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Frank W. Nelte

SOME BASICS OF ASTRONOMY THAT APPLY TO THE CALENDAR

When we talk about the calendar, it is helpful to be aware of certain basic facts of astronomy that have an impact on the calendar. So here is some very general information in this regard.

THE EARTH:

The earth revolves once around the sun in exactly 365 days and 5 hours and 48 minutes and 46 seconds. This is for calculation purposes also expressed as 365,242199 days. This we refer to as the solar year.

THE MOON:

There are different ways to calculate the movements of the moon, since the earth is moving at the same time. What concerns us is how we here on earth PERCEIVE the movements of the moon. This is known as a synodic month, or a lunation. A lunation is the time from one new moon to the next new moon.

3) So from our perspective here on earth, the moon revolves once around the earth in exactly 29 days and 12 hours and 44 minutes and 2,8 seconds. This is for calculation purposes also expressed as 29,530588 days.

A PERIOD OF 19 YEARS

A) 19 SOLAR years = 6939,601782 days

B) 19 JULIAN calendar years = 6939,75 days

C) 19 GREGORIAN calendar years = 6939,6075 days

D) 19 JEWISH calendar years (235 Jewish months) = 6939,689622 days

E) 19 LUNAR years (235 lunar months) = 6939,689531 days

ASSESSMENT OF THESE 19-YEAR PERIODS:

A) There is a difference between 19 solar years and 19 lunar years (i.e. 235 synodic months). In 19 solar years the 235 synodic months are 0,087749 days too long. This converts to being 2 hours 6 minutes 21,5 seconds too long for 19 years, or 1 day too long for every 216,52 years.

B) The difference between 19 solar years and 19 Jewish calendar years is that the 19 Jewish calendar years are 0,087840 days too long. This converts to being 2 hours 6 minutes 29,3 seconds too long for 19 years, or 1 day too long for every 216,304 years.

C) Thus the difference between 19 actual lunar years and 19 years in the Jewish calendar is negligible. These two differ by less than half a second per year. I have mentioned this here only to explain that sometimes you may see a slightly different fraction given for this period (216,52 years as opposed to 216,304 years, or even somewhere between these two), the reason being that one comparison may use

the data for 235 months in the Jewish calendar, while another comparison may use the data for 235 actual lunar months. The only important thing for us is that they both differ from the solar year to the tune of 1 full day for every 216 years. For all practical purposes we can refer to both, the actual 19 lunar years and the 19 Jewish calendar years, as simply "19 lunar years".

D) THE EFFECT of this is that, over a period of 216 years, lunar years UNAVOIDABLY move to one day later in the solar year. Every new moon in a 19-year period will after 216 years be one day later in relation to the equinoxes. In round numbers, after 1000 years every lunar month in a 19-year period will start almost 5 days later in the seasons than 1000 years before. This means that IF the intent is to keep the start of every year in the 19-year periods fixed within a specific season, THEN there cannot be an UNCHANGED sequence for when a 13th month is intercalated. A permanently fixed sequence of leap years would unavoidably result in the first month of every year in a 19-year period eventually progressing into the following season (i.e. from spring into summer).

To illustrate this by means of a theoretical example: Assuming that there were no changes from an astronomical point of view over the period of time that is involved, and using the Gregorian calendar for the whole period, then this shift from the time of Moses (approximately 1500 B.C.) to today would cover a period of about 3500 years. Thus if in this theoretical example the first month of year #1 in the cycle started on the spring equinox (March 21) in the days of Moses, then that same first month of year #1 in the cycle would today start 16 days later, on April 6. And if the first month of year #8 in the cycle started on April 18 in the days of Moses, then that same first month of the year #8 in the cycle would today start on May 4. So today the year #7 in the cycle would only end on May 3. The whole year would be wandering to a later date in the seasons.

The above is purely a hypothetical example to graphically illustrate the effect of the difference between 19 lunar years and 19 solar years. Using a fixed never-changing sequence of intercalating leap years into the 19-year sequence will have this wandering through the seasons as an unavoidable consequence.

E) In dealing with four different periods of 19 years (i.e. solar, lunar, Julian and Gregorian) here is what we find:

The lunar, Julian and Gregorian years are ALL longer than the actual solar years. Over a 19-year period this looks as follows:

THE 19 JULIAN YEARS are 3 hours 33 minutes 26 seconds longer than 19 solar years.

THE 19 LUNAR YEARS are 2 hours 6 minutes 21,5 seconds longer than 19 solar years.

THE 19 GREGORIAN YEARS are only 8 minutes 14 seconds longer than 19 solar years.

F) Expressed another way we find:

JULIAN YEARS are 1 day too long for every 128,19 years.

LUNAR YEARS are 1 day too long for every 216,52 years.

GREGORIAN YEARS are 1 day too long for every 3323,07 years. Since the Gregorian calendar was only instituted in 1582, this means that it will only be 1 day to long by the year 4905 A.D.. This need not concern us, and we can thus ignore the error in the Gregorian calendar, even as we can ignore the very small discrepancy between 235 months in the Jewish calendar and 235 actual synodic months.

POTENTIAL PROBLEM AREAS

The above facts mean that in any calendar discussions were need to only keep TWO potential problem areas in mind: the fact that Julian years are 1 day too long for every 128 years, and that Jewish years are 1 day too long for every 216 years. The other discrepancies can be ignored on the level that we would be examining.

The Julian calendar and the Jewish calendar thus both contain an error when compared to the solar years. However, because the error in the Jewish calendar is only 59% of the error of the Julian calendar, therefore any examination of B.C. dates will actually make the results achieved by the Jewish calendar look deceivingly flattering. As the dates in both these calendars (i.e. Jewish and Julian) recede into antiquity (i.e. to Ezra's time, then to David's time, then to the time of Moses, then back to Abraham, then back to Noah, etc.) it follows that THE GAP BETWEEN THEIR RESPECTIVE ERRORS WILL WIDEN. And that widening gap will make the incorrect results achieved by the Jewish calendar actually look good. But looks are deceiving.

To get a correct picture of what such results for B.C. dates look like, they need to be evaluated against the dates for the equinoxes in the Julian calendar in those B.C. years.

For example, the theoretical date of April 26 for the Passover in the year 3761 B.C. is TOTALLY UNREALISTIC. Since that date is in the JULIAN calendar, it means we need to know when the vernal equinox was for that year in Julian terms. Thus we find that for the theoretical year 3761 B.C. the equinox would have been on April 21. So in GREGORIAN calendar terms that April 26 Passover date for 3761 B.C. is really equal to MARCH 26.

So Year #1 in cycle #1 (i.e. 3761 B.C.) has a Julian Passover date of April 26, and a Gregorian Passover date of March 26.

Today 1997 is year #1 in cycle #304. And 1997 has a Gregorian Passover date of April 21. Thus, without any adjustments for the Julian calendar, it would look like the Passover date has hardly moved in almost 5760 years; in 3761 B.C. on April 26, and in 1997 on April 21. That seems pretty reasonable, a difference of just 5 days EARLIER! When the adjustments for the Julian calendar is taken into account, then we see that the difference is actually 26 days LATER! Thus the TOTAL DIFFERENCE is actually 31 days, from 5 days earlier to 26 days later. And that is exactly equal to the 31-day shift of the vernal equinox over that period of time.

This matter of the shifting equinox in the Julian calendar should always be kept in mind in any discussion of B.C. dates. In the typical computer program that spits out the dates for Holy Days in B.C. years according to the present Jewish calendar calculations it is easy to overlook this point.

Next, the Gregorian calendar can for all practical purposes be considered as keeping the seasons constant, in agreement with the solar year. Because of the sequence of intercalating the extra days for leap years in the Gregorian calendar, there are in actual fact very minor movements of the equinoxes and the solstices. To illustrate this, here are the exact times for the March equinox for the next few years, all expressed in Universal Time (UT), which is very similar to what used to be known as Greenwich Mean Time (GMT).

1996 = March 20, 8:03 a.m.

1997 = March 20, 1:55 p.m.

1998 = March 20, 7:54 p.m.

1999 = March 21, 1:46 a.m.

2000 = March 20, 7:35 a.m.

2001 = March 20, 1:31 p.m.

2002 = March 20, 7:16 p.m., etc.

For our purposes such minor shifts can be ignored.

THE SHIFTING OF THE JEWISH YEARS

This shift by the Jewish calendar of 1 day for every 216 years away from the equinox has been well known for a long time. For example:

A) In 1886 A.D. Isidore Loeb published in Paris that the Jewish cycle in 19 years exceeds the Gregorian by 2 hours, 8 minutes and 15,3 seconds . This makes a difference in 1900 years (i.e. in 100 cycles) of 8 days, 21 hours, 45 minutes and 5 seconds (as published in "Tables du Calendrier Juif", page 6, Paris 1886).

B)The Encyclopedia Britannica, 9th edition, volume 4, page 678, article "calendar" also stated that the Jewish years will move away from the equinox by 1 day in 216 years.

C) The Jewish Encyclopedia, copyright 1903, 1912, volume 3, page 500, article "Calendar, History of" makes exactly the same point. It states:

> "The assumed duration of the solar year is 6 minutes, 39,43 seconds in excess of the true astronomical value, which will cause the dates of the commencement of future Jewish years, which are so calculated, to advance from the equinox A DAY IN ERROR IN 216 YEARS."

EQUINOXES AND SOLSTICES

As far as the seasons and the equinoxes are concerned, here is a quotation from the Encarta 96 Encyclopedia.

"The two points at which the ecliptic intersects the celestial equator are called nodes or equinoxes. The sun is at the VERNAL EQUINOX about MARCH 21 and at the AUTUMNAL EQUINOX about SEPTEMBER 23. On the ecliptic, halfway between the equinoxes, are the summer and winter SOLSTICES. The sun arrives at these points about JUNE 21 and DECEMBER 22, respectively. The names of the four points correspond to THE SEASONS BEGINNING in the northern hemisphere ON THESE DATES. THE EQUINOXES ARE NOT FIXED, for the plane of the equator revolves in relation to the plane of the ecliptic. It makes a complete revolution once every 25,868 years. The movement of the equinoxes along the ecliptic is called the precession of the equinoxes. A correction for precession must be applied to celestial charts to find the true position of the stars at any given time." (Article "Ecliptic," Microsoft(R) Encarta(R) 96 Encyclopedia)

Thus, in general terms, we have the following situation:

SPRING: starts March 21; 92 days in length

SUMMER: starts June 21; 94 days in length

AUTUMN: starts September 23; 90 days in length

WINTER: starts December 22; 89-90 days in length

This means that in the Northern Hemisphere spring and summer together are 186 days long. By contrast, autumn and winter are only 179 days long (or 180 days in a Roman leap year).

The Jewish calendar has exactly 177 days in the first six months of the year. So in the Jewish calendar the First Day of Unleavened Bread (15th day of the first month) is always exactly 177 days earlier than the First Day of Tabernacles (15th day of the seventh month).

The difference between 186 days (spring plus summer) and 177 days is 9 days. Therefore, according to the present Jewish calendar, the Feast of Tabernacles will always start 9 DAYS EARLIER in the season of autumn, than the Feast of Unleavened Bread starts in the season of spring.

Example: For 1996 according to the Jewish calendar:

First Day of U.B. = April 4, which is 14 days after spring started on March 21.

First Day of FoT = September 28, which is 5 days after autumn started on Sept. 23.

This 9-day difference always holds true for the present Jewish calendar. IF the calendar was based on REAL new moons in the spring and in the autumn, then there would at times be 1-day fluctuations to either side of 9 days. But the key point to keep in mind is that the Feast of Tabernacles is ALWAYS about 9 days earlier in the season of autumn, than is the Feast of Unleavened Bread in the season of spring for that same year.

VERNAL EQUINOX IN JULIAN CALENDAR TERMS

In 325 A.D. the vernal equinox was on March 21 in the Julian calendar. From the above data it should be clear that the equinox moves 1 full day for every 128 years in the Julian calendar. So here is a chart with Julian years going back to the time of Moses, showing when the vernal equinox would have been. The autumn equinox and the two solstices would obviously also have moved correspondingly. But when considering theoretical dates in the days of Ezra or David or any other Old Testament individual, it is good to be aware of when spring would actually have started. Spring starts at the vernal equinox.

Keep in mind that Nisan 1 should NEVER be before the spring equinox. So when a theoretical date requires Nisan 1 to have been before the equinox that year, then you can confidently know that the theoretical data being presented to you must be flawed!

Here is the equinox data.

THE YEAR AND THE DATE OF THE SPRING EQUINOX

325 A.D. = MARCH 21

197 A.D. = MARCH 22

69 A.D. = MARCH 23

60 B.C. = MARCH 24

188 B.C. = MARCH 25

316 B.C. = MARCH 26

444 B.C. = MARCH 27

572 B.C. = MARCH 28

700 B.C. = MARCH 29

828 B.C. = MARCH 30

956 B.C. = MARCH 31

1084 B.C. = APRIL 1

1212 B.C. = APRIL 2

1340 B.C. = APRIL 3

1468 B.C. = APRIL 4

1596 B.C. = APRIL 5

etc.

This data should help in evaluating theoretical B.C. dates more effectively.

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