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Achaemenid Chronology and the Babylonian Sources

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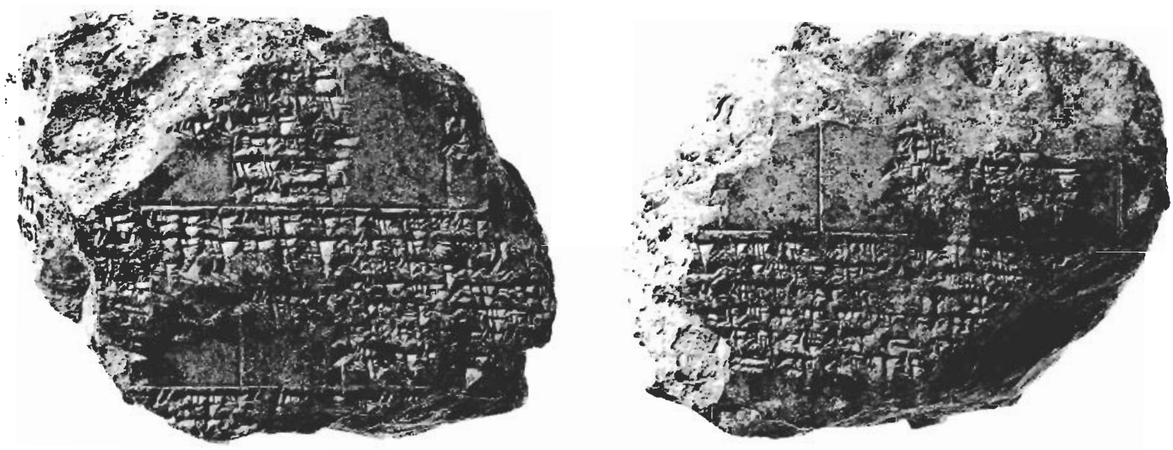
The Babylonian astronomical sources

It may be more than coincidence that there is a surviving source which in a single format could have provided Hipparchus and Ptolemy with all the accurate observations and chronology which they needed: the Babylonian eclipse lists. With the exception of one tablet more recently identified (BM 71537; see below) the relevant sources were already published or listed by the late A. Sachs in 1955,[4] under the broad heading 'Planetary and lunar observations, etc.: Moon'. Some of the texts are effectively astronomical Diaries for a single day;[5] others are evidently excerpted from the Diaries, and list (often describing in detail) all observed lunar and solar eclipses within the period which they individually cover, together with the dates (and often times) of eclipse 'possibilities' (i.e. eclipses not observable at Babylon because they took place wholly when the moon was below the horizon or during the hours of daylight, or eclipses which did not occur at all because the luni-solar conjunction or opposition was insufficiently close). The possibility of a lunar (or solar) eclipse occurs at intervals of six, or sometimes five, months, and this principle and the patterns of six- or five-month intervals were well understood by the Babylonians already by the eighth century BC. Solar eclipses may occur at half a month's interval before or after a lunar eclipse, but the pattern of six- or five-month intervals differs from lunar eclipses (hence lunar and solar eclipse lists are easily distinguishable). In principle a solar eclipse may occur both before and after a lunar eclipse, but this was not recognised by the Babylonians who only allowed one solar eclipse possibility at each luni-solar conjunction.

Some of the eclipse lists give the data in a conventional list format in one or more columns,[6] whereas others make use of the fact that eclipses of the same character typically recur at intervals of eighteen years (or more precisely 223 lunar months), the so-called Saros period, to construct elaborate tables setting out all the thirty-eight eclipse possibilities within each eighteen-year cycle in parallel columns, with the five-month intervals specified and often with rulings between each eclipse possibility.[7] Although many of the texts are poorly written and may represent little more than rough notes or memoranda, some of the tablets are beautifully written archival or library copies, in one case (Sachs *et al.* 1955: no. 1413) with 'firing holes' such as are found at an earlier period among the Assyrian tablets of Ashurbanipal's library at Nineveh (seventh century BC).

Two of the tablets formatted in Saros cycles are theoretical texts, setting out the pattern of eclipse possibilities with the dates given in terms of regnal year and lunar month, and with the position of the five-month interval carefully marked, but without any statement of whether an eclipse had been observed. These are the so-called 'Saros Canon' and the 'Solar Saros', both written in the Seleucid period.[8]

Among the remaining tablets formatted in Saros cycles one group stands out: Sachs *et al.* 1955: nos. 1414, 1415+ and 1419. They appear to be part of a set prepared by a single scribe for official purposes, describing a total of twenty-four Saros cycles covering the period (probably) from 747 to 315 BC. Horizontal rulings separate successive eclipse possibilities and vertical rulings separate the eclipse cycles (see Figs 6-7). Unusually these tablets turn not from top to bottom but sideways. Each tablet had part of twelve Saros cycles on the obverse and part of twelve more on the reverse. The complete Saros cycle of thirty-eight eclipses (or possibilities) was divided up into segments and written on (probably) eight tablets, of which we have fragments of three. If the series be deemed to start with the first eclipse of the reign of Nabonassar (which is not yet proven) then the surviving fragment of Sachs *et al.* 1955: no. 1414 dealt with (at least) eclipses 34 and 35 of the cycle, Sachs *et al.* 1955: no. 1415+ dealt with (at least) eclipses 16–20, and Sachs *et al.* 1955: no. 1419 dealt with (at least) eclipses 26–28. In all probability each tablet dealt with five eclipses, with a final tablet covering eclipses 36–38.[9] The



6-7 The lunar eclipse table fragment BM 32234 (Sachs *et al.* 1955: no. 1419). Parts of five columns survive on each side. The numbering of the columns reflects the proposed overall scheme of 24 cycles. The eclipse possibilities are identified by month and year of the Babylonian or Achaemenid king and by day, month and year in the Julian calendar. Each column is eighteen years later than the previous column, and reading down the columns each eclipse possibility is six months later than the previous possibility.

Obverse				
viii	ix	x	xi	xii
[...]	22/iii/591 BC	2/iv/573 BC	13/iv/555 BC	23/iv/537BC
[...]	xii/13 Nebuchadnezzar II	xii/31 Nebuchadnezzar II	i/1 Nabonidus	ii/2 Cyrus
4/ix/609 BC	15/ix/591 BC	25/ix/573 BC	6/x/555 BC	17/x/537 BC
vi/17 Nabopolassar	vi/14 Neb II	vi/32 Neb II	vii/1 Nabonidus	vii/2 Cyrus
[...]	12/iii/590 BC	22/iii/572 BC	3/iv/554 BC	[...]
[...]	xii/14 Neb II	xii/32 Neb II	xiib/1 Nabonidus	[...]

Reverse				
xiii	xiv	xv	xvi	xvii
[...]	[...]	[...]	5/vi/465 BC	[...]
[...]	[...]	[...]	iii/21 Xerxes	[...]
28/x/519 BC	7/xi/501 BC	19/xi/483 BC	29/xi/465 BC	11/xii/447 BC
vii/3 Darius I	viii/21 Darius I	viii/3 Xerxes	viii/21 Xerxes	ix/18 Artaxerxes II

chronological range of the series is proven by Sachs *et al.* 1955: no. 1414; although it is only the bottom left-hand corner of a tablet, its first preserved eclipse possibility (eclipse 35) is datable to 9 April 731 BC (in year 1 of Ukin-zer) and its last to 13 December 317 BC (in year 7 of Philip Arrhidaeus). While it would be presumptuous to suggest that these tablets represent Hipparchus' and Ptolemy's original Babylonian source, their source must have been something similar.

Two other features of this particular series of tablets are of interest. The times of eclipses are given, and, on each occasion in the preserved text where it is noted that an eclipse was not observed at Babylon, a precise time is given for the luni-solar opposition (syzygy); in many cases this time corresponds closely to the time of an eclipse observable elsewhere on the earth's surface. The earliest attested predictions appear to be rounded (perhaps to the nearest hour); nevertheless we appear to be dealing with a surprisingly sophisticated eclipse theory already in the eighth or seventh century BC (Stephenson and Steele, forthcoming).

In addition the tablets apparently gave details, at the appropriate points, of the death of the reigning king. Such details are a useful supplement to the deductions which one can make from changes in the dating of contemporary economic texts.[10] Only one such reference is preserved in this series of lunar eclipse tables (but see also below on the solar eclipse text BM 71537), but curiously, apart from a single brief citation (A. Sachs quoted in Parker and Dubberstein 1956: 17),[11] it remains unpublished. It concerns the death of Xerxes, shortly after a partial lunar eclipse which can be dated to 5 June 465 BC (corresponding to the third month of Xerxes' year 21):

BM 32234 (Sachs *et al.* 1955: no. 1419) Rev. col. xvi
(the beginning of the eclipse report is lost)
ina ⌈18?⌉ [...]
40? GAR Í[R *u* ZALÁG] ⌈TÚG⌉ AN ⌈GAR⌉
ina KI 4-ÀM *ár šá* PA *ád* KIN DIR
IZI 1⌈4?⌉ ⌈*ḫi*?- *ši*?⌉-*ár-šú* DUMU-*šú* GAZ-*šú*

'... in 18° [...]; 40° (duration) of onset, to[tality and clearing up], the "garment of the sky" was present; (the moon) was eclipsed in the area of the rear group of four stars of Sagittarius. (There was an) intercalary month Ulul. On the fourteenth(?) day of the month Ab, Xerxes – his son murdered him.'

Similar features appear in the only known example of a text detailing observed and possible solar eclipses in Saros cycles, BM 71537. Here too horizontal rulings separate successive eclipse possibilities and vertical rulings separate the eclipse cycles, but this tablet turns from top to bottom and the columns continue directly from obverse to reverse. Given the relative infrequency of observed solar eclipses, the small script employed and the very compressed format of this particular tablet, it seems possible that the entire eighteen-year cycle is contained on a single tablet. It is also possible that with twelve eclipse cycles on each side the tablet might have covered the time-span from Nabonassar to Philip in the same manner as

Sachs *et al.* 1955: nos. 1414, etc., do for lunar eclipses. However this suggestion should be taken with considerable caution since at present the earliest solar eclipse recorded in an astronomical Diary is that of 11 April 369 BC, and it is inevitable, given the relative infrequency of visible solar eclipses at any particular location, that solar theory developed later than lunar theory. The tablet contains predictions of solar eclipse times (Steele, forthcoming) and two dates for changes of royal rule, neither of which is directly associated with an observed eclipse:

(1) Obv. col. ii′ line 1′, the last line of an incomplete entry which, to judge by the tabulation, relates to an eclipse possibility on 15 November 359 BC (the month Ab of Artaxerxes II year 46, reads: [... *ina* AŠ.T]E TUŠ-*a*[*b*], '[...] sat [on the thro]ne'. The reference must be to the accession of Artaxerxes III, which followed within six months of the eclipse possibility.

(2) Rev. col. iii′ lines 8–10, a complete entry recording an eclipse possibility which 'passed by' on the 29th of the month Du'uzu in year 21 (of Artaxerxes III) (= 26 July 338 BC), followed by: KIN ¹*ú-ma-kuš* NAM.ME *ár-šú* DUMU-*šú ina* AŠ.TE TUŠ-*ab*, 'Month Ulul, Umakuš (went to his) fate; his son Aršu sat on the throne.' Umakuš here is a Babylonian rendering of Artaxerxes III's throne name usually rendered in Greek as Ochus. 'Went to his fate' is a common Babylonian expression for death, and by contrast with the reference to the death of Xerxes presumably indicates that Artaxerxes III died from natural causes.

These three references on BM 32234 and BM 71537 serve to underline the link seen in antiquity between eclipses and the death of kings; indeed such links underpin the survival of astrology as a significant Mesopotamian contribution to western ideas until at least the seventeenth century AD.

It should be added that the pattern of the eclipse tables is matched by fragments of similar tables of observations of Venus and Jupiter. Thus BM 32299 and BM 45674 (Sachs *et al.* 1955: nos. 1387–8) are fragments of a Neo-Babylonian Venus table in eight-year cycles covering at least the years 463–417 BC; and BM 36823 (Sachs *et al.* 1955: no. 1393) is a fragment of a Jupiter table in twelve-year cycles covering at least the years 526–489 BC.