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Behold, A Moon Is Born!

How the Jewish Calendar Works

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It was the last Shabbat morning of the Hebrew month when services were being conducted by the *balebatim* in a small Orthodox shul. The time came for *Birkat Ha-Ḥodesh,* the prayer for the new month. Following traditional custom, one of the men, a prominent academic at a local university, proclaimed the exact moment of the *molad,* by day, hour, minute, and part of a minute.

Then he paused. He knew that one does not announce the day or days on which *Rosh Ḥodesh* would fall without first announcing the time of the *molad,* but he was not exactly sure what is meant by the *molad.* "The *molad,*" he started, "is the time when the new moon is straight above Jerusalem." Then, in confusion, he stopped. He doubted that his conjecture was right and, besides, he had already done what was necessary; he had given the time as it appeared in the calendar posted on the wall. And so he continued with the recital of the prayer.

Our befuddled academician has plenty of company. Very few otherwise learned Jews—including rabbis, regardless of their affiliation—know precisely the meaning of the *molad* and its relation to the Jewish calendar. Since it is the pivot around which the calendar revolves, it is rather surprising that it is so largely wrapped in obscurity. We hope, therefore, that the explanations which follow will dispel some of the confusion.[1]

The Sun, the Moon, and the Earth

The *molad* is based on the changing relative positions of the three spatial spheres that are most familiar to us—the sun, the moon, and the earth. Looking at the sun, we perceive it as going around us in a complete circle in

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24 hours. The moon, however, takes about 25 hours to make its circuit. They can thus be compared to two runners of steady, but unequal, speeds who are pacing around a circular race track. The faster runner will periodically come alongside the slower one and then move ahead of him. He will gradually increase the gap between himself and his slower companion until the two are at opposite points on the track. From that time on, he will be advancing toward the other until he overtakes him once again.

Similarly, the sun gradually moves further and further ahead of the moon. If, on a particular day, the two of them were to rise about the same time, the next day the moon would rise almost an hour later than the sun. A week later, it would rise (and set) roughly six hours later than the sun, and a week after that, it would do so about twelve hours later. At that time, with the sun and moon at opposite directions from the earth, the one would rise approximately when the other was setting. The illuminated side of the moon would then be fully visible on earth, resulting in what we call a "full moon."

From that point on, the sun, like the faster runner, keeps diminishing the distance between it and the moon ahead of it. The moment when it catches up with the slower orb is called by astronomers the "**conjunction.**" It is listed in almanacs as the time of the "**new moon,**" the time when the old moon, having faded away, yields to the new. (At the time of conjunction, the moon—from the perspective of the earth—is usually on either one side or the other of the sun. There are times, however, when the moon is directly between the sun and the earth, thus causing a **solar eclipse**—the only way in which such an eclipse is possible.)

The conjunction lends itself to being the determinant as to when one month concludes and the next begins. It would seem, then, that if one knows the length of time between two conjunctions, one can simply add that period to the time of the first one to learn when the next meeting of sun and moon would take place, signaling the beginning of yet another month. Unfortunately for calendar purposes, however, the length of the period varies from month to month, so that conjunctions are hardly equidistant milestones.[2] The ancients, aware of that problem, averaged out the times in order to arrive at a convenient figure that could be remembered over the years without the necessity of recomputing the length of each individual period. That average, as established by the Greek astronomer Hipparchus (2nd century B.C.E.) and repeated by Ptolemy in his *Almagest* some three centuries later, was 29 days, 12 hours, 44 minutes and 3⅓ seconds. Though this figure is slightly inaccurate, it is utilized by Jewish calendar makers to the present day.[3]

Using this computation of the "**mean** [i.e., average] **synodic month**"[4], astronomers arrived at what is called the monthly "**mean conjunction**"—close to, but not precisely at, the true conjunction. It is a sort of theoretic new moon which has the advantage of coming at fixed periods (the mean synodic months) one after the other. The time of each of these "theoretic new moons" constitutes what came to be known in Hebrew as the ***molad*** for that month (literally, the "birth" of its moon).[5]

Where, Oh Where?

The first thing that one must realize in regard to the conjunction—and hence to its approximation, the *molad*—is that the time of its occurrence is totally independent of location on earth. Sunrise, noon and sunset result from the rotation of the earth, and so they come later to westerly locations than they do to easterly ones. The conjunction, on the other hand, results from the alignment of the sun, moon and earth. Hence, it comes about at the same moment for the entire globe. That moment, however, is a different time in different parts of the world. If it should be at noon in New York, for example, it would be, at that very same time, midnight halfway around the earth (e.g., in Chungking, China).

The same thing holds true for the *molad.* At the moment of its occurrence, the time is different in different locations. The time indicated in the Jewish calendar, however, is the time *at a particular place.* The question that arises, then, is "What is that place?" While it is generally thought that the time of the *molad,* as given in the *luaḥ,* is Jerusalem time, the facts are not clear. There is some reason to believe that it may be Babylonian time, and it is possible that it was adopted from the Greeks without making the proper correction for Jerusalem or Babylonia.[6]

Of one thing we can be certain: if there was a place in the past where the *molad* represented precisely the average conjunction, it definitely no longer does so now. The reason is that the time from *molad* to *molad* slightly exceeds the true time of a "mean synodic month"—from one "mean conjunction" to the next. Whereas the former, as pointed out, consists of 29 days, 12 hours, 44 minutes and 1 "**ḥeleq**" (or "part"—*3⅓ seconds*), the latter is, in fact, only 29 days, 12 hours and *2.9 seconds.*[7] Hence, the *molad* keeps creeping ahead of the "mean conjunction." While the difference is less than a half-second each month, it adds up over the centuries, at the rate of about one hour for every 700 years.[8]

The Disappearing Moon

What, precisely, does one see at the moment of the *molad*? The answer is, "Nothing."

First of all, the *molad* can come at any time of the day or night, and, therefore, the sun and moon may very well be on the opposite side of the earth from the side on which the observer stands. Secondly, the *molad* does not correspond to a specific cosmic phenomenon but is only a "mathematical construct." It is based on an *average* of times of actual cosmic phenomena—the conjunctions of sun and moon relative to the earth—and an *inaccurate* average at that.

What, then, does one see at the moment of the real, astronomical, conjunction? The answer again is "Nothing." At that time, the moon's complete area of illumination is on the side away from the earth. The side that faces the earth, even if it is within the observer's line of vision, blends in

to the blue of the sky. The only time one can see evidence of the conjunction is on those occasions when there is a solar eclipse. (See above.) Even then, one sees only diminution and disappearance of the disk of the sun. The face of the moon hiding the sun appears to be indistinguishable from the rest of the sky.

It is not only at the time of the conjunction that the moon cannot be seen. For some time before and after the conjunction, it remains invisible. The reason for this is as follows: The full moon, being opposite the sun, sets approximately at sunrise. A week later, the sun, having advanced closer to the moon, is ready to rise when the moon, now at "third quarter," has gone only halfway from east to west. Night after night, as the two get progressively nearer to each other, the illuminated part of the moon keeps waning, appearing to get narrower and narrower.

The time comes when the moon rises in the east just about at the break of dawn. What remains of the crescent can still be seen as the sky begins to glow, but, as the anticipation of sunrise brightens the heavens, that crescent gradually fades and becomes invisible.

During that day or the next, the sun catches up with the moon, and the conjunction occurs. From then on, the sun moves ahead of the young moon, rising and setting before it. The moon, with its newly formed crescent so thin at that time, may still be so close to the glare of the nearby sun that it remains invisible. If sufficient time elapses between conjunction and sunset, however, the moon may be high enough above the western horizon, as the sky darkens, so that its light can begin to be seen. Otherwise, it remains invisible until the following evening.[9]

Summing it all up: when the old moon gets closer to its rebirth as the new moon, it can last be seen when it rises in the east somewhat earlier than the sun. It then becomes invisible and remains so while the sun moves toward it and reaches it—to form the conjunction—and then passes beyond it. It will again be seen—some time after the conjunction—when it is about to set in the west after the setting sun, as the sky is already darkening. It is at the conjunction that the "new moon" is born. By the time it is seen, it is spoken of as the "**young moon.**"

The *molad,* then, is the approximation of the time of the *new moon,* not of the *young moon.* Although it varies from the time of the actual conjunction, it is most unlikely that it will be so late after the conjunction that it will just happen to coincide with the moment when the moon regains visibility. Hence, whether one considers the true, astronomical conjunction or the arithmetically calculated *molad,* what one sees at either time is NOTHING.

Seeing Is Believing

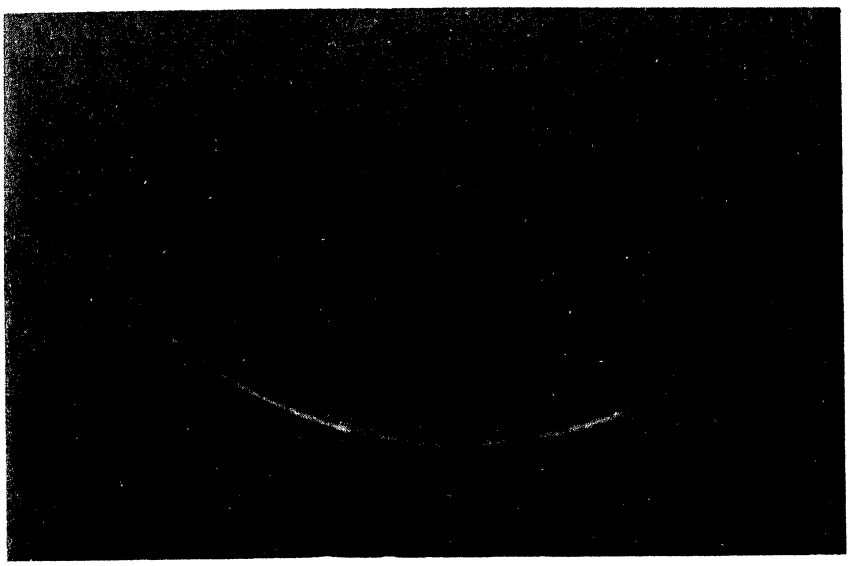
The Mishnaic tractate Rosh Hashanah describes the way in which the calendar was determined in the days before there was the set, calculated calendar which we have today. Witnesses would appear before the Sanhedrin each month to testify that they had seen the "new moon." They were

carefully cross-examined and, if the judges were satisfied, the Sanhedrin proclaimed the beginning of a new month. It was a privilege and a source of joy for two Jews to bring testimony that they had seen the "new moon" in the sky and to hear the Court declare, on the basis of their report, that the old month had given way to a new one.

The rationale for the practice of declaring the new month on the basis of observation was found in the midrashic interpretation of the verse, "*Ha-ḥodesh ha-zeh lakhem rosh ḥodashim.*" (Exodus 12:2). It was understood to mean that God showed Moses the "new moon" in the sky (*Ha-ḥodesh ha-zeh* = this "new moon") and told him that, in the future, that would be the signal to declare a new month. (*Lakhem rosh ḥodashim* = [shall be] for you [the basis for determining] the beginning of months.)[10]

If, as stated above, the actual new moon is invisible, what was it that the witnesses saw—what was it that Moses was shown—in the sky? The answer is that it was not the true new moon—the conjunction of sun and moon. It was the first appearance of the *young moon,* a day or so after that. That appearance of the young moon, shining in the west after sunset, when it too is about to follow the sun's descent below the horizon, is called the "*phasis*" (see illustration).

The phasis, unlike the new moon, does not occur at a predetermined time since it is dependent on atmospheric conditions as well as on the acuteness of vision of observers on the ground. Some may see it earlier and some later, while still others may not be able to see it at all until the following evening.



This photograph of the phasis (the first visibility of the young moon) was taken on April 25, 1971, at 7:15 PM CST, 21 hours and 13 minutes after the conjunction, in Charleston, Ill., by William D. Pence. It appeared originally in the February, 1972 issue of Sky and Telescope, *as probably "the youngest crescent ever photographed."*

The one thing that is definite is that it cannot be seen until after sunset, when the sky becomes dark enough for the thin crescent to stand out against the sky. By then, with the coming of evening, a new day begins, at least one day later than that of the conjunction.

Witnesses would come to the Sanhedrin (meeting the next day) to give testimony of what they had seen. If the Court were convinced that the young moon had been sighted the previous evening, they would declare that day to be **Rosh Ḥodesh**. Thus, *Rosh Ḥodesh* was never on the day of conjunction, and oftentimes two days later.

The sages seem to have been familiar with the distinction between the conjunction—or, at least, the *molad*—and the phasis, and they apparently used that knowledge as a check on the dependability of the witnesses' testimony. They also were well aware that the synodic month was about 29½ days. Hence, they ruled that months were to be limited to either 29 or 30 days, with no fewer than four months in a year having either one or the other of these two lengths.[11]

As no month shorter than 29 days was acceptable, the Court heard witnesses only after the lapse of 29 days since the previous *Rosh Ḥodesh*. If no acceptable witnesses appeared on the thirtieth day, the next day was declared to be the first of the new month, leaving the old month to have 30 days. Even if witnesses appeared on the thirtieth day, but they came at the time of the afternoon sacrifices or later, they would not be heard so as not to delay the afternoon service. (A declaration that the day was *Rosh Ḥodesh* would necessitate the appropriate additional offerings, which had to precede the afternoon ritual.) *Rosh Ḥodesh* was thereupon delayed until the morrow. After the destruction of the Temple, this rule was rescinded.[12]

The Great Changeover

According to Rav Hai Gaon, it was the patriarch Hillel II who took the critical step of developing a calendar which did not depend on making monthly or yearly decisions but on established computations. The date was 4119 A.M. (358-9 C.E.); the Academies in the Land of Israel under Roman rule had lost much of their power, and the Jews there were suffering under the pro-Christian Emperor Constantius and the harsh Roman Governor Gallus. Meanwhile, the Babylonian Jewish community had taken over much of Jewish leadership and were eager to assume responsibility for the crucial decision of setting the dates for the holidays. It may have been to prevent calendrical hegemony from passing away from the Land of Israel which motivated the formulation there of the new, calculated calendar.[13]

The new calendar continued to be based on the moon, but in a very different way from before. In the first place, it was no longer the phasis, but the *molad,* that was the determinant, since only the latter could be computed in advance. Secondly, the time of Tishri's *molad* was the only one used in setting up the dates for the entire year, with the first of each of the other months being dependent on arithmetic rather than astronomy. Once the days

were established on which one Rosh Hashanah (1 Tishri) should fall at the beginning of the year and when the next Rosh Hashanah would fall following the end of the year, the other months could fall into place.

Now, a basic principle adopted in organizing the new calendar was that a plain year—from Rosh Hashanah to Rosh Hashanah—should have no fewer than 353 days nor more than 355 days. (A leap year, with an extra 30-day month, could have 383, 384 or 385 days.) To make up that total, it was decided that five months (Tishri, Shevat, Nisan, Sivan and Av), as well as Adar Rishon in a leap year, should always have 30 days each, and five other months (Tevet, Adar [Adar Sheni in a leap year], Iyyar, Tammuz and Elul) should always have 29 days each (totaling, together, 295 days—325 in a leap year). The remaining two months (Ḥeshvan and Kislev) were then left flexible, having 29 or 30 days each, as required. Thus, if the second Rosh Hashanah is 353 (or 383) days after the first one, both Ḥeshvan and Kislev have 29 days. If the gap is 354 (or 384) days, Ḥeshvan has 29 and Kislev has 30. Finally, if the total is 355 (or 385) days, both have 30.

Although some of the months have 30 days while others have only 29 days, the 30th day from the beginning of the month is *always* observed as *Rosh Ḥodesh.* That means that a 30-day month has its 30th day as well as the day thereafter (the 1st of the next month) both called *Rosh Ḥodesh.* (In the case of a 29-day month, only the first of the next month is *Rosh Ḥodesh.*) The generally accepted view is that this double observance was instituted in the calculated calendar in recognition of the fact that the lunar month is roughly 29½ days long. The 30th day was therefore assumed to contain part of the new month as well as part of the old month.[14]

Hurry Up and Wait

With the use of the *molad* instead of the phasis, which, as pointed out above, is at least a day later than the *molad,* one might assume that, in the new system, Rosh Hashanah would always be earlier than it would have been under the old method. Yet, strangely enough, in three years out of five on an average, the first of Tishri comes not on the day of the *molad,* but one or two days after it.[15]

The reason for this state of affairs is that the *molad* of Tishri is not the sole determinant of when Rosh Hashanah is to be observed. There are four rules, each calling for a delay in particular circumstances. These rules are called **deḥiyyot**—"postponements," and they operate in different ways in different years of the 19-year cycle.

For mnemonic purposes, the four postponements are generally expressed in a jingle as follows:

לא אד"ו ראש
מולד זקן בל תדרוש
ג"ט ר"ד בשנה פשוטה גרוש
בט"ו תקפ"ט אחר העיבור עקור מלשרוש

(Note that all days begin at 6:00 P.M. the previous evening.)[16]

Rule 1: *"Lo ADU Rosh."*

THE KEY: א = Sunday (the 1st day of the week); ד = Wednesday (the 4th day); ו = Friday (the 6th day).

TRANSLATION: [The first day of] Rosh Hashanah may not be on Sunday, Wednesday or Friday.

MEANING: If the *molad* comes on any of these three days, Rosh Hashanah is not observed (Tishri does not begin) until the following day. The avoidance of Wednesday and Friday helps keep Yom Kippur from coming on Friday or Sunday, thus obviating the succession of two days with the full Sabbath restrictions. The avoidance of Sunday prevents Hoshana Rabbah (with its ritual of beating the willows) from coming on the Sabbath.[17]

APPLICABILITY: All 19 years of the cycle.

Rule 2: *"Molad zaqen bal tidrosh."*

THE KEY: "**Molad Zaqen**" = A *molad* which occurs when the day is already "old" (*zaqen*), having had 18 hours elapse since its start at 6:00 P.M. Hence, from noon on. (Literally, "the *molad* of an old one.")

TRANSLATION: Do not interpret the *molad* [as indicating that Rosh Hashanah is on that day if the *molad* comes] from noon or later.

MEANING: If the *molad* (only of Tishri, of course, since it is the only one that counts) comes at noon or later, Rosh Hashanah is postponed to the next day. If that next day is Sunday, Wednesday or Friday, then, by Rule 1, it is further postponed to the day thereafter.

This rule seems to be vestigial. Its original purpose was to help the Court to judge as to whether witnesses who claimed to have seen the young moon could actually have seen it. The supposition was that, if the calculated *molad* had come before noon, it was conceivable that the moon might have become visible at nightfall and the testimony could be accepted. If, however, the *molad* was computed to be at noon or later, the moon could not have been seen and the testimony would be rejected. Once the *molad* replaced the phasis as the determinant of the new month, the rationale no longer applied, but the memory lingered on.[18]

APPLICABILITY: All 19 years.

Rule 3: *"GaT RaD be-shanah peshutah gerosh."*

THE KEY: ג = Tuesday (the 3rd day); ט = 9 hours since the beginning of the day, i.e., 3:00 A.M.; ר"ד = 204 parts.

TRANSLATION: Drive out [Rosh Hashanah away from any *molad* that comes on] Tuesday from 3:00 A.M. plus 204 parts in a plain year.

MEANING: When the *molad* of Tishri occurs on Tuesday, Rosh Hashanah is postponed to Thursday not only if it (the *molad*) comes at noon or later (Rules 1 and 2), but even if it is as early as 3:00 A.M. and 204 parts. Were it not postponed, the plain year starting then would end up having 356 days, longer than acceptable. This rule cuts it down to a permissible 354 days.[19]

APPLICABILITY: Only the 12 plain years in the cycle.

Rule 4: *"Be-TaV TaQPaṬ 'aḥar ha-'ibbur 'akor me-lishrosh."*

THE KEY: ב = Monday (the second day); ט"ו = 15 hours after the beginning of the day, i.e., 9:00 A.M.; תקפ"ט = 589 parts.

TRANSLATION: Prevent [Rosh Hashanah] from taking root [on the same day as the *molad* if the *molad* occurs], in a year following a leap year, on Monday from 9:00 A.M. plus 589 parts.

MEANING: If the *molad* is on Monday at 3:00 A.M. plus 589 parts or later, Rosh Hashanah is observed on Tuesday. The purpose is not to keep the succeeding plain year from being too long (as in Rule 3), but to allow the preceding (leap) year to be long enough.[20]

APPLICABILITY: The 7 plain years following the 7 leap years.

The Winners and the Losers

It is generally known that, by reason of Rule 1, the first day of Rosh Hashanah can occur on only four days of the week (Monday, Tuesday, Thursday and Saturday). What is not so well known is that, as a result of all the *deḥiyyot*, each of those four has its own particular likelihood of starting the new year. (The first of Tishri comes on Thursday, the big winner, almost three times as frequently as it does on Tuesday, the big loser.)

Rule 1 makes the biggest contribution to this discrepancy. Because of it, *moladot* which occur on Sunday, Wednesday or Friday cannot signal Rosh Hashanah to come on their own days. Instead, they are added to the *moladot* of Monday, Thursday and Saturday, respectively, to give those days a double opportunity to be Rosh Hashanah. Tuesday, however, has no such advantage because the day preceding it (Monday) *can* be Rosh Hashanah. On the basis of this rule alone, Tuesday would have half the chance of the other permissible days of being the first of Tishri.

Rule 2, by contrast, is perfectly even-handed, giving to each of the four permitted days exactly as much as it takes from them. It gives them the last quarter (from noon to 6:00 P.M.) of the preceding permitted day and transfers *their* last quarter-day to the next permitted one.

Rule 3 continues to cut down on the opportunities that Tuesday has to start the new year. In the 12 plain years of the 19-year cycle, that day loses the benefit of more than one-third of its *moladot*, those from 3 A.M. and 204 parts until noon (which, by Rule 2 alone, would have been the cutoff point). They go to Thursday (the next permitted day), giving the latter a big advantage over its fellows.

Rule 4 finally gives Tuesday some small additional opportunity—at the expense of Monday—to be the first day of Tishri. In those 7 years out of 19 to which it applies, Tuesday is given the *moladot* of the last 2 hours and 491 *ḥalaqim* prior to Monday's noon to add to its own. This brings its chances of starting the new year up a trifle while bringing Monday's ranking down to third, slightly behind Saturday.

The differences among the days are not merely theoretical. In the three centuries from 1801 to 2100, there are, respectively, 32, 31, and 32 Thursday

Rosh Hashanahs, as against 11, 11, and 12 Tuesday New Year Days. Saturday's average over those 300 years is 28.7 days, while Monday's average is 28.3 days.[21]

Marching Along Together

Since the 10 contiguous months from Tevet to Tishri in a plain year (11 in a leap year) have fixed lengths, it is a simple matter to determine, from the day of the week on which one date falls, the day on which another will fall—provided that the two dates are between 1 Tevet and 29 Ḥeshvan. (From the first of Adar—or Adar Sheni in a leap year—to 29 Ḥeshvan, one need not even know whether the year has 12 or 13 months.) Thus, from the first day of Pesaḥ to Rosh Hashanah, there are always 163 days (23 weeks and 2 days), causing the latter always to come two days later in the week than the former. In the same way, the other holidays also move in lockstep with each other. (Ḥanukkah is an exception because its timing is affected by the two indeterminate months—Ḥeshvan and Kislev.)

This "lockstep phenomenon" makes for an "'**AT BaSh**" relationship between Pesaḥ and each of the other holidays. That means that the first day of Pesaḥ (*'aleph*) is always the same day of the week as the holiday beginning with the last letter of the alphabet (*tav*), the second day (*bet*) the same as the one beginning with next to the last letter (*shin*), etc. Specifically, if Pesaḥ begins on Sunday, Tishah be-'Av (*tav*) will also be on Sunday; the first day of Shavuot (*shin*) will be on Monday; Rosh Hashanah (*resh*) [as well as the first day of Sukkot and Shemini Atzeret] on Tuesday; Simḥat Torah—outside of Israel—(*quf*—from *Qeri'at Ha-Torah*, [the day celebrating] the reading of the Torah) on Wednesday; Yom (*Ẓom*) Kippur (*ẓadi*) on Thursday; and Purim (*peh*) on Friday. This Purim, it must be remembered, has to be the one *prior* to Pesaḥ since the two variable months intervene between Pesaḥ and the *next* Purim. Interestingly, Yom Ha-Atzmaut (*'ayin*) fits into its proper place, the same day as Pesaḥ's seventh.[22]

Of particular interest is the fact that the coming of Pesaḥ on Sunday coincides with the coming of the following Rosh Hashanah on Tuesday. We have seen, though, that a Tuesday Rosh Hashanah occurs very rarely (only 11 or 12 times in a century). Hence, a Sunday first day of Pesaḥ (with a Saturday night first seder) is also a rarity. It is a fortunate coincidence, but it was not arranged that way to avoid the difficulties caused by having the eve of the holiday, with all its special rules and all the necessary preparations, come on Shabbat. Regardless of advantages or disadvantages, each of the other holidays, as well, shares Rosh Hashanah's pattern of having three impermissible days and having its four permissible days coming with different frequencies.

Fourteen Kinds of Years

We have seen how Rosh Hashanah is always two days later than Pesaḥ of the year immediately preceding it. Knowing the day of Rosh Hashanah, however,

will not tell us precisely the day of the Pesaḥ of the *same* year since the two indeterminate months (Ḥeshvan and Kislev) intervene between them. In addition, the interposition between Rosh Hashanah and Pesaḥ of an extra Adar (with 30 days) in a leap year will push Pesaḥ two days further along in the week. Therefore, the structure of a Jewish year depends not only (1) on the day of Rosh Hashanah but (2) on the lengths of Ḥeshvan and Kislev, and (3) on whether it is a plain year or a leap year. These three variables determine the pattern of the year, known as its **qevi'ah**. (Once a year's *qevi'ah* is known, one can tell the days of every Rosh Ḥodesh and of every holiday, as well as the *sidrah* and *haftarah* for each Shabbat, since every year is identical.)

There are seven possible *qevi'ot* for plain years, and an additional seven for leap years, each being identified by two or three Hebrew letters.[23] The first letter is for the day of Rosh Hashanah, and the second for the configuration of Ḥeshvan and Kislev. (A year with each of the two months having 29 days is called "defective—**ḥaserah**" [ח], one with a 29-day Ḥeshvan and a 30-day Kislev is "regular—**ke-sidrah**" [כ], and a year having 30 days in each of the two months is "perfect—*shelemah*" [ש].) The third letter—when used—is for the day of Pesaḥ. While the year is completely defined even without it, the indication of Pesaḥ's day facilitates the use of the *'AT BaSh* and is, therefore, usually included.

The Bottom Line

We have come a long way since first raising the question of the meaning of the *molad* and its applicability to the calendar. We have shown how the *molad* is an approximation of the time of the conjunction of sun, moon and earth. It comes before the first sighting of the young moon (i.e., the phasis), on the basis of which the ancient Court declared the new month. We have also seen that only once a year (for the month of Tishri) does our present calendar depend on the time of the *molad,* and that, even then, there are four occasions for postponement of the month.[24]

The logical question then arises: What is the point of announcing in the synagogue each month the exact time of the next *molad*? The answer is that knowledge of that time is needed for quite a different purpose—for the ritual of "Sanctification of the Moon" (*Qiddush Levanah*). That celebration can be observed only during the first half of the life of the new moon, while it is still growing, before it begins to wane. By adding to the *molad* one-half the assumed length of the month (i.e., 14 days, 18 hours, 22 minutes, and 1 and ⅔ seconds), one can determine when *Qiddush Levanah* may no longer be recited.[25]

How ironic it is that the only *molad* which does count for the calendar—that of Tishri—is never announced because that month is the one month of the year which is not preceded by the *Birkat Ha-Ḥodesh.*

NOTES

1. Jewish calendrical calculation is known as *Sod Ha'Ibbur,* the "secret of intercalation." The secrecy involved probably reflects the intrinsic difficulty of the subject. Those interested in more detailed works on the calendar can consult Maimonides, *Mishneh Torah, Hilkhot Qiddush Ha-Ḥodesh,* available in translation, entitled *Sanctification of the New Moon,* by Solomon Gandz, with introduction by Julian Obermann and astronomical commentary by Otto Neugebauer (New Haven: Yale University Press, 1956); Solomon Gandz, *Studies in Hebrew Astronomy and Mathematics,* with introduction by Shlomo Sternberg (New York: Ktav, 1970); W.M. Feldman, *Rabbinical Mathematics and Astronomy* (New York: Hermon Press, 1965).

2. In 1983, the time from the conjunction in January to the conjunction in February was 29 days, *19 hours and 24 minutes* while, from July to August, it was 29 days and *only 7 hours.*

3. Hipparchus derived the average length of the month (the mean synodic month) by dividing the length of time from a previously recorded eclipse to one in his own time by the number of months (4,267) that had elapsed between them. Though his result was remarkably close to the actual figure, he was still slightly inaccurate. (He used the lunar eclipse of the *full* moon rather than the solar eclipse at the *new* moon since the former occurs at the same moment for all viewers while the latter is seen at different times depending on the location of the observer.)

The unit comprising 3⅓ seconds is called in Hebrew one *ḥeleq* (or "part") so that there are 18 *ḥalaqim* in a minute or 1080 in an hour.

4. From the Greek word, *synodos*—"coming together"—the meeting of the sun and the moon.

5. Maimonides, *Qiddush Ha-Ḥodesh,* 6:1, makes a clear distinction between the actual conjunction (called the *qibbuẓ*) and the mean conjunction (called the *molad*). See also "The Problem of the Molad" in Gandz, *Studies,* pp. 120 ff. The time of the first *molad* (a *molad* of Tishri) is traditionally calculated as BaHaRaD, i.e., Sunday night, at 11:00 P.M. plus 204 *ḥalaqim.* (ב= the second day, from Sunday at 6:00 P.M. to Monday at 6:00 P.M.; ה = five hours after 6:00 P.M.; ר"ד = 204 parts. See n.16, below.) That *molad* was assumed to have occurred in the year prior to Creation—*Shenat Tohu* (the Year of Chaos). See *Qiddush Ha-Hodesh,* 6:8, and *Sanctification,* pp. xl f., 91, and 115 f. If Creation was in Tishri (the view of Rabbi Eliezer [R.H. 10b]), then the second *molad Tishri* was on the day on which Adam was created, Friday, at 8:00 A.M., in the Year 2 Anno Mundi.

6. Prof. Otto Neugebauer writes: "There was never a time (before very modern times) that geographical time-corrections were *correctly* determined. (I doubt that one was very much interested.") (Private communication, March 2, 1987)

The belief that Babylonia was the location to which the time of the *molad* applied may have been at the base of the Saadia—Ben-Meir controversy. In the summer of 921 C.E. (4681 A.M.), Ben-Meir, a champion for the authority of Eretz Yisrael in calendar matters, proclaimed that both Ḥeshvan and Kislev of 4682 should each have 29 days, leading to a Sunday Pesaḥ. (See section "Fourteen Kinds of Years," below.) Saadia insisted on the commonly accepted calculation calling for 30 days for each of those months, leading to a Tuesday Pesaḥ. The difference between them may have been due to the fact that the *molad* of Tishri of the following year (4683) was on Tuesday, 3:00 A.M. + 441 *ḥalaqim.* This called for a postponement of Rosh Hashanah to Thursday (made possible by lengthening Ḥeshvan and Kislev of 4682) and a consequent delay in Pesaḥ of that year as well. (See Rule 3 in section "Hurry Up and Wait.") Ben-Meir, championing the primacy of Jerusalem, may have adjusted the time of the *molad* from what was assumed to be Babylonian time to the earlier local Jerusalem time, thus obviating the need for any postponements. For a record of the controversy, see H. Bornstein, *Maḥloqet Rav Sa'adia Ga'on u-ven Meir* (Warsaw: Schuldberg, 1904—reprinted).

7. *Astronomical Almanac, 1987,* U.S. Government Printing Office, Section D, p. 2. Other publications give slightly different values for the mean synodic month, but P. K. Seidelmann, director of the Nautical Almanac Office, U.S. Naval Observatory, writes: "Certainly, the value will change as you use different time periods for averaging. At the present time, the value is based on a period of about a hundred and fifty years into the past." (Private communication,

January 28, 1987.)

8. The *molad* is still within the range of fluctuation of conjunction-times in Jerusalem and in other "walled cities". Thus, in 1982, while the conjunction of October 17 (local Jerusalem time) was almost 16 hours *before* the time of the *molad*, the March 25 conjunction was 11½ hours *after* the *molad*.

9. The old moon can generally not be seen for at least 24 hours before the conjunction (with sightings less than 20 hours being very rare). The same time frame is true also of sightings of the young moon after the conjunction. See Joseph Ashbrook, "Astronomical Scrapbook," in *Sky and Telescope*, August, 1971, pp. 78 f. and February, 1972, pp. 95 f.; also James Muirden, *The Amateur Astronomer's Handbook*, 3rd edition (New York: Harper and Row, 1983), pp. 97 f. and Guy Ottewell, *Astronomical Calendar* (Greenville, So. Carolina: Department of Physics, Furman University, published annually).

During much of the month, the moon can be seen in the daytime also, but only because it is then far apart from the sun, with a substantial part of its face illuminated.

10. See Mekhilta, *Pisḥa*, 2 (Lauterbach translation, vol. 1, pp. 15–16) and Rashi on Ex. 12:2. The basic rules regarding the witnesses and the Sanhedrin are found in Mishnah *Rosh Hashanah*, chapters 1–2. See also Maimonides, *H. Qiddush Ha-Ḥodesh*, 1–3.

11. See Mishnah *Arakhin* 2:2.

12. See R.H. 4:4.

The term *molad* does not appear in the Talmud, but the concept was known; see *Rosh Hashanah* 20b. The description herein is somewhat simplistic, since other factors also influenced the Sanhedrin's acceptance of testimony (e.g., a desire to prevent certain holidays from falling on inconvenient days; see note 17, below, and also R.H. 20a f. concerning the Court's manipulation of testimony). We also do not know how accurately the Mishnah portrays the actual calendar in use in Temple times. We have evidence from sectarian writings (Book of Jubilees and Dead Sea Scrolls) of other calendrical systems in use during Second Temple times.

The Jewish calendar, both in the past and the present, is *lunisolar*. This article deals only with the lunar aspect, having to do with months. For the solar aspect, how the Mishnaic calendar kept the years in step with the seasons, see Maimonides, *H. Qiddush Ha-Ḥodesh* 4. For the solar aspect of the calculated calendar, see note 24 below.

13. The question of the origin of and reason for the calculated calendar is a matter of dispute. For Hai Gaon's opinion, see Menachem M. Kasher, *Torah Shelemah*, vol. 13 (New York, 1949), pp. 24–26. This entire volume is devoted to the question of the antiquity of the calendar. Many scholars have discounted the attribution of the calendar to Hillel II; see, e.g., Bornstein, *Maḥloqet* (note 6, above), especially Appendix 8. For an argument against Bornstein, see Zvi Langerman, "*'Eimatai Nosad Ha-Luaḥ Ha-'Ivri,*" in Meir Benayahu, ed. *'Asufot*, vol. 1, (Jerusalem: 1987), pp. 159–168. An overview of the development of the calendar is given by A.A. Akavia, "*Qiẓẓur Divrei Yemei Ha'Ibbur Be-Yisrael*" in his *Luaḥ le-Sheshet 'Alafim Shanah* (Jerusalem: Mossad Harav Kook, 5736), pp. xxxviii ff.

14. Maimonides (8:4) apparently believed that this was introduced with the new calendar, considering that, in the Mishnaic calendar, only the one day recognized by the Court as the beginning of the month was observed as *Rosh Ḥodesh*. For the view that the two-day *Rosh Ḥodesh* had a long history antedating the calculated month, see Gandz, "The Origin of the Two New Moon Days" in *Studies in Hebrew Astronomy and Mathematics*, pp. 32–74. (Also in *JQR*, n.s., vol. 40, 1949–50.)

An interesting consequence of the two-day *Rosh Ḥodesh* is that the first of those two days (like the single day following a 29-day month) is always one day later in the week than the last *Rosh Ḥodesh*. (This is because the 30th day comes 4 weeks and one day after the first of the month.) Hence, the days of *Rosh Ḥodesh* follow one another around the week. Thus, if *Rosh Ḥodesh* Nisan is on Tuesday, *Rosh Ḥodesh* Iyyar will be on Wednesday and Thursday, and *Rosh Ḥodesh* Sivan will be on Friday.

15. The probability of having *Rosh Ḥodesh* on the day of the *molad* is only 39%. There is a 47% chance of its coming one day later and a 14% chance (one year out of seven) of its being delayed by two days.

16. For the sake of convenience and simplicity, an average—6:00 P.M.—is used in traditional calculations in place of the variable times of sunset and nightfall.

17. The reasons for avoiding a Friday or Sunday Yom Kippur (and, therefore, a Wednesday or Friday Rosh Hashanah) are found in *Rosh Hashanah* 20a. (See also *Sukkah* 54b.) On the question of whether the willows may be beaten on Shabbat, see *Sukkah* 43b. *Yer. Sukkah* ch. 4, end of halakhah 1, relates a view calling for the avoidance of Saturday for *both* Rosh Hashanah and Hoshana Rabbah. (The objection to a Shabbat Rosh Hashanah—but not to a Shabbat Hoshana Rabbah—is waived there when conditions warrant. There is no evidence that Rosh Hashanah was ever prevented from coming on Saturday.) Akavia, in "*Kizzur,*" p. xl, shows, from dates given in Sherira Gaon's Epistle, that Rosh Hashanah was observed on Sunday, with a consequent Sabbath Hoshana Rabbah, long after Hillel II. ("Rosh Hashanah," here and elsewhere, refers to the first day of the holiday [1 Tishri].)

18. The Talmudic source is *Rosh Hashanah* 20b. Since it takes much longer than six hours from conjunction to phasis, the commentators have had great difficulty explaining this passage. One classical attempt is that of Judah Halevi, *Kuzari,* 2:20. See also Obermann in *Sanctification,* p. 92.

19. The lapse of time from one *molad* to the *molad* 12 months later—a plain year—is 50 weeks, 4 days, 8 hours, and 876 parts. Therefore, if the *molad* were to come at the beginning of a plain year on Tuesday at 3:00 A.M. plus 204 *ḥalaqim* or later, the *molad* of the following Tishri would occur on Saturday at noon or later. By Rules 1 and 2, Rosh Hashanah in that following year would have to be postponed from Saturday to Monday. Without the postponement of the first Rosh Hashanah, as mandated by Rule 3, that plain year would then be an impermissible 356 days long. (Remember that there are 1080 *ḥalaqim* ["parts"] to an hour.)

20. The only way that the *molad* at the *end* of a leap year could come at the specified time (Monday, 9:00 A.M. and 589 parts) or later would be if the *molad* at the *beginning* of that leap year were on Tuesday at noon or later. (From the *molad* at the beginning of a leap year to the one at the end—13 months later—the lapse of time is 54 weeks, 5 days, 21 hours, and 589 parts.) Because of Rules 1 and 2, therefore, that first Rosh Hashanah must have been postponed from Tuesday to Thursday. Without Rule 4's adjustment, the leap year would then be only 382 days long, shorter than required.

21. Full computation and tables are available from the first author on request.

In the Karaite calendar, which eschews the use of *deḥiyyot,* the holidays can, and do, fall on any day of the week (except Shavuot, which is always on Sunday) with more or less equal frequency. The Karaites, incidentally, use the phasis instead of the *molad,* although they compute in advance, and publish in their calendars their calculations of the times of the phasis. (As in the ancient Rabbinic calendar, *every* month is determined by the phasis, not just Tishri.) Thanks are due to Rabbi Moshe Firuz, calendar authority of the Karaite Jews in Israel, for providing the authors with the dates of their observance of Pesaḥ and Rosh Hashanah for the 52 years from 5693 to 5744.

22. If the first day of Pesaḥ comes on Saturday or Sunday, the fifth of Iyyar comes on Friday or Saturday respectively, but Yom Ha-Atzmaut is moved back to Thursday. (Since Pesaḥ never comes on Monday, there is never a Sunday Yom Ha-Atzmaut with a Shabbat Yom Ha-Zikkaron.) If Pesaḥ comes on Shabbat, then the ninth of Av also comes on Shabbat, but Tishah be-Av is observed on Sunday.

The *deḥiyyah* which keeps Rosh Hashanah from coming on Wednesday keeps the first day of Pesaḥ from coming on Monday which, in turn, insures that Purim can never come on Shabbat. (Shushan Purim can come on Shabbat but, in that case, the observances are spread out over three days. Cf. *Shulḥan 'Arukh, 'Oraḥ Ḥayyim* 688:6.)

23. Of the 12 theoretical combinations in a *plain* year (4 permissible days of Rosh Hashanah multiplied by 3 arrangements of Ḥeshvan and Kislev), five would end up with the following year's Rosh Hashanah coming on one of the three forbidden days, and are therefore impossible. For example, no 12-month year starting on a *Monday* could be "regular—*kesidrah*" since the last of its 354 days would be on Thursday, and the following day—the new Rosh Hashanah—would thus be on the impermissible Friday.

Of the 12 theoretical combinations in a *leap* year, 4 are eliminated for the same reason. In

addition, no year beginning on Tuesday could be "perfect—*shelemah*" even though, after its 385 days, the new Rosh Hashanah would be on Tuesday. While Tuesday obviously is permissible, it is here impossible. The reason is that any *molad* that would produce a Tuesday Rosh Hashanah (a *molad* between Monday noon and Tuesday just before noon) would result in a *molad* 13 months (adding up to 54 weeks, 5 days, 21 hours and 589 parts) later that would be too early to produce another Tuesday Rosh Hashanah.

This leaves 14 possible *qeviot* in all.

Some ḥumashim have lists of the years in each *qevi'ah*, giving the dates of all the *sidrot* and *haftarot* for that *qevi'ah*.

24. We do not include in the body of this article the change in the method of determining leap years that was introduced by the calculated calendar. (See note 12 above.) Essentially, it was the adoption of the Metonic cycle, computed by the Athenian Meton in 432 B.C.E. and used by the Babylonians for centuries. Based on the calculation that 235 lunar months equal 19 solar years, he established a rhythm of 12 plain years and 7 leap years. (The leap years are the 3rd, 6th, 8th, 11th, 14th, 17th and 19th years of the cycle. The mnemonic in Hebrew is *GUaḤ 'ADZaT.* To determine any year's place in the cycle, divide that year by 19 and note the remainder.) The equality is not exact since the 235 lunar months (counting from *molad* to *molad*) add up to 2 hours and 6½ minutes more than 19 solar years. Hence, since the adoption of the calculated calendar in 358-9, all Hebrew dates and holidays have moved ahead relative to the sun (with its solstices, equinoxes and seasons) an average of about 7½ days. (The Karaites, incidentally, observe the same leap years as do the Rabbanites.)

25. *Shulḥan Arukh, 'Oraḥ Ḥayyim,* gloss on 426:3. Under certain circumstances, the *molad* plays a part also in the observance of *Yom Kippur Qatan,* the fast held on the eve of Rosh Ḥodesh in most months. See *Magen Avraham* on *Shulḥan 'Arukh, 'Oraḥ Ḥayyim,* 417.