

Cuneiform Descriptions of Transient Phenomena

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Abstract. Sources from Ancient Mesopotamia contain mention of transient astronomical phenomena in two contexts: in records of observations, many of which can be dated, and in collections of omens, which use the appearance of such phenomena to predict future events. These omens consider quite a range of phenomena, but only rarely can they be dated in a precise way. This paper describes how transient phenomena were handled in both kinds of context.

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1. The Babylonian Diaries

Transient *objects* like comets and meteors are individual objects in their own right, whereas transient *phenomena* like eclipses and occultations mostly happen to other objects such as the Sun, Moon and stars. Many eclipses and occultations are fairly rapid (start to finish may take a few hours or less), but that is not a general rule, particularly as concerns stars. Records of observations collected from archaeological times have mainly been preserved in the so-called “Astronomical Diaries”, which contain day-by-day observations of events in the sky and on the Earth. Written on clay tablets, the Diaries bear records from the 7th to the 1st Centuries BC, but are unevenly distributed. Very few remain from the earlier half of this time, and only by the 3rd Century do they become more numerous. More than 1500 (mostly fragmentary) tablets have been preserved, and almost all come from the city of Babylon. Unfortunately they are far from complete: the texts may cover only about 5% of the time-span mentioned. Apart from the movement of the Moon and planets among the stars, the tablets list the first and last visibilities of the planets, and lunar and solar eclipses. They also report the weather, the water level in the river Euphrates, prices of basic commodities such as barley and dates, and events of local and regional interest. We also find mentions of meteors and comets.

2. Omens

While the number of Diaries may be impressive, they constitute only a minor section of Babylonian celestial lore. Most of the tablets concerning the sky are celestial omens. All Babylonian omens are in the form of conditional clauses: “If A (the sign) happens, then B (a future event) will happen”. It was generally believed in Mesopotamia that if nothing was done, the predicted events would in fact happen. The omens were seen as messages from the gods. Favourable omens indicated the benevolence of the gods; bad ones were meant to warn humans of undesirable future events. Nevertheless, the predicted events were not inevitable; it was possible to prevent unfavourable predictions from happening by means of prayer, rites and sacrifices.

Celestial omens first appear in the first half of the 2nd millennium BC, and mostly concern lunar eclipses. Omens from the sky did not, however, play an important role in

those early times; divinations from the liver of sheep were far more frequent. Only in the 1st millennium BC did celestial divinations become a dominant source of signs. However, interest in them had existed for centuries before that, and pertinent omens were also collected, as were the other signs. That finally led to the organization of celestial omens into an extensive edition comprised of about 70 tablets. The chief problem with omens is that they have no associated dates, and they need not be based on observations. While some of the descriptions of ominous signs sound plausible, others are hard to understand. The Babylonian omen collections have a tendency to strive for completeness in order to take care of every possible phenomenon, even if not yet observed. In the case of eclipses, impossible cases are sometimes included, such as lunar eclipses on day 20 or 25 of the lunar month. We therefore refer only occasionally to the omen literature.

3. Halley's Comet

In 1983 I was entrusted with the publication of the Diary tablets. When in 1984 the expected recurrence of Halley's Comet became a topic of general interest, I was asked whether the comet was mentioned in the Diaries. Since its approximate period is known, it was easy to look in the tablets concerning the years in question. What was not so easy was to read the pertinent passages, since the tablets were mostly somewhat damaged. The results were published by Stephenson & Walker (1985).

The earliest cometary observations in the clay tablets that could be identified with Halley's comet are from 164 BC. They are found on two tablets, with a slightly different wording. Both concern month VIII of the year 148 of the Seleucid era, corresponding to the span from October 20 to November 18 of 164 BC in the Julian calendar. Unfortunately, no day number was preserved for these observations; we know only the Babylonian month.

One passage reads: "The comet which previously had been seen in the east in the path of Anu in the area of Pleiades and Taurus, to the west (break)... and passed along in the path of Ea." The other reads: "... in the path of Ea in the area of Sagittarius, 1 cubit in front of Jupiter, the comet being 3 cubits high to the north ..."

Both passages need some explanation. The Babylonians divided the sky into three zones called "paths", which were parallel to the equator and bore the names of three major gods. The "path of Anu" refers to a band from $\sim +17$ to -17 declination; the "path of Ea" is the region of the sky south of it. The words "The comet which previously had been seen in the east" must refer to an observation in an earlier month, probably VII or VI. Thus, while the comet had been further north, in the path of Anu when it was observed earlier, it now had moved into the southern band. The second passage refers to an approach of Jupiter and the comet. 1 cubit is $\sim 2^\circ$. The relative position given was very useful for determining the orbit of the comet more precisely.

The appearance of Halley's Comet in 87 BC is documented in a Diary which is very fragmentary but which can at least be dated reliably. The observation of the comet is dated on month V, day 13, equivalent to August 24. The passage reads: "Night of the 13th, first part of the night, the comet (break) ... which in month IV day beyond day 1 cubit ... (break) ... between north and west, its tail 4 cubits"

Whatever the tablet said about the comet on the 13th of month V, is lost in a break. The observation reported was either the reappearance after perihelion, or the last visibility. The following partly broken sentences seem to concern only the preceding month, IV. The comet moved between 1° and 6° daily for approximately the duration of that month, as could be interpreted from the words, "day beyond day 1 cubit". When first visible, the comet was high in the eastern sky before dawn, so its tail would have pointed north-west. After perihelion the tail pointed more to the

north-east. The remark about the tail therefore very likely refers to what was seen in month IV. Though fragmentary, these reports can be identified as referring to Halley's comet.

There are also mentions of other comets, similarly badly preserved. They cannot be connected to a later comet because we do not have reports from the times of antiquity or later that could bridge the gap from modern observations.

Reports of comets also crop up in letters sent by observers to the Assyrian kings in the 7th Century BC. One contains the following sentence:

"If a comet becomes visible in the path of Anu: there will be a downfall of Elam in battle". The construction using "If" identifies it as a quote from an omen, which are always expressed as conditional sentences. But the quote occurs in a report to the Assyrian king, so something must have been observed that "fitted" the "If" clause of the omen. The date of the letter can be determined as 675 BC, but unfortunately that does not match the period of Halley's Comet.

The Babylonian word used for comet, *šallummû*, may be used not only for comets. In fact, the observations of Halley's Comet are a proof of that translation. In other contexts the word could just as well refer to meteors, which is how the *Chicago Assyrian Dictionary* translated *šallummû* in 1962.

4. Meteors

Meteors were frequently called "big stars" (a designation which was unfortunately also used occasionally for planets), or simply "star"; only from the description of its behaviour is it apparent that a meteor must be meant.

An early report is again from 7th Century letters to the Assyrian kings: "One double-hour of night had passed: a big star flashed from north to south". That was considered a good omen by the writer of the letter.

The Astronomical Diaries contain observations of meteors in 419 BC: "in the middle part of the day, a big star which was like a torch flashed from south to north, and the land heard the noise of the sky". In 292 BC: "a big star which was very bright and had a train, flashed from north to south; its light was seen on the ground ...".

5. Occultations and Eclipses

Occultations of stars or planets by the Moon are also transient phenomena, and were regularly noted in the Diaries. The Babylonian expression was "star X entered the Moon", – which is actually how it looks.

A good example is found for 400 BC April 11: "First part of the night, Saturn entered the Moon. At 28° of night (i.e. 112 minutes after sunset), Saturn returned from its inside". Sometimes an occultation was expected but not observed. This is expressed by the words, "the star (or planet) was set to the Moon's inside", meaning that the star was on a track leading to an occultation.

Close approaches of planets to stars often bear similar visual effects to occultations, and are frequently mentioned in the Diaries, when the smallest distance between them is 1 finger or 2 fingers, corresponding to 5' or 10', respectively. In rare cases the two bodies are said to have become one star.

The most vivid transient phenomena are eclipses of the Sun and Moon. As early as the first half of the 2nd millennium BC we find omens deriving from lunar eclipses, though they cannot be identified with eclipses that actually happened. From the 1st millennium BC, 8 chapters in a large omen collection deal with lunar eclipses. The descriptions of eclipses in those omens are sometimes rather detailed, but in my opinion they cannot be connected to actual eclipses, although some scholars believe the converse.

Apart from omens, eclipses are occasionally included in texts referring to daily life. For instance, a lunar eclipse is reported in a letter from the city of Mari in Syria that dates from the 18th Century BC; its significance was considered unclear so an inspection of the liver of a sheep was ordered to find out. The *Astronomical Diaries* and their derivatives contain frequent reports of eclipses. The oldest are from the 8th Century BC, and became increasingly detailed in the course of time. Reports from the 4th Century BC onwards can contain the following information:

(a) Date (year, month, day). (b) Time between moonrise and sunset (like most of time measurements, it is given in degrees of time, equivalent to 4 minutes). (c) Entrance angle of the shadow (indicated by direction, e.g., “it began on the north-east side”). (d) Time (from sunset) to maximal phase (“maximal phase” translates a Babylonian word that literally means “weeping, lamentation”; such lamentation was probably done during totality. The word is used both for total eclipses and for very long ones, hence the expression “maximal phase”). (e) Magnitude of maximal phase (often expressed as part of the lunar disk, e.g., “a quarter of the disk”, or measured in fingers, where 12 fingers correspond to totality). (f) Duration of maximal phase. (g) Time from the end of maximal phase to the end of the eclipse. (h) Direction in which the shadow leaves the disk (refers to the shadow covering increasingly little of the lunar disk, e.g., “from north-east to south-west it became clear”). (i) Total duration of the eclipse. (j) Weather (e.g., the wind blowing during the eclipse, and/or lightning and thunder, may be reported). (k) Presence or absence of planets (e.g., if planets - or Sirius - were visible during the eclipse, and/or if one of them rose or set during the eclipse). (l) Position of the Moon relative to a fixed star. (m) Time of start of the eclipse, relative to sunset or sunrise. (n) Time between sunrise and moonset. If an eclipse did not take place it is marked as “which passed by”. In the case of lunar eclipses, this could be known in advance; if a lunar eclipse was expected during daylight, it would not be possible to observe it.

There are collections of eclipse reports, some arranged like a spreadsheet in 18-year groups, such that each eclipse is accompanied to the left or right by an eclipse from 18 years before or after. This arrangement reflects the Saros cycle of 223 lunar months, after which eclipses with similar characteristics occur on the same dates in the Babylonian calendar, only with ~8 hours displacement. This period is therefore very good for predicting eclipses, and was probably used by the Babylonians from the 7th Century BC. It is also the basis of arithmetic formulæ for calculating eclipses, as found in Babylonian mathematical texts for astronomy.

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