days in the intercalary year implies that the 13th month should have 29 days. Then, by simple arithmetic, we get 6929 (354 * 19 + 29 * 7) days in the lunar cycle, while the solar part has 6939 3/4 days. The difference of almost 11 days is intolerable; and the 'theory of others' seems completely untenable, unless we come forward with a different reading.

The <u>only change</u> we suggest is to reevaluate what the word 'meuberet' means. The key to the puzzle comes from the tractate B. Arachin 9b. Explaining how it could happen that there were <u>eight full months in one year</u>, Rabbi Mesharshaya [5th cent. CE] said:

"It was 'shana meuberet' and additional month [ibbur shana] was of 30 days."

It was always tacitly assumed that the second part of this statement ['*ibbur shana* was of 30 days'] is a gloss on the first part [*shana meuberet*]. However, it is clear that to get eight full months one cannot just add an intercalary month of 30 days to a regular pattern of

30-29 days with its six full months. We suggest separating these two meanings: 'shana meuberet' in the Talmud has to mean a year of seven full months or 355 days. We will further call it a 'Jewish leap year.'

This is an important observation. In a recent paper this author suggested that in Talmudic times 'shana meuberet' could designate a *Julian leap* year.[5] Now we suggest an alternative meaning: the Talmudic expression 'shana meuberet' had a meaning of a *Jewish leap year* (of 355 days) while 'chodesh ibbur' was a different entity, counted separately from the rest of the year. Which meaning, however, was carried by the term 'shana meuberet' grossly depends on the role of the word 'only' in the 'theory of others.' For the sake of exposition we postpone this discussion to a later time. Notice that even when accepted as the *Jewish leap year*, 'shana meuberet' in the 'theory of others' has to be closely linked to the Julian leap year, overlapping in a special way.

4. THE 'THEORY OF OTHERS' RECOVERED

Under the above assumption of what 'shana meuberet' is, the 'theory of others' immediately becomes intelligible: it suggests adding a day to a Jewish year (which overlaps with a Julian leap year), thus allowing every fourth regular Jewish year to consist not only of 354, but also of 355 days.

Let us show that this system fits well into a 19-year cycle (with its 7 intercalary and 12 regular years). First note that without adding an additional day every Julian leap year, the calendar has on the lunar part only 6936 (354 * 19 + 7 * 30) days, whereas the Julian solar calendar has 6939 3/4 (365 1/4 * 19) days during 19 years. To make the lunar calendar match the solar we have to change the number of days in the lunar part. In every 19 years

there are on average 19/4 Julian leap years.[6] With these 4 3/4 days we can get, in the lunar cycle, 6940 3/4 (6936 + 4 3/4) days.

We see that the lunar 19-year cycle is one day longer than the solar cycle. Though the way to solve the problem is obvious (omit one day from the lunar calendar) the 'theory of others' is silent on this.

5. 'EPACT' SYSTEM

Remarkably, the 'theory of others' is known in world history, though in disguise. In one of his last papers, 'Ethiopic Easter Computus,' Otto Neugebauer described the system used by the Alexandrian church in the beginning of the second quarter of the 4th century.[7] Though all the Ethiopic tables came from 15th century scribes, they repeat the same 532 year pattern. However, the table found in the Armenian Patriarchate in Jerusalem contains the date "44th year of Diocletianus" (327-28 CE) and its *indictia* coincided with the *Paschal Festive Letters* of the Alexandrian Patriarch, Athanasius (298-373), from the year 328 on. Unlike Athanasius' *Festive Letters*, the Ethiopic tables also contain the dates of all major Jewish holidays, and Neugebauer was convinced that the tables (and the underlying system) had origins in the Alexandrian Jewish community. In the Greek and Medieval Latin literature, the system was given the name the *Epact*, where 'epact' meant the difference between the solar and lunar years.

The civil calendar used in Alexandria in the Roman period was a mixture of the old Egyptian calendar and the Julian calendar. In the latter, all the months are of 30 and 31 days and the additional 366th day was February 29, but in the former all months were of 30 days and 5-6 extra days were added only at the end of the year, in August. So the beginning of the Alexandrian civil year (*Thoth* 1) usually fell on August 29, except in the years preceding

Julian leap years, when an extra, 366th day was added to the previous civil year, so that year (*Thoth* 1) started on August 30.[8]

The Alexandrian church calendar was extremely simple and consistent. Passover (and other Jewish holidays) each year were moved, with regard to the Alexandrian civil calendar, 11 days down, but in the intercalary year were moved up 30 days.[9] The system of epacts during the 19 year cycle was *0, 11, 22, 3, 14, 25, 6, 17, 28, 9, 20, 1, 12, 23, 4, 15, 26, 7, 18,* so an epact at year **i** was computed by the formula $e_i = (e_{i-1} + 11)$ *modulo* **30**. The civil date of Rosh Hashana in the year **i** of the cycle was then computed as **30 - e**$_i$:

$$30, 19, 8, 27, 16, 5, 24, 13, 2, 11, 10, 29, 18, 7, 26, 15, 4, 23, 12,$$

where dates smaller than 14 stand for the second month *Phaophi* and dates greater than 14 for the first month *Thoth*.

We see that if we continue to subtract 11 days, the next cycle would start not on the 30th of *Thoth,* but on the 1st of *Phaophi*.[10] This was prevented by moving all the holidays down by 12 days in the last year of the cycle. This 12-day shift was called in the medieval literature 'saltus lunae' - 'jump of the moon.'

6. 'THEORY of OTHERS' vs. EPACT SYSTEM

The *Epact* system is equivalent to the 'theory of others.' Indeed, an 11-day shift down with respect to the Alexandrian civil calendar gives a 354-day lunar calendar year, but the same shift made in the Alexandrian civil leap year of 365 days leads to the lunar calendar year of 355 days. This is exactly what the 'theory of others' suggests.

Because Rosh Hashana in the Alexandrian *Epact* system fell no earlier than in September and thus always later than the Alexandrian 366th extra day, the only way for the

Alexandrian Jewish community to keep 11 day jumps consistently for all Jewish holidays from Rosh Hashana to Passover was to add the 355th day to the lunar calendar before Rosh Hashana, in the preceding month of Elul (which regularly contained 29 days).[11]

The 'theory of others' is seemingly silent on which month gets the added 355th day. But, in fact, detailed study unveils the facts. Having pointed to the annual 11-day shift for the Jewish festivals, 'others' also specified when to add the extra day. Saying 'from Atzeret to Atzeret' before 'from Rosh Hashana to Rosh Hashana' means that the addition of a day should be performed in the period when the two intervals overlap: from Rosh Hashana to the following Atzeret (Shavuot). And because between Passover and Shavuot there are exactly 50 days, it implies that the intercalation of a day has to be performed during the first six months following Tishrei, in one of the 29-day long months: Heshvan, Tevet, or Adar.[12] Such a move will spoil the 11-day-shift based on the Alexandrian civil calendar, because Rosh Hashana always starts after August 29, while Shavuot always starts before. In a sense, the 355th day of the Jewish calendar has to be added 'not far' from the 366th day of the Christian calendar, in such a way that none of the Jewish festivals falls in between.

Here one immediately recalls another calendar which has the 366th extra day during that six-month period - the Julian calendar with its February 29. This means that the 'theory of others' was based on the major Roman calendar system. Therefore it is truly independent of the Alexandrian church calendar and most likely goes back to the Jewish academy in Usha at the end of the 2nd century, where the 'others' taught.

7. 30-YEAR-CYCLE?

Because the 'others' are silent about 'saltus lunae,' let us look for another *Epact* system that does not need it. The only such system is a 30-year cycle. Subtracting 11 days

each year, with the addition of 30 days in the intercalary years, after 30 years (with 11 years intercalary) one comes to the same starting date in the Julian calendar.

The 30-year cycle is also known in history: it was championed by the Eastern Church, as is seen from the *Sardica Document* submitted by an Antiochean bishop to the Sardica Council in 343.[13] The bishop seemingly tried to prove that Jews might use the 30-year cycle: in that document the dates of Christian full moons (Nisan 14) are parallel to Jewish Passovers for the 16 years since 328; these dates coincide except for cases when Passover fell before the vernal equinox, in early March.

Though one cannot conclude from 16 years whether Jews actually used a 30- or a 19-year cycle or whether the latter was a part of the Molad or Epact system, the Antiochean bishop could have heard that Jews had used a 30-year cycle in the past, prior to a 19-year cycle. The bishop could have further assumed that the former cycle could have been in use as long ago as the time of Jesus - thence his proposal.[14]

8. THE WORD 'ONLY' IN THE 'THEORY OF OTHERS'

'Only', a seemingly accidental word in the first part of the statement (about regular years), can be an indicator of the cycle behind the 'theory of others' and of the true meaning of the 'shana meuberet.' There are two ways to read it.

In de-emphasizing 'only,' the 'theory of others' becomes a trivial statement about Jewish regular and leap years without any need for a 'saltus lunae.' This strongly speaks in favor of a 30-year cycle. 'Shana meuberet' can designate either the Jewish leap year or the Julian leap year. The only feature that would be missing in the former case is an indication of how often Jewish leap years have to be inserted.

In emphasizing 'only' in the first part, its lack in the second part (about leap years) indicates that once in a while a Julian leap year of 366 days does NOT necessarily meet a Jewish year of 355 days but meets a year of 354 days. This implicitly points to a 'masked' 'saltus lunae' and speaks in favor of a 19-year cycle. This interpretation suggests the 'Julian leap year' as the only true meaning for 'shana meuberet.' With this, the system becomes complete, except for an indication of how a 'saltus lunae' should be applied.

9. 'SALTUS LUNAE' IN THE 19-YEAR CYCLE

If the Jewish authorities did use the *Epact* system with a 19-year cycle in practice, one has to explain what they did with the 'saltus lunae,' because there is no place for a year of 353 days in a calendar that has Adar as the only variable month. The only solution is that the day was dropped, not in the last, 19th, year of the cycle, but in any Julian leap year of the cycle: for example, the 30th day in Adar was simply not added.

The suggested procedure of not allowing one year to be 355 days long (a 12-day jump down the calendar in the leap year instead of the standard 11-day jump) makes the use of the standard 'epact' table less convenient and, as we believe, forced the next emendations of the calendar. The resolution of the new problems led to the rise of the *Molad* system.

Remark. There is one more way to implement a 'saltus lunae' - intercalate a month of 29 days once in a cycle. In this case, the dispute between an anonymous sage and Rabban Shimon ben Gamliel acquires a completely different status as a fundamental dispute about 30- and 19-year cycles.

10. 'ORTHODOX' AND 'MODIFIED' 'OTHERS'

There is strong evidence (see the last section) that a variant of the "theory of others" was used until the year 359. Given that, let us show how all known facts about the calendar between late 2nd until mid-4th centuries can be interpreted in terms of 'others.' [15]

According to the same page of the Talmud (B. *Rosh Hashana* 19b) where Rabban Shimon ben Gamliel argued for intercalation of 'a month' (29 days), Rabbi Sim[l]ai testified that the Bet Din allowed the pair of Adar I and Adar II to be either both full (30+30), both defective (29+29), or one full and the second defective (30+29). The third option is for a *regular intercalary* year. The second option might reflect the 'saltus lunae' in Adar I (intercalation of a defective month, which might be an argument of Rabban Shimon as explained above). The first option points to the *intercalary leap* year within the *Epact* system with an extra 355th day in Adar II.

It is unclear for how long this ('orthodox') 'theory of others' survived, because later on that same page, the sages said that *"according to our rabbi"* (Rabbi Yehuda? Rav?!) the first option was forbidden. (This was confirmed by a later statement that "an Adar adjacent to Nisan is always defective.") Clearly the sages did not want to have four full months in a row. But how did they handle *intercalary leap* years (which come as often as <u>seven times every 76 years</u>)? Here the Elul option might come into play, and instead of two full Adars, the sages may have used the scheme 30+29 for the Adars, while Elul of that year became full.

Because a 'saltus lunae' is needed only once in 19 years, or *four* times in 76 years, there remain only *three* times in every 76 years in which Elul must be made full to compensate for a defective Adar II, while during 95-100 years there could be *four or five* times. The Talmud (B. *Rosh Hashana* 20ab, 21ab) speaks about *four* cases in which the

month Elul was made full. Those four cases occurred over the life of four generations from Rav to Rava, spread over 100 years.

Though the Elul option partially destroys the basic principle of Epact as a constant 11-day shift of all holidays along the Julian calendar and spoils the idea of a fixed table, it gives much needed flexibility for fixing Rosh Hodesh Tishrei and Nisan. This modified (c.220 ?) 'theory of others' seemingly still carried the name 'others,' as can be implied from the discussion between Abayee and Rava in B. *Rosh Hashana* 20a.

11. HISTORICAL PRIORITY

It is important to find the true author of the Epact system: the Church or the Jewish Alexandrian community. There is an interesting episode in the Talmud (Y. *Erubin* 21c):

"Rabbi Abahu went to Alexandria and they raised lulavin on Shabbat. Rabbi Ami heard and said: who will bring them Rabbi Abahu every year? Rabbi Yosi sent them a message: even though we wrote to you the dates of the festivals, keep the customs of your fathers, whose souls are at rest."[16]

Rabbi Ami (a disciple of Rabbi Yohanan) and Rabbi Abahu lived at the end of the 3rd century. Rabbi Yosi probably lived at the same time or slightly later. Whether the dates sent to Alexandria were computed from the 'theory of others' remains an open problem. If proved, the passage above would confirm Otto Neugebauer's belief that the Jewish community in Alexandria had priority before the local Church in use of the Epact theory. Moreover, it would complete the historic link between the 'theory of others' and the Epact.

Another point deserves special attention. The staunch fight of the Alexandrian Church for the 19-year cycle with its awkward 'saltus lunae' and against the 30-year cycle of the Antiochean Church could have two different explanations. Either the Church made

its own long path of trial and error (of which we are not fully aware[17]), or it had a clear understanding that the 19-year cycle gives a better approximation of the Ptolemaic value for the mean month. Then another belief expressed by Neugebauer, that "there is no sign of Alexandrian pagan astronomy in the Church Paschal calendar," should be scrutinized further.

12. WAS THE 'THEORY OF OTHERS' EVER IN USE?

The 'theory of others' seems to be referred to in the Talmud as an artifact of the past, but only by the 4th century (Abayee) and later sages (Ravina). Besides, the major rebuke against its 'orthodox' version was mild and rather 'technical' - its permission to have four full months in a row (from Shevat to Nisan), while its 'modified' version was charged with 'disrespect' toward Roshei Hodashim other than Nisan and Tishrei.[18] However, let us read carefully Hai Gaon's c. 992 words, as quoted c.1123 by Abraham bar Hiyah Savasorda:

"Rishonim [first sages] from Moshe Rabbeinu until the days of Hillel bar Yehuda always added one hour and 485 parts to the precise 19 year cycle. But in the year 630 of Era Alexandri [=359CE] they decided not to add anything more but keep the correct number." [19]

The only way to understand these words is to compare the Epact system of 6939d 18h with the Molad system of 6939d 16h 595p (29d 12h 793p * 235). The difference is precisely 1h 485p. This means that Hai Gaon recognized that the system preceding Molad was a variant of the Epact ("others") system. An additional fact, that al-Biruni (c. 1000 CE) mentioned the Epact system[20] among other calendar systems used by Jews, lends more weight to this option.

The 'theory of others' has too many advantages not to be used for an extended period. Its 30-year version, though imprecise, is especially simple and can be used in times of emergency (persecutions). So far we have considered the possibility that it was developed in the time of Rabban Shimon ben Gamliel, by his counterparts Rabbi Nathan and Rabbi Meir. But it might go back to Elisha ben Abyah and Rabbi Akiba,[21] and therefore to the time of the Bar-Kochba revolt. It could be that it was an *emergency system* which Rabbi Akiba introduced in the Diaspora and which was actually used for a brief time by Rabbi Chanania, a nephew of Rabbi Yehoshua, in Babylonia (B. *Berakhot* 63ab). During the dispute with an anonymous Tanna, Rabban Shimon could have argued for a switch to the 19-year cycle. In the latter form the 'theory of others' could have been continuously used in some other areas of the Diaspora, e.g., in Alexandria, until 359 CE.

EPILOGUE

The short dispute between an anonymous Tanna and Rabban Shimon ben Gamliel, registered in two places in the Talmud, buries forever and ever the 'comfortable' belief that the Molad system was the only Jewish calendar system. Moreover, an extra month of 29 days, advocated not by a dissident but by a Jewish leader, can be explained only in the framework of a so-called 'theory of others,' a Jewish variant of the Epact system. Whether it initially was a 19- or 30-year cycle is still an open question, depending partially on the epistemology of the word 'only.' Whether the system was ever in use in its 'orthodox' form and, if so, for how long, is another open question.

The existence of another viable calendar system in the Talmudic period carries dramatic historic consequences. Saadia Gaon's claim that the 'Jewish calendar originates from Mount Sinai' should then be understood as equating the Molad system to the system used in the Second Temple.[22] Accepting this, one cannot avoid the conclusion that after the

destruction of the Temple in 70 CE rabbanim lost that tradition entirely and were compelled to invent their own calendars. Though outwardly simplistic, these efforts give another flavor to Jewish intellectual life between the 2nd and the 10th centuries, which now can be seen as not solely a chain of Talmudic studies, but also as a continuous search for the best calendar. This search often was not straightforward and -- as numerous instances witness -- was subject to serious internal conflicts and excommunications.

The Molad system with *Dekhiyot* Rosh Hashana imposed upon it had to accommodate the year of 353 days. Another word had to be coined and there was no convenient inversion for the word 'pregnant'. This has dramatic philological consequences. 'Shana meuberet' slipped into its current meaning of the Jewish *intercalary* year while the years of 353, 354, 355 days acquired new names: *deficient, regular,* and *complete*.

Not being concerned with these particularities, the Church picked up the Epact system with the 'saltus lunae' fixed at the end of the 19-year cycle and quietly used it from 328 until the 1582 Gregorian reform, when it became a bit more complicated. This is just another unacknowledged Jewish present to Christianity.

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[1] Ch. Z. Slonimsky, *Yesod Haibbur.* (Warsaw, 1852): 32 ftn and Ch.Y. Bornstein, *Makhloket Rav Saadyah Gaon u Ben Meir* (Warsaw, 1904): 130. Cf. S. Stern, *Calendar and Community* (Oxford: Oxford Univ. Press, 2001): 203.

[2] See B. *Rosh Hashana* 6b and 20a, B. *Sukka* 54b, B. *Shabbat* 87b*, B. Arachin* 9b. "Atzeret" here means "Shavuot," celebrated 50 days after Passover.

[3] See B. *Horayot* 13b. The reason for expulsion seems to have been unrelated to our topic, though this needs further investigation.

[4] See *Makhloket (op.cit.)*: 31, and most recently *Calendar and Community* (*op.cit.*): 159-60.

[5] A. Belenkiy, "Sod Ha-ibbur: Shalosh Shitot B-luach Ha-ivri B-meot Ha-rishonot Le-sphira," *Proceedings of the 11th Conference on the History of Judea and Samaria.* Ariel, 2002, 275-86.

[6] Of course, every particular 19-year cycle contains either 4 or 5 leap years. However, four cycles, i.e. 76 years, contain exactly 19 leap years.

[7] O. Neugebauer, "Ethiopic Easter Computus." *Oriens Christianus*, 63, no. 4 (1979).

[8] E.G. Richards, *Mapping Time: The Calendar and its History* (Oxford: Oxford University Press, 1998): 157.

[9] After establishing the date of Passover and its day of the week it is easy to find the date of Easter.

[10] Seven intercalary months give 210 days, whereas nineteen 11-day jumps give only 209 days.

[11] In the calendar of the Alexandrian church, the distance between Rosh Hashana and the 'Passover feast' (Nisan 14) was always 190 days, so the intercalary month in the lunar calendar was Elul II. The system of intercalations of the second Elul goes back to the ancient Babylonian calendar. The 190 stands for 177 + 13. The 177 days before Nisan 1 show that previous six months were of 30 and 29 days interchangeably.

[12] Discussions in B. *Rosh Hashana* 6b and B. *Shabbat* 87b suggest that the 'theory of others' was interpreted to allow adding one extra day in Iyar as well.

[13] First analyzed by E. Schwartz, *Christliche and judische Ostertafeln* (Berlin, 1905); cf. *Calendar and Community*: 124-132.

[14] Ch. Y. Bornstein, aided by his great intuition, supported (though with a 20-year delay) the idea of a 30-year cycle used by the Jews in the beginning of the 4th century; see his 'Ibburim ve-Mahzorim,' *Ha-Tequfa*, 20 (1924): 319. His arguments, however, were purely Talmudic: references to Ravina's words in B. *Arachin* 9b and the 60-year calendar sent c. 240 by Shmuel Yarkhinai to Rabbi Yohanan (B. *Hulin* 95b). The "60" is nothing more than "double 30" divisible by 4, and thus a true cycle independent of the position of the first leap year. One can imagine that Shmuel sent 60 sheets of the Julian calendar for 60 years ahead, with Jewish holidays marked on them against Julian dates.

[15] One can only gasp when S. Stern (*op.cit.*, p. 164) discerns in Rabbi Yose's *"he never recited musaf on Rosh Hodesh because he was never certain when Rosh Hodesh was"* (Y. Sanhedrin 5:3) confirmation "that the calendar was still *empirically reckoned* in the days of Rabbi Yose [late 3rd cent.]." The traditional logic implies the reverse: rabbanim never liked the fixed calendar because they were never certain of when a Rosh Hodesh fell.

[16] Cf. *Calendar and Community*: 173, though Stern's discussion of this passage is irrelevant here.

[17] The path might begin after the Church's c.197 resolute break with the Quartodecimans, with a c.213/14 calendar by Demetrius, the 12th Alexandrian Patriarch. See 'Ethiopic Easter Computus.'

[18] B. *Rosh Hashana* 20a and B. *Arachin* 9b. Out of this sentiment the more flexible calendar with variable Cheshvan and Kislev was later born.

[19] A. Bar Chiyah Savasorda, *Sefer HaIbbur* (Publ. H. Filipowsky, London 1851), p. 97.

[20] Al-Biruni, *Chronology of Ancient Nations* (tr. Ed. Sachau, London 1879), p. 142, arranged it into an "Assaying circle." The "saltus lunae" was applied in the last 19th year. Sachau (see his remark on p. 406) completely misunderstood the meaning of this circle.

[21] See B. *Sukka* 54b.

[22] The present-day molad system is an exact copy of the so-called System B known in Babylon since at least 258 BC - see H. Hunger and D. Pingree, *Astral Sciences in Mesopotamia* (Leiden: Brill, 1999): 236-241. Recently Dennis Rawlins laid a claim of its Aristarchian origin (DIO, 11/1, May 2002). According to al-Biruni (*op.cit,* p. 68) his informants claimed that Jews began to use the molad system some 200 years after Alexander the Great's era.