

Teaching The Astronomical Visualization Used For The Explanation Of The Ancient Ein-Gedi Archaeological Zodiac And Its Related Inscription

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ABSTRACT

In teaching the history of astronomy, mosaics found at ancient synagogues in the Middle East are invaluable. The ancient Zodiac signs forming such mosaics are related to the seasons indicating the fact that the precession of the Earth axis had been neglected or even unknown. We demonstrate that the sage's derivations of the patriarch's ages in the chronology of the Septuagint version of the bible correspond to the signs of the zodiac, an assumption supported, for example, by the inscription found in the ruins of the Jewish synagogue in Ein-Gedi. Through our astronomical calculations we solve the sun-moon conjunctions occurring at the beginning of the zodiac signs – at the Vernal Equinox - considering the real sun's orbit. Since the Septuagint version of the bible is assumed to have been translated into Greek in the 3rd century BC from an earlier existing Hebrew source, the fact that the ages of the patriarchs correspond to the observations of the real sun's motion, leads to the conclusion that the Septuagint version is an important book of the history of science. As a result of our findings, the bible can, thus, be regarded as one of the most ancient detailed scientific teaching sources leading to improved astronomical models which determined the planetary orbits.

Keywords: Astronomy Teaching; Masoretic and Septuagint Text; Ancient Astronomy; Ancient Astrology

The biblical ages of the first ten patriarchs as given in the Septuagint and the Masoretic versions of the bible, are summarized in Figure 1.

Figure 1. The chronology from Adam to Noah, according to the Septuagint and the Masoretic versions of the Old Testament. The Septuagint data and the names' method of spelling in the Figure are based on the New English Translation of the Septuagint (NETS, 2009).

	SEPTUAGINT				MASORETIC			
	A	B	C	D	A	B	C	D
Adam	230	230	700	930	130	130	800	930
Seth	205	435	707	912	105	235	807	912
Enos	190	625	715	905	90	325	815	905
Kainan	170	795	740	910	70	395	840	910
Maleleel	165	960	730	895	65	460	830	895
Jared	162	1122	800	962	162	622	800	962
Henoch	165	1287	200	365	65	687	300	365
Mathousala	167*	1454	802	969	187	874	782	969
Lamech	188	1642	565	753	182	1056	595	777
Noe**	500	2144	348	950	500	1556	348	950

* In the Alexandrinus version from the 4th century AD, Metuselah's age in A is 187. In the earlier version, the figure was 167 in spite of the contradiction between the year of the deluge (2242) and the year of the death of Metuselah (2256).

** In some sources – 502.

We note that in the text we use the Masoretic names as follows: Adam, Set, Keenan, Mahalallel, Jared, Hanoch, Metuselah, Lemech, and Noah

A = Age when the forefathers were born in the lineage.

B = Anno Mundi.

C = Length of life after A.

D = Total length of life.

Students studying Genesis, Chapter 5, which provides the data summarized in Figure 1, are amazed by the high number of years in age assigned to the patriarchs in the two milestones of their long lives. When discussing the ages of the patriarchs at the time the forefathers were born (column A in Figure 1), most researchers only address the Masoretic version (see, for example, Barnouin, 1970 and the list of references in Kvasnica, 2005). In this work, however, we concentrate on the Septuagint version aiming to prove that the ages result from detailed astronomical-astrological calculations.

Our approach is based on the following:

We find in the Talmud that a person's characters are ruled by the various planets in each day of the week in which he was born, in accordance with common contemporary beliefs (See, for example, Talmud¹).

Such a strong relation is expressed in all major languages by naming the weekdays after the planets (as, for example, Saturday [after Saturn], Sunday and Monday in English).

The above interrelation between the names of the weekdays and the planets originates from the Planetary Hour's system as described, for example, in Rashi's (Rabbi Solomon Yitsacky) explanations to the Talmud².

Consequently, it is clear that the ancient cultures believed in the power of planets as rulers of the hours and the weekdays. And the question arises whether in the ancient cultures there were also rulers assigned to the mean months of the year in connection with the stars in the sky.

¹ Talmud, Mas. Shabbath 156a. "It was stated. R. Hanina said: The planetary influence gives wisdom, the planetary influence gives wealth, and Israel stands under planetary influence."

² Talmud2, Mas. Eruvin 56a. ש"הל"מ כצנ"ש - the abbreviations in Hebrew of the 7 planets ruling the first hours on the mornings of the weekdays from Sunday [המזר] to Saturday [שבתא] (המזר).

Unexpectedly, an inscription found in the ruins of a synagogue in Ein Gedy, near the Dead Sea (Figure 2, see Discussion) is claimed by us to have provided the answer:

Figure 2. The Ein Gedi Inscription (See Discussion):



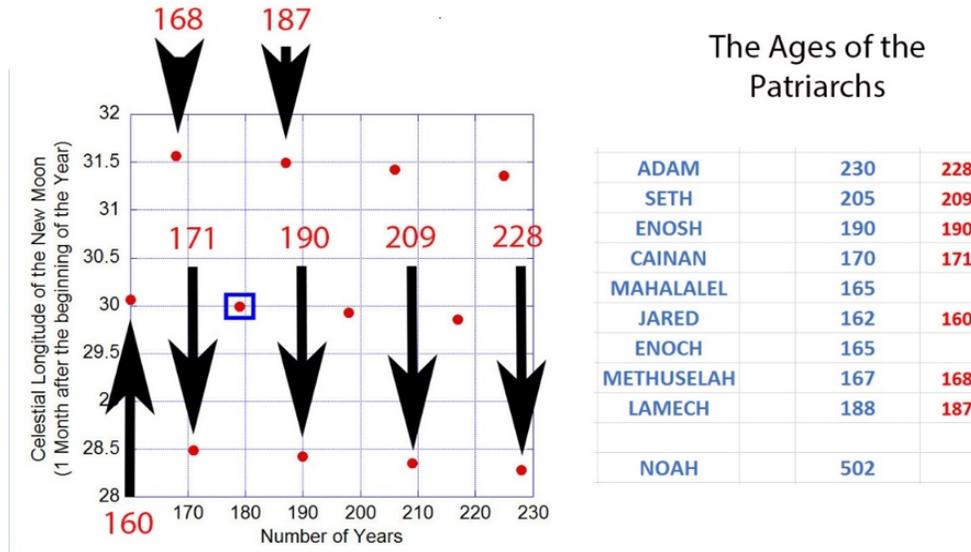
אדם (Adam) שת (Set) אנוש (Enosh) קינן (Keenan) מהללאל (Mahalallel) ירד (Jared)
 חנוך (Hanoch) מתושלה (Metuselah) למך (Lemech) נוח שם חם ויפת (Noah Shem Ham and Japheth)
 טלה (Aries) שור (Taurus) תאומים (Gemini) סרטן (Cancer) ארי (Leo) בתולה (Virgo)
 מאזניים (Libra) עקרב (Scorpio) קשת (Sagittarius) גדי (Capricorn) דלי (and Aquarius) דגים (Pisces)
 ניסן (Nisan) אייר (Iyar) סיון (Sivan) תמוז (Thammuz) אב (Ab) אילול (Ellul)
 תשרי (Tishrei) מרחשון (Marcheshvan) כסליו (Kislev) טבת (Tevet) שבט (Shevat)
 ואדר (and Adar)

The inscription clearly relates the 12 lunar months in the Hebrew calendar to the 12 Zodiac signs and the antediluvian Patriarchs.

As a result, we have added the assumption that the sages who wrote chapter 5 of Genesis were trying to make each patriarch the ruler of a zodiac sign in the sky (with Noah the ruler of 3 signs). Our next step was to calculate how many years would be required to correspond a new-moon as close as possible to the beginning of any zodiac sign in the sky?

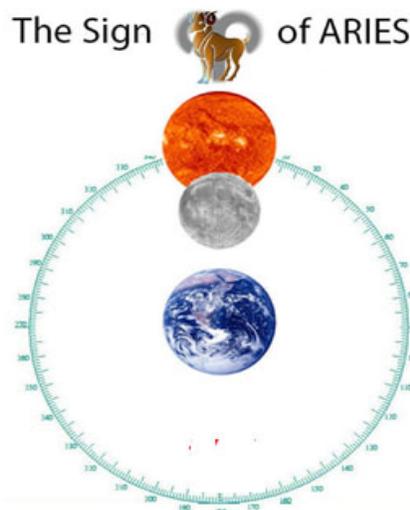
In solving that enigma, we were astounded to realize that the straightforward astronomical calculations led us to the ages of the patriarchs. Figure 3 summarizes the result of the calculations which are detailed in the following Sections.

Figure 3. Assuming that the first conjunction of the sun and moon takes place on a celestial longitude of 0° , the red dots indicate the number of years that must pass until a conjunction is found on a celestial longitude between 28° and 32° . The dot inside the blue square indicates that the number of years is $179\frac{1}{12}$ for the celestial longitude of 30° . On the right is the amazing comparison between the ages of the Patriarchs in Genesis 5 (in blue) and the calculation values (in red).



In Cohen, 2018, we showed that in the years of creation, the birth of Abraham, Exodus, and the building of Temples I and II, the sun, the moon and the beginning of the zodiac sign of Aries (= the beginning of Spring) form a straight line as seen from Earth (Figure 4).

Figure 4. The mean sun and the mean moon have both the same 0° celestial longitude at the Vernal Equinox (the beginning of the zodiac sign of Aries – the beginning of spring).



We showed that such astronomical visualizations of the sky are very rare events, taking place in cycles of 483, 502, or 1468 years, when the lengths of the year and the mean month are taken to be $Y_1 = 365.25$ and $M_2 = 29.5$ days, and $793/1080$ of an hour, correspondingly. Following the above concept, in the next Sections, we will demonstrate that the sages determined the cited ages of the biblical patriarchs in the Septuagint version by using our suggested ancient-world approach.

Such a connection is shown below to be derived from the eccentric motion of the sun as visualized in the second half of the first millennium BC. We first discuss below the motion of the mean-sun (MS) and the mean-moon (MM) both determined as moving on perfect circles surrounding the Earth at the center. We will then use the conjunctions of the Sun and the Moon (the new moon phases) in these two ideal motions to derive the average age of the patriarchs as related to different signs of the zodiac, separated by exactly 30^0 from each other (Section 2). In Section 3, given the visualization of the astronomers of the 2nd half of the first millennium BC, the real orbit of the Real Sun (RS) is discussed leading to the practically undeniable way that, as claimed by us, was used to determine the ages of the patriarchs from Adam to Noah when they begot their following generations.

The implications of our findings to the history of science and to the originality of the different versions of the biblical chronology are summarized in the Discussion.

THE MOTIONS OF THE MEAN SUN

We first determine what would have been the average age of the biblical patriarchs cited in column A in Figure 1, had they been calculated to correspond to the MS and MM conjunctions (= Mean Synodic Months = NMs) occurring at the beginning of the different signs of the zodiac, based on the 4th-3rd centuries BC astronomical input.

In this work we assume that when calculating the chronology of the Septuagint version, the celestial longitude of 0^0 was used to correspond to the beginning of the mean sign of Aries, the first sign of the zodiac.

We consider that in the biblical year of creation, the sun and the moon were believed to have been created on a Wednesday along with the 12 signs of the zodiac (Genesis 1). Since the measurement of time (as, for example, the start of the first "Tekufat Nisan", which is the start of the mean spring season) corresponded to the MS, we assume that the MS and the MM had been at the celestial longitude of 0^0 .

Since the MS is moving at a constant rate around the mean zodiac signs it moves from one sign to the next by advancing in constant steps of 30 degrees

Let us suppose that the first NM took place at exactly the celestial longitude of 0^0 with the sign of Aries. We now want to find the number of months and years required for the MS to produce a NM with the MM at the start of the new sign (the sign of Taurus) at exactly the celestial longitude 30^0 .

In order to perform such calculations, we first assume the picture of the world in which the MS is moving, as mentioned above, on a circle with the Earth at its center as described, for example, in the planetary system developed by Aristotle 384 BC – 322 BC.

By assuming that the lengths of the solar (tropical) year and the mean lunar (synodic) month used in the Septuagint biblical chronology were $Y_1 = 365.25$ days, and $NM_1 = M_1 = 29.5 \text{ days} + 44 \text{ minutes}$ [= 29.530556], correspondingly (Ptolemy's Almagest (Toomer, 1998) and the present Hebrew month use $M_2 = M_1 + 3^{1/3}$ seconds), the celestial longitudes of the NMs are calculated in degrees to occur in steps of 29.106092^0 from each other:

$$29.530556 * 360/365.25 = 29.106092^0$$

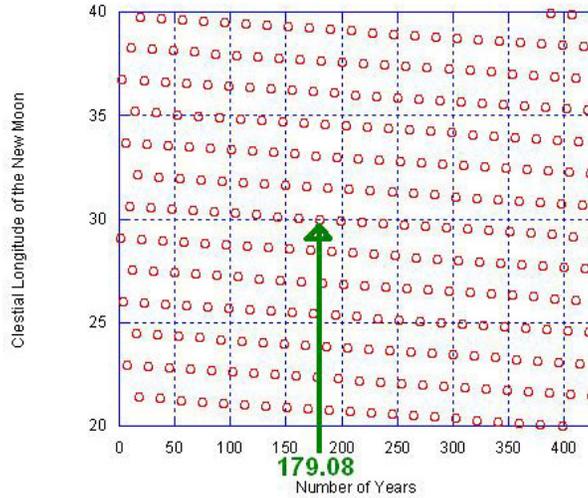
Our goal is, therefore, restricted to determine how many steps of 29.105092^0 are required for a NM to occur at the celestial longitude of 30^0 (within one hundredth of a degree).

It can be shown (Cohen, 2018; 2020) that 426 years, are exactly equal to 5269 NMs: The difference is practically negligible and amounts to 4 minutes:

$$5269 * (29.53055556) = 155596.5 \text{ days} - 4 \text{ m} = 426 \text{ years} - 4 \text{ m}.$$

Therefore, after a cycle of 426 years the NM will return to occur at the 0° celestial longitude.

Figure 5. Plots of the NMs within the cycle of 426 years that obtain a value between 20° and 40° (1/18 of the entire 5269 cycle of months covering 360°), and only one year (179.0833) corresponds to exactly 30°.



It can be seen (Figure 5) that the NM closest to the celestial longitude of 30 degrees occurs after 2215 months = 179¹/₁₂ Julian years:

$$2215 * 29.1060920 = 64469.993^0$$

$$\text{Modulo } 360 = 29.993^0.$$

In 2215 NMs, the MS would, thus, complete 179 + 1/12 cycles of 360 degrees. As to the exact number of years:

$$2215 * (29.5 \text{ days} + 44/60/24) = 2215 * 29.530555 = 65,410.18055555 \text{ days}$$

$$65,410.18055555/365.25 = (179 + 1/12) \text{ years } [-10 \text{ minutes}]$$

Consequently, if we have, for example, a mean NM at the beginning of the mean sign of Aries, then after (179 + 1/12) years, the celestial longitude of a NM will be at the beginning of the sign of Taurus.

Therefore, in order to move the NM around all 12 zodiac signs using similar steps, we would need

$$12 * (179 + 1/12) = 2149 \text{ years}$$

Astonishingly, this total number of years corresponds well with the sum of the first 10 generations of the patriarchs' ages (with the assumption that Noah represents 3 generations) in the Septuagint:

$$230 + 205 + 190 + 170 + 165 + 162 + 165 + 167 + 188 + 500 = 2142$$

We note that the sum is expected to be just roughly the same since the mean motions are replacing the real motions. We also note that the value of 2149 above, resulting from our calculations, does bring the final conjunction close to the celestial longitude of the original conjunction, since 2149 years = 5 cycles of 426 + 1 cycle of 19 years (5 cycles of 426 years brings a NM 20 minutes before the Vernal Equinox and with 100 minutes deviation in a 19 year's cycle it amounts to a relatively small deviation of 120 minutes).

THE MOTION OF THE REAL SUN

Johannes Kepler was a central figure in the scientific revolution of the 17th century and proved that the earth moves in an elliptical orbit with the sun being at one of the points of the parabola. The fact that the sun is at different distances from the earth during the year was, undoubtedly, known in the ancient world but all the motions of the planets including the sun were described as rotational motions on circles or spheres, with the earth at their center. Only in the 4th century BC a complex system of concentric spheres described by the Greek astronomer Callippus gave way to epicycles and eccentrics, and his model became the standard for correlating observations accurately over many centuries, and thus contributed to the accuracy of later astronomical theories (see, for example, Neugebauer, 1969).

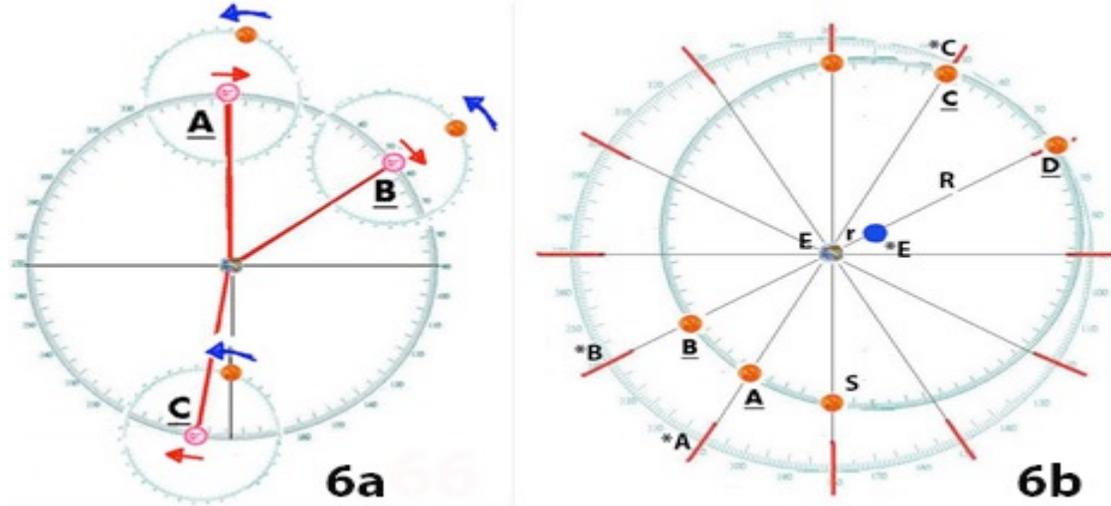
Apollonius of Perga 262-190 BC, had come out with a simpler, more accurate, epicyclical, or its equivalent eccentric, systems (Figure 6) which were both used to even better explain Callippus' observations. A century later (in 175 BC) Hipparchus measured the aphelion of the sun's orbit (when the sun is furthest away from earth) to be at what he believed to be a constant celestial longitude of 65.5^0 (with the spring point of Aries at 0^0).

But, even though only one millennium later al-Battani corrected Hipparchus' celestial longitude of the aphelion and showed that its value is constantly varying, accurate observations could have led astronomers before Hipparchus to longitudes shorter than 65.5. Since the celestial longitude of the aphelion advances gradually about 1 degree in 58 years, it follows that in the years 330 - 300 BC, the aphelion was at about $L_{ap} = 63$ degrees. This was between half a century to a century prior to the Greek translation of the Septuagint version by 70 Jewish sages. We shall refer to this value of the aphelion in the Discussion. However, regardless of the contemporary observed position of the aphelion, we assume in our derivations that all ancient astronomers accepted the anomalistic year (= the time between consecutive aphelion points) as identical in length with the tropical year as emphasized by Neugebauer, 1969. The celestial longitude of the aphelion remained constant in the calculations performed by the ancient astronomers including, specifically, those involved, as we claim, in the determination of the chronology of the Septuagint version of the bible.

To demonstrate our calculations, we shall use a simplified version of Apollonius' model as developed by Ptolemy based on Hipparchus' eccentric or epicycle systems for the tropical and the anomalistic year: As illustrated in Figure 6a, the MS moves in a clockwise motion on the large circle with a constant angular speed ($\omega = 360^0/\text{year}$), whereas the small circle, the center of which is on the large circle, represents the motion of the RS moving anticlockwise on the small circle with exactly 1/2 of the angular speed ω . With a radius R of the MS's orbit (AE in Figure 6a), the radius r of the RS's circle (AS in Figure 6a) was assumed by Ptolemy to be $r = R/24$ (= [the distance between E and *E]/[the distance between and *E] in Figure 6b).

The celestial longitudes of the 12 signs of the zodiac are assumed to have an equal extension of 30^0 each and are all positioned on an outer circle the center of which is the earth. The RS would be seen from earth at the beginning of each sign moving in unequal time steps from one sign to the next. The unequal steps of the real sun are easily visualized in the eccentric model (Figure 6b) by comparing the arc AB near the perihelion point of the motion (the closest distance), against the arc CD near the aphelion. The unequal time steps are better visualized in Figure 6a where in the aphelion's celestial longitude B (at 65.5^0) the motions of the RS and the MS are exactly in opposite directions. This causes the RS to be slower relative to the zodiac signs. However, as they approach the perihelion (point C in Figure 6a) the two directions are similar and the RS moves faster relative to the zodiac signs.

Figure 6. The epicycle (Figure 6a) and the eccentric (6b) models of the motion of the RS both lead to exactly the same varying speeds of the RS (see, for example, Ptolemy, mid-2nd century AD). Point A in Figure 6a represents the position of the MS on the day of creation, at the celestial longitude of 0^o, whereas point C represents its position at the beginning of the real autumn. Points B in Figure 6a and D in Figure 6b, are the aphelions the celestial longitudes of which are 65.5^o.



Using either one of the two models with the aphelion (where the celestial longitudes of the RS and the MS are identical – point B in Figure 6a, or point D in Figure 6b) is assumed to be at the celestial longitude of 65.5^o, the celestial longitudes of the RS corresponding to the celestial longitudes of the MS at the beginning of each sign can be calculated. The results are presented in Table 1.

Table 1. The celestial longitudes of the RS when the MS's longitudes correspond to the start of a mean sign of the zodiac: $C_R(I) = L_R(I+1) - L_R(I)$. [Note that when $I+1 = 13$, $C_R(12) = L_R(1) + 360 - L_R(12)$]. $D(I) = L_M(I) - L_R(I)$.

List the Number of the zodiac signs I	Zodiac sign S	Celestial Longitude of the Mean Sun L_M	Corresponding Celestial Longitude of the Real Sun L_R	MS-RS D	Real Sun Steps Between Consecutive zodiac signs C_R
1	Aries	0	2.1344	-2.1344	29.2062
2	Taurus	30	31.3406	-1.3406	28.8788
3	Gemini	60	60.2194	-0.2194	28.8267
4	Cancer	90	89.0461	0.9539	29.057
5	Leo	120	118.1031	1.8969	29.5313
6	Virgin	150	147.6344	2.36556	30.1559
7	Libra	180	177.7903	2.2097	30.775
8	Scorpio	210	208.5653	1.4347	31.1958
9	Sagittarius	240	239.7611	0.2389	31.2678
10	Capricorn	270	271.0289	-1.0289	30.9619
11	Aquarius	300	301.9908	-1.9908	30.3936
12	Pisces	330	332.3844	-2.3844	29.75

As mentioned above, let us, now, assume that the writers of chapter 5 in Genesis chose the NM in the Septuagint's year of creation to take place when the MS was at the celestial longitude of 0 degrees corresponding to the beginning of the sign of Aries. This assumption is supported, for example, by Maimonides (12th century), who emphasized that ancient Jewish sages believed that Nisan's NM took place on a Wednesday, close to the beginning of "Tekufat Nisan".

At that moment, the RS is positioned at the celestial longitude of 2.1344^0 . When the MS reaches the celestial longitude of 30^0 in correspondence with the beginning of the sign of Taurus, the RS would be at the celestial longitude of 31.3406^0 . Consequently, the RS would, thus, have to complete the required number of full turns plus $31.3406 - 2.1344 = 29.2062^0$ (as summarized in Table 1).

As a result, in order to find the RS at the beginning of the zodiac signs $S(i)$ when a NM takes place, the RS would have to move through them in steps of a full number of years plus the corresponding values $C(i)$ in Table 1 (calculated for the aphelion at 65.5^0) which are between 28.75^0 and 31.25^0 .

If we return to Figure 5 in order to find the number of years that are necessary to advance with required steps surrounding the average value of 179.0833 (calculated above for the MS), we get the detailed results shown as in the left part of Figure 3.

By studying the marked values in Figure 3 it is evident that the writers of the chronology of the Septuagint version used these exact calculations to determine the ages of the patriarchs when they begot their following generations. With the contemporary constraint applied in accordance with the ancient view that sun-moon conjunctions are related to historical milestones (see Discussion), it was possible to build up the general structure of the ages of the patriarchs based on the above calculations. Rounded, the numbers came out as 230, 205, 190, and 170 replacing 228, 209, 190 and 171 for the ages of Adam, Set, Enoch and Keenan when they became the fathers of Set, Enoch, Keenan and Mahalallel, respectively. The first zodiac sign for which the MS was expected to advance with a step slightly over 30 degrees, was the sixth sign. Consequently, the choice for the age of Jared, the 6th patriarch, was 162, very close to the calculated value of 160. The ages of 167 and 188 for Metuselah and Lemech were similarly chosen to correspond with the eighth and ninth zodiac signs, for which the calculated values were 168 and 187.

However, if we assume that they wanted to relate the NMs to real conjunctions occurring at the beginning of each sign, they knew that the number of years should not match the numbers in Figure 5 exactly. The real conjunctions would differ from the average as a result of the difference between the RM against the MM.

Neugebauer, 1969 points out that, as mentioned above, even before the 4th century BC the Babylonian astronomers had records indicating that the time steps between real NMs are not constant.

The maximum deviation in degrees between RS – RM and MS – MM conjunctions had been determined by the Hipparchus-Ptolemy's model to be over $\pm 7^0$. It is, therefore, expected that the number of years between two consecutive real NMs occurring at the beginning of adjacent zodiac signs could vary from the given values in Figure 5. However, the detailed astronomical calculation tools provided by Ptolemy (mid-2nd century AD) in the Almagest following Hipparchus general scheme (mid-2nd century BC) for the derivation of the estimated lengths of the real synodic months were not available when the bible was translated in the 3rd century BC. In fact, when we have used Ptolemy's methods they did not lead us to a better accuracy in calculating the 0-2 year's differences (except for one difference of 4 years) between our number of years corresponding to the set of NMs close to the mean value of $179^{1/12}$ years, against the very large number of years incorporated by the sages to the Patriarchs in Genesis 5 (A in Figure 1).

Moreover, the mean NMs satisfied a model of the rotation of the RS, which gave us a picture of the state of the art of contemporary astronomical achievements in the 3rd century BC: The ages A in Figure 1 describe the motion of the real sun during the year, an unprecedented scientific accomplishment. Chapter 5 of Genesis can therefore be considered a rare source text for understanding the historical developments of astronomy and the history of science in general, see Figure 7.

Figure 7. (Right) The ages of the first 9 patriarchs and the celestial longitudes of the mean NMs: Seven of the calculated average NMs motion of the sun (circular dots in red) compared to the ages of the patriarchs and the corresponding steps of the RS (squares in blue), calculated by using the astronomical eccentric of epicycle models in Figure 6. (Left) The comparison calculated for a celestial longitude of the aphelion at 63° and a ratio of the mean to the maximal RS's distances of 18/19.

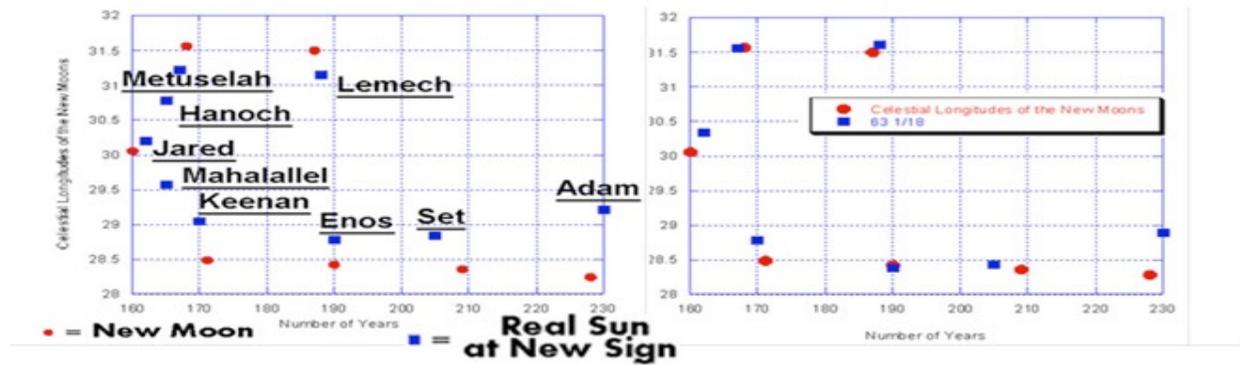


Figure 8. The eccentric visualization of the motion of the sun, and the biblical patriarchs' ages as related to the signs of the zodiac

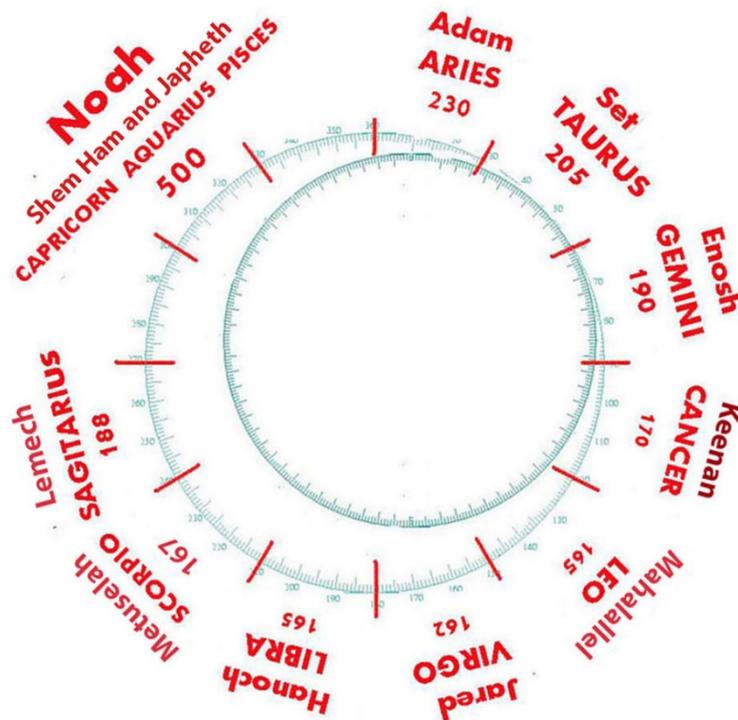


Figure 7 combines the following:

- a. The biblical ages of the patriarchs and their corresponding celestial longitudes as calculated in Table 1 assuming that each patriarch was born at the exact beginning of a mean zodiac sign (represented by the blue squares).
- b. The astronomical calculations of all celestial longitudes of the Mean Moon as in Figure 3 and 5 (represented by the circles).

Figure 8 summarizes the visualization of the ancient world, relating the patriarchs' ages when they begot their following generations with a new zodiac sign. This indicates their belief that each patriarch “controlled” his corresponding zodiac sign:

In the Figure, we show the span in years of the patriarchs’ “kingdoms” each attached to a zodiac sign. Those are the years when the scepter departed from the patriarchs to the next generation, as shown in the Figure: For example, the year 228 in the figure signifies the end of the “Kingdom of Adam” starting from the year of creation.

With the ages of Keenan and Hanoch chosen by the writers of the chapter in Genesis to be 165, there is no doubt that the motion of the RS around the Earth was their visualization of the years as related to it. Those two ages were needed by the sages who wrote the chapter to complete the motion of the sun during, approximately, $\frac{3}{4}$ of the solar year.

So, what about the remaining $\frac{1}{4}$ of the year? As explained in the Discussion, the sages assigned Noah control of the remaining 3 zodiac signs.

Based on this assumption, we found that the straightforward astronomical calculations suggest the year that Noah’s “kingdom” ended to be as follows:

6175 months after the birth of Noah the MS changed its longitude by:

$$6175 * 29.1060917^0 = 179730.11636^0 6175 \text{ and}$$

$$179730.11636^0 / 360^0 = 499.2503 \text{ years}$$

Indeed, adding 3 months (= 0.2503 years [+0.12 days]) to the time of year represented by the celestial longitude of the MS when Lemech begot Noah, would bring the year back to the celestial longitude of 0^0 , its original longitude when Adam was created.

6175 months equal 499 years and 3 months (plus a fraction of a day), indicating that Noah ended his kingdom at his 500th year. Accordingly, in the Septuagint and the Masoretic versions of the bible, Noah begot Shem when he was 500 years old indicating that the year 500 in the bible was also carefully chosen, which also provided the closest value to bring the sum closer to the value of $12 \times (179 + 1/12)$ discussed in Section 2.

DISCUSSION

During the years 1970-71 researchers D. Barag and Y. Porath from the Hebrew University of Jerusalem led the excavations of the synagogue near Kibbutz Ein-Gedi (Figure 9). The newly excavated synagogue was built in the lowest geographical point of the world, 410 meters below sea level near the Dead Sea. The excavations uncovered a highly relevant inscription, an engraving that relates the zodiac signs with the names of the patriarchs (Figure 2).

Figures 9. The general view of the Ein-Gedi synagogue today, including parts of the inscription in bottom-right. Part of the Inscription of the Western Aisle Mosaic., was uncovered by Barag, Porat and Netzer in 1972: Israel Exploration Society.



The ancient inscription provides solid proof to our basic assumption detailed in the sections above that the ancient Jews, like those who lived in Ein-Gedi as early as the first centuries AD and even prior to it, believed that there is a connection between the zodiac signs and the antediluvian patriarchs. The names of the first 9 patriarchs were engraved along with their equivalent zodiac signs starting from the 1st pair, Adam and Aries, through the 9th pair, Lemech and Sagittarius.

As for the three final zodiac signs, their names are written in a curious way: As in I Chronicle 1:1-4:

- 1: Adam, Set, Enosh,
- 2: Kenan, Mahalallel, Jered,
- 3: Henoah, Metuselah, Lemech,
- 4: Noah, Shem, Ham, and Japheth.

Noah is mentioned along with his three sons as the patriarch related to signs Capricorn, Aquarius and Pisces.

The last verb states that all four patriarchs Noah and his sons are related in the inscription to the remaining three zodiac signs Capricorn, Aquarius and Pisces.

The word and ו (in Hebrew) is used 3 times in the inscription: The first time it is used to show the relation between Noah and his three sons, all of whom were born before the deluge: Noah, Shem, Ham, **and** Yefet. This format of expression was used in Hebrew to denote a family unit and relates the three sons to Noah (שם הם ויפת). The second time the use suggests that Capricorn and Aquarius (and) Pisces all relate to Noah along with his three sons. The third time the word **and** connects the last two months of a Hebrew year which is short of the solar year by 10.88 days.

In this work we are interested only in the first two: It is clear that the engravers had to relate the four names they used to three zodiac signs. Moreover, when engraving the last three zodiac signs they used, as emphasized, the word and to connect them. If one claims (as, for example, in an enlightening study of the inscriptions by Magnés 2015 that only Capricorn and Aquarius were connected, and related to Noah, while the last zodiac sign is connected to one of the three sons, the question that arises is why mention all three sons?

Our derivations above suggest that all three final zodiac signs, Capricorn and Aquarius-Pisces, were linked to the 10th and last antediluvian patriarch the father of Shem, Ham and Yefet. The chronology of this is detailed in Genesis 11 against that of the 10 antediluvian patriarchs discussed in Genesis 5.

In summary of the previous sections, unlike some scribal attempts made in the past to relate the years mentioned in Genesis 5 with planetary cycles (as relating 777, the years of Lemech in Figure 1 B, D, to the “cumulative synodic periods of Jupiter and Saturn”, (Barnouin, 1970), our approach is exact and straightforward. Our comparison between

the calculated values of the number of years required to advance the RS – MM conjunctions in steps of 30^0 through the different seasons of the year and the ages of the patriarchs as presented in Figure 7, leave hardly any doubt that the ages of the patriarchs were determined by the sages who wrote the chronology of the bible based on astronomical calculations.

Moreover, it is known that the ancient world's estimates of the sun's distance from the Earth were erroneous. For example, the ratio of $r/R = 1/24$ used by Ptolemy to express the difference between the maximal and average distances of the sun from earth is off by about a factor of 2 from the presently accepted ratio. In fact, taking into account that the constant celestial longitude of the aphelion could have been measured to be 63^0 if calculations were performed in the late 3rd century BC and a larger ratio for the sun's distances would have been assumed, an even better agreement would have been achieved as shown in the left side of Figure 7.

Therefore, Figures 7 (left and right) show that examination of the method used by the sages to select of the ages of the patriarchs is invaluable to the study of the history of science, and astronomy in particular.

The motion of the RS was recognized by the ancient world as early as the basic biblical chronology in Genesis was put together. It can contribute to our understanding of the development of science side by side with the development of common beliefs regarding the role of the sun and moon in shaping the world's history. Such beliefs were known to exist in the ancient world as expressed, for example, through a very specific statement made in the ancient reference of Pirkei DeRabi Eliezer (6th century AD):

All the signs are servants to the sun-moon conjunctions and the generations of mankind, and on them the world sustains. And an expert in them is capable of understanding the connection between sun-moon conjunctions and the generations of mankind. And that is the biblical intention in stating [in Genesis 1, verse 14] – 'and let them be for signs, and for seasons'.

Such beliefs of the role of the sun, the moon and the planets were also known in the Hellenistic culture as articulated by the Hermetic approach (Bowker, 2005) and played an important role in several other different cultures, as in the Inca's myth (Kulmar, 1999). They expected that the movements of the sun and the moon had meaning beyond the laws of physics and held metaphorical value as symbols in the mind of God. This approach is well described in L. Ness' thesis in which he emphasizes the role of astrology in Judaism in Hellenistic times, see Ness, 1990.

Finally, Figure 1 calls attention to the known fact that the different chronologies were not derived independently. At least 7 patriarchs had the same age in both chronologies except for a difference of exactly 100 years. Only one version can be claimed as the original from which the other was modified (for reasons clarified in Cohen 2005; 2018).

Our findings explain the logic behind the determination of the ages in the Septuagint version, a logic which cannot be applied to the ages A (in Figure 1) in the Masoretic version.

If we, as scientists, are disinclined to accept the claim that the writers of the chronologies chose the patriarchs' ages randomly, we should prefer a scientific approach that explains them. As a consequence of our findings the ages A in the Masoretic version cannot be considered a part of the original biblical chronology.

AUTHOR BIOGRAPHY

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REFERENCES

- Barnouin, M. (1970). Recherches Numeriques sur la Genealogie de Gen. V. *Revue biblique* 77.
Bowker, J. (2005). Hermeticism in *the Concise Oxford Dictionary of World Religions*, Oxford.
Cohen, A. (2005). The chronology of the Septuagint text as opposed to the chronologies of the Masoretic and the Samaritan texts in light of land of israel, greek, and babylonian astronomy. *Judea and Samaria Res. Studies*, Vol. 14, ed. J. Eshel (Ramat-Gan and Ariel), (381-394), (in Hebrew with an English Abstract).

- Cohen, A. (2018). The changes in calendars in the ancient world as a tool to teach the development of astronomy. *Journal of Astronomy & Earth Sciences Education*, 5(1), 67-84. <https://doi.org/10.19030/jaese.v5i1.10193>
- Cohen, A. (2020). The mystical correspondence between the epoch of the hijra and the biblical year of creation supported by a tradition mentioned by Abu Al-Fadl and Abd Al-Qadir Baduni. *Journal of Astronomy & Earth Sciences Education*, 7(1), 31-42. Retrieved from <https://clutejournals.com/index.php/JAESE/article/view/10356>
- Kulmar, T. (1999). On the role of creation and origin myths in the development of Inca state and religion, *Folklore: Electronic Journal of Folklore*, 12, 7-15.
- Kvasnica, A. P. (2005). The ages of the antediluvian patriarchs in genesis 5, 2005 Student Academic Conference, Dallas Theological Seminary. <https://bible.org/article/ages-antediluvian-patriarchs-genesis-5>. https://www.academia.edu/37503485/Undoing_Edwin_Thiele's_twostep_emendation_vindicates_him_by_25_extrabiblical_synchronisms_With_25_August_2018_charts_30_September_2018_Edition_1.0?email_work_card=minimal-title. (In order to avoid any confusion Lietuvietis used 602 years from Noah's birth till the birth of his grandson Arphaxad)
- Maimonides, M., (12th century). 1956. "*Laws of Sanctification of the New Year (LSNY)*" Chap. 9, English translation by Gantz. Ein-Gedi Mosaic <https://www.christianhospitality.org/wp/bible-stones6/>
- Ness, L. (1990). *Astrology and Judaism in Late Antiquity*, Doctoral Dissertation, Miami University.
- NETS, 2009. *the New English Translation of the Septuagint* <http://ccat.sas.upenn.edu/nets/edition/01-gen-nets.pdf>
- Neugebauer, O. (1969). *The Exact Sciences in Antiquity*, Dover. Originally published in 1957.
- Toomer, G. J. (1998). *Ptolemy's Almagest*, Princeton University Press, ISBN 0-691-00260-6