



# GRECO-ROMAN ZODIAC SUNDIALS AND THEIR LINKS TO A QUMRAN CALENDAR (4Q208-4Q209)

Helen R. Jacobus

*University College London, Department of Hebrew and Jewish Studies,  
Gower St, London WC1E 6BT  
([Jacobus.helen@gmail.com](mailto:Jacobus.helen@gmail.com))*

---

## ABSTRACT

This paper proposes that the Greco-Roman zodiac sundials that flourished in Greece and Italy from about the second century BCE to the second century CE were related to a probable zodiac calendar found in astronomical Aramaic manuscript fragments in the Dead Sea Scrolls from Qumran, dated about c. 2,000 years BP and c. 2,170 years BP. I demonstrate that in the Ethiopic Book of Luminaries the zodiac signs have been substituted by numbered gates of heaven and that this codified model can be traced back to the Qumran texts. Furthermore, that this same pattern is evident in Greco-Roman sundials in an unencrypted form. I conclude that the paradigms in the proposed Qumran zodiac calendar and the Greco-Roman zodiac sundials are the same, making it likely that the Aramaic fragments contain a zodiac calendar.

---

**KEYWORDS:** Prosymna globe, Nafplio sundial, Aramaic Astronomical Book of Enoch, 4Q208-4Q209, Dead Sea Scrolls, Book of Luminaries, 1 Enoch Chapter 72

---

## 1. INTRODUCTION

From the about third century BCE to the second century CE zodiacal calendars were devised in the ancient Near East (Brack-Bernsen and Steele, 2004), the Classical world (Bowen and Goldstein, 1988) and in later antiquity (Evans and Berggren, 2006; Lehoux, 2007). As is known from the Roman scientific writer, Vitruvius (Rowland et al, 1999), and confirmed by archaeological finds (Gibbs, 1976), zodiac sundials were popular in the Greco-Roman period but not apparently in the ancient Near East where no undisputed sundials have been unearthed.

I show that there are some conceptual overlaps with respect to the probable codification of zodiac signs in the Ethiopic "Astronomical Book of Enoch," also known as the *Book of Luminaries* (1 Enoch Chapters 72-82) and, what I am arguing is, an Aramaic luni-solar zodiac calendar in the Dead Sea Scrolls. This calendar constitutes two texts in fragments known as the *Aramaic Astronomical Book of Enoch* (manuscript fragment titles: 4QAstronomical Enoch<sup>a-b</sup> which are often referred to by their manuscript numbers: 4Q208-4Q209) hidden in Cave 4 at Qumran on the north-west edge of the Dead Sea.

Not all of the Dead Sea Scrolls were written and copied at Qumran. In fact, one of these texts, 4Q208, may possibly predate the community that inhabited the site (Jull, 1995, Carmi, 2000) estimated by archaeologist Jodi Magness to be between 80 BCE and 68 CE (Magness, 2002). It is likely that the earlier manuscript, at least, was brought to Qumran to be part of an early Jewish archive, rather than having originated there. This study uses Greco-Roman zodiac sundials to show that these instruments are related to the proposed zodiacal paradigm in the luni-solar Qumran texts, and that, therefore, the hypothesis that the scheme in the scroll fragments is a luni-solar zodiac calendar is supported by contemporaneous artefacts in an adjacent culture.

## 2. BACKGROUND

Parts of the Ethiopic Astronomical Book of Enoch, also called *The Book of Luminaries*,

is known mainly from a number of medieval Ethiopic manuscripts, late antique Greek fragments and early and later Byzantine Greek secondary sources (Milik, 1976, Knibb, 1978, Nickelsburg and Vanderkam, 2004, VanderKam, 2012). It is an apocalyptic collection of several texts written at different periods; some parts of its chapters contain overlaps with sections of the Aramaic astronomical fragments from Qumran (Nickelsburg and VanderKam, 2004; VanderKam, 2012; Drawnel, 2011). *The Book of Luminaries* consists of Chapters 72-82 of 1 Enoch, or *The Book of Enoch*, one of the canonical books of the Ethiopic Bible which is divided into separate books composed over an unknown time-period.

In the biblical Book of Genesis, Enoch was the seventh patriarch from Adam, who lived in total for 365 years and then, instead of physically dying like other mortal, albeit more long-lived, biblical patriarchs in Genesis Chapter 5, "he walked with God" (Gen 5:21-24). 1 Enoch is attributed to Enoch, as the author, and therefore, is known as a pseudepigraphic work. Although cited in the book of Jude in the New Testament (Jude 1:14-15= 1 En. 60:8) it was not preserved by the Western Christian Church (Joseph, 2013; Moore, 2013). 1 Enoch, is a detailed mythological corpus, with a highly textually complex history, describing, in some sections, the angelic transmission of secret knowledge to Enoch, the divinely chosen recipient of magic, cosmology, astronomy, astrology and the calendar from the archangel, Uriel.

Since the discovery of the Dead Sea Scrolls in 1947, we now know that 1 Enoch was composed in Aramaic in antiquity, and that there is manuscript evidence that least three of its five sections were translated into Greek in the early Byzantine period (Milik, 1976; Knibb, 1978; Nickelsburg and VanderKam, 2004, 2012). It is thought that the Ethiopic translators who preserved the Book made use of both the Aramaic and Greek versions, with possibly some parts of the Astronomical section also surviving in a Greek manuscript from Oxyrhynchus, Egypt (Milik 1976, VanderKam, 2012).

Milik estimated that the quantity of recognisably overlapping text between 4QAstronomical Enoch <sup>a-d</sup> (4Q208-4Q211, that is, all the astronomical manuscripts including those that do not include the calendrical table in 4Q208-4Q209) and the textually corrupt and probably abbreviated *Book of Luminaries* was about 30 per cent (Milik, 1976).

The question of transmission is complex. Some content in the Ethiopic text which does not exist at Qumran may never have existed in antiquity, or if it did exist as earlier material it may have been lost, or not preserved.

The focus of this study rests mainly on Chapter 72 in the Ethiopic *Book of Luminaries* for which no trace is extant in the Dead Sea Scrolls; it may therefore be a later addition. This paper will show that the symbolism upon which 1 En. 72 (the abbreviation for 1 Enoch, chapter 72) is based is zodiacal. I argue that zodiac system is encrypted and can be applied to the Aramaic *Astronomical Book of Enoch* in the Dead Sea Scrolls, in particular to the first two fragmentary manuscripts 4Q208 and 4Q209, and to Greco-Roman zodiacal sundials. One of these instruments is highlighted in this paper in support of my hypothesis.

Although neither 4QAstronomical Enoch <sup>a-d</sup> nor the Ethiopic *Book of Luminaries* mentions the zodiac that does not mean that the zodiac is not represented in these texts. Number substitution for months and zodiac signs is attested in a group of late Babylonian calendar texts (Brack-Bernsen and Steele, 2004).

The scholarly thesis in the 19th century put forward in the first English translation by Richard Laurence (Laurence, 1821) and preserved until the early 20th century, the best known of which is the translation of the *Book of Enoch* by R.H. Charles, (Charles, 1912, repr. 1966) was that in the Ethiopic *Book of Luminaries* the zodiac was represented by the system of 12 heavenly "gates." These are numbered from one to six: the sun, moon and the stars rise in them in the east and set in them in the west. The following is an extract from the

introduction to Chapter 72 of the *Book of Luminaries*, translated by O. Neugebauer, lines 2-3.

"2. This is the first law of the luminaries: the light (called) the sun it rises through the gates of heaven in the east and sets through the gates of heaven in the west.

3. I saw six gates through which the sun sets; and (also) the moon rises and sets in those gates and the leaders of the stars and those they lead.

Six gates are in the east and six in the west and all of them are arranged in sequence."

In the mid to late 20th century, Otto Neugebauer rejected Charles's scholarly comments that the heavenly "gates" represented the zodiac (Neugebauer, 1981). Neugebauer drew his conclusions from his own study of early 20th century publications by S. Grébaud (Grébaud, 1918-19) of medieval Ethiopic lunar astronomical tables. These listed the rising of the moon through different "gates" on different days of alternate 29 and 30 day months. Neugebauer argued that since the moon rose for eight consecutive days through Gates 1 and 6 in these tables, the lunar "gates" could not symbolise the zodiac signs, but arcs on the horizon from which both the sun and moon rose and set throughout the year (Neugebauer, 1964, 1979).

The view that the "gates" cannot represent the zodiac signs in the Ethiopic *Astronomical Book of Enoch* and in the Cave 4 Aramaic fragments remains the consensus opinion among modern scholars today (although, note that Neugebauer only wrote about the Ethiopic *Book of Luminaries*, not 4QAstronomical Enoch <sup>a-d</sup>).

### 3. METHODOLOGY AND RESEARCH

In order to draw comparisons between Qumran and Greek time-related material culture I discuss Greco-Roman zodiac sundials that are contemporaneous with the proposed luni-solar zodiac calendar in the *Aramaic Astronomical Book of Enoch*. By demonstrating a correspondence between the zodiac schemes in the Greco-Roman

zodiac sundials and in *1 Enoch* 72, a solar text, and between *1 Enoch* 72 and 4Q208-4Q209 it can be shown that the luni-solar Qumran text is codified according to the same system as that in the solar Greco-Roman zodiac schemes. The proposed zodiac scheme in the lunar Aramaic fragments in the Dead Sea Scrolls may then be proved.

#### 4. THE PROSYMNA GLOBE DIAL

The Prosymna globe in the store room of the Archaeological Museum of Nafplio is described as “one of the most amazing scientific objects that has survived from antiquity” (Schaldach and Feustel, 2013, 6). In their mathematical paper, Schaldach and Feustel state that the globe “does not work with a pointer as most dials but with a terminator, the boundary of light and shadow, in a way that we can speak of a three-dimensional nomographical procedure.” Our main interest, however, is in the globe’s zodiac scheme.

The Prosymna globe is one of several types of zodiac dials in which the arrangement of the signs of the zodiac appear in a sequential order, either beginning at the summer solstice or the winter solstice (When I saw the dial it was on the floor by a pillar amongst boxes so it was not possible to see the whole clearly). The dial represents the celestial sphere from a geocentric perspective: the sun’s long shadow when rising due east at the vernal equinox would extend to *Krios* (Aries). The signs in this case begin at the summer solstice at the top as indicated by the position of Cancer and Gemini inscribed in the first circles. See Plate 1 and Table 1.

The dial was found by Carl Blegen in ancient Prosymna in the Argolid in the Peloponnese (Blegen, 1939) and published in further detail in the PhD dissertation of Sharon Gibbs (Gibbs, 1976). According to Blegen, the date is about 125-100 BC. The upper south face of this white (now grey) marble globe contains an arrangement of the zodiac signs inscribed within a grid crossing the central, vertical meridian line,

which represents the noon line, and engraved on either side of it.



Plate 1: Globe dial, Nafplio Archaeological Museum



Plate 2: Far left-hand side, showing alpha, beta, gamma, delta and epsilon, and final holes

The letters from the names of the signs are written in-between 13 hour lines which extend vertically in curved lines between the summer solstice signs at the top, and the winter solstice signs at the bottom, and seven horizontal day curves.

The inscribed lettering of the zodiac signs have been spaced out, letter by letter in proportion to their space. Cancer and Gemini are at the top, and Sagittarius and Capricorn, at the bottom, the summer solstice and winter solstice, respectively. Virgo–Aries; Libra–Pisces (the equinoctial months) are in the centre and Leo–Taurus and Scorpio–Aquarius; the signs between the solstices and the equinoctial months are written in slightly smaller letters above and below the equinoxes and solstices. The Cancer inscription at the very top straddles the meridian line; Taurus, Virgo, Pisces, Scorpio, Aquarius and Capricorn are ab-

breviated and there is an empty space on either side of the omega in Leo. See Table 1

Cance KAPKIN	r Gemini ΟΣΔΙΑΥΜΟΙ
Leo ΛΕΩΝ	Taur[us] ΤΑΥΡ
Virg[o] ΠΑΡΘΕΝ	Aries ΚΡΙΟΣ
Libra ΖΥΓΟΣ	Pisce[s] ΙΧΘΥΕ
Scorpi[o] ΣΚΟΡΠΙ	Aquari[us] ΥΔΡΗΧΟ
Sagittarius ΤΟΞΟΤΗΣ	Capri[corn] ΑΙΓΟ

Table 1: Transcription with translation of the zodiac signs on the Prosymna globe

The latitude of the globe, according to Schaldach and Feustel is 35.7°. There are patterns of lines above and below the zodiacal solstice circles. Schaldach and Feustel refer to the grid demarcating the zodiac signs as System II, the pattern of diamond-shaped lines above the summer solstice signs as System I, and the elongated lines beneath the winter solstice as System III. They describe the zodiac in System II simply as: “The zodiac is given in the common order, that is, counter clockwise. The solstices and equinoxes are not mentioned in the inscription, but they can easily be added: the summer solstice near the top, the winter solstice at the bottom line of that system” (Schaldach and Feustel, 2013, p.8).

There are a series of 13 shallow circular indentations arranged in two lines like sloping sides of a pyramid formation, six on either side of the indentation at the apex. The holes appear to have traces of bronze inside them. According to Blegen, these are for the insertion of brass pins to

cast a shadow to indicate the hour; Gibbs thought it more likely that they held a moveable brass stud “for marking timely positions of sunlight-shadow boundary.” Schaldach and Feustel reached a similar conclusion, arguing that “bronze rod studs” were fastened to the holes and that the “terminator cuts exactly the individual hole positions for every full hour only at the equinoxes” (pp.7, 9). Nine of the indentations are marked with a Greek numeral-letter. The top indentation at the apex, is un-numbered, the second to the sixth hole on the left hand side are numbered *alpha* (1) *beta* (2), *gamma* (3), *delta* (4), *epsilon* (5) and the far left shallow hole has a mark like an *omicron* without a right-hand foot (see Plate 2). On the right hand side, after the first shallow hole on the right which is also un-lettered, the indentations are numbered *theta* (8), *eta* (7), *zeta* (6) and the final indentation on the right is also like an *omicron* without a right foot (see Plate 3).



Plate 3: The Prosymna globe viewed from the right-hand side

Schaldach and Feustel believe that these are the archaic Greek letter *stigma* and that they are later, Roman additions, not Hellenistic, though they claim that this globe is the “very first [known] sundial in which hours were marked by Greek numerals” (idem, p.9). They state that the holes indicate: from the far right (the east), the 6<sup>th</sup> to the 11<sup>th</sup> hour; the 12<sup>th</sup> hour at the top of the vertical, central meridian line to the 6<sup>th</sup> hour, is the last hole on the left (the west). The hour indentations are related to both System I and System III, and System II (the zodiac) indicates the season.

The arrangement of the holes and Greek letter numbering is similar to that of a sphere dial in Macerata, Italy (see Carusi and Baldini, 1989, who also examined the Prosymna globe). On the opposite side of the Prosymna sphere there is an inscription which was not visible to me in the globe's current position. Carusi and Baldini translate it as, "Thaleia, a priest of the goddess Hera, has placed me as an indicator of the daily hours of sunshine." They suggest that the Macerata globe dial is earlier than the Prosymna globe and that the inscription on the latter would suggest that these instruments were kept in a temple and presided over by priests.

Schaldach and Feustel translate the Prosymna inscription as, "The priestess of the goddess Hera, Thalia, has ordained me, the herald of the sunny hours for the mortals." They agree with Blegen's dating but would also extend it to the first century BC. They also concur with Blegen that the inscription was engraved in the second century CE when the dial was consecrated in the Heraion. This interesting suggestion reminds us that in antiquity religion and astronomy were inter-connected and that astronomer-priests—here, a priestess—were involved in preserving astronomical knowledge and controlling its dissemination.

#### 4. 4Q208-4Q209 AND 1 EN. 72

The Dead Sea Scrolls are a collection of writings by different religious Jewish groups and comprise some 900 manuscripts that have been dated from the early second century BC to the first Jewish revolt against Rome in 68 CE. Less than a third are early versions of biblical books including fragments from the *Book of Jubilees* in Hebrew and fragments from *1 Enoch* in Aramaic (VanderKam 1994; Goodman, 2008).

The earliest manuscript at Qumran in fact comprises some of the fragments of the Aramaic Astronomical Book of Enoch, a text numbered *4QAstronomical Enoch<sup>a</sup>* (4Q208) ("4Q" standing for Cave 4 at Qumran). Scholars have generally accepted a date in the earlier half of the second centu-

ry BC for this manuscript (Vanderkam, 2012, pp. 339–40). 4Q208 has a younger sister manuscript, *4QAstronomical Enoch<sup>b</sup>* (4Q209).

This manuscript is dated to around the turn of the era when it was copied (Vanderkam 2012, p. 341). 4Q208 and part of 4Q209 apparently contain what J.T. Milik, who produced the first critical edition of the *Aramaic Book of Enoch*, called the "synchronistic calendar" (Milik, 1976, pp. 274–275), his term for the texts' schematic luni-solar calendar.

The texts describe the moon's daily waxing and waning phases in fractions of half-sevenths (the equivalent to one-fourteenth, a lunar fraction used in other Qumran calendars {Jacobus, 2013}). As discussed below, scholars dispute whether this fraction represents time periods of lunar visibility between sunset and moonrise, or moonset and sunset and other phenomena. It also lists the daily moon rises and moon sets in a numbered "gate" in a formulaic way. In the column of one fragment covering three consecutive nights, 4Q209, fragment 7, column 3, discussed below, the scribe notes when the sun rises in one numbered "gate" and when the moon rises in other portals, as the moon moves at a different speed. The repetitive formulaic style is a fascinating stream of ancient computer-tickertape. It is pure data.

This later manuscript, 4Q209, contains larger fragments of the "synchronistic calendar" and some similar text to parts of the Ethiopic Astronomical Book of Enoch (*1 Enoch* Chapters 73–79, 82). Only 4Q209 fragment 7, column iii contains this solar and lunar calendrical information together. It should be noted that not enough textual material ascertaining the year length of the moon and that of the sun with absolute certainty has survived.

In 4Q208-4Q209 the moon's waxing and waning phases are described for every day of a schematic lunar month, possibly of alternating 29 and 30 days (Milik, 1976, pp. 282–282). In the 30-day months the full moon occurs on night 15, and in the 29-day months the full moon falls on the 14<sup>th</sup> night



(Drawnel, 2011, Appendix 1, pp. 421-424, 438).

Milik thought that the solar year in the Qumran text was 364 days (Milik 1976, 275); it is also possible that it was 360 days consisting of 12 months of 30 days, the number of degrees in the zodiac, thereby describing the schematic motion of the sun of  $1^\circ$  per day. The Aramaic scroll from the same cave, *4QZodiac Calendar and Brontologion* (4Q318) lists an ideal 360-day zodiac calendar comprised of 12 months of 30 days each that schematically lists the zodiac sign of the moon for each day of the month (Greenfield and Sokoloff, 2000), the only other Aramaic calendar text in the scrolls.

The verbs combined with the fractions related to the moon in 4Q208–4Q209 may refer to the parts of illumination and darkness of the lunar surface during the day and during the night (Milik, 1976; Tigchelaar and García Martínez, 2000), or to time periods of lunar visibility and invisibility in the day and night between sunset and moonrise, and moonrise and sunset and other phenomena, based on Babylonian astronomical texts (Drawnel, 2007, 2011), in either case schematically given. Contra Duke and Goff (2014), I lean towards the former view that text denotes fractions of illumination and darkness on the moon's disc, on balance, among other reasons because it is easier to work out the day of the month visibly by looking at the moon in the lunar calendar (Jacobus, 2014, p. 341). The textual content, lunar fractions, the presence of the sun and "gate numbers," as shall be argued, suggests that the text is a co-ordinated luni-solar calendar similar, but not identical to Milik's "synchronistic calendar."

Drawnel cannot account for the presence of the sun and the "gates" in the text, and he claims that the citation of the sun is an "insertion" (Drawnel 2011, 299), rather than an integral part of the scheme. He states that the "gates" are mentioned "only randomly" in the Aramaic manuscripts (ibid, p. 293-4, p. 296).

However, where the "gates" do exist in the text, they make sense in terms of the zodiac calendar. The following is an extract from the *4QAstronomical Enoch<sup>b</sup>* (4Q209 frag 7, col. iii, lines 1-3) (below). The numbers in parentheses represent the sequential order of the verses as they actually appear in the manuscript; the data are written running on. The square brackets represent restorations by the modern scholar. The curly brackets contain what appears to be a repetition in the formula possibly due to the ancient copyist's eye "skipping" a line, or repeated deliberately as a reminder. The repeated phrase reappears after the notice on the sun, and this occurrence and formula is not attested in any other fragment.

**(1). [blank space. It (the moon) shines during the eighth night o]n this (month) four-sevenths. Then it (the moon) sets and enters. During this night the sun complet[es] (2) the passage across all the courses of the first gate. It (the sun) begins again to go and to emerge through its courses. [The moon](3) {sets and enters and it} is dark the rest of this night by three sevenths...**

In other words, on night eight of the lunar month in a 354-day lunar calendar in which the first day begins with the first visible crescent at  $0.5/7$ ths, the moon sets and rises in its "gate." If the full moon is seven-sevenths (and conjunction would equate with seven-sevenths of darkness) and it is light for  $4/7$ ths and dark for  $3/7$ ths it would make perfect sense for the eighth day of the month. Four-sevenths is just past the first quarter ( $3.5/7$ ths), the first half-moon usually reached on the sixth or seventh night of a lunar month.

The sun completes its journey through Gate 1 during the night according to the cosmological structure of the "gate." It rises at dawn through Gate 1 again and travels again through its courses. There is no contradiction in applying Neugebauer's theory that the "gates" represent fixed sunrise and sunset points on the local horizon through-

out the year to the sun's zodiac sign because the sun always rises and sets in the azimuth zone that corresponds to its zodiac sign, as is the premise in the zodiacal dials. The stars are invisible during the day so the sun's position in the zodiac cannot be seen.

The moon, which moves swiftly, about 13° per day on the ecliptic, as opposed to the sun's apparent movement of 1° per day, can be seen against the stars when it rises after sunset. Although Neugebauer argues that the "gates" in the Ethiopic *Astronomical Book of Enoch* also represent the rising and setting points of the moon on the horizon and that the "gates" of the sun and the moon are the same (Neugebauer, 1964, pp. 58-59), in the case of the moon and its fractions, it is more practical suggest that these and the moon's "gates" can more easily read as a zodiac calendar by looking at the waxing and waning moon on the ecliptic at night.

The text 4Q209 fragment 7, col. iii tells us that the sun is in Gate 1; the number of the "gate" through which the moon rises and sets on night eight was not given. A little further on in the fragment we learn that on night nine the moon enters Gate 5 at moonset (4Q209 frag 7 col. iii. Lines 4b-7), below:

**(4b). vacat And it (the moon) shines on night nine on this (month) (5). with four-and-a-half-[sevenths]. And then it sets and enters. This night the sun begins again to travel through [its] course[s, and to set] (6). through them. And then the [moo]n sets and enters the fifth gate. And it is dark during the rest of this night by [two-] (7). and-a-half-seve[nths]. And it (the moon) increases during this day up to five-sevenths, and its light is equivalent to five-sevenths.**

In *1 En. 72* which describes the sun's journey through the seasons, it is stated that there are six heavenly gates each for two months of the year on either side of the solstices and equinoxes. The text states that

the wind blows the chariot where the sun rises, and when the sun sets it turns north [to the summer solstice] in order to travel towards the east.

It rises in the first month from the "Great Gate," the fourth of these six gates in the east. The first month would be the month that follows the day of the spring equinox. The 12 months are then enumerated, each one defined by the sun entering their "gate" number. It also gives the proportion of daylight and night-time hours in fractions of 18ths, with the months of the equinoxes having nine hours each of daylight and nightfall.

As the months in *1 En. 72* are defined by the sun, not the moon, I have arranged the months and "gates" according to the data given in the text with the addition of corresponding zodiac signs to the months, so Month 1 equates to Aries, the first sign of the zodiac, and Month 2 equates to Taurus, the second sign, and so on until Month 12 which equates to Pisces, the last sign, see Figure 1.

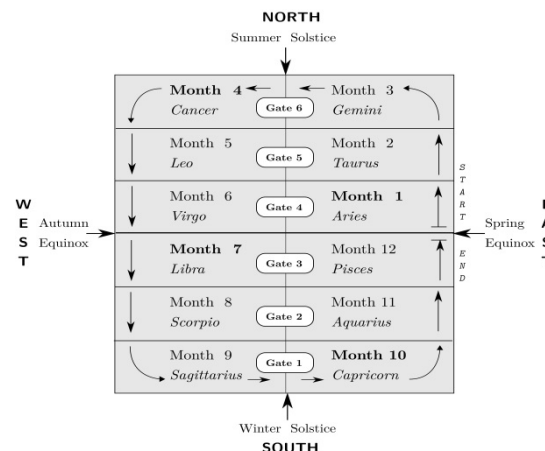


Fig. 1: The sun rises and sets in six "gates" traveling northwards through the year from Month 1 which equates to Aries and Gate 4

The beginning and ending of the sequence of zodiac signs are defined from the spring equinox. The six "gates" are double, serving two months, Month 1 as beginning at this point, at Gate 4, which also serves Month 6, the autumn equinox. Thus, from Month 1, the sun moves northwards towards the summer solstices, the signs of



Gemini and Cancer in Gate 6, and from Month 4, the sun travels southwards towards the winter solstice. From there the sun journeys northwards again to the spring or, vernal, equinox at the end of Month 12.

In the Ethiopic *Book of Luminaries* Month 1 begins at the "Great Gate." (1 En. 72:6). The lengths of these solar "months" in the text are given as 30 or 31 days. They are 30 days long except for Months 3, 6, 9, 12 which have 31 days. The year is 364 days long. (These are not divided into 52 weeks with Sabbaths. The Sabbath is not mentioned in either the Ethiopic *Book of Luminaries* or the Aramaic *Astronomical Book of Enoch*). The months in 1 En. 72 are, apparently, "solar months" defined by their starting point at the vernal equinox and divided into 30 and 31 day solar periods of time (as opposed to the emphasis on the scheme of lunar months, day by day, in the Aramaic *Astronomical Book from Qumran*).

The autumn equinox occurs in Gate 4 when it is stated that the day and night are

of equal lengths (1 En. 72:20-21) and the spring equinox Gate 3, when the day light and night-time lengths are equal (1 En. 72:31-32). See Table 2.

The schematic daylight scheme presented in fractions of eighteenths in a 2:1 ratio is more appropriate to daylight times in northern Europe than to Alexandria or Greece. Neugebauer points out that "nowhere on earth can the scheme as a whole based on reality." He added that although this ratio is attested in Babylonia (so Steele, 2013) that does not "constitute a sufficient basis for the assumption of mutual contacts. Very primitive methods offer only little freedom of choice" (Neugebauer 1964, p. 60 n.1).

Table 2 shows the arrangement of Months, "gates" and daylight and night-time lengths in proportions of 18ths for every month of the year, given in 1 En. 72 with my addition of the corresponding zodiac signs and the proportion of daylight hours in 24ths, to translate the proportions into units we can understand more easily.

**Table 2: Daylight and night-time lengths in 18ths given in 1 En.72, with additional data and highlights**

Months	1	2	3	4	5	6	7	8	9	10	11	12
Gates	4	5	6	6	5	4	3	2	1	1	2	3
Zodiac signs	♈	♉	♊	♋	♌	♍	♎	♏	♐	♑	♒	♓
Daylight (18ths)	10	11	12	11	10	9	8	7	6	7	8	9
Night-time (18ths)	8	7	6	7	8	9	10	11	2	11	10	9
Daylight length (hours)	13.33	14.66	16	14.66	13.33	12	10.66	9.33	8	9.33	10.66	12

I have highlighted in Table 2 the first Gate 1, Month 9, Nov/December, counting from the equinox, which has the shortest day, and the first Gate 6, Month 3, May/June, which has the shortest night of six hours. Month 1, corresponding to Aries in Gate 4 has 8 hours of night-time and Month 6, corresponding to Virgo and the other Gate 4, has 9 hours of night-time, being the autumn equinox.

The two Gates 4, as an example, do not each have equal daylight hours but, Virgo (Month 6, Gate 4), and Pisces, Month 12,

Gate 3, the months of the equinoxes, have equally divided days and nights of nine-eighteenths each. The daylight schemes, therefore, do not match up with the numerical order of the double "gate" numbers.

The sequence of the numbers probably reflects the arrangement of corresponding month-to-zodiac signs, instead (see Figure 1). The moon's months are also described in fractions of half-sevenths in an abbreviated form in parts of chapters 73 and 74 and the Ethiopic *Book of Luminaries*, 1 Enoch 73:3b-8 and 1 En. 74:3. The moon begins at

the first crescent but unlike the Qumran text, it is not harmonised in a calendar with the equinoxes or solstices.

Figure 2 describes the “gate” numbers in 1 En. 72 with the zodiac signs (not in the text) without the corresponding solar months. They are arranged in a circular format, with the signs spaced proportionally to a two-dimensional celestial sphere-like shape. At the vernal equinox the sun rises in the east in the “Great Gate,” Aries (replacing Month 1) in Gate 4. The arrangement of proportionally spaced signs echoes the Greco-Roman zodiac sundial paradigm which is interested in the shadows cast by the sun according to the seasons and the time of day.

Some sundial schemes begin at the top with the winter solstice zodiac signs, Sagittarius and Capricorn (Gate 1). Dials that have the winter solstice zodiac signs at the top include the hemispherical dial from Rome in the Vatican Museum (Gibbs, 1976, cat no. 1068G, p. 183, pl. 15). Other zodiac dials have the summer solstice signs, Gemini and Cancer (Gate 6), at the top, as in the Prosymna marble globe. The Figure 2 diagram of the pairs of “gates” in 1 En. 72 arranged opposite to each other (with corresponding zodiac signs added) with Gate 6 at the zenith describes the zodiac scheme in that instrument.

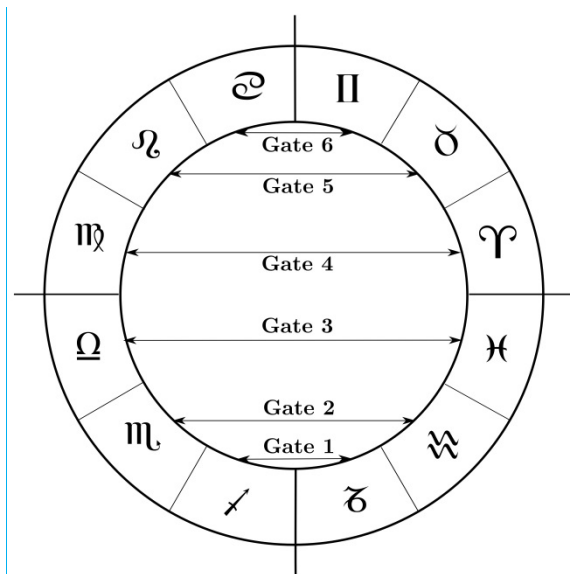


Fig. 2: Gate-pairs 1 to 6 in 1 En.72 replacing numbers with zodiac signs on a celestial sphere

So, returning to the Astronomical Book of Enoch in the Dead Sea Scrolls, I suggest that if we apply the zodiac that is evident from comparing 1 En. 72 with the Prosymna globe, a solar instrument, to the Qumran fragments, a luni-solar scheme, by aligning the “gates” of the sun and the moon to the zodiac signs with the sun’s signs adduced by azimuth zones, we may be able to prove that 4Q208-4Q209 is a zodiac calendar.

Taking 4Q209 frag 7 col. iii again, we learn that the moon shines on lunar night 8; no “gate” number is given. On the same night the sun completes its courses through Gate 1 and enters Gate 1. The moon enters Gate 5 on night 9. If we substitute the “gate” numbers for the corresponding zodiac signs, then we can say that the sun completes its courses through Sagittarius and enters Capricorn, both signs corresponding to Gate 1, the winter solstice. The moon enters Taurus on night 9. As the moon changes its sign every two and half days it would appear that the scribe only mentions the “gate” number when the sun or moon enters that gate for the first time, as intimated by Milik in his translation of this fragment, {Milik, 1976, p.281}. If so, then the night that the sun entered Gate 1, the moon, on night 8, was in Gate 4, corresponding to Aries. Milik dated night 8 to Tebet 8 in the Hebrew (and standard Babylonian) luni-solar calendar, that is, the 10th month from the vernal equinox. This month and indeed the date can coincide with the winter solstice today’s Hebrew calendar in years when an intercalation is due (see, for example the calendar converter programme online: <https://www.fourmilab.ch/documents/calendar/>).

The information in the text is now summarised below:

**Data in 4Q209, frag 7, col iii, lines 1-7:**

**The moon shines on Night 8 of the 10<sup>th</sup> month for four-sevenths.**

**The sun goes through Gate 1 during the night.**

**The moon is dark for three-sevenths.**

The moon shines on Night 9 of the 10<sup>th</sup> month for four and half sevenths.

The sun travels through its courses (Gate 1).

The moon sets and enters Gate 5.

The moon is dark by two and a half sevenths ...

*(fragment damaged)*

As above with zodiac signs and phases:

The moon shines on Night 8 of the 10<sup>th</sup> month. It is past the first quarter moon

The sun leaves Sagittarius (Gate 1: winter solstice)

The moon enters Taurus (Gate 5) on Night 9 of the 10<sup>th</sup> month. It is a waxing gibbous moon

The sun enters Capricorn (Gate 1) *(fragment damaged)*

The interpretation that 4Q209 fragment 7, column iii describes the 10<sup>th</sup> month of a schematic luni-solar zodiac calendar is visualised in Figure 3 (the diagram is an approximation as reconstructed from the existing data in the fragment, including Night 10, which following the formula will have the equivalent of five-sevenths light, as shown in the shaded areas):

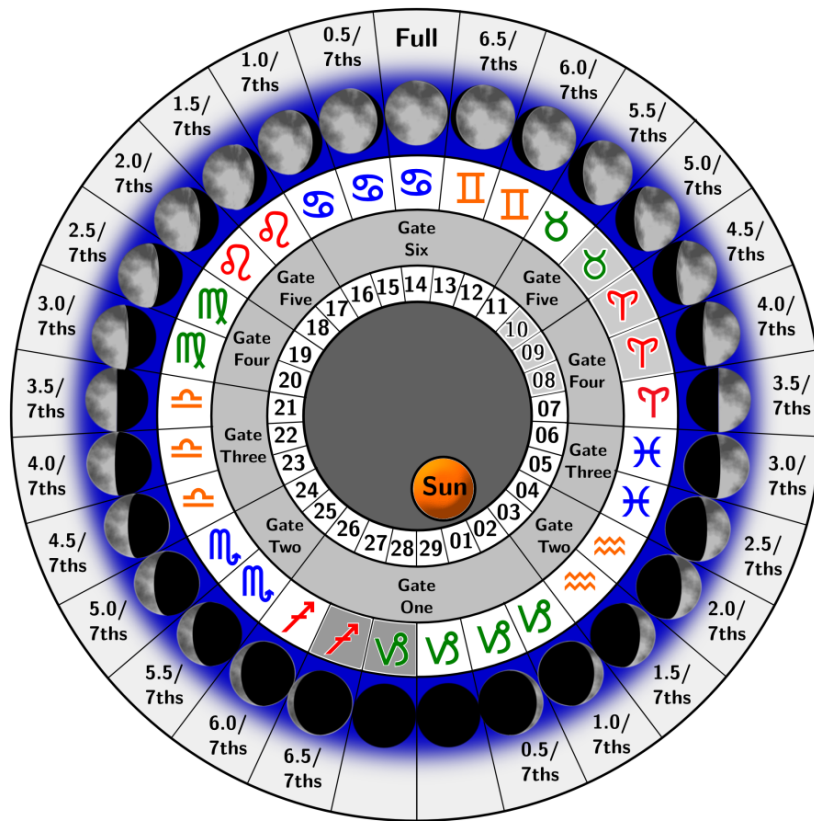


Fig. 3: The full month feasibly described in 4Q209 frag 7 col. iii. The inner circle comprises the days of the lunar month. Zodiac sign key: Aries ♈; Taurus ♉; Gemini ♊; Cancer ♋; Leo ♌; Virgo ♍; Libra ♎; Scorpio ♏; Sagittarius ♐; Capricorn ♑; Aquarius ♒; Pisces ♓

The lunar day numbers are in the inner circle. The fractions in the outermost wheel represent the proportions of light and dark on the lunar surface during the waxing phase (Days 1 to 14) and the waning phase (Days 15 to 28) or, the fractions here represent time intervals between sunset and moonrise, and

sunset to moonset, respectively (according to Drawnel, 2011, see above).

Based on schematic zodiac calendars in related texts from Mesopotamia and 4Q318 (see Brack-Bernsen and Steele, 1974, Jacobus, 2014, chapters 1 and 3) the moon's journey through Gates 4 and 5 lines up

with its movement from Aries (Gate 4) to Taurus (Gate 5) in 4Q209 frag 7 col iii, lines 4-8 (lines 8-10 on the page, can be reconstructed from the repeated formula).

It "rises and shines" (verbal phrase in the text for the waxing moon) for 4.5/7ths after sunset in Gate 4 [the "gate" number is not mentioned in the text] on the evening of Day 9 and sets and enters Gate 5. It rises in Gate 5 on Day 10 after sunset. The sun remains in Gate 1, (Capricorn).

The lunar nights when the sun and moon move to conjunction on nights 29 and 30 are not represented in the manuscript as the textual formula states that the moon is empty of light at the end of the month [4Q209, frag 6, line 9]. The sun has moved through two 'dark moon' days in Gate 1 (Sagittarius) from the previous month and entered Gate 12 (Capricorn) (4Q209 frag 7 col iii, lines 1-2 and 5-6). Accordingly, its next sign should be Aquarius (Gate 2), in the consecutive month.

Since we do not know whether the text describes a schematic 19-year luni-solar cycle, or indicates actual years, it is not feasible to pinpoint a year in reality. The alignment of the date in a lunar calendar with the solstices and equinoxes (which are solar positions) is known from the third century BCE Babylonian Uruk scheme (summary, Jacobus, 2014) and appears in a third century BC Babylonian horoscope (Rochberg, 1998, p.78). According to Rochberg, these alignments recorded by astrologers on birth chart texts have mantic significance (Rochberg, 1998).

This research independently produced the same astronomical model as Richard Laurence, in his Remarks to his English translation, *The Book of Enoch the Prophet* (Laurence, 1821). It proposes that this zodiacal construction can be applied both to the Ethiopic *Book of Luminaries* and to the Aramaic *Astronomical Book of Enoch*.

The schematic arrangement of the two and three days and nights that the moon remains in a zodiac sign (suggested in 4Q209 by the intermittent references to "gate" numbers) is based on late Babylonian zodiac calendar texts, *Kalendertexte*

(Brack-Bernsen and Steele, 2004) and probably the related Aramaic scroll from Qumran that contains a lunar zodiac calendar, *4QZodiac Calendar and Brontologion* (4Q318).

## DISCUSSION

Within the sociological context of the Dead Sea Scrolls in the milieu of a Jewish group, it should be noted that the Bible forbids people to make a map of the heavens, or to create anything physical astronomically. Deuteronomy Chapter 5, verse 8 reads:

*"You shall not make for yourself any idol or any image of anything which is in heavens above or that is in the earth beneath, or anything that is in the water under the earth"*

This probably explains why there are no diagrams, drawings, or any representative works of art or science at Qumran.

But does the biblical prohibition necessarily mean that Jews were not engaged in any intellectual scientific engagement with their neighbours in the region? This is, of course, unlikely.

Given that 4Q208 is dated to the same period as the Prosymna globe dial, there is no reason to rule out the idea that the Qumran text contained Greek science. Why this way round, and not the other direction, that is, the transmission of Judean scientific knowledge to Greece?

One argument would be that the luni-solar calendar in the Dead Sea Scrolls has alternating 29 and 30 days months. This is a Greek method of schematising the months. The first century BC Greek scientific writer Geminus refers to 59-day double month in his *Introduction to the Phenomena* Chapter 8.3 (Evans and Berggren, 2006) and the system is well attested. In contrast, the calendar in Babylonia did not have alternating 29 and 30 day months. The Babylonian calendar was based on the observation of the moon at an earlier time, and on mathematical predictive techniques later on, although schematic months are also attested (Steele, 2007, 2013).

#### 4. CONCLUSION

The Aramaic Astronomical Book of Enoch may be related to the science of Greek zodiac sundials and late Babylonian zodiac calendars. It is possible to argue that if the ordinal numbers of the heavenly “gates” represent the zodiac signs in the *Ethiopic Book of Luminaries* these same numbers can be applied to the “gates” in 4Q209 frag 7 column iii and correspond with those same signs.

The zodiac signs in the Greek sundials follow precisely the same order as the numerically substituted zodiac signs-for-“gates” in the *Ethiopic Book of Luminaries* and the Aramaic Astronomical Book of Enoch.

This paper accepts Neugebauer’s argument that the “gates” represent azimuth zones for the sun in the *Ethiopic Astronomical Book* (1 En. 72) but responds by pointing out that there is no contradiction in the theory that the solar “gates” are also zodiac signs. Furthermore, this is shown by the zodiacal sundials, including the Prosymna globe.

The moon uses the same “gate” numbers, that is, the zodiac signs; however, it is possible to see the moon against a background of stars, conversely its rising and setting points on the horizon may be less easy to record accurately in less-than-perfect conditions.

Accordingly, we may reject Neugebauer’s argument that the moon’s “gates” are also arc points on the horizon, and that they are, rather, on the ecliptic, instead. If solar Gate 4 is indeed Aries and Virgo, the “Great Gate” in the *Book of Luminaries*, it

would align materially with the Greco-Roman dials at the Mediterranean range of latitude very well as the equinoctial months are assigned the widest spatial area.

The Aramaic text of 4Q208 and 4Q209 at Qumran may be reconstructed to describe a schematic luni-solar zodiac calendar arranged according to Babylonian zodiac calendar texts with numerical “gates” corresponding to the zodiac signs. I suggest that the “gates” represent the zodiac signs in the Aramaic Astronomical Book of Enoch, that aspects of cosmology in this Qumran scheme were probably influenced by contemporaneous Greek scientific practice and late Babylonian astronomy and astrology, thereby creating the mould of Jewish astronomy unattested elsewhere.

#### ACKNOWLEDGEMENTS

My deepest thanks to the peer reviewers for their invaluable feedback and for the reference to the recently published Shaldach and Feustel study. I am also grateful to the participants of the conference for their important response to this paper and to Xenophon Moussas for his encouragement. Many thanks to Dionysios Kriaris for the reference to the ancient Globe of Macerata. I also thank him for the lift to Nafplio Archaeological Museum and to Xenophon for accompanying us. I am indebted to Warwick Cope-Williams for designing Figure 1 as a surprise, and to Derek Norcott for Figure 2, and for his beautiful production of Figure 3, as well as for all our discussions on the lunar “gates” of Enoch. The photographs were taken by the author.

#### REFERENCES

- Brack-Bernsen, L. and Steele, J.M. (2004) *Babylonian Mathemagics: Two Astronomical-Astrological Texts, Studies in the History of the Exact Sciences in Honour of David Pingree*, C. Burnett (ed.), Brill, Leiden.
- Bowen, A.C. and Goldstein B.R. (1988) Meton of Athens and astronomy in the late fifth century B.C. *A Scientific Humanist: Studies in Memory of Abraham Sachs*, Occasional Publications of the Samuel Noah Kramer Fund 9, Philadelphia.

- Carmi, I. (2000) "Radiocarbon dating of the Dead Sea Scrolls," in *The Dead Sea Scrolls: Fifty Years After Their Discovery*. Proceedings of the Jerusalem Congress, July 20-25, 1997. L. H. Schiffman et al (ed.), Jerusalem: Israel Exploration Society.
- Carusi, A. and Baldini, D. (1989) "Il globo di Matelica," *L'Astronomia*, 30-38.
- Charles, R.H. (1966) 1 Enoch, *The Apocrypha and Pseudepigrapha of the Old Testament in English*. Vol 2. 4<sup>th</sup> edition. (1<sup>st</sup> edition, 1912), Clarendon, Oxford.
- Drawnel, H. (2013) *The Aramaic Astronomical Book (4Q208-4Q211) from Qumran: Text, Translation, and Commentary*, Clarendon, Oxford.
- Duke, D and Goff, M. (2014) "The astronomy of the Qumran Fragments of 4Q208-4Q209," *Dead Sea Discoveries* 21, 176-210.
- Evans, J. and Lennart Berggren, J. (2006) *Geminus's Introduction to the Phenomena: A Translation and Study of a Hellenistic Survey of Astronomy*. Princeton University Press, Princeton.
- Gibbs, S. (1976) *Greek and Roman Sundials*. Yale University Press: New Haven.
- Lehoux, D. (2007) *Astronomy, Weather, and Calendars in the Ancient World: Parapegmata and Related Texts in Classical and Near-Eastern Societies*. Cambridge University Press, Cambridge.
- Goodman, M. (2008) *Rome & Jerusalem: the Clash of Ancient Civilizations*, Penguin, London.
- Grébaud, S. (1918-19) "Table des levers de la lune pour chaque mois de l'année," *Revue de l'Orient Chrétien* 21: 422-28.
- Greenfield, J.C. and Sokoloff, M. (2000) 4Q318 (4QZodiacology and Brontology ar), *Discoveries in the Desert of Judea vol. 36*, S. Pfann, et al., (ed.) Clarendon, Oxford.
- Jacobus, H.R. (2013) "Qumran calendars and the Creation: A Study of 4QcryptA Lunisolar Calendar (4Q317)," *Journal of Ancient Judaism* 48-104.
- Jacobus, H.R. (2014) *Zodiac Calendars in the Dead Sea Scrolls and their Reception: Ancient Astronomy and Astrology in Early Judaism*, IJS 14: Studies in Judaica, Brill, Leiden.
- Joseph, S. (2013) "'Seventh from Adam' (Jude 1:14-15): Re-examining Enochic traditions and the Christology of Jude," *Journal of Theological Studies* 64, 463-481.
- Jull, A.J.T, et al., (1995) "Radiocarbon dating of scrolls and linen fragments from the Judean desert," *Radiocarbon* 37.1: 11-19.
- Knibb, M.A. (1978) *The Ethiopic Book of Enoch: A New Edition in the Light of the Aramaic Dead Sea Fragments: In Consultation with Edward Ullendorff*. 2 vols. Clarendon, Oxford.
- Laurence, R. (1821) *The Book of Enoch The Prophet: An Apocryphal production, supposed to have been lost for ages, but discovered at the close of the last century in Abyssinia, now first translated from an Ethiopic Ms. in the Bodleian Library*. Oxford: Oxford University Press, pp: 197-199, 201.
- Magness, J. (2002) *The Archaeology of Qumran and the Dead Sea Scrolls*. Eerdmans, Grand Rapids.
- Milik, J.T. (1976) *The Books of Enoch: The Aramaic Fragments of Qumrân Cave 4*. Clarendon Press, Oxford.
- Moore, Nicholas J. (2013) "Is Enoch also among the Prophets? The Impact of Jude's Citation of 1 Enoch on the Reception of both texts in the Early Church," *Journal of Theological Studies* 64, 498-515
- Neugebauer, O. (1964) "Notes on Ethiopic astronomy," *Orientalia NS* 33: 49-71.
- Neugebauer, O. (1979) *Ethiopic Computus and Astronomy*. Österreichische Akademie Der Wissenschaften Philosophisch-Historische Klasse, 347/22. Verlag Der Österreichische Akademie Der Wissenschaften, Vienna.
- Neugebauer, O. (1981) The 'astronomical' chapters of the Ethiopic Book of Enoch (72 to 82), Translation and commentary, with additional notes on the Aramaic fragments



- by Matthew Black, *The Royal Danish Academy of Sciences and Letters*, Copenhagen, 3-42.
- Nickelsburg, G.W.E and Vanderkam, J.C. (2004) *1 Enoch: A New Translation*. Fortress Press, Minneapolis.
- Rochberg, F. (1998) *Babylonian Horoscopes*. Transactions of the American Philosophical Society 88. Philadelphia, American Philosophical Society.
- Rowland I.D. et al., (1999) *Vitruvius. Ten Books on Architecture*. Cambridge University Press: Cambridge.
- Simon J. (2013) "Seventh from Adam (Jude 1: 14-15): Re-examining Enochic Traditions and the Christology of Jude," *Journal of Theological Studies* 64, 463-481.
- Schaldach, K and Feustel, O. (2013) "The Globe Dial of Prosymna," *BBS Bulletin* 25 (iii) September, 6-12.
- Steele, J.M. (2007) "The length of the month in Mesopotamian calendars of the first millennium BC," (J.M. Steele, ed), *Calendars and Years: Astronomy and Time in the Ancient Near East*. Oxford, Oxbow, 133-148.
- Steele, J.M. (2013) "Shadow-length schemes in Babylonian astronomy," *SCIAMVS* 14: 3-39.
- Tigchelaar, E.J.C. and García Martínez, F. (2000) 4Q208-209. *4Q Astronomical Enoch<sup>a-b</sup>*. S. Pfann et al, (ed). *Discoveries in the Judean Desert 36 Qumran Cave 4. 26. Cryptic Texts and Miscellanea. Pt 1*, Oxford: Clarendon, 95-171.
- VanderKam, J.C. (1994) *The Dead Sea Scrolls Today*, Eerdmans, Grand Rapids, Michigan.
- VanderKam, J.C. (2012) *The Book of Luminaries. Chapters 72-82, 1 Enoch 2*, Nickelsburg, G.W.E and VanderKam, J.C, (Baltzer, K. ed.), Fortress Press, Minneapolis.