Once in a Jew Moon

Top (Cultural Calendars and Celestial Cycles): Different civilizations devised calendars based on solar, lunar, or lunisolar cycles. The outer diagrams represent astronomical alignments and calendrical intercalation schemes. The Moon–Earth–Sun layout highlights the tension between observational cycles and constructed systems.
Second (The Oven of Akhnai and Rabbinic Authority): In the Talmudic dispute over the purity of an oven, Rabbi Eliezer insists on a minority opinion, backed by signs from nature and heaven — including a river flowing backward and a divine voice. But the sages reject all evidence, asserting that law is not decided by miracles once given to humans.
Third (Halakhic Calendar and Defiance of Astronomy): Even when astronomical calculations proved the new Moon hadn't occurred, Rabbi Yehoshua obeys the Sanhedrin's ruling and appears before Rabban Gamliel on the declared Yom Kippur, carrying a stick and wallet. Another famous schism was between Rabbi Saadia Gaon and Rabbi Aaron ben Meir over Rosh Hashanah dates.
Bottom (Shabbat Beyond Earth): In deep space, solar day cycles may be minutes or years. How do human-defined timeframes such as Shabbat apply when detached from Earth's diurnal rhythm?



Once in a Jew Moon

The Jewish calendar was developed for witnesses observing the new Moon. So when witnesses claimed they saw the new Moon "in the morning east and evening west," Rabban Gamliel accepted their impossible testimony, then ordered Rabbi Yehoshua to violate his own calculated Yom Kippur — establishing that communal unity is more important than astronomical accuracy. From Arctic whalers to orbital Shabbat, each generation learns that "it is not in heaven" — religious law belongs to human authorities grappling with reality, not perfect celestial mechanics.



Jewish Calendar Authority ◦ Sunset at Poles ◦ Rabban Gamliel Decision ◦ "Not in Heaven" ◦ Ben Meir 921 CE ◦ Molad Calculation ◦ Arctic Whalers ◦ Astronaut Shabbat ◦ Lunar-Solar System ◦ Human Consensus ◦ Calendar Unity

"וכ״כ יש להסתפק במי שקרה לו שיבא בקיץ סמוך להנארדפאל. ששם יש איזה חדשים רצופים בקיץ יום ממש... לצוד התנינים הגדולים... מתי ישבות שבתו....."
("What about someone who comes in summer near the North Pole, where for several continuous months it is actual daytime... to hunt the great whales — determine his prayer times and Shabbat...")
— Rabbi Yisrael Lipschitz, c. 1850

Once in a Jew Moon

> *Pirkei Avot* 1:1 opens with the chain of tradition: "Moses received the Torah from Sinai and transmitted it to Joshua, and Joshua to the Elders, and the Elders to the Prophets, and the Prophets transmitted it to the Men of the Great Assembly."
>
> This transmission of authority defined who could determine Jewish law, including calendar matters. The chain continued through specific named authorities: Shimon the Righteous (one of the last of the Great Assembly), Antigonus of Socho, then paired leaders through the generations — the Zugot (pairs), where one served as Nasi (president) and one as Av Beit Din (head of the court).
>
> The pairs included Yose ben Yoezer and Yose ben Yochanan, Joshua ben Perachya and Nittai of Arbel, Judah ben Tabbai and Shimon ben Shetach, Shemaya and Avtalyon, and finally Hillel and Shammai. From Hillel descended a dynasty of leaders who held the title of Nasi through the destruction of the Second Temple in 70 CE and beyond.
>
> During the Temple period, this leadership controlled calendar determination. The Sanhedrin, with the Nasi presiding, declared new months based on witness testimony and intercalated years to maintain seasonal alignment. Their authority to declare time derived from the biblical verse (Leviticus 23:4): "These are the appointed seasons of the Lord, which you shall proclaim" — the Hebrew emphasizes "which YOU shall proclaim," granting human authorities the power to establish sacred time.
>
> After the Temple's destruction in 70 CE, the Sanhedrin reconvened in Yavneh under Rabban Yochanan ben Zakkai, then moved through various Galilean cities: Usha, Shefar'am, Beit She'arim, Sepphoris, and finally Tiberias. Despite lacking a Temple, they maintained calendar authority through the traditional chain of ordination (semicha) that connected each generation back to Moses.
>
> The Roman Empire increasingly restricted Jewish self-governance. Emperor Hadrian outlawed ordination after the Bar Kokhba revolt (132–135 CE). Constantine I (306–337 CE) further limited Jewish courts' jurisdiction.
>
> Hillel II served as Nasi from approximately 320 to 385 CE. Facing intensifying persecution and the imminent collapse of centralized Jewish authority, he made an unprecedented decision around 358 CE: publish the mathematical secrets of calendar calculation.

Jewish law marks each new day at sunset/nightfall. This convention creates practical problems at extreme latitudes where the Sun remains visible for months, or in orbit where astronauts experience sixteen sunsets daily. These edge cases test the boundaries of calendar law developed for Mediterranean latitudes.

The Jewish calendar combines lunar months with solar years. Each month begins with the new Moon — the molad — occurring every 29 days, 12 hours, 44 minutes, and 3⅓ seconds. Twelve such months fall short of a solar year by about eleven days. Left uncorrected, holidays would drift through the seasons: Passover in winter, Sukkot in summer. The

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calendar adds seven leap months over each nineteen-year cycle, using the correspondence that 235 lunar months approximately equal nineteen solar years.

During the Temple era, witnesses who observed the crescent moon testified before the Sanhedrin in Jerusalem. Signal fires transmitted the declaration from mountaintop to mountaintop. Witnesses could lie, clouds could obscure visibility, and distant communities received delayed notification.

The Nasi (president) presided over seventy sages whose declaration of the new Moon established the month, independent of astronomical observation.

When Hillel II published the calendar's mathematical rules previously guarded by the Sanhedrin, distant communities could now calculate dates independently. The rules he revealed included the precise length of the lunar month (29 days, 12 hours, 44 minutes, 3⅓ seconds); the nineteen-year Metonic cycle with leap years in years 3, 6, 8, 11, 14, 17, and 19; and four postponement rules (dechiyot) preventing Rosh Hashanah from falling on Sunday, Wednesday, or Friday. These dechiyot — Lo ADU (direct postponement), Molad Zaken (if the molad occurs after noon), GaTRaD (in regular years, if molad falls on Tuesday after 9 hours, 204 parts), and BeTuTaKPaT (after leap years, if molad falls on Monday after 15 hours, 589 parts) — ensure Yom Kippur never falls adjacent to Shabbat and that Hoshana Rabbah never falls on Shabbat, preserving the willow-beating ritual.

This transition from human declaration to mathematical calculation transformed calendar authority from political power to an algorithm. The chain of authority from Moses through the prophets, the Great Assembly, the Zugot, and the Nesi'im had preserved and developed this knowledge through centuries of astronomical observation and rabbinical refinement. When centralized authority became unsustainable, Hillel II ensured continuity by making the secret knowledge public. His calendar remains the foundation of Jewish temporal practice today, unchanged for over 1,600 years.

The Talmud records a calendar dispute in the late first century CE. Two witnesses appeared before Rabban Gamliel claiming they saw the new Moon in the morning in the east and the evening in the west — astronomically impossible testimony, which Rabbi Dosa ben Hurkinos said: "How can they testify that a woman gave birth, and the next day her belly is between her teeth (still pregnant)?". Rabbi Yehoshua and Rabbi Dosa ben Hurkinos declared them false witnesses.

Rabban Gamliel accepted their testimony anyway.

This affected all subsequent holiday dates. If Rabban Gamliel was wrong, then Rosh Hashanah occurred on the wrong day, making Yom Kippur fall on the wrong day ten days later. Rabbi Yehoshua calculated the correct dates according to his understanding and prepared to observe them.

Rabban Gamliel then ordered Rabbi Yehoshua to appear before him "with your staff and your wallet" on the day Rabbi Yehoshua calculated as Yom Kippur. Carrying objects violates the holy day's restrictions. Rabban Gamliel demanded public desecration of what Rabbi Yehoshua believed was the holiest day of the year.

Rabbi Akiva explained to Rabbi Yehoshua: "Whatever Rabban Gamliel has done is valid, for it says, 'These are the appointed seasons of the Lord, holy convocations, which you shall proclaim in their appointed seasons.' Whether in their proper time or not in their proper time, I have no appointed seasons other than these."

Rabbi Dosa ben Hurkinos stated: "If we come to question the court of Rabban Gamliel, we must question every court that has arisen from the days of Moses until now." Authority continuity took precedence over astronomical accuracy.

Rabbi Yehoshua took his staff and wallet and walked to Yavneh on his calculated Yom Kippur. When he arrived, Rabban Gamliel stood, kissed him, and declared: "Come in peace, my teacher and my student — my teacher in wisdom and my student because you accepted my words."

The Oven of Akhnai dispute, though not calendar-related, established similar principles of authority. The sages debated whether a particular oven (broken and repaired) could become ritually impure. Rabbi Eliezer ben Hyrcanus argued it could not, offering every possible proof. The other sages disagreed.

Rabbi Eliezer called for supernatural confirmation: a carob tree uprooted itself, a stream flowed backward, the walls of the study house began to fall. Each time the sages responded: "We do not derive law from trees, from streams, from walls."

Finally, Rabbi Eliezer demanded: "If the law is as I say, let it be proven from Heaven!" A divine voice proclaimed: "Why do you dispute with Rabbi Eliezer, seeing that in all matters the law agrees with him?"

Rabbi Yehoshua rose and declared, citing the biblical verse, "It is not in heaven" (Deuteronomy 30:12).

The Talmud reports God declaring: "My children have defeated Me, My children have defeated Me!" The law belongs to human authorities interpreting through human reason. God yields to the rabbinic court's majority decision.

The Ben Meir controversy of 921–922 CE tested whether human consensus could maintain unified practice. By then, Jewish authority had shifted from the Holy Land to Babylon, where the academies of Sura and Pumbedita had become centers of Jewish learning. Aaron ben Meir, claiming authority as a Tiberian scholar in the Holy Land, challenged Babylonian dominance through calendar calculation.

Ben Meir introduced a new rule (claiming to learn it from his Rabbinic mentors): the molad threshold should be 642 parts after noon (about 35⅔ minutes) rather than the traditional calculation. For the year 922, this meant Passover would fall two days earlier than the Babylonian calculation. This technical dispute meant different communities would observe holidays on different dates.

Ben Meir asserted that proximity to Jerusalem granted special calendar authority. His calculation might have reflected Jerusalem time versus Babylonian time — the 642 parts (an hour is 1080 parts) corresponding to the longitude difference between the two centers — or about questions of exact date of the Creation. But it was in fact less about the calendar

and more about authority, challenging the Babylonian academy's authority to determine Jewish law in opposition to the Holy Land's leadership.

Saadia Gaon, head of the Sura academy, wrote mathematical refutations, gathered support from Jewish communities, and challenged Ben Meir. The exilarch (leader of the Jewish diaspora, Reish Galuta) David ben Zakkai and the Babylonian academies excommunicated Ben Meir. Circular letters warned communities against following his calculations.

Saadia's position prevailed — modern astronomical calculations place the molad for Tishrei 922 at his calculated time. Unified practice took precedence over regional authority claims.

Modern geography creates new calendar challenges. Rabbi Yisrael Lipschitz, writing from Danzig in the 1850s, addressed communities in the far north where summer nights never fully darken. "During June and July," he observed, "the night shines like day. At the very least, even at midnight, one can clearly distinguish between tekhelet and white."

Traditional law uses the ability of our eyes to distinguish between blue and white threads to mark dawn prayers. Continuous visibility eliminates this marker. Rabbi Lipschitz rejected suggestions to estimate based on spring or autumn patterns, noting that communities observed dawn prayers on Shavuot "immediately at dawn," not at estimated times.

At the poles, more extreme conditions apply. "What about someone who comes in summer near the North Pole, where for several continuous months it is actual daytime? There the Sun circles the full horizon from east to south to west to north. How should a Jew who arrives there — along with sailors who go there to hunt giant whales — determine his prayer times and Shabbat?"

Rabbi Lipschitz proposed treating each complete Sun-circle as one day. If you arrive on Sunday, count seven Sun-circles to Shabbat. This solution maintains the seven-day cycle even when "day" loses conventional meaning. But he acknowledged deeper problems: when people at the pole can simultaneously observe the Sun with Europeans beginning Shabbat and Americans still in Friday afternoon, which temporal reality governs?

He concluded: "May the Holy One, Blessed Be He, enlighten our eyes with the light of His Torah." This acknowledges the limits of applying Mediterranean-based law to less common conditions.

Modern transportation forced confrontation with global date boundaries. The Chazon Ish (Rabbi Avraham Yeshaya Karelitz) calculated the halakhic date line at ninety° east of Jerusalem — approximately 125.2°E longitude — rather than the International Date Line's 180° from Greenwich (International Meridian Conference, 1884).

This placed Japan on Sunday when locals observed Saturday. The line would bisect eastern Russia, China, and Australia. To avoid splitting cities, he ruled the 125.2°E meridian curves around land masses, following water.

Most communities rejected this calculation, maintaining local Saturday as Shabbat. Travelers observe stringencies from minority opinions. Practice preserves unity over theoretical precision.

Theory became crisis during the Holocaust. Thousands of yeshiva students from Mir and other Lithuanian centers fled through Siberia to Kobe, Japan, and later to Shanghai. In Kobe — east of the Chazon Ish's calculated line — his view implied Shabbat would fall on Sunday while the local community observed Saturday. As Yom Kippur approached, they cabled desperately for guidance. Rabbi Herzog convened authorities who ruled for local practice. The Chazon Ish telegrammed back: "Eat Wednesday, fast Thursday, fear nothing." In Shanghai — west of his line — Shabbat was kept on Saturday with the established community. Survivors described agonizing between halakhic theory and communal cohesion.

Orbital flight creates additional complications. Jewish astronauts orbit Earth every ninety minutes, experiencing sixteen sunsets daily. Ilan Ramon on Space Shuttle Columbia is reported to have followed Cape Canaveral time, his last Earth residence. Judith Resnik lit electronic Shabbat candles according to Houston time. These choices reflect the same principle established by Rabban Gamliel: human decision creates sacred time when natural markers fail.

The principle "it is not in heaven" establishes that human authorities interpret law for practical circumstances. Rabbi Yehoshua's compliance with Rabban Gamliel prioritized communal unity over personal calculation. Saadia Gaon's victory over Ben Meir maintained unified practice against regional authority claims. Contemporary rulings for astronauts apply these same principles to orbital conditions.

An Optimization Vort.

In *Pirkei de-Rabbi Eliezer* (Parashat Noaḥ) it is stated that "from this, one can deduce that there are 32 species of birds," right after discussing the ark. Commentaries struck out the "from this" part as it seems to be unrelated. Some commentaries question further how can it fit the Haari Z"L comment that the total number of species is 72?

My late father noted a brilliant way to reconstruct both by noting that:

$$24 + \max\{W_g : 6W_g \leq 48 < 8W_g\} + 10 + \min\{A_b : 60 \leq 2A_b < 80\} = 72$$

First we note that *Pirkei* mentions that the pure were 7 and not 2 to have more pure than impure. Now let's calculate. For birds, the Torah lists 24 impure species, one pair each, giving 48 individuals.

Pure birds enter in sevens. Requiring the pure total to exceed the impure total leads to the bound $6W_g \leq 48 < 8W_g$ (otherwise either 6 would have been enough, or 8 would have been required). The solutions are $W_g = 7, 8$. The largest solution is $W_g = 8$. Thus the total bird species count is $W_g + W_b = 8 + 24 = 32$.

For land animals, the Torah identifies $A_g = 10$ pure species (7 livestock and 3 wild animals). Impure animals enter in pairs to have male and female. Imposing the same inequality $6A_g \leq 2A_b < 8A_g$ and taking the smallest solution gives $A_b = 30$. Hence the land-animal total is $A_g + A_b = 10 + 30 = 40$. The combined total is therefore $32 + 40 = 72$ species in the ark. Taking the maximum/minimum for pure/impure solutions is also a Midrashic principle. ■

Calendar Mathematics

Molad Calculation

The traditional Jewish lunar month length:

$$29d\,12h\,44m\,3\tfrac{1}{3}s = 29.530594 \text{ days}..$$

Modern astronomical value: 29.530589 days. Error accumulates at $\Delta = 5 \times 10^{-6} \times N$ days where N is months elapsed. After 1000 years (≈12,400 months): error ≈ 1.5 hours.

Metonic Cycle

19 solar years ≈ 235 lunar months:

$$19 \times 365.2422 = 6939.602 \text{ days.}$$

$$235 \times 29.530594 = 6939.689 \text{ days.}$$

Difference: 0.087 days per 19-year cycle. Leap years occur in years 3, 6, 8, 11, 14, 17, 19.

Mathematically, the pattern of leap years in this 19-year cycle has almost the same "tempo" as the diatonic major scale, a connection pointed out to me by Amit B. If we look at the gaps between leap years we obtain the circular sequence

$$(3, 2, 3, 3, 3, 2, 3),$$

consisting of five "long" gaps of three years and two "short" gaps of 2 years, distributed as evenly as possible around the nineteen-year cycle. The major scale does exactly the same thing on a 12-step chromatic circle: it uses seven notes arranged with five whole-tone steps and two semitone steps in the maximally even pattern

$$(2, 1, 2, 2, 2, 1, 2).$$

In both cases we are placing $k = 7$ marked points on a cycle of length N with $N \equiv 5 \pmod 7$ (here $N = 19$ years or $N = 12$ semitones). The average step sizes

$$12/7 = 1 + 5/7, \qquad 19/7 = 2 + 5/7$$

share the fractional part $5/7$, which forces the "five long, two short" pattern and fixes their relative ordering. Abstractly, the leap-year cycle and the major scale are two realizations of the same maximally even 7-beat rhythm.

Dechiyot (Postponements)

Rosh Hashanah cannot fall on Sunday, Wednesday, or Friday:

1. **Lo ADU**: Direct postponement.
2. **Molad Zaken**: If molad ≥ 18:00.
3. **GaTRaD**: Regular year, Tuesday ≥ 9h 204p.
4. **BeTuTaKPaT**: After leap, Monday ≥ 15h 589p.

Ben Meir Dispute (922 CE)

Ben Meir: Molad threshold = 642 parts.
Traditional: Molad threshold = 0 parts.
For Tishrei 4683 (922 CE):
Ben Meir: Day 2, 9h 204p.
Saadia: Day 2, 15h 589p.

Polar Day Solutions

Sun-circle method: Each 24h circuit = 1 day.
Origin timezone: Follow departure location.
Proportional: Calculate theoretical solar angle: $h = 15°(t - 12) - \lambda + E$.

Classical Source

Halakhot Pesuqot (Rav Yehudai Gaon, 8th century):

לעולם ראש חדש אדר סמוך לניסן הוא ערב הפסח, והפסח הוא ערב העצרת, והעצרת הוא ערב ראש השנה. לא בד״ו פסח, לא גה״ז עצרת, לא אד״ו ראש השנה וסוכה, לא אג״ו יום הכיפורים, ולא זבד פורים.

Translation:
Always, the new Moon of Adar close to Nisan is the eve of Passover; Passover precedes Shavuot; and Shavuot precedes Rosh Hashanah. Passover never occurs on days בד״ו (MoWeFr); Shavuot never on גה״ז (TuThSa); Rosh Hashanah and Sukkot never on אד״ו (SuWeFr); Yom Kippur never on אג״ו (SuTuFr); and Purim never on זבד (MoWeSa).

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