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CONTENTS

RITUALS FOR AN ECLIPSE POSSIBILITY IN THE 8TH YEAR OF CYRUS[1]

Paul-Alain Beaulieu and John P. Britton
Yale University

One of the most famous discoveries of ancient astronomers is the eclipse cycle known to us as the "Saros."[11] This cycle assumes that the moon returns to its original position relative to the nodes (the condition which governs eclipses) every 223 months. As it happens 223 months is also very nearly a whole number (239) of anomalistic months (in which the moon returns to its initial velocity), and roughly 11 days more than 18 years.[12] Consequently, one Saros cycle reflects approximate returns in lunar velocity and longitude as well as nodal elongation, a fact which made the Saros a convenient interval for investigating lunar visibility phenomena as well as eclipses, and which ultimately gave the Saros a central role in the development of the mathematical lunar theory known as System A.

These extended relationships—while important to the subsequent development of mathematical astronomy—have no bearing on the usefulness of the Saros as a simple period relationship for predicting eclipses, and need not have been known for this purpose. As an eclipse cycle the Saros implies simply that eclipses with the same magnitude and direction—qualities

11. The use of the term "Saros" to denote the eclipse cycle of 223 months is a modern anachronism which originated with Edmund Halley [*Phil. Trans.* (1691) 535–40] and was propagated by Simon Newcomb, despite efforts to correct it. For an account of its history see O. Neugebauer [1957, 141–43] and *HAMA*, 497 n 2. The Babylonian name for this interval was simply "18 years."

12. Accurately: $10.70^d = 10.42^d$ more than 18 sidereal years.

	(1)			(2)			(3)	(4)	(5)
Saros Cycle	*Babylonian Date* *King*	*Year*	*Month*	*Julian Date*			*Time of Full Moon (BCT)*	*Visibility in Babylon (BCT)*	*Magnitude*
0	Nabu-nasir	0	XII	-746	Feb	6	4;23	2.3 - 5.8	11.4
1	Ukin-zer (Pulu)	2	XII	-728	Feb	17	11;46	Daytime	(10.0)
2	Marduk-apla-iddin	10	XII	-710	Feb	27	19;00	17.1 - 20.3	8.9
3	Assur-nadin-sumi	6	XII	-692	Mar	10	2;04	0.2 - 3.3	8.3
4	Assur-aha-iddina	5	XII2	-674	Mar	21	8;58	Daytime	(6.7)
5	Samas-suma-ukin	11	I	-656	Mar	31	15;45	Daytime	(5.0)
6	Kandalanu	9	I	-638	Apr	11	22;24	21.4 - 23.5	3.7
7	Nabu-apla-usur	5	II	-620	Apr	22	4;57	4.4 - 6.1	2.1
8	Nabu-kudurra-usur	2	II	-602	May	3	11;26	None	-
9	" " "	20	II	-584	May	13	17;52	None	-
10	" " "	38	II	-566	May	25	0;18	None	-
11	Nabu-na'id	7	II	-548	Jun	4	6;44	None	-
12	Cyrus	8	III	-530	Jun	15	13;13	None	-

Figure 1.

which determined the astrological portent of an eclipse in Antiquity—should recur every 223 months, although at a given place some will occur during the day and thus not be visible. In fact, the position of the full moon recedes on average by roughly half a degree in 223 months, so the relationship implied in the Saros eclipse cycle is not quite exact.

The effect of this can be seen in Figure 1, which shows the application of the Saros cycle to the first lunar eclipse in the reign of Nabonassar (Nabû-nāṣir). The eclipse was observed in Babylon in month XII of the accession year of Nabonassar (-746 Feb 6), and its report, preserved in a text published as *LBAT* 1413 (= BM 41985), is the earliest observational record of a lunar eclipse that we possess. Beginning with this eclipse the table displays the following information. In column (1) are dates (years and months) in the Babylonian calendar at intervals of 223 months. In column (2) are the same dates in the Julian calendar. In column (3) are the times of full moon in hours and minutes reckoned from Babylonian midnight according to modern theory.[13] In column (4) are the durations of the lunar eclipses visible in Babylon, again in hours reckoned from Babylonian midnight.[14] Finally in column (5) are the (modern) magnitudes of each eclipse, those which were invisible in Babylon being shown between parentheses.

As can be seen from columns (4) and (5), the cycle works fine for a while, with daytime invisible eclipses alternating with observable eclipses as would be expected. Reflecting the inaccuracy of the eclipse cycle, however, the magnitudes drop steadily with each Saros, and eclipses disappear altogether after seven Saros cycles. For two, possibly three, cycles, this disappearance could have been ascribed to daytime eclipses, but by the next to last date in the table—month II in year 7 of Nabonidus—it would have been clear to ancient scholars that something was amiss.

13. From Goldstine [1973].

14. The times of eclipse beginnings and endings and the magnitudes shown in column (5) are from P. V. Neugebauer [1934]. These are based on the same elements as are Goldstine's computations of the time of syzygies. The latter, however, omit certain terms in the moon's motion which can have a sensible effect on the times of syzygy. Thus, despite greater precision, Goldstine's tables are less accurate than P. V. Neugebauer's.