Chapter 2
Preliminaries

Abstract Babylonian rising time schemes rely upon several concepts and techniques of Babylonian astronomy. This chapter outlines the Babylonian calendar (in particular the schematic calendar of 360 days), the tradition of schematic astronomy based upon the early astronomical work known as MUL.APIN, the use of the culmination of certain stars (known as *Ziqpu* Stars) to indicate specific moments of time, and the Babylonian development of the zodiac, a mathematical division of the ecliptic into twelve equal parts.

Keywords Babylonian astronomy · Calendar · Culminating point · MUL.APIN · Schematic astronomy · *Ziqpu* stars · Zodiac

2.1 The Calendar

The Babylonian calendar was a luni-solar calendar. The beginning of a month was determined by whether the new moon crescent was visible on the thirtieth evening of the previous month. If the moon was visible then the day just beginning was renamed the first day of the new month, the previous month then having 29 days; if the moon was not visible, then the day just beginning was confirmed as the thirtieth day of the current month and the new month would begin on the following evening. Various methods for calculating in advance whether the new moon crescent would be visible on the thirtieth evening were developed by the Babylonian astronomers during the first millennium (Brack-Bernsen 2002). There is considerable evidence that by about 300 BC, and perhaps earlier, month lengths were usually determined in advance by calculation rather than by means of observation (Steele 2007a). Twelve lunar months last about 10 days short of a solar year. In order to keep months roughly in line with the seasons, the Babylonians intercalated either a second Month VI or a second Month XII every 3 years or so. By the fifth century BC, a regular cycle of seven intercalations every 19 years had been adopted (Britton 2007).

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The fact that in a luni-solar calendar a month can be either 29 or 30 days long and that a year can contain either 12 or 13 months can make it inconvenient to use in calculations. This problem was avoided as early as the third millennium BC in Mesopotamia by the use of schematic calendars which set each month as containing 30 days and, at least from the early second millennium BC onwards, each year as containing exactly 12 months (i.e. without intercalation), making a total of 360 days in a year (Brack-Bernsen 2007). This schematic calendar was often used to simplify calculations in administrative contexts, such as the calculation of work rates, interest, etc., and was adopted in astronomy already in the Old Babylonian period. In the first millennium BC, a branch of astronomy which I term "schematic astronomy", which developed out of the important early astronomical work MUL. APIN (see Sect. 2.2), relied upon the notion of the schematic calendar of twelve thirty-day months with the solstices and equinoxes placed on day 15 of Months I, IV, VII and X. It is important to note that the schematic calendar never operated as a real-world calendar: it only acted either in a completely schematic framework, unconnected to the actual calendar, or as a computational convenience, allowing calculations to be made that could then be mapped onto the actual luni-solar calendar.

2.2 Schematic Astronomy

I use the term "schematic astronomy" to refer to a branch of astronomy in the first millennium BC which developed out of the astronomical tradition represented by second or early first millennium BC astronomical texts including tablet 14 of *Enūma Anu Enlil* (Al-Rawi and George 1992), the Three-Stars-Each texts (Horowitz 2014), and MUL.APIN (Hunger and Pingree 1989). These early texts all rely upon the schematic 360-day calendar and use simple monthly zigzag functions to model astronomical phenomena such as the variable length of daylight during the year and the duration of visibility of the moon through a month. Zigzag functions are simple mathematical computational tools where a function varies between a maximum and a minimum value in a series of steps of constant difference. For example, in MUL.APIN II ii 43–iii 12, the length of night is said to correspond to 3 minas weight of water in a waterclock on the 15th day of Month I, to 2 2/3 minas of water on the 15th of Month II, to 2 1/3 minas on the 15th of Month III, and to 2 minas on the 15th of Month IV. Each month the weight of water, which is assumed to be directly proportional to the passage of time, decreases by 1/3 mina. After Month IV, the length of night increases by 1/3 mina per month up to a maximum of 4 minas in Month X. Thus, on the 15th of Month V, night lasts 2 1/3 minas, on the 15th of Month VI it lasts 2 2/3 minas, etc. After Month X, the length of night decreases again by the same difference of 1/3 mina per month until we get back to Month I where we again find that night equals 3 minas of water. In later Babylonian mathematical astronomy, zigzag functions with non-integer periods were used (i.e. sequences which do not return to the starting value after one cycle through the maximum and minimum, but only after many cycles), but only simple zigzag functions with integer periods (usually either 12 months or 30 days) appear in texts of schematic astronomy.

During the Late Babylonian period, schematic astronomy co-existed alongside observational astronomy, goal-year astronomy (a type of astronomy in which predictions of future astronomical phenomena were made by applying lunar and planetary periods to past observations), and mathematical astronomy. Although to our eyes the schematic astronomy tradition seems primitive, largely divorced from empirical reality and fundamentally incompatible with these other branches of Late Babylonian astronomy, it does not seem that for the Babylonians schematic astronomy was considered any less a part of astronomy. Indeed, it is almost certain that the scribes who wrote texts containing schematic astronomy were the same scribes who recorded observations and made calculations using mathematical astronomy.

Fundamental to all schematic astronomy in the Late Babylonian period seems to have been the classic text of early Babylonian astronomy known as MUL.APIN. MUL.APIN is a compendium of astronomical and astrological material that was put together sometime in the late second or, in my opinion more likely, the early first millennium BC. It is preserved in many copies from both Assyria and Babylonia, including copies written as late as the last few centuries BC. The preserved copies attest to a very stable text, albeit with flexibility in layout on tablets. The modern edition reconstructs the text as written in a two-tablet series, and that is how I will cite the text. Tablet 1 of MUL.APIN contains a series of lists of stars[1]: (1) three lists of stars in the paths of Enlil, Anu and Ea, which correspond to stars within northerly, central and southerly ranges of declination; (2) a list of the dates in the schematic calendar of the first appearances (heliacal rising) of stars; (3) a list of simultaneously rising and setting stars; (4) a list of the number of days between the first appearances of stars; (5) a list of *Ziqpu* Stars which culminate in order (see Sect. 2.3); (6) a list of dates in the schematic calendar when stars culminate as other stars rise; and (7) a list of stars which stand in the path of the moon (i.e., zodiacal constellations). Tablet 2 contains a more diverse range of material including statements that the sun and the five planets pass through the same stars as the moon, procedures for determining intercalation, statements about the subdivision of the synodic arcs of each of the planets, a mathematical scheme for the length of shadow cast at different times of day on the days of the solstices and equinoxes, a mathematical scheme for the length of daylight and the duration of visibility of the moon, and a collection of celestial omens.

[1]No distinction is made between "star" and "constellation" in Akkadian; many of the "stars" I will refer to are groups of stars which represent a part or the whole of a constellation.

Several key concepts, methods and parameters from MUL.APIN underlie the Late Babylonian tradition of schematic astronomy including:

1. The schematic 360-day calendar with the solstices and equinoxes placed on the 15th day of Months I, IV, VII and X.
2. The length of daylight modelled as a zigzag function for the 1st and 15th days of each month with extrema in the ratio of 2:1.
3. The lunar visibility modelled as a zigzag function with the duration of visibility taken to be zero on the 30th day of a month and the whole night on the 15th day of the month. The daily change in the duration of lunar visibility is therefore equal to 1/15 of the length of night on the 15th of the month.
4. The length of a shadow cast by a gnomon multiplied by the time since sunrise is equal to a constant. The value of the constant on the 15th of each month is given by a zigzag function with extrema in the ratio 3:2.

A number of previously published texts can be seen to draw upon these foundations. For example, several late texts concerning shadlow-length schemes can be seen as expansions of items 1 and 4 (Steele 2013), one section of a Seleucid period compendium of material dealing with the calculation of month lengths and lunar visibilities (among other things) is founded upon the principles of items 2 and 3 (TU 11 Sect. 19; see Brack-Bernsen and Hunger 2002), and a late "reworking" of MUL.APIN draws upon all of these foundations.[2] I will argue in Chap. 6 that the rising time schemes draw upon items 1 and 2 of this list and should be understood as another example of schematic astronomy. The rising time scheme is particularly interesting in this regard because it demonstrates that new astronomical concepts, such as the zodiac, were incorporated within the tradition of schematic astronomy.

Finally, it is worth remarking that whereas most Late Babylonian astronomical texts contain either *data* relating to specific events (whether they be observed, predicted using Goal-Year methods, or calculated using mathematical astronomy) or *procedures* written in the second person instructing the reader how to make calculations or predictions, the schematic astronomical texts are generally *descriptive*, written in the third person and presenting a set of astronomical facts. These facts are independent of time (except in the sense of modelling variations over the year)—they are assumed to be a reflection of how the universe is in general rather than how it appears on a given occasion. Furthermore, no procedures are given for how these facts could be used in calculations. Thus, I suggest that the purpose of the schematic astronomy texts was to provide a theoretical mathematical description of celestial phenomena. I will return to the question of the purpose of schematic astronomy in Chap. 6.

[2] I have so-far identified five fragments of copies of this late reworking and will publish a full study of this work in due course.

2.3 *Ziqpu* Stars

The Akkadian word *ziqpu* is used in astronomical contexts to refer to the highest point ("culmination") of a heavenly body. Due to the daily rotation of the Earth, as viewed from a given location in the northern hemisphere, most stars appear to rise in the east, rotate across the night sky, crossing the meridian at their highest point, before setting in the west. Only the circumpolar stars deviate from this behavior, circling around the north celestial pole without reaching low enough to set below the horizon. Nevertheless, even the circumpolar stars reach their highest (and their lowest) point when crossing the meridian. Ignoring precession and the proper motion of stars, concepts which were unknown to the Babylonians, the stars remain in a fixed relationship to one another. As a result, the time interval between the culminations of two given stars is always the same. This property makes the culmination of stars a useful tool for measuring the passage of time at night. Unsurprisingly, therefore, Babylonian scholars made use of culminating stars along with water clocks to measure time during the hours of darkness.

The use of culminating stars to keep track of time can be traced back to at least the early first millennium BC, but may very well predate this period (Steele 2014). MUL.APIN contains a list of fourteen constellations whose culmination should be observed. Interestingly, this group of constellations is referred using a name which refers directly to their use: MUL.MEŠ *šá ziq-pi* "*Ziqpu* Stars". In the Neo-Assyrian period, we find evidence that the *Ziqpu* Stars were used in a wide range of contexts: a letter referring to a storm during the night notes that the beginning and the end of the storm occurred when certain *Ziqpu* Stars culminated, a ritual text indicates that certain parts of the ritual are to be performed when specific *Ziqpu* Stars culminate, two reports of observations of lunar eclipses time the event using *Ziqpu* Stars, and a collection of blessings from Ḫuzirina mentions the *Ziqpu* Stars as a group.[3] In addition, a small fragment which parallels a completely preserved text from much later Seleucid Uruk contains a list of distances between *Ziqpu* Stars.

Ziqpu Stars appear in a variety of contexts in the Late Babylonian period. For example, astrological texts relate the culmination of *Ziqpu* Stars with predictions for the life of an individual at birth,[4] and several fragmentary texts of schematic astronomy mention *Ziqpu* Stars.[5] In the observational texts, records of eclipses sometimes include a statement about when the eclipse began relative to the culmination of a *Ziqpu* Star. The report of the eclipse of 2 August 123 BC recorded in an Astronomical Diary is typical:

[3]For the report of the storm, see Lanfranchi and Parpola (1990: No. 249); for the ritual text, see van Driel (1969: 90–93); for the eclipse reports, see Parpola (1993: No. 134 and 139); for the blessing, see Horowitz (1994: 97).

[4]TU 14 and its duplicate U 197; see Sachs (1952).

[5]For example, BM 65756 (unpublished).

5 UŠ *ár* MÚL DELE *ziq-pi sin* AN.KU_{10}
(When the point) 5 UŠ behind the Single Star culminated, lunar eclipse.[6]

Unlike the Neo-Assyrian examples cited above, this and several other of the Late Babylonian eclipse report refer not just to the culmination of a *Ziqpu* Star but to the culmination of a point a distance behind (or, more rarely, in front of) the *Ziqpu* Star. This distance is recorded with the unit UŠ, which may be translated as "degree". In modern terms, this distance corresponds to the difference in Right Ascension between the star and the point which is culminating. Because it takes one day for the sky to perform one complete revolution, and because the Babylonians measured time using the same unit UŠ, this difference in Right Ascension can be equated with the time difference between the star and the point culminating. Thus, 1 UŠ = 1° of celestial rotation = 4 min of time. The rising time schemes use the same convention of stating positions behind *Ziqpu* Stars given in UŠ and the related units NINDA (1 UŠ = 60 NINDA) and *bēru* (1 *bēru* = 30 UŠ).

More than a dozen lists of *Ziqpu* Stars are known from sites throughout Babylonia (Steele 2014). These lists exist in two main forms: lists that give the distances in *bēru* and UŠ between consecutive *Ziqpu* Stars, and lists that give other information instead of these distances. The lists attest to a stable core repertoire of 25 *Ziqpu* Stars. Almost all of the *Ziqpu* Stars attested in other texts (astrological texts, observational texts, rising time texts) are taken from this core list of 25 stars. Those that are not are few and are always part of a constellation that already contains *Ziqpu* Stars (for example, the 25 star list includes 4 *Ziqpu* Stars in the constellation The Panther[7]: The Shoulder of the Panther, The Bright Star of its Chest, The Knee, and The Heel. The rising time text SpTU I 95 adds a fifth *Ziqpu* Star in this constellation, The Feet of the Panther). A more significant case is with the constellation The Twins. One *Ziqpu* Star list (AO 6478 and its duplicate K.9794) includes an entry for a Rear Twins in addition to a (Front) Twins Star, separated by 5 UŠ. The Front and Rear Twins both appear in the rising time texts.

Although several tablets containing *Ziqpu*-Star lists are known which include statements of the distances between the *Ziqpu* Stars, all but one tablet is damaged and do not preserve all of the entries.[8] Unfortunately, the fully preserved list, AO 6478, differs from all of the other lists both in style (all other lists have entries in the form *x ana* SN "*x* to SN", where *x* is a distance and SN is a star name, whereas entries on AO 6478 have the form TA SN_1 EN SN_2 *x* "From SN_1 to SN_2 *x*"), and in

[6]Diary No. -122D Obv. 8 (my translation).

[7]I follow Hunger and Pingree (1989) in translating MÚL.UD.KA.DUḪ.A as "The Panther" (Akkadian *nimru*), based upon the arguments presented in Parpola (1983: 93). Literally, MÚL.UD.KA.DUḪ.A in Sumerian is "Demon with the Gaping Mouth" and the Seleucid period uranology text MLC 1866 describes this constellation as a human figure. It is unclear whether MLC 1866 reflects a late re-interpretation of the name or whether the constellation had always been seen as a human figure rather than a panther. In the absence of compelling evidence either way, I translate "panther" simply to maintain consistency with earlier publications.

[8]See Table 2 in Steele (2014) for a summary of the preserved entries in the various lists.

the number of stars included in the list (AO 6478 is the only list to include the Rear Twins). Furthermore, the total of the distances given in AO 6478 is 364 UŠ, whereas other sources such as the Neo-Assyrian blessing referred to above explicitly refer to the total circuit of the *Ziqpu* Stars as being 360 UŠ,[9] which is what we would expect. It may well be that the text of AO 6478 is corrupt in giving the total as 364 UŠ because the entry for the Rear Twins Star is given in a different format to the other entries in the list: it reads *bi-rit* MUL.MAŠ.TAB.BA 5 UŠ "between the Twins 5 UŠ", rather than the expected TA MUL.MAŠ.TAB.BA EN MÚL.MAŠ.TAB.BA EGIR-*i* 5 UŠ "From the (Front) Twin to the Rear Twin 5 UŠ".[10] It is possible that the author of AO 6478 intended that this should be interpreted as meaning that the Twins constellation extended for 5 UŠ, and that the interval between the Twins and the next star in the list was to be taken as being from the Twins, skipping over the distance between the two Twins. This interpretation brings the entries into agreement with the 25 star *Ziqpu* Star lists which omit the Rear Twin but have the same value for the distance between the Twins and the next star. The rising time texts bring some clarity to this problem. As will be discussed in the commentary to BM 35456 (Sect. 4.3.1), it is now apparent that the distance of 30 UŠ between The Handle of the Crook and The Twins given in the *Ziqpu* Star lists is to be understood as the distance between The Handle of the Crook and The Rear Twin, with the Front Twin placed 5 UŠ in front of The Rear Twin and therefore 25 UŠ behind The Handle of the Crook.

There is one further difficulty in establishing the *Ziqpu* Star list, however. Even with the new understanding of the positions of the two Twins Stars, the total distance for the circuit of the *Ziqpu* Stars implied by AO 6478 would still not be the expected 360 UŠ, but rather 359 UŠ. So far as they are preserved, the distances between the *Ziqpu* Stars in all of the other lists are identical with those found on AO 6478. However, none of the other lists preserve all of the distances in the list and even combining all of the sources, there remains a gap in the entries around the stars the Yoke and the Rear Harness.[11] The sequence of stars in this part of the list is Eru, The Harness, The Yoke, The Rear Harness and The Circle.[12] The distances between these stars in AO 6478 are 25 UŠ between Eru and The Harness, 8 UŠ between The Harness and The Yoke, 9 UŠ between The Yoke and The Rear Harness and 12 UŠ between The Rear Harness and The Circle, totaling 54 UŠ. As I will discuss in Sect. 4.5.1, the rising time texts imply a distance of 55 UŠ between Eru and The Circle. It is worth noting also that this part of the list on AO 6478 is the only part

[9]The text (STT II 340, Obv. 12) reads: 12 DANNA MUL.MEŠ [*z*]*iq-pi šá* KASKAL *šu-ut* [d]*en-lil*"12 *bēru* are the *Ziqpu* Stars in the path of Enlil". 1 *bēru* = 30 UŠ therefore 12 *bēru* = 360 UŠ.

[10]See already Koch (1996).

[11]The only list to preserve these entries is the Sippar planisphere but the text is very badly damaged at this point and Horowitz and Al-Rawi's (2001) readings of the traces are clearly based upon what they expected to find using AO 6478 as a model.

[12]It is worth noting here that the list VAT 16436, which does not contain values for the distances in UŠ, mixes up the order of the entries in this part of the list, swapping the Harness and the Rear Harness.

Table 2.1 The 25 core *Ziqpu* Stars. Uncertain distances are given in parentheses (note that while these three individual distances may be uncertain, their total is not)

Star	Distance to next star (UŠ)	Additional stars
The Shoulder of the Panther	10	
The Bright Star of its Chest	20	
The Knee	20	10 UŠ to The Foot of the Panther
The Heel	10	
The Four Stars of the Stag	15	
The Dusky Stars	15	
The Bright Star of the Old Man	10	
Nasrapu	15	
The Crook	10	
The Handle of the Crook	30	25 UŠ to The Front Twin
The Twins (The Rear Twin)	20	5 UŠ behind The Front Twin
The Crab	20	5 UŠ to The Rear Stars of the Crab
The 2 Stars of the Head of the Lion	10	
The 4 Stars of its Breast	20	
The 2 Stars of its Thigh	10	
The Single Star of its Tail	10	
Eru	25	
The Harness	(10)	
The Yoke	(10)	
The Rear Harness	(10)	
The Circle	15	
The Star from the Doublets	5	
The Star from the Triplets	10	
The Single Star	10	
The Lade of Life	20	

where the distances are not all multiples of 5 UŠ. I tentatively suggest either that the distances between The Harness and The Yoke, between The Yoke and The Rear Harness and between the Rear Harness and The Circle were assumed to be each 10 UŠ or that the distances between The Harness and The Yoke and between The Rear Harness and The Circle were 8 UŠ and 12 UŠ as in AO 6478, but that the distance between The Yoke and The Rear Harness be increased to 10 UŠ. Without further evidence, I assume the former (simpler) option.

Table 2.1 lists the 25 core *Ziqpu* Stars together with the distances between then in UŠ, so far as these can be established on the basis of the various *Ziqpu*-Star lists and the assumptions made above. In addition, I give the positions of the additional stars not in the 25-star list which appear in the rising time texts. It is worth noting that the preserved lists do not all begin with the same star. For this reason, I have chosen to arbitrarily begin the list with The Shoulder of the Panther. This star provides the starting point for the rising time schemes. Finally, it is worth noting that the preserved lists exhibit considerable variation in the writing of star names. I have elsewhere argued that this may be because the list was something that was remembered by the scribes and occasionally written down rather than being a text which was copied (Steele 2014).

Two ways of referring to the culmination of *Ziqpu* Stars are found in the rising time texts: (1) the expression *ana ziq-pi* DU, literally meaning "goes to its highest point", immediately following the name of the *Ziqpu* Star; and (2) the expression *ina* UGU or *ina muḫ-ḫi*, literally "in its topmost" immediately before the star name.[13] The two expressions do not appear to have any functional difference and so both can be translated simply as "culminate". In order to maintain a distinction which reflects the difference in syntax of the original texts, I translate the first expression "(star name) culminates" and the second "at the culmination of (star name)".

2.4 The Zodiac

The development of the zodiac as a uniform division of the path of the sun, moon and planets was a key step in Babylonian astronomy. Motion through the zodiac may be tracked through its division into twelve equal parts, each of which is subdivided into 30 UŠ. The position of a body within a zodiacal sign is its celestial longitude and since the complete zodiac contains $12 \times 30 = 360$ UŠ, we can translate UŠ as degree if we wish. Positions perpendicular to this motion, broadly equivalent to modern celestial longitudes, can be measured above or below the middle of the zodiacal band (Steele 2007b).

The zodiac has its origin in two concepts within earlier Babylonian astronomy: a list of the constellations which stand in the path of the moon (in modern terms, the zodiacal constellations) and the schematic calendar. MUL.APIN contains a list of eighteen zodiacal constellations. Observational texts from before the beginning of the 4th century BC often report the position of the moon or a planet either within, in front of, or behind one of these constellations. Sometime towards the end of the fifth century BC,[14] the model of the schematic calendar in which the year contains twelve 30-day months was used to create an equivalent "schematic" zodiac in which there were twelve constellations each of which contain 30 UŠ. Just as the schematic

[13] In other contexts, *ina* UGU is often used simply to add emphasis to an expression and can be translated simply as 'at', and such a translation was, for example, used by Lanfranci and Parpola (1990: 178) in their edition of the letter referring to the night-time storm discussed above. For further discussion of why I believe it is correct to translate this phrase as 'culminate' when the text is referring to *Ziqpu* stars, see Steele (2014).

[14] Possible dates for the development of the zodiac have been proposed for between the middle of the fifth century BC (Rochberg-Halton 1991) to within a few years of 400 BC (Britton 2010).

calendar simplified mathematical calculation, the uniformly divided zodiac simplified astronomical calculation. A useful consequence of the parallelism of the schematic calendar and the zodiac is that in one day the sun's mean motion will be equal to 1 UŠ.[15] Assuming the sun is at the beginning of the zodiac (0° in Aries) at the beginning of the solar year, then the schematic date and the sun's position are equal. For example, on Month V day 10, the sun will be 10° within the fifth sign of the zodiac (Leo). A consequence of this is that when using the schematic calendar the solstices and equinoxes are placed at 15° within Aries, Cancer, Libra and Capricorn. It should be noted, however, that the zodiac was not only used in the context of the schematic calendar. For example, in the System A and System B lunar theories, which operate with lunar months and a value for the true length of the solar year, the vernal equinox is placed at 10° and 8° within Aries respectively.

The signs of the zodiac were named after zodiacal constellations that fell within the relevant section of the path of the moon. Some texts preserve two alternative names for two of the signs, presumably because the standard names had not yet been agreed upon. In my translations I use the modern name of the zodiacal sign when the text is referring to a sign and give a literal translation of the name when it is used as a constellation. For example, I translate MÚL.ALLA as "Cancer" when used as a zodiacal sign but as "The Crab" when used as a constellation name. Similarly, I render MÚL.ḪUN as "Aries" when it is a zodiacal sign but "The Hired Man" when it is a constellation.

Some of the rising time texts make use of a division of each zodiacal sign into twelve "micro-signs", each of 2½°. The micro-signs are named after the regular signs and given in sequence beginning with the same sign as the governing zodiacal sign. Thus, the first microzodiac sign of Aries is Aries, the second micro-zodiacal sign of Aries is Taurus, etc., up to the twelfth microzodiac sign of Aries which is Pisces. In Taurus, the first microzodiac sign is Taurus, the second is Gemini, etc., up to the twelfth microzodiac sign of Taurus which is Aries. The full system of microzodiac signs is shown in Table 2.2. In the rising times texts, the microzodiac signs are referred to both by their number within the governing zodiacal sign and by their microzodiac sign name given together with the governing zodiacal sign name. For example:

9-*tú* ḪA.LA *šá* MÚL.RÍN MÚL.MAŠ *šá* MÚL.RÍN
9th portion of Libra (which) is Gemini of Libra

Outside of the rising time texts, the system of micro-zodiacal signs is found in various astrological texts, most notably the so-called "microzodiac series" which correlates various items including *materia medica* and hemerological material with the micro-zodiacal and zodiacal signs.[16]

[15]The parallelism between schematic dates and the sun's mean motion produces a value of 13 UŠ per day for the mean motion of the moon, a value which underlies the so-called *Dodecatemoria* and *Kalendertext* astrological schemes. See Brack-Bernsen and Steele (2004).

[16]Weidner (1967), Monroe (2016).

Table 2.2 The micro-zodiac system

Portion	Aries	Taurus	Gemini	Cancer	Leo	Virgo	Libra	Scorpio	Sagittarius	Capricorn	Aquarius	Pisces
1	Aries	Taurus	Gemini	Cancer	Leo	Virgo	Libra	Scorpio	Sagittarius	Capricorn	Aquarius	Pisces
2	Taurus	Gemini	Cancer	Leo	Virgo	Libra	Scorpio	Sagittarius	Capricorn	Aquarius	Pisces	Aries
3	Gemini	Cancer	Leo	Virgo	Libra	Scorpio	Sagittarius	Capricorn	Aquarius	Pisces	Aries	Taurus
4	Cancer	Leo	Virgo	Libra	Scorpio	Sagittarius	Capricorn	Aquarius	Pisces	Aries	Taurus	Gemini
5	Leo	Virgo	Libra	Scorpio	Sagittarius	Capricorn	Aquarius	Pisces	Aries	Taurus	Gemini	Cancer
6	Virgo	Libra	Scorpio	Sagittarius	Capricorn	Aquarius	Pisces	Aries	Taurus	Gemini	Cancer	Leo
7	Libra	Scorpio	Sagittarius	Capricorn	Aquarius	Pisces	Aries	Taurus	Gemini	Cancer	Leo	Virgo
8	Scorpio	Sagittarius	Capricorn	Aquarius	Pisces	Aries	Taurus	Gemini	Cancer	Leo	Virgo	Libra
9	Sagittarius	Capricorn	Aquarius	Pisces	Aries	Taurus	Gemini	Cancer	Leo	Virgo	Libra	Scorpio
10	Capricorn	Aquarius	Pisces	Aries	Taurus	Gemini	Cancer	Leo	Virgo	Libra	Scorpio	Sagittarius
11	Aquarius	Pisces	Aries	Taurus	Gemini	Cancer	Leo	Virgo	Libra	Scorpio	Sagittarius	Capricorn
12	Pisces	Aries	Taurus	Gemini	Cancer	Leo	Virgo	Libra	Scorpio	Sagittarius	Capricorn	Aquarius

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