

David Gans on the Gregorian reform, modern astronomy, and the Jewish calendar

If we are to identify a uniting thread, or a common denominator, ~~between in~~ David Gans' diverse works, ~~— history on the one hand, and astronomy on the other —~~ this must be an interest in the measurement of time. [David Gans \(1541-1613\) was a leading Jewish historiographer and astronomer of the early modern period. Born in Lippstadt, he received a rabbinic education in Cracow under R. Moses Isserles, and in Prague, where he spent most of his life, under R. Loew b. Betzalel \(the Maharal\); but he also immersed himself in the study of history, mathematics, and astronomy.](#) Both his major works, *Tsemah David* ([a Jewish and world chronography](#)) and *Nehmad ve-Naim* ([a handbook of astronomy](#)), assume in very different ways a range of notions about chronology, calendars, and the flow of time. Gans [also](#) wrote a specific treatise on the Jewish calendar, entitled *Maor ha-Qaton* ('the smaller luminary', i.e. the moon – Gen. 1:16); but unfortunately this work is lost. Nevertheless, a sufficient number of references are made to calendar and chronology in the works that are extant to convey his views on the Jewish calendar and, in particular, the Jewish calendar's significance for the study of astronomy and its relationship with its Christian counterpart.¹

By the late 16th century, when Gans was writing, there existed a rich tradition of scholarship on the Jewish calendar for him to draw on. The early 12th century had witnessed an eruption of monographic writing on the Jewish calendar, with books later to be known under the standard title '*Sefer ha-Ibbur*' ('Book of the intercalation' or 'calendar'), authored by Abraham b. [Ḥayya](#), Jacob b. Samson (both c. 1123/4), and Abraham ibn Ezra. These were followed, later in the century, by Maimonides' *Laws of the Sanctification of the Month*, a part of the *Mishneh Torah*, his code of law, and somewhat later, in 1310, by Isaac Israeli's monumental *Yesod Olam*, on which David Gans himself wrote a commentary; these last two authors are frequently quoted by Gans in his astronomical work.² In the 12th century and following, moreover, a large number of opuscles on the Jewish calendar were composed and preserved on their own or more commonly incorporated into large manuscripts, typically in liturgical compendia.³ There were also much earlier treatises on the Jewish calendar, attributed for example to Sa'adya Gaon (dating from the 920s), although now, and probably also by Gans' time, these earlier works were all lost.⁴ There were also, besides, the works

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¹ In his seminal article on David Gans as an astronomer, Georg Alter describes the treatise *Maor ha-Qaton* as 'a work on arithmetic and geometry' ('David Gans: a Renaissance Jewish astronomer', conveniently reprinted by Gad Freudenthal in 'Dossier: Georg Alter (1891-1972) on David Gans (1541-1613)', *Aleph* 11.1 (2011) 61-114, on p.64). However, all Gans' references to this work which I have seen suggest, as its title also indicates, that it was actually a treatise on the moon and the lunar calendar. Mention must also be made of a commentary attributed to David Gans on Isaac Israeli's *Yesod Olam*, which Alter was not aware of and which includes astronomical as well as calendrical material: ms. Oxford Bodl. Opp. 277, fols. 405r-433v. In a certain sense, David Gans was closely emulating Abraham Zacuto, whose *oeuvre* similarly encompassed both astronomy and history.

² See previous note. On the production of calendar monographs in the 12th century, see S. Stern and C. Burnett, *Time, Astronomy, and Calendars in the Jewish Tradition*, Leiden: Brill, 2014.

³ For what might be the earliest of these, dating from the second quarter of the 12th century, see S. Stern and J. Isserles, 'The astrological and calendar section of the earliest *Maḥzor Vitry* manuscript (MS ex-Sassoon 535)', in *Aleph* (forthcoming, 2015). Note also a short calendar treatise attributed to Samuel b. Meir (Rashbam), a grandson of Rashi, composed in the city of Reims in 1129/30 and preserved in a large (and much later) compilation of works on the Jewish calendar, ms. Moscow Guenzburg 365/9 (fol. 171r).

⁴ Sa'adya's works on the calendar are very briefly quoted by Rashi (commentary on *bRosh ha-Shanah* 20b) and Jacob b. Samson (ms. Oxford, Bodleian, Opp. 317, chs. 37-8), [but they are not extant in any European manuscript. The first two folios of Sa'adya's treatise on the calendar against the Qaraites have also been preserved \(ms. Cambridge T-S 10 K2\).](#)

of non-Jewish scholars on the Jewish calendar, Muslim as well as Christian. Of the latter, several works on the Jewish calendar had been composed in Latin, starting from the late 13th century⁵ and culminating with the first ever printed book on the subject by the Christian Hebraist Sebastian Münster, the *Kalendarium Hebraicum* (Basel, 1527). But one of the more recent works that Gans was to engage with the most was Azariah de Rossi's *Meor Enayim* (Mantua, 1573-75), whose controversial views on the Jewish calendar and chronology provoked Gans into giving his own responses.

In this vast literature on the Jewish calendar, a reader like Gans would have found extensive descriptions, discussions, and justifications of the Jewish calendar calculation and its astronomical foundation. This typically included a variety of algorithms for calculating the time of the *molad* (mean conjunction of sun and moon), on whose day the new month is supposed to begin; explanations of the postponement rules (whereby the new month is sometimes postponed by one or two days from the day of the *molad*), and their origins and halakhic rationale; explanations of the sequence and lengths of the months of the year, whereby 30- and 29-day months succeed each other in alternation, with however some variable months; demonstrations of how the 19-year cycle of intercalations enables the lunar calendar to remain in line with the solar year; schemes for constructing annual calendars on the sole basis of the *molad* of the New Year; and the various methods of calculating the *tequfot* (equinoxes and solstices), on whose day the widespread medieval Jewish custom was to refrain from drinking water. Treatises on the Jewish calendar often included also comparisons with non-Jewish calendars (Islamic, Christian, sometimes even Zoroastrian and others) and calendar conversion schemes.

Against this rich background, Gans had little new to contribute to the study of the Jewish calendar; in what remains of his work, his contribution on the Jewish calendar is not surprisingly modest. Yet although his approach may be regarded as traditional and conservative, some of his insights on the Jewish calendar were somewhat radical, and may be regarded as precursors of its modern study. As we shall see, his purpose in this context was largely to engage polemically with the Christian calendar, which had only recently emerged from the trauma of the Gregorian calendar reform, and which demonstrated in Gans' eyes the inherent superiority of the Jewish calendar.

1. *Tsemaḥ David*, 4118 AM: Hillel institutes the Jewish calendar

Two events of major importance for the history of calendars appear in Gans' *Tsemaḥ David* (first printed in Prague, 1592): the 4th-century CE institution of the rabbinic calendar, and the Gregorian calendar reform of 1582.

The emphasis Gans places on these events, by allocating full entries to them in his world historical chronicle, says something of his passion for the calendar and time reckoning. This passion also finds expression elsewhere, for example in the entry for the year 4003 AM (in the first part of *Tsemaḥ David*, which is dedicated to Jewish history), i.e. 242/3 CE, where he includes a disproportionately long account of Rav Ada bar Ahavah, for no other reason than that this sage was accredited with the invention of a precise calculation of the *tequfot*. After explaining in some detail what this calculation consists of, he concludes somewhat apologetically: 'I have disclosed this for the lovers of the science of calendar calculation (לאוהבי חכמת העיבור), even though this is not the right place for it' (p. 45a of the first edition).

But an apology of this kind was unnecessary for the year 4188 AM, where Gans writes the following:

⁵ See C. Philipp E. Nothaft, *Medieval Latin Christian Texts on the Jewish Calendar: A Study with Five Editions* (Leiden: Brill, 2014).

Hillel the Patriarch instituted the order of intercalation according to the *tequfah* of Rav Ada, because until his time they used to sanctify (the months) on the basis of (new moon) sighting and intercalate years according to time and necessity, as Maimonides writes in chapter 5 of the *Laws of the Sanctification of the Month*. But fearing that the fixed court would be removed from the Land of Israel, Hillel the Patriarch laid out for our benefit the calculation of the calendar as we are accustomed in the entire Jewish Diaspora until this day and until the coming of our redeemer. And so Nahmanides⁶ wrote in his glosses on the *Book of the Commandments*, positive commandment no. 153, and so wrote the great astronomer R. Isaac Israeli in his book, *Yesod Olam*, part 4 chapter 9, i.e. that we rely on his calculation of *tequfot* and intercalations and conduct ourselves so until the coming of the Teacher of Righteousness, in such a way that through all the years of our exile we fix and intercalate with the authority of the court that is in the Land of Israel. And this was in the year 670 of (the era of) contracts, year 290 of (the era of) the destruction of the Temple, which is the year 4118 of (the era of) Creation – and this seems to me the true calculation, better than any other calculation, which the author of *Meor Enayim* also concurs with, since Maimonides, our rabbi Ha^vya Gaon, and R. Abraham (bar Hⁱya^vya) the Prince agreed to it... and so is written in *Sefer Yohasin*, letter heh, p. 90. (*Tsemah David*, 1st edn. pp. 46b-47a)

As I have shown elsewhere, the theory that the fixed, calculated rabbinic calendar was instituted by Hillel the Patriarch in the mid 4th century is not attested in any contemporary rabbinic source, and is only one of several theories on the origins of the calendar that began circulating in rabbinic and other circles from the late 9th century onwards. But of all these theories, which included attributions of the calendar to R. Gamaliel, R. Judah the Patriarch, R. Isaac Napha, an Eliezer b. Paruah, ~~or~~ ~~at~~ ~~the~~ unnamed *Sanhedrin*, or a body of sages sometimes called ‘sons of Issachar’, the Hillel tradition had become dominant well before David Gans’ period. In its first, late 10th-century formulation, this tradition attributed to Hillel the institution of the fixed cycle of intercalations, the 19-year cycle, but not any other element of the calendar calculation; but by the mid 12th century, the tradition had expanded to include the calculation of new months, which effectively encompassed the entire calendar calculation; whilst in the 13th century, Nahmanides went as far as suggesting that Hillel sanctified in advance all the new months to occur between his time and the end of history. Although Gans expresses this theory in more moderate terms (‘we rely on his calculation’, etc.), he does take the attribution of the calendar to Hillel completely for granted and in a completely uncritical way – in contrast, perhaps, to his predecessor Isaac Israeli (whom he cites), who does indeed endorse the tradition in several places (*Yesod Olam* 4:9, and implicitly 4:14, 4:18), but elsewhere suggests that the calendar was in fact established much later than Hillel, ‘near the end of the period of the sages of the Talmud ... approximately 4260 years according to the era of Creation’, i.e. 499/500CE (ibid. 4:5). By Gans’ period, the Hillel tradition had become standardized and was no longer the object of scrutiny.⁷

On the matter of Hillel’s date, the earlier sources ascribed his institution to the year 670 of the era of contracts, i.e. the Seleucid era (SE), which should mean 358/9 CE.⁸ Gans does not provide the equivalent year of the Christian era (as he never does in part 1 of *Tsemah David*), but instead equates this year to 290 from the destruction of the Temple, and 4118 AM (era of Creation). The latter equivalence is consistent with Gans’ chronology, which he lays down briefly in the entry for the year 3442 AM, and then argues out in full in a polemical passage against Azariah de’ Rossi’s *Meor Enayim*, in the entry for 3448 AM (pp. 27a-28b). His argument with Azariah de’ Rossi hinges on more substantial issues of biblical and post-biblical chronology, and will not detain us here. But in the

⁶ So, correctly, in the first edition. The Frankfurt edition (1692) has erroneously ‘Maimonides’ (רמב"ם).

⁷ See S. Stern, *Calendar and Community: a History of the Jewish Calendar, 2nd cent. BCE – 10th cent. CE* (Oxford 2001), pp. 175-9.

⁸ Responsum of Ha^vya Gaon, quoted in Abraham b. Hⁱya^vya, *Sefer ha-Ibbur* 3:7.

course of his argument, he makes it clear that in his chronology, the 'present' year, 5352 AM, is equivalent to 1904 of the era of contracts (SE). This is consistent with 670 SE = 4118 AM.

However, the equivalence that Gans consistently makes between SE and AM years is problematic, because if 5352 AM corresponds as it should to 1591/2 CE, then this in turn should correspond to 1903, not 1904, of the Seleucid era;⁹ and thus likewise 670 SE, the year of Hillel's institution, should have been equated to 4119 AM. This one-year error is likely to have arisen from a widespread confusion in late medieval sources between the era of Creation that was in common use and that Gans himself assumes in his chronicle,¹⁰ and the Babylonian era of Creation which began one year later (and could be found in some earlier sources, e.g. Babylonian Talmud *Avodah Zarah* 9a-b). Gans' error is surprising, however, because someone of his learning should have been well aware of these two eras of Creation, and hence of the correct relationship between the Seleucid era and the era of Creation in common use.¹¹ His error is all the more surprising in that he refers, in the entry for 3448 AM (above mentioned), to Maimonides, *Laws of the Sabbatical Year* 10:4 and *Laws of the Sanctification of the Month* 11:16, where in both passages Maimonides explicitly assumes the common era of Creation, whereby 670 SE should have been equated 4119 AM.

The final statement in this passage, 'and this seems to me the true calculation (וּחְשׁוֹן), better than any other calculation', is a little enigmatic. He may be referring to his equivalence of 670 SE = 4118 AM, which is in fact mistaken, but then the sources he cites do not appear to be relevant to this. More likely, he simply means that the *date* ('calculation') of Hillel's institution, given as 670 SE by Hayyā Gaon, Abraham bar Hiyyā, and Abraham Zacuto in *Sefer Yoḥasin*, is true and better than any other. He may be aiming at Samuel b. Isaac ha-Sardi's *Sefer ha-Terumot*, where the date is given instead as 600 SE.¹²

2. *Tsemah David*, 5343 AM: the Gregorian calendar reform

Turning now to the second part of *Tsemah David*, which is devoted to world history, we find an entry that may be regarded as the Christian counterpart to the above: the reform of the Julian calendar by Pope Gregory XIII. The year is given as 5343 AM and 1583 CE, which again appears to be an error, since the Gregorian reform is known to have been instituted in 1582 CE. The intention is presumably to refer to October 1582 CE, when the reform was formally implemented, and when the Jewish year 5343 had already begun:¹³

⁹ The equivalence between SE and CE years is firmly established by an abundance of ancient and medieval sources, Jewish and non-Jewish sources.

¹⁰ For example dating the expulsion from Spain to 5252 AM, i.e. 1492 CE.

¹¹ The existence of two eras of Creation, 'eastern' (i.e. Babylonian) and 'western' (Palestinian, and normative in Gans' period) was well known in medieval literature on the Jewish calendar, and discussed for example by Abraham bar Hiyyā in the same chapter (*Sefer ha-Ibbur* 3:7; see further Stern, *Calendar and Community*, pp. 272-3).

¹² Samuel b. Isaac ha-Sardi, *Sefer ha-Terumot*, 45:1:4. This work was completed in c. 1225; although it was only first printed after *Tsemah David*, in 1596 (Salonika), its second printing in Prague in 1605, together with the general popularity of the work, makes it more than likely that Gans had access to a manuscript of it.

¹³ Confusion about the date of the reform may also have resulted from the delayed and piece-meal adoption of the Gregorian calendar in Bohemia and other parts of the Holy Roman Empire between the years 1582 and 1585: see D. Steinmetz, *Die Gregorianische Kalenderreform von 1582: Korrektur der christlichen Zeitrechnung in der Frühen Neuzeit* (Oftersheim: Steinmetz, 2011), ch. 4 (on Bohemia, pp. 172-76) and pp. 466-69; K. Fischer, 'Appended Note: On the Calendar Reform in Bohemia and Moravia,' in *Gregorian Reform of the Calendar*, ed. G. V. Coyne, M. A. Hoskin, and O. Pedersen (Vatican City: Specola Vaticana, 1983), pp. 281-84 (references courtesy of Philipp Nothaft). There are further errors in Gans' dates: see n.15 below.

5343/1583. Gregory XIII, pope in Rome, instituted there in Rome the new calendar,¹⁴ and abolished the calculation that Julius Caesar had instituted by fixing the length of the year as 365 days and a quarter, as discussed above for the year 3715. For he found that over the period of 1628 years, from the institution of Julius (Caesar) until his time, there were ten days in excess of the true calculation. Therefore, in the year 5343, 1583 according to the Christians, on 15 October, which should have been followed on the next day by 16 October, he counted for the next day 25 October,¹⁵ in such a way that he subtracted from that year the ten excessive days; and from then onwards he fixed the length of the year to something very close to the calculation of R. Ada b. Ahavah. If the Lord is well disposed to me, I shall discuss this at length elsewhere, as this is not the right place for it. (p. 114a)

The last sentence, together with the entry as a whole, reveals again the importance that Gans conferred to calendars and time reckoning; although in fairness, the Gregorian reform was a genuinely important event of recent history which any chronicler in Gans' time would have been right to draw attention to.

The main point of interest, in this passage, is the claim that the year length of the new, Gregorian calendar was 'very close' to that of R. Ada – a claim that is also made in the entry for 3715, the year of the institution of the Julian calendar. This is actually incorrect, as Gans himself was later to make clear in *Nehmad ve-Naim*, ch.164 (to be discussed below). The relevant year lengths are as follows:

Julian year: 365 days, 6 hours

R. Ada year:¹⁶ 365 days, 5 hours, 55 minutes, 25 ½ seconds (approximately)

Gregorian year: 365 days, 5 hours, 49 minutes, 12 seconds.

The year of R. Ada is thus half way between the Julian and Gregorian years, if anything closer to the Julian, and certainly not 'very close' to the Gregorian. Gans is presumably well aware of this, but he is implicitly making in this passage a disingenuous, political point: that the reform of the Christian calendar was based on the Jewish calendar, which was recognized by Christians to be more accurate. Whilst it is true, in historical terms, that the Jewish calendar was taken account of in the process of reformation of the Christian calendar (in particular, for its lunar reckoning of the date of Easter), to claim that the Gregorian calendar was based on the Jewish year length was a gross, polemical exaggeration. This claim, however, was to be developed further by Gans in his major astronomical work, *Nehmad ve-Naim*.

3. *Nehmad ve-Naim*, prologue/epilogue: Jews and Christians in polemics

Perusal of Gans' astronomical monograph, *Nehmad ve-Naim*, suggests that it mainly served a didactic purpose, being addressed to a non-specialist, Jewish, rabbinically educated readership. But although it does not present the original research of a frontline astronomer, which in fairness David Gans was probably not, this work has the merit of reporting on recent discoveries and theories that were at the cutting edge of astronomy in Gans' period. Furthermore, as we shall presently see, this

¹⁴ Lacking a generic Hebrew word for 'calendar', Gans transliterates it as קולענדר.

¹⁵ One would expect 26 October (for a 10-day shift); but anyway these dates are wrong, as the transition was from 4 October to 15 October (I am grateful to P. Nothaft for pointing this out).

¹⁶ The year length pseudepigraphically attributed to R. Ada (see above), and first attested in 12th-century sources, is the result of the division of 235 lunations by 19, representing the 235 months in the 19-year cycle of the Jewish calendar, where the lunation is taken as 29 days, 12 hours, and 793 of 1080 parts of the hour.

work conveys throughout its pages an underlying, polemical claim of Jewish primacy over the age-old discipline of astronomy.¹⁷

Although a work of astronomy, the calendar also looms high in it. The relationship between astronomy and calendar, the former underpinning the latter, was well established in Jewish tradition, as exemplified already in the earlier works of Abraham b. Hiyya¹⁸ and even more so Isaac Israeli, whose books on the calendar included very substantial astronomical sections, and likewise Maimonides' *Laws of the Sanctification of the Month*.¹⁸ It is thus no surprise that Gans writes in his prologue or epilogue, in defence of the study of astronomy, that Jews should study it because it is the foundation of the calendar, and understanding astronomy is therefore a religious duty.¹⁹

But in Gans' period more than ever, the relationship between astronomy and calendar had been thrown into the limelight through the recent reformation of the Christian calendar. The Gregorian reform of 1582, indeed, had been largely based on astronomical science and consultation with astronomical experts. Accordingly, the atmosphere of *Nehmad ve-Naim* is charged with the recent events of the Gregorian reform. This emerges already in the following, highly polemical passage of the prologue (or epilogue, as it appears in ms Brno, [Strnor Oblastnn Archht MS 1613](#)):

The perfect proof that our Sages were experts in astronomical science is adduced from the length of the solar year and its *tequfot* according to R. Ada, and the length of the lunar month, and the structure of the 19-year cycle, and the other calendar calculations. Not one of them has ever changed – nothing was altered from their days until the present, so that we do not need to correct our year or change our calendar calculation, as the scholars of the nations have done seven times already, as is explained in my book *Maor ha-Qaton*. Even the gentile scholars themselves, the great, ancient astronomer Hipparchus (?), and also the gentile scholars of today, have all praised and complimented us on the precision of these calculations, and have been surprised and amazed that we have kept the same calculation without change or correction for much more than a thousand years, and that it has remained precise and accurate without error or (need of) correction until today (Jessnitz edn. 1743, p. 7d)

In this passage, Gans is implicitly capitalizing on the Gregorian reform to make a claim of Jewish calendrical superiority. Much of what he writes could be disputed: that the Christian calendar has been reformed 'seven times', and that in contrast, the changelessness of the Jewish calendar is proof of its complete accuracy. But as we shall see, throughout the rest of his work Gans will not be inhibited from upholding this polemical claim and even defending it on scientific, astronomical grounds.

Still in the prologue/epilogue, towards the end, a further reference is made to Jewish-Christian interaction. The context is Gans' justification of the study of astronomy, in addition to the argument that has already been mentioned above:

When the gentiles see us devoid of knowledge, they are surprised about us, and they insult us and curse us ... What shall we do on the day when gentile scholars talk to us and ask us

¹⁷ On the cultural context of Gans' astronomical work, see A. Néher, *David Gans (1541-1613) : Disciple du Maharal, assistant de Tycho Brahe et de Jean Kepler* (Paris: Klincksieck, 1974); D. B. Ruderman, *Jewish Thought and Scientific Discovery in Early Modern Europe* (New Haven: Yale University Press, 1995), pp. 82-7.

¹⁸ See further Stern and Burnett, *Time, Astronomy, and Calendars* (above, n.2).

¹⁹ This is his third argument in defence of astronomy, in what appears as a prologue in the printed edition (on pp.9d-10a) and epilogue in the manuscript version (see further Tamas Visi's article in this volume).

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the rationale of the system that is at the foundation of our calendar? For them, our tradition is not sufficient. Would it look good that we place our hands on our mouths and look like the dumb who cannot open their mouths? Would this be our glory, or the glory of our Creator?²⁰ (p. 10a)

The reference to gentiles asking Jews about their calendar and its scientific rationale – to which, Gans urges, Jews should make themselves ready to respond – is most likely grounded in historical reality, and perhaps related again to the Gregorian reform, in so far as some medieval Christian calendar reformers studied the Jewish calendar as a model of lunar calendar accuracy.²¹ These exchanges and debates between Jews and Christians constitute an important background to Gans' polemical argument, throughout *Nehmad ve-Naim*, in support of the Jewish calendar and the astronomical values that the calendar implies.²²

4. *Nehmad ve-Naim*, ch. 161, on the date line: Gans and modern discoveries

Before turning to the more polemical passages of *Nehmad ve-Naim*, ch.161 provides a good illustration of Gans' interest in recent discoveries – a modernist stance which, as we shall later see, he avoids elsewhere when it suits his ideological agenda. The issue at hand is that of the date line. Earlier medieval scholars had long been aware of the fact that there had to be a meridian, somewhere around the terrestrial globe, which by common convention would demarcate two zones with a different date. Nowadays, the International Date Line runs approximately through the centre of the Pacific Ocean; the date of those to the east of it, e.g. Hawaii, is one day behind the date of those to the west, e.g. Japan. This line is not objective, but only determined by common, international agreement. From a Jewish perspective, however, the location of this line has major implications, as it determines the dates of festivals, and more regularly the weekly Sabbath, for those who live in these borderline regions.

The problem was discussed in the 12th century by Judah ha-Levi (*Sefer ha-Kuzari* 2:20) and Zerahiah ha-Levi (*Sefer ha-Ma'or* on *bRosh ha-Shanah* 20b), who placed the date line 90 degrees east of the meridian of Jerusalem; but this solution was problematic for a variety of reasons – not least, that this line was deemed to run through inhabited lands – and clearly tailored for the purpose of explaining an obscure Talmudic passage. A more simple, indeed a natural solution was later proposed, in 1310, by Isaac Israeli (*Yesod Olam* 2:17), although he was most probably not the first to have conceived it. Based on the medieval assumption that the inhabited world extended from China in the east to the Atlantic shores of Europe and Africa in the west, covering no more than half the globe, Israeli simply concluded that the day began in the Far East in China and ended in West, not far from his native Toledo; whereas the exact location of the date line meridian, somewhere in the oceans on the other side of the globe, did not matter much as no one lived there.

The discovery of the American continent upset the medieval worldview in more than one way, and also put into question Israeli's definition of the beginning of the day. It became unclear, indeed,

²⁰ The last word translates יוצרינו, which I conjecture is the correct reading. The printed text reads נוצרינו, an odd phrase translating as 'our Christians'; if this reading is correct or deliberate, the meaning of the sentence becomes: 'Is this our glory, or is it the glory of the Christians?'

²¹ See Nothaft, *Medieval Latin Christian Texts on the Jewish Calendar*.

²² Not all references to the Jewish calendar in *Nehmad ve-Naim* will be surveyed in this article. Other passages of interest include a discussion on the seven-day week in ch.97. Gans argues that although the seven-day week was ordained by God, it is still fitting to seek a rationale for it, and this is that the seven planets rule successively over the hours and complete their cycle after seven days. The week is thus not an arbitrary time-period, but 'a natural thing' (דבר טבעי), which explains, in his view, why other nations have also adopted it.

whether American should be considered an extension of Europe, thus marking the end of the day in the west, or an extension of India and China, thus marking its beginning in the east. More fundamentally, the existence of inhabited lands around the entire globe defeated Israeli's argument, as in the absence of an uninhabited oceanic hemisphere, it was no longer possible to treat the Far East as the natural beginning of the day: in theory, the date line could now be located anywhere.

In a lengthy chapter (ch. 161), Gans explains the problem of the date line and Israeli's solution, which he clearly favours. But right at the end, he points out that the discovery of the New World, and in particular the more recent discovery of New Guinea²³ – because of its proximity to the extremity of the Far East, where the problem of the date line is particularly acute – has proved false the beliefs of the early scholars, both Jews and Gentiles, and has undermined completely Israeli's solution. Consequently, the problem of the date line remains, for Gans, unresolved, as he concludes:

You must know, my reader, that I raised these questions and quandaries before the great, the eminent counsellors, the Christian scholars who sit before our lord the Emperor Rudolph, may his glory be elevated – wise and learned men with sharp minds, whose intelligence is unfathomable. But after they delved into these questions for several days and discussed them with me, they confessed openly that they knew no correct or satisfactory answer. (p. 50a)²⁴

Gans' account of his conversations with the great scholars of Rudolph II's court is obviously intended to ~~impress the reader, raise his own status and profile,~~ as well as ~~raise~~ his authority as a scientist. ~~But~~ but although he was able to ~~present challenge these scholars~~ with a problem that they could not resolve, the ~~impression-feeling~~ remains that his relationship with ~~these scholars~~ them was not entirely on an equal footing.

Although America had been discovered more than one century earlier, Gans presents himself here as if he was the first to have thought of this problem. Whilst this highly doubtful, it remains possible that the problem of the date line was of more interest to Jews than Christians, because of the strict Jewish observance of Sabbath and festivals and insistence on reckoning them on the right dates (even though the exact date of Easter and other liturgical occasions should really also have been an issue for Christians, not for least those travelling around the globe). Still, Gans avoids presenting this as a specifically Jewish issue, and seems to derive some pride at having outstripped, in this area, his Christian rivals.

5. Nehmad ve-Naim, ch. 213, on the lunation: criticism and credulity

In ch.213, Gans discusses the lunation, i.e. the average interval between two new moons – a subject of great importance for the Jewish, lunar calendar, and to some extent also for medieval and early modern astronomy. This chapter, more than any other discussed in this article, can be identified as making a genuine contribution to the modern study of the Jewish calendar, even if its ultimate conclusion falls back, as we shall see, on religious traditionalism.

Earlier on, in ch.203 (a chapter on 'the duration of the circuit of the moon on its orbit ... and the length of the lunar month'), Gans refers to 'the exact calculation' (חשבון המדויקדק), alternatively

²³ The discovery of the New World and its geography are described in detail above in chs. 93-97, starting with 'America' (north America) and 'Peru' (south America), and ending with New Guinea in ch.97. Ch.161 is another opportunity for Gans to describe what he perceives as the continent of New Guinea – a subject of great interest and curiosity which Gans clearly had close to heart. See further Alter (above, n.1), p. 99.

²⁴ See further Alter, pp.102-3; Néher, pp. 338-48.

'exact value') of the lunation, which he says he has received from his contemporary, 'the outstanding astronomer' Johannes Kepler. After giving Kepler's values of the sidereal lunation, Gans writes:

According to [Kepler], the length of the duration of the lunar month, between one *molad* and the next one after it, according to his exact calculation is 29 days, 12 hours, 44 minutes, 3 seconds, 11 thirds, ... all according to the mean motion. And this is very close to the calculation of our Sages, whose length of the month is 29-12-793.²⁵ For the only difference between the calculation of our Sages and his calculation is one part of twenty-four thousands of the hour.²⁶

Kepler's value of the lunation, exactly as quoted by Gans, is attested in his later writings (written after *Nehmad ve-Naim*), but presumably Gans received it from Kepler through some other means.²⁷ The difference between Kepler's lunation and the lunation assumed in the rabbinic calendar is, as stated, very slight. If one expresses the Jewish value using the same, sexagesimal notation as Kepler, one obtains the following:

Kepler's lunation: 29^d;12;44,3,11^h

Jewish lunation: 29^d;12;44,3,20^h

As Gans correctly notes, the difference between them is only 1/24,000 of the hour (in the sexagesimal notation, 9 thirds).²⁸

For Gans, however, the purpose of citing Kepler in this chapter is not to point out or to correct a slight imperfection in the Jewish calendar, but rather, on the contrary, to lend scientific support to the Jewish value. This becomes evident as one progresses further through the work. For by the time the reader gets to ch.213, Kepler is long forgotten and Gans – true to his style – simply assumes the Jewish calendar lunation to be the most accurate. To cite:

Know, that as to the length of the lunar month from the time of its renewal until it is renewed a second time in its mean motion, we have an old tradition from our fathers that it is 29 days, 12 hours, 793 parts, where there are 1080 parts to the hour. And this calculation is deep and very recondite, and more precise than all the calculations of the ancient and modern astronomers. And the gentile scholars have long concurred with us from ancient times, as I have explained at length in my book, *Maor ha-Qaton*. Even the gentile scholars of the present day, when they see us in this generation deprived and devoid of scientific learning, of the knowledge of the stars, and of the knowledge of the constellations, are astounded and astonished by the precision of this calculation, 29-12-793. From where did we know it, or who told us this precise calculation?

The gentile, Christian scholars of Gans' generation may well have wondered at the precision of the lunation in the Jewish calendar, especially in comparison to the lunation that was assumed in the

²⁵ i.e. 29 days, 12 hours, and 793 parts of the hour (there are 1080 parts to the hour). The text is somewhat garbled in the printed edition (קרוב מאד שחשבוני חז"ל שמונעת החודש כ"ט י"ב ת"שצג) but the general sense is clear.

²⁶ The text reads *בשנה* instead of *בשעה*. Gans goes on to refer to his work, *Maor ha-Qaton*, ch. 21 of the part on the month.

²⁷ Johannes Kepler, *Epitome Astronomiae Copernicanae* book VI, part 4 (1619-21), ed. M. Caspar, *Johannes Kepler Gesammelte Werke*, vol. 7 (Munich, 1953), p. 448: '*periodus una mediocris absolvitur diebus 29. horis 12. 44. pr. 3. sec. 11. ter.*' (reference courtesy of Philipp Nothaft).

²⁸ This means that it would take 24,000 lunar months, or approximately 1940 years, for the discrepancy to accumulate to only one hour. Modern values suggest a slightly larger discrepancy, of about half a second or 1/7200 of the hour. In this notation, 'd' are days and 'h' are hours divided in minutes (44), seconds (3), and thirds (11 or 20).

Easter cycle, although this had now been corrected by the Gregorian reform. What Gans fails to mention, however, is that modern astronomers such as Kepler still had a slightly different values for the lunation – as he mentioned himself ten chapters earlier – and that the Gregorian reform was based on one of these modern values.²⁹ The impression he gives, somewhat falsely, is that modern gentile astronomers considered the Jewish lunation to be scientifically the most accurate.

This passage should be read not only as an endorsement of the Jewish calendar, but also as a statement of intention, on Gans' part, to use the lunation of the Jewish calendar as an astronomical value, as we shall see further in the next section of this article. This rather extraordinary use of a calendrical value for purposes of astronomical inquiry – when normally the exact reverse would be expected, since astronomy is meant to be empirically based, whereas the calendar is meant to be based on astronomy – is what gives Gans' astronomy a distinctly Jewish brand.

Although Gans may be misrepresenting the views of modern astronomers, he is on stronger grounds with regard to ancient astronomers, suggesting that they concurred with the Jewish value of the lunation. Indeed, as Gans knew well, exactly the same value is found in Ptolemy's *Almagest*, where it is attributed to the even earlier astronomer Hipparchus (2nd century BCE).³⁰ The use by Hellenistic astronomers of exactly the same lunation as the Jews raises the question of the origins of the Jewish lunation. This is precisely the subject of this chapter of *Nehmad ve-Naim*, as indicated in its title: 'The length of the lunar month, which is 29-12-793 – from where do we know it?'

The possibility that the Jewish value of the lunation, which lays at the foundation of the Jewish calendar and the dates of its festivals, might have been borrowed from non-Jewish sources was a cause of embarrassment which earlier rabbinic scholars had dealt with in different ways. In this chapter, Gans polemicizes against Azariah de' Rossi (though without mentioning him by name) who had argued, a few decades earlier, that the Jewish lunation was not given by God to Moses at Mount Sinai but borrowed by the Jews, in fact, from Hipparchus;³¹ against this, Gans defends the Sinaitic origin of the Jewish value. Yet paradoxically, and in spite of his traditionalism, Gans manifests in this same chapter a remarkably critical approach to early rabbinic sources, going in some ways much further, in his criticism, than Azariah de' Rossi. It is in this chapter that Gans shows his modern colours, and it is here that he makes what could be termed a contribution to the modern study of the Jewish calendar.

The central issue, in this debate, is a *baraita* (tannaitic source) in the Babylonian Talmud, which, if authentic, would be by far the earliest source attesting the lunation of the Jewish calendar:

Our rabbis taught: once the sky was covered with clouds, and the likeness of the moon was seen on the 29th of the month. The people were minded to declare (this day) a new moon, and the court wanted to sanctify it, but Rabban Gamaliel said to them: 'I have received as a tradition from my father's father's house, that the renewal of the moon does not occur after less than 29 days and a half, two thirds of an hour, and 73 parts.' (*bRosh ha-Shanah* 25a)

²⁹ According to N. M. Swerdlow, 'The length of the year in the original proposal for the Gregorian calendar', in *Journal for the History of Astronomy* 17 (1986) pp. 109–18, the lunar component of the Gregorian calendar was based on the synodic month of the Prutenic Tables (Erasmus Reinhold, 1551), which was 29^d;12;44,3,10,48^h (reference courtesy of Philipp Nothaft).

³⁰ Ptolemy, *Almagest* 4:2 (Toomer 1984: 176), where it is expressed in sexagesimal notation as 29;31,50,8,20^d (i.e. fractions of the day).

³¹ Azariah de' Rossi, *Meor Enayim, Imrei Binah*, ch.40; in translation, J. Weinberg, *Azariah de' Rossi, The Light of the Eyes*, New Haven: Yale University Press, 2001.

The value given here is equivalent to 29 days, 12 hours, 793 parts, i.e. the value of the lunation that was later adopted in the fixed rabbinic calendar. This passage, attributing this value to Gamaliel, suggests that rabbinic knowledge of this value predated Ptolemy (mid 2nd century CE) and possibly even Hipparchus (depending on how many generations Gamaliel's 'father's father's house' stretched back to).³² This Talmudic passage had been invoked for some time, notably by Abraham b. Hiyya (Sefer ha-Ibbur 2:2), to prove the antiquity of the Jewish value of the lunation, and even to claim that Hipparchus has borrowed it, in fact, from the Jews. Azariah de' Rossi considered this claim to be historically unlikely; but to counter it, all he suggested was that Gamaliel's attribution of the tradition to his 'father's father's house' was unreliable, as it was Gamaliel or his predecessors who must have borrowed the value from Hipparchus.

Gans goes much further than Azariah de' Rossi in his critique of this Talmudic passage. At the risk of undermining his own argument, he questions the entire tradition and claims that the text has been interpolated. His argument, in support of this claim, is two-fold. Firstly, a number of versions of this passage, which Gans quotes (but which are actually totally different passages, drawn from other early rabbinic works), present the same value for the lunation but without the 73 parts. Secondly, 73 parts are out of context in this story, as according to Gans, Gamaliel must have been referring to the true lunation, which determines whether or not the new moon crescent will be visible; in this period, indeed, and as is evident from the story itself, the calendar was based on the sighting of the new moon crescent. Gans argues that unlike the mean lunation, which was later used as the basis of the fixed rabbinic calendar, the true lunation is a variable value for which the precision of 73 parts would have been irrelevant. In short, the original text of this Talmudic passage must have read '29 days and a half, and two thirds of an hour', only; it does not attest, therefore, the value of the lunation assumed in the later, fixed rabbinic calendar.

In broad terms, Gans is right on both counts, although on his own argument, the 'two thirds of the hour' should be equally irrelevant to the value of the true lunation, which can sometimes be even less than 29 ½ days, and sometimes quite a few hours more. But in any event, the argument that this passage was interpolated could have been taken much further. In the mid 19th century, H. Z. Slonimsky did go further and argued that a larger section of the text must have been later interpolated, because in fact, Gamaliel was not referring to the true lunation at all – an astronomical concept which made little sense in the context of this story – but rather, much more simply, to the minimal number of days in a lunar month. All Gamaliel needed to say, indeed, was that a lunar month could not be shorter than 29 days, which is why its 29th day, when the crescent had been sighted, could not be declared the beginning of the new month. According to Slonimsky, the original Talmudic text thus read: 'I have received as a tradition ... that the renewal of the moon does not occur after less than 29 days'.³³ Slonimsky may well be right, but Gans could be defended as philologically more cautious, since part of his argument depends on the textual evidence of parallel or similar sources.

In arguing that this passage is interpolated, Gans demonstrates a remarkable level of intellectual honesty. This argument, indeed, goes against his main contention, in this chapter, that the lunation of the Jewish calendar had ancient origins, going back to Moses at Mount Sinai. By arguing that the only Talmudic source that attests to this lunation was actually a later interpolation, Gans was

³² The identity of this Gamaliel is not clarified in the text, but there are only two possible options. If it is Gamaliel the Elder, this makes him contemporary with Paul in the mid-first century (Acts 5:34); in *Tsemaḥ David*, Gans citing Zacuto's *Sefer Yoḥasin* gives this Gamaliel's date of death as 3810 (49/50 CE). If it is Gamaliel II, he would normally be dated to the late 1st – early 2nd centuries CE; in *Tsemaḥ David*, he is said to have become Patriarch in 3833 (72/3 CE). In the second part of *Tsemaḥ David* (p. 28a), the astronomer Ptolemy is correctly dated to the reigns of Hadrian, Antoninus, and Marcus Aurelius, i.e. the mid 2nd century CE.

³³ H. Z. Slonimsky, *Yesodei ha-Ibbur*, first edn. Warsaw, 1852, p. 32 n.; see *Calendar and Community*, pp. 201-2.

jettisoning an important source of evidence. He was under no pressure to do so, since no one before him had ever suggested that the text was interpolated (even Azariah de' Rossi seems to accept the Talmudic text as it is).

Yet simultaneously, Gans is remarkably dishonest by omitting, in my view deliberately, to refer in this whole chapter to the lunation of Hipparchus and Ptolemy, from where – as Azariah de' Rossi had argued – the Jewish lunation was in fact most likely to have been borrowed.³⁴ Jewish medieval writers on the calendar were well aware of the lunation of Hipparchus and Ptolemy, which they regarded as a problem: as we have seen, Abraham b. Hiyya³⁵ argued in reverse that it was Hipparchus who took the lunation from the Jews; whilst Isaac Israeli claimed that Hipparchus and Ptolemy's value was really slightly shorter than the Jewish one, which obviated the suggestion that one was borrowed from the other.³⁵ Gans was also well aware of this problem, as he refers to it explicitly in his prologue/epilogue:

This Hipparchus, according to the writings of the author of *Sefer Yoḥasin*, page 17 and the author of *Meor Enayim*, chapter 40, analysed all the ancient calculations of³⁶ lunar eclipses going back 400 years, and he defined (his results) in hours, parts, instants, fractions, and fractions of fractions,³⁷ so that his result for the length of the lunar month was identical (מכוון) to that of our Sages, which is 29-12-793. (page 8b)

But although he refers to Azariah de' Rossi's *Meor Enayim*, and although he seems to acknowledge that Hipparchus obtained his value through his own calculation (and not, for example, by taking it from the Jews), Gans is cautious in his prologue/epilogue not to refer to Azariah de' Rossi's claim that the Jewish lunation was taken from Hipparchus and Ptolemy. In chapter 213, where he defends the Sinaitic origins of the Jewish lunation, Ptolemy and Hipparchus are not even mentioned. Gans simply evades the issue, and instead, he concludes the chapter and his critique of the Talmudic passage as follows:

However, it seems that although we do not have a complete proof from the *baraita* above mentioned regarding the tradition of the value of 29-12-793, and even if nothing of this tradition is mentioned anywhere in the Talmud ... nevertheless, we should not deny for this reason that this value is a tradition that we have from our fathers, and our fathers from our fathers, back to Mount Sinai.

This deliberate evasiveness regarding the relationship between the Jewish lunation and Ptolemy's is necessary for Gans to pursue his agenda, which is to present the Jewish calendar as completely original to the Jews, and to ascribe it both antiquity and perfect astronomical accuracy. His insistence on Sinaitic origins (which effectively means, Divine revelation) lends further weight to his argument, even though few Jewish scholars were daring enough make this claim, and it was generally rejected by Gans' predecessors (not just by Azariah de' Rossi). The only authority that Gans invokes in support of Sinaitic origins of the Jewish lunation is a passage of Maimonides, in his *Laws of the Sanctification of the Month*; but this passage is open to interpretation, particularly as Maimonides himself rejects the Sinaitic origins of the calendar lunation in his earlier commentary on

³⁴ This is the view that modern scholars have taken; more precisely, that Ptolemy's value of the lunation was taken from early Arabic translations of the *Almagest*, at the turn of the 9th century, when the fixed rabbinic calendar was in formation (*Calendar and Community*, pp. 207-10).

³⁵ Isaac Israeli, *Yesod Olam* 3:12; see also 4:7. Israeli was relying on Arabic versions of the *Almagest*, where the value of the lunation had been slightly shortened: see B. R. Goldstein, 'Ancient and Medieval Values for the Mean Synodic Month', *Journal for the History of Astronomy*, 34.1 (2003) pp. 65-74.

³⁶ The printed edition reads טע, perhaps an error for לע, which I am translating 'of'.

³⁷ The terminology is random, but it refers to Ptolemy's sexagesimal notation.

the Mishnah; according to later medieval halakhists such as Solomon b. Aderet, the passage in *Laws of the Sanctification* does not support Sinaitic origins either.³⁸ A better source that Gans could have invoked was Sa'adya Gaon, at least as presented (and perhaps re-interpreted) by Isaac Israeli; Israeli, however, rejected his theory of Sinaitic origins, claiming instead that the prophets and early sages of Israel had deduced the length of the lunation from empirical observational data, much in the same way as Hipparchus had himself independently proceeded.³⁹

In short, in this chapter of *Nehmad ve-Naim* David Gans combines, somewhat incongruously, scholarly and critical acumen with regard to the authenticity of the Talmudic *baraita*, and credulous faith in the Sinaitic origins of the Jewish calendar's lunation. This theory of Sinaitic origins was not widely shared, and in Gans' case may have been motivated by an ulterior agenda: to invest the Jewish calendar with the highest level of accuracy, and hence, to use it as the foundation of his astronomical exposition. Gans' partiality for the Jewish calendar, and his preference of Jewish calendar values over more accurate astronomical values (such as Kepler's lunation, which he cites but then ignores), becomes in fact one of the most problematic aspects of this astronomical work. This is particularly evident when he discusses the length of the year, as we shall see in the next and final section of this article.

6. *Nehmad ve-Naim*, ch. 164, on the year: calendar and astronomy

Chapter 164 of *Nehmad ve-Naim* is on the definition and length of the solar year. Gans begins by explaining that the length of the year is very difficult to measure accurately (which is quite correct). He then presents the length of the year according to Jewish calendrical tradition, in which there are in fact two distinct traditions. The year length according to the Amora (Talmudic sage) Samuel is 365 $\frac{1}{4}$ days, and thus identical to the year length assumed in the Julian calendar – although Gans, characteristically, avoids mentioning this.⁴⁰ The year length according to Rav Ada is slightly shorter: 365 days, 5 hours, 997 parts, and 48 instants, where there are 76 instants in the part. This value is derived from the 19-year cycle of the fixed rabbinic calendar, and was probably first formulated in 11th-century Spain, although Gans believes, as everyone did in this period, that it is a genuine amoraic tradition.⁴¹ He then moves on to the astronomers, first ancient, with Ptolemy whose year length is similar to Rav Ada's, 365 $\frac{1}{4}$ days minus 1/300 day, then modern, with the year length of his contemporary Tycho Brahe, which is shorter by about 6 minutes. As Gans indicates, all these values can be converted into sexagesimal notation, as follows; compared in this way, the similarity of Rav Ada's and Ptolemy's year lengths is particularly striking:

Samuel: 365^d,6^h (i.e. 365 days and 6 hours)

³⁸ Maimonides, *Laws of the Sanctification of the Month*, 5:2 and *Commentary on the Mishnah, Rosh ha-Shanah* 2:7; Solomon b. Aderet, *Responsa* 4:254, arguing not implausibly that Maimonides only means that the principle of a calculated calendar (but not its specific values) was ordained at Sinai.

³⁹ Isaac Israeli, *Yesod Olam* 4:6 (Sa'adya and Sinaitic origins), 3:12 and also 4:7, 4:9 (prophets and sages of Israel). Sinaitic origins are also ascribed to the Jewish lunation by R. Hananel (11th century), cited in R. Bahya in his commentary on Exodus, 12:2; R. Hananel is likely also drawing on a tradition ascribed to Sa'adya, and it is not impossible that Sa'adya himself espoused it. More ambivalent is Abraham b. Hyyeavya in *Sefer ha-Ibbur*, who in 2:2 refrains from this theory and only ascribes the lunation to R. Gamaliel 'fathers' fathers', but in 3:4 (at the end) and 3:5 lapses into an ascription to Sinaitic origins; the matter, however, is not given a systematic discussion. Note also the mystical narrative (but not quite of Divine revelation, and not at Sinai) in Jacob Marcaria's *Sefer Evronot* (Riva, 1561), p. 2a, whereby Issachar went up to heaven and there established the 1080 parts of the hour.

⁴⁰ Samuel's year length is attested in the Babylonian Talmud (*bEruvin* 56a), and was probably directly derived, in fact, from the Julian calendar (see S. Stern, 'Fictitious calendars: early rabbinic notions of time, astronomy, and reality', in *Jewish Quarterly Review*, n.s. 87, 1996, pp. 103-129, on pp. 105-6).

⁴¹ *Ibid.* pp. 107-8.

Rav Ada: 365^d;5;55,25,26⁴²

Ptolemy: 365^d;5;55,12

Tycho Brahe: 365^d;5;49

He then concludes this chapter by explaining how he found out about Tycho's value. This passage is interesting, as it says something of how astronomical information was disseminated in this period:

And now, I shall disclose to the reader that I heard from the mouth of the great scientist, on whom present-day scholars have testified that since the days of Ptolemy there has not been a scientist as great as him, namely, the scholar Tycho Brahe, (I heard him) saying that he investigated all the ancient values and found, in his analysis, that the measurement of the year is less than Ptolemy's value, and that the precise measurement is very approximately 365^d;5,49^h. And so I heard from an outstanding scholar who was the disciple and colleague of Tycho Brahe, and who also succeeded him at the head of the scholars before our master the emperor Rudolph, who⁴³ agreed to this value – and this is less than Rav Ada's value by about 6 minutes. (page 51a)

This difference of 6 minutes is quite significant, but Tycho Brahe's value was not as revolutionary as Gans made out (which says something, perhaps, of the extent of Gans' knowledge of modern astronomy): already three centuries before, the Alphonsine Tables had assumed the same or a similar year length, and it is chiefly on the basis of this Alphonsine year length that the Gregorian calendar was instituted in 1582.⁴⁴ In this light, it is quite remarkable that an astronomer like Gans, in the next chapters and in the rest of his work, ignores Tycho Brahe's well-known, modern year length, and instead reverts to the year length of Ptolemy, which he should know is 6 minutes too long. His justification, in ch.164, is very simple:

... and it is fitting to rely on this (Ptolemy's) opinion, because it is close to the opinion of our Sages according to Rav Ada.

Purely because of its similarity to Rav Ada's, the year length of Ptolemy is preferred over modern, more accurate astronomical values. As a result of this, in the following chapters, Gans goes on to present a complete solar theory based on the archaic year length of Ptolemy. Thus again, the normal expectation has been reversed: instead of the calendar being based on astronomical values, Gans' astronomy is based on the values of the Jewish calendar.

Gans was not the first to have advanced this argument. Already in the early 12th century, Abraham b. [Hiyya'ayya](#) explained several times that he preferred Ptolemy's solar year length for exactly the same reason:

And this opinion (Hipparchus and Ptolemy's solar year length) is better to rely on than any other opinion, because it comes to the same as the opinion of our Rabbis, who built upon it the calendar calculation; and between this opinion of the length of the year and the opinion

⁴² The printed edition has 10 (ט"י) instead of 26. There are several other number errors in this chapter.

⁴³ The relative pronoun refers most likely to Tycho's successor, rather than to Rudolph II, although the phrasing is ambiguous.

⁴⁴ As argued by Swerdlow (above, n.28). The Alphonsine tropical year length is 365;14,33,9,57^d, i.e. about 365^d;5;49,16^h. The value that Gans attributes to Tycho Brahe (with 49 minutes but no seconds) is, as he says, a simplification; 16th-century astronomers assigned different values for seconds and further fractions. Modern values of the mean tropical year have not substantially changed.

of Rav Ada bar Ahavah there is no difference that anyone should be concerned with, due to its minuteness.⁴⁵

In the following passage, Abraham b. [Ḥiyyaʿayya](#) ignores this minute difference between Ptolemy and Rav Ada, and goes even further by claiming that Ptolemy followed Rav Ada, which suggests that he borrowed his values directly from him.⁴⁶

We rely on the number of days of the solar year according to Ptolemy, the head of the astronomers, because his opinion almost always agrees with that of our Rabbis, and he relies, for the calculation of the days of the solar year, on the opinion of Rav Ada bar Ahavah, upon which the calendar calculation is constructed. Similarly, his opinion regarding the motion of the moon followed the aforementioned Rav Ada, which is the opinion of our Rabbis.⁴⁷

By opting for Ptolemy, Abraham b. [Ḥiyyaʿayya](#) was choosing to ignore the shorter values of the Muslim astronomers (for which, in fact, he explicitly apologizes),⁴⁸ more specifically al-Battānī's year length of 365^d;5,46,24^h. In this period, however, al-Battānī's newer value had not gained universal acceptance, and Ptolemy remained a respectable authority to rely on. But in Gans' time, in contrast, and all the more so in the scientific circles that he frequented, the shorter year length of the Alphonsine Tables and the modern astronomers was firmly established, having been used, for example, for the Gregorian calendar reform, whereas Ptolemy had become long outdated. Gans' preference for Ptolemy, ideologically motivated, would have had a decisively 'ancient', archaizing flavour.

Georg Alter, in his seminal article on David Gans, explained that the reason why Gans adopted a Ptolemaic model of astronomy (with, for example, the earth at the centre of the universe) was because he considered Copernicus too revolutionary to his liking, and he had not yet become acquainted with Tycho Brahe's model at the time when he was writing.⁴⁹ This explanation is possible, but in the particular case at hand – the length of the lunation and of the solar year – Gans' preference for ancient over modern astronomy was motivated by a deliberate agenda, which was to present an astronomical system that agreed as closely as possible to the values of the Jewish calendar. In so doing, he may have had in mind his almost exclusively Jewish, rabbinically educated readership. But he was also constructing a polemical claim that the Jews were the most ancient astronomers, and that they could therefore lay claim over the discipline of astronomy. Furthermore,

⁴⁵ Abraham b. [Ḥiyyaʿayya](#), *Tzurat ha-Aretz* ch.12 (Offenbach, 1720, p.13a). 'Comes to the same as' translates the somewhat opaque Hebrew על אצו' (Offenbach edn.) or לא אצו' (ed. R. Lasri, Jerusalem: *Ha-Makhon le-Tekhunah ve-Qiddush ha-Hodesh*, 2009, p.69).

⁴⁶ A similar claim is made in his *Sefer ha-Ibbur*, 3:5, though not explicitly mentioning Ptolemy. Not surprisingly, Azariah de' Rossi argued the reverse, that Rav Ada adopted his year length from Ptolemy (cited above, n.30). Gans does not respond to this, just as he eludes Azariah's argument about the origins of the Jewish lunation.

⁴⁷ Abraham b. [Ḥiyyaʿayya](#), *Sefer Heshbon Mahlekhot ha-Kokhavim*, ch. 8, ed. J. M. Millas Vallicrosa, *La obra Sefer Hešbon mahlekhot ha-kokavim (Libro del calculo de los movimientos de los astros) de R. Abraham bar Ḥiyya ha-Bargeloni*, Barcelona: Consejo Superior de Investigaciones Científicas, Instituto Arias Montano, 1959, p. 46. The Ptolemaic year length is used accordingly in the rest of this work, e.g. in ch. 19 (p. 106) for the calculation of equinoxes and solstices. Raymond Mercier has argued that Abraham b. [Ḥiyyaʿayya](#)'s preference for the Ptolemaic year length, because of its similarity to the year of Rav Ada, leads to inconsistencies in his astronomical tables (the *Luhot ha-Nasi*) where sometimes the *Almagest*'s solar rates of motion are used in combination with al-Battānī's *radices* (R. Mercier, 'Astronomical tables of Abraham bar Ḥiyya', in Stern and Burnett, *Time, Astronomy, and Calendars* (above, n.2), pp.155-207, on p.178-81 and 206 where he concludes that the Jewish calendar was used by Abraham bar [Ḥiyyaʿayya](#) 'as a basis for a full astronomical system').

⁴⁸ *Tzurat ha-Aretz* ibid., Offenbach p.15b, Lasri p.73.

⁴⁹ Cited above, n.1, on p.94.

by ignoring the shorter year length that had been used as the basis of the Gregorian calendar, Gans could pretend that even after the Gregorian reform, the calendar of the Jews remained the most accurate of all.

As we have seen earlier on in this article, the idea of Jewish calendar supremacy is explicitly stated in the prologue/epilogue of *Nehmad ve-Naim*; and we have also seen Gans' spurious claim, in *Tsemah David*, that the Gregorian calendar was based on the year length of Rav Ada. In *Nehmad ve-Naim*, he avoids making such a preposterous claim, which could easily have been dismissed on factual grounds; and he also makes sure that due reverence is given to Tycho Brahe, Johannes Kepler, and other contemporary astronomers. Nevertheless, Gans insists on using the year of Ptolemy, the ancient astronomer, and the year Rav Ada as the baseline of his astronomical, solar theory, just as he uses the Jewish calendar lunation instead of Kepler's for his lunar theory. These ideological choices did not make for good astronomy, but they had the advantage of buttressing his polemical claim of Jewish superiority over the Christian calendar of the Gregorian reform.