The Callippic Epoch of the Three Chaldean Dates in Ptolemy's Almagest

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The Almagest includes, among a long list of other astronomical data, the following three observations from Seleucid Babylonia in the 2nd half of the 3rd century B.C.:

No. 1- Almagest (IX.7): On the earlier observations of greatest elongations of Mercury: In the 75th year in the Chaldean calendar, Dios 14, at dawn (*ἑῷος*), [Mercury] was half a cubit above [the star on] the southern scale [of Libra]. Thus at that time it was in ♎ $14^1/_6$º, according to our coordinates. This moment is in the 512th year from Nabunassar, 9/10 Thoth (29/30 Oct. 237 B.C.) in the Egyptian calendar [year 11 of Ptolemy III Euergetes (246-222 BC)], dawn (*ὄρθρος*), at which time the longitude of the mean sun was ♏ $5^1/_6$º. Therefore, the greatest morning elongation was 21º.

No. 2- Almagest (IX.7): As above: In the 67th year in the Chaldean calendar, Apellaios 5, at dawn (*ἑῷος*), [Mercury] was a half a cubit above the northern [star in the] forehead of Scorpius. Thus at that time it was in ♏ $2^1/_3$º, according to our coordinates. This moment is in the 504th year from Nabunassar, 27/28 Thoth (18/19 Nov. 245 B.C.) in the Egyptian calendar [year 3 Ptolemy III], dawn (*ὄρθρος*), at which time the longitude of the mean sun was ♏ $24^5/_6$º. Therefore this [greatest morning] elongation was $22^1/_2$º.

No. 3- Almagest (XI.7): On the correction of Saturn's periodic motions: It remains to demonstrate the correction of the periodic motions. For this purpose we again select one of the accurately recorded ancient observations. In this it is declared that in the 82nd year in the Chaldean calendar, Xandikos 5, in the evening (*ἑσπέρας*), the planet Saturn was 2 digits below [the star on] the southern shoulder of Virgo. Now that moment is in the 519th year from Nabunassar, 14 Tybi (1/2 Mar. 229 B.C.), in the Egyptian calendar [year 18 of Ptolemy III], evening (*ἑσπέρας*), at which time we find the longitude of the mean sun as ♓ 6;10º. But the fixed star on the southern shoulder of Virgo had a longitude at that time of our observation of ♍ $13^1/_6$º; thus at the moment of the observation in question, since to the intervening 366 years correspond a motion of the fixed stars of about $3^2/_3$º, its longitude was , obviously ♍ $9^1/_2$º. And the planet Saturn had the same longitude, since it was 2 digits to the south of the fixed star. By the same argument, since we showed that in our time its apogee was at ♏ 23º, at the observation in question it must have had a longitude of ♏ $19^1/_3$º. From this we conclude that at the above moment the apparent distance of the planet from the then apogee was 290;10º of the ecliptic, while the mean sun was 106;50º from the same apogee.

Rearranging the above in a chronological order, we get the following:

a1): 5 Apellaios 67 SBE = 18/19 Nov. 245 B.C., dawn observation.
b1): 14 Dios 75 SBE = 29/30 Oct. 237 B.C., dawn observation.
c1): 5 Xandikos 82 SBE = 1/2 March 229 B.C., evening observation.

Because the Babylonian equivalent of the 3rd observation dated 5 Xandikos 82 SBE in the corresponding Astronomical Diary turns out to be 6 Addaru 82 SBE, it is possible that the "Macedonian" version of this date had a midnight day-epoch rather than the Babylonian sunset.

To determine whether or not these dates can be translated into a Callippic calendar whose organisation has been briefly dealt with elsewhere, I have considered the following data:

a2): Summer solstice of 330 B.C. = c. 02:00 UT, 28 June.
b2): Midnight 29 June 330 B.C. = day-epoch of the Chaldean dates.
c2): JDN (**Midnight 29 June 330 B.C.** following the summer solstice) = **1601070**

d2): JND (Midnight 19 Nov. 245 B.C. before dawn observation) = 1632260
e2): JDN (Midnight 30 Oct. 237 B.C. before dawn observation) = 1635162
f2): JDN (Midnight 1 Mar. 229 B.C. before evening observation) = 1637841

To determine whether the above quoted Chaldean dates have a common Callippic epoch in 311 B.C., the following equations must be solved for X

a3): 1 + {(1632260 – X) + INT [(1632260 – X) ÷ 63]} MOD 30 = 5 (Apellaios)
b3): 1 + {(1635162 – X) + INT [(1635162 – X) ÷ 63]} MOD 30 = 14 (Dios)
c3): 1 + {(1637841 – X) + INT [(1637841 – X) ÷ 63]} MOD 30 = 5 (Xandikos)

The only value that satisfies the above equations simultaneously is **X = 1608069**

This is the JDN of Midnight 27 August 311 B.C.

To determine whether this epoch date (27 Aug. 311 B.C.) is simply a random number or a Callippic date itself, it should be mapped on to the Callippic calendar, beginning with Midnight 29 June 330 B.C. (midnight following the summer solstice):

JDN (27 Aug. 331 B.C.) – JDN (29 June 330 B.C.) = 1608069 – 1601070 = **6999 days**

6999 ÷ 63, Q_1 = 111
6999 + 111 = 7110
7110 ÷ 30, Q_2 = 237 , r = 0
Callippic Month 237 + 1 = 238 = Hyperberetaios
Day of Month = 0 + 1 = 1 (i.e., 27 Aug. 311 B.C. corresponds to 1 Hyperberetaios of the Callippic calendar with Midnight 29 June 330 B.C. epoch)

Conclusion:

Counting Callippically from Midnight 1 Hyperberetaios = 27 Aug. 311 B.C., one gets 5 Apellaios 67 SBE, 14 Dios 75 SBE, and 5 Xandikos 82 SBE.

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