The Sky over Ancient Iraq: Babylonian Astronomy in Context

2 Keeping the Watch: Babylonian Astronomical Diaries and More

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schedule

1. astronomical diaries and more – sources, content
2. production of a diary
3. predicting the future, explaining the past

747 BCE
Neo Assyrian era
Assurbanipal

625
Neo Babylonian era
Nebukadnezzar
Cyrus

538
Persian era
Xerxes

331
Seleucid era
Alexander the Great

141 BCE
Parthian era
1 astronomical diaries and more – sources

reports
- astronomical diaries: ca. 1000, 652–60 BCE
- eclipse reports: ca. 100, 747–10 BCE
- excerpts: ca. 100, ca. 600–50 BCE

predictive texts
- Almanacs: ca. 100, 261 BCE – 75 AD
- Normal Star Almanacs: ca. 100, 292–50 BCE
- Goal Year texts: ca. 100, 236–56 BCE
- Goal Year procedure texts: ca. 5, 600(?)–100 BCE

geographical distribution: roughly 99% from Babylon, 1% from Uruk, few from Nippur

British Museum
Babylon
Uruk

1 astronomical diaries – content

Babylonian term: "regular watch" (naṣāru ša ginê)

- ca. 1000 tablets from Babylon, nearly all in British Museum; 2 from Uruk
- range of dates: 652 BCE – 60 BCE (most from 380–60 BCE)
- each diary covers 6, sometimes 4 or 7 calendar months

content of each monthly section

1 celestial phenomena from day to day
2 market rate of six commodities (barley, sesame, dates, “mustard”, “cress”, wool)
3 zodiacal signs of the planets (after ca. 400 BCE)
4 level of river Euphrates
5 historical events

1 celestial phenomena

1 passages of Moon and planets by “Normal Stars”
2 synodic phenomena of planets (first/last appearances, stations)
3 6 time intervals between moonrise/set and sunrise/set (“Lunar Six”)  
4 solstice and equinox dates
5 occasional other phenomena: comets, shooting stars, etc.
6 weather: winds, clouds, rain, etc.
example: BM 41581 (*ADRT II*, No. –168A)

- arrived in British Museum June 25 1881 along with ca. 800 tablets, including ca. 300 with astral science

“Regular watch from month V [to the end of] month VIII of year 143, king Antiochus.”
example: BM 41581 (ADRT II, No. –168A)
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"Regular watch from month V [to the end of] month VIII of year 143, king Antiochus."
month V, day 1 (lines 1–2)

[Year] 143, king Antiochus. Month V, the 1st, sunset to moonset: 12 (UŠ); it was bright [...], it was low to the sun. The moon was 2 cubits in front of the Bright Star of the Furrow, the moon being 1 cubit 8 fingers [low] to the south, it stood 2 1/2 cubits [in front of Saturn] to the west, the moon being 3 cubits 8 fingers low to the south.

unit of time: 1 UŠ ("time degree") = 4 modern minutes (360 UŠ = 1 day)
- Babylonian day began at sunset
- Babylonian month began with first appearance of lunar crescent at sunset

units of distance: 1 cubit = 24 fingers ≈ 2.2°
- "in front of", "behind" = along ecliptic in sense of daily rotation of sky
- "above", "below" = perpendicular to ecliptic
month V, day 1 (lines 1–2)

The moon was 2 cubits in front of the Bright Star of the Furrow (α Vir), the moon being 1 cubit 8 fingers [low] to the south, it stood 2 1/2 cubits [in front of Sat]urn to the west, the moon being 3 cubits 8 fingers low to the south.
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Babylon, 7 PM Aug. 17 until 4 AM Aug 18 169 BCE (day 1, month V, year SE 143)

sunset: 6:45 PM, moonset: 7:41 PM, suggested time of observation: near moonset
lines 2–11 (continuation of celestial report: month V days 2–29)
Night of the 2nd, the moon [stood] 2 1/2 cubits behind Mars [to the east, the moon being ...] low to the south; the north wind blew. Night of the 3rd, the moon was 3 cubits below the Southern Part of the Scales (α Lib), the moon [having passed] a little to the east. (etcetera ...)

lines 12–15 (market rates, zodiacal positions, river level, historical section)
That [month] the equivalent of 1 shekel of wrought silver was: very good barley, 1 kur 1 pān 5 sut; dates, 1 kur 4 pān 1 sūt, at the end [of the month], 2 kur; mustard, 3 kur; cress, 2 pān 4 sūt; sesame, 1 pān 1 sūt 3 qa; wool, [... minas]
At that time Jupiter was in Leo; around the 22nd, Venus’s first appearance in the west in Virgo; at the end of the month, it was in [Libra]; around the 25th, Mercury’s first appearance in the east in Virgo; Saturn: in the beginning of the month in Virgo; around the 19th, Saturn’s last appearance in the beginning of Libra; Mars was in Libra.
That month the river level receded by 1 cubit, in total the gauge was 31.
That month I heard as follows: king Antiochus marched victoriously through the cities of Melūḫḫa and [...]. The (Greek) citizenry [organized] a procession and a ritual according to Greek custom [...]

units of capacity: 1 kur = 5 pān, 1 pān = 6 sūt, 1 sūt = 6 qa (1 kur ≈ 180 l, 1 pān ≈ 36 l, 1 sūt ≈ 6 l, 1 qa ≈ 1 l)
units of weight: 1 mina = 60 shekel (1 mina ≈ 500 g, 1 shekel ≈ 8.3 g)
2 production of a diary

- diaries produced by collective of (ca. 15?) scholarly priests connected to Esagila temple
- observations ⇒ preliminary reports ⇒ diaries for usually 6, sometimes 4 months

**preliminary reports** (Mitsuma 2015)

1. “preliminary diaries”: astronomical data, sometimes also river level, market data, historical events, for up to 30 days
2. “short diaries”: data from all categories for up to 2 months

“preliminary diary” with celestial data for days 26–28, month I, year SE 127 (April/May 185 BCE):

Year 127, month I, night of the 26th, last part of the night, clouds were in the sky; the moon was 3 1/2 cubits behind the Rear Star of the Head of the Hired Man (α Ari). [The 26th], thin clouds were in the sky. (etcetera)

BM 31581 = ADRT II No. –184A; Y. Mitsuma, 2015, “From Preliminary Diaries to Short Diaries ...”, SCIAMVS 16, 53–73
short diary month IX + preliminary diary month X, year SE 116 (Dec 196 – Jan 195 BCE)

BM 55523+55553 = ADRT II No. –195D; Y. Mitsuma, 2015, “From Preliminary Diaries to Short Diaries ...”, SCIAMVS 16, 53–73
3 from observation to prediction

excerpt with Jupiter observations, Artaxerxes II yr 43 – Alexander the Great yr 13 (362/1–323/2 BCE)

BM 35531+ = H. Hunger, ADRT V No. 66
1 [Year 2 of Artaxerxes III], month VI, 29th: first appearance in Virgo, rising of Jupiter to sunrise 14 Uš, ideal first appearance on 27th.
2 Month VIII, night of 3rd, end of night, it was 1 2/3 cubits above the Bright Star of the Furrow (α Vir).
3 Month XI, 1st, stationary in east in Libra; not observed.
4 Month XII, 27th: opposition (to sun).
5 Year 3, month I, 25th, stationary in west 1 2/3 cubits above the Bright Star of the Furrow, 4 fingers back to the west.
6 Month II, night of 14th, beginning of night: moving back to east it was 1 2/3 cubits above the Bright Star of the Furrow.
7 Month VI, 7th: last appearance in Libra.
8 Month VII, 9th: [first appearance] in Libra, it was bright, rising of Jupiter to sunrise 13 (Uš), ideal first appearance on 8th.
first appearance (eastern horizon, just before sunrise)
Jupiter during years 2–3 of Artaxerxes III (357–356 BCE)

- **1st appearance**
- **last appearance**
- **1st station**
- **opposition**
- **2nd station**

**Ecliptic coord. TAN**
- Apparent: BC357-09-24
- 20h00m00s (BMT)
- Inclination=+23°44'18''
- Mag: 8.5/11.0/8.0
- FCV:+38°00'00''

**Synodic cycle (from 1 to 8):** average distance of 33.1° covered in 13.5 months

**Investigation of longer data set would reveal:**

- 71 calendar years (65 cycles): good period for Jupiter’s synodic phenomena
- 83 calendar years: good period for Jupiter’s star passages
3 from observation to prediction: Goal Year methods

prediction for “Goal Year” $Y$ using observations of:

Mercury: $Y - 46$
Venus: $Y - 8$
Mars: $Y - 79$ (synodic phenomena)
      $Y - 47$ (star passages)
Jupiter: $Y - 71$ (synodic phenomena)
      $Y - 83$ (star passages)
Saturn: $Y - 59$
Moon: $Y - 18$

predictable by this method:
planets: synodic phen., star passages
moon: eclipses, Lunar Six intervals

not predictable by this method:
star passages of the moon
irregular phenomena (comets etc.)

Goal-Year text for 194 SE (118/7 BCE), from Babylon
BM 34034, H. Hunger, 2006, ADRT Vol. VI. Goal Year Texts, No. 69

predictive texts based on Goal Year methods:
Goal Year texts: ca. 100, 236–56 BCE
Goal Year procedure texts: ca. 5, ca. 600(?)-100 BCE
Almanacs: ca 100, 261 BCE – 75 AD
Normal Star Almanacs: ca. 100, 292–50 BCE
3 economic and historical sections – explaining the past

market rates in the Babylonian Chronicles (“Market Prices Chronicle”):

[At the ti]me of [...] ... kur of wool [...] the market value ... [...]  
At the time of [...] was purchased [...] 6 10 minas of copper, market rate of [his] land [...]  
At the time of Hammurabi [...]  
At the time of Kurigalzu [...] sesame: 3 pān, wool: 3 minas [...]  
Year 21 of Merodach-baladan [...] 1 kur; barley: 1 kur; dat[es: ...]  
Year 13 of ... [...] Year 9 of Nebukadnezzar [...]  
Year 1? of Mar[duk... ...] 1 sūt 3 qa [...] ... [...] 1 sūt, ... qa [...]  
Years 10, 11, 12, 1[3 ...] barley: 1 kur ... [...] for 4 shekels ... [...]  
Year 5, year 6 ... [of Nabû-šuma-iškun? ...] sūt 4 qa [...]  

- BM 48498 (Grayson ABC No. 23), from Babylon, written ca. 650–50 BCE  
- market rates from Hammurabi (1750 BCE) until Nabu-šuma-iškun (748 BCE)  

astrological procedure for “predicting” ⇒ explaining? market rates (SpTU I 94):

If you want to make a prediction for the region of the market rate of barley: BROKEN – you investigate the course of the planets and you observe the first appearance, the last appearance, the station, the opposition/conjunction, the approaching, the faintness and brightness of the planets, and the zodiacal sign in which they begin to ascend and descend, and then you make a prediction for your year, and it will be correct. (...)  
If the Moon takes up a high path in the region of Akkad: in Akkad the market rate will increase. If it takes up a low path: the market rate will decrease.  

- SpTU I 94, from Uruk, library of diviner Iqîšâ, ca. 330 BCE
3 economic and historical sections – explaining the past

**compilation of lunar eclipse reports** ("Saros Text") for 609–447 BCE

*Xerxes year 21, month III, day 14* (June 5, 465 BCE)

[Month III, ...], at 18 UˇS [...], 40 UˇS (duration of) onset, tot[ality and clearing]. The “garment of the sky” was present. It was eclipsed in the area of the Four Rear (Stars) of Pabilsag (Sagittarius). (There was) a second month VI. Month V, the 14th, Xerxes: his son killed him.

tablet: BM 32234 = *ADRT* V No. 4), from Babylon, written after 447 BCE

possibly relevant entry from omen series *When Anu and Enlil, Tablet 20* (lunar eclipses):

If an eclipse occurs in month III, day 14: a powerful king who won renown will die and his son, who was not named for the kingship, will seize the throne and there will be hostilities, variant: pestilence.