Problems of dating of the Babylonian "Astrolabes"

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Many historians share the opinion, that the astronomical records on the “Babylonian astrolabes” reflect real astronomical observations, and that these records can be used for their dating. This assumption was investigated by M.G. Nickiforov in [1]. The contradictions, which were found in the text of the “Babylonian astrolabes”, lead to several conclusions and hypothesis, which are described in the present paper.

Key words: ancient astrolabe, Babylonian astrolabe, Babylonian astronomy

Origin and content of the "Astrolabes". The *astrolabe* is one of the oldest goniometric tools for measuring the positions of the stars. However, according to the historians, this device was not known in Ancient Babylonia. *Babylonian astrolabe* is an unsuitable term, used by the scientist, who denotes not a device, but a special kind of the most ancient astronomical cuneiform documents of the Babylon origin; the contents of these documents will be described and analyzed below.

For the sake of convenience instead of *Babylon astrolabe* below we write simply "astrolabe".

Figure 1. Ancient Babylonian 'Astrolabe' [c. 1000 BC].

The earliest of the texts, preserved to present days, is the so called *"astrolabe B*" or *"Berlin astrolabe"*. It has been found in Ashur and is dated approximately 1100 B.C. This round *astrolabe* is divided into twelve equal segments. Each segment corresponds to a month of the Babylonian calendar. The disk is further subdivided into three rings, the central ring represents the northern sky, the middle ring is the central band of the sky lying around the celestial equator, and the outer ring is the southern sky, as viewed from Babylon. These correspond to their concept of the division of the

sky into three bands, namely Path of Anu (middle part of the sky), Path of Ea (southern part of the sky) and Path of Enlil (northern part of the sky); see ***Figure 1.***

It is accepted, that among all kinds of astrolabes, the round astrolabes are the oldest ones. In ***Figure 2*** fragments of round astrolabes are shown.

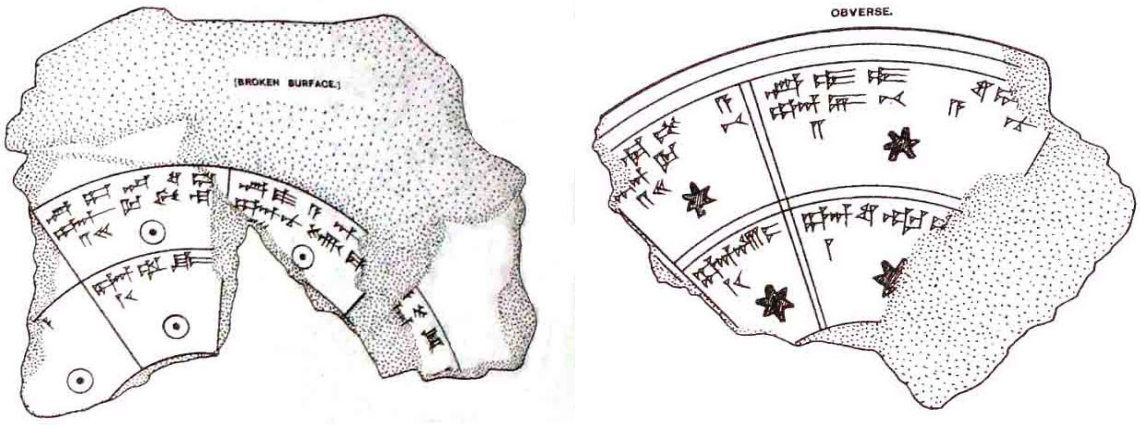

Figure 2. Fragments of round astrolabes.

Later type of such texts (for example, so-called *"astrolabe P"*) can be found on rectangular "astrolabes" in the form of tables containing three columns on twelve lines, corresponding to the areas of sky *Ea*, *Anu* and *Enlil.* According to Shaumberger, stars of *Ea* are the southern stars which have declination less than about -17 degrees. Stars of *Anu* are the stars, placed in the region of the celestial equinox, and stars of *Enlil* are the northern stars, which have declination greater than about +17 degrees.

Table1

Month		**Stars of *EA***	**Stars of *ANU***	**Stars of *ENLIL***
1.	Nisan	IKU	DIL.BAT	APIN
2.	Iyar	MUL.MUL	SHU.GUI	*Anunitum*
3.	Sivan	SIBA.ZI.AN.NA	UR.GU.LA	MUSH
4.	Tammuz	KAK.SI.DI	MASH.TAB.BA	SHUL.PA.E
5.	Ab	BAN	MASH.TAB.BA.GAL.GAL	MAR.GID.DA
6.	Elul	*kalitum*	UGA	SHU.PA
7.	Tishren	NIN.MAH	*zibanitum*	EN.TE.NA.MASH.LUM
8.	Arashsamnu	UR.IDIM	GIR.TAB	LULGAL
9.	Kislev	*salbatanu*	UD.KA.DUH.A	UZA
10.	Tebet	GU.LA	*Alluuttum*	A^{mushen}
11.	Shevat	NU.MUSH.DA	SHIM.MAH	DA.MU
12.	Adar	KUA	*Marduk*	KA.A

Each one of the Elam, Akkad and Amurru star lists has only one column of star names. However the names in any of these lists coincide with the stars of the "astrolabes", and their order corresponds exactly to the order of the twelve months in the "astrolabes". Therefore, the lists of stars mentioned above and the "astrolabes" represent related texts, which we further unite and consider as documents of one and the same kind. The specialists in the problems of the "astrolabes" accept that these are approximately dated 11 century B.C. [2]. They assume that the "astrolabes" reflect results

of real astronomical observations and contain information about heliacal risings of the specified stars and constellations for the corresponding month (here *heliacal rising* means the first appearance of a star or constellation in the morning sky).

Astronomical verification of the traditional views. Since the declinations of the stars change as a result of the lunar-solar precession, the positions of the stars or constellations in certain sky areas can be used for astronomical dating. If the "astrolabes" really reflect observations, then:

- The stars and the constellations in each column of the "astrolabe" should be *ordered by longitudes* to correspond to the order of the heliacal risings associated with respective fixed months of the year.
- The stars and the constellations in each column of the "astrolabe" should be *ordered by declinations* or *areas of the sky* (northern stars, southern stars, stars of the middle of the sky).

A translation of the contents of the "astrolabes" based on the results in [3] is presented in **Table 2.**

Table 2

Month		**Stars of *EA***	**Stars of *ANU***	**Stars of *ENLIL***
1.	Nisan	β Peg	***Venus***	Tri + γ And
2.	Iyar	Pleiades	γ Per	β And
3.	Sivan	γ Ori	δ Leo	δ Can (?); Hya?
4.	Tammuz	α CMa	**α and β Gem**	***Jupiter***
5.	Ab	δ CMa	**α Gem**	Ursa Major
6.	Elul	part of Puppies	γ Crv	α Boo
7.	Tishren	γ Vel	α Lib	γ Cen (?!)
8.	Arashsamnu	δ Ser or part of Lupus	Scorpion	α Leo
9.	Kislev	***Mars***	δ Cyg + Lac +Cep	α Lyr
10.	Tebet	β Aqr	Cancer	ζ Aql
11.	Shevat	from α, β Sag to α Phe	ε Peg	**Not identified**
12.	Adar	α PsA	***Jupiter***	part of UMa ***Mars*** (?)

Verification based on content and longitudes

1. From the 36 objects of the "astrolabe", one of the names is not identified; the identification of two constellations (3.3 and 3.7) does not allow us to find them in the northern sky during any historical epoch. The stars α, β Gem and the planet Jupiter appear in the "astrolabe" twice. Furthermore, "both of the Jupiters" are divided from each other by several constellations, but Jupiter cannot pass such a distance in one year.

2. The „astrolabe" contains the planets of Venus, Mars and Jupiter (twice), and all these identifications are obtained from the analysis of Babylonian texts. The presence of moving planets contradicts the concept about heliacal risings in star "astrolabe" and the attribution of each astronomical object mentioned in the "astrolabe" to a certain month.

3. Constellations of the "astrolabe" columns are ordered by longitude only for the southern stars *(Ea)*. In the set of stars of the middle of the sky *(Anu)* the assumption for order by longitude contradicts the identification of five constellations: №3, №4 or №5, №9 and №10. The most part of northern stars of the "astrolabe" *(Enlil)* is not ordered by longitude. Thus, in the framework of the

traditional translation of the text the hypothesis that the order of the constellations in the "astrolabe" follows the order of their heliacal risings does not find a confirmation.

Verification based on declinations. In table 3 the calculated declinations of the stars and constellations on 11 century B.C. are presented.

Table 3

Month		Stars of *EA*	Stars of *ANU*	Stars of *ENLIL*
1.	Nisan	**β Peg** **-1÷ +14°**	***Venus***	**Tri.** + γ And **+13÷+26°**
2.	Iyar	**Pleiades** **+10°**	**γ Per** **+38°**	β And +19°
3.	Sivan	**γ Ori** **-2°**	***δ Leo*** ***+35°***	**ε Hya, β Can** **+13°**
4.	Tammuz	α CMa -17°	α и β Gem +27°	***Jupiter***
5.	Ab	δ CMa -26°	***α Gem (?)*** **+32°**	Ursa Major +52÷+75°
6.	Elul	part of Puppies ~-40°	γ Crv -1°	α Boo +37°
7.	Tishren	γ Vel ~-40°	α Lib 0°	***γ Cen*** ***-32°***
8.	Arashsamnu	**δ Ser** or Lup **+24°** ~ -25°	Scorpion -35÷-10°	α Leo +23°
9.	Kislev	***Mars***	***δ Cyg*** ***+41°***	α Lyr +40°
10.	Tebet	β Aqr -15°	Cancer 23°	**ζ Aql** **+14°**
11.	Shevat	*α β Sag* to *α Phe* *-40÷-50°*	ε Peg 0°	**Not identified**
12.	Adar	α PsA -42°	***Jupiter***	**part of UMa** ***Mars***

- The calculated positions of the constellations for 11-th century B.C. mismatch their specified positions to areas *Ea*, *Anu* and *Enlil*. The constellations with incorrectly specified positions are marked red. There are at least two problems even in the "good" area *Ea,* positions №1 and №2.

- The calculations show, that there is no historical epoch or turn of the heavenly sphere on a longitude, for which the hypothesis that the order of the constellations in the "astrolabe" follows the order of their declinations is correct.

Conclusions

1. The verifications based on the content of the "astrolabes", the order of the constellations by longitude and the order of the constellations by declination show that the traditional view on the "astrolabes" causes many contradictions.

2. It is possible that the Babylonian "astrolabes" actually do not represent real observations of the star sky. They could be related to some ritual or could be religious or astrological texts.

3. If the "astrolabes" mirror real astronomical observations, probably some basic parts of the Babylonian astronomical texts are deciphered incorrectly, and at least the identification of the constellations, stars and planets for all texts are incorrect.

4. Even if we assume, that the "astrolabes" reflect real astronomical observations, it is difficult to say if the available information could be used for astronomical dating of these observations. Most probably, the “astrolabes” are dated by some archaeological data or by other reasons.

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