4Q318: A JEWISH ZODIAC CALENDAR AT QUMRAN?*

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The zodiology *4QZodiology and Brontology ar* (4Q318)[1] has been recognised as a calendar by several scholars. However, its method of functioning has hitherto been relatively unexplored, in contrast to the scholarship on the 364-day calendar traditions.[2]

This paper will explain how the zodiology, or selenodromion, described as a "zodiacal calendar" by the official editors[3] and "a different calendrical system" by E. Tov,[4] is an intricate calendar, astronomically. We shall show that it is a working, schematic calendar that is related directly to the Jewish calendar in use today. The relationship between the zodiology and the brontologion will also be reassessed, based on new evidence. We shall also trace and identify the historical and cultural background of *4QZodiology and Brontology ar* (4Q318) across the Classical world. The place of the Qumran zodiac calendar in the discourse on sectarianism is not discussed in depth in this essay.

I. *Description*

4Q318 is paleographically dated by Ada Yardeni to the early Herodian period (late first century BCE to the early first century CE).[5] However,

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* I am indebted to my supervisor, Professor George. J. Brooke, for his helpful comments and to Dr Charlotte Hempel for her kind encouragement. This paper is based on a chapter of the author's PhD dissertation.

[1] Cf. J. C. Greenfield and M. Sokoloff, "318. 4QZodiology and Brontologion ar," in *Qumran Cave 4. 26: Cryptic Texts and Miscellanea Part I* (DJD 36; ed. P. S. Alexander et al.; Oxford: Clarendon, 2000), 259–274; sections on paleography by Ada Yardeni, 259–61, and astronomical aspects by David Pingree, 270–73.

[2] The term preferred by Uwe Glessmer for the 364-day calendars in the Dead Sea Scrolls, in U. Glessmer, "Calendars in the Qumran Scrolls," in *The Dead Sea Scrolls After Fifty Years: A Comprehensive Assessment* (ed. P. W. Flint and J. C. VanderKam; Leiden: Brill, 1999), 2: 213–278.

[3] Greenfield and Sokoloff, "4QZodiology and Brontologion ar," 259.

[4] E. Tov, "Foreword," in S. Talmon, J. Ben Dov, and U. Glessmer, *Qumran Cave 4. 16: Calendrical Texts* (DJD 21; Oxford: Clarendon, 2001), xi–xii, here xi.

[5] A. Yardeni, "Palaeography", in Alexander et al., *Qumran Cave 4. 26*, 259–261, here 260.

in the Shrine of the Book in Jerusalem, the text has, unusually, been assigned a different date, pushing it back a hundred years, to the late second century BCE.[6]

The zodiology concludes with almost four extant lines of a thunder-omen text, the bronotologion. The days of the months are represented by Aramaic numeral signs, which are used in some documentary and non-documentary texts for numbers, or days of the week, months, or measurements.[7] The extant Aramaic month names, Shevat שבט (4Q318 VII, 4) and Adar אדר (4Q318 VIII, 1) were adopted by the Jews from the Standard Mesopotamian Calendar.[8] The signs of the zodiac attested here are the earliest known in Aramaic.[9]

The calendar text describes a repeated formulaic arrangement reflecting a schematic monthly transit of the moon through the signs of the zodiac for twelve 30-day months: a 360-day year. As the moon orbits the earth, it spends on average about two and a half days in each sign; in the schematic arrangement of 4Q318, which does not deal with fractions, it spends two and three days in the signs.

The sun takes a month to traverse each zodiac sign, and a year to transit all twelve signs. (Variations of this astronomical paradigm are repeated throughout this essay in comparative texts). To place the 4Q318 calendar in its astronomical context, the lunar year is 354 days long and the solar year is approximately 365¼ days long: 11¼ days longer. In the Hebrew calendar, in order to keep the calendrical months in line with the seasons, every two to three years, an extra month is added to the year: seven times that are fixed in the 19-year cycle in the

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[6] Display card for the "Brontologion," Shrine of the Book, Jerusalem, April, 2008.

[7] E. Tov, *Scribal Practices and Approaches Reflected in the Texts Found in the Judean Desert* (STDJ 54; Leiden: Brill, 2004), 212–213 n. 265; Talmon, Ben Dov, and Glessmer, *Qumran Cave 4. 16*, 42 and bibliography 137 n. 15; Yardeni, "Palaeography", in Alexander et al., *Qumran Cave 4. 26*, 261.

[8] M. E. Cohen, *Cultic Calendars of the Ancient Near East* (Bethesda MD: University Press of Maryland, 1993), 386. Later Jewish literature ascribes the adoption of the Aramaic month-names to the returnees from the Babylonian exile who brought the calendar back with them, *y.Roš Haš.* 1.56d.

[9] J. C. Greenfield, "The Names of the Zodiacal Signs in Aramaic and Hebrew," in *Au Carrefour des Religions: Mélanges Offerts à Phillipe Gignoux* (Res Orientales 7; ed. Rika Gyselen; Bures-sur-Yvette: Groupe pour l'Étude de la Civilisation du Moyen-Orient, 1995), 95–103; Greenfield and Sokoloff, "4QZodiology and Brontologion ar," 267–9.

same position, for all time.[10] This is a luni-solar calendar; if the extra month is not intercalated, the calendar would slip back by 11¼ days every year, which is the case with a purely lunar calendar.

When reconstructed according to the average amount of characters per line in the extant columns, the selenodromion consists of just over seven and a half columns.

The brontologion assigns almost three lines to the protasis-apodosis of thunder in Taurus (4Q318 VIII, 6–8); Gemini is incomplete at one line (4Q318 VIII, 9). If each prediction by thunder comprised, formulaically, about three lines per zodiac sign, as per the thunder in Taurus pericope, the brontologion would consist of almost four columns. If so, the entire, portable scroll containing the complete zodiology and brontologion would probably consist of almost twelve columns, assuming that the text began immediately with the zodiology without a preamble.

Below is a reconstruction of column VIII, which gives the moon's journey through the zodiac for the month of Adar, and the remains of the brontologion.

4Q318 VIII, 1–9: Adar 1–Adar 30 and Brontologion

1 אדר ב/ וב// דכרא ב/// וב/// תורא ב//[/// וב///// וב///// תאומיא]
2 ב//////// וב//////// ס[רטנא ב¬ וב¬/ א]ריא ב¬// [וב¬/// וב¬////]
3 בתו]לתא[ב¬///// וב]¬////// מוזניא ב¬//[///// ב¬///]///// עקרבא]
^/3^
4 [ב¬/]//////// וב3 קש[תא ב3// וב3/// ג]ד יא[ב3//// וב3/////]
5 דו[לא] ב3////// וב3[/////// וב3///////]/ נו[ניא ב3//////// וב3¬]
6 דכר[א] *vacat* [אם בתורא] ירעם מסבת על[
7 [ו]עמל למדינתא וחרב [בד]רת מלכא ובמדינת אב[
8 להוא ולערביא[ ]א כפן ולהוון בזזין אלן כא[לן] *vacat*
9 אם בתאוסיא ירעם דחלה וסרע מנכריא ומ[*vacat*

1. Adar. In 1 and 2 Aries, in 3 and 4 Taurus, in 5 [and in 6 and in 7 Gemini]
2. in 8 in 9 Cancer, [in 10 and 11 L]eo, in 12 and[in 13 and in 14]
3. Vir[go], in 15 and in [16 Libra, in 1]7 in 18 [Scorpio,]
4. in [1]9 and in 20, and < in 21 > Sagitt[arius, in 22 and in 23 Cap] ricorn, [in 24 and in 25]

[10] The principle of this paradigm in antiquity is well summarised in W. K Pritchett and O. Neugebauer, *The Calendars of Athens* (Cambridge MA: Harvard University Press, 1947), 6. In the Hebrew calendar, the extra month is an additional Adar: every two to three years, there is an Adar I and Adar II.

5. Aquarius, in 26 and in 2[7 and in 28] Pi[sces and 29 and in 30]
6. Aries. *Vacat* [If in Taurus] it thunders (there will be) *msbt*[11] against
7. [and] affliction for the province, and a sword [in the cou]rt of the king and in the province,[12][
8. will be. And to the Arabs [ ], hunger, and they will plunder each oth[er *vac*]*at*
9. *vacat* If in Gemini it thunders, (there will be) fear and sickness from the foreigners and *m*[

(English translation according to Greenfield and Sokoloff)[13]

a. *Background*

As Michael Wise has shown, there are close correspondences between the 4Q318 brontologion and the genre of late Greek brontologia and Akkadian omen literature.[14] Pingree suggested that the Akkadian texts were probably a common ancestor, although the zodiac had not been introduced when they were written in the 8th to 7th centuries BCE. In the cuneiform corpus, predictions could be based on the occurrence of thunder in a particular month, or on the occurrence of thunder when the moon is visible at a particular phase.[15]

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[11] Yardeni suggests the second letter is a *ṣade* (Greenfield and Sokoloff, "4QZodiology and Brontologion ar," 263). For a discussion of the possible meaning of the reading]מסבת על cf. M. O. Wise, *Thunder in Gemini and Other Essays on the History, Languages and Literature of Second Temple Palestine* (JSPSup 15; Sheffield: Sheffield Academic Press, 1994), 23–27. Greenfield and Sokoloff read the disputed letter as a *samech,* cf. "4QZodiology and Brontologion ar," 263; see also Ursula Schattner-Rieser, *Textes Araméens de la Mer Morte* (LACA 5; Brussels: Safran, 2005), 126–28, nn. 165, 167; Klaus Beyer transcribes the questionable letter as a *šin* in the 1994 edition and as a *kap* in the 2004 edition, cf. *Die aramäischen Texte: Ergänzungsband* (Göttingen: Vandenhoeck & Ruprecht, 1994), 128–9; Beyer, *Die aramäischen Texte vom Toten Meer* (Göttingen: Vandenhoeck & Ruprecht, 2004), 2: 167–8.

[12] Greenfield and Sokoloff argue that]ובמדינת אב should be read as]ובמדינתא ב, cf. Greenfield and Sokoloff, "4QZodiology and Brontologion ar," 264; Wise reads]אב as connected to a toponym, in *Thunder in Gemini*, 29–32; so, Beyer, *Die aramäischen Texte,* 2: 167–8.

[13] Greenfield and Sokoloff, "4QZodiology and Brontologion ar," 264.

[14] Wise, *Thunder in Gemini*, 23–34, nn. 24, 29, 31, 36–39, 46, 47–50, 57, 58, 63, 66, 67, 69, 70, 71, 75, 77; R. Leicht, *Astrologumena Judaica: Untersuchungen zur Geschichte der astrologischen Literatur der Juden* (Tübingen: Mohr Siebeck, 2006), 18–24.

[15] D. Pingree, "Astronomical Aspects," in Alexander et al., *Qumran Cave 4. 26*, 270–272. H. Hunger, *Astrological Reports to Assyrian Kings* (State Archives of Assyria 8; Helsinki: Helsinki University Press, 1992), cf. for example texts 31: 4, r.1–3; 32: 1–5; 33: 1–6; 444: 1–4; 119: 5–9 (I thank Dr Jon Taylor of the British Museum for the last reference).

b. *4Q318: Babylonian Month-names*

Aramaic month-names appear in the post-exilic biblical books,[16] in 5th century BCE documents from Elephantine,[17] and in a substantial number of Persian-era papyri from Wadi Daliyeh.[18] The Standard Mesopotamian Calendar, based on the Metonic cycle (seven additional months over nineteen years), was standardised in Mesopotamia in the fifth century BCE.[19]

In addition to 4Q318, the other texts with Babylonian calendar month-names from Qumran Cave 4 include 4Q332 *4QHistorical Text D* (ca. 25 BCE) 2 2: שבט (Shevat)[20] and 4Q322a *4QHistorical Text H?* 2 5:] למ̇[רח]שוֹן [(of Ma[rhe]svan).[21] 4Q332 *4QHistorical Text D* 2 2–3 seems to synchronise two calendars:

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[16] Ezra 6:15; Neh 1:1; 2:1; Esth 2:16; 3:7,7,13; 8:9,12; 9:1,15,17,19,20; Zech 1:7; 7:1. See S. Stern, "The Babylonian Calendar at Elephantine," *Zeitschrift für Papyrologie und Epigraphik* 130 (2000): 159–171, 159 n. 4; *idem*, *Calendar and Community: A History of the Jewish Calendar Second Century BCE–Tenth Century CE* (Oxford: OUP, 2001), 29 n. 131.

[17] B. Porten, *Archives from Elephantine* (Berkeley: University of California Press, 1968), 128–130, 311–314, pl. 9. S. Stern, "Babylonian Calendar;" *idem, Calendar and Community*, 28–30; B. Porten and Ada Yardeni, eds., *Textbook of Aramaic Documents from Ancient Egypt* (2 vols.; Jerusalem: Hebrew University, 1989); J. C. VanderKam, *Calendars in the Dead Sea Scrolls: Measuring Time* (London: Routledge, 1988), 114; B. Porten, "The Calendar of Aramaic Texts from Achaemenid and Ptolemaic Egypt," *Irano-Judaica* 2 (1990): 13–32.

[18] D. M. Gropp, *Wadi Daliyeh II: The Samaria Papyri from Wadi Daliyeh* (DJD 28; Oxford: Clarendon, 2001), 35. Papyri with extant or part-extant dating formulae include: WDSP 1.1 (20th Adar); 2.12 ([Tebe]t); 3.11–12 (3rd Shevat); 4.1; 5.1; 6.1 (10th Shevat); 7.19 (5th Adar); 8.12–13; 9.15–16; 10 recto 1, 12; 12. 10–11; 14.1; 15.1; 16.1; 17.1–2, 8–9; 18.11; 19.1; 20.1; 22.10–11; see also J. Dušek, *Les manuscrits araméens du Wadi Daliyeh et la Samarie vers 450–332 av. J-C* (Leiden: Brill, 2007).

[19] O. Neugebauer, *The Exact Sciences in Antiquity* (New York: Dover Publications, 1969), 7; J. Britton and C. Walker, "Astronomy and Astrology in Mesopotamia," in *Astronomy Before the Telescope* (ed. C. Walker; New York: St Martin's, 1996), 42–67, here 46; (19 solar years are equivalent to 235 months comprised of 12 years of 12 months and seven years of 13 months).

[20] J. Fitzmyer, "332. 4QHistorical Text D," in Alexander et al., *Qumran Cave 4. 26*, 281–286, 283 and Pl. XVII; see also S. Talmon and J. Ben-Dov, "*Mišhmarot* Lists (4Q322–324c) and 'Historical Texts' (4Q322a; 4Q331–4Q333) in Qumran Documents," in *Birkat Shalom: Studies in the Bible, Ancient Near Eastern Literature, and Postbiblical Judaism Presented to Shalom M. Paul on the Occasion of his Seventieth Birthday* (ed. C. Cohen; Winona Lake IN: Eisenbrauns, 2008), 2: 927–942.

[21] E. J. C. Tigchelaar, "322a. 4QHistorical Text H?," in *Wadi Daliyeh II: The Samaria Papyri from Wadi Daliyeh* (DJD 28; ed. M. Gropp et al.; Oxford: Clarendon, 2001), 125–128, 127 and Pl. XL.

1 [to] give him honour among the Arab[s]
2 [on the n]inth of Shebat,[22] this (is) [ ]
( ]שׁעה לשבט זה[בת)
3 [ ] which is the [tw]entieth[23] in the month [of]
( ]שׁרים בחדשׁ[ע] שהוא ה[)
4 [ ] with secret counsel Salome (Shelamzion) came[
5 [ ] to confront the[ ]
6 [ ] Hyrcanus rebelled [against Aristobulus]
7 [ ] to confront[ ]
(4Q332 2, 1–7, transcriptions and translation according to Joseph Fitzmyer)[24]

The apparent double-dating of a calendar with an Aramaic month-name (line 2) and the 364-day calendar tradition (line 3)[25] would suggest that the former was not rejected by the author, or authors, of the historical texts.[26] There is also an early documentary text with an Aramaic month-name: 4Q345Deed ar or Heb, possibly from Naḥal Ḥever[27] (373–171 BCE, carbon-dated, but glue-contaminated).[28]

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[22] J. Fitzmyer, "4QHistorical Text D," 283–84, Pl. XVII; Talmon, Ben Dov, and Glessmer, *Qumran Cave 4. 16*, 12–13, cf. S. Talmon, "What's in a Calendar? Calendar Conformity and Calendar Controversy in Ancient Judaism: The Case of the 'Community of the Renewed Convenant," in *The Bible and the Dead Sea Scrolls Vol. 2: The Dead Sea Scrolls and the Qumran Community* (ed. J. H. Charlesworth, Waco TX: Baylor University Press, 2006), 25–58, 40. Talmon states that the Babylonian month-names "only seldom" appear in the Dead Sea Scrolls.

[23] The letters in שׁרים[ע] are "doubtful" see Fitzmyer, "4QHistorical Text D," 283.

[24] See Fitzmyer, "4QHistorical Text D," 283.

[25] M. G. Abegg, "The Calendar at Qumran," in *Judaism in Late Antiquity, Part 5: The Judaism of Qumran. A Systemic Reading of The Dead Sea Scrolls* (ed. A. J. Avery-Peck et al.; Leiden: Brill, 2001), 1: 145–171, esp. 151–53; Talmon, Ben Dov, and Glessmer, *Qumran Cave 4. 16*, 13–14, 37–81; J. Ben-Dov, *Head of All Years: Studies in the Qumran Calendars and Astronomy in their Ancient Context* (STDJ 78; Leiden: Brill, 2008), 11, 15–18.

[26] It is unclear how calendrical texts which include the Babylonian calendar fit into the various Essene hypotheses. The latter posit that a sect at Qumran rejected the lunar calendar and that calendrical differences were at the heart of an alleged schism between this group and "mainstream" Judaism; see, for example, VanderKam, *Calendars in the Dead Sea Scrolls*, 113–16; Talmon, "What's in a Calendar?," 25–58.

[27] Hannah M. Cotton and Ada Yardeni, *Aramaic, Hebrew, and Greek Documentary Texts from Naḥal Ḥever and Other Sites with an Appendix Containing Alleged Qumran Texts* (DJD 27; Oxford: Clarendon, 1997), 292–295, fig. 29, Pl. LVI; cf. H. Eshel, "4Q348, 4Q343 and 4Q345: Three Economic Documents from Qumran Cave 4?," *JJS* 52 (2001): 132–135. Eshel argues that the documents came from Qumran.

[28] A. J. T. Jull et al., "Radiocarbon Dating of Scrolls and Linen Fragments from the Judaean Desert," *Radiocarbon* 37:1 (1995), 11–19, here 12. 4Q345: באלול (in Ellul) recto, upper version, line 1; lower version, line 10, see Cotton and Yardeni, *Aramaic, Hebrew, and Greek Documentary Texts*, 292–3.

At first, scholars working on 4Q318 assumed that the zodiology covered a 364-day year, and that 4Q318 was a sectarian text.[29] This theory was questioned separately by Matthias Albani, who stated that it was "most probably based on an ideal 360-day calendar attested in Babylonian and Hellenistic zodiacal astrology,"[30] and Uwe Glessmer.[31] Greenfield and Sokoloff, in a 1995 paper, which underlies their edition in DJD 36, concluded that the 4Q318 zodiology was a 360-day calendar that was "non-sectarian in content," because, as scholars agree, the sectarian group at Qumran did not produce texts in Aramaic and followed a calendar of 364 days.[32]

II. *The Calendrical Scheme*

The table below provides a reconstruction of 4Q318 using the basic format employed by Michael Wise,[33] but reconstructed according to a year of 360 days (instead of 364 days), which is also the number of degrees in the zodiac. The table (fig. 1) is restored according to the schematic pattern in 4Q318, whereby the moon takes two days to traverse one sign, two days again for the next sign, and three days for the third sign. This pattern is repeated every month.

The months are synodic, meaning that the moon moves from conjunction with the sun, to the next conjunction, or from one phase to the next identical phase. When the moon is completing its orbit of

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[29] Wise, *Thunder in Gemini,* 17–22; R. Eisenman and M. O. Wise, *The Dead Sea Scrolls Uncovered* (London: Penguin, 1993), 258–63.

[30] M. Albani, "Horoscopes in the Qumran Scrolls," in *The Dead Sea Scrolls After Fifty Years* (2 vols.; ed. P. W. Flint and J. C. VanderKam; Leiden: Brill, 1999), 2: 279–330, esp. 296–301, here fig. 3 (298–9) and 296 n. 58; *idem*, "Der Zodiakos in 4Q318 und die Henoch-Astronomie," *MBFJTFL* 7 (1993): 3–42; *idem, Astronomie und Schöpfungsglaube: Untersuchungen zum Astronomischen Henochbuch* (WMANT 68; Neukirchen-Vluyn: Neukirchener Verlag, 1994), 83–87, 123–9.

[31] U. Glessmer, "Calendars in the Qumran Scrolls," in Flint and VanderKam, eds., *Dead Sea Scrolls After Fifty Years*, 2: 213–278, esp. 259–260.

[32] J. C. Greenfield and M. Sokoloff, "An Astrological Text from Qumran (4Q318) and Reflections on Some Zodiacal Names," *RevQ* 16 (1995): 507–25; see also Greenfield and Sokoloff, "4QZodiology and Brontologion ar," 270. Under "Previous discussion," Greenfield and Sokoloff list the authors' 1995 paper only, "4QZodiology and Brontologion ar," 259. Albani's work is, however, noted, but Michael Wise's detailed study of the zodiology and the brontologion in *Thunder in Gemini* is not cited at all.

[33] Wise, *Thunder in Gemini*, 22. Albani also reconstructed 4Q318 according to a 360-day calendar using a different format, cf. Albani, "Horoscopes in the Qumran Scrolls," 298–99; he also questioned Wise's 364-day reconstruction, *ibid.*, 297, 300, 299 note.

the earth, it passes through the first zodiac sign that it traversed at the beginning of the month again at the month's end. Hence, the moon passes through thirteen signs in a synodic month.

Each month begins with the zodiac sign following the sign which corresponds to the luni-solar month, for example, Nisan (March-April), the first month, is cognate with Aries, the first zodiac sign, and so forth. Thus, the first zodiac sign traversed by the moon is Taurus, the second sign of the zodiac (see fig. 1)—a significant feature that most puzzled Wise[34] and Sokoloff and Greenfield.[35]

With 4Q318, it is possible to see that the calendar was intercalated because the data in the text itself show that the months are aligned to their correct seasons by their corresponding zodiac signs. Adar, the 12th month, is aligned to February to March, which corresponds to the sign of Pisces. As in the Babylonian calendar, day 1 of the month corresponds to the first crescent and day 14/15 is the full moon. The full moon moving through the zodiac on 14 Adar would be in the opposite sign to Pisces, which is Virgo. This information is given in the text at 4Q318 VIII, 2–3. Therefore, one can check the data are correct both from the position of the moon in the zodiac and the date. If the months and days were not given in the text, then it would be a simple astronomical table, but by adding in the months and days, it becomes a calendar. To be specific it becomes and a very basic lunar ephemeris.

As originally suggested by Wise, the 4Q318 zodiac calendar begins after the moon's conjunction with the sun, when the first crescent can be seen.[36]

The Qumran zodiology tells us in which zodiac sign the moon is situated on most given Hebrew dates in most years. For example, November 1, 2007 (the date this presentation was given in Birmingham),

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[34] Wise, *Thunder in Gemini*, 38–42.

[35] Sokoloff and Greenfield, "4QZodiology and Brontologion ar," 264–5, nn. 9,11. They attribute this feature to the order of the constellations in the MUL.APIN, by Albani, "Der Zodiakos," 27–32. See also, M. J. Geller, "New Documents from the Dead Sea: Babylonian Science in Aramaic," in *Boundaries of the Ancient Near Eastern World: A Tribute to Cyrus H. Gordon* (JSOTSup 273; ed. M. Lubetski et al.; Sheffield: Sheffield Academic Press, 1998), 224–229. David Pingree's astronomical explanation is correct, "Astronomical Aspects," in Alexander et al., *Qumran Cave 4. 26*, 271 (as this essay will show).

[36] Wise, *Thunder in Gemini*, 38–42. Wise subsequently dismissed the idea because it conflicts with the calendar of the Essene Hypothesis, see *ibid.*, 42.

Figure 1: 4Q318 Zodiac Calendar Reconstructed (extant frags. cols. IV, 5–9; VII, 1–9; VIII, 1–6)

	Nisan (Aries) *March–April*	Iyyar (Taurus) *April–May*	Sivan (Gemini) *May–June*	Tammuz (Cancer) *June–July*	Av (Leo) *July–Aug*	Elul (Virgo) *Aug–Sept*	Tishri (Libra) *Sept–Oct*	Heshvan (Scorpio) *Oct–Nov*	Kislev (Sagitt) *Nov–Dec*	Tevet (Capric) *Dec–Jan*	Shevat (Aquar) *Jan–Feb*	Adar (Pisces) *Feb–Mar*
1	Taurus	Gemini	Cancer	Leo	Virgo	Libra	Scorpio	Sagitt	Capric	Aquar	Pisces	Aries
2	Taurus	Gemini	Cancer	Leo	Virgo	Libra	Scorpio	Sagitt	Capric	Aquar	Pisces	Aries
3	Gemini	Cancer	Leo	Virgo	Libra	Scorpio	Sagitt	Capric	Aquar	Pisces	Aries	Taurus
4	Gemini	Cancer	Leo	Virgo	Libra	Scorpio	Sagitt	Capric	Aquar	Pisces	Aries	Taurus
5	Cancer	Leo	Virgo	Libra	Scorpio	Sagitt	Capric	Aquar	Pisces	Aries	Taurus	Gemini
6	Cancer	Leo	Virgo	Libra	Scorpio	Sagitt	Capric	Aquar	*Pisces*	Aries	Taurus	Gemini
7	Cancer	Leo	Virgo	Libra	Scorpio	Sagitt	Capric	Aquar	Pisces	Aries	Taurus	Gemini
8	Leo	Virgo	Libra	Scorpio	Sagitt	Capric	Aquar	Pisces	Aries	Taurus	Gemini	Cancer
9	Leo	Virgo	Libra	Scorpio	Sagitt	Capric	Aquar	Pisces	Aries	Taurus	Gemini	Cancer
10	Virgo	Libra	Scorpio	Sagitt	Capric	Aquar	Pisces	Aries	Taurus	Gemini	Cancer	Leo
11	Virgo	Libra	Scorpio	Sagitt	Capric	Aquar	Pisces	Aries	Taurus	Gemini	Cancer	Leo
12	Libra	Scorpio	Sagitt	Capric	Aquar	Pisces	Aries	Taurus	Gemini	Cancer	Leo	Virgo
13	Libra	Scorpio	Sagitt	Capric	Aquar	Pisces	Aries	Taurus	Gemini	Cancer	Leo	Virgo
14	Libra	Scorpio	Sagitt	Capric	Aquar	Pisces	Aries	Taurus	Gemini	Cancer	Leo	Virgo
15	Scorpio	Sagitt	Capric	Aquar	Pisces	Aries	Taurus	Gemini	Cancer	Leo	Virgo	Libra
16	Scorpio	Sagitt	Capric	Aquar	Pisces	Aries	Taurus	Gemini	Cancer	Leo	Virgo	Libra
17	Sagitt	Capric	Aquar	Pisces	Aries	Taurus	Gemini	Cancer	Leo	Virgo	Libra	Scorpio
18	Sagitt	Capric	Aquar	Pisces	Aries	Taurus	Gemini	Cancer	Leo	Virgo	Libra	Scorpio
19	Capric	Aquar	Pisces	Aries	Taurus	Gemini	Cancer	Leo	Virgo	Libra	Scorpio	Sagitt
20	Capric	Aquar	Pisces	Aries	Taurus	Gemini	Cancer	Leo	Virgo	Libra	Scorpio	Sagitt
21	Capric	Aquar	Pisces	Aries	Taurus	Gemini	Cancer	Leo	Virgo	Libra	Scorpio	Sagitt
22	Aquar	Pisces	Aries	Taurus	Gemini	Cancer	Leo	Virgo	Libra	Scorpio	Sagitt	Capric
23	Aquar	Pisces	Aries	Taurus	Gemini	Cancer	Leo	Virgo	Libra	Scorpio	Sagitt	Capric
24	Pisces	Aries	Taurus	Gemini	Cancer	Leo	Virgo	Libra	Scorpio	Sagitt	Capric	Aquar
25	Pisces	Aries	Taurus	Gemini	Cancer	Leo	Virgo	Libra	Scorpio	Sagitt	Capric	Aquar
26	Aries	Taurus	Gemini	Cancer	Leo	Virgo	Libra	Scorpio	Sagitt	Capric	Aquar	Pisces
27	Aries	Taurus	Gemini	Cancer	Leo	Virgo	Libra	Scorpio	Sagitt	Capric	Aquar	Pisces
28	Aries	Taurus	Gemini	Cancer	Leo	Virgo	Libra	Scorpio	Sagitt	Capric	Aquar	Pisces
29	Taurus	Gemini	Cancer	Leo	Virgo	Libra	Scorpio	Sagitt	Capric	Aquar	Pisces	Aries
30	Taurus	Gemini	Cancer	Leo	Virgo	Libra	Scorpio	Sagitt	Capric	Aquar	Pisces	Aries

corresponds to Marchesvan 20, in an intercalary year in the Jewish calendar. According to 4Q318, the moon's position in the zodiac on Marchesvan (Heshvan) 19, 20 and 21, is in Leo (see fig. 1). In a modern ephemeris, based on the zodiac which was fixed by Ptolemy almost 2,000 years ago, (which does not take precession into account), the moon entered Leo on November 1, 2007.[37]

For 4Q318 to be so accurate, suggests that a similar form of today's luni-solar Hebrew calendar may have been in use at the turn of the era[38] and that it was harmonised with the 360-day year[39] and the zodiacal arrangement in the text. The 4Q318 zodiac calendar would thereby integrate three cycles: the sun, the moon, and the stars (the zodiac) into a single, perpetual calendar.

While there is a scholarly dispute as to whether the 364-day year schemes began on the full moon,[40] or just after the full moon,[41] or at last lunar visibility,[42] or during the darkness of the new moon,[43] the 360-day zodiac calendar of 4Q318 begins when the first lunar crescent can be observed.

III. *Evidence for Zodiac Calendars in Antiquity*

Sources from different traditions inform us that:

1. the moon takes a month of thirty days to travel through all the zodiac signs (the lunar zodiac) from first crescent to the next month's first crescent, and two and half days to traverse each zodiac sign and

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[37] N. F. Michelsen and R. Pottenger, *The American Ephemeris for the 21st Century 2000–2050 at Noon* (expanded 2nd ed.; San Diego: ACS, 1996).

[38] Extensive empirical testing of the 4Q318 zodiac calendar and the Hebrew calendar is contained in this author's PhD diss. (University of Manchester, forthcoming). Results show a stronger correlation in intercalary years.

[39] Lis Brack-Bernsen, "The 360-Day Year in Mesopotamia," in *Calendars and Years: Astronomy and Time in the Ancient Near East* (ed. J. Steele; Oxford: Oxbow Books, 2007), 83–100, esp. 93–96, 98.

[40] M. G. Abegg Jr., "Does Anyone Really Know What Time It Is: A Re-Examination of 4Q503 in Light of 4Q317," in *The Provo International Conference on the Dead Sea Scrolls: Technological Innovations, New Texts and Reformulated Issues* (ed. D. W. Parry and E. Ulrich; Leiden: Brill, 1999), 396–406.

[41] Talmon, Ben Dov, and Glessmer, *Qumran Cave 4. 16*, 14.

[42] J. Ben-Dov and W. Horowitz, "The Babylonian Lunar Three in Calendrical Scrolls from Qumran," *ZA* 95 (2005): 104–120.

[43] M. O. Wise, "Second Thoughts on דוק, and the Qumran Synchronistic Calendars," in *Pursuing the Text* (JSOTSup 184; ed. J. C. Reeves and J. Kampen; Sheffield: Sheffield Academic Press, 1994), 98–120; Wise, *Thunder in Gemini*, 230–231.

2. that the sun takes a year to travel through the zodiac and a month to traverse a single zodiac sign (the solar zodiac).

Zodiac calendars existed in the Greco-Roman and Greco-Babylonian world from the late third century BCE until at least the first century BCE. The following sections will survey different cultural sources for this central theme in late antiquity. I will proceed by covering Hellenistic and Jewish literary sources, Hellenistic documentary sources, Hellenistic epigraphic and inscriptional texts, an Hellenistic epigraphic artefact, and Mesopotamian sources.

a. *Philo*

Philo (ca. 20 BCE–50 CE) provides the basic exposition of how the solar and lunar zodiacs work. The simple astronomical rule is inserted (as a kind of midrash) in the pericope on Joseph's second dream (Gen 37: 9–11), in *Dreams* 2.112–13:

> Well, the students of the upper world tell us that the Zodiac, the largest of the circles of heaven (τὸν ζῳδιακὸν κύκλον μέγιστον…οὐρανὸν), is formed into constellations out of twelve signs (δυοκαίδεκα), called *zodia* (ζῳδίων) or "creatures," from which it also takes its name. The sun and moon (ἥλιον δὲ καὶ σελήνην), they say, ever revolve along the circle (ζῳδίων) [*zodia*] and pass through each of the signs, though the two do not move at the same speed, but at unequal rates as measured in numbers: the sun taking thirty days (ἡμέραις τριάκοντα), and the moon about a twelfth (δωδεκατημορίῳ) of that time, that is, two and half days (ἡμερῷν δυεῖν καὶ ἡμίσους). He, then, who saw that heaven-sent vision, dreamt that the eleven stars made him obeisance, thus classing himself as the twelfth (δωδέκατον), to complete the circle of the zodiac (ζῳδιακοῦ συμπλήρωσιν κύκλου).[44]

Philo also refers to the lunar zodiac (*Spec. Laws* 2.142) in his explanation of the reasons for the celebration of the New Moon festival *noumenia* (νουμηνία), in the calendar of biblical feasts, (*Spec. Laws* 2.142–213):

> …the moon traverses the zodiac in a shorter fixed period than any other heavenly body. (…οὐρανὸν ἁπάντων ἐν ἐλάττονι προθεσμία σελήνη τὸν ζῳοφόρον περιπολεῖ). For it accomplishes that revolution in the span of a single month, and therefore, the conclusion of its circuit, when the moon ends its course at the starting point at which it began.…[45]

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[44] Philo, *Dreams* 2.112–13 (trans. Colson and Whitaker, LCL).
[45] Philo, *Spec. Laws* 2.142 (trans. Colson and Whitaker, LCL).

The pericope informs us that the lunar zodiac was part of the scientific vocabulary at that time. Philo refers to the solar zodiac while explaining the biblical rationale for Exod 12:2, that the year begins at the spring equinox when the sun is in Aries (*QE* 1.1):

> For they call the Ram, the head of the zodiac (κεφαλὴν τοῦ ζῳοφόρον . . . τὸν κριόν), since in it the sun appears to produce the vernal equinox.[46] (cf. Josephus. *Ant* 3. 248, below).

He also refers to the solar zodiac in terms of the equinoxes in *Creation* 1.116:

> The sun, too, the great lord of the day, bringing about two equinoxes each year, in spring and autumn, the spring equinox in the constellation of the Ram (κριῷ) and autumn equinox in that of the Scales (ζυγῷ) . . .[47]

The pericope brings to mind the explanation by Geminos that in the ancient Greek luni-solar calendar the days and months were reckoned by the moon and the years were reckoned by the course of the sun.[48] The separation between the solstices and equinoxes (the *tequfot*), which are solar, and the months, which are lunar, are suggested in Philo's statements on calendars and cosmology.

In *Moses* 2.124[49] within a lengthy passage associating the garments of the High Priest with the cosmos (*Moses* 2.122–126), Philo asserts that the twelve gems on the priestly breastplate represent the signs in the solar zodiac, arranged to correspond to the four seasons of the solar year.

> . . . the [twelve] stones (δώδεκα λίθοι) at the breast, which are dissimilar in colour, and are distributed into four rows of threes, what else should they signify but the zodiac circle (ζῳδιακοῦ κύκλου)? For that circle, when divided into four parts, constitutes by three signs (ζῳδίων) in each case the seasons of the year—spring, summer, autumn, winter—those four, the transition in each of which (τροπὰς τέσσαρας, ὧν ἑκάστης) is determined by three signs (τρία ζῴδια), and made known to us by the

[46] Philo, *QE* 1, Question 1 (trans. Marcus, LCL).
[47] Philo, *Creation* 116 (trans. Colson and Whitaker, LCL).
[48] J. Evans and J. Lennart Berggren, *Geminos's Introduction to the Phenomena: A Translation and Study of a Hellenistic Survey of Astronomy* (Princeton: Princeton University Press, 2006), 176–7 (VIII. 5).
[49] Philo, *On Abraham. On Joseph. On Moses* (trans. Colson, LCL).

> revolutions of the sun (ἡλίου περιφοραῖς)…[50] (cf. Josephus, *Ant.* 3.186, below).

In a similar vein, Philo relates the solar zodiac to the four seasons, without mentioning months, in relation to the Menorah in the Temple (Exod 25: 31–40),[51] in *QE* 2, Questions, 76, 77:

> (Question 76) [Exod 25:33 Heb.]: At each season of the year the sun completes (its course) through three zodiacal signs (ζῳδίων)[52] which He has called "mixing bowls"…. For example the spring (consists of) Aries, Taurus, Gemini; and again, in the summer, Cancer, Leo, Virgo; and in the autumn, Libra, Scorpio, Sagittarius; and in the winter, Capricorn, Aquarius, Pisces. And He likens the form and nature of the zodiacal signs to those of a nut…[53] (cf. Josephus, *Ant.* 3.182; *J.W.* 5.217, below).[54]
>
> (Ques. 77) [Exod 25: 34–6 Heb.]: Each branch constitutes one season of the year through three zodiacal signs (ζῳδίων),[55] as has been said [Ques. 76, above], while the lampstand represents the seasons of the year, which are four.[56]

An intriguing question arises concerning the details of Philo's calendar in *Creation* 60; Philo's commentary on Gen 1:14–17, includes a discourse about the stars, the sun, and the moon for determining signs, seasons, days, months and years (*Creation* 55–61) in which he appears to state that the year has 360 days, derived from 12 months of 30 days, cf. *Creation* 60:

> The heavenly bodies were created also to furnish measures of time: for it is by regular revolutions of sun, moon and the other bodies, that days and months and years were constituted…For out of one day came "one," out of two, "two," out of three, "three," out of a month "thirty" (καὶ ἐκ μηνὸς τὰ τριάκοντα), out of a year (καὶ ἐξ ἐνιαυτοῦ) the number equivalent to the days made up of twelve months (δώδεκα μηνῶν)…[57]

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[50] Philo, *On Moses*, 2.124 (trans. Colson, LCL); cf. the translation by Yonge, which includes the equinoxes and solstices, C. D. Yonge, *The Works of Philo* (Peabody MA: Hendrickson, 2004), 501.

[51] Philo, *QE* 2, Questions 73–81 and 122–131, correspond.

[52] Philo, *QE* 2 (trans. Marcus, LCL). Question 76, 125 n. *c*.

[53] Philo, *QE* 2 (trans. Marcus, LCL). Question 76, 125.

[54] Philo, *QE* 2 (trans. Marcus, LCL); R. Marcus, "The Armenian Translation of Philo's Quaestiones in Genesim et Exodum," *JBL* 19.1 (1930): 61–64.

[55] Philo, *QE* 2 (Marcus, LCL), 127 n. *e*.

[56] Philo, *QE* 2 (trans. Marcus, LCL). Question 77, 127.

[57] Philo, *Creation* 1.60 (trans. Colson and Whitaker, LCL).

Elsewhere, Philo describes an awareness of calendar diversity, ostensibly between different nations.

> (*QE* 1, Quest.1) [Exod 12: 2]: But not all (peoples) treat the months and years alike, but some in one way and some in another. Some reckon by the sun, others by the moon. And because of this, the initiators of the divine festivals have expressed divergent views about the beginning of the year…Wherefore (Scripture) has added, "This month (shall be) to you the beginning,"…[58]

It is a moot point whether Philo really thought that the ordinance of Exod 12:2 should apply to all peoples,[59] or if he was referring to a problem of heterogeneous calendar practices by different groups of Jews.

In sum, Philo was certainly familiar with both the lunar and solar zodiacs; he may also have known of a 360-day year, which consisted of the zodiac traversed monthly by the moon, and a solar zodiac, orbited annually by the sun.

b. *Josephus*

In ancient Jewish literature, the frequent analogies between the zodiac and the Tabernacle are unique to Philo and Josephus.[60] As outlined above, most of Josephus's references to the zodiac and the calendar are similar to those of Philo. Although Josephus (37–c.100 CE) knew of Philo, he does not refer specifically to his writings, nor does he cite him as a source.

Josephus refers to the use of the zodiac in the Jewish, luni-solar calendar, when he wrote that Nisan, the first month of the year, corresponds to the Macedonian month Xanthicus/Xandikos:[61]

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[58] Philo, *QE* 1 (trans. Marcus, LCL), 4–5.

[59] Cf. Philo, *QE* 1 (Marcus, LCL), 5 n. *b*.

[60] J. Klawans, *Purity, Sacrifice, and the Temple: Symbolism and Supersessionism in the Study of Ancient Judaism* (Oxford: OUP, 2006), 125–128. Cf. Exod 28 LXX; Sir 45: 6–13; *Letter of Aristeas*, 96–99 and see N. Fernández Marcos, "Rewritten Bible or Imitatio? The Vestments of the High Priest," in *Studies in the Hebrew Bible, Qumran and the Septuagint Presented to Eugene Ulrich* (VTSup 101; ed. P. W. Flint, E. Tov and J. C. VanderKam; Leiden: Brill, 2006), 321–336.

[61] A. E. Samuel, *Greek and Roman Chronology: Calendars and Years in Classical Antiquity* (HdA I,7; München: C. H. Beck, 1972), 139–151. The Macedonian calendar was no longer luni-solar in the first century CE; Stern suggests that Josephus was drawing an equivalence with the Jewish months anachronistically, *Calendar and Community*, 37–8.

> Τῷ δὲ μηνὶ τῷ Ξανθικῷ, ὃς Νισὰν παρ' ἡμῖν καλεῖται καὶ τοῦ ἔτους ἐστὶν ἀρχή, τεσσαρεσκαι—δεκάτῃ κατὰ σελήνην ἐν κριῷ τοῦ ἡλίου καθεστῶτος…
>
> In the month of Xanthicus, which with us is called Nisan and begins the year, on the fourteenth day by lunar reckoning, the sun being then in Aries,…[62]

Like Philo, Josephus also employs the zodiac in the context of attributing cosmological symbolism to the Tabernacle and the priestly vestments; however, in *Ant.* 3.186, Josephus equates the gems in the ephod with the (lunar) months of year[63] and the twelve signs of the zodiac:

> Τήν τε δωδεκάδα τῶν λίθων εἴτε τοὺς μῆνάς τις θέλοι νοεῖν, εἴτε τὸν οὕτως ἀριθμὸν τῶν ἀστέρων, ὃν ζωδιακὸν κύκλον Ἕλληνες καλοῦσι,…
>
> As for the twelve stones, whether one would prefer to read in them the months or the constellations of like number, which the Greeks call the circle of the zodiac…[64]

Both Josephus and Philo refer to the twelve loaves on the table of the Tabernacle (Lev 24:6). According to Josephus the loaves overtly represent the zodiac and the calendar as emerges from two separate texts. In *J.W.* 5.217b, the zodiac signs are associated with the year and in *Ant.* 3.182a the loaves are associated with the months (cf. Philo, *Heir* 175–6):

> *J.W.* 5.217b:…the loaves on the table, twelve in number, the circle of the Zodiac and the year (οἱ δ' ἐπὶ τῆς τραπέζης ἄρτοι δώδεκα τόν τε ζῳδιακὸν κύκλον κὰι τὸν ἐνιαυτόν).[65]
>
> *Ant.* 3.182a: Again, by placing upon the table the twelve loaves, he signifies that the year is divided into as many [lunar] months (μῆνας)…[66]

The first and second parts of the above passages are also connected to each other and Philo: according to *J.W.* 5.217a the seven planets are aligned to the seven branches of the Menorah (cf. Philo's *QE* 2, Questions 75 and 78); similarly, *Ant.* 3.182b which also deals with the

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[62] Josephus, *Ant.* 3.248 (trans. Thackeray, LCL).

[63] Elsewhere, Josephus emphasizes that the Jewish calendar was lunar: *Ant.* 2.318; 3.240; 3.248; 4.78; 4.84, see Stern, *Calendar and Community*, 22 n. 97, 35.

[64] Josephus, *Ant.* 3.186 (trans. Thackeray, LCL).

[65] Josephus, *J.W.* 5.217 (Thackeray, LCL).

[66] Josephus, *Ant.* 3.182b (Thackeray, LCL), Books 1–3, 404, n. *a*; *ibid.*, 403 n. *c* § 145.

Menorah (cf. Philo QE 2, Questions 75–79) uses the zodiac metaphorically and is explicitly astrological.

c. *Ovid*

Both the solar and lunar zodiacs are mentioned in Ovid's *Fasti*. Ovid (b. 43 BCE) imparts the history of Roman calendar reform, from the legendary past of Romulus, through to Julius Caesar (*Fasti*, 3. 99–166). He records that the prehistorical Roman calendar had 10 months.[67] Therefore, people could not have known that the sun takes 12 months to traverse the zodiac and that the moon covers the same distance in one month.

> Who had then noticed…that the (zodiac) signs which the brother travels through in a long year, the horses of the sister traverse in a single month? The stars ran their courses free and unmarked throughout the year; yet everybody agreed that they were gods.[68]

It is noteworthy that the Julian calendar (introduced during Ovid's lifetime in 46–45 BCE) was solar.[69] Yet, Ovid includes both the solar and lunar zodiac in his list of scientific paradigms known at this time. Vitruvius, the Roman writer, architect and engineer, explained the solar and lunar zodiac in *On Architecture*, which he presented to Augustus in the mid-20s BCE, around the time of our scroll. He concluded,

> In other words, that circuit which the moon runs thirteen times in twelve months, the sun measures out only once in the same number of months.[70]

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[67] The scholarly consensus is that the very early Roman calendar had 304 days, consisting of 10 months: April, June, Sextilis, September, November and December had 30 days, and March, May, Quintilis and October, 31 days (Samuel, *Greek and Roman Chronology*, 167–70; R. Hannah, *Greek and Roman Calendars: Constructions of Time in the Classical World* [London: Duckworth, 2005], 98–100). The Latin month-names from Quintilis to December describe these months' numerical positions in the calendar in a year beginning in March (*Fasti* 3: 149–151).

[68] Ovid, *Fasti* 3.105–112 (Frazer, LCL). Frazer notes that Ovid is referring to "Apollo and Diana, the sun and moon, and the signs of the zodiac." 128 n. *c*.

[69] Bonnie Blackburn and L. Holford-Strevens, *The Oxford Companion to the Year* (Oxford: OUP, 1999), 671.

[70] Translation from Vitruvius, *On Architecture* 9.1.6, cf. *Vitruvius: Ten Books on Architecture* (trans. I. D. Rowland; ed., I. D. Rowland and T. N. Howe; Cambridge: CUP, 1999), 110.

d. *Era Dionysios*

A solar zodiac calendar, Era Dionysios, is attested in eight references to it in Ptolemy's *Almagest* (mid-2nd century CE).[71] The calendar, which possibly originated in Alexandria,[72] covers a 45-year period in the third century BCE. It began on the summer solstice, about four months before the regnal year of the co-regency of Ptolemy I Soter and his son Philadelphus Ptolemy II, in 285 BCE. The last recorded date was 241 BCE, during the reign of Ptolemy III Euergetes (246–222 BCE). It, therefore, spanned three generations of kings.[73]

Ptolemy refers to a number of dates in the Dionysian calendar, each comprising the Era year number, day and month identified by its corresponding zodiac sign.[74] In several instances the date corresponds closely to the zodiac degree.

Where there is a discrepancy between the zodiacal date and the mean zodiacal longitude of the sun, it is a few days' difference of degrees.

Jones rejects the statements by the scholiasts that the dates and the degree of the sun's position in the zodiac were meant to coincide (see notes above and below), although he accepts that Ptolemy himself may have understood the Dionysian calendar in this way.[75] Jones also ques-

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[71] G. J. Toomer, *Ptolemy's Almagest* (London: Duckworth, 1984), 13–14, 450, 451, 452, 464, 464, 502, 505 n. 67, 522 (*Almagest* 9.7, 9.10, 10.9, 11.3).

[72] A 9th–10th century scholion on the *Almagest*, translated by A. Jones in "A Posy of Almagest Scholia," *Centaurus* 45 (2003): 69–78, here 70–71, states: "Dionysius, who made his abode in Alexandria, made a practice of naming the months from the names of the pertinent zodiacal signs, so that Hydron is the same as Mechir according to the Alexandrian calendar, because the sun is then in Aquarius (Hydrochoos); and the same should be said for the remaining months." (Scholion to *Almagest* 9.7, text 1). (The practice of swapping months for their corresponding zodiac signs is also attested in cuneiform texts of the same period, see below).

[73] A. Jones, "Ptolemy's Ancient Planetary Observations," *Annals of Sciences* 63 (2006): 284–290, here 285 and n. 47. The co-regency was possibly established on December 1, 285 BCE; Ptolemy I died in 282 BCE, see Nina Collins, *The Library of Alexandria and the Bible in Greek* (Leiden: Brill, 2000), 23–24.

[74] See also A. Jones, "On Greek Stellar and Zodiacal Date-Reckoning," in Steele, ed., *Calendars and Years*, 149–167, esp. 150, 162–64; B. L. van der Waerden, "Greek Astronomical Calendars III: The Calendar of Dionysios," *Archive for the History of Exact Sciences* 29:2 (1984): 125–130. Van der Waerden states that the calendar began at the summer solstice, at 1 Cancer (June 26–284 = 285 BCE) and had 5 or 6 epogemenal days at the end of Gemini (in order to function annually, an extra day may have been added every fourth year to compensate for the 365-day Egyptian cultic calendar which was a quarter of a day short of the true solar year). O. Neugebauer, *A History of Ancient Mathematical Astronomy, Part 3* (3 vols; SHMPS 1; Berlin: Springer, 1975), 1066–7; Samuel, *Greek and Roman Chronology*, 50–1 and n. 6.

[75] Jones, "Posy," 73.

tions the accuracy of another scholiast, who had described the calendar as follows:

> Dionysius named the twelve months, which had thirty days, by transference from the twelve zodiacal signs, and likewise (named) the days from the degrees at which the sun was approximately in mean motion… (Scholia to *Almagest* 11.3; text 2).[76]

In Jones's view, the Dionysian calendar included five and six epogemenal days in its count of the year[77] which were distributed among the months in a manner similar to the divisions in the parapegmata (see below), where the zodiac is present. In these calendars, the solar zodiac months vary from 29 to 32 days, with the longer months in the summer, and comprise 365-day years.[78]

Even if Jones is correct, the principle of the calendar of Dionysios (certainly, as understood by the scholiasts) in which the date was, arguably, intended to correspond with the degree of the sun in the zodiac, may be viewed as a similar, solar version of the 4Q318 zodiac calendar in which the date can tell us the zodiac sign of the moon on a particular day.

e. *Parapegmata*

According to Evans and Berggren a parapegma is a "(star calendar) that permits one to know the time of year by the observation of the stars."[79] Taub notes various forms concerned with weather.[80] Definitions of parapegmata vary. This is partly because many different types of parapegmata existed in antiquity (e.g. documentary texts, literature, an inscribed stone or wall with placement-holes for pegs designed to correspond to a date). Parapegmata may display the sun's approximate position in the zodiac; the length of each of the four seasons, the length of day and night, and the risings and settings of constellations and stars.[81]

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[76] Jones, "Posy," 73; see also "Greek Stellar and Zodiacal Date Reckoning," 160, 163.

[77] Jones, "Ptolemy's Ancient Planetary Observations," 289, and see note above.

[78] Jones, "Greek Stellar and Zodiacal Date Reckoning," 164; "Posy," 287–9.

[79] Evans and Berggren, *Geminos's Introduction*, 2.

[80] Liba Taub, *Ancient Meteorology* (London: Routledge, 2003), 51–2, 173–4.

[81] In ancient astronomy, the length of daylight can be used to calculate which zodiacal constellation is rising over the eastern horizon at a given time and latitude; this can be used to ascertain the time, and to compute a horoscope, see J. Evans,

They could also list festivals, anniversaries and other significant dates, sometimes with reference to more than one local calendar (mostly solar calendars).[82]

Lehoux discusses in detail whether extant parapegmata apparently containing zodiacal calendar-related data are actually based on lost zodiac calendar systems constructed by late fifth, and fourth century BCE Greek astronomers, such as Eudoxus, Euctemon, Meton, and Callippus. These astronomers are frequently cited as authorities in parapegmata.[83] In contrast to Jones, Lehoux concludes that the parapegmata do not include lost zodiacal calendar systems.[84] This scholarly debate falls outside the scope of this research; however, the genre of parapegmata with zodiacal components are part of the background to 4Q318, particularly as they are known to have been combined with brontologia, see below.

f. *Parapegma with a Lost Brontologion*

The 13th century *Oxford Parapegma* (C. Baroccianus 131, fos. 423–423 v) contains a brontologion similar to that attested by 4Q318.[85] The thunder text appears at the end of one calendrical month only, i.e. February, when the sun is in Aquarius.[86] The days of the month are listed

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The History and Practice of Astronomy (Oxford: OUP, 1998), 95–99, 109–125; Francesca Rochberg, "A Babylonian Rising Times Scheme in Non-Tabular Astronomical Texts," in *Studies in the History of the Exact Sciences in Honour of David Pingree* (ed. C. Burnett et al.; Leiden: Brill, 1994), 56–94; *eadem*, *The Heavenly Writing: Divination, Horoscopy, and Astronomy in Mesopotamian Culture* (Cambridge: CUP, 2004), 24.

[82] Daryn Lehoux, *Astronomy, Weather and Calendars in the Ancient World: Parapegmata and Related Texts in Classical and Near-Eastern Societies* (Cambridge: CUP, 2007).

[83] Lehoux, *Astronomy*, 72–87; 97. A. Rehm, "Das Parapegma des Euktemon," in *Griechische Kalender II* (Sitzungberichte der Heidelberger Akademie der Wissenschaften philosophisch-historische Klasse; ed. F. Boll; Heidelberg, 1913), 2–38; B. L. van der Waerden, "Greek Astronomical Calendars I: The Parapegma of Euctemon," *Archive for the History of Exact Sciences* 29:2 (1984): 101–114; A. Bowen and B. R. Goldstein, "Meton of Athens and Astronomy in the Fifth Century BCE," in *A Scientific Humanist: Studies in Memory of Abraham Sachs* (Occasional Publications of the Samuel Noah Kramer Fund 9; ed. E. Leichty et al.; Philadelphia: University of Pennsylvania Museum, 1988), 53–63; A. Jones, "Ptolemy's Ancient Planetary Observations," 287; *idem*, "Zodiacal Date Reckoning," 156–162, 164.

[84] Lehoux, *Astronomy*, 77–9, 81–4.

[85] The manuscript is dated by N. G. Wilson to 1250–1280, cf. "A Byzantine Miscellany: MS Barocci 131 described," in *Jahrbuch der Österreichischen Byzantinistik* 27 (1978): 157–79. My thanks to Colin Harris and Dr Bruce Barker-Benfield of the Bodleian Library, Oxford, for their assistance.

[86] Lehoux, *Astronomy*, 164, 392–399 (brontologion, 392, translation, 396).

according to the Julian calendar as newly-reformed under Augustus,[87] and the text includes astronomical (and astrological), calendrical and culture-specific data that can help us to date the original text.

The following is an extract from the parapegma, which uses Julian calendar dates, with the brontologion:

> Risings and settings of the fixed stars.
> February: according to the Greeks, Peritios. According to the Egyptians, Mechir…
> 26. The star on the knees rises, and there are contrary winds.
> Also the swallows appear. (This month [February]) is situated in the constellation of Aquarius. The night is 13 hours, and the day is 11.
> This month, when the moon is in Aquarius: if there is thunder, it signifies terrible wars on earth, confusion and diseases among men, ruin of grain and other crops, and the destruction of some lands. According to Eudoxos, many storms. What is sown will be no good. Destruction of beasts. If there is an earthquake, it signifies death.[88]

Weinstock and Lehoux date the original parapegma to 15 CE based on the text's double-date for the Egyptian New Year with August 20 in the Julian calendar.[89] The parapegma also lists the birthday of Augustus on September 23, the autumn equinox; Weinstock locates the text in Asia Minor where the birthday of Augustus was officially celebrated.[90] However, as Augustus died in 14 CE and there is no entry for Tiberius who succeeded him in the same year, it may be that the parapegma was written in advance of the year for which it was intended.

The Oxford brontologion has similarities to folio 42v Suppl. Gr. 119, a 16th century manuscript from the Bibliothèque Nationale, Paris, as noted with reference to 4Q318 by Greenfield and Sokoloff, David Pingree and Michael Wise.[91] According to Greenfield and Sokoloff the Paris zodiology and brontologion "can be viewed as being similar in

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[87] Blackburn and Holford-Strevens, *The Oxford Companion to the Year*, 671.

[88] Lehoux, *Astronomy*, 164, 392–399.

[89] Lehoux, *Astronomy*, 398 n. 204; S. Weinstock, "A New Greek Calendar and Festivals of the Sun," *JRS* 38 (1948): 37–42, esp. 39–40. The Egyptian New Year is determined by the rising of Sirius (Sothis) which takes 1,460 years to return to the start of its calendrical cycle, on Thoth 1, which is July 19 in the Julian calendar. As it was known that a Sothic cycle was completed in 139 CE, it is possible to reckon the Julian year in the parapegma from the date that Thoth 1 falls in the text.

[90] Weinstock, "New Greek Calendar," 39–40.

[91] Greenfield and Sokoloff, "4QZodiology and Brontologion ar," 270 n. 30; Pingree, "Astronomical Aspects," in Alexander et al., *Qumran Cave 4. 26*, 271–2, 271 n. 35; Wise, *Thunder in Gemini*, 35. The Greek manuscript was edited by P. Boudreaux, *Catalogus Codicum Astrologorum Graecorum* 8.3 (Brussels: Lamertin, 1912), 193–7.

construction" to 4Q318,[92] and Wise refers to it as a "structural twin to the Qumran text."[93]

Pingree argues that the Aramaic brontologion and zodiology found in 4Q318 might not be connected.[94] His position is surprising considering that he himself drew attention to the similarity between 4Q318 and the Paris manuscript in which a brontologion follows the zodiology.

The Paris and the new Oxford brontologia both mention Eudoxus as a source; (the Paris brontologion further names the Egyptians [Αἰγύπτιοι], Babylonians [Βαβυλώνιοι] and Chaldeans [Χαλδαῖοι] as authorities [γράφουσι] in its predictions).

The Oxford brontologion appears in the context of a parapegma mentioning the sun's position in a corresponding constellation, whereas in the Paris MS (as with 4Q318), the brontologion follows a selenodromion, the lunar zodiac.[95]

Prior to the publication of Lehoux's book the complete Oxford parapegma (with the brontologion) was virtually unknown, as the thunder-omen pericope had been removed from the parapegma when it was published in 1952.[96] Although unaware of the text's connection with the Dead Sea Scrolls, Lehoux pointedly notes Weinstock's decision to excise the brontologion, as follows:

> It is true that the material here is more or less what we should expect in a brontologia (sic) rather than what we should expect in a 'pure' parapegma. Nevertheless, parapegmata are flexible things, and it is clear that the material was seen as closely enough related to warrant inclusion in this text by a copyist. Far from ruining the urtext, the copyist has composed a new hybrid text of some interest. The inclusion of the Eudoxus reference is particularly noteworthy. Unfortunately, we only have this type of entry for the month of February.[97]

We now have a close relative to the Qumran brontologion dating from the early first century CE providing further support to Yardeni's

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[92] Greenfield and Sokoloff, "4QZodiology and Brontologion ar," 270 n. 30 (unfortunately, they did not publish the translation by A. Wasserstein).

[93] Wise, *Thunder in Gemini*, 35.

[94] Pingree, "Astronomical Aspects," in Alexander et al., *Qumran Cave 4. 26*, 271.

[95] Pingree, "Astronomical Aspects," in Alexander et al., *Qumran Cave 4. 26*, 271.

[96] The parapegma was edited by S. Weinstock, *Catalogus Codicum Astrologorum Graecorum* 9.1 (Brussels: Lamertin, 1952), 128–37; Weinstock did not mention the brontologion in his article, "New Greek Calendar," 37–42. (Ironically, Wise cited the article in *Thunder in Gemini*, 40 n. 90). Lehoux, *Astronomy*, 392–3 n. 195.

[97] Lehoux, *Astronomy*, 392–3, n. 195.

proposed date for 4Q318. The newly published complete Oxford parapegma confirms that there was a late Hellenistic tradition to add a brontologion to a corresponding calendrical text. 4Q318, then, was part of that tradition.

g. *Other Parapegmata*

The earliest parapegma, the Greco-Egyptian papyrus *P.Hibeh 27*[98] is dated to ca. 300 BCE; it contains dates according to the Egyptian calendar of when the sun is in successive zodiac signs,[99] star risings and settings, detailed mathematical data about day and night lengths, and cultic feast days.

As it is contemporary with the calendar of Dionysios this suggests that there was an interest in developing zodiacal calendar forms at least from the time of Ptolemy I Soter (305–282 BCE) onwards.

Miletus I is the only extant inscriptional parapegma with zodiacal data.[100] Originating from Greece, it is of comparatively late date, 110–109 BCE. There are placement holes for a peg, and the inscriptions list stellar risings and settings, winds, and the date on which the sun enters a zodiac sign.

The second century BCE Greek papyrus from Egypt *P.Rylands. 589*[101] is extremely interesting as it correlates the known 25-year Egyptian solar calendar with the sun's position in the zodiac, apparent new moons, the corresponding luni-solar cycle (including intercalary months), and data of full and hollow (29 or 30-day) months.

Turner and Neugebauer date the calendar to ca. the summer of 180 BCE, the first regnal year of (the then five-year old) Ptolemy VI Philometor. Its astronomical basis—the position of the solstices and the equinoxes—is dated to 300 BCE.

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[98] B. P. Grenfell and A. S. Hunt, *The Hibeh Papyri, Part 1* (London: Egypt Exploration Society, 1906), 138–57, esp. 140; Lehoux, *Astronomy*, 153–4, 217–223; Evans, *History and Practice of Ancient Astronomy*, 201–3. P.Hibeh 27 IV–XIV.

[99] Jones, "Ptolemy's Ancient Planetary Observations," 287.

[100] Lehoux, *Astronomy*, 180–1, 478–80. Miletus I inv. 456 B; *idem*, "The Miletus Parapegma Fragments," *ZPE* 152 (2005): 125–140; H. Diels and A. Rehm, "Parapegmenfragmente aus Milet," *Sitzungsberichte der königlich preussischen Akademie der Wissenschaften, philosophisch-historische Klasse* 23 (1904): 92–111; H. Dessau, "Zu den Milesischen Kalenderfragmenten," *ibid.*, 266–8.

[101] E. G. Turner and O. Neugebauer, "Gymnasium Debts and Full Moons," *Bulletin of the John Rylands Library* 32 (1949): 80–96. Formerly P.Rylands 666. (The papyrus also lists the accounts for a school). Lehoux, *Astronomy*, 179–180, 474–77. P.Ryl. 589, IX, frg 4; X, frg 4; X, frg 5; XI, frg 5; XI, frg 6; XII, frg 6.

Commenting on the correlation of the months to the zodiac signs Turner and Neugebauer observe that this component functions in a limited way (as the seasons retrogress in the Egyptian 365 day year by approximately one day every four years):

> Thus we have to accept the fact that correlations between the zodiac and the wandering year were not considered without value in spite of their short-lived character.[102]

Turner and Neugebauer's observations are resonant for 4Q318: in both calendars the sun, the moon, and the zodiac have been harmonised.

h. *Hellenistic Epigraphic Artifact*

The world's oldest-known geared mechanism, *The Antikythera Mechanism*, was called an ancient Greek "calendar computer" by Derek J. de Solla Price, the scholar who wrote the first modern study of it.[103] He dated the mechanism, in which one of its many astronomical features is the integration of the zodiac into the Egyptian calendar,[104] to ca. 80 BCE.

Price's research has largely been superseded by major advances in technology as reflected in the work of Michael. T. Wright (with the late A. G. Bromley)[105] and the work of the international Antikythera Mechanism Project team; the latter have recently published their preliminary findings.[106]

The bronze machine, now believed by a proportion of modern researchers to have been made by or during the period of Hipparchus (190–126 BCE), has been re-dated to 150–100 BCE on the basis of the epigraphic style of the engraved Greek lettering.[107] The great front dial

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[102] Turner and Neugebauer, "Gymnasium Debts," 83–84.

[103] D. J. de Solla Price, *Gears from the Greeks: The Antikythera Mechanism—A Calendar Computer from ca. 80 BC* (TAPS 64:7; Philadelphia: APS, 1974), 1–70 (repr. by Science History Publications, New York, 1975); *idem*, "An Ancient Greek Computer," *Scientific American* 200: 6 (June 1959): 60–67.

[104] The Egyptian calendar was used for astronomical purposes by the Greeks, see O. Neugebauer, *The Exact Sciences in Antiquity*, 95.

[105] M. T. Wright, "The Antikythera Mechanism Reconsidered," *Interdisciplinary Science Review* 32:1 (2007): 27–43.

[106] T. Freeth et al., "Decoding the Ancient Greek Astronomical Calculator Known as the Antikythera Mechanism," *Nature* 444 (Nov 2006): 587–591; N. Kollerstrom, "Decoding the Antikythera Mechanism," *Astronomy Now* 21:3 (2007): 28–31.

[107] According to Charalambos Kritzas, Director Emeritus of the Epigraphic Museum, Athens, in Freeth et al., "Decoding," online link to Supplementary Notes 2

displays two concentric scales. The inner scale, which is fixed, shows the Greek zodiac with 360 divisions: ΧΗΛΑΙ (Chēlai), Libra, is visible to the naked eye as are the last letters of [ΠΑΡΘΕ]ΝΟ[Ν] of Parthenon (Virgo) and very recently, with the aid of surface imaging, ΣΚΟΡΠΙΟΣ (Scorpio) can be seen.[108] The outer ring, which was designed to be moveable, is a calendar engraved with the Egyptian month-names in Greek letters with corresponding days, also in groups of 30.

According to Wright, the displays might have been used to compare the Egyptian solar calendar with different, local lunar calendars.[109] This idea is interesting in the light of the synchronised calendar texts in the Dead Sea Scrolls. If Wright is correct, the evidence of the mechanism and Qumran would suggest a possible preoccupation on the part of ancient astronomers, or a cross-cultural norm, to co-ordinate various calendrical systems prevalent in the region. In any event, the Antikythera Mechanism attests to a zodiac calendar system from Greece.

i. *Evidence from Mesopotamia*

The relationship between developments in astronomy between Greece, Egypt and Mesopotamia from the late fourth and third centuries BCE continues to be a subject of scholarly exploration. The consensus view is that the direction of transmission was from Mesopotamia to Greece rather than the other way round.[110]

(glyphs and inscriptions). http://www.nature.com/nature/journal/v444/n7119/suppinfo/nature05357.html

[108] Kollerstrom, "Decoding," 30; Price, *Gears*, 17–18.

[109] M. T. Wright, "Counting Months and Years: The Upper Back Dial of the Antikythera Mechanism," *Bulletin of the Scientific Instrument Society* 87 (December 2005): 8–13. *Idem*, "Understanding the Antikythera Mechanism," *Proceedings of the 2nd International Conference on Ancient Greek Technology, Athens, 17–21 October, 2005* (Athens: Military Museum, 2006), 49–60.

[110] A. Sachs, "Babylonian Horoscopes" *JCS* 6 (1952): 71–73; O. Neugebauer and A. Sachs, "The 'Dodekatemoria' in Babylonian Astrology," *AfO* 16 (1952–53): 65–66; J. Steele, "Greek Influence on Babylonian Astronomy?" *Mediterranean Archaeology and Archeometry* Special Issue 6. 3 (2006): 153–160; Francesca Rochberg, *The Heavenly Writing*, 1–16, 15–20, 238–244; A. Jones, "Evidence for Babylonian Arithmetical Schemes in Greek Astronomy," in *Die Rolle der Astronomie in den Kulturen Mesopotamiens* (GMS 3; ed. Hanne D. Galter; Graz: rm-Druck & Verlaggesellschaft mbH, 1993), 77–94; G. J. Toomer, "Hipparchus and Babylonian Astronomy," in *A Scientific Humanist: Studies in Memory of Abraham Sachs* (Occasional Publications of the Samuel Noah Kramer Fund 9; ed. E. Leichty et al.; Philadelphia: University Museum, 1988), 353–362.

There appears to be a close relationship between the 4Q318 zodiology and a group of Babylonian lunar zodiacal texts, many of which were copied in Uruk and Babylon in the late second or early first century BCE.[111] These feature the *micro-zodiac*, in which each of the twelve signs of the zodiac are subdivided again into 12 signs.

Abraham Sachs was among the first to identify the micro-zodiac though he himself did not yet use that term. The micro-zodiac takes several forms and seems to serve a number of purposes: astrological, astronomical and calendrical. Sachs's text, TCL 6 no. 14 (AO 6483)[112] is known to be related to other compositions copied in Uruk during the Seleucid era, and one in Babylon in the Seleucid or Arsacid era.[113]

The tablet begins with a description of the main waxing and waning phases of the moon's disc in the lunar month: Last Quarter, Dark Moon, First Quarter, Full Moon, Dark Moon (Obv 1–4). There then follows an astrological formula (lines 7–12). The first sub-division of Aries is the micro-zodiac portion Aries; the sub-divisions follow each other in the order of the signs of the zodiac, ending with Pisces (lines 13–19). Each sub-division of the zodiac sign corresponds to two and a half days within a 30-day schematic lunar month (line 10).

The predictions for each position of a zodiac sign within the micro-zodiac mainly concern the nature of the horoscope subject's death and the overall quality of their lives (Obv 22–25). With reference to the early section detailing the micro-zodiac in Aries according to an astrological formula (lines 12–19), Sachs commented:

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[111] Scholarship on the micro-zodiac includes Sachs, "Babylonian Horoscopes;" Neugebauer and Sachs, "Dodekatemoria;" Francesca Rochberg-Halton, "Elements of the Babylonian Contribution to Hellenistic Astrology," *JAOS* 108:1 (1988): 57–60; Erica Reiner, *Astral Magic in Mesopotamia* (Philadelphia: APS, 1995), 114–117; U. Koch-Westenholz, *Mesopotamian Astrology: An Introduction to Babylonian and Assyrian Celestial Divination* (Copenhagen: Museum Tusculanum, 1995), 165–170; H. Hunger and D. Pingree, *Astral Sciences in Mesopotamia* (Leiden: Brill, 1999), 29; Lis Brack-Bernsen and J. Steele, "Babylonian Mathemagics: Two Mathematical Astronomical-Astrological Texts," in Burnett et al., ed., *Studies in the History of the Exact Sciences*, 95–121; Francesca Rochberg, "A Babylonian Rising Times Scheme" in Burnett et al., ed., *Studies in the History of the Exact Sciences*, 56–94; H. Hunger, "How to Make the Gods Speak: A Late Babylonian Tablet Related to the Microzodiac," *AS* 27 (2007): 141–151; E. F. Weidner, "Gestirn-Darstellungen auf babylonischen Tontafeln," *Sitzungsberichte der Österreichischen Akademie der Wissenschaft, philosophisch-historische Klasse* 254: 2 (1967): 1–54: pls. 1, 5, 6, 9, 10 (VAT 7847 + AO 6448) and B. L. van der Waerden, "Die Zahlen der Texte (VAT 7815 and 7816)," *ibid.*, 50–52.

[112] Sachs, "Babylonian Horoscopes," 65–75.

[113] Sachs, "Babylonian Horoscopes," 72 n. 54.

> One possibility—which, however, is not very likely—is that we are dealing with essentially nothing more than a crude schematic description of an astronomical phenomenon, namely, the motion of the moon through the zodiac. Specifically, the text might be saying that if one starts with a conjunction of sun and moon at the beginning of Aries, the moon will pass through the whole zodiac in the ensuing 30 days, remaining in each sign of the zodiac 2½ days, while the sun stays in Aries for the whole period of 30 days.[114]

Sachs's interpretation may receive support from the Hellenistic texts discussed above. His comments also describe a similar structure to the one attested in the 4Q318 zodiac calendar. A difference is that the Qumran micro-zodiac begins in Taurus and contains a two- and three-day schematic lunar zodiac arrangement (not two and half days). Furthermore, no explanatory prologue survives in 4Q318 and we can only speculate whether one originally existed.

j. *Mesopotamian Zodiac Calendars*

Assyriologists have divided the micro-zodiac texts into two closely related main groups: the *Dodekatemoria* and the *Kalendertexte* (calendar texts). Interestingly, the texts are written in a kind of code, or puzzle. In a substantial number of late Babylonian astrological and astronomical texts the month-numbers or the names of the months are used to indicate zodiac signs.[115]

In the *Kalendertexte* the month-number can represent the month-name and the zodiac sign, for example: I = Nisan, or Aries; II = Iyyar, or Taurus. There is also a column which states the degrees within the zodiac sign. In the *Dodekatemoria* month-names represent the corresponding zodiac sign, for example Av = Leo.[116]

Roughton et al. suggest that this "no doubt reflects the parallelism between the division of the ideal 360-day year into twelve 30-day months with the division of 360° into twelve 30° signs, which was

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[114] Sachs, "Babylonian Horoscopes," 71.

[115] Hunger and Pingree, *Astral Sciences*, 17; Brack-Bernsen and Steele, "Babylonian Mathemagics," 95–121.

[116] Brack-Bernsen and Steele, "Babylonian Mathemagics," 101, 102; Lis Brack-Bernsen and H. Hunger, "The Babylonian Zodiac: Speculations on its Invention and Significance," *Centaurus* 41 (1999): 280–291, 288; Lis Brack-Bernsen, "The Path of the Moon, the Rising Points of the Sun, and the Oblique Great Circle on the Celestial Sphere," *Centaurus* 45 (2003): 16–31, here 25; Reiner, *Astral Magic*, 114–116.

the origin of the Babylonian zodiac."[117] Van der Waerden argues that zodiac signs, introduced in the late 5th century, were meant to correspond with months, as the unequal sizes of the constellations could not be calendrical.[118]

In the *Kalendertexte* the moon's course through the zodiac is presented in a mathematical pattern, possibly to make the data more interesting.[119] In these texts, the moon's zodiacal position is represented by ordinals 277° apart;[120] in the *Dodekatemoria* group, the ordinals are consecutively 13° ahead of the next.[121]

When the *Kalendertext* puzzle is unravelled, a schematic zodiac calendar of twelve 30-day months in a 360-day year emerges: "a date in the schematic calendar corresponds directly to a position in the zodiac."[122]

Brack-Bernsen and Steele exchanged data from the *Kalendertexte* with the data from the *Dodekatemoria* texts and produced what they called a *Dodekatemoria scheme* consisting entirely of ordinals. This scheme gives the ideal position of the moon on a date in an ideal 360–day year.[123]

If we convert the ordinals in the *Dodekatemoria scheme* back again into month-names and zodiac signs, the result is recognisably similar to the 4Q318 zodiology (cf. fig 2). One notable difference is that, like TCL 6 no. 14 (AO 6483) discussed above, the *Dodekatemoria scheme*

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[117] N. A. Roughton, J. M. Steele, and C. B. F. Walker, "A Late Babylonian Normal and *Ziqpu* Star Text," *Archive for the History of the Exact Sciences* 58 (2004): 537–572, esp. 551–552; Brack-Bernsen, "The Path of the Moon," 17, 24–26; Rochberg, *The Heavenly Writing*, 129–130; Glessmer, "Calendars in the Qumran Scrolls," 259–260; Albani, "Horoscopes in the Qumran Scrolls," 300 n. 68; Greenfield and Sokoloff, "4QZodiology and Brontologion ar," 264.

[118] B. L. van der Waerden, "History of the Zodiac," *AfO* 16 (1952): 216–230, 221.

[119] Brack-Bernsen and Steele, "Babylonian Mathemagics," 112. Two of the *Kalendertexte*, published for the first time, came from a purchased collection which contained 5th century BCE tablets. This is earlier than other known *Kalendertexte*, which date to the late 4th, late 3rd and early 2nd century BCE (95, 105).

[120] Brack-Bernsen and Steele, "Babylonian Mathemagics," 98, 102, 112; Brack-Bernsen and Hunger, "The Babylonian Zodiac," 288; Reiner, *Astral Magic*, 114–5; Steele "Greek Influence?," 3. Hunger and Pingree, *Astral Sciences*, 29–30; Weidner, "Gestirn-Darstellungen," 50–52.

[121] Brack-Bernsen and Steele, "Babylonian Mathemagics," 102; Neugebauer and Sachs, "Dodekatemoria," 52–3.

[122] Brack-Bernsen and Steele, "Babylonian Mathemagics," 102, 105.

[123] Brack-Bernsen and Steele, "Babylonian Mathemagics," 106–119, especially 115 and 118.

begins in Aries whereas the Qumran text begins one sign ahead in Taurus.[124]

Unlike TCL 6 no. 14 (AO 6483), the moon does not traverse each of the 12 zodiac signs in two and a half days in the *Dodekatemoria scheme*. Rather, like 4Q318, it moves through the signs in two and three day intervals. However, the two and three day arrangement attested in the *Dodekatemoria scheme* differs from that in 4Q318.[125]

Another important difference is that the *Dodekatemoria scheme* includes the degrees at which the moon will enter the zodiac sign at sunset each day. There are no references to zodiacal degrees in the Qumran text.

The *Dodekatemoria scheme* begins at 13° Aries, and increases by 13° around the zodiac each day, the mean diurnal motion of the moon. This suggests that the texts were allowing about 24 hours after conjunction, an ideal 13° elongation of the moon from the sun, for the first lunar crescent to be observed.[126]

This implies that the calculations were reckoned from 0° Aries as the beginning of the zodiac. The starting point of 0° Aries is intriguing, as it suggests that Babylonian scholars were using the tropical zodiac (in which the spring equinox corresponds with 0° Aries), a system which is attributed to Hipparchus (fl. ca. 150–120 BCE).[127] His knowledge of Babylonian astronomy is well-attested, although the process of transmission is unknown.[128]

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[124] I thank Dr. Jonathan Ben-Dov for our discussion on this key difference.

[125] The two to three-day lunar zodiac pattern in the *dodekatemoria scheme* is 2–2–2–3–2–2–3–2–2–3–2–2–3, Brack-Bernsen and Steele, "Babylonian Mathemagics," 119; cf. 4Q318: 2–2–3–2–2–3–2–2–3–2–2–3–2–2.

[126] I am grateful to Professor Francesca Rochberg for our conversation on this matter.

[127] Evans, *History and Practice of Ancient Astronomy*, 213–214; Roughton et al. also found that micro-zodiac texts appear to situate the vernal equinox at 0° Aries, see "A Late Babylonian and Normal and *Ziqpu* Star Text," 452 n. 28. (Re: the Antikythera Mechanism, Price found the autumn equinox at 0°–1° Libra, *Gears*, 18–19, n. 11).

[128] G. J. Toomer, "Hipparchus and Babylonian Astronomy," 353–362; Evans, *History and Practice of Ancient Astronomy*, 214. B. R. Goldstein and A. C. Bowen, "A New View of Early Greek Astronomy," *Isis* 74:3 (September 1983): 330–340, 339–340; A. Jones, "Evidence for Babylonian Arithmetical Schemes in Greek Astronomy," 86–89. Neugebauer, *History of Ancient Mathematical Astronomy*, 613–614.

Figure 2: *Dodekatemoria Scheme* with Numbers Converted Back to Month-Names and Zodiac Signs

	Nisan (Aries) *March–April*	Iyyar (Taurus) *April–May*	Sivan (Gemini) *May–June*	Tammuz (Cancer) *June–July*	Av (Leo) *July–Aug*	Elul (Virgo) Aug–Sept	Tishri (Libra) *Sept–Oct*	Heshvan (Scorpio) *Oct–Nov*	Kislev (Sagitt) *Nov–Dec*	Tevet (Capric) *Dec–Jan*	Shevat (Aquar) *Jan–Feb*	Adar (Pisces) *Feb–Mar*	°
1	Aries	Taurus	Gemini	Cancer	Leo	Virgo	Libra	Scorpio	Sagitt	Capric	Aquar	Pisces	13
2	Aries	Taurus	Gemini	Cancer	Leo	Virgo	Libra	Scorpio	Sagitt	Capric	Aquar	Pisces	26
3	Taurus	Gemini	Cancer	Leo	Virgo	Libra	Virgo	Sagitt	Capric	Aquar	Pisces	Aries	9
4	Taurus	Gemini	Cancer	Leo	Virgo	Libra	Virgo	Sagitt	Capric	Aquar	Pisces	Aries	22
5	Gemini	Cancer	Leo	Virgo	Libra	Scorp	Libra	Capric	Aquar	Pisces	Aries	Taurus	5
6	Gemini	Cancer	Leo	Virgo	Libra	Scorp	Libra	Capric	Aquar	Pisces	Aries	Taurus	18
7	Cancer	Leo	Virgo	Libra	Scorp	Sagitt	Capric	Aquar	Pisces	Aries	Taurus	Gem	1
8	Cancer	Leo	Virgo	Libra	Scorp	Sagitt	Capric	Aquar	Pisces	Aries	Taurus	Gem	14
9	Cancer	Leo	Virgo	Libra	Scorp	Sagitt	Capric	Aquar	Pisces	Aries	Taurus	Gem	27
10	Leo	Virgo	Libra	Scorpio	Sagitt	Capric	Aquar	Pisces	Aries	Taurus	Gemini	Canc	10
11	Leo	Virgo	Libra	Scorpio	Sagitt	Capric	Aquar	Pisces	Aries	Taurus	Gemini	Canc	23
12	Virgo	Libra	Scorp	Sagitt	Capric	Aquar	Pisces	Aries	Taurus	Gemini	Canc	Leo	6
13	Virgo	Libra	Scorp	Sagitt	Capric	Aquar	Pisces	Aries	Taurus	Gemini	Canc	Leo	19
14	Libra	Scorpio	Sagitt	Capric	Aquar	Pisces	Aries	Taurus	Gemini	Cancer	Leo	Virgo	2
15	Libra	Scorpio	Sagitt	Capric	Aquar	Pisces	Aries	Taurus	Gemini	Cancer	Leo	Virgo	15
16	Libra	Scorpio	Sagitt	Capric	Aquar	Pisces	Aries	Taurus	Gemini	Cancer	Leo	Virgo	28
17	Scorp	Sagitt	Capric	Aquar	Pisces	Aries	Taurus	Gemini	Canc	Leo	Virgo	Libra	11
18	Scorp	Sagitt	Capric	Aquar	Pisces	Aries	Taurus	Gemini	Canc	Leo	Virgo	Libra	24
19	Sagitt	Capric	Aquar	Pisces	Aries	Taurus	Gem	Cancer	Leo	Virgo	Libra	Scorp	7
20	Sagitt	Capric	Aquar	Pisces	Aries	Taurus	Gem	Cancer	Leo	Virgo	Libra	Scorp	20
21	Capric	Aquar	Pisces	Aries	Taurus	Gem	Cancer	Leo	Virgo	Libra	Scorpio	Sagitt	3
22	Capric	Aquar	Pisces	Aries	Taurus	Gem	Cancer	Leo	Virgo	Libra	Scorpio	Sagitt	16
23	Capric	Aquar	Pisces	Aries	Taurus	Gem	Cancer	Leo	Virgo	Libra	Scorpio	Sagitt	29
24	Aquar	Pisces	Aries	Taurus	Gemini	Cancer	Leo	Virgo	Libra	Scorpio	Sagitt	Capric	12
25	Aquar	Pisces	Aries	Taurus	Gemini	Cancer	Leo	Virgo	Libra	Scorpio	Sagitt	Capric	25
26	Pisces	Aries	Taurus	Gemini	Cancer	Leo	Virgo	Libra	Scorpio	Sagitt	Capric	Aquar	8
27	Pisces	Aries	Taurus	Gemini	Cancer	Leo	Virgo	Libra	Scorpio	Sagitt	Capric	Aquar	21
28	Aries	Taurus	Gemini	Cancer	Leo	Virgo	Libra	Scorpio	Sagitt	Capric	Aquar	Pisces	4
29	Aries	Taurus	Gemini	Cancer	Leo	Virgo	Libra	Scorpio	Sagitt	Capric	Aquar	Pisces	17
30	Aries	Taurus	Gemini	Cancer	Leo	Virgo	Libra	Scorpio	Sagitt	Capric	Aquar	Pisces	20

However, according to the consensus view, Babylonian scholars did not use the tropical zodiac beginning with 0° Aries.[129] Thus, it seems that the data in the micro-zodiac texts imply that astronomical-astrological knowledge from Seleucid era Mesopotamia[130] reflected —apparently, later—developments in the Hellenistic world.

The astronomy behind 4Q318, in which the zodiac also begins at 0° Aries,[131] could, therefore, be more accurately described as Greco-Babylonian, rather than Mesopotamian, as evidenced by complex, cross-cultural influences. Our zodiac calendar from Qumran appears to be a descendant from these texts.[132]

IV. *Conclusion*

This essay argues that the 4Q318 zodiology is a functioning, schematic lunar zodiac calendar that can be used with the Jewish calendar today. This Qumran calendar is closely related to extant Greco-Babylonian zodiacal calendars and horoscopic cuneiform texts. It is also connected to a tradition of zodiac calendar systems which developed in Ptolemaic Egypt and Greece for which there is archaeological support.

There is little doubt that, with the chronological and cultural clarifications outlined above, the scholarly view that the 4Q318 zodiology is rooted (very broadly-speaking) in Mesopotamian and Hellenistic astronomy is correct.[133]

The 4Q318 brontologion is now confirmed to belong to a late Hellenistic tradition of compositing zodiacal calendars with brontologia, a feature found in a datable early first century CE text. 4Q318 is a unique witness to both traditions in Aramaic.

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[129] Neugebauer states, "As far as we know, this norm [0° Aries] is attested nowhere in Babylonian astronomy," *History of Ancient Mathematical Astronomy*, 600.

[130] Or, possibly earlier as the date of the two new texts is uncertain, see Brack-Bernsen and Steele, *Babylonian Mathemagics*, 105 (above).

[131] As Pingree noted, "Astronomical Aspects," in Alexander et al., *Qumran Cave 4. 26*, 271.

[132] When the position of the moon in the zodiac in the Hebrew calendar is compared to the moon's position in the corresponding dates in the *Dodekatemoria* scheme there is a correlation in non-intercalary years, cf. a better correlation in the intercalary years in 4Q318 (data in this author's thesis).

[133] For example, A. Lange, "Pre-Maccabean Literature from the Qumran Library and the Hebrew Bible," *DSD* 13:3 (2006): 277–305; Greenfield and Sokoloff, "4QZodiology and Brontologion ar," 270.

The lunar and solar zodiac calendars are attested in the writings of Philo and Josephus, as well as Ovid, and are assigned sacred significance in the Jewish writers' works.[134] As well as being of relevance for the study of the history of the Jewish calendar, and of ancient calendars, astronomy and astrology,[135] the Qumran lunar zodiac calendar should stimulate discussion about the plurality of calendars in Second Temple Judaism. By excluding it from the discourse on calendars in the Dead Sea Scrolls and its use by Jewish groups in antiquity, we are ignoring the contextual significance of 4Q318 and every available testimony on this subject.

[134] The possible later reception of the Jewish zodiac calendar after the first century CE has not been explored in this paper.

[135] My thanks to Dr Mladen Popović for sending me a copy of his monograph on 4Q186 and 4Q561, *Reading the Human Body: Physiognomics and Astrology in the Dead Sea Scrolls and Hellenistic-Early Roman Period Judaism* (STDJ 67; Leiden: Brill, 2007).