John M. Steele

A Text Containing Observations of Mars from the Time of Nebuchadnezzar II

Summary

This paper dates and analyzes a cuneiform text from Uruk containing planetary observations. I show that the observations date to the first fourteen years of the reign of Nebuchadnezzar II (604–591 BC) and concern the planet Mars. The date of this text places it among the earliest texts containing detailed records of astronomical observations from Babylonia.

Keywords: Babylonia; Mars; observations; Nebuchadnezzar II; Uruk.

In diesem Beitrag wird ein Keilschrifttext aus Uruk datiert und analysiert, der Planetenbeobachtungen enthält. Es wird gezeigt, dass diese Beobachtungen in die ersten vierzehn Jahre der Regierungszeit von Nebukadnezar II (604–591 v. Chr.) datieren und den Planeten Mars betreffen. Die Datierung dieses Textes macht ihn zu einem der frühesten Texte mit detaillierten Aufzeichnungen von astronomischen Beobachtungen aus Babylonien.

Keywords: Babylonien; Mars; Beobachtungen; Nebukadnezar II; Uruk.

John Steele, Mathieu Ossendrijver (eds.) | Studies on the Ancient Exact Sciences in Honor of Lis Brack-Bernsen | Berlin Studies of the Ancient World 44
(ISBN 978-3-9816384-5-5; URN urn:nbn:de:kobv:11-100246190) | www.edition-topoi.de

1 Introduction

The tablet W 23009, published as SpTU V 266 by von Weiher,[1] contains observations of the synodic phenomena of a planet for the first 14 years of the reign of a king whose name is not preserved. The tablet was excavated from the so-called 'house of the *āšipu*' in Uruk (excavation area U 18) along with several other astronomical tablets.[2] The tablet is small and badly damaged and preserves only a few observation reports from years 12 to 14. Despite the paucity of preserved observational data, it is possible to identify Mars as the planet whose observations are recorded and to determine that the observations date to the reign of Nebuchadnezzar II.

The principal interest of this tablet lies not in the details of the observations themselves, which as mentioned are badly preserved, but rather in its date. Only four other texts containing planetary observations of the kind found on SpTU V 266 are known from before the end of Nebuchadnezzar's reign:

- BM 41222:[3] Observations of Saturn, approaches of Mars and Mercury, and phenomena of Mars, covering parts of the period from (at least) year 8 of Ḫumbaḫaldašu (681 BC) to year 12 of Nabopolassar (614 BC). Positions of the planets relative to stars are measured in cubits.

- HSM 1899.2.112:[4] Observations of the synodic phenomena of Mars from the beginning of Šamaš-šumu-ukin's reign (681 BC) to (at least) year 39 of Nebuchadnezzar (566 BC). The early part of the text gives only very brief statements of the dates of first and last visibilities (often accompanied by a statement that the phenomena was not observed); the last part of the text, from the time of Nebuchadnezzar, contains detailed observations of first and last visibilities, stations, and acronychal risings including the position of Mars relative to a star measured in cubits.

- BM 76738 + 76813:[5] Observations of the first and last visibilities of Saturn from (at least) the beginning to year 14 of Kandalanu (648–634 BC). Occasionally, the position of Saturn relative to a star is given with measurements in degrees.

- W 22797:[6] Observations of first and last visibilities and stations (but not acronychal risings) of Saturn from (at least) years 28 to 31 of Nebuchadnezzar II (577–574 BC). The position of Saturn relative to a star is given with measurements in cubits.

1 The abbreviation *SpTU V* refers to the volume von Weiher 1998.
2 von Weiher 1998, 1; Clancier 2009, 47–72; Robson 2008, 227–240; Ossendrijver (unpublished).
3 Published: Hunger, Sachs, and Steele 2001, No. 52.
4 Published: Britton 2004.
5 Published: Walker 1999.
6 Published: SpTU IV 171 by von Weiher (1993); discussion: Hunger 2000.

The first three tablets in this list are all almost certainly from Babylon. The last tablet, hereinafter SpTU IV 171, was excavated from the same 'house of the *āšipu*' in Uruk as SpTU V 266. It is interesting, therefore, that we have two tablets from this house containing collections of planetary observations from the time of Nebuchadnezzar. It is believed that this house was occupied by two families of scholars, one during the late fifth and early fourth centuries BC and the other during the late fourth and early third centuries BC.[7] Thus, both SpTU IV 171 and SpTU V 266 must have either been brought to this house by one of these later scholars or be a copy of an earlier tablet. It remains an open question whether the observations recorded on either of these tablets were made in Uruk or in Babylon.[8]

2 The text

SpTU V 266 is a fragment from the upper left corner of a tablet. Almost all of the obverse is lost, but a decent amount of text is preserved on the reverse. It is unclear from von Weiher's copy whether the tablet originally contained more than one column on each side. If it did, then each column of each side probably contained entries for 3 or 4 years, which would imply that more or less the whole of the original height of the tablet is preserved; if it is only a one column tablet, then a little under one half of the height of the tablet is preserved. Context would suggest that little is lost at the end of lines 5–7 on the reverse, whether or not the tablet originally contained one or two columns.

In addition to a copy, von Weiher gives a transliteration but no translation of the tablet. Von Weiher's transliteration is mainly just an attempt to identify the preserved signs without trying to understand the astronomical content of the tablet. Many of his readings are marked with a question mark (and some do not agree with his copy). I have therefore attempted a new reading of the tablet, guided both by the copy and the transliteration, but also making a number of educated guesses to correct what seem to be likely misreadings. These educated guesses go beyond what I would normally allow myself when trying to read damaged portions of a tablet, but seem to be the only way to make any progress in understanding the text at this time as, unfortunately, the tablet itself is currently inaccessible in Iraq and I have not been able to obtain a photograph to allow a proper collation. I discuss all my corrections to von Weiher's transliteration in the critical apparatus.

7 Clancier 2009, 47–72.

8 For discussions of whether there was a tradition of observational astronomy at Uruk, see Ossendrijver (unpublished) and Steele 2016.

2.1 Transliteration

Obverse

(1) MU-1 $^{\text{Id}}$A[G$^{?}$.NÍG.DU.ŠEŠ]

(2) ⸢GU$_4$$^{?}$ 4 + x$^{?}$⸣ […]

remainder lost

Reverse

(1′) x x […]

(2′) MU-12 BAR 24 x [IGI]

(3′) GAN 24 10 UŠ *ina* IGI [DELE]

(4′) *šá* ⸢IGI ABSIN$^{?}$⸣ *ina* IGI ABSIN U[Š TA x]

(5′) *ana* ŠÚ LAL-*sa* AB$^{?}$ IK$^{?}$ ŠE ⸢14$^{?}$⸣

(6′) 1$^{!}$ *šá* GIŠ.KUN-*šú* *ana* ŠÚ DIB UŠ

(7′) *e-lat* GAL$^{?}$ KI-*tum* GU$^{?}$ *ana* GE$_6$ NA

(8′) MU-13 ZÍZ 11 Š[Ú]

(9′) MU-14 SIG 18 ŠU ⸢x⸣ […]

(10′) *ina* IGI GIŠ.R[ÍN UŠ …]

2.2 Translation

Obverse

(1) Year 1, Ne[buchadnezzar$^?$ …]

(2) Month II$^?$, the 4(+x$^?$)th$^?$ […]

(remainder lost)

Reverse

(1′) … […]

(2′) Year 12, Month I, the 24th, [first visibility]

(3′) Month IX, the 24th, 10 degrees in front of [the Single Star]

(4′) in Front of the Furrow, in front of the Furrow, it was station[ary. From the xth]

(5′) it moved back to the west. … Month XII, the 14th$^?$

(6′) it passed the 1 (Star) of his Rump to the west and was stationary

(7′) above …

(8′) Year 13, Month XI, the 11th, la[st visibility.]

(9′) Year 14, Month III, the 18th … [first visibility. The nth]

(10′) in front of Lib[ra it was stationary.]

2.3 Critical apparatus

Obverse

(1) Von Weiher read SIG after the year number, but Mars's last visibility took place in month II of that year and the planet was not visible again until month V. We would in any case expect a king's name after the year number in the first line of the tablet and the traces in the copy are consistent with ^{Id}A[G.NÍG.DU.ŠEŠ] for Nebuchadnezzar.

(2) The traces at the beginning of this line in the copy are consistent with the reading GU_4 for Month II, but my reading is based upon the expected date of Mars's last visibility and must be treated with caution.

Reverse

(2′) The sign at the end of this line appears to begin with three vertical wedges in the copy and so may perhaps be either a distance measurement or a NA interval but in the former case there does not seem to be enough space for a star name before the end of the line and in the latter case we would expect IGI 'first visibility' to appear before the NA interval. Perhaps the traces are simply a damaged IGI.

(3′–4′) There must be a star name written at the end of line 3′ and/or the beginning of line 4′. On the given date, Mars was about 7 degrees to the east of the Normal Star γ Virginis 'The Single Star in Front of the Furrow', which is usually written DELE *šá* IGI ABSIN. There is space at the end of line 3′ for DELE and line 4′ begins with a *šá*. The damaged signs which follow the *šá* are most likely, therefore, to be read IGI ABSIN, which is just about consistent with the traces in the copy. Following these traces we have signs which von Weiher read TI-*qé* for a form of the Akkadian verb *leqû* 'to take away'. I cannot make sense of such a verb here and so propose to read these signs as *ina* IGI ABSIN. This still problematical, however, as it would appear to follow directly another statement of *ina* IGI DELE *šá* IGI ABSIN. It is possible that the scribe here has mistakenly given the star name twice (reading the signs as DELE ⟨*šá*⟩IGI ABSIN); alternatively, he may be giving a second, general statement of the position of Mars as 'in front of the (constellation) Furrow'. The broken text at the end of line 4′ can be restored either TA x 'From the xth' or simply *u* 'and' referring to the following statement about the retrograde motion of the planet at the beginning of line 5′.

(5′) Von Weiher read the beginning of this line as *ana* ŠÚ ½ SA DU-*ik*, but he copied an AB sign rather than a DU sign. The signs as given in von Weiher's transliteration do not make sense without emending the SA to a KÙŠ to give *ana* ŠÚ ½ KÙŠ DU-*ik* 'it proceeded ½ cubit to the west.' However, at this time, Mars was moving retrograde (to the west as stated) and DU is normally only used for direct motion (to the east). I suggest instead assuming that the sign read as ½ is a misreading of LAL and we have the phrase *ana* ŠÚ LAL-*sa* 'it moved back to the west,' a common phrase in early observational texts (see, for example, SpTU IV 171 line 16). The following signs remain problematical, however. It would be possible to take AB as 'Month X,' but I do not know how to then read the following IK sign. Mars did have its acronychal rising around the 28th of Month X, but acronychal risings are not normally reported in texts from early in Nebuchadnezzar's reign, and I see no way of reading the IK sign as a day number followed by a sign (e.g. E) or phrase (e.g. *ana* ME E-*a*) referring to acronychal rising.

(6′) The star GIŠ.KUN A 'The Rump of the Lion' (θ Leonis) is one of the Normal Stars used in later astronomical texts. The star group 2 *šá* GIŠ.KUN-*šú* '2 (Stars) of his Rump,' which presumably includes θ Leonis, appears in the standard list of 25 *ziqpu* stars,[9] and one might expect that the reference to the '1 (Star) of his Rump,' is a mistake for '2 (Stars) of his Rump.'

(7′) The reading and interpretation of this line is very problematical. A reference to Mars being above a star makes sense; however, at that time Mars was slightly to the west and about 6 degrees below θ Leonis (a star with a very high positive latitude of about 9.65 degrees). Thus, Mars must be above another star, as well as being below θ Leonis. A plausible candidate would be χ Leonis. However, I am unsure how to make a star name out of the signs in this line. Perhaps KI-*tum* is referring to the area between the legs of the Lion, and we are to assume a missing UR before the sign I read as GU (but note von Weiher reads SAL + UD for the signs I read as GU *ana*).

(8′) The traces of the sign at the end of this line are probably part of ŠÚ for 'last visibility' rather than *ina* as read by von Weiher. The gap between the day number and ŠÚ suggests that Mars's position on this day was not included in the observation report and so the scribe has spaced out the signs to fill up the whole line.

(9′) Following the day number we would expect either IGI 'first visibility' or a reference to the position of Mars. Von Weiher reads the sign KU plus some traces, which could be the first part of *ku-t*[*al*] 'back' (the preserved traces following the KU would allow for such a reading), but we would then expect *ina* before *ku-tal* 'in the back of' (*ina ku-tal* is used in this context in the early observational text BM 41222 Side A II 7′). Furthermore, von Weiher copied a ŠU not a KU sign. Nevertheless, *ku-t*[*al*] makes

9 Steele 2015.

more sense than ŠU here, so I have provisionally accepted this reading. On this date, Mars was in the rear part of the Twins, so 'back' may refer either to a part of one of the Twin's anatomy or is used in the general sense to mean the rear part of the constellation.

(10′) Von Weiher read the star name as GIŠ.K[UN] (θ Leonis) but Mars was at a longitude of approximately 185 degrees at the time of its first station, which places the planet in Libra. From the copy, a reading GIŠ.R[ÍN …] would be possible. The star is very probably α Libra, a Normal Star called RÍN *šá* ULÙ 'The Southern Part of the Scales', probably here written GIŠ.R[ÍN *šá* ULÙ].

3 Date

The reverse of the tablet records the following dated observations:

– Year 12 Month I Day 24 [first visibility]
– Year 12 Month IX Day 24 [first station] 10 degrees in front of γ Virginis
– Year 12 Month XII Day 14? second station near θ Leonis
– Year 13 Month XI Day 11 [last visibility]
– Year 14 Month III Day 18 [first visibility]

It is immediately apparent that the observations concern a planet with a synodic period of a little over 2 years. This is sufficient to identify the planet as Mars. The distribution of the dates of the synodic phenomena is also characteristic of Mars. Knowing that the text contains observations of Mars, a search of the tables of the phenomena of Mars computed by N. A. Roughton and kindly made available to the author,[10] quickly shows that only during the reign of Nebuchadnezzar II do the dates of the phenomena recorded in the text agree with modern computation. This date is confirmed by comparing the positions of Mars given for the observations of first and second station, which agree well with modern computation.

Other characteristics of the text also argue for an early date: (1) the use of degrees rather than cubits for the measurement of celestial distances is rare and only found in early observational texts, and (2) the writing GIŠ.RÍN rather than RÍN is much more common in early texts rather than late texts.

10 For details of Roughton's tables, see Roughton 2002, 370.

Babylonian date	Julian date	Phenomena	Computed date	Difference
Year 12 I 24	23/5/593 BC	First visibility	25/5/593 BC	–2 days
Year 12 IX 24	14/1/592 BC	First Station	5/1/592 BC	+9 days
Year 12 XII 14[?]	2/4/592 BC	Second Station	26/3/592 BC	+7 days
Year 13 XI 11	17/2/591 BC	Last visibility	13/2/591 BC	+4 days
Year 14 III 18	24/6/591 BC	First visibility	24/6/591 BC	0 days

Tab. 1 A comparison of the observed dates of the synodic phenomena of Mars with those computed in Roughton's tables.

4 The observations

Now that the date of the observations in SpTU V 266 has been established it is possible to analyze the observations it contains. Tab. 1 compares the fully preserved dates of the observed phenomena with the results of modern computation. The dates of the observed phenomena were converted to Julian dates using the tables of Parker and Dubberstein.[11] Note that Parker and Dubberstein's date may differ from the true Babylonian calendar by one day; a one-day error, however, is insignificant for this analysis. Computed dates were taken from Roughton's tables. These tables were calculated for an observer in Babylon, but the dates of the synodic phenomena should vary by no more (and usually much less) than one day than these if the observations were made in Uruk. Any resulting one-day error caused either by the visibility criteria or the date conversions is significantly less than the uncertainty in the date of visibility phenomena caused by the day-to-day variation in local observing conditions due to weather etc.

In general, the observed dates of visibility phenomena are in good agreement with the computed dates, with a tendency for the computed dates to be slightly later for first visibilities and slightly earlier for last visibilities, suggesting that Schoch's visibility criteria for Mars are slightly too high. In general, the differences between observed and computed dates are of the same magnitude to those found by Britton in his analysis of early the Mars observations from the time of Nebuchadnezzar on HSM 1899.2.112 and Walker in his analysis of the Saturn observations from the time of Kandalanu on BM 76738 + 76813.[12] The dates of the stationary points are considerably less accurate, both late by several days. The lateness of these observations no doubt reflects the difficulty in determining exactly when Mars changes from direct to retrograde motion; for

11 Parker and Dubberstein 1956.

12 Britton 2004; Walker 1999. See also de Jong 2002, a study of the Saturn observations on BM 76738 + 76813 and SpTU IV 171.

several days around the station, Mars moves very slowly (less than about 0.15 degrees for 5 days before and after the station).

Only one detailed measurement of the position of Mars at a synodic phenomenon is fully preserved: Mars was 10 degrees in front of γ Virginis on the 24th of Month IX of year 12. According to the NASA Horizon online ephemeris, Mars's longitude was 146.77 degrees and its latitude +4.04 degrees on this date. The longitude and latitude of γ Virginis at this period was 154.40 degrees and +3.01 degrees respectively.[13] Various studies have shown that the term 'in front of' refers approximately to a displacement eastwards in celestial longitude.[14] The computed longitude difference between Mars and γ Virginis on the date of the observation is 7.63 degrees, slightly less than the 10 degrees stated in the observation report; it is not unreasonable to suppose that the 10 degrees stated in the text is a rounded figure.

5 Conclusion

SpTU V 266 provides further evidence that the practice of regular observation of planetary synodic phenomena was already well established by the early sixth century. The observations contained in this text are recorded in a remarkably similar style to later texts; although there are small differences in terminology, especially in the names of stars, the basic format of a planetary observation report as it existed in the early sixth century BC continued until the Seleucid period. This text, the other early planetary texts, and the existence of compilations of lunar eclipse observations and of lunar six data from this period,[15] also show an interest in the systematic collection of astronomical data concerning one planet or lunar phenomena, which must surely be linked to the development of predictive methods at this period.[16]

13 The coordinates of γ Virginis were taken from Sachs and Hunger 1988, 18, for the year –600.

14 See most recently Jones 2004.

15 For the lunar eclipse texts, see Hunger, Sachs, and Steele 2001, Nos. 1, 6, and 7; and for the lunar six texts, see Huber and Steele 2007.

16 On this topic, see, for example, Brack-Bernsen 1999; Britton 2008; Steele 2000; Steele 2011; and, in general terms, Brown 2000, 161–207.

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