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A New Perspective on the List of Rising and Setting Stars in Astrolabe B

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§1. Introduction

§1.1. The list of rising and setting stars in Astrolabe B, the List hereafter, has either been dismissed as incorrect and virtually meaningless as an astronomical document, or interpreted as a theoretical model not based on actual observations. This impression ensues from three assumptions: that logograms E_3 and $ŠU_2$ are to be read as verbal forms denoting simultaneous action of rising and setting stars, that at least two stars are circumpolar and therefore could neither rise nor set, and that another four designate planets, which do not consistently rise or set in the same month. This article addresses only the first of these assumptions with a non-simultaneous interpretation of the pairs of stellar triads for each month in the List.

§2. A Functional Interpretation

§2.1. Astrolabe B (VAT 9416) is the most ancient and complex exemplar of a type of astronomical text known as Astrolabes, The Three Stars Each,[1] Twelve Times Three (Schott 1934: 311 n. 2), or The Thirty-Six Stars (van der Waerden 1949), with the common characteristic of listing three stars for each month. Preserved in both circular and list form, they reflect the astronomical system ascribed to Marduk and his organization of the universe in tablet V of *Enuma Eliš* and his division of the sky into the three Paths of Ea, Anu and Enlil, generally thought to correspond to the southern, central and northern parts of the sky. These texts have been comprehensively treated in a recent monograph (Horowitz 2014), which remains foundational for further studies.[2] Astrolabe B was excavated in Assur in 1911 and was published by Weidner (1915: 66-102). Schroeder's handcopy appeared in 1920 as KAV 218. From the information contained in the colophon, the tablet can be dated from the early to middle 12th century BCE.[3] The work of a Babylonian scribe serving in the Assyrian court, it became part of the collection of religious, literary and lexical texts known as the "library of Tiglath-pileser I."

§2.2. Double horizontal lines divide the tablet into four sections. The first, also referred to as the menology, is a Sumerian-Akkadian list of stars for each month, with additional notations as to an almanac of activities and/or festivities for the month and its association with a god. The second names twelve stars for each of the three paths, placing them in relation to each other according to their position in the sky. The third is the actual astrolabe list of the Ea, Anu and Enlil stars for each month. The fourth, the List, names the same three stars for each month as in section III, paired with the three stars listed six months later.

§2.3. The List contains 24 lines divided into 12 pairs (one for each month) by single horizontal rulings and 3 columns, representing the celestial paths, by vertical double rulings. Although some scholars consider these and the previous 12 lines as one section,[4] Horowitz (2014: 3-4) is convincing in his division of the tablet into four sections as the double horizontal

[1] This is the original name by which the texts were known in the Mesopotamian sources, translating the expression MUL.MEŠ 3.TA.AM$_3$.

[2] Other recent works on the subject include Casaburi 2003; Kolev 2013. Discussions of the Astrolabes are also found in Horowitz 1998: 154-166; Hunger and Pingree 1999: 50-57; and Steele 2017: 10-12.

[3] For this dating and further bibliography, see Horowitz 2014: 29-31.

[4] Hunger and Pingree 1999: 51; Casaburi 2003: 10; Kolev 2013: 148.

rulings between them would indicate. The format of each pair of lines is:

Month-name, Ea-star,	Anu-star,	Enlil-star	E_3
Ea-star,	Anu-star,	Enlil-star	$ŠU_2$

§2.4. Linguistically, the interpretation proposed here analyzes the last word of each line as a noun in adverbial use designating time. E_3 and $ŠU_2$ are understood as abbreviated forms of ^{d}UTU.E_3(.A) and ^{d}UTU.$ŠU_2$.A,[5] to be read (*ina*) *ṣīt šamši* and (*ina*) *ereb šamši* and translated "(at sun)rise" and "(at sun)set." Alternatively, they could be interpreted as singular verbal forms with the Sun as the implied subject: (the Sun) rises; (the Sun) sets.[6] All previous editions of the text have analyzed the last word as a verb, either in the third person singular or plural, and the three stars as its subject. Thus, the common translation of any two lines has been:

Month-name, Ea-star,	Anu-star,	Enlil-star	rise(s),
Ea-star,	Anu-star,	Enlil-star	set(s).

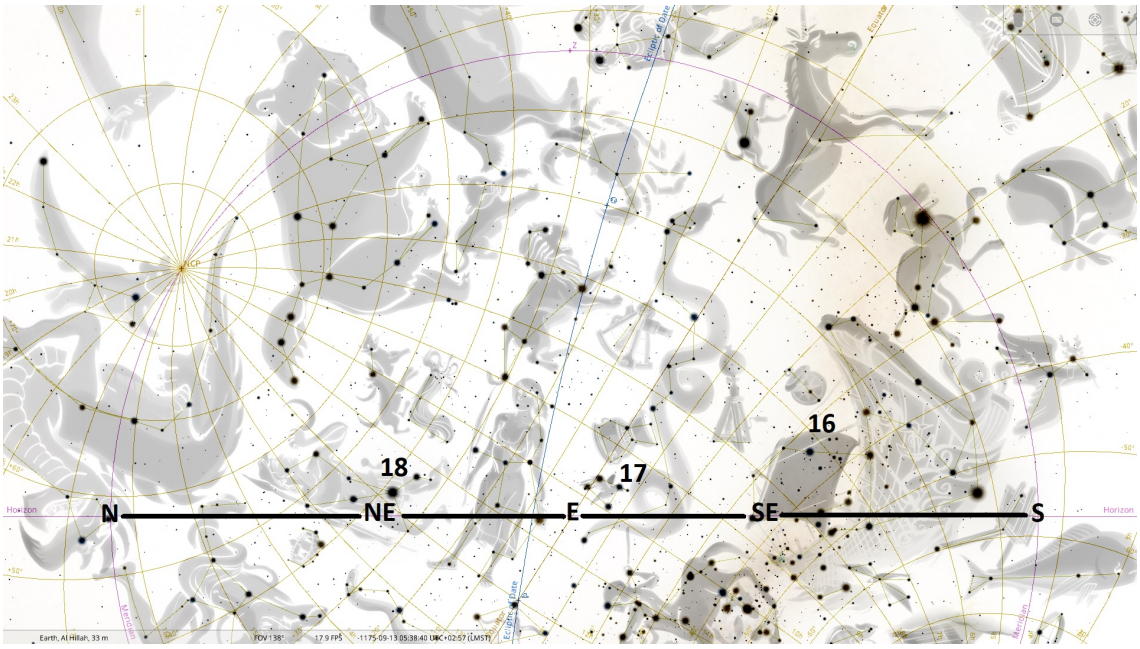

Figure 1: East from Babylon at sunrise Month VI Day I (observations from Babylon throughout are from Al Hillah at 32° 27' 49.21" N, 44° 25' 10.66" E, 33 m elevation, 5 km south of Babylon)

§2.5. The right side of the tablet is not preserved and when it was first published Weidner interpreted the verbal forms as singular.[7] In his new edition, Horowitz supplies a missing MEŠ sign at the end of each line and therefore translates the verbal forms as plural.[8] Plural forms seem to be the norm in the first millennium parallels of Astrolabe B IV, the List, where, however, E_3 is replaced by the then more common term KUR, *napāḫu*, "to light up." The description of the List and its parallels, together with the section in *Mul.Apin* I iii 13-33, as lists of rising and setting stars, is therefore based on the interpretation of the verb pairs E_3/KUR – $ŠU_2$ as *aṣû*/*napāḫu* and *rabû*, terms used in astronomical contexts to in-

[5] According to Schroeder's copy, the A sign is partially preserved at the end of line 34.

[6] For another example of the Sun as the implied subject of rising and setting, see the text in Steele 2017: 33-44 (A 3414 + U 181a-d). It might be objected, however, that the Sun may have been explicitly mentioned in the missing first line and then omitted throughout the text.

[7] Weidner 1915: 66-67 reads E_3 and $ŠU_2$ as *uṣṣi* and *irabbi*. This interpretation is also followed by Kolev 2013: 156-157, 165-167.

[8] Horowitz 2014: 40-42. Similarly, Casaburi 2003: 61-62, although the lacunae are left blank. See also a new handcopy of KAV 218 in Horowitz 2014: Pls. I and III, and photographs in Casaburi 2003: frontispiece; Kolev 2013: 147 and 151; and Horowitz 2014: Pls. II and IV.

[9] For the edition and discussion of parallel texts, see Horowitz 2014: 158-169. Plural forms, if present, can also be

dicate the rising and setting of the Sun and other celestial objects.[9] "Rise" and "set" have been understood in various contexts to refer either to a star's heliacal rising and setting, or in a looser sense to a star crossing the horizon.[10] The pair has been interpreted in the List of Astrolabe B as describing stellar motion mirrored on opposite horizons:

> A list of simultaneously rising and setting stars is also found in the so-called Astrolabe B Three Stars Each text. In that text, and in later texts related to it, the rising and setting stars mirror one another. In other words, if star A rises as star B sets, then star B rises and star A sets. Astronomically, this relationship only holds if the stars are situated on the celestial equator or have equal but opposite declinations. (Hunger and Steele 2019: 184)

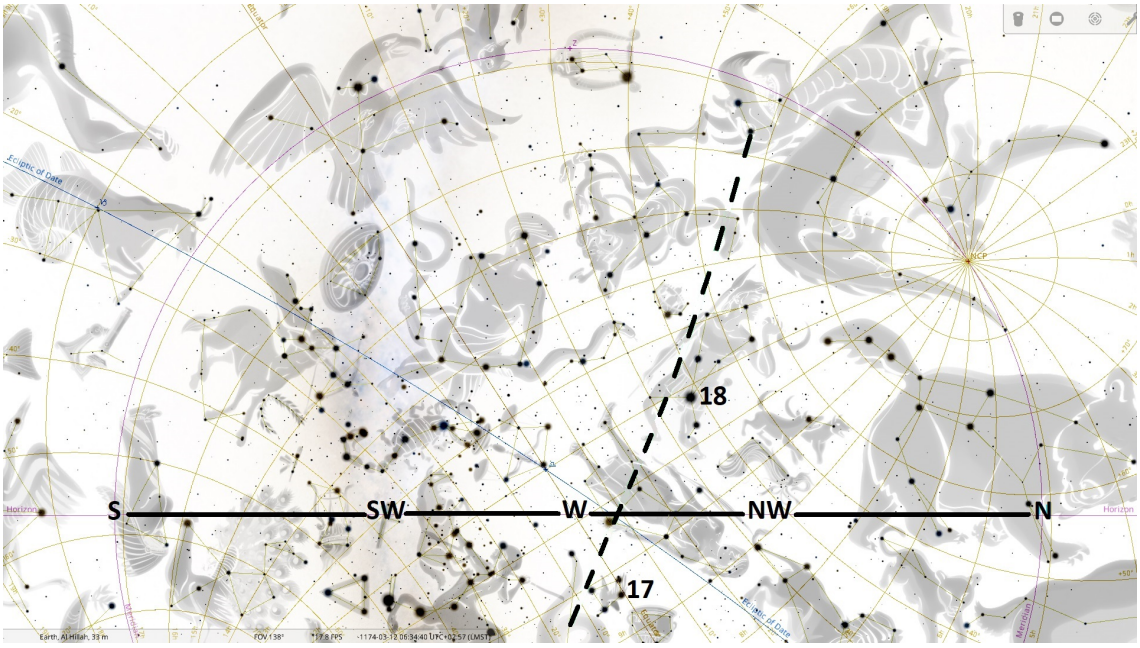

Figure 2: West from Babylon at sunrise Month XII Day 1. The dashed line corresponds to the eastern horizon at sunrise six months earlier in Figure 1

§3. Simultaneously Rising and Setting Triads: A Problematic Interpretation

§3.1. A pervasive influence on the early acceptance of a verbal interpretation of E_3 and $ŠU_2$ as expressing simultaneous action of stellar triads must have been the observable celestial phenomenon well attested historically, for example, in the astronomically correct Greek mythology surrounding Orion and Scorpio in Aratus's *Phaenomena*.[11] Stars in Orion and Scorpio are also among the opposing pairs of lunar stations or markers around the ecliptic. Borrowed from India and functioning primarily as "a grid for the daily position of the moon" (Varisco 1994: 89), the predawn simultaneous rising and setting of opposing pairs of lunar stations served in certain medieval Arab almanacs as milestones along the solar year. Since "rise" and "set" are included in the range of logographic readings for E_3 and $ŠU_2$, and since the observation of simultaneously rising and setting constellations is so well known, the application of these notions in the context of the List would be suitable were it not for one critical requirement: the pairs of stellar triads for each month must alter-

understood nominally as "sunrises" and "sunsets," referring to all the observations in a month. Forms with ventive endings, which occur only with KUR, must be understood verbally and are admittedly problematic. It seems possible that later copyists understood the three stars as the subject or that the verbs have a technical meaning of becoming visible at sunrise and sunset.

[10] Reiner and Pingree 1981: 6, 16; Hunger and Steele 2019: 182.

[11] 634-646, in Hard 2015: 154.

nate in their rising and setting roles every six months. This makes the hypothesis of simultaneous risings and settings untenable, unless it is also assumed that either the compiler was inept, or that the risings and settings are schematic and not based on actual observations.

§3.2. Figures 1 and 2 illustrate why the simultaneous rising and setting interpretation for the stellar triads in the List does not work astronomically. Figure 1 shows the stars of Vela/Puppis, Corvus and Boötes, which have been identified by several scholars over the past century with the stellar triad rising in Month VI.[12]

§3.3. As shown in Figure 2, any observational basis for this interpretation breaks down with the requirement that the three stars set together in the West in Month XII.

§3.4. It is, therefore, not surprising to find negative assessments of the astronomical value of the List,[13] raising the question of the supposed utility of a textual tradition so well perpetuated. In addition to confirming the months in a luni-solar calendar, we suggest it had real and observable value in connecting stellar constructs with the communication of seasonal exigencies associated with the appearance of each star over the astronomical year.

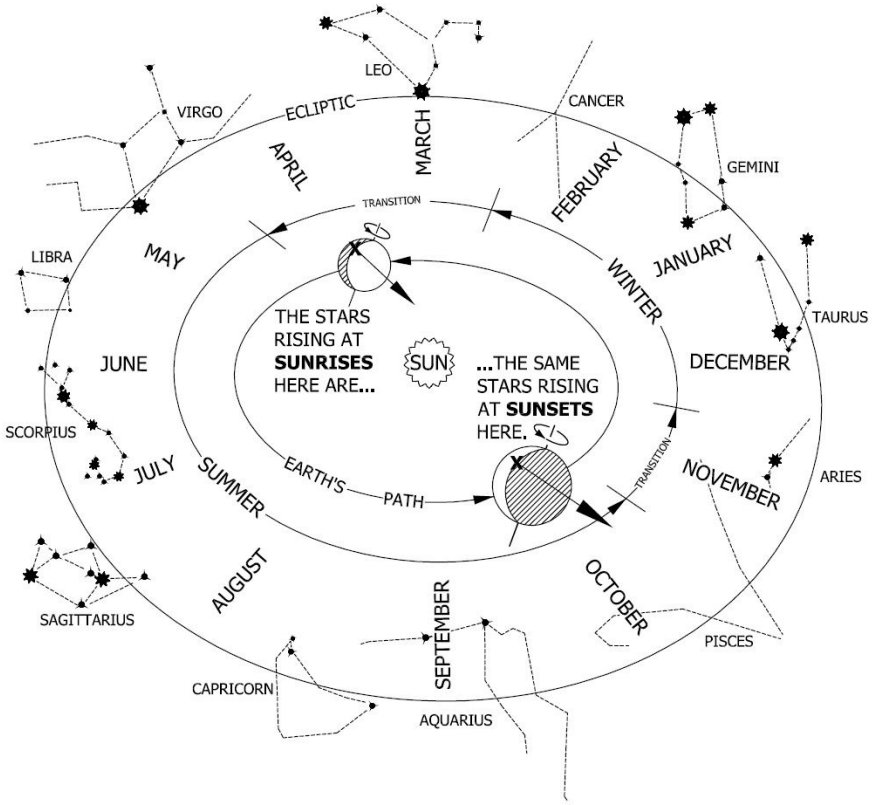

Figure 3: Stars of April sunrises and October sunsets, 2023 CE. The stars in the Earth's shadow appear to be in substantially the same positions with respect to the horizon just before sunrise and just after sunset six months later

12 Star 16 (Ea VI, ^{mul}*Kalītu*), Star 17 (Anu VI, ^{mul}UGA), Star 18 (Enlil VI, ^{mul}ŠU.PA). Also note the use of the homonym ^{mul}UG$_5$.GA, evening Anu-star in Month XII, for ^{mul}UGA, morning Anu-star in Month VI (this homonym may also be a pun referring to the bird's propensity for carrion, as in the Carrion Crow).

13 "This list is meaningless as an astronomical document (it is basically mythological), as is also the list at the end of section three of 'Astrolabe B' where this list is mechanically converted into one in which three constellations rise in a month and three set" (Hunger and Pingree 1999: 63). "Part IV, with its false theory for the setting of stars, would have added no new useful information on its own" (Horowitz 2014: 4). "... to our eyes the schematic astronomy tradition seems primitive, largely divorced from empirical reality ..." (Steele 2017: 11).

§4. Non-Simultaneous Observations at Sunrise Month *n* and at Sunset Month *n*+6

§4.1. Instead of a "meaningless," "mechanically converted" list of stars impossibly rising and setting simultaneously, we propose a meaningful solution, an observational model with support from ancient Mesopotamia and Greece. Figure 3 illustrates how the List works astronomically for stellar designations understood as non-circumpolar fixed stars, simply by adopting a transformative change in perspective from simultaneous risings and settings of two triads occurring on a single day,[14] to twice daily observations of stars rising over an entire month. This solution may be summarized as follows: the first triad of each pair is observed above the eastern horizon before sunrise and the second is observed above the eastern horizon after sunset in Month *n*. The same pair of triads appears in reverse order, exchanging their roles in the morning and evening observations in Month *n*+6. This dual observation model afforded a second opportunity in the evening to confirm morning observations made under conditions of limited visibility, thus enhancing the utility of the List.

§4.2. Since the position of any star with respect to the eastern horizon at sunrise on any given day is substantially the same at sunset six months later, any three stars observed rising above the eastern horizon before sunrise will be observed in substantially the same positions above the same horizon six months later after sunset. In Figure 4, for example, the same stars appear above the eastern horizon just after sunset in Month XII as did above the same horizon just before sunrise six months earlier in Figure 1.

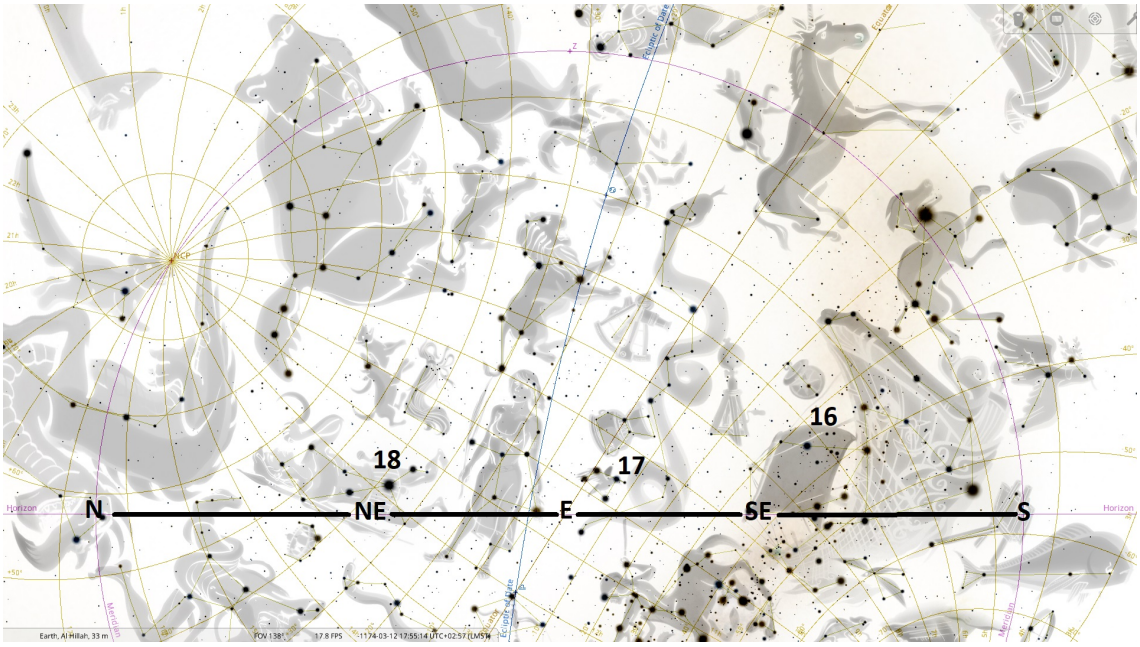

Figure 4: East from Babylon at sunset Month XII Day I. The view is virtually the same as at sunrise Month VI Day 1, as in Fig. 1 above

§5. Ancient Awareness of Stars Exchanging Roles at Sunrise and Sunset Every Six Months

§5.1. Other sources indicate that the ancient Mesopotamians recognized and took advantage of the phenomenon of stars trading places in the sky at sunrise and sunset every six months. The most recent to be cited here is from Uruk and dates from between the 5th and 3rd centuries BCE. W 22281a is a partially preserved tablet published by Hunger in 1976 and more recently by Steele (2017: 28-32). The text is incomplete, but Hunger and Pingree summarize what is most pertinent: constellations and indi-

[14] Horowitz 1998: 163, for example, focuses on the correspondence between the day of a star's heliacal rising and the new moon as the explanation for the function of the Astrolabes. He suggests on the basis of "indirect evidence" that "... the Ea-stars for each month, at least, were meant to rise on the first of the month," even though he also observes: "It is not explicitly stated in the 'Astrolabes' which day the month-stars were supposed to rise ..."

vidual stars that "cross the meridian just before sunrise on the 15th of each month,"[15] will do so again "after sunset six months later," just as the pairs of triads in the List along the eastern horizon.

§5.2. An earlier non-astronomical text demonstrates that familiarity with this phenomenon, at least with two stars in the List, was not confined to specialized observers. In the context of royal propaganda, the report of the 8th campaign of Sargon II cites both the morning and evening observations of "The Arrow" and "The Bow" stars for Months IV and V at opposite sides of the astronomical year to deepen the impression that Sargon personally observed the year-round presence of snow and ice on Mount Uauš:

> *i-na um-še* GAL.MEŠ u_3 *dan-na-at* EN.TE.NA *ša qa-aš$_2$-tu šu-kud-du <i-na> še-rim li-la$_2$-a-ti uš-*[*ta-ba-ru*]*-u$_2$ ni-pi-iḫ-šu-un / šal-gu ur-ru u$_3$ mu-šu ṣe-ru-uš-šu$_2$ kit-mu-ru-ma gi-mir la-a-ni-šu lit-bu-*[*šu ḫal-pu-u$_2$*] u_3 *šu-ri-pu*
>
> (a mountain) upon which perpetual (lit.: "day and night") snow is piled up in (the seasons of both) extreme heat and severest cold, when the rising of the Bow star (and) Arrow star [are continually present] <in> the morning (and) evening (respectively), and whose entire face is co[vered with frost] and ice. (RINAP 2, 65: 100-101)

§5.3. The morning observation of these adjacent constellations in the heat of summer, Months IV and V, is linked to the evening observation of the same stars in the cold of winter, Months X and XI, showing that seasonal opposites were commonly associated with the same stars, depending on morning or evening observation six months apart.

§5.4. *Mul.Apin* II i 9 and 16 also indicates that certain stars were observed in the morning and evening six months apart, as in the morning appearance of "The Arrow" in Month IV and its evening appearance in Month X:

> DIŠ *ina* ^{iti}ŠU UD 15 KAM ^{mul}KAK.SI.SA$_2$ IGI.LA$_2$-*ma*
>
> *ina Du'ūzi* UD 15 *Šukūdu innammarma*
>
> On the 15th of Du'uzu, the Arrow becomes visible, and
>
> DIŠ *ina* ^{iti}AB UD 15 KAM ^{mul}KAK.SI.SA$_2$ *ina li-la-ti* IGI.LA$_2$-*ma*
>
> *ina Ṭebēti* UD 15 *Šukūdu ina līlâti innammarma*
>
> On the 15th of Ṭebetu, the Arrow becomes visible in the evening, and (Hunger and Pingree 1989: 72, 74-75)

§6. Twice Daily Observations of Apparent Stellar Motion in *Mul.Apin*

§6.1. In *Mul.Apin* I iii 49-50 there is also indication of separate morning and evening observations:

> u_4-*mu* 1 UŠ.TA.AM$_3$ MUL^{meš} *ina šer$_3$-ti ana* GI$_6$ KU$_4$^{meš}-*ni*
>
> *ūmu* 1 UŠ *kakkabū ina šērti ana mūši irrubūni*
>
> The stars enter into the night in the morning 1 degree each day.
>
> u_4-*mu* 1 UŠ.TA.AM$_3$ MUL^{meš} *ina li-la-a-ti ana u$_4$-me* E$_3$^{meš}-*ni*
>
> *ūmu* 1 UŠ *kakkabū ina līlâti ana ūmi uṣṣūni*
>
> The stars come out into the day in the evening 1 degree each day.[16]

§6.2. *Mul.Apin* I iii 49 is consistent with apparent stellar motion from one morning observation to the next as stars enter one degree toward the departing darkness as the daylight rises from the eastern horizon as illustrated in Figure 5 (left). *Mul.Apin* I iii 50 is consistent with apparent stellar motion from one evening observation to the next as stars enter one degree toward the departing daylight as darkness rises from the eastern horizon as illustrated in Figure 5 (right).

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[15] Hunger and Pingree 1999: 99. Steele 2017: 28 n. 5, commenting on this phrase in Hunger and Pingree, notes that "the list is not a record of observations but rather part of a mathematically derived scheme and so invisibility of the stars at sunrise is not significant."

[16] Hunger and Pingree 1989: 57. Although these lines were not included in Hunger and Pingree's astronomical commentary, they are now discussed in Hunger and Steele 2019: 186-187.

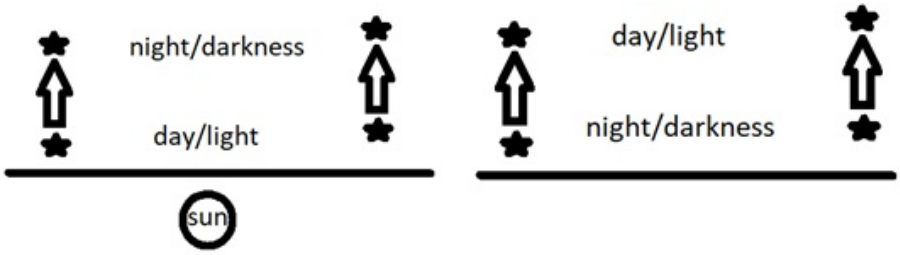

Figure 5: Apparent stellar motion in *Mul.Apin* I iii 49-50

§7. Aratus: Twice Daily Observations of Signs From Zeus

§7.1. In ancient Greece this practice was documented by Aratus, who related that "the time to plough the fallow field, the time to plant" are "already indicated everywhere through signs from Zeus." One needed only to take note of the "stars that emerge from the ocean at dawn or when night is just beginning. For in truth the sun passes through all of them in the course of the year as he drives his huge furrow, and runs up against one and then another, now at his rising and now at his setting, and so it is that different stars look down on different days."[17]

§8. The List as "heavenly writing"

§8.1. The List tradition seems to lie very near the core notion of "heavenly writing" as a sequence of stellar triads with messages from the gods written with signs in the sky above the eastern horizon as if in a line of a tablet. Apparent correlations of the lexical values of many of the component signs in the names of the stars in the List with the seasonal exigencies of their months may explain why the List was transmitted over so many centuries. Rather than a series of randomly conceived, fanciful imaginings handed down from star *gazers*, these were graphic reminders of seasonal exigencies from the gods for star *readers*:

> To the ancient Mesopotamian literati of the middle of the first millennium B.C., the patterns of stars covering the sky were a celestial script. … In these Babylonian inscriptions, the metaphor (of the "heavenly writing," *šiṭir šamê* or *šiṭirti šamāmī*) is not used explicitly for astrology or celestial divination, but the notion of the stars as a heavenly script implies their capacity to be read and interpreted. (Rochberg 2004: 1)

§8.2. The lines ruled onto this heavenly tablet at monthly intervals may also have been visualized as the mesh of the mythological net Marduk fashioned to defeat the enemy Tiāmat in *Enuma Eliš*. With this net he defeats primordial chaos and sets up an unchanging order composed of the parts of his defeated foes. In so doing, he dispels the confusion overshadowing what was likely a pre-existing series of disjointed myths and stellar connections, weaving them into the network of a single, meaningful space-time narrative. Marduk's network enabled those who mastered it to overcome and even exploit like captive enemies the predictable seasonal challenges of the solar year and to take advantage of the recurring opportunities they brought about. A connection between Marduk, his unchanging order, and the annual solar cycle is also evident in the designation for his distinguishing star, $^{\text{mul}}{}^{\text{d}}$AMAR.UTU, "Bull Calf of the Sun." Figure 6 is based on *Stellarium*'s stereographic projection of a portion of this network above the eastern horizon as viewed from Babylon.[18]

[17] *Phaenomena* 740-751, in Hard 2015: 157.

[18] For month dates in *Stellarium* we assumed 30-day months, commencing 15 days after the vernal equinox for the mean occurrence of the first new moon. For the year we used 1177/1176 BCE, a year within the range of the dating of the text and one in which the first new moon after the vernal equinox occurred very near this mean.

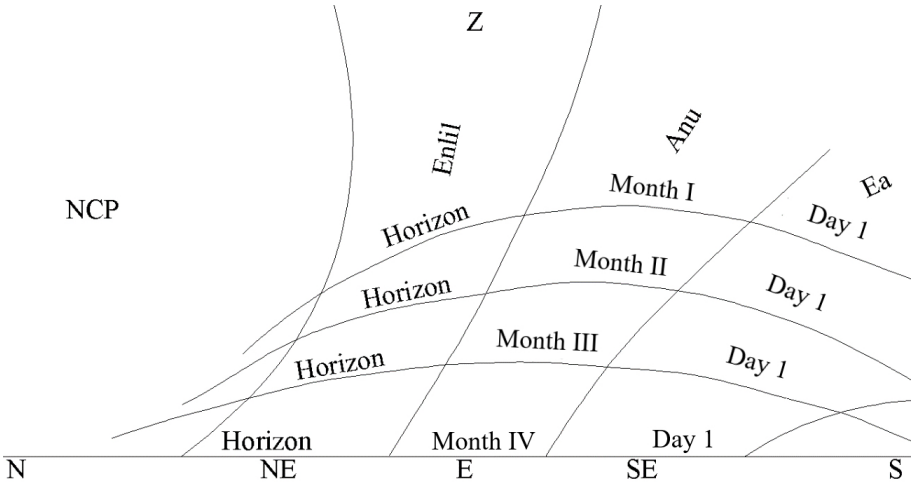

Figure 6: Mesh of Marduk's net: horizontal lines and curves in the figure are positions of the horizon at sunrise on Months I-IV Day 1

§9. Conclusions

§9.1. The linguistic solution proposed in this article provides a functional model for the List in Astrolabe B, generally considered detached from astronomical observations. Reading E_3 and $ŠU_2$ as abbreviations for sunrise and sunset aligns with the phenomenon of the appearance of the same stars at dawn and dusk six months apart. Therefore, we suggest a shift from the previous interpretation of triads of rising and setting stars to triads of morning and evening stars, both observed above the eastern horizon. We are currently revising an extended work in which each star in the List is associated with its seasonal exigency and identified within the lines of a heavenly tablet as described above. We also show how precession had so altered the positions of the stars within the unchanging solar frame that their task of carrying a particular message from the gods would have had to pass to more suitable stellar assemblages. Therefore, star identifications made on the basis of the late Astronomical Diaries, for example, ought not be assumed to control the same star name in much earlier contexts. We also raise the possibility that star names later identified with planets were still used in the List for stars. Finally, we offer alternate proposals for those designations understood as circumpolar stars and an explanation for the function of the circular Astrolabes.

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