THE ORIGIN OF THE ANCIENT EGYPTIAN CALENDAR

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ABSTRACT

In 1904 Eduard Meyer stated that the Egyptian calendar was invented about 4231 B.C., and some of the principal Egyptologists of his generation adopted this theory with minor modifications. In recent years it has been realized that 4231 B.C. was far back in the prehistoric period, long before the invention of writing, and of necessity later dates have had to be advanced for the adoption of the calendar as we know it.

Primitive man in Egypt regulated his life entirely by the cycle of the Nile's stages. Nature divided his year into three well-defined seasons—Flood, Spring, and Low Water or Harvest, with the Flood Season, following the hardship of the Low Nile, the obvious starting point for each annual cycle. The Egyptian early recognized the fact that usually twelve moons would complete a Nile year, but his lunar reckoning always remained secondary to his Nile reckoning, and he never adopted solar seasons. However, by about 3200 B.C. he probably recognized the heliacal rising of the prominent star Sothis as a definite phenomenon heralding the coming flood, and he began to count the observed reappearance of the star as his New Year Day. His year he now adjusted to twelve artificial moons of 30 days each, followed by about five days in which he awaited the reappearance of Sothis.

For several centuries the calendar was fixed to the star and thus was approximately correct, but the experience of generations was apparently proving that the perfect year should be 365 days long, and in 2773 B.C. a year of this length was adopted, by the simple expedient of neglecting to readjust the calendar by annual observations. Since no change was ever permitted thereafter, the Egyptian calendar was only correct once in every 1460 years.

THE calendar of the ancient Egyptians was one of man's earliest experiments in almanac making. Certainly it was one of his most enduring, for in the first centuries of the Christian era it was still being used much as it had been during the pyramid age three thousand years earlier. This uninterrupted existence throughout more than half of man's recorded history has given it an almost mysterious quality which has been so intriguing to modern scholars that within my own memory—and even within this last year or so—many an article on its origin has appeared, all differing more or less fundamentally in the story they strive to reconstruct.

The approach to this problem has usually started with a statement made by Censorinus in 238 A.D. to the effect that the Egyptian New Year Day in 139 A.D. fell on July 21, when the bright star Sothis—which we know as Sirius—after having been invisible for a season, made its annual reappearance in the eastern sky just before sunrise. Since the Egyptian civil year was one of 365 days and that of Sothis was one of 365¼ days, this coincidence could only have happened at intervals of about 4 × 365 years, or in 1317, 2773, and 4231 B.C.[1] Believing that the ancient Egyptian calendar could only have been invented on one of these occasions of coincidence, and further believing that 2773 B.C. fell in the Fourth Dynasty when the calendar was already in use, Eduard Meyer stated in 1904 that the calendar must have been introduced in 4231 B.C.[2] Eventually Meyer concluded that it was not until 3200 B.C. that Menes, the first historical king of Egypt, united the Two Lands,[3] yet he never altered his date for the invention of the calendar, which would thus have been in uninterrupted use for a thousand years before the beginning of Egyptian history—and equally long, we now suppose, before the development of writing. James Henry Breasted[4] accepted Meyer's theory that the invention of the calendar in 4231 B.C. was "the oldest fixed date in history." Evidently realizing the difficulties which this involved, Breasted eventually attributed the invention of the calendar to a predynastic "First Union" of the Two Lands, which, while it is supposed to have taken place in the forty-third century B.C. and to have lasted for eight hundred years,[5] has left no written document nor any other tangible trace in history. Eventually Ludwig Borchardt[6] gave Meyer's theory a momentary support by his

[1] The dates of the so-called "Sothic periods," as given by different historians, vary slightly among themselves. Here, as in the following pages, they are uniformly made to agree with the latest corrected tables by P. V. Neugebauer in *Astronomische Nachrichten*, v. 261, no. 6261, 1937. I owe this reference to the kindness of Otto Neugebauer—who is not to be confused with his namesake, the compiler of the tables.

[2] *Aegyptische Chronologie* (*Philosophische und historische Abhandlungen der Königlich preussischen Akademie der Wissenschaften*, 1904), p. 41; and (in the same *Abhandlungen* for 1907) *Nachträge zur ägyptischen Chronologie*. In the following pages the references will be cited as Meyer, *Chron.*, or Meyer, *Nachtr.* In 1913 he repeated the thesis in his *Geschichte des Altertums* (3rd edition), § 159.

[3] *Die Ältere Chronologie . . . Ägyptens, Nachtrag zum ersten Bande der Geschichte des Altertums* (1931), p. 68; referred to below as Meyer, *Ältere Chron.* This 1931 edition appeared after Meyer's death, and a note by the editor, H. E. Stier, on page 74, calls attention to Alexander Scharff's recent theory that the calendar was invented in 2773 B.C.

[4] *Ancient Records*, I, pp. 25 ff.; *A History of Egypt*, pp. 32, 44.

[5] "The Predynastic Union of Egypt," *Bulletin de l'Institut français d'archéologie orientale*, XXX (1930), p. 709; *Ancient Times* (2nd edition, 1935), pp. 54, 58. He appears to have been led into this idea partly by one of Sethe's brilliant and seemingly plausible philological exercises, *Der ægyptischen Ausdrücke für rechts und links*, and also by Sethe's *Urgeschichte und älteste Religion der Ägypter*.

[6] *Die Annalen und die zeitliche Festlegung des alten Reiches* (*Quellen und Forschungen zur Zeitbestimmung der Ägyptischen Geschichte*, Band 1), p. 30. Borchardt's chronology was strongly criticized by Peet, *Journal of Egyptian Archæology*, vol. VI (1920), pp.

attempt to place Menes close to Meyer's date for the invention of the calendar. This combination appealed to Kurt Sethe whose study of the origin of the calendar,[7] while unsatisfactory in its conclusions, is a most valuable compendium of all the available material.

In recent years the various modifications of Meyer's theory have been less generally accepted than formerly, and the tendency has been toward the more reasonable hypothesis that the calendar was a product of some later period.

One of the most recent and most ingenious schemes for avoiding this difficulty—but one which unhappily was inspired, I understand, by tempting but false etymologies for the Egyptian season names—was propounded last year by Professor Jotham Johnson of the University of Pittsburg.[8] He argued that the primitive Egyptian had a lunar calendar until the morning of June 18, 3251 B.C. when Sothis appeared over the eastern horizon just before the dawn of a day on which the new moon occurred. From that day onward the calendar was fixed to Sothis, but gradually the calendar became so far divorced from the terrestrial seasons that it had to be corrected by exactly one whole four-month season on June 18, 2773 B.C.—after which it became the wandering year of the historic period.

Alexander Scharff of the University of Munich had long seen the difficulties inherent in Meyer's theory, and in 1927 [9] he had stated that the calendar must have been invented in 2773 B.C.—a whole Sothic period later than had usually been proposed. Before that date he assumed that the Egyptian reckoned time by some wholly different system, which he did not exactly define but which in one place he seems to say was based on a year of 320 days.

149 ff., and by Meyer, *Ältere Chron.*, p. 41, but Borchardt modified it only very slightly in *Quellen*, Band 2, *Die Mittel zur zeitlichen Festlegung von Punkten der Ägyptischen Geschichte* (Kairo, Selbstverlag, 1935). So far as this refers to the XVIII Dyn., it is analyzed—unfavorably—by W. F. Edgerton in *American Journal of Semitic Languages*, LIII (1937), pp. 188 ff. In both parts, although Borchardt's conclusions are unsatisfactory, he makes a great deal of important material available, but I have a feeling that the complexity with which he treats the subject would have made the ancient Egyptian's head spin. References below will be to Borchardt, *Quellen*.

[7] *Die Zeitrechnung der alten Aegypter*, in the *Nachrichten der K. Gesellschaft der Wissenschaften zu Göttingen, Philologisch-historische Klasse*, 1919–1920. It will be quoted below simply as Sethe, with the pagination of the *Nachrichten*, in which pages 287–320 are of 1919, and pages 28–55 and 97–141 are of 1920.

[8] *Journal of the American Oriental Society*, **59** (1939), p. 403.

[9] *Grundzüge der ägyptischen Vorgeschichte*, p. 54, in *Morgenland; Darstellungen aus Geschichte und Kultur des Ostens*, Heft 12. See note 35 below.

Two years ago Otto Neugebauer,[10] now at Brown University, came out with an extremely intriguing and still more revolutionary theory. He stated that if the primitive Egyptian kept records of the days which elapsed between the successive inundations of the Nile over a period not exceeding fifty years, an average of these periods would infallibly lead to a 365 day year without the observation of any heavenly body whatever. This is unquestionably true in the light of our present day knowledge, but it is doubtful whether it was equally obvious to the Egyptian in the stone age.[11] The figures which Neugebauer himself uses give differences in the lengths of the intervals between floods of as much as 80 days in a single generation, and come to exactly 365 days only once in that period.[12] When one Nile year might be only 335 days long and another as much as 415, it is a question whether primitive man would ever, unaided, have arrived at the conception of an average Nile year or would have known how to calculate it, had he thought of it. Setting a calendar by the Nile flood would be about as vague a business as if we set our calendar by the return of the Spring violets. However, Neugebauer's very interesting theory appealed to Scharff as supplying evidence on the nature of the Egyptian calendar before 2773 B.C.—and perhaps even as late as 2000 B.C.—and he now enthusiastically endorses it in part, even if not in all its details.[13]

Before examining the problem of the origin of the calendar afresh a digression appears to be justified on a matter which, even recently, has been the subject of discussions likely to complicate the whole question in the minds of some readers.

[10] "Die Bedeutungslosigkeit der 'Sothisperiode' für die älteste ägyptische Chronologie," in *Acta Orientalia*, XVII (1938), pp. 169 ff. In briefer form, with additional remarks by Jean Capart, in *Chronique d'Égypte*, No. 28, July, 1939, pp. 258 ff.

[11] This would require not only a count of the days between successive floods, but a Nilometer, sufficiently massive to withstand the erosion of the inundations, on which comparable stages of the Nile might be measured. Sethe (*Urgeschichte und älteste Religion der Ägypter*, §§ 109 ff.) believed that there was such a Nilometer on the Island of Roda near Memphis, as early as prehistoric times. This is pure hypothesis, as is recognized by Scharff on p. 9 of the article cited in note 13 below.

[12] He uses the figures given by Sir William Willcocks for 1873–1904, before the completion of the Aswān dam. They were doubtless typical of the years before the Nile was artificially controlled. Borchardt (*Quellen*, I, p. 7) uses a non-continuous series of 32 high Niles between 1798 and 1888, which give comparable results.

[13] *Die Bedeutungslosigkeit der sogennanten ältesten Datums der Weltgeschichte*, read to the Phil.-hist. Abteilung der bayerischen Akademie der Wissenschaften zu München in July, 1939, and (in summary) to the Archæological Congress in Berlin in August, 1939, and published in the *Historische Zeitschrift*, **161**, pp. 3 ff. Scharff seems to approve most of Neugebauer's theory except that (pp. 15, 18) he hesitates to accept a 365 day year as early as the I-II Dyns. See note 35 below.

In modern studies on the historic Egyptian calendar one sometimes reads of a "civil" or "wandering year" and of a co-existent "fixed year" by which festivals might be kept in unvarying relation to the more or less true solar seasons of the inundation, agriculture, and the important reappearance of Sothis.[14] It may be as well at the outset of this paper to state that the ancient Egyptians, from the Old Kingdom to the Roman Period, have not left a single trace of such a fixed calendar. Out of the thousands which have survived from dynastic Egypt, not one document gives equivalent dates in the known "wandering" year and the hypothetical "fixed" year. Furthermore, by the time that relations with the outside world were such as to result in unprejudiced foreign evidence on the customs of Egypt, we find the Egyptian both ignorant of, and unreceptive to the idea.

About 600 B.C.,[15] Thales of Miletus introduced the Egyptian year of 365 days to the Greeks, without hint of any correction being required, and Herodotus, when he was in Egypt about 460 B.C., heard only of a 365 day year and was under the impression that it was not only an accurate measure of time, but that it was the only accurate year devised by any contemporary people. When in 488 B.C. Darius adopted the Egyptian calendar for Persia, it was as an unmodified 365 day year, and after 120 years a whole month had to be intercalated to correct the Persian calendar. The credit for the discovery that a solar year consisted of 365¼ days was given by classical authors to Eudoxos of Knidus (408–355 B.C.) whose calculations were probably those used by the Macedonian Ptolemy III Euergetes when, by the Canopic Decree of 237 B.C., he attempted to introduce a 365¼ day year in Egypt.[16] In that decree

[14] Sethe, pp. 311 ff., "Das feste Jahr." Meyer (*Chron.*, pp. 31 ff., "Das angebliche feste Jahr,") unanswerably refutes some of the arguments current before the appearance of Sethe's *Zeitrechnung*.

[15] The following paragraph is largely drawn from Sethe, pp. 315–318.

[16] Meyer, *Chron.*, p. 31; translation in J. P. Mahaffy, *A History of Egypt under the Ptolemaic Dynasty* (1899), pp. 111 ff., and in Edwyn Bevan, *A History of Egypt under the Ptolemaic Dynasty* (1927), pp. 207 ff. The decree is definite proof that a fixed calendar was unknown to the Egyptians in the III Cent. B.C. It is dated March 6, 237 B.C., when the flood and the reappearance of Sothis were expected to take place on the last of the Month *Payni* (95 days before New Year Day) and is an attempt to fix the calendar unalterably to the seasons as they were in that year, inconvenient though they would seem to be. It provides that an intercalary day be added, in every fourth year, to the five festivals of the gods at the end of the year, "in order that it may not occur that some of the national feasts kept in winter may come in time to be kept in summer . . . as has formerly happened." Furthermore, in order that Ptolemy Euergetes should always be credited with correcting "the former defect in the arrangement of the seasons," it provides that this sixth god's festival shall be named for the Benefactor Gods—Ptolemy and his wife, Arsinoe.

no reference is made to the idea being native to Egypt, and in fact it appears to have been regarded by the Egyptian people as an abhorrent foreign innovation with which they would have absolutely nothing to do, in spite of the fact that it was said to have the sanction of their own priesthood. It was only in 46 B.C. that Sosigenes of Alexandria [17] evolved for Caesar the Julian Year of 365¼ days, and twenty years afterwards Augustus imposed upon Egypt an era of Julian Years, starting with August 1st, 30 B.C., under the name of the Alexandrian year. Even this—called by the Egyptians the "Greek Year" to distinguish it from the year "according to the Egyptians," or "according to the ancients" [18]—was not used by the natives until they had given up their own religion and had adopted Christianity. In short, the whole history of a year with intercalations, as we see it in classical times, is a history of an innovation obnoxiously foreign to the native Egyptian. There is no hint in the whole four centuries and a half covered by the classical literature that the Egyptians had any memory of ever having used a fixed year or ever having recognized its desirability.

The ancient Egyptian calendar of the historical period gives clear evidence that it originated in the climate of the land. Egypt has been, to all intents and purposes, rainless for many thousand years, and all living things in the Nile valley have been dependent on the fluctuations of the river. In the very occasional years when the Nile flood is average, the river is lowest at the First Cataract about the end of May and at the head of the Delta some two weeks or more later. Soon afterwards come the floods from the equatorial rains on the water-shed of the upper Nile during the preceding winter. The river rises slowly at first and then more rapidly, until it reaches its height at the First Cataract about September 1st and a month later at the Delta head where, by the middle or end of October, the highest of the flooded lands begin to emerge once more and the waters fall, until they reach their lowest again the following June.

[17] It was probably Greek mathematicians in Alexandria who told Diodorus (I, 50) in 60–56 B.C. that the Egyptians "reckon . . . their month of 30 days and they add 5¼ days to the 12 months, and in this way fill out the cycle of the year." All other evidence is against such having been the native practise at this time, but the facts were doubtless well known to the Alexandrian Greeks.

[18] Meyer, *Chron.*, p. 32. Otto Neugebauer reminds me of the fact that 200 years after the Julian Calendar reform the astronomer Ptolemy was still performing his calculations in the 365 day Egyptian year. This, however, was merely for convenience—not because of chauvanism. The Julian year is still being used in preference to the Gregorian by astronomers, sometimes to the confusion of archæologists.

During the palæolothic period, whenever the periodical rise of the Nile got under way, the settlements of the primitive Egyptians along the river banks and in the marshes, where they had been established to be near water, would have to be abandoned for others on higher ground. For a space, the Nile people would look down from the desert edge upon a broad lake covering meadows, groves, and swamps, and they would be forced to subsist on fishing, fowling, and hunting. This season in the language of their descendants, the dynastic Egyptians, was *Akhet*—"the Flood." In due course the waters would fall, and the Egyptians would follow the edge of the receding flood across the alluvial plain, pasturing their flocks—once they had domesticated any—on its meadows fast growing green, themselves eating the wild fruits and vegetables which sprang up and ripened in the hot, moist soil, and—when they had learned to save the seed from the last low Nile—strewing it over the wet, black mud where it would sprout and mature very shortly under the cloudless skies. This season in the language of their descendants was *Prōyet*—"the Coming Forth," "the Spring." As the waters descended, man returned to the river and to the permanent swamps where water could be had most easily, and waited for the next flood. This season was called by his descendants *Shōmu*—perhaps meaning at first "the Low Water," but later surely understood as "Harvest-time."[19] Thus the Egyptian recognized but three seasons, and when he adopted a word for "year" he chose a form of the word *ronpy*, "to be young," or "fresh" as of plants, and he considered this year as beginning with the first signs of the rising water which would bring out the verdure once more. These first signs of the awaited flood would be such as primitive hunters and fishermen might learn. First the waters would turn green from the algæ floating down from the swamps of the upper Nile, and the green water would last until the flood was definitely under way. The river itself and the river animals, the hippopotami, crocodiles, and fish whose actions foretold the coming flood, must have been the first harbingers of another cycle of seasons to primitive man. At this stage in his

[19] Sethe, p. 294; Alan H. Gardiner, *Egyptian Grammar*, p. 203. The word *Shōmu* seems to be derived from two words meaning "deficiency" of "water." Later it acquires two meanings: (1) the season of low water, and (2) the harvest. Usually its "determinative" differs with the meaning, but an XVIII Dyn. ostracon found by the Metropolitan Museum's Expedition (and shortly to be published by W. C. Hayes, *Ostraca and Name Stones from the Tomb of Sen-Mūt*, No. 106) writes the word in a date with both determinatives.

development he probably could not count beyond the number of his fingers and surely was not interested in predictions beyond the immediate future.

By the time stone-age man first felt the need of some other means of predicting the future stages of the river—probably as agriculture became his chief interest—he must already have become accustomed to counting the phases of the moon. He would early have realized that once the Nile is rising, some four moons must pass before he could sow his seed corn on the emerging mud; how at least four moons again would be required for the grain to ripen; and how a third four moons would pass before the flood would reappear again. Of course, even in the ideally normal year such a count would be only approximate. We know that each moon is theoretically about 29½ days, and twelve moons only 354 days, and that therefore in three successive floods—aside from the irregularities of the river itself—an error of a little more than a moon would have occurred. However, the ideal flood occurs perhaps only once in a generation, and year after year the actual period between one low Nile and the next might be anywhere between 11 and 14 moons. An early or a late flood would sometimes make such a moon reckoning correct, sometimes wrong, but to primitive man the moon still would serve as a ready rule of thumb for predicting the seasons. And after all, the coming of the flood was the start of the new year, regardless of the moon count.

Long after he had evolved a far more practical calendar, the Egyptian still retained some memories of his primitive lunar reckoning. It gave him his subdivision of the year into twelve parts, and the moon gave its name *abod* to each of those parts, as it has to our "months." About 1850 B.C. lunar months, alternately 29 and 30 days long and totally unrelated to the then current civil calendar, still served to set the periods of priestly temple service.[20] From then down to Roman times there seem to be traces of lunar months in religious calendars, and it would appear that the coronations of the kings were supposed to take place on the day of the full moon.[21] In 1100 B.C. astronomical tables still had a technical term for the mid-month which appears to go back to a time when a month was literally a moon and the mid-month

[20] Meyer, *Chron.*, p. 52; Sethe, p. 301.

[21] Borchardt, *Quellen*, II, pp. 39 ff., 69 ff. This theory is approved by Edgerton, *Amer. Jour. of Semitic Languages*, LIII (1937), pp. 188 ff. He quotes, however, Černý, *Ägyptische Zeitschrift*, LXXII (1936), pp. 109–118, for an emergency at the death of Ramesses III which caused his successor, Ramesses IV, to be installed immediately.

was full moon time.[22] Even in Pliny's [23] time it was a popular by-word that the flood might be expected on the new moon next after the summer solstice, and Vettius Valens,[24] probably through some misunderstanding of a similar popular saying, supposed that the New Year was on the new moon preceding the reappearance of Sothis.

However, lunar reckoning was always of secondary importance to the Egyptian. Those whose calendars are lunar count the start of each day from sunset, when the new moon, the new month, and the new year all take their beginning.[25] The Egyptians, on the contrary, alone of all ancient peoples, commenced their day at dawn,[26] and when their writing was invented the same ideogram stood for both the words "sun" and "day."

Nevertheless, the Egyptian never adopted solar seasons. His seasons were always those of the Nile, whose rise and fall, originating in the distant and unknown south, the prehistoric Egyptian could have had little or no reason to associate with the sun. Only during a brief period in the fourteenth century B.C. did Egyptian beliefs give full credit to the Sun for its controlling influence on terrestrial life.[27] But even then the relationship of the Sun to the phases of the Nile was not clearly understood, and it was apparently only in classical times that the solstice was regarded as an omen of the coming inundation. Thus, about 450 B.C. Herodotus [28] wrote: "the Nile, at the commencement of the Summer Solstice, begins to rise and continues to increase for a hundred days and as soon as that number is passed it forthwith retires and contracts its stream, continuing low during the whole winter until the Summer Solstice comes around again." Later Pliny was told that the river rose at the full moon next after the Summer Solstice, and similar beliefs have been current until modern times.[29]

[22] Sethe, pp. 130, 136.

[23] *Natural History* (ed. Bohn), Book 5, Chapter 10.

[24] Sethe, p. 296.

[25] Sethe, p. 119.

[26] Sethe, pp. 130–138.

[27] Sethe, pp. 28–30. During the reign of Akh-en-Aten (1375–1358 B.C.) the "Hymns to the Sun" attributed to that heavenly body full control over all nature, including the Nile (Breasted, *A History of Egypt*, pp. 371–376; *Development of Religion and Thought in Ancient Egypt*, pp. 312 ff.). However, Sethe (pp. 37 ff.) is wrong in assuming an importance for the winter solstice, which actually seems to have played no part in Egyptian thought.

[28] Book II, 19.

[29] For Pliny, see above, note 23. For recent beliefs, see E. W. Lane, *Manners and Customs of the Modern Egyptians* (1836), II, pp. 254 ff.; Lepsius, *Chronologie*, p. 213.

Here it is important to recall certain fundamental points in our problem. First, the rise of the Nile began the new year. Second, the erratic nature of this event was too variable to be itself a measure of time for a people who were becoming more and more cultivated. Third, the moon had proved only a little better. And fourth, the sun did not seem to the Egyptian to have any connection with the question. Yet there is something in man which makes him look to the heavens for his calendar, and the Egyptian, like all others, turned to the sky for some sign that his new year was approaching.

In the cloudless Egyptian nights one of the most prominent, single, heavenly bodies is the great star Sothis. As is the case with all fixed stars, there is a period in each year when Sothis has disappeared from the night sky, rising and setting in daylight. Then one morning its rising is just sufficiently earlier than the sunrise for it to be seen once more for a short time in the dawn as a prominent feature of the eastern sky. About 7000 B.C. Sothis was visible in the dawn at the head of the Nile Delta around May 21st, which was so long before even an exceptionally early flood that no possible relation could have been seen by any primitive Egyptian between the star and the rising Nile. But since about every 120 years this annual reappearance occurs a day later in the solar year, gradually the star's rising was retarded until, in the latitude of the Delta, it took place just before sunrise on June 17 [30] in 3500 B.C. Very slowly—so slowly that it took generations to make a day's difference—the star's reappearance was delayed further until it came on June 23 about 2800 B.C.—and the later it came the more certain it was to be regarded as a harbinger of the flood.

The reappearance of this brightest of stars in the dawn is a striking sight. It must have been especially so to primitive man suffering in the fiery heat of an Egyptian June, when the Nile was at its lowest, and his longing for the flood was keenest. Gradually he began to associate the return of Sothis with the first stages of that longed-for high Nile which he grew to expect would follow soon afterwards. When it was that man became conscious of this association we shall never know. Obviously it was an idea which took shape slowly.

[30] Throughout Coptic and Arab times, at least, the night of June 17 was celebrated as "the Night of the Drop" when it was believed that a miraculous drop fell into the Nile, causing it to rise. After July 3 the flood was usually obvious enough to be proclaimed daily by criers in the streets of Cairo. Lane, *loc. cit.*

However, it is impossible to doubt the fact that, as early as the dawn of the historic period, the Egyptian was already regarding Sothis as the harbinger of the all important inundation. From one of the royal tombs at Abydos, dating from the first historic Egyptian dynasty, there comes a little ivory tablet which is now in Philadelphia in the University Museum. On it is inscribed a brief and primitive inscription which has been interpreted "Sothis Bringer of the New Year and of the Inundation."[31] Coming to us from a slightly later period—but in all probability repeating the words of a much earlier composition—is a passage in the Pyramid Texts describing Sothis as the creator of all green growing things, and hence of the year itself.[32]

Here we have statements in the very dawn of history naming Sothis, the recognized master of the annual flood, as the creator of the year—by which of course we may understand the calendar.

We need have very little doubt that this association of Sothis with the year was at least as early as about 3200 B.C.—a date which, it must be realized, can only be fixed approximately—when the Egyptian communities were united by Menes, the first King of Upper and Lower Egypt.[33] Menes also is credited with founding the capital city, Memphis, at the head of the Nile Delta, and it is noteworthy that it was the observation of the reappearance of Sothis at Memphis which was regarded as official throughout

[31] University Museum, E 9403; Petrie, *Royal Tombs*, II, pls. V, 1, VIa, 2; Sethe, *Beiträge zur ältesten Geschichte Ägyptens*, p. 63; *Zeitrechnung*, p. 294. Borchardt, who apparently never had laid eyes on the tablet, published retouched photographs of it (*Quellen*, I, p. 53, n. 1), gratuitously adding the hieroglyphic signs for "month 2" in the blank space in its lower right hand corner. Unfortunately for his theory, he had not noticed that the inscription on it is incised, and therefore no part of it could have faded out, as he seems to have assumed. I have examined both the tablet itself and a photograph which I received through the kindness of Dr. Hermann Ranke and can testify that the Petrie publication is accurate. More recently, Scharff has described the tablet (*Ältesten Datums*, p. 14, note 1) as bearing the notation "the year of the cow counting," but this gives no explanation for the hieroglyphic sign *akhet*, of which Sethe takes account.

[32] *Pyramid Texts*, 965 a-b, makes the characteristically punning statement that "It is Sothis, thy beloved daughter, which has made the fresh green ('the New Year offering'—*rnp-wt*) in this thy name of year (*rnp-t*)." Scharff, *Ältesten Datums*, pp. 17–18, 31.

[33] Meyer (*Ältere Chron.*, pp. 68–69) dates Menes, founder of Dyn. I and traditionally of Memphis, to about 3200 B.C., admitting the possibility of an error of as much as 100–200 years either way. Scharff (*Die Altertümer des Vor- und Frühzeit Ägyptens* (1931), pp. 31–32, and *Ältesten Datums*, pp. 21–22) dates Menes to 3000 B.C. However, he seems to approve the recent figures of Farina for the Turin Papyrus, by which the XI Dyn. begins apparently in 2143 B.C. and the I–VIII Dyns. covered 955 years. This gives a minimum date of 3097 B.C. for Menes, without making any allowance for the 18 kings of the IX–X Dyns., except insofar as the X Dyn. may have been contemporary with the first half of the XI Dyn.

Egypt during the historic period.[34] With Menes began the written records of the lengths of the reigns of the kings, expressed in years, months, and days, which later annalists had no difficulty in combining with later records in the composition of the Palermo Stone, the Turin Papyrus, and the History by Manetho. And another, and most important point, each and every year on the Palermo Stone had an inundation, which would not have been the case had the civil year differed markedly from the natural year, as Scharff has suggested.[35]

It must be realized, however, that even when the primitive Egyptian began to recognize the reappearance of Sothis in the dawn as an omen of the coming flood, he had not immediately established what we call a "fixed" calendar. His calendar was without doubt still dependent on an annual observation of Sothis, and a successful observation of the heliacal rising without instruments presents its difficulties. Ludwig Borchardt [36] attempted the observation between 1924 and 1927, with various collaborators stationed up and down the Nile between the latitudes of ancient Thebes and ancient Heliopolis under conditions simulating, as nearly as he could imagine, those of ancient times. Today the reappearance of Sothis is due early in August when a mist often hovers over the inundated valley at dawn, and in addition the modern air is likely to be befogged with chimney smoke. Furthermore, the point of the sunrise on the horizon is nearer to that of

[34] This is a tradition preserved by Olympiodorus (writing in 565 A.D.), who stated that the whole land had followed the Memphite observation for the official date of the heliacal rising of Sothis. *Cf.* Sethe, p. 309. It should be remembered that when Sothis reappeared at Memphis on any given day, its heliacal rising had taken place at Aswān six days earlier.

[35] Scharff (*Gründzuge*, pp. 55–56; *Ältesten Datums*, pp. 15, 18) lays great stress upon the fact that the sum of the months and days in two adjacent regnal year spaces at a change of kings on the front of the Palermo Stone totals only 10 months and 20 days. Hence, he argues that the 365 day year was not in use in the first two dynasties. He can not, however, escape the fact that in a similar place in line 4 on the back of the stone, at the change of reign from Saḥu-Rēʿ to Nefer-ir-ka-Rēʿ, the total is only 11 months and 13 days, although the 365 day year admittedly existed in the V Dynasty. In these two places where there seem to be intervals between reigns (in the one case of 45 and in the other of 22 days) it is possible that these may be the periods between the death of one king and the coronation of the next, which had to await the presence of the successor in the capital and the occurrence of the full moon. See note 21 above. Further, Scharff forgets that if a year consisted of 320 days only, some years would have no inundation at all.

[36] Ludwig Borchardt and Paul Viktor Neugebauer, *Orientalistische Literaturzeitung*, 1926, cols. 309 ff.; 1927, cols. 441 ff. In the latter article the authors had the collaboration of members of the Egyptian Survey Department. These experiments (among the most enlightening contributions to the study of the Egyptian calendar) prove that primitive observers could have established a 365 day year only after long experience.

the star rise than it was when the latter took place at the solstice, and the star is therefore more difficult to see in the growing dawn. Hence, the modern observers sometimes did not see the star for as many as five mornings after it should have been visible, and while about 3200 B.C. conditions were better, there must have been many a year when the first glimpse of the star was a day or so late—in which case it would probably be a day too early the next year. To this uncertainty of observation another day would have to be added every fourth year as we add the day to our leap years. Indeed, when the primitive Egyptian first began to keep account of the days between heliacal risings he must have been very far from believing in anything like a fixed year.

Since his year was based on a primitive observation which had to be made annually, each New Year was marked with some uncertainty, but for the First Dynasty Egyptian that was surely not as great a drawback as it sounds to us. The Mohammedan months do not begin, even today, in theory, until one of the faithful has actually seen the new moon in the sunset, and I can well remember how once or twice there was a great deal of doubt, while I was still living in Egypt, as to when the month-long fast of Ramadan might be broken.[37] To primitive man a day or so of doubt of this sort would have caused far less bother than it does to his modern peasant descendant, and to him it causes little bother enough.

I suggest, then, that the Egyptian of the time of Menes was starting his year with an observation of the reappearance of Sothis. The divisions of the year were borrowed from prehistoric customs with, however, some important modifications. There were still the three seasons of Flood, Spring, and Harvest—now always of 120 days each. The "moons" were so convenient that they were retained as "months," even when it was found that they could not coincide with Sothis. From now on for civil affairs they were artificially ordered, each of exactly 30 days—or three ten day "weeks"—and between one reappearance of the star and the next there were always twelve months and a few days over. These extra days "Over and above the Year"[38]—which came between

[37] Lane (*Modern Egyptians*, II, p. 229) describes how the observation of moon-rise was made in Cairo a little over 100 years ago.

[38] Sethe (pp. 303 ff.) gives all the existing data on the five intercalary days, but his interpretation—that the year was originally of 360 days only—can hardly be accepted. It fits in, however, with the thesis of Scharff, *Ältesten Datums*, p. 16. The days "Over and above the Year" at first headed the new year (Sethe, *Urkunden des A. R.*, I, pp. 25, 27; Breasted, *Ancient Records*, I, §§ 218, 221); in later calendars they closed the old year.

the last month of the old year and the first of the new, and on which the reappearance of Sothis was to be awaited—were the "Birthdays of the Gods." [39] Usually the heliacal rising came after the fifth of them, and according to the now existing texts, on them the births of five gods of the Osiris cycle were to be celebrated. Sometimes six days would pass before the star's reappearance, and then perhaps the birthday of another god would be celebrated.[40] The next year, or the year after, the star would probably be visible a day before it was expected, in which case the last of the birthdays would be lost for a year. The important thing is that none of the twelve months were ever increased or diminished, and the uncertainty was always confined to these days "Over and above the Year."

I believe this to have been the situation during the first two dynasties. The commencement of each year was dependent on the heliacal rising of Sothis being observed, with the result that while most years might be 365 days long, every fourth year was probably a day longer, and any other year might be a day or two longer or shorter, depending on the accidents of observation. Yet we know that throughout the later historical period the year differed from the star, and also from the ever variable Nile. The problem, therefore, is when was the Egyptian "wandering" year first used.

Throughout the most familiar part of Egyptian history the "civil" year contained only 365 days, with the result that its New Year Day was "wandering" both in respect to the solar seasons and in relation to Sothis as well. As has been mentioned already, the civil New Year coincided with the reappearance of the star in 139 A.D. and hence, we may suppose, in 1317 B.C. From the period between 1317 and 2773 B.C. there are several items of evidence which demonstrate that the civil calendar was consistently "wandering" throughout that period. From the Eighteenth Dynasty we have calendrical dates for the reappearance of Sothis in 1469 B.C., as recorded in the Elephantine Festival Calendar of Tḥutmose III,[41] and in 1545 B.C. in the calendar of the Ebers Papyrus

[39] Sethe, *Die altaegyptischen Pyramidentexte*, par. 1961 c; only in the pyramid of Nefer-ka-Rēʿ (Pepy II). See also Meyer, *Chron.*, p. 40; Scharff, *Grundzüge*, p. 56. Scharff (*Ältesten Datums*, p. 17) states that this passage, while of the Old Kingdom, is not very ancient.

[40] In the attempted calendar reform of Ptolemy III Euergetes (see above, note 16) the extra day in every fourth year was to be dedicated to Euergetes and Arsinoe in their divine quality.

[41] Sethe, *Urkunden der 18. Dynastie*, p. 827. The calendar is for an unrecorded year in the reign of Tḥut-mosĕ III when the reappearance of Sothis took place on the 3rd

of the reign of Amen-ḥotpe I.[42] In the Twelfth Dynasty the Kahun Temple Day Book of 1877 B.C. fixes the date for that year,[43] and in the Eleventh Dynasty the dekan tables symbolizing the heavens on the lids of coffins give dates for the reappearance of Sothis between 2101 and 2021 B.C., which are absolutely consistent with the later dates for the same event.[44] Naturally, as we go further back through the Old Kingdom, inscriptions are rarer—both due to the accidents of time and the fact that the earlier Egyptian was less literate than his descendants—and no further observations of the reappearance of Sothis have happened to survive.

There are, however, other records which show that the civil calendar was shifting consistently at least as far back as 2350 B.C.[45] Meyer showed that the flax harvest in the Twelfth Dynasty, about the year 1940 B.C., took place at the appropriate calendrical date in the wandering year.[46] Furthermore, we know from various in-

Month of *Shōmu*, Day 28. This is 19 days later than the date given in the Ebers Papyrus calendar (see next note), and hence there must have been an interval of about $4 \times 19 = 76$ years between the two calendars.

[42] Sethe, *op. cit.*, p. 44; *Zeitrechnung*, p. 313; Meyer, *Nachtr.*, p. 7; Edgerton, *Amer. Jour. of Semitic Languages*, LIII (1937), pp. 195 ff., where the calendar is dated to 1536 B.C. The calendar is for the 9th year of Amen-ḥotpe I when the reappearance of Sothis took place on the 3rd Month of *Shōmu*, Day 9.

[43] Borchardt, *Zeitschrift für ägypt. Sprache*, XXXVII (1899), p. 99; Meyer, *Chron.*, pp. 51 ff. Scharff (*Ältesten Datums*, pp. 19, 21, 31) seems to believe that observations of Sothis began only at about this time.

[44] They tabulate the stars and constellations as they rose on each of the twelve hours of the night, at intervals of ten days, disregarding—probably for simplicity's sake—the five intercalary days at the end of the year. Four coffins from Asyūt (Chassinat and Palanque, *Fouilles dans la Nécropole d'Assiout*, p. 127, pl. XXV, and p. 196; Lacau, *Sarcophages antérieurs au nouvel Empire*, II, p. 107; *cf.* Sethe, p. 306, n. 3, and p. 43, n. 1) and one from Thebes (published only in a preliminary report by Winlock, *Bulletin of The Metropolitan Museum of Art*, Nov., 1921, Part II, p. 50, fig. 24) set the reappearance of Sothis in the XII hour of the night between the 171st and 180th days of the year. A fifth (Chassinat and Palanque, *op. cit.*, pp. 117–118) is of the same type but only goes to the 160th day. A sixth coffin (from Asyūt; Chassinat and Palanque, *op. cit.*, p. 145) sets the reappearance between the 181st and 190th days. The situation shown in the first group of coffins was such as existed from 2101 to 2061 B.C., when Egypt was reunited by Neb-ḥepet-Rēʿ Mentu-ḥotpe. That shown in the last-mentioned coffin is the condition as it existed between 2061 and 2021 B.C. These are dates in the XI Dyn., agreeing very well indeed with our knowledge of Egyptian history and archaeology. They, furthermore, show that these Middle Kingdom dekan tables were kept up to date by periodic corrections.

[45] Often we can not be certain of the exact nature of acts described in documents bearing calendrical dates, and therefore cannot use them in controlling the seasons described. Thus, builders' marks from Lisht (Lansing, *M.M.A. Bulletin*, April, 1933, II, pp. 5–8; November, 1933, II, p. 6) are dated between March and September, but they do not define the operations recorded sufficiently to be used as a check on the calendar of the period.

[46] Meyer, *Nachtr.*, pp. 18 ff.

scriptions that the quarrying season was from January through March in the Twelfth Dynasty, or in terms of the contemporary calendar from the 2nd Month of *Akhet* to the 1st Month of *Prōyet*. In the Sixth Dynasty, when quarrying must have been done at the same season, the corresponding calendar dates were from the 2nd Month of *Shōmu* to the 1st Month of *Akhet*, showing that a shift of about 125 days had taken place in the Egyptian calendar in the five centuries between about 1850 and 2350 B.C.[47]

At each of these several dates the calendar was at variance with the true seasons and with Sothis by about one day for every four years which had elapsed since 2773 B.C. The conclusion is—it seems to me—inescapable that in 2773 B.C. the calendar had been in agreement with the star, and in that year the observations on which this relation had depended were discontinued. The date is astronomically fixed as the start of the wandering calendar of succeeding centuries. We have not, however, sufficient knowledge to do more than guess at what was the historic occasion for this all important change.

In all probability Djoser founded the Third Dynasty about 2778 B.C.,[48] with the famous sage I-em-ḥotpe as his vizier, and Egypt entered upon one of its most flourishing periods under an all-powerful, centralized government.[49] Doubtless the census takers, the tax collectors, and the hosts of royal scribes who were now managing the land found highly unsatisfactory a year whose beginning depended on the chances of an observation of a star in the dawn. The experience of centuries by now had seemed to show that the year should contain 365 days, and this definite figure was adopted for administrative purposes.

But in terms of this new "civil" year the heliacal rising of Sothis gradually came later by a day every four years, until, about a century or so after Djoser's reign, the inscriptions in the Old Kingdom masṭabahs call for offerings on two separate New Year Days—*Wepy-ronpet*, "the Opener of the Year," and *Tepy-ronpet*,

[47] Meyer (*Chron.*, pp. 179 ff.) compared these dates when his chronology placed the mean date of the VI Dyn. at 2500 B.C. and concluded that there was a difference in the quarrying season in the two periods. In the above calculation I have used 2350 B.C. as the mean date of the VI Dyn., following his *Ältere Chron.*, p. 68, and the quarrying season of the two periods becomes identical.

[48] Meyer, *Ältere Chron.*, p. 68. In *Geschichte*, § 231, he credits Djoser with a reign of 19 years.

[49] Scharff (*Grundzüge*, p. 57; *Ältesten Datums*, p. 18) believes that the 365 day calendar was invented at this time.

"the First of the Year." [50] The first of these festivals, in Twelfth Dynasty calendars, is also "the Coming Forth of Sothis"; the second festival in all likelihood was the New Year invented for the calendar when it became definitely and obviously separated from nature.

In the meantime, it must not be forgotten that the date of the first appearance of the Nile flood fluctuates between very wide limits, and for several generations after the fixing of the calendar in 2773 B.C. the "civil" year would still have been, to all appearances, as closely related to the flood as ever. By the time that the flood always fell outside of the calendrical "Flood Season"—*Akhet*—the "civil" calendar had been so long established that no one had the temerity to do anything about it. It was perhaps at this time, while the "civil" calendar was becoming less and less dependable in foretelling the true seasons, that the conservative priesthood invented the coronation oath which called for the new king to swear—as we are informed—"never to intercalate a month or a day nor to vary a festival but to preserve the 365 days as they were ordained of old." [51]

And so for the next three thousand years the Egyptian obstinately refused to follow a fixed calendar, until he adopted the Alexandrian year with Christianity—and to this latter year the Coptic priest still adheres as uncompromisingly as his ancestors followed the ancient calendar.

In conclusion, it is my belief that his calendar was not an invention made by the Egyptian on any one day at dawn, when a series of phenomena happened to coincide. On the contrary, it was a gradually developed method of predicting approximately the almost unpredictable rise of the Nile. For a few centuries before 2773 B.C. it depended on the observation of the reappearance of Sirius, and the resulting self-adjusting year was as true a measure

[50] Meyer, *Chron.*, pp. 36, 40; Sethe, p. 303. Scharff (*Ältesten Datums*, pp. 16 and 19, note 2) seems to be sceptical of this theory of Meyer's; firstly, because in New Kingdom inscriptions the Egyptian himself confused the two festival names; and secondly, because his own theory denies the existence of a Sothic year in the Old Kingdom.

[51] So far as I am aware, we do not know of this oath before its mention by P. Nigidius Figulus of the 1st Cent. B.C. (Sethe, p. 310; Meyer, *Chron.*, p. 31), but it unquestionably goes back to some period when there was a lively memory of such attempts and a reasonable fear of their repetition. No office holder is ever called upon to abjure a crime which has never been invented. Of course, this oath might have been inspired by the attempted reform of Ptolemy III in the III Cent. B.C., but it is unlikely that such an oath could have been wrung from a king in so enlightened a period.

of solar time as was the much later Julian year. However, as man became more civilized he felt the need of some method of time reckoning more definite than nature itself. In 2773 B.C. he dropped his New Year's observations and took up the 365 day year, which actually brought his seasons back into their original places only once again during his whole history.

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WHEN DID THE BYZANTINE EMPIRE AND CIVILIZATION COME INTO BEING?

By P. van den Ven.

No one has ever contested the fact that the Byzantine Empire disappeared at the capture of Constantinople by the Turks, which disaster effected the complete destruction of the previous state of things in the Greek medieval world. There are in the history of mankind very few events which have brought with them so many radical changes in every branch of human life in so short a period. But disagreements are numerous when it is a question of establishing an initial date as regards the Byzantine Empire as well as the Byzantine civilization.

The division of history into periods is, as everyone knows, from its very nature, conventional and arbitrary, for history really never stops, and all the historical events are so connected with one another as to form an uninterrupted succession. But it would be impossible to master the enormous mass of facts in history without marking certain halting places which correspond, within reasonable limits, to reality, that is, to the beginning and the end of a definite evolution in society, in so far as this beginning and end may be perceived. This classification has also some importance as regards specialization of historical research. Byzantine studies to-day form a special field with its own means for particular investigation, and it is of practical utility to determine the extent of this branch of learning and not to trespass on the domain of other studies. There is a risk of failing to recognize in many cases the real character of events, especially their distant causes, if the investigator has poorly classified them in their ensemble and has left to specialists in neighboring fields the care of investigating facts directly connected with those of his own concern.

The difficulty of establishing a date beyond dispute, to mark the beginning of the Byzantine Empire and civilization, comes from the fact that it is hard to find an event which sets off in every aspect of life the starting point of the new evolution of the eastern world. Politically speaking, there is no fixed line of demarcation between the Roman and Byzantine Empires. Those who have given special attention to the Roman structure of the eastern State, that structure which remained the real basis until the end, do not perceive any beginning of a new evolution and therefore do not admit the existence of an empire distinct from the Roman. They have considered, of course, above all, the political institutions. Some who have in addition investigated the social institutions, the church, art, literature, and private life, have been led to a different view. They discover a new type of state and civilization in the beginning of the fourth century. Let us briefly examine the arguments for each position and see if it is possible definitely to determine the beginning of the Byzantine era.

The supporters of the uninterrupted evolution of the Roman Empire down to the fifteenth century point with good reason to the fact that the so-called Byzantine Empire is heir and successor to the old Roman Empire. While in the west of the empire the civilization of ancient Rome was completely destroyed by the Germanic invasions, which thus prevented any continuity between the empire of Theodosius and that of Charlemagne, in the east there were for centuries no invasions, no sack of the capital by the barbarians, and therefore no interruption of the Roman life and the Roman State. There is no break in the continuity of the long series of Roman emperors from Augustus to Constantine VII, who was killed in 1453. The foundation of the Western Empire by Charlemagne has no importance in this connection, as it was an artificial creation which the legitimate emperors ruling at Constantinople never recognized, and which in turn never prevented these emperors from maintaining, theoretically at least, what they believed to be their rights over the western provinces of the old Roman State. The empire of Charlemagne did not replace the Western Roman Empire, for the latter never existed any more than an Eastern Roman Empire existed. There were sometimes several emperors, but always, theoretically and legally, only one empire. The separation made by Theodosius in 395 between the east and the west had only an administrative character, which did not at all alter the legal unity of the State. The abdication of Romulus Augustulus in 476 does not mark the end of the so-called Western Roman Empire. Its only effect was to replace the imperial authority in the hands of a single emperor—this emperor was recognized by the barbarians who dispossessed Romulus—and furthermore to reestablish the situation which existed under a sole ruler.[1]

Because of these facts, therefore, certain historians reject the terms "Byzantine" or "Greek" which others apply to the Roman Empire in the east after Constantine the Great or Theodosius. They con-

[1] See J. B. Bury, A History of the later Roman Empire from Arcadius to Irene, I (1889), pp. v. ff.; J. Bryce, The Holy Roman Empire (1909), pp. 23 ff., 322 ff.; L. Hahn, Das Kaizertum (Das Erbe der Alten, Heft VI) Leipzig, 1913, pp. 82 ff.

sider it identical with the old Roman Empire, "which endured, one and undivided, however changed and dismembered, from the first century B. C. to the fifteenth century A. D."[2] They only consent to call it late Roman, and, after the creation of a distinct western empire at Rome in 800, they call it Eastern Roman. Prof. J. B. Bury, the foremost of the historians of this opinion, maintains that all lines of demarcation which have been drawn between the Roman and Byzantine Empires are arbitrary, that "no Byzantine Empire ever began to exist, the Roman Empire did not come to an end till 1453."[3] Great as were the changes undergone by this State since antiquity, it never ceased to be the Roman Empire; and if it changed from century to century, it was along a continuous line of development, so that we can not give it a new name, just as we can not give a new name to a man when he enters into a new period of his life, when he passes from youth to maturity and to old age. We designate a man as young and old, and so we may speak of the earlier and later ages of a kingdom or an empire.[4] Since the publication of his excellent History of the Later Roman Empire, in 1889, Bury has not given up his point of view, as one can observe in the reading of his recent work, The Constitution of the Late Roman Empire (Cambridge, 1910), where he failed to mark any distinct period in the evolution of the form of government from the time of Augustus.

Another historian, L. Hahn, who is well known for his studies on the influence of Romanism in the Greek world, has called attention only to the Roman factor in the eastern part of the empire.[5] He gives preeminence to this down to the time of Justinian, and he fails to show in the slightest degree the workings of any other element. He rejects almost completely the influence of the Orient,[6] which in the mind of Fr. Cumont was particularly strong from the third century of the Roman Empire,[7] and he does not appear to recognize any particular event as the starting point of a new evolution.

N. Jorga,[8] impressed by the strength and the relative increase of the Roman element before Justinian, does not recognize Justinian as a Byzantine ruler. During the three centuries which followed the foundation of Constantinople, the Roman institutions were translated and adapted to the Greek surroundings, and that work was still in progress under Justinian. "The name Byzantine is given to the type of civilization slightly Roman, conspicuously Greek, and 'most Christian' (in the Greek sense also), which was thus pro-

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[2] Bury, op. cit., p. viii.
[3] Ibid., p. v.
[4] Ibid., p. vi.
[5] Ludwig, Hahn, op. cit., passim.
[6] Ibid., pp. 56 ff.
[7] Fr. Cumont, Mithra, p. xi.
[8] The Byzantine Empire (London, 1907), pp. 3 ff.

duced. The name is appropriated to the result." Therefore, according to Jorga, Byzantinism begins only after Justinian, when it takes the place of Romanism. Finlay, Gregorovius, Zachariae von Lingenthal had been of the same opinion and had believed in the continuation of the Roman antiquity till the seventh century.[9] Because of the lack of any racial feeling, adds Jorga, "the empire remained what it had always been, an agglomeration of nationalities, governed according to the Roman laws and holding a political ideal which had been formed at Rome.[10] That political ideal slowly found a substitute in Christianity." The Roman empire became more and more the Christian world, the true Christian world, "orthodox" if not catholic. Rejecting the West as Arian under the Goths, as idolatrous during the dispute as to images, as perverters of dogma under the Pope, and anathematizing the Mussulmans without trying to convert them, it acquired the consciousness of holding the one and only Christian truth, and of thus being the new "chosen people" of the Lord.

It is not to be denied that for centuries after Constantine Romanism was very strong, and the best advocate of the beginning of Byzantinism in the fourth century, K. Krumbacher, acknowledges it distinctly:

> Das gesamte Staatswesen, die Technik und die Grundsätze der äusseren und inneren Politik, Gesetzgebung und Verwaltung, Heer—und Flottenwesen lag als ungeheures Ergebnis theoretischer Studien, praktischen Sinnes und reicher Erfahrung fertig da, als der östliche Reichsteil selbständig wurde; und so sehr die Griechen sich hier bald als Herren im eigenen Hause fühlten, dieses unschätzbare Erbstück aus dem lateinischen Westen haben sie, trotz einzelner Anderungen in der Verwaltung (Themenverfassung) und anderen Teilen des Staates, prinzipiell niemals angetastet.[11]

But, what separates Krumbacher's opinion from the others related above, is that it is not onesided; as we shall see, it takes into account the whole question, and weighs carefully the different factors which came in force in the East in the fourth century.

Bury places the beginning of the period of the history of the empire, which he calls "late Roman" and which others call Byzantine, in 395. It is interesting to note the reason for his adopting this date. "In the year 395 A. D. the empire was intact, but with the fifth century its dismemberment began, and 395 A. D. is consequently a convenient date to adopt as a starting point."[12] Quite logically, Prof. Bury does not take his point of departure in the history of the Eastern provinces of the empire by attributing to them a rôle quite distinct from that of ancient Rome; he takes his

[9] See K. Krumbacher, Geschichte der byzantinischen Litteratur, 2 ed. (1897), pp. 13 ff.
[10] Op. cit., p. 36; see pp. 33 ff.
[11] Die griechische und lateinische Litteratur und Sprache (Die Kultur der Gegenwart (Teil I, Abteilung VIII), 1905, p. 242).
[12] Op. cit., p. ix.

starting point in an event which is especially important in the annals of the empire as considered in its ancient state with Italy as its center. In his mind it is not the East which separates itself from the West and begins an independent existence; it is the empire as a whole which becomes dismembered by the invasion of the Western provinces. Bury grants theoretically, in the beginning of the evolution of the "Later Roman Empire," as much importance to the western provinces as to the eastern, and his point of departure is more concerned with the destinies of the West than with those of the East. But here we find one of the weak points of Bury's argument. Practically he treats the history of the western provinces as briefly as possible, to the extent that he feels obliged to anticipate criticism of a lack of proportion. "I am concerned with the history of the Roman Empire, and not with the history of Italy or of the West, and the events on the Persian frontier were of vital consequence for the very existence of the Roman Empire, while the events in Italy were, for it, of only secondary importance. Of course, Italy was a part of the empire; but it was outlying—its loss or recovery affected the Roman Republic (strange to say) in a far less degree than other losses or gains. And just as the historian of modern England may leave the details of Indian affairs to the special historian of India, so a general historian of the Roman empire may, after the fifth century, leave the details of Italian affairs to the special historian of Italy."[13] This is an admission of the fact that after the fifth century the West had only a very secondary importance in the destinies of the empire; that the center of gravity of the empire thereafter was in the East. In spite of the belief in the continuation of the Roman Empire—a belief which remained the same, handed down as it was by traditions, formulæ, and survivals, and strongly maintained by the Roman structure of the state— the fact that Italy and Rome were no more the center about which the empire, its institutions and its civilization revolved, marks a change so radical and so far-reaching that it is difficult to understand why Bury, who has excellently written the history of this change, refuses to harmonize his general viewpoint with the facts which he brings out. It is hard to perceive why he declines to accept the appellation "Byzantine" so thoroughly deserved by a state which he recognizes as being so very different from the old Roman Empire.

This is another weak point in Bury's argument. When the emperors in dividing the government of the East and the West were independent of each other, or hostile, as were Arcadius and Honorius, and as a matter of fact East and West went each more and more in

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[13] Ibid., p. xi.

its own way, Bury defends the conception of the theoretical unity of the Empire, while taking care not to affirm its unity in reality. Have not facts in history greater importance than formulæ, which are the heritage of a past which has ceased to be in harmony with the present?

From all this it is evident that the matter in question is not merely the judicious choice of a name, but rather a consideration of the very essence of things under that name. Is the Roman Empire really the Roman Empire down to the fifteenth century, in spite of its numerous transformations? Could it have remained for so long a period the same living creature, the nature of which does not change at the different periods of its life? Did not the transformations which it underwent, in the fourth century and later, permeate so deeply that it is proper from that time on to give it another name corresponding to its new nature? Let us examine now the arguments of those who fix the beginning of the new evolution in the fourth century and recognize its extent by giving the period the name of Byzantine.

The late leader in Byzantine studies, K. Krumbacher, is the first, I believe, to have determined the various elements which have formed the Byzantine civilization, the mixed character of which differs strikingly from the unity of the old Greek culture. He recognizes four elements, the gradual intermingling of which has produced the new civilization—i. e., Hellenism, Romanism, Christianity, and oriental influences.[14] A great event started the whole new combination—the establishment of the capital at Byzantium (326). The importance of this event in the destiny of the Empire can not be overestimated. What, indeed, separates the Byzantine era from the Roman era is, above all, the removal of the center of the Empire from the West to the East and, consequently, the gradual substitution of the Greek language for the Latin. The first official and definite step in this course is the foundation of the new capital, Constantinople, and the second one, connected with the first, is the definitive division of the Empire into two parts—Greek East, Latin West (395)—never to be united again.

The rapid growth of the capital further strengthened the Greek character of the East and gave it a center which gradually became more and more important. The natural centralizing power of Constantinople appears in many ways. For instance, in ecclesiastical matters, at the Council of Chalcedon (451) the new Rome prevailed over the older See of Alexandria. On the other hand, following the decline of the western part of the Empire, the power of the old Roman State concentrated more and more in the Greek East. At Con-

[14] Die griech. und lat. Lit. und Spr., pp. 237 ff.; Gesch. der byz. Litt., 2 ed., pp. 1 ff.

stantinople and in the central provinces the Greek element had been predominant from ancient times, especially among the people and in the church, and the number of people who spoke Latin had always been slight. Greek culture had always stood higher and the Greek language had always been universal. Now, by the much more powerful means at its disposal, the Greek element was in a way to gain the upper hand against the Roman element, which, growing for some time, had been weakening after the dismemberment of the West by the Germans. This Greek element was therefore called upon to take the place of the Roman element in the government of the state. This happened slowly but surely, so that in the centuries after Justinian the state was undergoing an Hellenization of its limbs as well as of its head. The change of the basis of the Empire from Roman to Greek, the transformation from Roman to Romaic or Byzantine was accomplished in the different branches of the organization of the state with varying rapidity. At the last the old system was destined to be more and more thoroughly broken down by the power of natural circumstances.

But the great place of the Greek element in the Byzantine Empire does not destroy the force of the statement that there was neither linguistic nor national unity in the eastern world and that the Greek in the East never had in that respect the position of the Latin in the West. The existence of the old oriental civilizations in many provinces of the eastern empire and the official maintenance of the Latin as language of the state explains this to a great extent.

> Das ungeheure Gefüge, durch dessen Festigkeit das byzantinische Reich den furchtbaren Stürmen der Perser, Araber, Seldschuken, Slawen, Normannen, Franken, Türken und anderer Völker so lange widerstehen konnte, ist römische Arbeit. . . . Der Staatsgedanke war unendlich viel stärker als das nationale und sprachliche Sonderbewusstsein. So übernahmen die Griechen denn natürlich auch den Namen Römer. . . . So wunderbar fest und fein war die Struktur des römischen Staatsgebäudes, dass ein so eminent unpolitisches Volk, wie die Griechen im Altertum gewesen sind und heute sind und sicher auch im Mittelalter waren, es im Laufe vieler Jahrhunderte nicht ernstlich zu beschädigen vermochte. . . . Die Fortwirkung der alten römischen, nun in griechisches Gewand gekleideten Tradition im gesamten öffentlichen und privaten Leben der Byzantiner und die Art, wie die herrschenden griechischen und orientalischen Menschen sich mit der ihnen innerlich fremdartigen Staats- und Rechtsordnung abfanden wie sie sich ihr anschmiegten und wie sie mit ihr operierten, gehört zu den interessantesten, freilich auch zu den am wenigsten aufgeklärten Seiten der inneren Geschichte von Byzanz.[15]

Although by the foundation of New Rome and the division of the Empire in 395, neither Constantine nor Theodosius intended to change at all the Roman basis of the Empire and to give it the Greek character which it assumed only later, the developments occasioned

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[15] Die griech. und lat. Lit. und Sprache, p. 242.

by these two events created the new evolution; and it may be said, with Krumbacher, that the foundation of Constantinople as a capital really marks the beginning of that evolution, while at the same time the initial changes may have remained invisible. We have seen that the failure of perceiving those symptoms or of giving to them the importance they deserve explains the opinion of those who postpone the beginning of Byzantinism till the seventh century and see in the preceding centuries only the old age and the fall of antiquity.

Simultaneously with this we notice other great changes which contributed to the making of a new era. In religion, especially, thanks to the same emperor, Constantine, Christianity officially takes the place of paganism, and consequently represents one of the most striking differences between Byzantinism and antiquity. A good deal of the Byzantine civilization is to be explained by the influence of the Christian religion and the Christian church.

As for the oriental element, it had always been strong in the Greek East; and the various old oriental cultures had never ceased in their influence. The provinces of the empire where the intellectual life was most developed were in direct contact with the native civilization, and it is certain that the latter gave to Hellenism an oriental character, which from Egypt, Palestine, Syria, and Asia Minor spread to Constantinople and the European provinces. From the Orient came many of the habits of thought and customs of the Byzantines, many characteristics in literature and art, many elements of the court and the state organization, "wie die Auffassung des Kaisertums als einer mysteriösen Macht, der Gegensatz brutaler Volksleidenschaft und grausamster Despotie, die hieratische Grandezza, das Eunuchentum, die blutigen Palastrevolutionen und das unheimliche Intrigenspiel, der starre Formalismus im Leben wie in der Litteratur, die Beliebtheit orientalischer Erzählungsstoffe."[16]

There is no doubt that the political changes introduced by Constantine and Theodosius brought into action the Greek and oriental elements. Furthermore Constantine made Christianity the state religion. Another great feature, the substitution of the bureaucracy for the military organization of the old empire, is the work of Constantine and his predecessor Diocletian.[17] Therefore it seems certain that the beginning of the Byzantine Empire and civilization must be placed in the fourth century, and if a date is necessary, in the year 326, when Constantinople was founded by Constantine. This, however, does not mean the sudden disappearance of the old state of things and instant rise of the new condition of affairs. All that we have said points to an exceedingly gradual change and beginning,

[16] Die griech. und lat. Lit. und Sprache, p. 250.
[17] See Krumbacher, Gesch. der byz. Litt., 2 ed., p. 7.

in no way comparable to the sudden termination of the period in 1453.

This argument, which was strongly developed by Krumbacher, has received careful consideration and acceptance with certain recent writers of universal histories, who have given an especial place to the Byzantine period [18] and also in some general works of great value.[19] Helmolt's universal history develops the same theory, but, while emphasizing the oriental and Hellenistic elements, it neglects entirely the Roman factor, and so presents just as inaccurate a view by completely overlooking the ever recognized influence of Rome as did the earlier historians who perceived no other element.[20] It is also worthy of mention that Wilamovitz-Moellendorf, in 1897, attempting to determine the end of Antiquity, places this terminus in the beginning of the fourth century: "Die Tatsachen sind da: nur wer sie aus Trägheit oder Vorurteil ignorirt kann bestreiten, dass die Weltgeschichte um 300 an einem der Wendepunkte des grossen Weltenjahres gestanden hat, dass sich ein Ring an der Kette der Ewigkeit schloss, und wo äusserlich Continuität zu sein scheint, in Wahrheit nur ein neuer Ring sich mit dem vorigen gerührt." [21]

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[18] Lindner, Weltgeschichte, Bd. I (1901), pp. 121 ff.

[19] E. g., H. Gelzer, Abriss der byzantinischen Kaisergeschichte, in Krumbacher, Gesch. der byz. Litt., 2 ed., p. 912; Hesseling, Essai sur la civilisation byzantine, Paris, 1907, pp. 13, 37; J. Bryce, The Holy Roman Empire (1909), pp. 321 ff., 341.

[20] H. E. Helmolt, The World's History, V (1907), pp. 27 ff.

[21] Weltperioden, Rede . . . gehalten von U. v. W.—M. (1897), p. 8.

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THE HISTORY OF ANCIENT ASTRONOMY
PROBLEMS AND METHODS

O. NEUGEBAUER

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Ce qui est admirable, ce n'est pas que le champ des étoiles soit si vaste, c'est que l'homme l'ait mesuré.—ANATOLE FRANCE, *Le Jardin d'Épicure.*

I. INTRODUCTION

1. In the following pages an attempt is made to offer a survey of the present state of the history of ancient astronomy by pointing out relationships with various other problems in the history of ancient civilization and particularly by enumerating problems for further research which merit our interest not only because they constitute gaps in our knowledge of ancient astronomy but because they must be clarified in order to lay a solid foundation for the understanding of later periods.

I wish to emphasize from the very beginning that the attitude taken here is of a very personal character. I do not believe that there is any single approach to the history of science which could not be replaced by very different methods of attack; only trivialities permit but one interpretation. I must confess still more: I cannot even pretend to be complete in the selection of topics essential for our understanding of ancient astronomy,[1] nor do I wish to conceal the fact that many of the steps which I myself have taken were dictated by mere accident. To mention only one example: without having been brought into contact with a recently purchased collection of Demotic papyri in Copenhagen, I would never have undertaken the investigation of certain periods of Hellenistic and Egyptian astronomy which now seem to me to constitute a very essential link between ancient and medieval astronomy. In other words, though I have always tried to subordinate any particular research problem to a wider program of systematic analysis, the impossibility of elaborate long-range planning has again and again been impressed upon me. The situation is comparable to entering a vast mountainous region on a single trail; one must simply follow the winding path, trying to give account of its general direction, but one can never predict with certainty what new vistas will be exposed at the next turn.

2. The enormous complexity of the study of ancient astronomy becomes evident if we try to make the first, and apparently simplest, step of classification: to distinguish between, say, Mesopotamian, Egyptian, and Greek astronomy, not to mention their direct successors, such as Hindu, Arabic, and medieval astronomy. Neither geographically nor chronologically nor according to language can clear distinctions be made. Entirely different conditions underlie the astronomy in Egypt of the Middle and New kingdoms than in the periods after the Persian conquest. Greek astronomy of Euclid's time has very little in common with Hipparchus' astronomy only a hundred and fifty years later. It is evident that it is of very little value to speak about a "Babylonian" astronomy regardless of period, origin, and scope. And, worst of all, the concept "astronomy" itself undergoes changes in meaning when we speak about different periods. The fanciful combination of a group of brilliant stars to form the picture of a "bull's leg" and the computation of the irregularities in the moon's movement in order to predict accurately the magnitude of an eclipse are usually covered by the same name! For methodological reasons it is obvious that a drastic restriction in terminology must be made. We shall here call "astronomy" only those parts of human interest in celestial phenomena which are amenable to mathematical

[1] Also the bibliography, given at the end, is very incomplete and is only intended to inform the reader where he can find further details of the specific viewpoint discussed here and to list the original sources.

treatment. Cosmogony, mythology, and applications to astrology must be distinguished as clearly separated problems —not in order to be disregarded but to make possible the study of the mutual influence of essentially different streams of development. On the other hand, it is necessary to co-ordinate intimately the study of ancient mathematics and astronomy because the progress of astronomy depends entirely on the mathematical tools available. This is in conformity with the concept of the ancients themselves: one need only refer to the original title of Ptolemy's "*Almagest*," namely, "Mathematical Composition."

3. The study of ancient astronomy will always have its center of gravity in the investigation of the Hellenistic-Roman period, represented by the names of Hipparchus and Ptolemy. From this center three main lines of research naturally emerge: the investigation of the previous achievements of the Near East; the investigation of pre-Arabic Hindu astronomy; and the study of the astronomy of late antiquity in its relation to Arabic and medieval astronomy. This last-mentioned extension of our program beyond antiquity proper is not only the natural continuation of the original problem but constitutes an integral part of the general approach outlined here. Astronomy is the only branch of the ancient sciences which survived almost intact after the collapse of the Roman Empire. Of course, the level of astronomical studies dropped within the boundaries of the remnants of the Roman Empire, but the tradition of astronomical theory and practice was never completely lost. On the contrary, the rather clumsy methods of Greek trigonometry were improved by Hindu and Arabic astronomers, new observations were constantly compared with Ptolemy's results, etc. This must be paralleled with the total loss of understanding of the higher branches of Greek mathematics before one realizes that astronomy is the most direct link connecting the modern sciences with the ancient. In fact, the work of Copernicus, Brahe, and Kepler can be understood only by constant reference to ancient methods and concepts, whereas, for example, the meaning of the Greek theory of irrational magnitudes or Archimedes' integrations were understood only after being independently rediscovered in modern times.

There are, of course, very good reasons for the fact that ancient astronomy extended with an unbroken tradition deep into modern times. The structure of our planetary system is such that it is simple enough to permit the achievement of relatively far-reaching results with relatively simple mathematical methods, but complicated enough to invite constant improvement of the theory. It was thus possible to continue successfully the "ancient" methods in astronomy at a time when Greek mathematics had long reached a dead end in the enormous complication of geometric representation of essentially algebraic problems. The creation of the modern methods of mathematics, on the other hand, is again most closely related to astronomy, which urgently required the development of more powerful new tools in order to exploit the vast possibilities which were opened by Newton's explanation of the movement of the celestial bodies by means of general principles of physics. The confidence of the great scientists of the modern era in the sufficiency of mathematics for the explanation of nature was largely based on the overwhelming successes of celestial mechanics. Essentially the same held for scholars in classical times. In antiquity, mathematical tools were not available to explain any physical phenomena of higher complexity than the planetary movement. Astronomy thus became the only field of ancient science where indisputable certainty could be reached. This feeling of the superiority of mathematical astronomy is best expressed in the following sentences from the introduction to the *Almagest:* "While the two types of theory could better be called conjecture than certain knowledge —theology because of the total invisibility and remoteness of its object, physics because of the instability and uncertainty of matter— . . . . mathematics alone . . . . will offer reliable and certain knowledge because the proof follows the indisputable ways of arithmetic and geometry."[2]

II. EGYPT

4. A few words must be said about Egyptian mathematics before discussing the astronomical material. Our main source for Egyptian mathematics consists of two papyri[3]—certainly not too great an amount in view of the length of the period in question! Still, it seems to be a fair assumption that we are well enough informed about Egyptian mathematics. Not only are both papyri of very much the same type but all additional fragments which we possess match the same picture—a picture which is paralleled by economic documents in which occur precisely those problems and methods which we find in the mathematical papyri. The Egyptian mathematical texts, furthermore, find their direct continuation in Greek papyri,[4] which again show the same pattern. It is therefore safe to say that Egyptian mathematics never rose above a very primitive level. So far as astronomy is concerned, numerical methods are of primary importance, and, fortunately enough, this is the very part of Egyptian mathematics about which we are best informed. Egyptian arithmetic can be characterized as being predominantly of an "additive" character, that is, its main tendency is to reduce all operations to repeated additions. And, because the process of division is very poorly adaptable to such procedures, we can say that Egyptian mathematics does not provide the most essential tools for astronomical computation. It is therefore not surprising that none of our Egyptian astronomical documents requires anything more than simple operations with integers. Where the complexity of the phenomena exceeded the capacity of Egyptian mathematics, the strongest simplifications were adopted, consequently leading to little more than qualitative results.

5. The astronomical documents of purely Egyptian origin are the following: Astronomical representations and inscriptions on ceilings of the New Kingdom,[5] supplemented by the so-called "diagonal calendars" on coffin lids of the Middle Kingdom[6] and by the Demotic-Hieratic papyrus "Carlsberg 1."[7] Secondly, the Demotic papyrus "Carlsberg 9," which shows the method of determining new moons.[8] Though written in Roman

[2] *Almagest* I, 1 (ed. Heiberg I, 6, 11 ff.).

[3] Math. Pap. Rhind [Peet *RMP;* Chace *RMP*] and Moscow mathematical papyrus [Struve *MPM*]. For a discussion of Egyptian arithmetic see Neugebauer [1], for Egyptian geometry Neugebauer [2], and, in general, Neugebauer *Vorl.* The most recent attempt at a synthesis of Egyptian science, by Flinders Petrie (*Wisdom of the Egyptians* [London, 1940]), must unfortunately be considered as dilettantish not only because of its disregard of essential source material but also because of its lack of understanding for the mathematical and astronomical problems as such.

[4] The continuation of this tradition is illustrated by the following texts: Demotic: Revillout [1]; Coptic: Crum *CO*, No. 480, and Sethe *ZZ*, p. 71; Greek: Robbins [1] or Baillet [1]. For Greek computational methods in general, see Vogel [1].

[5] Examples: The Nut-pictures in the cenotaph of Seti I (Frankfort *CSA)* and Ramses IV (Brugsch *Thes.* 1) and analogous representations in the tombs of Ramses VI, VII, and IX.

[6] Cf. Pogo [1] to [4].

[7] Lange-Neugebauer [1].

[8] Neugebauer-Volten [1].

times (after A.D. 144), this text undoubtedly refers to much older periods and is uninfluenced by Hellenistic methods. A third group of documents, again written in Demotic, concerns the positions of the planets.[9] In this case, however, it seems to be very doubtful whether these tables are of Egyptian origin rather than products of the Hellenistic culture; we therefore postpone a discussion to the section on Hellenistic astronomy.[10] The last group of texts is again inscribed on ceilings and has been frequently discussed because of their representation of the zodiac.[11] There can be no doubt that these latter texts were deeply influenced by non-Egyptian concepts characteristic for the Hellenistic period. The same holds, of course, for the few Coptic astronomical documents we possess.[12] It is, finally, worth mentioning that not a single report of observations is preserved, in strong contrast to the abundance of observational records from Mesopotamia. It is hard to say whether this reflects a significant historical fact or merely that we are at the mercy of the accidents of excavation.

Speaking of negative evidence, three instances must be mentioned which play a more or less prominent role in literature on the subject and have contributed much to a rather distorted picture of Egyptian astronomy. The first point consists in the idea that the earliest Egyptian calendar, based on the heliacal rising of Sothis, reveals the existence of astronomical activity in the fourth millennium B.C. It can be shown, however, that this theory is based on tacit assumptions which are very implausible in themselves and that the whole Egyptian calendar does not presuppose any systematic astronomy whatsoever.[13] The second remark concerns the hypothesis of early Babylonian influence on Egyptian astronomical concepts.[14] This theory is based on a comparative method which assumes direct influence behind every parallelism or vague mythological analogy. Every concrete detail of Babylonian and Egyptian astronomy which I know contradicts this hypothesis. Nothing in the texts of the Middle and New Kingdom equals in level, general type, or detail the contemporaneous Mesopotamian texts. The main source of trouble is, as usual, the retrojection into earlier periods of a situation which undoubtedly prevailed during the latest phase of Egyptian history. This brings us to the third point to be mentioned here: the assumption of an original Egyptian astrology. First of all, there is no proof in general for the widely accepted assertion that astrology preceded astronomy. But especially in Egypt is there no trace of astrological ideas in the enormous mythological literature which we possess for all periods.[15]

[9] Neugebauer [3]. [10] Cf. below, p. 24.

[11] I know of the following representations of zodiacs: *No. 1* (Ptolemy III and V, i.e., 247/181 B.C.): northwest of Esna, North temple of Khnum (Porter-Moss *TB* VI, p. 118); *Nos. 2 and 3* (Ptolemaic or Roman): El-Salâmûni, Rock tombs (Porter-Moss *TB* V, p. 18); mentioned by L'Hôte, *LE*, pp. 86–87. *No. 4* (Ptolemaic-Roman; Tiberius): Akhmîm, Two destroyed temples (Porter-Moss *TB* V, p. 20); mentioned by Pococke *DE*, I, pp. 77–78. *No. 5* (Tiberius): Dendera, Temple of Ḥatḥor, Outer hypostyle (Porter-Moss *TB* VI, p. 49). *No. 6* (Augustus-Trajan): Dendera, Temple of Ḥatḥor, East Osiris-chapel central room, ceiling, west half (Porter-Moss *TB* VI, p. 99). *Nos. 7 and 8* (1st cent. A.D.): Athribis, Tomb (Porter-Moss *TB* V, p. 32). *No. 9* (Titus and Commodus): Esna, Temple of Khnum (Porter-Moss *TB* VI, p. 116). *No. 10* (Roman): Dealer in Cairo, publ. Daressy [1], pp. 126–27, and Boll, *Sphaera*, Pl. VI. Five other representations of the zodiacal signs are known from coffins, all from Ptolemaic or Roman times. On the other hand, the original Egyptian constellations are still found on coffins of the Saitic or early Ptolemaic periods.

[12] The only nonastrological Coptic documents known to me are the tables of shadow lengths published by U. Bouriant and Ventre-Bey [1].—P. Bouriant [1] did not recognize that the text published by him was a standard list of the planetary "houses" with no specific reference to Arabic astronomy.

[13] Neugebauer [4], Winlock [1], Neugebauer [5].

[14] Sponsored especially by the "Pan-Babylonian" school.

[15] It is interesting to observe how deeply imbedded is the assumption that astrology must precede as-

The earliest horoscope from Egyptian soil, written in Demotic, refers to A.D. 13;[16] the earliest Greek horoscope from Egypt concerns the year 4 B.C.[17] We shall presently see that the assumption of a very late introduction of astrological ideas into Egypt corresponds to various other facts.

6. It is much easier to show that certain familiar ideas about the origin of astronomy are historically untenable than to give an adequate survey of our real knowledge of Egyptian astronomy. A. Pogo is to be credited with the recognition of the astronomical importance of inscriptions on the lids of a group of coffins from the end of the Middle Kingdom,[18] apparently representing the setting and rising of constellations, though in an extremely schematic fashion. The constellations are known as the "decans" because of their correspondence to intervals of ten days. He furthermore saw the relationship between these simple pictures and the elaborate representations on the ceilings of the tombs belonging to kings of the New Kingdom.[19]

It can be safely assumed that the coffin lids are very abbreviated forms of contemporaneous representations on the ceilings of tombs and mortuary temples of the rulers of the Middle Kingdom. The logical place for these representations of the sky on ceilings explains their destruction easily enough. The earliest preserved ceiling, discovered in the unfinished tomb of Senmut, the vezir of Queen Hatshepsut,[20] is about three centuries later than the coffin lids. Then come the well-preserved ceiling in the subterranean cenotaph of Seti I[21] and its close parallels in the tomb of Ramses IV[22] and later rulers.[23] The difficulties we have to face in an attempt to explain these texts can best be illustrated by a brief discussion of the above-mentioned papyrus "Carlsberg 1." This papyrus was written more than a thousand years after the Seti text but was clearly intended to be a commentary to these inscriptions. In the papyrus we find the text from the cenotaph split into short sections, written in Hieratic, which are followed by a word-for-word translation into Demotic supplemented by comments in Demotic. The original text is frequently written in a cryptic form, to which the Demotic version gives the key. We now know, for instance, that various hieroglyphs were replaced by related forms in order to conceal the real contents from the uninitiated reader. How successfully this method worked is shown by the fact that one such sign, which is essential for the understanding of a long list of dates of risings and settings of the decans, was used at its face value for midnight instead of evening.[24] It is needless to emphasize what the recognition of such substitutions means for the correct understanding of astronomical texts. A complete revision of all previously published material is needed in the light of this new

tronomy. Brugsch called his edition of cosmogonic and mythological texts "astronomische und astrologische Inschriften" in spite of the fact that these texts do not betray the slightest hint of astrology.

[16] Neugebauer [6].

[17] *Pap. Oxyrh.* 804. From this time until A.D. 500 more than sixty individual horoscopes, fairly equally distributed in time, are known to me.

[18] Cf. n. 6.

[19] Some of Pogo's assumptions must, however, be abandoned, because they are based on the distinction of different types of such coffin inscriptions. A close examination of these texts (and also unpublished material) shows that all preserved samples belong to the same type. A systematic edition of all these texts is urgently needed if we are to obtain a solid basis for the study of Egyptian constellations.

[20] Winlock [2], pp. 34 ff., reprinted in Winlock *EDEB*, pp. 138 ff., and Pogo [5]. The final publication has not yet appeared.

[21] Frankfort *CSA*.

[22] Brugsch *Thes.* I opposite pp. 174–75, but incomplete (cf. Lange-Neugebauer [1], p. 90).

[23] Cf. n. 5.

[24] Sethe, *ZAA*, p. 293, n. 1, and Lange-Neugebauer [1], p. 63.

insight into the Egyptian scheme of describing the rising and setting of stars the year round. One point, however, must be kept in mind in every investigation of Egyptian constellations. One must not ascribe to these documents a degree of precision which they were never intended to possess. I doubt, for example, very much whether one has a right to assume that the decans are constellations covering exactly ten degrees of a great circle on the celestial sphere. I think it is much more plausible that they are constellations spread over a more or less vaguely determined belt around the sky, just as we speak about the Milky Way. It is therefore methodically wrong to use these star lists and the accompanying schematic date lists for accurate computations, as has frequently been attempted.

The second Demotic astronomical document, papyrus Carlsberg 9, is much easier to understand and gives us full access to the Egyptian method of predicting the lunar phases with sufficient accuracy. The whole text is based on the fact that 25 Egyptian years cover the same time interval as 309 lunations. The 25 years equal 9125 days, which are periodically arranged into groups of lunar months of 29 and 30 days. The periodic repetition of this simple scheme corresponds, on the average, very well with the facts; more was apparently not required, and, we may add, more was not obtainable with the available simple mathematical means which are described at the beginning of this section. The purpose of the text was to locate the wandering lunar festivals within the schematic civil calendar, as is shown by a list of the "great" and "small" years of the cycle, which contain 13 or 12 lunar festivals, respectively.[25] Accordingly, calendaric problems are seen to be the activating forces here as well as in the decanal lists of the Middle and New Kingdom. The two Carlsberg papyri thus give us a very consistent picture of Egyptian stellar and lunar astronomy and its calendaric relations and are in best agreement with the level known from the mathematical papyri.

Before leaving the description of Egyptian science, brief mention should be made of the much-discussed question of the "scientific" character of Egyptian mathematics and astronomy. First of all, the word "scientific" must be clearly defined. The usual identification of this question with that of the practical or theoretical purpose of our documents is obviously unsatisfactory. One cannot call medicine or physics unscientific even if they serve eminently practical purposes. It is neither possible nor relevant to discover the moral motives of a scientist—they might be altruistic or selfish, directed by the desire for systematization or by interest in competitive success. It is therefore clear that the concept "scientific" must be described as a question of methods, not of motives. In the case of mathematics and astronomy, the situation is especially simple. The criterion for scientific mathematics must be the existence of the concept of proof; in astronomy, the elimination of all arguments which are not exclusively based on observations or on mathematical consequences of an initial hypothesis as to the fundamental character of the movements involved. Egyptian mathematics nowhere reaches the level of argument which is worthy of the name of proof, and even the much more highly developed Babylonian mathematics hardly ever displays a general technique for proving its procedures.[26]

[25] The "great" and "small" years (already mentioned in an inscription of the Middle Kingdom) have given rise to much discussion (cf., e.g., Ginzel *Chron.*, I, pp. 176–77) which can now be completely ignored.

[26] See the discussion in Neugebauer *Vorl.*, pp. 203 ff.

Egyptian astronomy was satisfied with a very rough qualitative description of the phenomena—here, too, we miss any trace of scientific method. The first scientific attack of mathematical problems was made in the fifth century B.C. in Greece. We shall see that scientific astronomy can be found shortly thereafter in Babylonian texts of the Seleucid period. In other words, the enormous interest of the study of pre-Hellenistic Oriental sciences lies in the fact that we are able to follow the development far back into *pre*-scientific periods which saw the slow preparation of material and problems which deeply influenced the shape of the real scientific methods which emerged to full power for the first time in the Hellenistic culture. It is a serious mistake to try to invest Egyptian mathematical or astronomical documents with the false glory of scientific achievements or to assume a still unknown science, secret or lost, not found in the extant texts.

III. MESOPOTAMIA

7. Turning to Babylonian astronomy, one's first impression is that of an enormous contrast to Egyptian astronomy. This contrast not only holds in regard to the large amount of material available from Mesopotamia but also with respect to the level finally reached. Texts from the last two or three centuries B.C. permit the computation of the lunar movement according to methods which certainly rank among the finest achievements of ancient science—comparable only to the works of Hipparchus and Ptolemy.

It is one of the most fascinating problems in the history of ancient astronomy to follow the different phases of this development which profoundly influenced all further events. Before giving a short sketch of this progress as we now restore it according to our present knowledge, we must underline the incompleteness of the present state of research, which is due to the fact that we do not yet have reliable and complete editions of the text material. The observation reports addressed to the Assyrian kings were collected by R. C. Thompson[27] and in the editions of Assyrian letters published and translated by Harper,[28] Waterman,[29] and Pfeiffer;[30] much related material is quoted in the publications of Kugler,[31] Weidner,[32] and others. But Thompson's edition gives the original texts only in printed type, subject to all the misunderstandings of this early period of Assyriology, and very little has been done to repair these original errors. Nothing short of a systematic "corpus" of all the relevant texts can provide us with the requisite security for systematic interpretation. The great collection of astrological texts, undertaken by Virolleaud[33] but never finished, confronts the reader with still greater difficulties, because Virolleaud composed complete versions from various fragments and duplicates without indicating the sources from which the different parts came. And, finally, the tablets dealing with the movement of the moon and the planets were discussed and explained in masterly fashion by Kugler;[34] but here, too, a systematic edition of the whole material is necessary.[35] Years of systematic work will be needed before the foundations for a reliable history of the development of Babylonian astronomy are laid.

8. Kugler uncovered step by step the ingenious methods by which the ephemer-

[27] Thompson *Rep.* (1900).

[28] Harper *Letters*.

[29] Waterman *RC*.

[30] Pfeiffer *SLA*.

[31] Kugler *SSB* and Kugler *MP*.

[32] Weidner *Hdb.*, Weidner [1], [2], and numerous articles in the pre-war volumes of *Babyloniaca*.

[33] Virolleaud *ACh*.

[34] Kugler *BMR* and *SSB*.

[35] Such an edition by the present author is in preparation; it is quoted in the following as *ACT*.

ids of the moon and the planets which we find inscribed on tablets ranging from 205 B.C. to 30 B.C. were computed.[36] It can justly be said that his discoveries rank among the most important contributions toward an understanding of ancient civilization. It is very much to be regretted that historians of science often quote Kugler but rarely read him;[37] by doing this, they have disregarded the newly gained insight into the origin of the basic methods in exact science. This is not the place to describe in detail the Babylonian "celestial mechanics," as it might properly be called; that will be one of the tasks of a history of ancient astronomy which remains to be written. A few words, however, must be said in order to render intelligible the relationship between Babylonian and Greek methods. The problem faced by ancient astronomers consisted in predicting the positions of the moon and the planets for an extended period of time and with an accuracy higher than that obtainable by isolated individual observations, which were affected by the gross errors of the instruments used. All these phenomena are of a periodic character, to be sure, but are subject to very complicated fluctuations. All that we know now seems to point to the following reconstruction of the history of late Babylonian astronomy. A systematic observational activity during the Late Assyrian and Persian periods (roughly, from 700 B.C. onward) led to two different results. First, the collected observations provided the astronomers with fairly accurate average values for the main periods of the phenomena in question; once such averages were obtained, improvements could be furnished by scattered observational records from preceding centuries. Secondly, from individual observations, for example, of the moment of full moon[38] or of heliacal settings, etc., short-range predictions could be made by methods which we would call linear extrapolation. Such methods are frequently sufficient to *exclude* certain phenomena (such as eclipses) in the near future and, under favorable conditions, even to predict the date of the next phenomenon in question. After such methods had been developed to a certain height, apparently one ingenious man conceived a new idea which rapidly led to a systematic method of long-range prediction. This idea is familiar to every modern scientist; it consists in considering a complicated periodic phenomenon as the result of a number of periodic effects, each of a character which is simpler than the actual phenomenon.[39] The whole method probably originated in the theory of the moon, where we find it at its highest perfection. The moments of new moons could easily be found if the sun and moon would each move with constant velocity. Let us assume this to be the case and use average values for this ideal movement; this gives us average positions for the new moons. The actual movement deviates from this average but oscillates around it periodically. These deviations were now treated

[36] The first tentative (but very successful) steps were made by Epping *AB* (1889). Then follow Kugler's monumental works *BMR* (1900) and *SSB* (published between 1907 and 1924), supplemented by Schaumberger's explanation of the determination of first and last visibility of the moon (1935) and continued by the present author with respect to the theory of latitude and eclipses (Neugebauer [8], [9], Pannekoek [2] and van der Waerden [1]). The theory of planets is treated in Kugler *SSB*, to be supplemented by Pannekoek [1], Schnabel [2], and van der Waerden [2]. All previously published texts and much unpublished material will be contained in Neugebauer *ACT*. The whole material amounts to about a hundred ephemerids for the moon and the planets, covering the above-mentioned two centuries.

[37] Abel Rey, *La Science orientale avant les grecs* (Paris, 1930), and E. Zinner, *Geschichte der Sternkunde* (Berlin, 1931), are brilliant examples showing complete ignorance of Kugler's results.

[38] Frequently mentioned in the "reports" to the Assyrian court (e.g., Thompson *Rep.*).

[39] A classic example is the treatment of sounds as the result of the superposition of pure harmonic vibrations.

as new periodic phenomena and, for the sake of easier mathematical treatment, were considered as linearly increasing and decreasing. Additional deviations are caused by the inclination of the orbits. But here again a separate treatment, based on the same method, is possible. Thus, starting with average positions, the corrections required by the periodic deviations are applied and lead to a very close description of the actual facts. In other words, we have here, in the nucleus, the idea of "perturbations," which is so fundamental to all phases of the development of celestial mechanics, whence it spread into every branch of exact science.

We do not know when and by whom this idea was first employed. The consistency and uniformity of its application in the older of the two known "systems" of lunar texts point clearly to an invention by a single person. From the dates of the preserved texts, one might assume a date in the fourth or third century B.C.[40] This basic idea was applied not only to the theory of the moon (in two slightly modified forms) but also to the theory of the planets. In this latter theory the main point consists in refraining from an attempt to describe directly the very irregular movement, substituting instead the separate treatment of several individual phenomena, such as opposition, heliacal rising, etc.; each of these phenomena is treated with the methods familiar from the lunar theory as if it were the periodic movement of an independent celestial body. After dates and positions of each characteristic phenomenon are determined, the intermediate positions are found by interpolation between these fixed points.[41] It must be said, however, that the planetary theory was not developed to the same degree of refinement as the lunar theory; the reason might very well be that the lunar theory was of great practical importance for the question of the Babylonian calendar: whether a month would have 30 or 29 days. For the planets no similar reason for high accuracy seems to have existed, and it was apparently sufficient merely to compute the approximate dates of phenomena, which, in addition, are frequently very difficult to observe accurately.

We cannot emphasize too strongly that the essential point in the above-described methods lies not in the comparatively high accuracy of the results obtained but in their fundamentally new attitude toward the whole problem. Let us, as a typical example, consider the movement of the sun.[42] Certain simple observations, most likely of the unequal length of the seasons, had led to the discovery that the sun does not move with constant velocity in its orbit. The naïve method of taking this fact into account would be to compute the position of the sun by assuming a regularly varying velocity. It turned out, however, that considerable mathematical difficulties were met in computing the syzygies of the moon according to such an assumption. Consequently, another velocity distribution was substituted, and it was found that the following "model" was satisfactory: the sun moves with two different velocities over two unequal arcs of the ecliptic, where velocities and arcs were determined in such a fashion that the initial empirical facts were correctly explained and at the same time the computation of the conjunctions became suffi-

[40] The attempts to determine a more precise date (Schnabel *Ber.*, pp. 219 ff., and Schnabel [1], pp. 15 ff.) are based on unsatisfactory methods. The generally accepted statement that Naburimannu was the founder of the older system of the lunar theory relies on nothing more than the occurrence of this name in one of the latest tablets in a context which is not perfectly clear.

[41] This is shown by a tablet for Mercury, to be published in Neugebauer *ACT*. The interpolation is not simply linear but of a more complicated type known from analogous cases in the lunar theory.

[42] For details see Neugebauer [10] and [9] § 2.

ciently simple. It is self-evident that the man who devised this method did not think that the sun moved for about half a year with constant velocity and then, having reached a certain point in the ecliptic suddenly started to move with another, much higher velocity for the rest of the year. His problem was clearly this: to make a very complicated problem accessible to mathematical treatment with the only condition that the final consequences of the computations correctly correspond to the actual observations—in our example, the inequality of the seasons. The Greeks[43] called this a method "to preserve the phenomena"; it is the method of introducing mathematically useful steps which in themselves need not be of any physical significance. For the first time in history, mathematics became the leading principle for the structure of physical theories.

9. It will be clear from this discussion that the level reached by Babylonian mathematics was decisive for the development of such methods. The determination of characteristic constants (e.g., period, amplitude, and phase in periodic motions) not only requires highly developed methods of computation but inevitably leads to the problem of solving systems of equations corresponding to the outside conditions imposed upon the problem by the observational data. In other words, without a good stock of mathematical tools, devices of the type which we find everywhere in the Babylonian lunar and planetary theory could not be designed. Egyptian mathematics would have rendered hopeless any attempt to solve problems of the type needed constantly in Babylonian astronomy. It is therefore essential for our topic to give a brief sketch of Babylonian mathematics.

[43] E.g., Proclus, *Hypotyposis astron. pos.* v. 10 (ed. Manitius, 140, 21).

I think it can be justly said that we have a fairly good knowledge of the character of mathematical problems and methods in the Old Babylonian period (*ca.* 1700 B.C.). Almost a hundred tablets from this period are published;[44] they contain collections of problems or problems with complete solutions—amounting to far beyond a thousand problems. We know practically nothing about the Sumerian mathematics of the previous periods and very little of the interval between the Old Babylonian period and Seleucid times. We have but few problem texts from the latter period, but they give us some idea of the type of mathematics familiar to the astronomers of this age. This material is sufficient to assure us that all the essential achievements of Old Babylonian times were still in the possession of the latest representatives of Mesopotamian science. In other words, Babylonian mathematical astronomy was built on foundations independently laid more than a millennium before.

If one wishes to characterize Babylonian mathematics by one term, one could call it "algebra." Even where the foundation is apparently geometric, the essence is strongly algebraic, as can be seen from the fact that frequently operations occur which do not admit of a geometric interpretation, as addition of areas and lengths, or multiplication of areas. The predominant problem consists in the determination of unknown quantities subject to given conditions. Thus we find prepared precisely the tools which were later to become of the greatest importance for astronomy.

Of course, the term "algebra" does not completely cover Babylonian mathemat-

[44] These texts were published in Neugebauer *MKT* (1935–38) and in Neugebauer-Sachs *MCT* (1945). A large part of the *MKT* material was republished in Thureau-Dangin *TMB* (1939). For a general survey see Neugebauer *Vorl.*

ics. Not only were a certain number of geometrical relations well known but, more important for our problem, the basic properties of elementary sequences (e.g., arithmetic and geometric progressions) were developed.[45] The numerical calculations are carried out everywhere with the greatest facility and skill.

We possess a great number of texts from all periods which contain lists of reciprocals, square and cubic roots, multiplication tables, etc., but these tables rarely go beyond two sexagesimal places (i.e., beyond 3600). A reverse influence of astronomy on mathematics can be seen in the fact that tables needed for especially extensive numerical computations come from the Seleucid period; tables of reciprocals are preserved with seven places (corresponding to eleven decimal places) for the entry and up to seventeen places (corresponding to twenty-nine decimal places) for the result. It is clear that numerical computations of such dimensions are needed only in astronomical problems.

The superiority of Babylonian numerical methods has left traces still visible in modern times. The division of the circle into 360 degrees and the division of the hour into 60 minutes and 3600 seconds reflect the unbroken use of the sexagesimal system in their computations by medieval and ancient astronomers. But though the base 60 is the most conspicuous feature of the Babylonian number system, this was by no means essential for its success. The great number of divisors of 60 is certainly very useful in practice, but the real advantage of its use in the mathematical and astronomical texts lies in the place-value notation,[46] which is consistently employed in all scientific computations. This gave the Babylonian number system the same advantage over all other ancient systems as our modern place-value notation holds over the Roman numerals. The importance of this invention can well be compared with that of the alphabet. Just as the alphabet eliminates the concept of writing as an art to be acquired only after long years of training, so a place-value notation eliminates mere computation as a complex art in itself. A comparison with Egypt or with the Middle Ages illustrates this very clearly. Operation with fractions, for example, constituted a problem in itself for medieval computers; in place-value notation, no such problem exists,[47] thus eliminating one of the most serious obstacles for the further development of mathematical technique.

The analogy between alphabet and place-value notation can be carried still further. Neither one was the sudden invention made by a single person but the final outcome of various historical processes. We are able to trace Mesopotamian number-writing far back into the earliest stages of civilization, thanks to the enormous amount of economic documents preserved from all periods. It can be shown how a notation analogous to the Egyptian or Roman system was gradually replaced by a notation which developed naturally in the monetary system and which tended toward a place-value notation. The value 60 of the base appears to be the outcome of the arrangement of the monetary

[45] Incidentally, we also have an example (Neugebauer-Sachs *MCT*, Problem-Text A) of purely number theoretical type from Old Babylonian times (so-called "Pythagorean numbers"); but it should be added that we do not find the slightest trace of number mysticism anywhere in these texts.

[46] Place-value notation consists in the use of a very limited number of symbols whose magnitude is determined by position. Thus 51 does not mean 5 plus 1 (as it would with Roman or Egyptian numerals), but 5 times 10 plus 1. Analogously in the sexagesimal system, five followed by one (we transcribe 5,1) means 5 times 60 plus 1 (i.e., 301).

[47] Example: to add or to multiply 1.5 and 1.2 requires exactly the same operations as the addition or multiplication of 15 and 12.

units.[48] Outside of mathematical texts, the place-value notation was always overlapped by various other notations, and toward the end of Mesopotamian civilization a modified system became predominant. It seems very possible, however, that the idea of place-value writing was never completely lost and found its way through astronomical tradition into early Hindu astronomy,[49] whence our present number system originated during the first half of the first millennium A.D.

10. We now turn to the periods preceding the final stage of Babylonian astronomy which culminated in the mathematical theory of the moon and the planets described above. It is not possible to give an outline of this earlier development because most of the preliminary work remains to be done. A few special problems, however, which must eventually find their place in a more complete picture, can now be mentioned.

In our discussion of the methods used in the lunar and planetary theories, we had occasion to mention the extensive use of periodically increasing and decreasing sequences of numbers. A simple case of this method appears in earlier times in the problem of describing numerically the changing length of day and night during the year. The crudest form is the assumption of linear variation between two extremal values.[50] Two much more refined schemes are incorporated in the texts of the latest period, but it seems very likely that they are of earlier origin. Closely related are two other problems: the variability of the length of the shadow of the "gnomon"[51] and the measurement of the length of the day by water clocks.[52] The latter problem has caused considerable trouble in the literature on the subject because the texts show the ratio 2:1 for the extremal values during the year. A ratio 2:1 between the longest and the shortest day, instead of the ratio 3:2, which is otherwise used,[53] would correspond to a geographical latitude absolutely impossible for Babylon. The discrepancy disappears, however, if one recalls the fact that the amount of water flowing from a cylindrical vessel is not proportional to the time elapsed but decreases with the sinking level.[54] It is worth mentioning in this connection that the outflow of water from a water clock is already discussed in Old Babylonian mathematical texts.[55] This whole group of texts, however, leads to nothing more than very approximate results. This is seen from the fact that the year is assumed, for the sake of simplicity, to be 360 days long and divided into 12 months of 30 days each.[56] This schematic treatment has its parallel in the schemes which we have met in Egyptian astronomy and which we shall find again in early Greek astronomy; we must once more emphasize that elements from such schemes cannot be used for modern calculations, since this would assume quantitative accuracy where only qualitative results had been intended.

The calendaric interest of these problems is obvious. The same is true of the

[48] For details see Neugebauer [11] and Neugebauer *Vorl.*, chap. iii § 4. The theory set forth by Thureau-Dangin *SS* (English version Thureau-Dangin [1]) does not account for the place-value notation, which is the most essential feature of the whole system.

[49] Cf. Datta-Singh *HHM* I and Neugebauer [12], pp. 266 ff.

[50] E.g., Weissbach *BM*, pp. 50–51.

[51] Weidner [1], pp. 198 ff.

[52] Weissbach *BM*, pp. 50–51; Weidner [1], pp. 195–96.

[53] Schaumberger *Erg.*, p. 377.

[54] Neugebauer [19].

[55] Thureau-Dangin [2] and Neugebauer *MKT*, I, pp. 173 ff.

[56] This schematic year of 360 days, of course, does not indicate that one assumed 360 days as the correct length of the solar year. A lunar calendar makes correct predictions of a future date very difficult. The schematic calendar is in practice therefore very convenient for giving future dates which must, at any rate, be adjusted later.

oldest preserved astronomical documents from Mesopotamia, the so-called "astrolabes."[57] These astrolabes are clay tablets inscribed with a figure of three concentric circles, divided into twelve sections by twelve radii. In each of the thirty-six fields thus obtained we find the name of a constellation and simple numbers whose significance is not yet clear. But it seems evident that the whole text constitutes some kind of schematic celestial map which represents three regions on the sky, each divided into twelve parts, and attributing characteristic numbers to each constellation. These numbers increase and decrease in arithmetic progression and are undoubtedly connected with the corresponding month of the schematic twelve-month calendar. It is clear that we have here some kind of simple astronomical calendar parallel (not in detail, but in purpose) to the "diagonal calendars" in Egypt. In both cases these calendars are of great interest to us as a source for determining the relative positions and the earliest names of various constellations. But here, too, the strongest simplifications are adopted in order to obtain symmetric arrangements, and much remains to be done before we can answer such questions as the origin of the "zodiac."

11. Few statements are more deeply rooted in the public mind or more often repeated than the assertion that the origin of astronomy is to be found in astrology. Not only is historical evidence lacking for this statement but all well-documented facts are in sharp contradiction to it. All the above-mentioned facts from Egypt and Babylonia (and, as we shall presently see, also from Greece) show that calendaric problems directed the first steps of astronomy. Determination of the season, measurement of time, lunar festivals—these are the problems which shaped astronomical development for many centuries; and we have seen that even the last phase of Mesopotamian astronomy, characterized by the mathematical ephemerids, was mainly devoted to problems of the lunar calendar. It is therefore one of the most difficult problems in the history of ancient astronomy to uncover the real roots of astrology and to establish their relation to astronomy. Very little has been done in this direction, mainly because of the prejudice in favor of accepting without question the priority of astrology.

Before going into this problem in greater detail, we must clarify our terminology. The modern reader usually thinks in terms of that concept of astrology which consists in the prediction of the fate of a person determined by the constellation of the planets, the sun, and the moon at the moment of his birth. It is well known, however, that this form of astrology is comparatively late and was preceded by another form of much more general character (frequently called "judicial" astrology in contrast to the "genethlialogical" or "horoscopic" astrology just described). In judicial astrology, celestial phenomena are used to predict the imminent future of the country or its government, particularly the king. From halos of the moon, the approach or invisibility of planets, eclipses, etc., conclusions are drawn as to the invasion of an enemy from the east or west, the condition of the coming harvest, floods and storms, etc.; but we never find anything like the "horoscope" based on the constellation at the moment of birth of an individual. In other words, Mesopotamian "astrology" can be much better compared with weather prediction from phenomena observed in the skies than with astrology in the modern sense of the

[57] This name is rather misleading and is merely due to the circular arrangement. Schott [1], p. 311, introduced the more appropriate name "twelve-times-three." Such texts are published in CT 33, Pls. 11 and 12. Cf. also Weidner *Hdb.*, pp. 62 ff. and Schott [1].

word. Historically, astrology in Mesopotamia is merely one form of predicting future events; as such, it belongs to the enormous field of omen literature which is so familiar to every student of Babylonian civilization.[58]

Indeed, it can hardly be doubted that astrology emerged from the general practice of prognosticating through omens, which was based on the concept that irregularities in nature of any type (e.g., in the appearance of newborn animals or in the structure of the liver or other internal parts of a sheep) are indicative of other disturbances to come. Once the idea of fundamental parallelism between various phenomena in nature and human life is accepted, its use and development can be understood as consistent; established relations between observed irregularities and following events, constantly amplified by new experiences, thus lead to some sort of empirical science, which seems strange to us but was by no means illogical and bare of good sense to the minds of people who had no insight into the physical laws which determined the observed facts.

Though the preceding remarks certainly describe the general situation adequately, the historical details are very much in the dark. One of the main difficulties lies in the character of our sources. We have at our disposal large parts of collections of astrological omens arranged in great "series" comprising hundreds of tablets. But the preserved canonical series come mainly from comparatively late collections (of the Assyrian period) and were thus undoubtedly subject to countless modifications. We must, moreover, probably assume that the collection of astrological omina goes back to the Cassite period (before 1200 B.C.)—a period about which our general information is pretty flimsy. From the Old Babylonian period only one isolated text is preserved[59] which contains omina familiar from the later astrology. Predictions derived from observations of Venus made during the reign of Ammiṣaduqa (*ca.* 1600 B.C.) are preserved only in copies written almost a thousand years later[60] and clearly subjected to several changes during this long time. We are thus again left in the dark as to the actual date of the composition of these documents except for the fact that it seems fairly safe to say that no astrological ideas appear before the end of the Old Babylonian period. Needless to say, there are no astrological documents of Sumerian origin.

The period of the ever increasing importance of astrology (always, of course, of the above-mentioned type of "judicial" astrology) is that beginning with the Late Assyrian empire. The "reports" mentioned previously, preserved in the archives of the Assyrian kings, are our witnesses. But here, again, a completely unsolved problem must be mentioned: we do not know how the "horoscopic" astrology of the Hellenistic period originated from the totally different omen type of astrology of the preceding millennium. It is, indeed, an entirely unexpected turn to make the constellation of the planets at a single moment responsible for the whole future of an individual, instead of observing the ever shifting phenomena on the sky and thus establishing short-term consequences for the country in general (even if represented in the person of the king). It seems to me by no means self-evident that this radical shift of the character of astrology actually originated in Babylonia. We shall see in the next section that the horoscopic practice flourished especially in Egypt. It might therefore very well be that the new tendency originated in Hellenistic times

[58] A comprehensive study of the development of the astrological omina literature by E. F. Weidner is in course of publication (Weidner [2]).

[59] Šileiko [1]. [60] Langdon *VT*.

outside Mesopotamia and was reintroduced there in its modified form. It might be significant that only seven horoscopes are preserved from Mesopotamia, all of which were written in the Seleucid period,[61] a ridiculously small number as compared with the enormous amount of textual material dealing with the older "judicial" astrology. It must be admitted, however, that the oldest horoscopes known are of Babylonian origin. On the other hand, at no specific place can all the elements be found which are characteristic for astrology from Hellenistic times onward. Neither Babylonian astrology nor Egyptian cosmology furnishes the base for the fundamental assumption of horoscopic astrology, namely, that the position of the planets in the zodiac decides the future. And, finally, it must be emphasized that the problem of determining the date and place of origin of horoscopic astrology is intimately related to the problem of the date and origin of mathematical astronomy. Horoscopes could not be cast before the existence of methods to determine the position of the celestial bodies for a period of at least a few decades. Even complete lists of observations would not be satisfactory because the positions of the planets in the zodiac are required regardless of their visibility at the specific hour. This shows how closely interwoven are the history of astrology and the history of planetary theories.

IV. THE HELLENISTIC PERIOD

12. Before beginning the discussion of the Hellenistic period, we must briefly describe the preceding development in Greece. Our direct sources of information about astronomy and mathematics before Alexander are extremely meagre. The dominating influence of Euclid's *Elements* succeeded in destroying almost all references to pre-Euclidean writings, and essentially the same effect was produced by Ptolemy's works. Original documents are, of course, not preserved—one must not forget that even our oldest manuscripts of Greek mathematical and astronomical literature were written many centuries after the originals.[62] It is therefore not surprising that our present-day knowledge of early Greek science is much more incomplete and subject to conjecture than the history of Mesopotamian or even Egyptian achievements where original documents are at our disposal. One point, however, can be established beyond any doubt: early Greek astronomy shows very strong parallelism with the early phases of Egyptian and Babylonian astronomy, with respect to scope as well as primitiveness. The astronomical writings of Autolycus[63] and Euclid[64] struggle in a very crude way with the problem of the rising and setting of stars, making very strong simplifications which were forced upon them by the lack of adequate methods in spherical geometry. The final goal is again to establish relations between the celestial phenomena and the seasons of the years; the problem is thus of essentially calendaric interest. In addition to these simple treatises, however, we do find one work of outstanding character: the planetary theory of Eudoxos, Plato's famous contemporary. He made an attempt to explain the peculiarities of a planetary movement known as retrogra-

[61] Two are published by Kugler *SSB*, II, 554 ff., and refer to the years 258 and 142 B.C., respectively. One (probably 233 B.C.) is published in Thompson *AB* 251. Among four unpublished horoscopes, discovered by Dr. A. Sachs, two are very small fragments, one can be dated 235 B.C., and the last was cast for the year 263 B.C.; the last is the oldest horoscope in the world.

[62] The oldest preserved manuscript of Euclid's *Elements* was written about twelve hundred years after Euclid (cf., e.g., Heath *Euclid*, I, p. 47).

[63] Autolycus, ed. Hultsch (Leipzig, 1885).

[64] *Euclidis opera omnia*, Vol. VIII, ed. Menge (Leipzig, 1916).

dation by the assumption of the superposition of the rotation of two concentric spheres around inclined axes and in opposite directions. In this way he reached a satisfactory explanation of the general type of planetary movement and thereby inaugurated a new period in the history of astronomy which was marked by attempts to explain the movements of the planetary system by mechanical models. It contains the nucleus for all planetary theories of the following two thousand years, namely, the assumption that irregularities in the apparent orbits can be explained as the result of superposed circular movements. It is only since Galileo and Newton that we know that the circular orbits do not play an exceptional role and that the great successes of the Greek theory were merely due to the accidental distribution of masses in our planetary system. It is, nevertheless, of great historical interest to see how a plausible initial hypothesis can for many centuries determine the line of attack on a problem, simultaneously barring all other possibilities. Such possibilities were actually contained in the approach developed by the Babylonian astronomers in the idea of superposing linear or quadratic periodic functions. These arithmetical methods were, however, almost completely abandoned by the Greek astronomers (at least so far as we know) and survived only in the treatment of certain smaller problems.

One of these smaller problems is again related to calendaric questions but also to a basic problem of mathematical geography: the determination of the geographical latitude by means of the ratio of the longest to the shortest day. We have already mentioned the Babylonian methods of describing the change in the length of the days by means of simple sequences. These "linear" methods reappear in Greek literature and can be followed far into the early Middle Ages[65] in spite of the invention of much more accurate methods.[66] The term "linear" does not refer so much to the fact that the sequences in question form arithmetic progressions of the first order but is intended to emphasize the contrast with the "trigonometric" method applied to the same problem and explained in the first book of the *Almagest*. Here the exact solution of the problem by the use of spherical trigonometry is given. In contrast thereto, the linear methods yield only approximate results, but with an accuracy which was certainly sufficient in practice, especially when one takes into account the inaccuracy of the ancient instruments used in measuring time. Historically, however, the main interest lies much less in the perfection of the results than in the method employed and in its influence on the further development. A close investigation of early Greek astronomy and mathematics[67] reveals an interesting fact. The determination of the time for the rising and setting of given arcs of the ecliptic, which lies at the heart of the question of the changing length of day and night, appears to be the most decisive problem in the development of spherical geometry. It is typical for the whole situation that a Greek "mathematical" work, the *Sphaerics* of Theodosius (*ca.* 200 B.C.), does not contain a single astronomical remark. The structure and contents of the main theorems, however, are determined by the astronomical problem in question; the methods applied constitute a very interesting link between the Babylonian linear methods and the final trigonometrical methods.

Trigonometry undoubtedly has a very

[65] Neugebauer [13] and [18].

[66] *Almagest* II, 7 and 8. Cf. also *Tetrabiblos* I, 20 (ed. Robbins, p. 94), 21 (ed. Boll-Boer, pp. 46, 47 ff.).

[67] This investigation has been carried out by Olaf Schmidt (doctoral thesis, Brown Univ., 1943 [unpublished]).

long history. We find the basic relations between the chord and diameter of a circle already in use in Old Babylonian texts which employ the so-called "Thales" and "Pythagorean" theorems.[68] In sharp contrast to the Greek models for the movement of the celestial bodies, which operate with circles and therefore necessarily require trigonometrical functions, we find no applications of trigonometry in the cuneiform astronomical texts of the Seleucid period which are exclusively based on arithmetical methods described above.

So far as we know, spherical trigonometry appears for the first time in the *Sphaeric* of Menelaos[69] (*ca.* A.D. 100). The astronomical background of this work is much more outspoken than in Theodosius, but here, too, much is left to the reader, who must be familiar with the methods of ancient astronomy to understand all the astronomical implications. The modern scholar faces an additional difficulty, namely, the modification of the Greek text by the Arabic editors. The Greek original is lost, and what we possess is only the Arabic version made almost a thousand years later. In this interval falls the gradual transformation of Greek trigonometry, operating with chords, to the modern treatment, which uses the sine function. It is well known that this change goes back to Hindu astronomy, where the chords subtended by an angle were replaced by the length of the half-chord of the half-angle,[70] i.e., our "sin α." It is, however, a much more involved question to separate these new methods from those used originally by Menelaos; this question must be answered if we wish to understand the development of ancient spherical astronomy. This, in turn, is necessary in order to appreciate the contributions made by the Hindu-Arabic astronomers which eventually led to the modern form of spherical trigonometry.

13. It is of great interest to see that the very same problem—the determination of rising times—leads to still other methods which are now known partly as "nomography," partly as "descriptive geometry." We have a small treatise, written by Ptolemy, called the *Analemma*.[71] He first introduces in a very systematic way three different sets of spherical coordinates, each of which determines the position of a point on the celestial sphere. Then these coordinates are projected on different planes, and these planes are turned into the plane of construction, just as we do today in descriptive geometry. Finally, certain scales are used to find graphically the relations between different coordinates, again following principles which we now use in nomography. The Arabs used and developed these methods in connection with the construction of sundials.[72] Another method of projection, today called "stereographic," is given in Ptolemy's *Planisphaerium*. The theory of perspective drawing in the Renaissance is directly connected with this work.[73]

The practical importance of the determination of the rising times or the length of the days is not restricted to the theory of sundials. The length of the longest day increases with the geographical latitude, thus giving us the means to determine the latitude of a place from the ratio of the

[68] Cf. Neugebauer-Struve [1], pp. 90–91; Neugebauer *MKT*, I, p. 180; and Neugebauer-Sachs *MCT*, Problem-Text A.

[69] Krause *Men*.

[70] Cf., e.g., Braunmühl *GT*, chap. 3.

[71] Ptolemy, *Opera* II, pp. 187–223. No complete translation of this badly preserved text has yet been published, but an excellent commentary has been given by Luckey [1]. These methods, using descriptive geometry, are of an older date, as is evident from the fact that they are already mentioned by Vitruvius (beginning of our era). Cf. Neugebauer [14] and Luckey [2].

[72] Cf., e.g., Garbers *ES* and Luckey [2].

[73] Ptolemy, *Opera* II, pp. 225–59, translated in Drecker [1]; cf. also Loria in M. Cantor, *Geschichte der Mathematik*, IV, p. 582.

shortest to the longest day. The ratio 3 : 2 accepted by Babylonian astronomers for the ratio of the longest to shortest daylight led the Greek geographers to determine erroneously the latitude of Babylon as 35° (instead of $32\frac{1}{2}$°). This error seriously affected the shape of the eastern part of the ancient map of the world.[74] The precise relationship can only be established by using spherical trigonometry, but here, too, the "linear" methods were applied to various values of the basic ratio in order to give the law for the changing length of the days for the corresponding latitude. It must be remarked, however, that at this stage of affairs the concept "latitude" does not yet actually appear, but the ratio of the longest to the shortest day itself was used to characterize the location of a place. Zones of the same ratio were considered as belonging to the same "clima," a concept which plays a great role in ancient and medieval geography. The difference in character and behavior of nations living in different climates furnished one of the main arguments for the influence of astronomical phenomena on human life.[75]

The second geographical coordinate—the longitude—caused more trouble. The difference in longitude between two places on the earth is essentially equivalent to the difference in local time. But there existed no clocks or signals to compare the local time at far-distant places. Only one phenomenon could be used as a time signal, namely, records of simultaneous observations of a lunar eclipse from two different places. If each observer took note of the local time at which he observed the beginning and end of a lunar eclipse, a comparison of these records would then furnish the needed information. Hipparchus proposed the use of this method for an exact construction of the map of the world, but his program was never carried out. Only one pair of simultaneous observations seems to have been made, the eclipse of 331 B.C., September 20, recorded three hours earlier in Carthage than at Arbela.[76] Actually the difference in local time between these two localities is much smaller, and consequently the ancient map of the world suffers from a serious distortion in the direction from east to west. Here we see one of the most essential differences between ancient and modern science at work. Ancient science suffered most severely from the lack of scientific organization which is so familiar in our own times. In antiquity, generations passed before a new scientific idea found a follower able to use and develop methods handed down from a predecessor. The splendid isolation of the great scholars of antiquity can only be paralleled with the first beginnings of the new development in the European Renaissance. It seems to me beyond any doubt that even centers like Alexandria or Pergamon during their height would appear very poorly equipped if compared with a modern university of moderate size. And these centers themselves were few and practically isolated at any particular time; and at all times they were dependent upon the mood of some autocratic ruler. No wonder that the great achievements of antiquity are either the result of priestly castes of sufficiently stable tradition or of a few ingenious men who expended tremendous energy in restoring and enlarging the structure of a science known to them from the written legacy of their predecessors. One must not think

[74] For the determination of the size of the earth by Eratosthenes (about 250 B.C.), Marinus of Tyre (about A.D. 100), and Ptolemy (about A.D. 150), see Mžik *EGM*, pp. 96 ff., and, in general, Heidel *GM*, chap. xi. Cf. also Honigmann *SK* and Neugebauer [13].

[75] E.g., *Tetrabiblos* II, 2.

[76] Ptolemy *Geographia* i. 4. 2 (ed. Nobbe, p. 11). Cf. also Mžik-Hopfner *PDE*, p. 21, n. 3. For Hipparchus' program see Strabo *Geography* i. C. 7; also Berger *GFH*, pp. 12 ff.

that mathematics and astronomy, like the popular philosophical systems or the art of rhetoric, were taught in the same manner from generation to generation. Three centuries separate Hipparchus from Ptolemy, one Eudoxos from Euclid, Euclid from Archimedes and Apollonius. To be sure, the literary tradition was never interrupted between these outstanding men, but most of the intermediate literature at best merely preserved and commented. This explains not only why ingenious ideas were frequently lost (e.g., Archimedes' methods of integration) but also why it was so easy to destroy ancient science almost completely in a very short time. Astronomy alone had a slight advantage because of its practical usefulness in navigation, geography, and time-reckoning, supplemented by the fortunate accident that the Easter festival followed the lunar calendar of the Near East, thus sanctioning lunar theory when other secular sciences fell into total desuetude.

The extreme paucity of scientists at almost any given time in antiquity gave rise to another phenomenon in Greek literature: the publication of commentaries and popularizing works. A work like the *Almagest*, written in purely scientific style, was certainly unintelligible to the majority of people who needed or wanted to know a modest amount of astronomy. Hence books were written which attempted to explain Ptolemy's text sentence by sentence,[77] or which gave abstracts accompanied by explanations of the main principles as far as this could be done without mathematics.[78] We can observe the same phenomenon in geography. The first chapter of Ptolemy's *Geography*[79] contains a very interesting theory of map projection, whereas the remaining twelve chapters constitute an enormous catalogue of localities from all over the then known world and the corresponding values of longitude and latitude to be plotted into the network which was to be constructed according to the method explained in the first chapter. This, again, was not geography for the entertainment of the general reader. To satisfy popular tastes, there was another literature, represented by works like Strabo's *Geography*.[80] These more pleasant writings furnished serious competition to the strictly scientific literature and determined to a large extent the character of the field in late antiquity and the Middle Ages.

14. For the modern historian of ancient astronomy it is therefore of the greatest value to have an additional source of astronomical literature in which the earlier tradition was kept alive without interruption for a much longer period: the astrological texts. We have already mentioned that astrology in the modern use of the word appeared very late in antiquity. The art of casting horoscopes can be said to be a typical Hellenistic product, the result of the close contact between Greek and oriental cultures.[81] We possess Greek papyri from Egypt from the beginning of our era to the Arabian conquest showing us the application of astronomical methods in a great number of specific horoscopes and in minor astronomical treatises.[82] In addition, an enormous astrological literature is preserved, catalogued during the last fifty years in the twelve volumes of the *Catalogus* by Cumont and

[77] The commentaries of Pappus and Theon of Alexandria (and presumably of Hypathia) are of this type. For these texts cf. Rome *CPT*.

[78] Represented, e.g., by Theon of Smyrna (second cent. A.D.) or Proclus (fifth cent. A.D.).

[79] Edited by Nobbe (1843). The first chapter is excellently discussed by Mžik and Hopfner *PDE*.

[80] Edited and translated in the "Loeb Classical Library" by H. L. Jones (8 vols.; 1917–32).

[81] Cf., e.g., Capelle [1], who shows that only weak traces of astrological ideas in Greek literature can be followed as far back as 400 B.C.

[82] Concerning horoscopes, see above, n. 17. Examples of astronomical treatises are Pap. Ryl. 27, 464, 522/24, 527/28, or Curtis-Robbins [1].

his collaborators.[83] Finally, Vettius Valens, who wrote shortly before Ptolemy,[84] and Ptolemy himself as the author of the famous *Tetrabiblos*, must be mentioned.[85]

Modern scholars have not yet made full use of this vast material. The reason is only too clear: the amount of work to be done surpasses by far the power of a single individual, and the work itself is certainly not very pleasant. The astronomical part must be extracted from occasional remarks, short computations, and similar instances submerged beneath purely astrological matter of a very unappealing character. But this work must eventually be done and will give valuable results. As an example might be mentioned the question of discovering the principle according to which the equinox was placed in the zodiac. This question must be answered, for on it depend our calculations in the determination of constellations, chronology, etc. Moreover, systematic checking of astrological computations will frequently yield information about the character of the astronomical tables used at the time.

We touch here upon a point of great importance for the modern attitude toward ancient astronomy. The usual treatment of ancient sciences as a homogeneous type of literature is very misleading. It is necessary to realize that very different levels of astronomy or mathematics were coexistent, almost without mutual contact or interference. One misses the essential points in the understanding of ancient astronomy if one naïvely considers various documents in their chronological order. Even works by the same person must sometimes be separated from one another. Ptolemy's *Almagest* is purely mathematical, the *Tetrabiblos* (written after the *Almagest*)[86] is purely astrological, and his *Harmonics*[87] contains a chapter on the harmony of spheres employing concepts of the planetary movements which contains such strong simplification of the actual facts that one would try in vain to find similar assumptions in any of the other works of Ptolemy. In other words, it is necessary to evaluate each text in its proper surrounding and according to its traditional style. One cannot, for example, speak without qualification of the contact between Babylonian and Greek astronomy. Such a contact might even have worked in opposite directions in different fields. For instance, we have already referred to the possibility that Hellenistic astrology returned to Babylonia in the form acquired in Egypt or Syria, whereas observational material from Mesopotamia undoubtedly influenced Greek mathematical astronomy deeply. In general, it can be said that the growth of ancient sciences shows much more irregularity and stratification than modern scientists, accustomed to the fact of the uniform spread of modern ideas and methods, are prone to assume.

The lack of uniformity in the whole field of ancient astronomy in general necessarily interferes also with the investigation of any special problem. We have already mentioned the fact that astrology in the Assyrian age differed considerably from the horoscopic type which prevailed in late antiquity and the Middle Ages. But there exists a third type, standing between the omina type ("when this and this happens in the skies, then such and such a major event will be the consequence") and the individual birth horoscope, namely, the "general prognostication," explained in full detail in the first two books of the *Tetrabiblos*. This type of

[83] *CCAG*. Cf. also Boll [2].

[84] Kroll *VV*.

[85] Ptolemy, *Opera* III, 1, and "Loeb Classical Library" (ed. F. E. Robbins).

[86] This follows from the introduction to the *Tetrabiblos*.

[87] Düring *HP* and *PPM*.

astrology is actually primitive cosmic physics built on a vast generalization of the evident influence of the position of the sun in the zodiac on the weather on earth. The influence of the moon is considered as of almost equal importance, and from this point of departure an intricate system of characterization of the parts of the zodiac, the nature of the planets, and their mutual relations is developed.[88] This whole astronomical meteorology is, to be sure, based on utterly naïve analogies and generalizations, but it is certainly no more naïve and plays no more with words than the most admired philosophical systems of antiquity. It would be of great interest for the understanding of ancient physics and science in general to know where and when this system was developed. The question arises whether this is a Greek invention, replacing the Babylonian omen literature, which must at any rate have lost most of its interest with the end of independent Mesopotamian rule, whether it precedes the invention of the horoscopic art for individuals or merely represents an attempt to rationalize the latter on more general principles.[89] Thus we see that even in a single field of ancient astronomical thought the most heterogeneous influences are at work; the analysis of these influences has repercussions on almost every aspect of the study of ancient civilizations.[90]

15. The same branching-off into very different lines of thought must also be recognized in the development of Greek mathematics. The line of development characterized by the names of Eudoxus, Euclid, Archimedes, and Apollonius is to be separated sharply from writings like Heron[91] and Diophantus[92] or the *Arithmetic* of Nicomachus of Gerasa.[93] Here, again, the question of oriental influence cannot be discussed as one common phenomenon. Egyptian calculation technique and mensuration were certainly continued in similar works in Hellenistic Egypt and found their way into Roman and medieval practices. At the same time, Babylonian numerical methods influenced Alexandrian astronomy. How Babylonian algebraic concepts eventually reached Greek writers like Diophantus is still completely unknown, but that it did is supported by the strong parallelism in methods and problems.[94] Equally lacking is detailed information as to the revival of these methods in Moslem literature.[95] On the other hand, the problems which emerged from the discovery of the irrational numbers are undoubtedly of Greek origin. It is, however, not correct to consider writings of the same person as equally representative of "Greek" mathematics. Those parts of Euclid's *Elements* (the majority of the work) which deal more or less directly with the problem of irrational numbers are, as we said before, Greek. Most likely of equally Greek origin is Euclid's astronomical treatise called *Phenomena*,[96] which is written on so elementary a level that nobody would attribute it to the author of the *Elements* if the authorship were not so firmly established. And, finally, Euclid's *Data*[97] contains the treatment of purely algebraical problems by geometrical means—which can be interpreted as the direct geometrical transla-

[88] For the whole complex of the ancient justifications of astrology, see Duhem, *SM*, II, 274 ff.

[89] This is the assumption of Kroll [1], p. 216, for the tendency exhibited in Ptolemy's *Tetrabiblos*.

[90] Cf. the excellent survey of this situation in Boll [2].

[91] First century A.D.; cf. for this date Neugebauer [14], pp. 21 ff.

[92] Usually dated about A.D. 300; cf., however, Klein [1], p. 133, n. 23.

[93] Greek text ed. Hoche (Leipzig, 1866); English translation: D'Ooge-Robbins-Karpinski *Nic.*

[94] Vogel [2]; Gandz [3].

[95] Gandz [1], [2], [3].

[96] *Opera* VIII; cf. above, p. 16.

[97] *Opera* VI.

tion of methods well known to Babylonian mathematics.[98] These methods of "geometrical algebra" in turn determine the whole structure of Apollonius' theory of conic sections.[99]

Greek mathematics is by far the best-investigated field of ancient science (and of the history of science in general);[100] the situation with respect to the source material is very good[101]—except where only Arabic manuscripts are preserved.[102] But one must not forget that also this tradition suffers from severe gaps. This is due not only to the destruction of manuscripts over a period of two thousand years but also to the effect of literary influence. I refer not only to the above-mentioned elimination of older treatises by the overshadowing of the great works of the Hellenistic period. The Greeks themselves contributed to the distortion of the picture of the actual development by inventing seemingly plausible stories where the real records were already lost. The oft-repeated stories about Thales, Pythagoras, and other heroes are the result.[103] We should now realize that we know next to nothing about earlier Greek mathematics and astronomy in general and about the contact with the Near East and its influence in particular. The method which involves the use of a few obscure citations[104] from late authors for the restoration of the history of science during the course of centuries seems to me doomed to failure. This amounts to little more than an attempt to understand the history of modern science from a few corrupt quotations from Kant, Goethe, Shakespeare, and Dante.

16. Undoubtedly the most spectacular advances in the history of astronomy until very recent times were scored in the theory of the planets. The catch-words "Ptolemaic" and "Copernican" refer to different assumptions as to the mechanism of the planetary movement. This is not the place to underline the fact that the Copernican theory is by no means so different from or so superior to the Ptolemaic theory as is customarily asserted in anniversary celebrations,[105] but we must briefly analyze Ptolemy's own claims to having been the first one who was able to give a consistent planetary theory.[106] This claim seems to contradict not only the existence of pre-Ptolemaic planetary tables in Roman Egypt as well as in Mesopotamia but also Ptolemy's own reference to such texts. What Ptolemy means, however, becomes clear if one reads the details of the introduction to his own theory. He requires an explanation of the planetary movement by means of a combination of uniform circular movements which refrains from simplifications like the assumption of an invariable amount for the retrograde arc and similar deviations from the actual observations. Indeed, in order to remain in close agreement with the observations, Ptolemy had to overcome difficulties which Hipparchus was not able to

[98] Neugebauer [15].

[99] Zeuthen *KA* and Neugebauer [16].

[100] Best exposition: Heath *GM* and *MGM* and Euclid. A selection of texts is given in Thomas *GMW*.

[101] Most of the texts are edited in the Teubneriana collection.

[102] Menelaos alone is now edited (Krause *Men.*), but Books v, vi, and vii of Apollonius' *Conic Sections* are still unavailable in a modern edition. Archimedes' construction of the heptagon is published in a free translation of the Arabic version in Schoy *TLAB*, pp. 74–91; cf. also Tropfke [1].

[103] As an example might be mentioned the criticism of the story of the Thales eclipse by Pannekoek [3], p. 955; Dreyer *HPS*, p. 12, n. 2; Neugebauer [9], pp. 295–96. Cf. also Frank, Plato, or Heidel [1].

[104] The fragments collected by Diels *VS* not only give an extremely incomplete picture of the lost writings but were certainly very much distorted by the authors from whose works they are taken. One needs only to look at the picture of oriental writings obtained from Greek tradition as compared with the originals.

[105] The correct estimate can be found in Thorndike *HM*, Vol. V, chap. xviii.

[106] *Almagest* IX, 2.

master and which led Ptolemy to a model which is very close to Kepler's final solution of the problem, by assuming not only an eccentric position of the earth but also an eccentric point around which the movement of the planetary eccenter appears to be uniform. The resulting orbit is of almost elliptical shape with these two points as foci.[107] This whole theory is closely related in method to the explanation of the "evection" of the moon (a periodic perturbation of the moon's orbit discovered by Ptolemy) by a combination of eccentric and epicyclic movements. Both theories are real masterpieces of ancient mathematical astronomy which far surpassed all previous results.

It is not surprising that Ptolemy's results overshadowed all previous works. All that we know about his forerunners comes mainly from the *Almagest* itself. We hear that Hipparchus used eccenters and epicycles for the explanation of the anomalies in the movement of the sun and the moon,[108] and we learn about theorems for such movements proved by Apollonius.[109] This brings us to the very period (about 200 B.C.) from which the oldest cuneiform planetary texts are preserved—computed, however, on entirely different principles. These cuneiform texts cover the two centuries down to the time of Caesar. A direct continuation, chronologically speaking, but of still another type, are planetary tables from Egypt, written in Demotic or Greek.[110] These tables give the dates at which the planets enter or leave the signs of the zodiac. Such tables were known to Cicero[111] and are most likely the "eternal tables" quoted with contempt by Ptolemy.[112] We do not know how these tables were computed, and their occurrence in Greek as well as in Demotic leaves us in doubt as to their origin—showing us only the degree of interrelation we can expect in Hellenistic times.

The most interesting question would, of course, be to learn more about Hipparchus' astronomy. He is most famous as the discoverer of the precession of the equinoxes. Though this fact cannot be doubted,[113] underlining its importance lays the wrong emphasis on a phenomenon which gained its importance only from Newton's theory, which showed that precession depends on the shape of the earth and thus opened the way to test the theory of general gravitation by direct measurements on the earth. For ancient astronomy, however, precession played a very small role, requiring nothing more than sufficiently remote and sufficiently reliable records of observations of positions of fixed stars. The change in positions must then eventually become evident; and little difficulty was encountered in incorporating this slow movement into the adopted model of celestial mechanics. What we actually need to appreciate in Hipparchus' contribution must be derived from a careful study of all relevant sections of the *Almagest*, not by the schematic method of obtaining "fragments" from direct quotations but by a comparison of Ptolemy's methods and the older procedures which he frequently mentions. That such an approach can lead to well-defined results has recently been shown in the theory of eclipses.[114]

17. One of the most important prob-

[107] Cf. Schumacher [1] for the Ptolemaic theory of Venus and Mercury. For the Greek planetary theory in general, see Herz *GB* I.

[108] *Almagest* III, 4.

[109] *Almagest* XII, 1 (=Apollonius, ed. Heiberg, II, 137).

[110] Neugebauer [3]. Cf. above, p. 5.

[111] Cicero *De divinatione* ii. 6, 17; cf. also ii. 71. 146.

[112] *Almagest* IX, 2.

[113] Schnabel's attempts (Schnabel [1]) to prove that precession was taken into consideration in the cuneiform texts are, to say the least, inconclusive and in part based on mere scribal errors.

[114] Schmidt [1].

lems in connection with Hipparchus is, of course, the problem of the dependence of Hipparchus (and Greek astronomy in general) on Babylonian results and methods. Whatever the conclusions derived from a deeper knowledge of Hipparchus' astronomy may turn out to be, one thing is clear: the century between Alexander's conquest of the Near East and Hipparchus' time is the critical period for the origin of Babylonian mathematical astronomy as well as for its contact with Greek astronomy. Since Kugler's discoveries, which showed the exact coincidence between numerical relations in cuneiform tablets and in Hipparchus' theory,[115] no one has doubted Babylonian priority. It is an undeniable fact that the Babylonian theory is based on mathematical methods known already in Old Babylonian times and does not show any trace of methods considered to be characteristically Greek. The problem remains, however, to answer the question: What caused the sudden outburst of scientific astronomy in Mesopotamia after many centuries of a tradition of another sort? On what background can we understand, for example, the report[116] that the "Chaldaean" Seleucus from Seleucia on the Tigris[117] completed the heliocentric theory, previously proposed as a hypothesis by Hipparchus? Greek influence on late Babylonian astronomy must not be denied or asserted on aprioristic grounds, if we really want to understand a phenomenon of great historical significance.

These remarks are not intended to make Greek influence alone responsible for the new developments in Mesopotamia. As a matter of fact, this answer would only raise the equally unsolved question why Greek astronomy suddenly emerged from many centuries of primitiveness to a scientific system. The alternative, Greek or Babylonian, might even exclude the right answer from the very beginning. It also seems possible that the rise of mathematical astronomy in Hellenistic times resulted from the suddenly intensified contact between several types of civilization, in some respects to be paralleled with the origin of modern science in the Renaissance. In other words, neither the Greeks nor the Orientals might have been alone responsible for the new development but rather the enormous widening of the horizon of all members of the culture of the Hellenistic age. One result of this process was probably the new attitude toward the relationship between the individual and the cosmos, expressed in the new form of horoscopic astrology. In this case it is quite evident that Egypt and Greece—and perhaps Syria as well—contributed about equally much to the refinement and spread of this new creed. It is equally possible that the contact between Greek scholars, trained to think in geometrical terms which Greek mathematics had developed in the fifth century, and Babylonian astronomers, equipped with superior numerical methods and observational records, brought into simultaneous existence two closely related types of mathematical astronomy: the treatment by arithmetical means in Babylonia and the model based on circular movements in the Greek centers of learning in the eastern Mediterranean. It may well be that competition, not borrowing, was the chief contributor to the initial impetus.[118] At any rate, it is clear that each detail in the development of Hellenistic astronomy which we will be able to understand better will reveal a new aspect in the fascinating process of the

[115] Kugler *BMR*, p. 40.

[116] Plutarch *Plat. quaest.* vii. 1. 1006 C (ed. Bernardakis, *Moralia*, VI, 138). Cf. also Heath, *AS*, pp. 305 ff. and Duhem *SM*, I, 423 ff.

[117] Strabo xvi. 739. Seleucus may have lived about 150 B.C.

[118] Neugebauer [17], pp. 30–31.

creation of the new world which was destined to become the foundation of the Roman and medieval civilizations.

The unique role of the Hellenistic period in the field of sciences, as in other fields, can be described as the destruction of a cultural tradition which dominated the Near East and the Mediterranean countries for many centuries, but also the founding of a new tradition which held following generations in its spell. The history of astronomy in the Hellenistic age is especially well suited to demonstrate that the great energies liberated by the disintegration of an old cultural tradition are very soon transformed into stabilizing forces of a new tradition, which includes about as many elements of development as of stagnation.

V. SPECIAL PROBLEMS

18. Every research program in a complex field will face the need of constant modification and adjustment to unforeseen complications and new ramifications. Problems can arise and results be obtained without having been anticipated in the original question. The context of a mathematical text, for example, can determine with absolute certainty the meaning of a word otherwise only vaguely defined; sign-forms in a papyrus which is exactly dated by astronomical means may furnish valuable information for purely paleographical problems. From dates and positions given in Demotic astronomical texts, it follows that the Alexandrian calendar introduced by Augustus was used by Egyptian scribes only a few years after the reform,[119] very much in contrast to the common opinion that the Egyptians were especially conservative in general and in calendaric matters in particular. In short, from few, but solidly established, facts we can learn more than from all general speculations.

One of the problems which at first sight lies very much outside the history of ancient astronomy is the study of social and economic conditions of the ancient civilizations. There are, however, several points of contact between these studies and astronomy. We are indebted to Cumont for a masterly investigation of the information contained in the astrological literature from Hellenistic Egypt.[120] His results are not only of interest for the history of ancient civilization but also illustrate very well the background of the men who used and transmitted the astronomical material known to us from the planetary tables or from Vettius Valens. It turns out that the soil in which these practices were rooted was essentially Egyptian, in spite of the use of the Greek language in the documents. This is in perfect harmony with the close parallelism between Greek and Demotic planetary texts mentioned above and shows the constant interaction of Greek and native influences in Hellenistic Egypt. It also shows how dangerous it is to decide the authorship of Hellenistic doctrines or methods simply on the basis of such superficial grounds as the language used.

The analogous question for Babylonia seems to be easier to answer. The Mesopotamian origin of the astrological omina cannot be doubted. We would, however, like to know more about the background of the astronomers of the latest period. It is well known that the names of three Babylonian astronomers appear in Greek literature[121] and that two of them actually were found on astronomical tablets, though in an unclear context. For one particular place, the famous city of Uruk in South Babylonia, we can go much further. It can be shown that the scribes and owners of our texts belong to one of two

[119] Neugebauer [6], p. 119.

[120] Cumont *EA*. See also Kroll [1].

[121] Cumont [1].

"families," or perhaps "guilds," of scribes who frequently call themselves scribes of the omen-series "Enuma Anu Enlil."[122] We can follow the work of these scribes very closely for almost a hundred years until the school of Uruk ceased to exist, probably because of the Parthian invasion of Babylonia in 141 B.C. In contrast thereto, the school of Babylon survived the collapse of the Greek regime, as is proved by a continuous series of astronomical texts down to 30 B.C. This is an interesting result in comparison with the assumption that Babylon practically ceased to exist after the Parthian occupation. The grouping of our texts according to well-defined schools is also of interest from another point of view. It can be shown that two different systems of computation existed side by side for a long time. Competing schools of this sort constitute a phenomenon which is usually considered characteristic for Greek culture.

19. Countless thousands of business documents are preserved from all periods of Mesopotamian history. For the urgently needed investigation of ancient economics, a precise knowledge of the metrological systems is of the greatest importance. Unfortunately, the scientific study of Babylonian measures has been sadly neglected. Fantastic ideas about the level and importance of astronomy in the earliest periods of Babylonian history led to theories which brought measures of time and space in close relationship with alleged astronomical discoveries. We know today that all these assumptions of the early days of Assyriology must be abandoned and that Babylonian metrology must be studied from economic and related texts clearly separated according to period and region. For the determination of Old Babylonian relations between various measures, the mathematical texts are of great value because they contain numerous examples which give detailed solutions of problems in which metrological relations play a major role. The consequences of such relations, established with absolute certainty, are manifold. For example, we now know from Old Babylonian mathematical texts the measurements of several types of bricks[123] as well as the peculiar notation used in counting bricks. It is evident that such information is of importance for the understanding of contemporary economic texts dealing with the delivery of bricks for buildings, thus leading to purely archeological questions. Metrological relations are also needed if we wish to gain an insight into wages and prices.[124] Returning to our subject, it must be said that metrology is of great importance not only for the history of the economics of Mesopotamia but also for purely astronomical problems. Distances on the celestial sphere are measured in astronomical texts by units borrowed from terrestrial metrology. The comparison between ancient observation and modern computations thus requires a knowledge of the ancient relations between the various units. This problem is by no means simple because our astronomical material belongs to relatively late periods, Assyrian and Neo-Babylonian, and the metrological system of these times is much more involved than the Old Babylonian. Mathematical texts would certainly be of great help here too, but the few tablets from this period are so badly preserved that they present us with at least as many new questions as they answer. Neo-Babylonian economic texts will therefore furnish the main point of departure for the study

[122] For this series cf. Boll-Bezold-Gundel *SS*, pp. 2 ff., and Weidner [2].

[123] Neugebauer-Sachs *MCT*, Problem-Text O and Sachs [1].

[124] Waschow [1], p. 277, found, in discussing mathematical texts, that the value of the area-measure "še" must be changed by a factor 60 against older assumptions. It is obvious how such facts influence the interpretation of economic texts.

of the latest phase of Mesopotamian metrology and its astronomical applications.

It might be mentioned, in this connection, that theories about direct relationship between early Mesopotamian metrology and astronomy also gave rise to the rather unfortunate concept of high accuracy in the determination of weights, measures of length, etc. It is of great importance to realize that the absolute values of all metrological units are subject to great margins of inaccuracy and local and temporal variations. The first step in a historical investigation of Mesopotamian metrology must therefore be to establish from economic and mathematical texts the *ratios* between the units; these ratios have an incomparably better chance of showing unformity than the absolute values deduced from accidental archeological finds.

20. Closely related to metrological problems is the question of the accurate identification of ancient star configurations. Much work remains to be done before it will be possible to give a reliable history of the topography of the celestial sphere in general, or even of the zodiacal constellations.[125] In spite of attempts to make Egypt responsible for many forms,[126] the predominant influence of Babylonian concepts on the grouping of stars into pictures must be maintained. But neither Babylonian nor Egyptian developments are known in detail. The identification of Egyptian constellations is especially difficult, mainly because it must be based on relations between the times of rising and setting and therefore depends on elements which are grossly schematized in the texts at our disposal. The situation in Mesopotamia is slightly better because we have actual observations in addition to the schematic lists, at least for the later periods which are of special importance for the Hellenistic forms of the constellations.

For the period following the publication of the *Almagest*, we must take into account the possibility of still other complications. We know from explicit remarks in the *Almagest* that Ptolemy's star catalogue introduced deviations from older catalogues.[127] Astrological wórks, however, may very well have maintained pre-Ptolemy standards both with respect to the boundaries of constellation and the counting of angles in the zodiac. We have already mentioned the stubborn adherence of astrological writers to methods of computation which were made obsolete by the development of spherical trigonometry.[128] For the modern historian it is therefore of importance to establish the specific standard according to which a given document was written, especially when chronological problems are involved.

21. While metrology is a much-needed implement for economic history and the understanding of ancient astronomy, astronomy itself serves general history in chronological problems. Chronology is the necessary skeleton of history and owes its most important fixed points to astronomical facts. We need not emphasize the use of reports of eclipses, especially solar eclipses, for the determination of accurate dates to form the framework into which the results of relative chronology must be fitted. It must be underlined, however, that the available material is by no means exhausted. A better understanding and reinvestigation of the reports of the Assyrian astronomers will certainly furnish new information of chronological value. It must be stated, on the other

[125] The best summary is given by the Boll-Gundel article, "Sternbilder," in Roscher *GRM*, Vol. VI (1937), cols. 867–1072.

[126] Cf. esp. Gundel *DD* and *HT* and the criticism of Schott [2].

[127] *Almagest* VII, 4 (ed. Heiberg, p. 37).

[128] Cf., e.g., *Tetrabiblos* I, 20 (ed. Robbins, pp. 94–95).

hand, that not too much is to be expected from older material. In order to make ancient observations accessible to modern computation, a certain degree of accuracy must be granted; this accuracy seems to be missing in the earlier phases of the development of astronomy. This, for instance, makes the older Egyptian material so ill suited for chronological purposes. For later periods, however, Egypt has furnished and will furnish much information from astrological documents. It is particularly calendaric questions, such as the use of eras and similar problems, which have been illuminated by the dating of horoscopes.

The great variety of calendaric systems, local eras, and older methods of dating raises many difficulties in ancient chronology. This difficulty was clearly felt also by ancient astronomers and was the cause of the early use of consistent eras in Babylonian and Greek astronomy. The Babylonian texts always use the Seleucid Era, whereas Ptolemy reduces all dates to the Nabonassar Era but uses the Old Egyptian years of constant length. This crossing of Egyptian and Babylonian influences is paralleled by the subdivision of the day into hours. The Egyptians divided the day into twelve parts from sunrise to sunset, thus obtaining hours whose length depended on the season. The Babylonian astronomers used six subdivisions of day and night, but these units were of constant length. Combining the Egyptian division into 24 hours with the Babylonian constancy of length, the Hellenistic astronomers used "equinoctial" hours for their computations and solved the problem of finding the relationship between seasonal and equinoctial hours by spherical trigonometry.[129] One sees here again what a multitude of relations, problems, and methods contributed to shape concepts such as a continuous era or the 24-hour day which are so familiar to us today.

Ancient chronology and the accurate analysis of ancient reports have turned out to be of interest even to a modern astronomical problem. In 1693 Halley discovered the fact[130] that the moon's position appeared to be advanced compared with the expected position as computed from positions recorded by Ptolemy. This "acceleration" can be explained by a slow increase in the length of the solar day or by a decrease in the rotational velocity of the earth. Such a decrease is caused by tidal forces,[131] and it is of great interest to determine the amount as accurately as possible. For this purpose, accurate positions of the moon in remote times are of great value, and such positions can, indeed, be derived from records in cuneiform texts.[132] Modern measurements of high precision can thus be supplemented by observations in antiquity.

22. Not only are Hellenistic astronomy and Hellenistic astrology the determining factors for the astronomy and astrology of the Middle Ages in Europe, but its influence is equally important for the development of astronomical methods and concepts in the Middle and Far East. We must therefore at least mention an enormous field which still awaits systematic research: Hindu science. This does not mean that there is not an extensive literature on this subject; indeed, even a small number of original texts are published.[133] The main trouble lies, however, in the tendency of the majority of publications by Hindu authors to claim priority for Hindu discoveries and to deny foreign in-

[129] *Almagest* II. 9.

[130] Edm. Halley, "Emendationes ac notae Abatênii observationes astronomicas, cum restitutione tabularum lunisolarum ejusdem authoris," *Philosophical Transactions*, **17** (1693), No. 204, pp. 913–21.

[131] Cf., e.g., Jeffreys [1].

[132] P. V. Neugebauer [1].

[133] For the literature until 1899, see Thibaut *AAM*. The best discussion of Hindu astronomy is still Burgess *SS* (1860).

fluence, as well as in the opposite tendency of some European scholars. This tendency has been especially strong so far as Hindu mathematics is concerned,[134] and it is aggravated by the inadequate publication of the original documents, from which usually only scattered fragments are cited in order to prove some specific statement. As a result, there is no means today to obtain an independent judgment from the study of the original texts which are preserved in enormous number, though of relatively late date for the most part.

The situation with respect to Hindu astronomy is not much better. There can be little doubt that the original impetus came from Hellenistic astronomy; the use of the eccentric-epicyclic model alone would be sufficient proof even if we did not also find direct witness in the use of Greek terminology.[135] This fact is interesting in itself, but it may very well be that the period of reception lies between Hipparchus and Ptolemy; systematic study might therefore reveal information about pre-Ptolemaic Greek astronomy no longer preserved in available Greek sources. Hindu astronomy would in this case constitute one of the most important missing links between late Babylonian astronomy and the fully developed stage of Greek astronomy represented by the *Almagest*.

The fundamental difficulty in the study of Hindu astronomy lies in the character of the preserved textual material. The published and commented texts consist exclusively of cryptically formulated verses giving the rules for computing certain phenomena, making it extremely difficult to understand the actual process to be followed. It is evident, on the other hand, that no astronomy of an advanced level can exist without actually computed ephemerids. It must therefore be the first task of the historian of Hindu astronomy to look for texts which contain actual computations. Such texts are, indeed, preserved in great number, though actually written in very late periods. Poleman's catalogue[136] of Sanskrit manuscripts in American collections lists about a hundred such manuscripts in the D. E. Smith collection in Columbia University in New York. In their general arrangement, these texts are reminiscent of the cuneiform ephemerids from Seleucid times and must reveal many details of the Hindu theory of the planetary movement if attacked by the same methods which have proved so successful in the case of the Babylonian material. The complete publication of this material is an urgent desideratum in the exploration of oriental astronomy.

As mentioned above, the texts in the D. E. Smith collection are of very recent origin, only a few centuries old. This does not mean that the methods used are not of very much earlier date. This is shown by the investigation of one of these texts,[137] which deals with the problem of the varying length of the days during the year. Though written about 1500, the computations are based on methods going back to a much older period. Analogous results can be expected in the remaining material, and there is no reason to assume that the D. E. Smith collection exhausts all the preserved material.

23. In the preceding sections we have frequently touched on methodological questions. In closing, I wish to underline a few principles in a more general way. As is only natural, the study of the development of ancient science began under the

134 Cf., e.g., Datta-Singh *HHM* (reviewed in Neugebauer [12]).

135 Thibaut *AAM*, pp. 43 ff. The Babylonian ratio 3 : 2 for the ratio between the longest and shortest days of the year also occurs in India (Thibaut *AAM*, pp. 26–27; Kugler *BMR*, pp. 82 and 195), though it would be suitable only for the latitude of the northern corner of India. For the planetary theory, see Kugler *BB*, p. 120; Schnabel [2], p. 112; Schnabel [1], p. 60.

136 Poleman *CIM*, pp. 231 ff. See also Emeneau *PIT*, pp. 318 ff.

137 Schmidt [2].

influence of the ancient tradition. Herodotus, Diodorus, the commentators of Plato, etc., were the sources which determined the picture of the early stages of Greek and oriental mathematics and astronomy. But while students of political history, art, economics, and law learned in the early days of systematic archeological research to consider this literary tradition about the ancient Orient as nothing more than a supplementary source to be checked by the original documents, the majority of historians of the exact sciences have remained in a stage of naïve innocence, repeating without criticism the nursery stories of ancient popular writers. This is all the more surprising because many of these stories should have revealed their purely fictitious character from the very beginning. Every invention considered of basic importance is attributed to a definite person or nation: Thales "discovered" that a diameter divides the area of a circle into two equal parts, Anaximandes and several others are credited with the discovery of the obliquity of the ecliptic, the Egyptians discovered geometry, the Phoenicians arithmetic—and so on, according to an obvious pattern of naïve restoration of facts the origins of which had been totally forgotten. Modern authors then add stories of their own, such as the idea that the construction of the pyramids required mathematics, the assumption of supposedly marvelous skies of Mesopotamia,[138] and the notion of Egyptian Stone Age astronomers industriously determining the heliacal rising of Sirius or carrying out a geodetic survey of the Nile Valley.

It is clear that the replacement of the traditional stories by statements based exclusively on results obtainable from the original sources will not be very appealing. This is the inevitable result in the development of every science; for increased knowledge means giving up simple pictures. In the history of science, an additional element must be added to the steady increase of complexity resulting from a better understanding of our sources. Not only do we learn to interpret our material more accurately but we also learn to see everywhere the immense gaps in our preserved sources. We will more and more be forced to admit that many, and essential, steps in the development of science are hopelessly destroyed; that we, at best, are able to sketch mere outlines of the history of science during certain sharply limited periods; and that many of the driving forces might actually have been quite different from those which we customarily restore on the analogy of later periods.

One consequence of this situation seems to me to be evident: unless the history of science now enters the stage of specialization, it will lose all value in the framework of historical research. It must be clearly understood that the history of science must work with methods and must consider its problems from viewpoints which correspond to the methods and standards of other branches of historical research. The idea must definitely be abandoned that the history of science must adapt its level to the alleged requirements of the teaching of the modern fields of science. The intrinsic value of this research must be seen in its contribution to our understanding of the historical processes which shaped human civilization, and it must be made clear that such an understanding cannot be reached without the closest contact with the other historical fields. The call for specialization is not very popular. I am convinced, however, that a well-founded insight into the details of a single essential step in the development is at present of higher value and more fascinating than any attempt at general syn-

[138] For the poor conditions of actual observation cf. Koldewey *WB*, p. 192; Vogt [1], pp. 38–39; cf. also Boll [1], pp. 48 and 157.

thesis. It is ridiculous to believe that we are anywhere able to reach "final" results in the study of the development of human civilization. But the overwhelming richness of all phases of human history can be appreciated only if we occupy ourselves with the real facts as accurately as possible and do not attempt to hide their manifold aspects under the veil of hazy generalizations or let our judgment be guided by the naïve idea of human "progress." Every synthesis written fifty years ago is now completely antiquated and at best enjoyable for its literary style; the careful study of the original works of the ancients, however, will reveal to everyone and at any time the development of their achievements.[139]

The call for specialization must not be misunderstood as a plea for the disregard of the general outlines of the historical conditions. On the contrary, specialized work can be accomplished successfully only if the points of attack are selected under constant consideration of possible interference from other problems and other fields. It is indeed the most gratifying result of detailed research on a well-defined problem that it necessarily uncovers relationships which are of primary importance for the understanding of larger historical processes. The actual working program, however, needs restriction and minute detail work. The most essential task is that of making the original sources accessible as easily as possible in their best available form. By the indefatigable work of Heiberg, Hultsch, Tannery, and many others, we possess today a great part of the extant writings of the Greek scientists in excellent editions. We owe to Sir Thomas Little Heath many brilliant commentaries and translations of Greek mathematicians.[140] To make Greek and oriental source material more generally accessible, supplemented, of course, by modern translations and commentaries, will be the foremost problem of the future. The extension of this program to include medieval material, on the one hand, and Middle Eastern documents, on the other, appears as a logical consequence, worthy of the serious efforts of all scholars who wish to contribute to the understanding of the past of our own culture.

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[139] An excellent example is Delambre *HAA*, published in 1817 and still not surpassed or even equaled because of its direct contact with the original sources.

[140] On the other hand, much remains to be done to repair the harm caused by classical philologists who made their editions inaccessible to modern scientists by translating them into Latin instead of a modern language. Great opportunities have been spoiled by this absurd attitude. It has fortunately never occurred to Orientalists to translate their texts into Hebrew. It should be mentioned, however, that the Arabic version of Euclid's *Elements* was published in Latin(!) translation by Besthorn, Heiberg, and others (Copenhagen, 1897–1932).

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Harmonics. *See* Düring.

QS — *Quellen und Studien zur Geschichte der Mathematik, Astronomie und Physik.*

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ZA	*Zeitschrift für Assyriologie*.
ZDMG	*Zeitschrift der Deutschen Morgenländischen Gesellschaft*.
Zeuthen *KA*	ZEUTHEN, H. G. *Die Lehre von den Kegelschnitten im Altertum*. Copenhagen, 1886.

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THE ORIGIN OF THE EGYPTIAN CALENDAR

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Probably no calendaric institution has continued over a longer period than the Egyptian calendar. After its uninterrupted use during all of Egyptian history, the Hellenistic astronomers adopted the Egyptian year for their calculations. Ptolemy based all his tables in the *Almagest* on Egyptian years; even as late as A.D. 1543 Copernicus in *De revolutionibus orbium cœlestium* used Egyptian years. The explanation of this fact is very simple: astronomers are practical-minded people who do not connect more or less mystical feelings with the calendar, as the layman frequently does, but who consider calendaric units such as years, months, and days as nothing but conventional units for measuring time. And because *the* main requirement of every measuring unit is, of course, its constancy, the Egyptian calendar is an ideal tool: twelve months of thirty days each, five additional days at the end, and no intercalation whatsoever. It is no wonder that the Hellenistic astronomers preferred this system to the Babylonian lunar calendar with its very irregularly changing months of twenty-nine and thirty days combined with a complicated cyclic intercalation—not to mention the chaos of Greek and Roman calendars.[1]

The ideal simplicity of the Egyptian calendar, however, raises serious problems for the historian. Should we assume that astronomers, for the sake of their own calculations, imposed on the rest of the population a calendar with no respect for sun and moon? No scholar will accept this viewpoint, even if he does not hesitate to speak (in cases of no consequence) of Egyptian "astronomers" or Egyptian *Kalendermacher*. Only one other solution seems to remain: the simplicity of the Egyptian calendar is a sign of its primitivity; it is the remainder of prehistoric crudeness, preserved without change by the

[1] It may be remarked that for the same reason modern astronomy does not use the Gregorian calendar for computations but Julian years instead (the continued use of Egyptian years would be inconvenient because of the discrepancy of about one and a half years with the adopted historical chronology of our times).

Egyptians, who are considered to be the most conservative race known in human history.

Even this second solution, however, is by no means satisfactory. I do not have in mind the sophisticated argument that one of the strongest foundations for the belief in the extreme Egyptian conservatism is the very maintenance of the calendar and should therefore not be used as an *explanation* of the calendar. What I mean is the fact that there is no astronomical phenomenon which possibly could impress on the mind of a primitive observer that a lunar month lasts 30 days and a solar year contains 365 days. Observation during one year is sufficient to convince anybody that in about six cases out of twelve the moon repeats all its phases in only 29 days and never in more than 30; and forty years' observation of the sun (e.g., of the dates of the equinoxes) must make it obvious that the years fell short by 10 days! The inevitable consequence of these facts is, it seems to me, that *every theory of the origin of the Egyptian calendar which assumes an astronomical foundation is doomed to failure.*

Four years ago I tried to develop the consequences of this conviction as far as the Egyptian *years* are concerned. I showed[2] that a simple recording of the extremely variable dates of the inundations leads necessarily to an average interval of 365 days. Only after two or three centuries could this "Nile calendar" no longer be considered as correct, and consequently one was forced to adopt a new criterion for the flood, which happened to be the reappearance of the star Sothis. I do not want to repeat the discussion here, but I should like to state that I still think that this theory is in perfect agreement with the structure of the Egyptian calendar, which has only three seasons, admittedly agricultural and not astronomical, and which has no reference to Sothis at all.[3] I did not see, at that time, any satisfactory

[2] O. Neugebauer, "Die Bedeutungslosigkeit der Sothisperiode für die ältere aegyptische Chronologie," *Acta orientalia*, XVII (1938), 169–95.

[3] I wish to take this opportunity to make some remarks about an interesting paper by H. E. Winlock, "The Origin of the Egyptian Calendar" (*Proceedings of the American Philosophical Society*, LXXXIII [1940], 447–64), where the problem of the Egyptian year is treated independently of my paper.

The most important point seems to me that Winlock reached the same conclusion, namely: the classical theory that *both* Nile and Sothis are responsible for the beginning of the years must be abandoned. The old story of the "creation" of the Egyptian calendar in 4231 B.C. can now be considered as definitely liquidated. An objection has been raised against my theory of a "Nile-year" resulting from averaging the strongly fluctuating explanation of the second characteristic element of the Egyptian calendar—the *months* of invariably 30 days' length. How are we to explain these artificial months, seemingly so contradictory to all our experience with ancient calendaric systems?

The solution which I finally believe to have found for this problem is nothing but the radical abandoning of the concept that the 30-day months should be explained by some kind of primitive astronomy and the clear insight into the fact that the 30-day months are by no means peculiar to Egypt but play a very important role also in Mesopotamia, the classical country of the strictly lunar calendar.

I can best start by quoting two sentences from Sethe's *Zeitrechnung:* "Bei den Aegyptern haben sowohl Lepsius als Ed. Meyer und Andere die Existenz eines Mondjahres für die Urzeit als a priori selbstverständlich vorausgesetzt . . . . und Brugsch wollte sogar das Fortbestehen eines solchen Mondjahres in geschichtlicher Zeit neben dem Siriuswandeljahr aus zahlreichen Angaben über Mondstände

intervals between the inundations. This objection is that there is no proof of the existence of "Nilometers" at so early a period (*ibid.*, p. 450, n. 11). However, no precise Nilometer is required for my theory. The sole requirement is that somebody recorded the date when the Nile was clearly rising. As a matter of fact, *every* phenomenon which occurs only once a year leads to the same average, no matter how inaccurately the date of the phenomenon might be defined. The averaging process of a few years will automatically eliminate all individual fluctuations and inaccuracies and result in a year of 365 days. Fractions, however, would be obtained only by much more extensive recording and by accurate calculation. The actual averaging must, however, be imagined as a very simple process based on the primitive counting methods as reflected in the Egyptian number signs: the elapse of one, two, or three days recorded by one, two, or three strokes. After ten strokes are accumulated, they are replaced by a ten-sign, thereafter ten ten-signs by a hundred symbol, etc. This is the well-known method of all Egyptian calculations. This method finally reduces the process of averaging to the equal distribution of the few marks which are beyond, say, three hundred-signs and five ten-signs; in other words, there is no "calculation" at all involved in determining the average length of the Nile-years. Of course, we need not even assume the process of counting all the single days every year: the averaging of the excess number of days over any interval of constant length (say twelve lunar months) gives the same result. This equal distribution of counting-marks finally makes it clear that no fractions will be the result of the process.

Winlock's own theory assumes the prediction of the flood at an early epoch according to lunar months (pp. 454 ff.). Thereafter, Menes is credited with having begun to determine the beginning of the years by observing the Sothis star (pp. 457–58), the seasons still being of variable length because of their composition by lunar months (p. 459). Finally, Djoser around 2773 B.C. is supposed to have dropped the actual New Year's observations by installing the year of "12 times 30 + 5 days" because "experience of centuries by now had seemed to show that the year should contain 365 days" (p. 462). I cannot see how *experience* from observing Sothis could have created this assumption of the length of the year because Sothis after one hundred years of 365 days each rises 25 days too late! This obvious *contradiction* between the year of 365 days and any astronomical observations seems to me just the most striking argument in favor of looking for another phenomenon which leads to a 365-day year—the flood of the Nile.

. . . . schliessen."[4] But, he goes on, "schwer liesse sich von einem solchen alten Mondjahre die Brücke zu dem geschichtlichen Wandeljahre . . . . schlagen." This conclusion of Sethe is obviously the generally accepted viewpoint. However, how can one justify the total ignoring of the textual evidence amply collected, for example, by Brugsch in his *Thesaurus*,[5] which shows clearly a great interest in the real lunar months? Indeed, Brugsch's assumption of the existence of real lunar months has only been confirmed since his time.[6] I admit, of course, that Borchardt[7] overemphasized the importance of the full-moon festivals for the coronation ceremonies and that his chronological construction, based on this theory, requires checking. The fact remains, however, that at all periods of Egyptian history the real lunar months had their well-defined religious significance. One need only recall the countless passages where we are told about the loss and restitution of the moon's eye, of its magical importance, etc. Indeed, one should be surprised that the behavior of the real moon should have been totally disregarded and have been replaced by meaningless intervals of 30 days. Moreover, we now know that the "short" and "long" years mentioned in the list of offerings at Benihasan[8] (Twelfth Dynasty) are the years containing either twelve or thirteen lunar festivals (say, new moons), respectively; this is shown by a Demotic papyrus in which a simple cycle of twenty-five years is developed according to which one can tell whether a certain year contains twelve or thirteen new moons and on what dates in the civil calendar they can be expected.[9] In other words, we have to admit the *coexistence* of real lunar months and of the civil calendar with its 30-day months. Sethe's contradiction then disappears, and we no longer need astronomy to explain the 30-day months: all "astro-

[4] K. Sethe, *Die Zeitrechnung der alten Aegypter* ("Nachr. Ges. Wiss. Göttingen, Phil.-hist. Kl.," 1919, pp. 287–320, and 1920, pp. 28–55, 97–141), pp. 300 and 301.

[5] H. Brugsch, *Thesaurus inscriptionum aegyptiacarum*, Vol. I: *Astronomische und astrologische Inschriften altaegyptischer Denkmäler* (Leipzig, 1883).

[6] Winlock, *op. cit.*, pp. 454 f.

[7] L. Borchardt, *Die Mittel zur zeitlichen Festlegung von Punkten der ägyptischen Geschichte und ihre Anwendung* (Cairo, 1935).

[8] *Urkunden d. aeg. Altertums*, VII, 29, 18=P. E. Newberry, *Beni Hasan I*, p. 25, ll. 90 f.

[9] Neugebauer-Volten, "Untersuchungen z. antiken Astronomie. IV: Ein demotischer astronomischer Papyrus (Pap. Carlsberg 9)," *Quellen u. Studien z. Gesch. d. Mathematik*, Abtl. B, IV (1938), 383–406.

nomical" interest is restricted to the actual observation of the real moon with no resultant influence on the civil calendar.

But how are we to explain the coexistence of the schematic 30-day months side by side with the real lunar months? The answer sounds paradoxical at first but is actually very simple: *schematic months are the natural consequence of a real lunar calendar.*

Here the analogy with the situation in Mesopotamia enters the picture. The actual behavior of the moon is so complicated that not before the very last centuries of Babylonian history was a satisfactory treatment of the movement of the sun and the moon developed sufficiently accurate to predict the length of the lunar months for an appreciable time in the future. In other words, only a highly developed theoretical astronomy (today we would say "only celestial mechanics") is able to determine the further course of a lunar calendar. Private and public economy require the possibility of determining future dates regardless of the irregularity of the moon and the inability of the astronomers to predict the outcome. A simplified calendar is equally useful also for the past because it eliminates the necessity of keeping exact records of the actual length of each month. It is amply testified from Babylonian sources how this natural demand was met: beside the real lunar calendar there was a schematic calendar of twelve months of 30 days each, regardless of the real moon. A few well-known examples are sufficient to prove this statement: contracts for future delivery were dated in this schematic calendar, regardless of the actual outcome in the particular year,[10] past expenses[11] and rents are calculated according to a 360-day business year and to 30-day months,[12] etc. But it is interesting to see that this schematic year was also in use in astronomical texts. Solstices and equinoxes are listed as falling on the fifteenth of the Months I, IV, VII, and X, although everybody knew that the dates in the real lunar calendar would be totally different in almost all cases. The same holds with

[10] Thureau-Dangin, *RA*, XXIV (1927), 188 ff. These examples belong to the Old Babylonian, Persian, and Neo-Babylonian periods.

[11] Kugler, *ZA*, XXII (1908), 74 f.

[12] Neugebauer, *Mathem. Keilschrift-Texte*, III, 63.

the lengths of day and night,[13] the shadow length,[14] rising and setting of fixed stars,[15] etc.[16] This use of the schematic calendar in an astronomical context is especially important; it demonstrates clearly that the schematic dates do not represent an attempt to approximate as closely as possible the real facts but merely constitute a way of expressing future dates in round numbers according to a general scheme whose exact relation to the real lunar calendar remains to be established later on when actually needed.

It is evident that the analogous situation in Egypt is sufficient to explain analogous consequences. No one was able to predict exactly the moon's behavior, and a schematic calendar was therefore quite necessary wherever economic life demanded regularity and simplicity. "The" Egyptian calendar is therefore in all respects the result of practical needs alone, and "astronomy" is restricted to the simple fact that the real lunar festivals were regulated by direct observation, with no attempt to influence the civil calendar, and vice versa. It is only a slight difference in emphasis which brought about the almost total eclipse of the schematic calendar in Babylonia and of the lunar calendar in Egypt. The deeper reasons for this difference in emphasis can perhaps be found in the difference of social and economic structure of the two countries. In unified Egypt with its centralized administrative system the schematic calendar naturally had a much higher importance for the life of the whole country[17] than in the

[13] E.g., Weissbach, "Bab. Miscellen," *Wiss. Veröff. DOG*, IV (1903), 50 f., and Kugler, *Sternkunde*, Ergänzungsheft, 88 ff.

[14] Weidner, *AJSL*, XL (1924), 186 ff.

[15] CT, XXXIII, 1–8.

[16] It is very possible that many dates in cuneiform sources are actually meant in the schematic calendar, but we have no means to prove it. It would be, however, equally difficult to prove that the real lunar calendar is meant.

[17] When I reviewed the content of this paper at the meeting of the American Oriental Society in Boston, Professor H. Frankfort asked whether the institution of the schematic calendar could be assumed to belong to the reign of Djoser. I think that no serious objection can be raised against such an assumption, because the only condition for the creation of the schematic calendar is a sufficiently well-organized and developed economic life. On the other hand, means to determine such a date by *astronomical* considerations do not exist.

The problem of the invention of the schematic months must not be confused with the problem of the period at which the 365-day year was introduced. The two institutions are absolutely independent—at least in principle. The 365-day year must have been created city-states of early Mesopotamia, where each community enjoyed the right of having a calendar of its own.[18]

It is worth noticing that the parallelism between the Babylonian and Egyptian situation also holds for the astronomical documents which we possess from the Twelfth Dynasty and from the New Kingdom. The decanal lists in the coffins from Asyut[19] represent the same type of schematic astronomical calendars as do the Babylonian texts,[20] and the same holds for the star calendars around the figure of Nut in the cenotaph of Seti I and in the tomb of Ramesses IV.[21] Here again, as in Babylonia, we see that astronomy in its earlier stages of development makes no attempt to give exact dates but applies simple schemes which strongly idealize the real facts.[22]

To summarize, both the Egyptian and the Babylonian calendaric concepts display a higher complexity than usually admitted by modern scholars. One point needs special stressing: this complexity must not be considered as the struggle of two or three competing calendaric systems in the modern sense of the word but represents the peaceful coexistence of different methods of defining time moments and time intervals in different ways on different occasions. The situation is here very much the same as in ancient metrology: no need is felt to measure, e.g., grain and silver and fishes by the same units of

at a period when the inundation coincided roughly with the season called "inundation." Such a coincidence held for the centuries around 4200 and again in the centuries around 2800. The latter date (i.e., the time of Djoser) has been considered by Winlock (*op. cit.* p. 462) as the date of the definite establishment of the Egyptian year. The analysis of all available evidence for the use of the 365-day year by A. Scharff (e.g., *Historische Zeitschrift*, CLXI [1939], 3–32) also shows that there is no reason to maintain the earlier date (as I was still inclined to do in my paper in *Acta orientalia*).

18 Cf., e.g., N. Schneider, "Die Zeitbestimmungen der Wirtschaftsurkunden von Ur III," *Anal. Or.*, Vol. XIII (1936).

19 Cf., e.g., Pogo, *Isis*, XVII (1932), 16–24, and *Osiris*, I (1935), 500–509.

20 Of course, only as far as the *method* is concerned; the content is totally different.

21 For the astronomical and mythological interpretation of these texts see Lange-Neugebauer, "Papyrus Carlsberg I", *Kgl. Danske Vidensk. Selsk. Hist.-fil. Skrifter*, Vol. I, No. 2 (1940). It is a methodical mistake to use these documents as astronomically precise and to calculate their date under this assumption—not to mention the fact that there does not yet exist a satisfactory explanation of essential features of the "diagonal calendars" on the coffin lids.

22 The same can be observed in early Greek astronomy, e.g., in Autolycus (*ca.* 300 B.C.), *De ortibus et occ. II*, theorem 6 (ed. Hultsch, p. 118).

weight, nor is an attempt made to establish well-defined relations between these measures. Exactly in the same sense all modern talk about ancient "luni-solar calendars" constitutes an anachronism: some elements of ancient life are regulated according to the seasons; others, according to the moon (and in Egypt also according to the Nile and Sothis). But no Egyptian thought about a Sothis-lunar calendar or any analogous construction. The key to understanding the origin of the Egyptian calendar seems to me to be the insight into the *independence* of all its elements which we still see in existence in historical times: the Nile, the Sothis star, the fiscal calendar, and the moon.

BROWN UNIVERSITY

Macrobius, Ambrosius Aurelius Theodosius

MACROBIVS

FRANCISCVS EYSSENHARDT

ITERVM RECOGNOVIT

ADIECTAE SVNT TABVLAE

LIPSIAE
IN AEDIBVS B. G. TEVBNERI
MDCCCLXXXXIII

Copy 2

monem adducitis nihil ex omnibus quae a ueteribus
elaborata sunt aut ignoratio neget aut obliuio sub-
trahat, superfluum uideo inter scientes nota proferre.
sed nequis me aestimet dignatione consultationis
grauari, quidquid de hoc mihi tenuis memoria sug-
gesserit, paucis reuoluam.' post haec, cum omnes para-
tos ad audiendum erectosque uidisset, ita exorsus est.
2 M. VARRO in libro RERVM HVMANARVM, quem DE
DIEBVS scripsit, homines inquit qui ex media
nocte ad proximam mediam noctem his horis
uiginti quattuor nati sunt, uno die nati dicun-
3 tur. quibus uerbis ita uidetur dierum obseruationem
diuisisse, ut qui post solis occasum ante mediam no-
ctem natus sit, illo quem nox secuta est — contra
uero qui in sex noctis horis posterioribus nascitur, eo
die uideatur natus qui post eam noctem diluxerit.
4 Athenienses autem aliter obseruare idem Varro
in eodem libro scripsit, eosque a solis occasu ad
solem iterum occidentem omne id medium
tempus unum diem esse dicere: Babylonios
porro aliter: a sole enim exorto ad exortum
eiusdem incipientem id spatium unius diei no-
mine uocare: Vmbros uero unum et eundem
diem esse dicere a meridie ad insequentem
5 meridiem. quod quidem inquit Varro nimis ab-
surdum est. nam qui kalendis hora sexta apud
Vmbros natus est, dies eius natalis uideri de-
bebit et kalendarum dimidiatus et qui post
6 kalendas erit usque ad horam eius dici sextam.
populum autem Romanum ita, uti Varro dixit, dies
singulos adnumerare a media nocte ad mediam proxi-
mam multis argumentis ostenditur. sacra sunt enim

1 inducitiſ *P* a *om.* *B′P*; quẹ͏̊ ueteribuſ *P*, *supra* quẹ *add.* nicħ coꝛ̃ *P*² 4 dignatione ∗ (*fuit* m) *B* 8 marcuſ *BP* 10 ⊢oriſ *P* 11 quatuor *P* 13 diuidiſſe *B′* 14 quēmox | nox *B* ſequuta *P* 20 babiloniοſ *BP* 21 exortom *B′* 29 oram *B′* eiuſdem *P* 31 annumerare *P*

Romana partim diurna, alia nocturna, et ea quae
diurna sunt ∗∗∗∗∗∗∗∗∗∗∗ ab hora sexta noctis
sequentis nocturnis sacris tempus impenditur. ad hoc 7
ritus quoque et mos auspicandi eandem esse obserua-
tionem docet. nam magistratus, quando uno die eis
et auspicandum est et id agendum, super quo processit
auspicium, post mediam noctem auspicantur et post
exortum solem agunt, auspicatique et egisse eodem
die dicuntur. praeterea tribuni plebis, quos nullum 8
diem integrum abesse Roma licet, cum post mediam
noctem proficiscuntur et post primam facem ante
mediam noctem sequentem reuertuntur, non uidentur
afuisse diem, quoniam ante horam noctis sextam
regressi partem aliquam illius in urbe consumunt.
QVINTVM quoque MVCIVM iureconsultum dicere 9
solitum *legi* lege non isse usurpatum mulierem,
quae, cum kalendis Ianuariis apud uirum ma-
trimonii causa esse coepisset, a. d. IIII kalen-
das Ianuarias sequentes usurpatum isset: non
enim posse impleri trinoctium, quo abesse a
uiro usurpandi causa ex duodecim tabulis de-
beret, quoniam tertiae noctis posteriores sex
horae alterius anni essent, qui inciperet ex
kalendis.
VERGILIVS quoque id ipsum ostendit, ut hominem 10
decuit poeticas res agentem, recondita atque operta
ueteris ritus significatione

'torquet' inquit 'medios nox humida cursus
et me saeuus equis oriens adflauit anhelis.'

27 Vergilius Aen. V 738

2 *post* ſunt *est* ∸|∸ *pictum in P, lacunam expleuit Carrio* 4 auſpicondi *ut uid.* *B′* 6 preceſſit *B* 8 auſpicatiq. ∗∗ & ∗∗ | eodem egiſſe die *P* 12 mediam noctem proficiſcuntur et poſt *om.* P 13 die͏̊ (*fuit* diē) *P* ſextā ∗ | *P* 16 legi *add. Pontanus* non iſſe *P*²: nouiſſe *P* uſur|patū ∗ *P* 18 cẹpiſſet *P* addiem quartum *BP* 19 eſſet *B* poſſet *b* 22 poſteriorıſ *B′* 25 uirgiliuſ *BP* 28 corſuſ P′ 29 afflauit *bP*

THE ATTIC NIGHTS OF AULUS GELLIUS

WITH AN ENGLISH TRANSLATION BY

JOHN C. ROLFE, PH.D., LITT.D.
UNIVERSITY OF PENNSYLVANIA

IN THREE VOLUMES

I

2nd Cent AD
(b. c. 130)

LONDON : WILLIAM HEINEMANN
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MCMXXVII

10 lucescit. Ad hoc ritus quoque et mos auspicandi
eandem esse observationem docet; nam magistratus,
quando uno die eis auspicandum est et id super
quo auspicaverunt agendum, post[1] mediam noctem
auspicantur et post meridiem sole magno agunt,[2]
auspicatique esse et egisse eodem die dicuntur.
11 Praeterea tribuni plebei, quos nullum diem abesse
Roma licet, cum post mediam noctem proficiscuntur
et post primam facem ante mediam sequentem re-
vertuntur, non videntur afuisse unum diem, quoniam,
ante horam noctis sextam regressi, parte aliqua illius
in urbe Roma sunt.

12 Q.[3] quoque Mucium iureconsultum dicere solitum
legi, non esse usurpatam mulierem, quae, cum Kalen-
dis Ianuariis apud virum matrimonii causa esse coe-
pisset, ante diem IV. Kalendas Ianuarias sequentes
13 usurpatum isset; non enim posse impleri trinoctium,
quod abesse a viro usurpandi causa ex *Duodecim
Tabulis* deberet, quoniam tertiae noctis posterioris
sex horae alterius anni essent, qui inciperet ex
Kalendis.

14 Istaec autem omnia de dierum temporibus et
finibus ad observationem disciplinamque iuris antiqui
pertinentia cum in libris veterum inveniremus, non
dubitabamus quin Vergilius quoque id ipsum osten-

[1] cum post, *Puteanus*; dum post, *Damsté*.
[2] meridiem sole magno agunt, *Hertz*; meridiem solem agnum (sole magnum, *V*), ω; meridialem solem agunt, *Hosius*.
[3] Q. *added by* ς, *Macrob.*

---

[1] Fr. 7, Huschke; *Jur. Civ.* iv. 2, Bremer.
[2] Dec. 27th; January at that time had twenty-nine days.
[3] vi. 4.
[4] *Posterioris* is nom. pl. See Varro *De Ling. Lat.* viii. 66.

over, the ceremony and method of taking the auspices point to the same way of reckoning; for the magistrates, whenever they must take the auspices, and transact the business for which they have taken the auspices, on the same day, take the auspices after midnight and transact the business after midday, when the sun is high, and they are then said to have taken the auspices and acted on the same day. Again, when the tribunes of the commons, who are not allowed to be away from Rome for a whole day, leave the city after midnight and return after the first lighting of the lamps on the following day, but before midnight, they are not considered to have been absent for a whole day, since they returned before the completion of the sixth hour of the night, and were in the city of Rome for some part of that day.

I have read that Quintus Mucius, the jurist, also used to say[1] that a woman did not become her own mistress who, after entering upon marriage relations with a man on the day before the Kalends of January, left him, for the purpose of emancipating herself, on the fourth day before the Kalends of the following January;[2] for the period of three nights, during which the *Twelve Tables*[3] provided that a woman must be separated from her husband for the purpose of gaining her independence, could not be completed, since the last[4] six hours of the third night belonged to the next year, which began on the first of January.

Now since I found all the above details about the duration and limits of days, pertaining to the observance and the system of ancient law, in the works of our early writers, I did not doubt that Virgil also derit, non exposite atque aperte, sed, ut hominem decuit poeticas res agentem, recondita et quasi operta veteris ritus significatione:

15 Torquet (inquit) medios nox umida cursus
Et me saevus equis oriens afflavit anhelis.

16 His enim versibus oblique, sicuti dixi, admonere voluit, diem quem Romani "civilem" appellaverunt a sexta noctis hora oriri.

III

De noscendis explorandisque Plauti comoediis, quoniam promisce verae atque falsae nomine eius inscriptae feruntur; atque inibi, quod Plautus in pistrino[1] et Naevius in carcere fabulas scriptitarint.

1 Verum esse comperior quod quosdam bene litteratos homines dicere audivi, qui plerasque Plauti comoedias curiose atque contente lectitarunt, non indicibus Aelii nec Sedigiti nec Claudii nec Aurelii nec Accii nec Manilii super his fabulis quae dicuntur "ambiguae" crediturum, sed ipsi Plauto
2 moribusque ingeni atque linguae eius. Hac enim iudicii norma Varronem quoque usum videmus.
3 Nam praeter illas unam et viginti quae "Varronianae" vocantur, quas idcirco a ceteris segregavit, quoniam dubiosae non erant set consensu omnium Plauti esse censebantur, quasdam item alias probavit

[1] in pistrinum (pistrino, σ), *added in* ς.

[1] *Aen.* v. 738.
[2] *Crediturum* seems an archaism for *credituros*; see i. 7.

indicated the same thing, not directly and openly, but, as became one treating poetic themes, by an indirect and as it were veiled allusion to ancient observance. He says:[1]

For dewy Night has wheeled her way
Far past her middle course; the panting steeds
Of orient Morn breathe pitiless on me.

For in these lines he wished to remind us covertly, as I have said, that the day which the Romans have called "civil" begins after the completion of the sixth hour of the night.

III

On investigating and identifying the comedies of Plautus, since the genuine and the spurious without distinction are said to have been inscribed with his name; and further as to the report that Plautus wrote plays in a bakery and Naevius in prison.

I am convinced of the truth of the statement which I have heard made by men well trained in literature, who have read a great many plays of Plautus with care and attention: namely, that with regard to the so-called "doubtful" plays they would[2] trust, not the lists of Aelius or Sedigitus or Claudius or Aurelius or Accius or Manilius, but Plautus himself and the characteristic features of his manner and diction. Indeed, this is the criterion which we find Varro using. For in addition to those one and twenty known as "Varronian," which he set apart from the rest because they were not questioned but by common consent were attributed to Plautus, he accepted also some others, influenced by the style and humour of their language, which was

necessum est atque in sese colendo non aeque esse
13 parcum. Nam si avaritia sola summa omnes hominis partes affectionesque occupet et si ad incuriam usque corporis grassetur, ut per illam unam neque virtutis neque virium neque corporis neque animi cura adsit, tum denique id vere dici potest effeminando esse et animo et corpori, si[1] qui neque sese neque aliud
14 curent, nisi pecuniam." Tum Favorinus "Aut hoc," inquit, "quod dixisti, probabile est, aut Sallustius odio avaritiae plus quam par fuit[2] eam criminatus est."

II

Quemnam esse natalem diem M. Varro dicat, qui ante noctis horam sextam postve eam nati sunt; atque inibi de temporibus terminisque dierum qui civiles nominantur et usquequaque gentium varie observantur; et praeterea quid Q. Mucius scripserit super ea muliere quae a[3] marito non iure se usurpavisset, quod rationem civilis anni non habuerit.

1 Quaeri solitum est, qui noctis hora tertia quartave sive qua alia nati sunt, uter dies natalis haberi appellarique debeat, isne quem nox ea consecuta
2 est, an qui dies noctem consecutus est. M. Varro in libro *Rerum Humanarum*, quem *De Diebus* scripsit, "homines," inquit, "qui inde a[4] media nocte ad

[1] si, *added by H. J. Müller.*
[2] par fuit, *suggested by Hosius;* potuit, *MSS.*; decuit, *Damsté.*
[3] quae a, *Erbius;* quia, ω.
[4] inde a, *Hertz;* n, ω; ex, *Macr.* i. 2. 3.

[1] The reading of the MSS., *potuit*, might perhaps be supported by such expressions as Catull. lxxvi. 16, *hoc facias, sive id non pote, sive pote.*

other things as well, and cannot be equally niggardly in his care of himself. For if extreme avarice, to the exclusion of everything else, lay hold upon all a man's actions and desires, and if it extend even to neglect of his body, so that because of that one passion he has regard neither for virtue nor physical strength, nor body, nor soul—then, and then only, can that vice truly be said to cause effeminacy both of body and of soul, since such men care neither for themselves nor for anything else except money." Then said Favorinus: "Either what you have said is reasonable, or Sallust, through hatred of avarice, brought against it a heavier charge than he could justify."[1]

II

Which was the birthday, according to Marcus Varro, of those born before the sixth hour of the night, or after it; and in that connection, concerning the duration and limits of the days that are termed "civil" and are reckoned differently all over the world; and in addition, what Quintus Mucius wrote about that woman who claimed freedom from her husband's control illegally, because she had not taken account of the civil year.

It is often inquired which day should be considered and called the birthday of those who are born in the third, the fourth, or any other hour of the night; that is, whether it is the day that preceded, or the day that followed, that night. Marcus Varro, in that book of his *Human Antiquities* which he wrote *On Days*, says:[2] "Persons who are born during the

[2] xiii. Frag. 2, Mirsch.

proximam mediam noctem in his horis viginti quat-
3 tuor nati sunt, uno die nati dicuntur." Quibus verbis ita videtur dierum observationem divisisse, ut qui post solem occasum ante mediam noctem natus sit, is ei dies natalis sit, a quo die ea nox coeperit; contra vero, qui in sex noctis horis posterioribus nascatur, eo die videri natum, qui post eam noctem diluxerit.

4 Athenienses autem aliter observare, idem Varro in eodem libro scripsit, eosque a sole occaso ad solem iterum occidentem omne id medium tempus unum
5 diem esse dicere. Babylonios porro aliter; a sole enim exorto ad exortum eiusdem incipientem[1] totum
6 id spatium unius diei nomine appellare; multos vero in terra Umbria unum et eundem diem esse dicere a meridie ad insequentem meridiem; "quod quidem," inquit, "nimis absurdum est. Nam qui Kalendis hora sexta apud Umbros natus est, dies eius natalis videri debebit et Kalendarum dimidiarum et qui est post Kalendas dies ante horam eius diei sextam."

7 Populum autem Romanum ita, uti Varro dixit, dies singulos adnumerare a media nocte ad mediam
8 proximam, multis argumentis ostenditur. Sacra sunt Romana partim diurna, alia nocturna, sed ea quae inter noctem fiunt diebus addicuntur, non noctibus;
9 quae igitur sex posterioribus noctis horis fiunt, eo die fieri dicuntur qui proximus eam noctem in-

[1] insequentem, *Damsté*.

---

[1] xiii. Frag. 3, Mirsch.

[2] That is, according to the Roman reckoning. By the alleged Umbrian reckoning, the first day of the month would begin at midday and end at the next midday.

twenty-four hours between one midnight and the next midnight are considered to have been born on one and the same day." From these words it appears that he so apportioned the reckoning of the days, that the birthday of one who is born after sunset, but before midnight, is the day after which that night began; but that, on the other hand, one who is born during the last six hours of the night is considered to have been born on the day which dawned after that night.

However, Varro also wrote in that same book[1] that the Athenians reckon differently, and that they regard all the intervening time from one sunset to the next as one single day. That the Babylonians counted still differently; for they called by the name of one day the whole space of time between sunrise and the beginning of the next sunrise; but that in the land of Umbria many said that from midday to the following midday was one and the same day. "But this," he said, "is too absurd. For the birthday of one who is born among the Umbrians at midday on the first of the month will have to be considered as both half of the first day of the month and that part of the second day which comes before midday."[2]

But it is shown by abundant evidence that the Roman people, as Varro said, reckoned each day from midnight to the next midnight. The religious ceremonies of the Romans are performed in part by day, others by night; but those which take place by night are appointed for certain days, not for nights; accordingly, those that take place during the last six hours of the night are said to take place on the day which dawns immediately after that night. More-

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With the complements of
Samuel I. Feigin

THE TETRAGRAMMATON: AN OVERLOOKED INTERPRETATION

WILLIAM A. IRWIN

The problem of the tetragrammaton has been given renewed attention in recent months. In this *Journal*, III (1944), 1–8, Raymond A. Bowman advanced the view that the name is derived from a root meaning "to speak"; and in the *Journal of Biblical Literature*, LVII, 269 ff., Julian Morgenstern adduces the usage of Second Isaiah to show that the word *hû*ʾ was understood as a divine title. In this he was anticipated by Samuel I. Feigin, whose discussion in his *Missitrei Heavar*[1] is such as to merit its being presented to readers who may not have seen it in the Hebrew original. He says (pp. 355 and 430–31):

"The name Yahweh is an imperfect from היה in the ancient form which had *pathaḥ* with the preformative *yod* and *waw* as the second radical instead of the later *yod*. It appears also as the first person אֶהְיֶה when God speaks on his own behalf [Exod. 3:14; Judg. 6:16; Hos. 1:9].

"Perhaps, too, the participial form of the verb היה, namely הוּא [Hûʾ], is used to signify Yahweh.[2] Compare, 'I, I am He [Hûʾ], and

[1] New York: Hebrew Publication Society of Palestine and America, 1943.

[2] [The form is a passive participle with stative meaning. As וַיִּשְׁתַּחַו is contracted to וַיִּשְׁתַּחוּ, so הַוּוּי (later הָוּוּי) was contracted to הוּי and finally הוּא, probably under the influence of the third person pronoun. While הֹוֶה expresses the existence of temporary things (Eccles. 2:22) and הוֹיָה (Exod. 9:3) expresses God's power acting temporarily, the passive form הוּא expresses constant existence which is befitting as an epithet of God. For the passive participle expressing constant action compare *ʾahûzê ḥereb* (Song of Songs 3:8), "constant holders of sword"; *bāṭuaḥ*

there is no god with me' (Deut. 32:39) with the verse in Isaiah, 'I, I am Yahweh, and beside me there is no saviour' (Isa. 43:11). The word Hû᾽ in Deuteronomy means Yahweh. The same meaning attaches to the verse, 'I, I am He [Hû᾽] who wipes out your transgressions for my own sake, and your sins I will not remember' (Isa. 43:25), namely, 'I am Yahweh.' So likewise, 'I, I am He [Hû᾽] who comforts you' (Isa. 51:12), namely, 'I, Yahweh, comfort you.' Also in the verses, 'I, Yahweh, am the first, and with the last I am He [Hû᾽]' (Isa. 41:4), 'I am He [Hû᾽], and none can deliver from my hand' (Isa. 43:13), 'And unto old age I am He [Hû᾽], and unto gray hairs I will carry' (Isa. 46:4), 'I am He [Hû᾽], I am the first, yea I am the last' (Isa. 48:12)—in all these verses one can interpret 'I am Yahweh.' Also the verse, 'For my mouth, it [Hû᾽] has commanded, and his spirit, it [Hû᾽] has gathered them' (Isa. 34:16), which Professor David Yellin explains as an ellipsis for 'His mouth, it has commanded' (*Hiqrê Miqrā᾽* on Isaiah [1939], p. 36) is to be interpreted, 'For the mouth of Yahweh'; Hû᾽ serves in place of Yahweh.

"Also some proper names which end in Hû᾽ are to be explained as compounded of the participle of הוה, standing for Yahweh, and another element. At times Hû᾽ is shortened still further. Compare, for example, Abîhû, son of Aaron, and Abiyahu or Abiyah, king of Judah. Both are one, but in Abîhû the name of God is expressed by the participle of הוה, while in Abiyah the name of God appears in the regular form. The name is to be interpreted as 'Yahweh is my God.' So too, Elîhû (I Chron. 26:7; 27:18), Elîhu᾽ (Job 32:2, 5, 6; 34:1; 36:1; I Sam. 1:1; I Chron. 12:20), and Elijah [᾽Eliyāh and ᾽Eliyahû]: the interpretation of both is 'Yahweh is my God.'

"The name Solomon, too, is to be explained as compounded of Shālôm and Hû᾽, 'Peace of Yahweh,' but the name of Yahweh is written as the participle Hû᾽, which can be shortened to Hû, and, finally, *waw* falls out and only *he* with *mappiq* is left, from which at length the *mappiq* also falls out as if a pronominal suffix were before us. And, indeed, Nathan called Solomon by the name Jedidiah (II Sam. 12:25), for the two names have the same meaning, 'The peace of Yahweh' and 'Beloved of Yahweh.' Compare the names Shelemiah and Shelemiahû, in which the tetragrammaton is preserved in shortened form.

"Sometimes the name is compounded of two divine names. The name Dôdāwāhû (II Chron. 20–37) is compounded of Dôd and Hû, and even the *waw* connecting the two names is preserved. But in the name Dôdô (I Chron. 11:12, 26, etc.) not alone is the *waw* connecting the names lost but also the root Hû is contracted to *ô*, as at the beginning of names Yahû is reduced to Yô.[3]

"The *Dwdh*, mentioned in the stela of Mesha, the *᾽r᾽l* of which Mesha carried into the city of Ataroth and dragged before Chemosh in Keriath (Inscription of Mesha, ll. 12–13), was, it seems, compounded of *Dwd* and an abbreviation of the participle of הוה, signifying Yahweh. We have here a divine name compounded of Dwd and Hû᾽, but each one appearing in its own right. Professor Albright in his latest book, *Archaeology and the Religion of Israel* (1942), explains *᾽r᾽l* as a proper name, Uriel; *Dwdh* he explains as *dodah* with *mappiq*—her *dod*, namely of Ataroth (p. 218, n. 86). But he gives a completely new meaning to the word *dwd;* that it is 'chief.' Against this one may note that the noun does not appear with this meaning anywhere in Hebrew. . . . . Accord-

(Isa. 26:3), "it is constantly trusting"; *haššedûdah* (Pss. 137:8) "the professional robber"; *᾽āṣûr weʿāzûb* (Deut. 32:36) "permanent ruler and helper." The use of intransitive verbs in passive participle to express stative meaning is common in the Mishnah.

For another contraction of ו compare כִּי, "branding," from כְּוִי (Isa. 3:24). For contraction of א compare רִית (Mesha Stone, l. 12) for רְאִיַת "gazing stock." For contraction of ע compare רוּת for רְעוּת "friendship."

For other examples of contraction of ו compare שָׂחוּ, "swim," from *saḥw* (Gesenius-Buhl, 16th ed., p. 781), אָחוּ "pasture" from *᾽aḥw*, which is still found in Aramaic אַחֲוָה (Onqelos Gen. 41:2, 18).

Compare also יְהוּא "it will be" (Eccles. 11:3) for יְהוּ with additional א.—S.I.F.]

[3] [For two deities used as a personal name compare Ì-lí-û-^{d}Šamaš, Ì-lí-û-^{d}Sin, ^{d}Sin-û-^{d}Šamaš (see J. J. Stamm, *Die akkadische Namengebung* [1939], p. 135).—S.I.F.]

ingly it seems preferable to explain ʾrʾl as an object of the cult which stood in the eyes of Mesha for Yahweh, and he dragged it before Chemosh his god. Dwdh, then, is the name of a deity, Dawidhu = Dawid + Hu."[4]

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[4] [*Ibid.* For *hûʾ* as the divine name see James A. Montgomery, "The Hebrew Divine Name and the Personal Pronoun *hū*" (*JBL*, LXIII [1944], 161–63). Professor Montgomery adduces other examples where *hûʾ* stands for Yahweh. The phrase אַה הוּא (II Kings 2:14) is possibly to be read אֵיפֹה הוּא, "Where is Hû," namely, Yahweh. Very instructive is the verse Jer. 5:12, where לֹא הוּא, "there is no Hu," is parallel to denying Yahweh.—S.I.F.] (Montgomery's article appeared since the above was written.—W. A. I.)

THE ORIGIN OF ʾĔLÔH, "GOD," IN HEBREW

SAMUEL I. FEIGIN

As is well known the name *ʾĕlôh*, "God," is explained either as an enlargement of *ʾēl* or as derived from a special root *ʾlh*.[1] It seems to me that we have in *ʾeloh* a compound name of *ʾēl*, "God," and *ʾah* a shortened form for *ʾahyeh*, "I shall be," the designation of Yahweh in the first person (Exod. 3:14; Judg. 6:16; Hos. 1:9). As Yahweh the third person is related to *ʾehyeh*, originally *ʾahweh* the first-person *qal* of the root *hwy*,[2] also *ʾah* abbreviation of *ʾahyeh* in the first person is related to *yāh* shortened form of Yahweh in the third person.[3] The *ʾa* which was lost in the combination is recompensated by lengthening the vowel *â*, as the lost *aʾ* is recompensated by lengthening the preceding vowel in syllables ending with ʾ. Thus *baraʾ* became *barâ*, "he created"; *raʾš*, "head," became *râšim*, "heads," finally *rôš;* and *yaʾmar*, "he will say," becomes **yâmar*, finally *yômar*, so also *ʾelaʾh* became *ʾelâh*.

The form *ʾelâh* is preserved in Aramaic and in Hebrew becomes, as usual, *ʾelôh*. In cuneiform both forms are preserved *ilaḫi* and *iluḫa*.[1]

For such a combination of deities compare Dwdh,[4] namely, Dawid + Hu.[5] In the same region is found also Ishtar-Kemosh.[6] It is interesting to note that in both cases the other element precedes the element of the national deity, Ishtar before Kemosh, Dawid before Hû = Yahweh. Moreover, both may have some connection with the deity of love, Ishtar being the well-known deity of love in Babylonia and the West, and Dawid, judging from the name *dôd*, means love also.

Whether Dwdh was regarded as a separate deity or was only a manifestation of Yahweh as god of fertility is hard to decide.

The two elements of *ʾel* and *ʾah*, of which the name *ʾelâh* = *ʾelôh* is compounded, may have been originally two special deities, *ʾel* being the deity of earth and *ʾah* = Yahweh the deity of heaven and the national deity of the Hebrews in general and of Israelites in particular.[7] But Professor G. Cameron pointed out to me that *ʾēl* may have been a kind of determinative "god" in general and has no specific designation as "god of the earth."

The singular *ʾĕlôh*, pronounced *ʾĕlôah*, is used in plural form *ʾĕlôhîm*, originally "gods," but later "God" in the singular. This interchange between "god" and "gods" to designate the same divinity was found also in the old period in ilAmurru, "the god Amurru" and ilîAmurru (DINGIR.DINGIR.MAR.TU). Also, *Baʿal* appears as *Beʿālîm*, *ʿAshtōreth* as *ʿAshtārôth*, *ʿAnath* as *ʿAnāthôth*, the manifestations of the deity in various places and in various functions.[8]

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[1] See Gesenius-Buhl, *Hebräisches und aramäisches Handwörterbuch* (16th ed.; 1915), p. 39.

[2] See *Missitrei Heavar*, p. 355, and above, p. 257. The origin of it is "I shall be with you," as is explained in Exod. 3:12.

[3] For *yâh* being shortened from Yahweh see Gesenius-Buhl, *op. cit.*, p. 289.

[4] Mesha Inscription, l. 12.

[5] See *Missitrei Heavar*, pp. 430–31, and also above, p. 258. Professor Irwin calls my attention to the compound deity *ʿntyhw* (A. Cowley, *Aramaic Papyri of the Fifth Century* [1923], No. 44:3).

[6] Mesha Inscription, l. 17.

[7] Cf. the interesting article of Professor G. Levi della Vida, "*El ʿelyon* in Genesis 14:18–20," *JBL*, LXIII (1944), 1–9.

[8] Cf. W. F. Albright, *From the Stone Age to Christianity* (1940), p. 161.

(no author indicated)

Tractate concerning the consecration of the Calendar, and concerning the ~~[illegible]~~ method of Intercalation –

(no pub. or date)

Grace E. Amadon

Should begin with Chapter 12

id tute facias ipse licet: Itémque si cursum medium dierum viginti, triginta, quadraginta, usque ad centesimum cupias notari characteribus. Explicata enim atque explorata ratio est, ubi cursum medium unius diei notum habeas. Consentaneum est autem illud cognitum & comprehensum animo habere, medius ille solis motûs quid intervalli perlustret novem & viginti dierum spatio, quid trecentis & quatuor supra quinquaginta diebus, quibus efficitur annus ille lunaris, cujus sunt ordine dispositi menses, qui annus adeo ordinatus dicitur. Hos enim cursus medios qui ritè cognorit, is facilè rationes illas perceperit, ex quibus dilucidè perspiciatur, luna nova quando se aperiat. Nam à nocte mensis ea, qua primùm luna nova se aperit, ad proximi mensis illam noctem qua rursus aperiatur luna nova, dies toti intercedunt viginti novem.

Nec omnino contingit unquam, ut plures, paucioréfve intersint dies solidi. Atqui hoc unum est, quod hisce rationibus quærimus, luna videlicet nascens quando primùm aperiatur. Tum ex quo certa quædam luna nova hoc anno apperiatur, usque dum anno vertente luna nova aperiatur eadem, aut abit omnino tempus id, quod annum diximus ordinatum, aut uno die plus: atque eadem est annorum omnium ratio. Cursus igitur solis iste medius novem & viginti diebus perlustrat duodetriginta gradus, partes quinque & triginta, & secundam unam: character est 28. 35. 1. anno autem ordinato trecentos & quadraginta octo gradus, partes quinque & quinquaginta, atque decem & quinque secundas: character est 348. 55. 15.

Solis in orbe sic, ut in reliquorum circulis planetarum, punctum est certum, quò cum planeta commearit, tam est remotus à terris, quàm cùm maximé. Et tanquam id, quod est in solis orbe, punctum, ita quod in cæteris planetarum (luna tamen excipitur) orbibus inest, æquabiliter movetur, atque annis septuaginta unum ferè gradum conficit. Atqui hoc punctum, quod idem solis altitudo nominatur, diebus decem semper unam & dimidiatam secundam conficit, quæ dimidia tertiæ sunt triginta: diebus centum secundas quindecim: mille dierum partes duas, & secundas triginta: decem millibus dierum conficit quinque & viginti partes. Ex quo intelligitur idem punctum diebus viginti novem perlustrare secundas quatuor &

eo

eo amplius: & anno illo ordinato ſecundas tres ſupra quinquaginta: Dictum à nobis ante eſt, hujuſce ratiocinii ſtirpem repeti ab ineunte nocte quinta hebdomadæ, & eadem tertia menſis Niſan, anni videlicet quater milleſimi, nongenteſimi, triceſimi octavi poſt conſtitutum mundum. Ad hujus ratiocinii principium iſtud confecerat motio ſolis media gradus ſeptenos, ternas partes, atque duas & triginta ſecundas ex ariete: character eſt 7. 3. 32. & hæc ſolis altitudo quæ vocatur, ſex & viginti gradus, inſuper partes quinque & quadraginta, & octo ſecundas è geminis: character eſt 26. 45. 8. Ergo ſi quando libeat ſcire ſol ubi ſit ſecundum motum medium, primò numerum dierum, qui à principio hujus ratiocinii uſque ad id tempus præterierint, notum eſſe neceſſe eſt, & converſionem ſolis mediam his diebus confectam, quam ex iis, quæ poſui, ſignis cognoſci licet, ſic addere ad ſtirpem hujus computationis, ut ſuo quæque partium genera generi conjungantur. Nam ubi converſionis ejus erit terminus, ibi tunc temporis ſol ex curſu medio locum habebit. Placet autem rei adjungere exemplum. Si quæreretur, ubinam ex medio curſu ſol eſſet in anno primo hujus computationis, ineunte nocte ſabbati, qui dies erat decimus & quartus menſis Tamuz, ſiquidem ab ſtirpe ad principium ejus diei, quo quæritur locus ſolis, intercedebant dies centum, curſus ſolis medius his centum diebus definitus ſumeretur, oporteret, nempe gradus octo & nonaginta, tres ſupra triginta partes, & ſecundæ tres & quinquaginta: quæ adderentur ad gradus ſeptenos, partes ternas, duas & triginta ſecundas Arietis, ubi ſol erat initio hujus computationis. Ex quibus una collectis ſumma fieret centum & quinque graduum, partium ſeptem & triginta, & ſecundarum viginti quinque: character eſt 105. 37. 25. Itaque prima illa nocte ſabbatica ſol ex medio curſu in Cancro exiſtebat, in ſeptima & triceſima parte gradus decimi & ſexti. Quòd autem quotidianus ſolis curſus medius interdum prima nocte ipſa determinetur, interdum ante ſolis occaſum horâ unâ, nonnunquam etiam tantundem poſt ſolis obitum, id omnino in exponendo motu ſolis, quatenus ad lunæ rationem pertinet, ne attingimus quidem. At in explicando medio lunæ curſu locus ille ſtudioſè tractabitur. Atque hujus motus inveſtigandi ratio ſemper eſt eadem. nam

nam & mille post annos si subducendis & addendis spatiis excursis reliquorum summa fiat, eámque adjungas ad eum locum, quem sol secundum motum medium obtinebat in principio hujus ratiocinii, certò cognoscas ubinam sol tum motu illo medio feratur. Idem de lunæ motione media dicendum: idémque de cujusque stellæ. Cùm ejus quotidianam motionem mediam cognoveris quanta sit, sciásque motionis ejus principium unde ducatur, post annos, aut dies tot, quot libuerit, certò comperias ea ubi feratur motione illa media, si cursum medium hisce diebus aut annis confectum adjicias ad illum locum, qui stellæ erat ab initio. Eadem ratio in illa altitudine solis est. Si ad eum, ubi initio erat altitudo solis, locum addas & spatium diebus aut annis præteritis confectum, quovis die solis ubi sit altitudo reperias. Si quis autem primum alicujus cycli aut sæculi annum malit esse hujus computationis caput, quàm eum annum, qui fuit à nobis propositus, datur illi eligendi optio. Atque caput istuc sive id antecedat, sive multis annis subsequatur hoc, quod est à nobis, perspicuum est quid oporteat fieri. Namque explicatum est, quem cursum sol definiat ordinato anno toto, quem diebus novem & viginti, quem denique die uno. Demonstratum est etiam annum, cujus sint pleni menses, uno die esse longiorem eo, qui ordinatus nominatur: annum autem illum, qui completur mensibus cavis, uno die minorem esse, quàm ordinatum. Jam de anno intercalari, illum, si menses ejus sint ordine dispositi, majorem esse anno communi & eodem ordinato diebus triginta: sin autem illius sint pleni menses, fore, ut ordinatum annum communem superet diebus uno & triginta: cùm verò habeat menses cavos, eundem novem & viginti diebus esse majorem anno illo ordinato. Quibus rebus perspectis & cognitis, facile est solis investigare ac consesequi cursum medium in quot visum fuerit dies aut annos: quem cùm addideris ad id, unde nos hujus ratiocinii stirpem repetiimus, cursum medium solis cognoveris ad quem volueris annum & diem stirpem nostram subsequentem, quem tu diem feceris computationis principium. Hunc autem si detraxeris huic eidem, unde nos computationis duximus initium, medium solis cursum compertum habueris in quem libuerit aut annum, aut diem stirpem nostram antecedentem, à quo tu die

exordium

exordium computationis ceperis. Et quæ in medio curſu ſolis, eadem eſt tenenda ratio in lunæ ac reliquorum notorum ſiderum motu medio. Ac de ſolis quidem medio curſu quærendo cùm in diem venientem, tum in præteritum ſatis dictum eſt.

CAPUT DECIMUM ET TERTIUM.

Ut in quemvis diem verus ſolis curſus inveſtigari poſſit? Namque indidem & veram cardinum anni commiſſionem cognoſci.

§. I. SEquitur, ut agamus de ſolis curſu vero: hunc quovis die tibi cognitum eſſe velis, primùm in diem eundem ità, ut expoſuimus, ſolis inveſtiges curſum medium: deinde ſolis etiam altitudinem: tum hanc ſubducas è medio ſolis curſu, ex quo quod reliquum fuerit, id *propria ſolis via* dicitur.

§. II. Porrò videndum eſt hæc *propria ſolis via* quot ſit graduum. Nam ſi pauciorum eſt, quàm centum & octoginta, è confecto medio ſolis curſu ſubducenda eſt etiam hujus *propriæ viæ* portio: ſin autem plurium eſt, uſque dum trecentorum & ſexaginta ſit graduum, ad ſolis confectum curſum medium portio hujus viæ propriæ addatur, neceſſe eſt. Quibus ita ſubductis aut additis, inde quod erit, ſolis erit curſus verus.

§. III. Tenendum eſt autem hanc ſolis viam propriam, cùm ſit aut ipſorum centum & octoginta, aut trecentorum & ſexaginta graduum, portione tum omnino carere, atque ſolis eundem eſſe curſum verum, & medium.

§. IV. At propriæ hujuſce viæ portio quænam eſt illa tandem? Nimirum ſi gradus occupat decem, portio ejus eſt viginti partes: ſi occupat viginti, portio eſt partes quadragenæ: ſi triginta, portio eſt partes octo & quinquaginta: ſi quadraginta, pro portione debetur gradus unus, & partes quindecim: ſi quinquaginta, gradus unus, & novem & viginti partes pro portione debentur: ſi ſexaginta, portio erit gradus unus, & partes una & quadraginta: ſi ſeptuaginta, erit portio gradus unus, atque una & quinquaginta partes: ſi octoginta, portio erit gradus unus, & partes septem & quinquaginta: si nonaginta, portio erit gradus unus, & undesexaginta partes: si centum, gradus unus, & octo ac quinquaginta partes erit portio: si centum & decem, portio gradus unus erit, & partes tres ac quinquaginta: si centum & viginti, portio gradus unus, ac quinque & quadraginta partes erit: si centum & triginta, portio gradus item unus erit, atque partes tres & triginta: si centum & quadraginta, erit portio gradus unus, & partes undeviginti: si centum & quinquaginta, portio gradus unus, & una pars erit: si centum & sexaginta, portio erit duæ & quadraginta partes: si centum & septuaginta, portio erit partes viginti una: sin autem centum & octoginta ipsos occupat gradus, portio, sicut docuimus, erit omnino nulla: sed cursus medius solis erit idem, atque verus.

§. V. Cùm verò via ista propria sit longior gradibus centum & octoginta, tum illius longitudo tota detrahetur è trecentis & sexaginta gradibus, atque ejus portio cognoscetur: ut si ista propria via graduum sit ducentorum, hos è trecentis & sexaginta subduci gradibus oporteat, unde reliqui fiant gradus centum & sexaginta, quorum, ut ante diximus, portio est partes duæ & quadraginta: eadem est igitur & ducentorum graduum portio.

§. VI. Similiter sit propria via ista trecentorum graduum, hi subducentur de gradibus trecentis & sexaginta: restabunt sexaginta, quorum quidem jam cognovisti portionem esse gradum unum, & unam & quadraginta partes, quæ eadem trecentorum etiam est portio graduum. Eadem est ratio in reliquis numeris tenenda.

§. VII. Jam si via illa propria quinque & sexaginta sit graduum, quoniam portio sexaginta graduum gradus est unus, & una & quadraginta partes: septuaginta verò graduum portio est gradus unus & una & quinquaginta partes: tum illæ portiones duæ differunt inter se partibus decem, consequens est, ut unusquisque gradus pro rata portione partem unam habeat: ex quo id efficitur, portionem propriæ viæ ejus, quæ gradus obtinet quinque & sexaginta, esse gradum unum, & partes sex & quadraginta.

§. VIII. Ergo illius, quæ gradus obtineat septem & sexaginta, propriæ viæ portio erit gradus unus, & partes octo & quadra-

quadraginta. Atque idem erit modus servandus in omni ejusmodi via, cùm graduum decadibus unitates erunt adjuncti, cùm in solis, tum in ratione lunæ.

§. IX. Harum rerum exemplum ejusmodi ponatur. Si quis solis investiget cursum verum qualis esset primo nostro ratiocinii hujus anno, prima nocte sabbatica, quæ erat quarta decima mensis Tamuz, priùs idem quærat qualis esset tum cursus solis medius, quem cùm, sicut ostendimus, compererit centum & quinque graduum fuisse, partiùmque septem & triginta, ac quinque & viginti secundarum, solis etiam quærat altitudinem: nempe reperietur ea fuisse sex & octoginta graduum, partium quinque & quadraginta, & secundarum trium & viginti: tum subducat hanc altitudinem ex solis cursu medio, relinquetur via duodeviginti graduum, partium duarum & quinquaginta, & duarum etiam secundarum: character est 18. 52. 2. Verùm in omni hujusmodi via nunquam partium habetur ratio, cùm sint pauciores quàm triginta: & triginta si colligantur, vel plures, pro gradu uno putantur, ísque cæteris viæ gradibus additur: qua ratione via hæc erit graduum undeviginti: unde fit, ut illius sit portio sic, ut diximus, partes duodequadraginta.

§. X. Atque hæc via cùm sit minor gradibus centum & octoginta, nimirum oportet partes duodequadraginta portionem ejus ex solis medio cursu detrahi. Itaque ex eodem relinquentur gradus centum & quatuor, undesexaginta partes, & secundæ viginti quinque: character est 104. 59. 25. Ergo prima illa nocte sabbatica verus solis cursus è Cancro confecerat gradus quindecim, quinque & triginta secundis minus: sed & in exquirendo solis & lunæ cursu vero, & in reliquis calculis ad eorum cognitionem ducentibus habenda ratio est non secundarum, sed partium: nisi secundas ferè triginta colligas, quæ pro parte una sunt ducendæ, atque in earum ponendæ numero.

§. XI. Solis igitur cùm liceat cursum verum cognoscere qualis sit quolibet tempore, facile est quorumcunque anni cardinum investigare horam ipsam sive subsequentium stirpem hanc, ex qua nos exordium hujus ratiocinii duximus, sive multis annis antecedentium.

CAPUT DECIMUM ET QUARTUM.

Lunæ medios cursus esse duos: nam ipsam in exiguo quodam orbe ferri, & exiguum hunc in majori orbe orbem converti: conversionem exigui orbis vocari lunæ cursum medium. Quantum hic cursus medius spatii conficiat uno die, diebus decem, diebus undetriginta, diebus centum, anno illo ordinato qui dicitur, diebus item mille, & decem millibus dierum? Et alterum viæ cursum medium nuncupari: quantum spatii perlustret & iste his definitis temporibus? Qualis esset cursus lunæ medius ad epocham hujus ratiocinii? Et quis esset tum viæ cursus medius? Nam his cognitis in quemvis diem cursum lunæ medium facile cognosci proinde, ac solis.

§. I. LUNA medios cursus definit duos. Nam ipsa exiguo in orbe convertitur, qui quidem orbis non globum terrenum complexu suo coercet & continet omnem, ejusque in eo orbe cursus medius, viæ cursus medius esse dicitur. exiguus enim hic orbis & ipse movetur etiam in orbe majore, qui terram complectitur totam. Atque hujus orbis exigui majorem illum circulum conficientis motio media ea est, quam lunæ medium cursum vocitent. Hic igitur lunæ cursus medius singulis diebus conficit gradus decem & tres, atque decem partes, & secundas quinque & triginta: character est 13. 10. 35.

§. II. Igitur diebus decem conficit centum atque unum & triginta gradus, partes quinque & quadraginta, quinquaginta secundas: character est 131. 45. 50. Ita diebus centum id spatii conficit, ut ex eo si subducantur, quoad ejus fieri possit, gradus trecenti & sexaginta, restent septem gradus, & triginta, & ducenti, partes duodequadraginta, tres & viginti secundæ: character est 237. 38. 23. Quod igitur spatium conficit mille dierum, ex eo si similis fiat detractio, remanebunt gradus quidem ducenti decem & sex; partes verò tres supra viginti, & secundæ quinquaginta: character est 216. 23. 50. Itaque si fiat detractio hæc eadem ex spatio decem millibus

bus dierum confecto, supererunt gradus tres, * tres & quinquaginta partes, secundæ viginti: character est 3. 53. 20. Jam si fiat detractio eadem ex spatio, quod novem & viginti diebus conficit, superabunt duo & viginti gradus, partes sex, & quinquaginta sex secundæ: character est 22. 6. 56. Et quod anno illo ordinato conficit spatium, ejus, cùm fuerit facta detractio, reliquiæ erunt gradus trecenti ac quatuor & quadraginta, partes sex & viginti, secundæ tres & quadraginta: character est 344. 26. 43. Similis est reliquorum numerorum ratio.

§. III. Jam viæ cursus medius uno die conficit decem & tres gradus, atque tres partes, ac secundas quatuor & quinquaginta: character est 13. 3. 54. decem verò diebus centum & triginta gradus, partes undequadraginta, secundis omnino nullis adjunctis: character est 130. 39. diebus igitur centum id spatium percurrit, ex quo si subducuntur, quoad fieri possit, gradus trecenti & sexaginta, supererunt ducenti & sex supra viginti gradus, partes novem & viginti, tres & quinquaginta secundæ: character est 226. 29. 53. Idem si fiat in spatio per mille dierum confecto, superabunt gradus centum & quatuor, octo & quinquaginta partes, & secundæ quinquaginta: character est 104. 58. 50. similiter si fiat in spatio decem millibus dierum confecto, gradus trecenti & viginti novem, partes duodequinquaginta, secundæ viginti erunt reliquæ: character est 329. 48. 20. Idémque si fiat in spatio per viginti novem dies confecto, remanebunt gradus duodeviginti, partes tres & quinquaginta, secundæ quatuor: character est 18. 53. 4.

§. IV. Quod si similiter facias in spatio, quod idem cursus anno conficit ordinato, reliqui gradus trecenti quinque erunt, decem & tres secundæ, nullis adjunctis partibus: character est 305. 13. Atque ineunte quinta hebdomadæ nocte illa, quod secundum nos quidem harum rationum caput est, lunæ cursus medius perlustraverat gradum unum, partes decem & quatuor, atque secundas quadraginta tres è Tauro; character est 1. 14. 43. Eadem hora viæ cursus medius gradus lustraverat

§. II. *Tres & quinquaginta.* Omnes editiones habent octo & quinquaginta: sed numerus conveniens est *tres.*

rat quatuor & octoginta, duodetriginta partes, & quadraginta duas secundas: character est 84. 28. 42. Ut autem medium lunæ cursum cognoveris, & noveris is qualis fuerit id temporis, à quo ratiocinii ducitur exordium, cui cursum medium postea confectum oportet addi, sanè quovis die lunæ cursus medius qui sit, scire licet eadem ratione ac via, qua solis ipsius. Ac cùm pervestigaris ac cognoveris qui sit lunæ cursus medius prima nocte, tum etiam animum advertas ad solem, ut in quo sit signo teneas.

§. V. Nam ex quo sol discedit à mediis Piscibus, usque dum ad medium Arietem pervenerit, lunæ cursum medium sic, ut est, reliqueris: dum autem ab Ariete medio commearit ad ingressionem Geminorum, addendæ sunt ad lunæ cursum medium quindecim partes: dum ab introitu Geminorum ad Leonis commearit introitum idem addes: dum ab introitu Leonis ad mediam Virginem feratur, addes tantundem: dum à media Virgine ad dimidiam Libram volvitur, rursus lunæ cursum medium relinques ita, ut est: dum verò à dimidia Libra ad Sagittarii volvitur introitum, oportet ex lunæ cursu medio quindecim partes eximi; dum ab Sagittarii fertur introitu ad ingressionem Aquarii, oportet medio è lunæ cursu partes eximi triginta: & dum ab ingressione Aquarii ad dimidios Pisces fertur, oportet quindecim eximi partes è lunæ cursu medio.

§. VI. Postquam autem lunæ cursum medium ita vel auxeris, vel minueris, vel in suo statu conservaris, eum habueris ut est eo die, in quem inquiris, tertia fere horæ parte post solis obitum. Hinc illum dicunt esse cursum lunæ medium ad horam contemplandæ lunæ.

CAPUT

CAPUT DECIMUM ET QUINTUM.

De investigando lunæ cursu vero.

§. I. SI quis igitur quo libuerit die lunæ cursum verum scire expetit qui sit, primùm quærat eodem illo die sub horam contemplandæ lunæ qualis ejusdem sit cursus medius; item & qualis sit viæ cursus medius: tum etiam solis cursus medius quis sit id temporis: postea solis cursum medium è medio lunæ cursu subducat, & quod superaverit, duplicet. Atque id à duplicando *distantia duplicata* nominatur.

§. II. Quas verò rationes capitibus istis complector, his ego, sicut jam demonstravi, nihil aliud effici volo, nisi ut lunæ ratio exploratè cognoscatur. Hæc igitur *duplicata distantia* nunquam fieri potest, ut qua nocte luna se aperiat, atque oculis percipi possit, aut graduum sit pauciorum quinque, aut plurium, quàm duorum & sexaginta.

§. III. Quæ cùm ita sint, animum adverteris ad duplicatam hanc distantiam. Nam si graduum est omnino quinque, aut aliquanto major, nihil prorsus addi necesse est: verùm ut gradus obtinet sex, quoad compleat undecim, ad medium illum viæ cursum adjungi gradum unum opus est: ut enim gradus obtinet duodecim, quoad compleat duodeviginti, ad medium illum viæ cursum binos oportet addi gradus: ut est graduum undeviginti, quoad compleat quatuor & viginti, ad ejusdem viæ cursum medium additos oportet gradus tres: ut est viginti quinque graduum, quoad compleat unum & triginta, ad eundem viæ cursum medium gradus addentur quatuor: ut est duorum & triginta, quoad compleat duodequadraginta, ad eundem viæ cursum medium oportet addi gradus quinque: ut est undequadraginta, quoad compleat quinque & quadraginta, ad ejusdem viæ cursum medium sex oportet addi gradus: ut est graduum sex & quadraginta, quoad compleat unum & quinquaginta, ad viæ cursum medium septem oportet addi gradus: ut est duorum & quinquaginta, quoad compleat undesexaginta, ad viæ cursum medium gradus oportet addantur octo: ut est sex-

ſexagenorum, quoad tres & ſexaginta compleat, ad viæ curſum medium gradus novem addantur, neceſſe eſt. Atque hiſce gradibus cùm eſt amplificatus viæ curſus medius, tum *concinna via* dicitur.

§. IV. Tum verò videndum eſt, via illa concinna quem graduum numerum contineat. etenim ea cùm habeat pauciores, quàm centum & octoginta gradus, ejus quidem portio de lunæ curſu medio, ut eſt ſub horam contemplandæ lunæ, ſubducenda eſt: Contrà ſi hos magnitudine ſuperet, quoad compleat gradus trecentos & ſexaginta, portio ejus eſt addenda medium ad lunæ curſum, eum, qui eſt ſub horam contemplandæ lunæ: Quo vel addito, vel detracto lunæ medio curſui, curſus exiſtet lunæ verus, is qui erit ſub horam contemplandæ lunæ.

§. V. Atenim via concinna cùm aut centum & octoginta, aut trecentorum & ſexaginta ipſorum ſit graduum, tum quidem ejus portio nulla eſt: ſed ſub horam contemplandæ lunæ * ut curſus medius, ita lunæ curſus verus ſeſe habet.

§. VI. Sed hæc concinna via quam portionem habet tandem? Nimirum ſi graduum eſt denûm, pro portione quinquaginta partes habet: ſi graduum eſt viginti, portio ejus eſt gradus unus, & duodequadraginta partes: ſi graduum eſt triginta, portio ejus eſt gradus duo, & quatuor atque viginti partes: ſi graduum eſt quadraginta, portio ejus gradus erunt tres, & partes ſex: ſi graduum eſt quinquaginta, portio ejus tres erunt gradus, & partes quadraginta quatuor: ſi ſexaginta ſit graduum, portio ſit gradus quatuor, & partes decem & ſex: ſi ſit ſeptuaginta graduum, erit portio gradus quatuor, atque partes una & quadraginta: ſi ſit octoginta graduum, portio erit quinque gradus: ſi nonaginta ſit graduum, portio erit quinque gradus, & totidem partes: ſi centum eſt graduum, portio ſunt quinque gradus, & partes octo: ſi graduum eſt centum & decem, portio ſunt gradus quatuor, & partes undeſexaginta: ſi centum

§. V. *Ut curſus medius.* In editione ſuperiori extat אלא אם יהיה מקום: in poſteriori autem editione correctè legitur אלא יהיה מקום:

§. VI.

centum & viginti ſit graduum, *portio erit gradus quatuor, & quadraginta partes: ſi centum & triginta graduum eſt, portio ſit gradus quatuor, & partes undecim: ſi graduum eſt centum & quadraginta, portio eſt tres gradus, & partes tres ſupra triginta: ſi centum & quinquaginta graduum eſt, *portio erit gradus duo, & partes duodequinquaginta: ſi centum & ſexaginta ſit graduum, portio gradus unus erit, & partes ſex & quinquaginta: ſi centum & ſeptuaginta ſit graduum, * erit portio quaſi gradus unus, partes videlicet undeſexaginta: ſi ſit centum & octoginta ſtrictè graduum, portio erit, ut ante dixi, nulla: ſed verus lunæ curſus idem erit, qui medius.

§. VII. Jam ſi via concinna ſpatio centum & octoginta graduum ſit major, tum illam de gradibus trecentis & ſexaginta detraxeris, & ejus portionem noveris quæ ſit, item, ut in via ſolis. Atque eadem illa via concinna ſi graduum decadibus adjunctas habeat unitates, unitatum portiones colligentur ex eo, quod duas inter decadum portiones interſit, diſcrimine. Namque portionum ratio in via concinna eſt eadem, quæ in via ſolis.

§. VIII. Quærat igitur aliquis curſum lunæ verum quis eſſet ineunte nocte ſexta hebdomadæ, menſis Jar ſecunda, præſente hoc anno, qui hujus ratiocinii caput eſt; omnino ab ineunte hujus ratiocinii nocte principe ad ejus, in quam lunæ motus verus exquiritur, noctis initium, ipſi dies ſunt novem ſupra viginti: primùm igitur curſus medius ſolis inveſtigetur, quis tum eſſet: prodibit enim quinque & triginta graduum, partium duodequadraginta, atque trium & triginta ſecundarum: character eſt 35. 38. 33. Deinde verò ſub horam contemplandæ lunæ quis id temporis eſſet lunæ curſus medius? is autem erat tunc ipſum graduum trium & quinquaginta, partium ſex & triginta, & ſecundarum undequadraginta: character

§. VI. *Portio erit gradus quatuor, & quadraginta partes.* Hæc eſt lectio editionis ſuperioris, & ea veritati conſentanea: nam in editione recentiori mendosè legitur, *& viginti partes.*

Portio erit gradus duo. In omnibus editionibus, quas mihi videre contigit, legitur hîc *gradus tres*; ſed mendosé: nam æquabilis, conſtans, & rata portionum ratio poſtulat *gradus duo.*

Erit portio quaſi gradus unus, &c. Hic enunciatio noſtri ſcriptoris eſt ſic ſatis ambigua: docet autem ratio portionum nullum gradum integrum; ſed omnino partes undeſexaginta tum ei pro rata portione fore.

ter est 53. 36. 39. Tum etiam viæ cursus medius qualis esset? scilicet ille tunc erat centum & trium graduum, unius & viginti partium, & secundarum sex & quadraginta: quorum character est 103. 21. 46. Postea solis cursum medium de medio lunæ cursu detrahat: ita reliqui fient decem & septem gradus, duodesexaginta partes, & secundæ sex: quod spatium cùm duplicaverit, habebit scilicet distantiam duplicatam triginta quinque graduum, sex & quinquaginta partium, & secundarum duodecim: quorum character est 35. 56. 12. Igitur ad viæ cursum medium, adjungenda est, ut exposui, portio quinque graduum: unde prodibit * via concinna centum & octo graduum, atque unius & viginti partium: partes autem in hujusmodi via, quemadmodum in explicando motu solis docuimus, nihil omnino curantur.

§. IX. Postremò, quærendum est de portione viæ concinnæ, quæ cùm esset centum & octo graduum, portio ejus sit quinque gradus, & una pars: Quoniam verò via concinna pauciorum erat, quàm centum & octoginta graduum, quinque gradus, & partem unam portionem ejus oportet de medio cursu lunæ detrahi: Itaque supererunt in eo cursu gradus duodequinquaginta, partes triginta quinque, & secundæ undequadraginta, quod pro parte perfecta habendum, & reliquis partibus annumerandum erit. Ergo cursus lunæ verus ad horam illam lustraverat è signo Tauri gradus duodeviginti, & triginta sex ex undevigesimo gradu partes: character est 18. 36. Eadem ratione sub quamlibet horam contemplandæ lunæ quis sit cursus lunæ verus investigaveris, atque id usque ab ineunte præsente anno, qui est nostri ratiocinii princeps ad infinitum tempus.

CAPUT

§. VIII. *Via concinna centum & octo graduum.* In superiori editione mendosè hic legitur *centum & octoginta*: in inferiori verò editione legitur emendatè *centum & octo*: quanquam & in illa ipsa editione superiori mendum hoc corrigitur initio articuli sequentis.

CAPUT DECIMUM ET SEXTUM.

Lunæ latitudo quid, qualis, ubi, quanta ſit, & quomodo cognoſci poſſit? Etenim lunæ latitudinem interdum eſſe nullam.

§. I. QUEM orbem curſus lunæ ſempiternus conficit, is ab eo, quem ſol perpetuò luſtrat, ſic eſt inflexus, ut ejus dimidia pars altera in ſeptentrionem, altera vergat in meridiem. Sed in eo puncta ſunt duo, alterum alterius è regione, ubi hi circuli duo ſeſe contingant. Atque luna in horum uno cùm exiſtit, in ſolis orbe convertitur, atque adeo ipſi ſoli exadverſum eſt: verùm ab alterutro cùm diſcedit, vel in ſeptentrionem fertur, vel in meridiem. Punctum autem, unde luna curſum ſuum inflectere cœpit ad ſeptentriones, id nominatur *Caput*, & id, ex quo ad meridiem declinat, *Caudam* nuncupant. Ac punctum illud *Caput* quod dicitur, motum habet certum & æquabilem, nullàque fit unquam in ipſius motu neque acceſſio, neque deceſſio. Id ſignorum orbem conficit retrò contrario motu, atque ſol. nam ab Ariete ad Piſces, & ad Aquarium à Piſcibus convertitur: ſimilis eſt ejus deinceps converſio.

§. II. Hujus igitur *Capitis* curſus medius uno die conficit tres partes, & ſecundas undecim: diebus igitur decem unam & triginta partes, & ſecundas ſeptem & quadraginta: diebus centum gradus quinque, partes decem & ſeptem, atque ſecundas tres & quadraginta: character eſt 5. 17. 43. dierum verò mille, gradus duos & quinquaginta, partes quinquaginta ſeptem, & ſecundas decem: character eſt 52. 57. 10. Unde fit, ut ſi ex eo, quod decem millibus dierum conficit, ſpatio ſubducas, quoad fieri poſſit, trecentos & ſexaginta gradus, reliqui fiant gradus centum & ſexaginta novem, una & triginta partes, & ſecundæ quadraginta: character eſt 169. 31. 40. Jam diebus novem & viginti conficit gradum unum, partes duas & triginta, & ſecundas novem: character eſt 1. 32. 9. & anno ordinato gradus duodeviginti, partes quatuor & quadraginta, ſecundas duas & quadraginta: character eſt 18. 44. 42. Idem hic

hic *Capitis* cursus medius ineunte illa nocte quinta hebdomadæ, quæ stirps est hujus ratiocinii, graduum erat centum & octoginta, partium septem & quinquaginta, & secundarum duodetriginta: character est 180. 57. 28.

§. III. In quamcunque horam scire velis Caput id quem definiverit cursum verum, oportet in eandem horam ejusdem cursum medium pervestiges itidem, ut in ratione solis & lunæ: tum ut ejus cursum medium detrahas de gradibus trecentis & sexaginta: Quod enim spatii reliquum erit, is erit ad horam illam cursus verus *Capitis*, cujus è regione *Cauda* semper erit.

§. IV. Si quis exempli causâ quærat Capitis hujus quis esset cursus verus ineunte sexta nocte hebdomadæ, quam consequebatur dies mensis Jar secundus eo anno, qui est hujus ratiocinii stirps: Omnino ab initio noctis ejus, quæ hujus ratiocinii princeps est, usque ad primam illam noctem, qua de quæritur, dies sunt viginti novem.

§. V. Capitis igitur hisce diebus confectum cursum medium investigabit eo, quo scit, modo: qui cùm fuerit additus ei, quem idem Caput jam definierat ineunte illa hujus ratiocinii principe nocte, cognoscet cursum medium Capitis esse duorum graduum, & octoginta, & centum, partium novem & viginti, & secundarum septem & triginta: character est 182. 29. 37. Postea verò numerum hunc subducet è gradibus trecentis & sexaginta. Itaque reliqui erunt septem gradus & septuaginta & centum, partes triginta, & secundæ tres & viginti: character est 177. 30. 23. Hic omnino Capitis erat tum cursus verus: verùm secundarum nulla est ducenda ratio. Ex quo fit, ut id temporis Caput statuatur è signo Virginis septem & viginti gradus, & partes triginta confecisse, atque de Piscibus è regione tantundem Cauda.

§. VI. Semper enim inter Caput & Caudam omnino dimidius interjectus est circulus: igitur ubi pervestigaris ac cognoveris Caput in quo signo, quo signi gradu, quave parte sit, intelliges Caudam in signi ab isto septimi eadem numero parte inesse; ut si Caput in gradu decimo certi cujusdam signi situm est, erit Cauda item in gradu decimo signi ejus, quod est ab illo septimum.

§. VII.

§. VII. Cognito Capitis, & Caudæ, lunæque curſu vero, ipſa inter ſe conferantur. Nam ſi luna gradum atque partem eandem obtineat, quam obtinet vel Caput, vel Cauda, luna neque ad ſeptentriones, nec ad meridiem curſum ſuum inflexit: ſin autem lunam cernas Caput antecedentem ſic, ut ad Caudam commeet, lunæ regio eſt aquilonaris: contra ſi Caudam antecedat ita, uti convertatur ad Caput, ejus eſt regio auſtralis.

§. VIII. Inflexio lunæ in auſtrum & aquilonem lunæ latitudo nominatur, aquilonaris tum, cùm regionem obtineat aquilonarem, & ſi converſa ſit in auſtrum, auſtralis. Itaque cum punctorum alterutro cùm eſt conjuncta luna, latitudine, ſicut expoſui, omnino caret.

§. IX. Nunquam lunæ latitudo ſive aquilonaris, ſive auſtralis procedit ultra gradus quinque: ſedenim viam ita conficit, ut à Capite profecta paulatim à ſolis orbe recedat tamdiu, dum ab eo disjuncta ſit quinque gradus: tum ſenſim ad eundem ſolis orbem accedit ita, ut Caudam cùm attingat omnino latitudinem habeat nullam: rurſúmque ab eo pedetentim removetur ad eandem diſtantiam, tum ita denuò ſenſim appropinquat, uti tandem latitudine careat.

§. X. Quo tempore cunque ſcire quis expetit latitudo lunæ quanta ſit, & quam ad partem inflexa, ad ſeptentriones, an ad meridiem, is Capitis, & lunæ curſum verum perveſtiget qualis ſit eodem illo tempore: tum è vero lunæ curſu curſum verum Capitis detrahat. Nam quod reliquum erit, id *via lata* nominatur. Quæ quidem via lata ab uno gradu uſque, dum compleat centum & octoginta gradus, luna ad ſeptentriones: ſin longior eſt, luna curſum ſuum inflexit ad meridiem. Quod ſi via lata aut centum & octoginta gradus ipſos compleat, aut ipſos trecentos & ſexaginta, luna latitudinem prorſus habet nullam. Tum verò videndum etiam eſt, quantam via lata portionem habeat: tantundem enim luna inclinata eſt vel ad aquilonem, vel ad auſtrum, quæ, ut expoſui, latitudo lunæ dicitur aquilonaris, aut auſtralis.

§. XI. Jam de portione, ſi via lata graduum eſt decem, duæ & quinquaginta partes ejus eſt portio: ſi graduum eſt viginti, portio ejus eſt gradus unus, atque tres & quadraginta partes: ſi graduum eſt triginta, portio ejus eſt gradus duo, & partes triginta:

triginta: si graduum est quadraginta, terni gradus, & partes decem & tres portio ejus est: si graduum est quinquaginta, portio ejus est tres gradus, & partes quinquaginta: si graduum est sexaginta, portio ejus est gradus quatuor, & viginti partes: si septuaginta graduum est, portio ejus est gradus quatuor, & partes duæ & quadraginta: si graduum est octoginta, gradus quatuor, & partes quinquaginta quinque portio ejus erit: si graduum est nonaginta, erit ejus portio gradus quinque.

§. XII. Quod si decadibus unitates etiam aliquot adjunctæ sunt, quid portionis his conveniat colliges ex eo scilicet additamento, quo duarum proximarum decadum portiones inter se differunt, ita; ut in solis & lunæ ratione demonstratum est. Sit igitur via lata trium & quinquaginta graduum, quoniam via lata cùm sit graduum omnino quinquaginta, pro portione gradus habet tres, & partes quinquaginta, & eadem cùm sexaginta sit graduum, gradus quatuor, & partes viginti, hæ duarum decadum portiones partibus inter se differunt triginta: unde cognoscitur cujusque gradus portionem esse partes ternas. Qua ratione fit, ut via lata cùm sit trium & quinquaginta graduum, pro portione tres habeat gradus, & partes undesexaginta. Similis est reliquorum ratio numerorum.

§. XIII. Cùm autem ad nonagesimum usque gradum, id quod docuimus, cognoris via lata quam habeat portionem, omnino omni magnitudine via lata quam portionem habeat noveris. Etenim via lata plurium, quàm nonaginta cùm sit graduum, quoad compleat centum & octoginta, tum illius magnitudinem oportet de gradibus centum & octoginta demi, & quod reliquum erit, quæ sit ejus portio declarabit ¶.

§. XIV. Rursus si via lata procedit ultra centum & octoginta gradus, usque dum assequatur ducentos & septuaginta, oportet ex ejus magnitudine centum & octoginta detrahi gradus, & ex eo quod restiterit, cognoveris, quid portionis habeat.

§. XV.

¶ Postrema capitis hujus verba quindecim, quorum vis est, *Scilicet, hæc erat primâ illâ nocte lunæ latitudo, & ea quidem australis, siquidem via lata centum & octoginta gradus excedebat*, hîc in textu extant, atque ita extant, ut nullatenus cohæreant; nec ullam sententiam idoneam exprimant: ut pateat ab inscio librario esse hoc loco posita præposteré.

§. XIX.

§. XV. Quod si via lata ducentos & septuaginta gradus excedat, usque dum assequatur trecentos & sexaginta, ejus oportet magnitudinem eximi de trecentis & sexaginta gradibus, atque ex eo, quod supererit, quid portionis habeat, cognosci licebit.

§. XVI. Sit graduum, exempli gratiâ, via lata centum & quinquaginta, eos oportebit de gradibus centum & octoginta demi: restabunt igitur triginta gradus: quorum portio est, ut ante docuimus, duo gradus & partes triginta: eandem hanc portionem habent etiam gradus centum & quinquaginta.

§. XVII. Sit via lata graduum ducentorum, oportebit ex illis subduci centum & octoginta: remanebunt igitur viginti: quorum portionem uno gradu, partibúsque quatuor & triginta à nobis ante definitam, ducenti gradus sibi quoque vendicant.

§. XVIII. Sit denique trecentorum via lata graduum, illos oportebit subduci de gradibus trecentis & sexaginta: reliqui fient sexaginta: quorum portio gradibus quatuor, & viginti partibus à nobis est ante definita: quæ eadem & trecentorum est graduum portio. Atque eadem est omnium ratio numerorum.

§. XIX. Fac igitur scire quem velle lunæ quanta latitudo fuerit, & quam ad partem, septentriones, an ad meridiem ineunte illa nocte secunda mensis Jar, quam consequeretur vigilia sabbati, præsenti scilicet hoc anno, qui stirps est hujus ratiocinii. Jam id quidem promptum & expositum est, ut tunc temporis cursus lunæ verus confecerit de Tauro duodeviginti gradus, * & partes sex & triginta: character est 18. 36. Caput autem illud quod vocatur, è Virgine gradus viginti septem, & partes triginta: character est 27. 30. Unde si cursus Capitis eximatur de cursu lunæ, ducentorum inveniatur via lata, atque unius & triginta graduum esse, * & partium sex: character est 231. 6. Sedenim in ejusmodi via nunquam ulla partium habetur ratio. Qua re fit, ut ex iis, quæ sunt à nobis in hoc

§. XIX. *Et partes sex & triginta.* In editione superiori mendosè legitur hîc *partes quadraginta*, cùm idem hoc correctè extet in extremo articulo capitis proximi superioris.

Et partium sex. In editione superiori legitur, *Et partium decem.* Verùm parvi refert. nam summonet scriptor noster in hac quidem re partium nullam habendam esse rationem.

hoc capite dictatæ, viæ latæ portionibus, hujus quidem viæ latæ portio sit tres gradus, atque partes tres & quinquaginta: scilicet hæc erat primâ illa nocte lunæ latitudo, & ea quidem australis, siquidem via lata centum & octoginta gradus excedebat.

CAPUT DECIMUM ET SEPTIMUM.

Multiplices & varias rationes quibus investigetur & exploratè cognoscatur luna se num certa nocte quadam aperiat, annon? Nam in lunæ motu errores & anfractus ingentes esse: hinc natum illud sapientum, sol viam suam novit scilicet, luna non item. Omnem disciplinam veris & certis rationibus confirmatam tam à profanis, quàm à sanctis accipiendam.

§. I. HActenus explicavimus quæ patere & prompta debent esse ante, quàm investigaris quando futurum sit, ut luna se aperiat. Quod si cognitum & perspectum habere velis, primùm solis, lunæ, ac Capitis cursum verum exquiras, atque id in horam contemplandæ lunæ: deinde solis cursum verum è lunæ cursu vero subducas necesse est: & quod porrò supererit, id prima longitudo nominatur.

§. II. Et cùm investigaris Capitis & lunæ cursum, idem lunæ latitudo primò quanta, tum sítne australis, an aquilonaris, cognosces: atque hæc item latitudo prima nominatur. Atqui primam hanc & longitudinem & latitudinem etiam atque etiam consideres, & utramque in animo quasi insculptam habeas.

§. III. Hanc igitur ad longitudinem primam atque latitudinem animum advertes, ut qua nocte illam inveneris graduum esse restrictè novem, aut eo breviorem, omissis aliis rationibus, intelligas tum omnino fieri non posse ut Israeliticâ terrâ totâ luna se aperiat. Contra non dubites, quin totâ Palestinâ luna aperiatur ea nocte, qua longitudo prima gradus excedat quindecim; Atque nihil est, quòd rationes aliæ subducantur. Cùm autem illa longitudo prima sit ultera novem gradus procedens, quoad obtineat quindecim, tum verò opus illas inire

inire rationes, quibus cognoſcatur, fierine poſſit, ut luna ſe aperiat, necne.

§. IV. Sic ſe res habet, curſus lunæ verus ſi ſit inter principium Capri & extremum Geminorum: ſin autem, idem hic curſus lunæ verus volvitur ab initio Cancri ad extremum Sagittarium, tum ſi longitudo prima decem ipſorum eſt graduum, aut etiam pauciorum; conſtat lunam ea nocte non poſſe totâ Paleſtinâ ſe aperire: rurſúſque ſi ſit longitudo prima plurium, quàm viginti quatuor graduum, pro certo ſcies per omnem Judæorum regionem lunam aperiri. Et eadem longitudo prima cùm procedit ultra gradus decem, quoad aſſequatur viginti quatuor ipſos, oportet ſubducendis rationibus quæri luna ſe aperiat, necne.

§. V. Rationes illæ ſunt ejuſmodi: primùm ut obſervetur luna in quo ſigno verſetur: Nam ſi luna eſt apud Arietem, oportet de longitudine prima partes eximantur undeſexaginta: ſi apud Taurum, eximetur gradus unus: ſi eſt apud Geminos, detrahendæ ſunt partes duodeſexaginta: ſi apud Cancrum, tres & quadraginta partes: ſi apud Leonem, totidem: ſi apud Virginem, partes ſeptem & triginta: ſi apud Libram, partes triginta quatuor: ſi apud Scorpionem, partes triginta quatuor: ſi apud Sagittarium, partes ſex & triginta: ſi apud Caprum, partes quatuor & quadraginta: ſi apud Aquarium, partes tres & quinquaginta: ſi apud Piſces, duodeſexaginta partes: Atque primæ longitudinis cùm ſint detractiones illæ factæ, tum ea longitudo ſecunda dicitur.

§. VI. Quòd autem portiones illæ de longitudine prima ſubducantur, id ideo fit, quòd luna non eodem in loco, quo eſt, eſſe videatur: Differt enim alius ab alio tam in longitudine, quàm in latitudine: ac nimirum hoc illud eſt, quod *diſcrimen à ſpecie*, vel *parallaxis* nominatur. Cùm igitur ad lunæ conſpectum ac viſionem diriguntur tempora, tum illud in longitudine *diſcrimen à ſpecie* ſemper è longitudine prima detrahitur ità, ut expoſuimus.

§. VII. Jam ad latitudinis *diſcrimen à ſpecie* quod attinet, cùm luna curſum ſuum inflexit ad ſeptentriones, tum propter *diſcrimen à ſpecie* de latitudine prima portiones illius eximuntur. Sin autem curſum ſuum ad meridiem inflexerit, ob idem *discrimen à specie* latitudini primæ adduntur quotquot sunt portiones ejus. Quibus additis demtísve portionibus, secundæ latitudinis vocabulo nuncupatur.

§. VIII. Sed quot sunt illæ tandem portiones, quæ latitudini vel adduntur, vel detrahuntur? Nempe luna cùm versetur in Ariete, partes novem: cùm in Tauro, partes decem: cùm in Geminis, partes sedecim: cùm est apud Cancrum, partes septem & viginti: cùm apud Leonem, partes duodequadraginta: cùm apud Virginem, partes quadraginta quatuor: cùm in Libra, partes quadraginta sex: cùm in Scorpione, partes quadraginta quinque: cùm apud Sagittarium, partes quadraginta quatuor: cùm apud Caprum, partes triginta sex: cùm apud Aquarium, quatuor & viginti partes: cùm apud Pisces, duodecim partes.

§. IX. His igitur cognitis portionibus, eas aut latitudini primæ, sicut ante dixi, detraxeris, aut addideris, & extiterit latitudo secunda, quam ex his, quæ supra dicta sunt, facilè cognoveris, utrùm aquilonaris, an australis sit. Cùm autem pervestigaris illa latitudo secunda quot sit graduum, ac partium, id diligenter etiam atque etiam memoriâ custodias.

§. X. Rursus enim ex ista latitudine secunda eximendum est aliquid, eam ob causam, quoniam luna suo ipsius in orbe cursum suum paulum inflectit. Atenim quo tandem modo definietur illud aliquid, quod etiam ex secunda latitudine eximendum est? Nempe dum lunæ cursus volvitur ab Arietis aut Libræ principio ad eorum gradum vicesimum, partes sunt duæ detrahendæ de latitudine secundâ quinquepartitâ: ex quo autem movetur aut ab Arietis gradu vicesimo, usque dum commearit ad Tauri gradum decimum, aut à gradu Libræ vigesimo, usque dum commearit ad decimum Scorpionis gradum, demenda pars est tertia latitudinis secundæ: dum fertur aut à Tauri gradu decimo ad ejusdem gradum vicesimum, aut à decimo Scorpionis item ad vigesimum, quarta pars latitudinis secundæ ex ea demenda est: dum fertur à Tauri & Scorpionis gradu vicesimo ad extremum & Taurum & Scorpionem, quinta pars secundæ latitudinis eximenda inde est. Jam ex quo luna Geminorum & Arcitenentis attigit initium, donec commearit ad eorum gradum decimum, latitudinis secundæ sextans exi-

eximendus eſt: horum cùm attigit gradum decimum, uſque dum pervenerit ad vigeſimum, dimidium ſextantis è latitudine ſecunda demitur: dum inde luna fertur ad quintum & viceſimum gradum eorum ipſorum ſignorum, de latitudine ſecunda quadrans ſextantis eximitur. Cùm verò luna fertur aut à gradu vigeſimo quinto Geminorum ad quintum Cancri, aut à quinto & vigeſimo gradu Arcitenentis ad quintum Capricorni, tum è latitudine ſecunda demetur omnino nihil: hîc enim in orbe ſuo luna curſum ſuum nequaquam inflectit. Rurſum cùm à gradu quinto Cancri & Capricorni luna movetur eorum ad decimum, de latitudine ſecunda quadrans ſextantis eximitur. Dum lunæ curſus à gradu decimo ſive Cancri, ſive Capricorni volvitur ad eorum vigeſimum, dimidium ſextantis eximitur de latitudine ſecunda. Dum à Cancri & Capri gradu vigeſimo volvitur ad extremum ſignum, eximitur de latitudine ſecunda ſextans. Nam luna dum ab initio Leonis & Aquarii gradum ad decimum commeat, è latitudine ſecunda quinquepartita demitur una pars. Cùm eſt illorum aſſecuta gradum decimum, uſque dum ad viceſimum commearit, quadrans è latitudine ſecunda detrahitur: detrahitur ex ea pars tertia, dum luna Leonis à gradu viceſimo Virginis ad decimum, aut ab Aquarii viceſimo Piſcium ad decimum convertitur: & dum ab horum decimo gradu ſignorum convertitur ad extremum, è latitudine ſecunda quinquepartita partes ſunt duæ deducendæ. Atque id, quod è latitudine ſecunda demitur, *orbitam lunæ* nominant.

§. XI. Tum oportet etiam animum advertere ad lunæ latitudinem, & videndum aquilonaris ſit, an auſtralis. Quæ ſi eſt aquilonaris, oportet iſtam *orbitam lunæ* quam vocant de longitudine ſecunda etiam detrahi: ſin autem auſtralis eſt, eam addi longitudini ſecundæ neceſſe eſt; tum videlicet, cùm luna convertitur ab initio Capri ad extremos Geminos. Contra verò dum ſex alia ſigna perluſtrat, ſi curſum ſuum inflexit ad ſeptentriones, *orbitam* hanc oportet ad longitudinem ſecundam addi: ſin ad meridiem, eam oportet de ſecunda longitudine demi: atque hæc cùm fuerint addita longitudini ſecundæ, vel detracta, tum ea tertia longitudo nominatur: ſin autem in orbe ſuo luna curſum nihil inflectit, & de latitudine ſecunda, quia ratiocinium ita fert, demendum est nihil, ipsa longitudo secunda omnino erit eadem, quæ est tertia, qua nihilo plus, nihilo minus habet.

§. XII. Tum etiam tertia longitudo ista, quæ nihil est aliud, quàm qui gradus inter solem & lunam intercedunt, videndum est quo sit in signo: si aut in Piscibus, aut in Ariete, tertiæ longitudini sexta pars ejus addetur: si in Aquario aut Tauro, addetur ei pars quinta: si in Capro aut Geminis, eidem sextans addetur: si in Sagittario aut Cancro, longitudo tertia nec amplificabitur, neque minuetur, sed ut est, ita relinquetur. Si fuerit in Scorpione aut Leone, de longitudine tertia demetur pars ejus quinta. Si aut in Libra, aut in Virgine, ex ea demetur pars tertia: Atque longitudo tertia cùm est aut amplificata, aut diminuta, & si rationes ita postulant, in suo statu conservata, quarta incipit longitudo nominari. Secundum hæc etiam redeundum est ad lunæ primam latitudinem, ex qua tripartita sunt semper eximendæ partes duæ, atque hæc est illa, quæ regionis altitudini portio dicitur tribui, quæ portio quidem, cùm latitudo lunæ sit aquilonaris, longitudini quartæ debet addi, & ex eadem demi, cùm australis est lunæ latitudo. Porrò quod erit longitudo quarta, subductâ vel additâ portione illâ, id *visionis arcus* appellatur.

§. XIII. Sed quo ista facilius intelligantur, ponatur exemplum hujusmodi. Si quærat aliquis num eo, qui hujus ratiocinii princeps est, anno, prima nocte, quam sequeretur vigilia sabbati mensis Jar dies secundus, luna aperiretur, aut occultaretur: is primò solis & lunæ cursum verum exquirat, & lunæ latitudinem etiam sic, uti demonstravimus, quærat eodem ejus anni tempore quænam esset: inveniet autem solis cursum verum è Tauro perlustrasse tum gradus septem, & novem partes: character est 7. 9. Lunæ verò cursum verum ex eodem signo confecisse duodeviginti gradus, & partes triginta sex: character est 18. 36. Jam lunæ latitudo reperietur in austri partibus trium fuisse graduum, & partium trium & quinquaginta: character est 3. 53. Hæc tum erat lunæ latitudo prima. Dematur igitur cursus solis è cursu lunari, superabunt gradus undecim, & partes septem & viginti: character est 11. 27. Atque hæc erat tunc temporis prima longitudo. Quoniam verò

luna

luna tum in Tauro verſabatur, *diſcrimen à ſpecie* gradus erat unius, quem eximi de prima longitudine convenit: Ita reperietur ſecunda longitudo decem graduum, & partium viginti ſeptem: character eſt 10. 27. Itémque in latitudine *diſcrimen à ſpecie* partium erat decem, quas latitudini, quoniam erat auſtralis, oportet additas: ex quo latitudo ſecunda reperietur graduum fuiſſe quatuor, & partium trium: character eſt 4. 3. Quòd autem luna tum è Tauro confecerit duodeviginti gradus, neceſſe eſt, ut latitudinis ſecundæ quadrans ex ipſa dematur, quam *orbitam lunæ* nominant. Ergo *lunæ orbita* illa tunc temporis erat gradus unus, & una pars. nam ſecundarum quidem nulla habetur ratio.

§. XIV. Cúmque eſſet auſtralis lunæ latitudo, & curſus ejus verus inter Capri principium & initium Cancri volveretur, *orbitam lunæ* convenit addi longitudini ſecundæ, unde prodibit longitudo tertia graduum undecim, & partium duodetriginta: character eſt 11. 28. Quæ longitudo cùm eſſet in Tauro, eidem addendi ſunt etiam gradus duo, & partes duodeviginti, quæ eſt ejus quinta pars. Itaque longitudo quarta graduum erit decem & trium, & partium ſex, & quadraginta: character eſt 13. 46. Rurſus igitur redeundum eſt ad latitudinem primam, ex qua tripertita partes oportet duas detrahi: prodibit igitur ea portio, quæ regionis altitudini tribuitur, quæ duorum erit graduum, & partium quinque & triginta, quam ex longitudine quarta demi neceſſe eſt ideo, quòd luna curſum ſuum ad meridiem inflexerat. Itaque reliqui fient gradus undecim, & totidem partes: character eſt 11. 11. Omnino hujus ea nocte, quam dixi, magnitudinis erat arcus viſionis. Eadémque ratione cognoveris etiam ad infinitum tempus quavis nocte quot graduum, & quot partium ſit arcus viſionis.

§. XV. Atque perveſtigatus & cognitus ille viſionis arcus circonſpiciendus eſt. Nam is cùm novem eſt graduum, aut pauciorum, tum fieri poteſt, ut tota Judæorum regione luna ſe aperiat. Sin autem plurium, quàm decem & quatuor ſit graduum, haud ſanè poteſt luna occultari his quidem certè, qui terram Iſraeliticam incolunt.

§. XVI. Ubi verò viſionis arcus aliquid uſurpet de gradu decimo, quod idem erit dicendum uſque ad extremum gradum quar-

quartum decimum, ex ejus & primæ longitudinis terminis inter se collatis cognoscetur luna num aperiatur, an non. Nimirum isti sunt qui termini visionis appellantur.

§. XVII. De terminis igitur visionis, si visionis arcus procedat ultra novem gradus, ad extremum gradum decimum, & quidem aliquanto supra, sítque longitudo prima graduum decem & trium, aut eo major, luna se pro certo aperiet: sin autem vel visionis arcus est tantus, prima verò longitudo brevior, quàm posuimus, vel contra, luna delitescet.

§. XVIII. Si visionis arcus procedat ultra gradus decem, usq; ad ultimum gradum undecimum, & quidem aliquanto supra, sítque longitudo prima duodecim graduum, aut etiam eo major, luna sine dubio se aperiet: sin visionis arcus cùm sit talis, longitudo prima sit minor, contráve; luna se occultabit.

§. XIX. Si visionis arcus procedat ultra gradus undecim, usque ad ultimum gradum duodecimum, & quidem aliquanto supra; sítque longitudo prima graduum undecim, aut paulo major, pro certo se luna aperiet. At si, horum alterum cùm sit ejus magnitudinis, alterum existat minus, luna delitescet.

§. XX. Si visionis arcus procedat ultra gradus duodecim usque ad extremum decimum & tertium, & quidem aliquanto supra, & longitudo prima compleat gradus decem, aut eo plus, constat fore, ut luna se aperiat. Delitescet autem cùm horum alterum ejus sit magnitudinis, & ex ea, quæ dicta est, aliquid alteri desit.

§. XXI. Si denique visionis arcus procedat ultra gradus decem & tres, ad extremum gradum quartum decimum, & quidem aliquanto supra, & longitudo prima compleat gradus novem, aut eo plus, haud dubiè luna aperietur. Secus autem si cùm horum alterum ejus sit magnitudinis, alterum sit minus. Atque hæc est omnis omnino terminorum circunscriptio.

§. XXII. Nunc, exempli causâ, quæramus quinam esset visionis arcus ea nocte, quam subsequeretur vigilia sabbati dies secundus mensis Jar isto ipso anno, unde nos hujus ratiocinii repetimus initium. Inita igitur & subducta ratione eum, sicut demonstravimus, inveniemus tum fuisse graduum undecim, & totidem partium. Cùm igitur visionis arcus determinaretur inter gradum decimum, atque decimum & quartum, cùm longitudine

gitudine prima comparetur necesse est, quam ostendimus fuisse tunc graduum undecim, & partium septem & viginti. Quoniam igitur visionis arcus procedebat ultra gradus undecim, & longitudo prima patebat item ultra undecim, constat ex definitis terminis lunam ea nocte se aperuisse. Similiter licet ex quovis arcu visionis cùm longitudine prima collato judicare.

§. XXIII. Ex his omnibus cognosci facilè potest, quot & quantas addendo, deducendóque rationes putare necesse fuit, & quàm multum suscipere laboris, uti tandem vias illas rationésque faciles atque explicatas inveniremus. Id adeo, quòd luna in suo motu anfractus habeat ingentes: unde natum est illud sapientum, SOL VIAM SUAM NOVIT SCILICET, LUNA NON ITEM.

§. XXIV. Iidem sapientes dixerunt tum celeriùs, tum tardiùs lunam moveri: Etenim & in his subductis rationibus tum lunæ lustrationi nonnihil addendum, tum ex eadem fuit aliquid detrahendum ad investigandum visionis arcum. Ex quo fit etiam, ut visionis arcus, sicut exposuimus, modò longior, modò brevior sit.

§. XXV. At qua de causa hæ putantur rationes, addatur hoc, & deducatùr istud, & quì harum rerum unaquæque sit intellecta, atque etiam quæ sit singularum rerum causa & ratio, ad fastorum & geometriæ cognitionem pertinent, de qua Græci homines docti libros ediderunt quàm plurimos, qui iidem nunc quidem in nostrorum manu sunt sapientium. Nam qui sunt scripti quondam ab eruditis ex tribu Issacharis Judæis, qui vatum erant tempore, hi non ad nos usque pervenerunt: sedenim harum disputationum rationes cùm afferantur eæ, in quibus nullum liceat reperire vitium, nec quisquam habeat, quod opponat, quid est, quod de auctore laboremus? Omnem enim disciplinam rationibus veris & certis confirmatam accipiemus sive profectam à Prophetis, sive à gentibus. Etenim probantur nobis auctores, qui doctrinamsuam veris argumentis & rationibus certis probant.

CAPUT

CAPUT DUODEVICESIMUM.

Fieri posse, ut luna cùm se aperiat, non appareat tamen: atque hoc usque à Moyse traditum, ut luna nascens cùm non appareret in principio mensium, menses senatus definiret vicissim alium plenum, alium cavum: & ex tabularum ratione quoque menses hodie vicissim finiri plenos & cavos, nonnunquam hunc ordinem inverti tamen. Et hodie cùm mensis est plenus item, ut olim, celebrari intercalationis menstruæ sacrum epulare.

§. I. JAM id quidem omnibus apertum & perspicuum est, ut cùm inita & subducta ratio declaret fore, ut nocte in aliqua luna se aperiat, tamen occultetur, si forte nube obducitur. Præterea autem occultatur his, qui locum habitant valde depressum, aut quibus ab occidente mons præcelsus atque editus oppositus est. Namque horum sedes abs sede priorum nihil differt. Enimvero qui locis in humilibus habitant, his ne tum quidem aperitur luna, cùm est maxima: verùm aut montium altitudines, aut oras maritimas incolentibus, aut mare magnùm navigantibus etiam minima aperitur.

§. II. Atqui tempore brumali, eóque sereno, luna eadem multo videtur esse major, quàm æstiva tempestate item serenâ. Namque hyeme si tempus serenum est, purius cœlum conspicitur, ob eam causam, quod aër terræ proximus sit simplicior, quippe pulvis cùm eo nullus immisceatur. At æstate quamvis sit tempestas serena, cum pulvere confusus aër fumi est instar, unde fit, ut luna longè minor conspiciatur.

§. III. Cùm visionis arcus, & quæ ad illum comparanda est longitudo prima restrictè definita reperitur, luna est valde pusilla, & nisi in locis admodum excelsis, oculis percipi non potest: sin autem & visionis arcus, & longitudo prima prælongi sint sic, uti terminis amborum spatii sit aliquid ex consequenti gradu adjunctum, luna erit ipsa itidem magna, ut & visionis arcus, & longitudo prima, & cunctis adeo manifesta.

§. IV.

§. IV. Quocirca duo potiſſimum conveniebat ſenatum Hieroſolymitanum animo conſiderare: unum, quo anni tempore luna nova conſpecta eſſet: alterum erat locus, ex quo luna viſa erat, de quo poſteriore quidem interrogabantur ii, qui veniebant lunæ nuncii: Nam ſi ratione ſubducta intellectum eſſet lunam ejus ſtrictè magnitudinis eſſe, qua cadit ſub aſpectum, velut ſi viſionis arcus eſſet graduum novem, & partium quinque, & longitudo prima omnino trium & decem graduum, tum ſi qui de illa luna nuncium vel æſtivo tempore, vel ex humili loco attuliſſent, illorum erat fidei permagna ſuſpicio, & moroſè admodum excutiebantur. Rurſus hæc eadem luna tempore brumali, vel etiam tempeſtate æſtiva in loco perquam edito non dubitabatur, quin eſſet conſpecta, niſi forte nube obduceretur.

§. V. Dictum eſt à nobis, ſi qui lunam ſuo tempore naſcentem conſpicati, de illa ad ſenatum Hieroſolymitanum referrent, atque huic ipſi probarentur, calendas eodem die finitas à ſenatu, ac conſecratas eſſe. Ab his numerabantur dies novem & viginti, & nocte trigeſima ſive luna occultaretur, ſive nubes eſſet illi oppoſita, cujus cauſa non conſpiceretur, ſenatus die triceſimo toto de naſcente luna nuncios præſtolabatur: qui ſi nulli veniſſent, menſis uno die fiebat longior, atque uno & triceſimo die demum calendæ ſecundæ ab illis inſtituebantur.

§. VI. Putandum verò non eſt, ſi trigeſima ab his calendis nocte luna deliteſceret etiam, conſtitutum iterum menſem plenum, quem eundem intercalarem appellant, ac prima & trigeſima demum die calendas inſtitutas eſſe; quippe cùm fieri poſſet, ut hujus quoque menſis trigeſima nocte luna non appareret. Rurſus igitur intercalandum fuiſſet, & rejiciendæ in diem unum & triceſimum calendæ. Sic omnes deinceps menſes anni conſtitiſſent ex uno & triginta diebus: unde ſub anni menſem ultimum evenire potuiſſet, ut luna naſcens conſpiceretur aut quinto, aut ſexto & vigeſimo die menſis, quo quid eſſe poteſt ineptius? Quid incommodum magis?

§. VII. Nec verò res eſt inſolens, ut anno toto luna nova non conſpiciatur: imò & hoc uſitatum maximè, & ejus generis alia multa, præſertim in regionibus illis, ubi diutinæ ſunt pluviæ & frequentes nubes: neque enim id dicimus, lunam nonnunquam anno toto prorsus non conspici, sed non conspici novam mensibus ineuntibus, etsi postea cernitur, interdum quia omnino fieri non potest, ut ad mensem ineuntem appareat, interdum aut quia objecta illi nubes est, cùm alioqui non occultetur, aut quia est valdè pusilla, nec quisquam magno contendit opere, ut eam conspicetur.

§. VIII. Hæc erat igitur doctrina sapientium, quam usque à Mose acceperant alii ab aliis, ut nisi luna nascens mensibus singulis ineuntibus appareret, senatus menses institueret vicissim alium plenum ex diebus triginta, alium cavum ex novem & viginti. Similiter cum res conficitur subducendis calculis vicissim menses pleni cavíque constituuntur quidem, non item consecrantur: neque enim menses consecrantur, nisi ex lunæ visione: quanquam & ex ratione calculorum tum menses duo pleni, tum duo cavi continuantur.

§. IX. Atque menses cùm ex tabularum ratione finiuntur, tamen sic tempus semper observatur, ut si venientis luna nova mensis se aperiat, aut suo se aperiat tempore, aut certè nocte consequenti, quæ dicitur intercalaris: nunquam verò ante tempus, id est, nocte duodetrigesima. Atqui quando fiat, ut luna aperiatur, aut delitescat his, quas exposuimus, rationibus facilè cognosci potest. Nimirum & inde fit, ut modò duo menses pleni continuentur, modò duo cavi. Atqui nunquam in anno menses pleni sunt pauciores quatuor, neque plures octo. Cùm verò mensis ex tabularum ratione fiat uno die longior, itidem; ut si hoc idem fiat ex visione lunæ novæ, celebratur illud menstruæ intercalationis sacrum epulare, de quo in tertio hujus disputationis capite disseruimus.

§. X. Quod autem in digestis Talmudicis passim ea scripta sint, quæ declarant abs senatu Hierosolymitano ad rationem tabularum finiri tempora, huic eidem ab ipso Mose datam esse copiam, ac concessam facultatem instituendi menses plenos & cavos: item aliquando cavos ab eo menses in annum insertos esse novem, aliudve horum simile, id ita interpretandum est, dum luna suo tempore non conspiceretur.

§. XI. Et quod sapientes dixerunt necessitatis ergô mensem constitui plenum, quódque ex tabularum ratione tum senatus menses cavos & plenos alternabat, tum idem duos continuabat

Vide Capitis tertii articulum 17.

menses

menſes vel plenos, vel cavos, ſola hæc cauſa erat, quòd luna nova ſuo tempore viſa non fuerit. Etenim ſuo tempore ſi apparuiſſet, nempe ubi aperiebatur continuò poſt ejus cum ſole conjunctionem, ibi verò calendæ conſecrabantur uſque.

§. XII. Quæ quidem ita fuerant cùm eſſet apud Hieroſolymam ſenatus ille, qui in tempore finiendo lunæ novæ viſionem ſequeretur. Nunc verò finitur ex hac tabularum ratione, quæ per omnes omnino Judæos pertinuit, ſic, ut diſputationibus in iſtis diſſeruimus.

§. XIII. Explanatum eſt in iis libris, qui ſunt de Aſtrologiæ & Geometriæ ratione, quemadmodum luna cùm ſe aperiat in Judæa, in omnibus etiam, quæ ad occidentem Judææ ſunt ex adverſo, regionibus itidem aperiatur. Si verò ſubducta ratione cognoſcatur lunam in Judæa occultatum iri, fieri tamen poteſt, ut in regionibus, quæ ſunt è regione Judææ ad occidentem, conſpiciatur. Ita fit, ut ſi qua in provincia ad occidentem Judææ ſitâ luna nova conſpecta ſit, * inde concludi non poſſit, lunam in Judæa perinde conſpectum iri.

§. XIV. Rectè autem poſſit effici lunam naſcentem in Judæa non cerni eò, quòd ne ſummis quidem cernatur è montibus ejus provinciæ, quæ eſt è regione Judææ ad occidentem.

§. XV. Item conſtat lunam novam, in Judæa cùm occultetur, in nullis omnino regionibus iis, quæ ſunt ad orientem è regione Judææ, aperiri. Cùm autem in illa ſe aperiat, poteſt; ut in his aperiatur, & non aperiatur. Unde ſi in regione aliqua, quæ Judææ reſpondet in orientis partibus, luna conſpiciatur, dubium nullum eſſe poteſt, quin itidem in Judæa conſpiciatur. Et cùm non aperiatur in regionibus illis quæ ſunt ad orientem contra Judæam, nihil inde ſequitur: etenim fieri poteſt, ut in Judæa tamen aperiatur.

§. XIII. *Inde concludi non poſſit*, &c. Editiones variant hoc loco. nam in recentiori legitur, אין בזה ראייה שלא יראה בארץ ישראל אלא אפשר שנראה הירח בארץ ישראל: Quod eſt, Inde concludi non poſſit lunam in Judæa non iri conſpectum; ſedenim fieri poteſt, ut in Judæa etiam cernatur. at hoc utpote ſententiæ contrarium mendoſum eſt: in antiquioribus autem editionibus correctè legitur, אין בזה ראייה שנראה הירח בארץ ישראל, id eſt, Inde concludi non poſſit lunam in Judæa perinde conſpectum iri.

§. XVI. Sic se habent illæ regiones in orientis & occidentis partibus sitæ, si modò sint è regione Judææ: dum videlicet in mundi partem aquilonarem vergunt à gradu tricesimo ad quintum & tricesimum. Quæ regiones autem magis aut minùs sunt ad septentriones inflexæ, earum alia ratio est, quippe quæ è regione Judææ non sunt. Jam quæ diximus de his, quæ sunt ad orientem & ad occidentem exadverso Judææ regiones, eò diximus, ut omnia paterent, quæ spectarent ad lunæ contemplandæ rationem, ut amplificaretur doctrina legis, ac corroboraretur. Neque enim illarum incolæ regionum ad lunæ visionem menses finiebant ipsi, vel ex ea re quidquam capiebant commodi: Omnes enim in calendis celebrandis ad consecrationem ejus, qui erat in Judæa, senatus se dirigebant, ut sæpè dictum est.

CAPUT

CAPUT UNDEVICESIMUM.

Quî ſcire poſſis, quantum aut ad ſeptentriones aut ad meridiem inflectatur à circulo æquinoctiali luna, & quorſum convertat cornua?

§. I. QUoniam voluerunt ſapientes, ut ex nunciis lunæ novæ, cùm examinarentur, inter alia permulta, quæreretur etiam quam in mundi partem inflexa luna eſſet, viſum eſt nobis hanc quoque rationem explicare. Verùm de eo, quoniam ad lunæ viſionem perſpiciendam nihil conducit, non tam accuratè quidem & exquiſitè diſputabimus: ſed ante quàm ad planetarum veniamus inflexiones, pauca quædam de ſignorum inclinatione dicenda ſunt.

§. II. Linea illa media orbis ſigniferi, quam ſol luſtrat, non eſt ea, quæ medium mundum ab oriente ad occidentem ambiat, id quod efficit æquinoctialis circulus, à quo diſcedit illius dimidia pars ad aquilonem, dimidia ad auſtrum.

§. III. Duobus autem locis illum, qui ab oriente ad occidentem mundum medium complectitur, circulum æquinoctialem contingit: quorum alter eſt ad Arietis introitum, alter ejus è regione ad introitum Libræ. Igitur ſignorum illa ſex, quorum primum Aries, extremum eſt Virgo, vergunt ad ſeptentriones, & ad meridiem ſex iſta, quorum Libra prima eſt, Piſces ultimi.

§. IV. Atque ab æquinoctiali circulo ſigna paulatim declinant ad ſeptentriones ab Arietis initio ad Cancri principium, quod ipſum ad aquilonarem mundi partem verſus diſtat ab æquatore gradus tres & viginti, & dimidiatum ferè gradum. Rurſum à capite Cancri ſigna ſenſim inflectuntur ad æquatorem uſque ad principium Libræ, quod in ipſo inſiſtit æquatore. Ab principio autem Libræ uſque ad initium Capricorni ſigna ſic ab æquatore recedunt in auſtralem mundi partem, uti tandem Capricorni principium ad auſtrum verſus ab æquatore ſit disjunctum gradus tres ſupra viginti, & dimidium circiter gradum. Atque ab initio Capricorni ad Arietis initium ſigna ſenſim ad æquatorem etiam accedunt.

§. V.

§. V. Quoniam igitur principium Arietis & Libræ in ipso insistit æquatore, sequitur, cùm ad alterutrum sol commearit, illum neque in mundi plagam australem, neque in aquilonarem inclinare: sed his duabus mundi partibus interjectum medium oriri & obire: ut in omnibus, quæ habitantur, terris dies & noctes inter se sint æquales.

§. VI. Ex his igitur videre licet signorum unumquemque gradum aut ad septentriones inclinatum esse, aut ad meridiem; ita, ut suum quæque habeat inflexio modum alia majorem, alia minorem, nec excedat vigesimum tertium & dimidium ferè gradum, cùm sit quàm maxima.

§. VII. Sic igitur res est, modum amplificat graduum multitudo, & numerandi capitur initium ab Ariete. Gradus autem decem habent inflexionem quatuor graduum: viginti gradus inflexionem altero tanto majorem. Habent triginta gradus inflexionem undecim graduum & semissis: quadraginta, inflexionem quindecim graduum: quinquaginta, duodeviginti graduum: sexaginta, graduum viginti: septuaginta graduum inflexio duobus istam gradibus superat: hanc etiam inflexio graduum octoginta superat uno gradu: porrò nonaginta graduum inflexio dimidio gradu major est istâ.

§. VIII. Quod si decadibus unitates adjunctæ sunt, earum portionem ex eo, quod inter duas inflexiones proximas intercedit, inflexionis discrimine collegeris eodem modo, atque in solis & lunæ ratione docuimus. Exempli causa quinque gradus inflexionem habent duorum graduum; itaque tres & viginti gradus habent inflexionem novem graduum. Similis est ratio reliquarum * decadibus adjunctarum unitatum.

§. IX. Utque graduum inflexionem noris à primo ad nonagesimum, omnium omnino graduum inflexionem cognoveris item, ut & de lunæ latitudine disseruimus. Cùm enim gradus sunt plures, quàm nonaginta, idque usque ad centum & octoginta, graduum numerus est de centum & octoginta eximendus. Nam si sint plures, quàm centum & octoginta gradus

§. VIII. *Decadibus adjunctarum unitatum.* Hic in editione recentiore correctè legitur האחרים שהן עם העשרות In antiquioribus autem editionibus vox עם desideratur.

dus, ídque ad ducentos & ſeptuaginta, ex eorum numero demendi ſunt gradus centum & octoginta. Si graduum numerus ſuperat etiam ducentos & ſeptuaginta, uſque ad trecentos & ſexaginta, eorum numerum ex trecentis & ſexaginta detrahetur: tum facilè erit reliquorum cognoſcere graduum inflexionem, quæ eadem ſine ulla aut acceſſione, aut deceſſione, inflexio eſt ejus numeri, de quo quæritur.

§. X. Si quis igitur ſcire expetit quot gradus ab æquatore ſit inflexa luna vel ad aquilonarem mundi partem, vel ad auſtrum, primum id quærat, quænam ſit inflexio gradus ejus, in quo lunæ curſus verus volvitur, & quam in partem mundi ſit converſa ad ſeptentriones, an ad meridiem: deinde lunæ latitudinem primam videat quanta ſit & qualis, an aquilonaris, an auſtralis: tum ſi latitudo lunæ prima, & ejus, in quo volvitur lunæ curſus verus, gradus inflexio vergit in eandem mundi partem vel aquilonarem, vel auſtralem, ſimul agregentur: ſin autem altera in ſeptentriones, altera ſit in meridiem converſa, harum minor è majori eximatur. Ac tum demum quod ſupererit ſpatium, id omnino luna ab æquatore eſt inflexa in eam mundi partem, in qua major illarum fuit inventa.

§. XI. Quæratur igitur quantum ab æquatore converſa luna eſſet epochali nocte illa ſecunda menſis Jar, præſentis hujus anni, à quo nos initium hujuſce ratiocinii repetimus. Gradum, in quo tum lunæ volvebatur curſus verus, oſtendimus ſupra Tauri fuiſſe undevigeſimum, cujus gradus inflexio quaſi duodeviginti graduum erat ad ſeptentriones verſus: lunæ verò latitudo prima graduum ferè quatuor erat, eaque auſtralis. Itaque ſi de majori numero minor eximatur, reliqui fient gradus decem & quatuor. Tantum videlicet erat tum ab æquatore inflexa luna ad ſeptentriones, ſiquidem in ea parte mundi ſita erat illa inflexio duodeviginti graduum, qui numerus duorum major erat. Sed hæc quidem ratio, quoniam ad lunæ viſionem perſpiciendam nihil juvat, non eſt accuratè inita & ſubducta.

§. XII. Jam ſi quis ſcire velit, lunæ quorſum erunt obverſa cornua, ſitum ejus etiam ad æquatorem comparet. Nam ſi luna aut in ipſo inhæreat æquatore, aut ab eo duos omnino, tréſve gradus abierit ad ſeptentriones, vel ad meridiem, è regione

gione medii occidentis collocata esse videbitur, & ejus cornua solis ipsum ad ortum conversa.

§. XIII. Sin autem ab æquatore longiùs recesserit ad septentriones, videbitur inter occidentem & septentrionem esse sita, & ejus cornua ab oriente inclinata in meridiem.

§. XIV. Sin ab æquatore sit remota procul ad austrum versus, inter occidentem & meridiem sita videbitur, & ejus cornua ab oriente ad septentriones inflexa, pro magnitudine ejus ab æquatore distantiæ atque inflexionis.

§. XV. Atque ex his, qui de luna nascente renunciarent, tentandæ fidei causa, quærebatur etiam & illud, luna quàm altè ferebatur. Id cognoscitur ex *arcu visionis*, qui si brevior est, cursus lunæ propiùs à terra volvi, si longior, luna moveri videtur altiús. Ut enim *visionis arcus* longus est, ita lunam oculi altam à terra percipiunt.

§. XVI. Explicatæ sunt rationes omnes, quæ requiruntur ad perspiciendam lunæ visionem, & interrogandos eos, qui veniebant lunæ nuncii sic, ut intelligentibus hæc omnia promta sint, & aperta. Etenim nulla prorsus doctrinæ ratio à Lege nostra excluditur. Ut igitur hæc de luna doctrina percipiatur, confugiendum est non ad alienorum hominum monumenta, sed ad hunc librum divinum: ille, ille lectitandus est: nihil enim in eo desideratur.

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CRONOLOGIA HISTORICA

Scritta in lingua Turca, Persiana, & Araba,

DA

HAZI HALIFE' MUSTAFA',

E tradotta nell'Idioma Italiano

DA GIO: RINALDO CARLI

NOBILE JUSTINOPOLITANO,

e Dragomano della Serenissima Republica di Venezia.

CONSACRATA

All'Illustrissimo, & Eccellentissimo Sig.

GIO: BATTISTA DONADO

SENATORE, E SAVIO GRANDE.

IN VENETIA, M. DC. XCVII.
Appresso Andrea Poletti, all'Italia.
CON LICENZA DE' SUPERIORI.

di lui vasti pensieri. Formato dunque un numeroso, e valido Esercito uscirono uniti in Campagna, e nelle pianure di Hirat venuti col sudetto Ibcà Han a battaglia, restarono abbattuti.

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Passò Tahir Bibers Sultano d'Egitto alla visita del Pellegrinaggio della Meca l'anno 668

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Fù dalli Tartari distrutta, e desolata la Provincia di Haran.

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Altre Trupe Tartare di Mogul azzuffatesi colle Greche le batterono.

Mancò di vita in Cairo Seid Ahmet Elbedevi venerato, e stimato come persona pia l'anno 675

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Menchiut Temer Principe Scita, correndo colli suoi Tartari per invader, e saccheggiar la Città di Hamus, fù attaccato dall'Esser-

cito.

cito Egitio, e con grande svantaggio delle sue Truppe necessitato a ritirarsi.

Il Principe Rucnedin Gauriano s'impatronì del Regno di Candehar.

Mancò di vita in quest'anno Erdogrul Gasì Padre di Osmano primo Principe di questa Imperial Prosapia, chiamato anche egli per soprano- me il Guerriero l'anno 680 *Ciò è il Bellicoso.* *Ciò è Ottomano.*

Il Principe Ibcà Han delli Tartari di Mogul, e figliuolo di Hellahiù Han, in quest'anno professò la Legge Maomettana, e per dar parte di questa sua conversione, spedì Allamei Sirasi in qualità d'Ambasciator Estraordinario al Sultan d'Egitto, partecipandoli pure haver mutato il nome primiero in quello d'Ahmet.

Morì il Principe Menchiut Temer Scita l'anno 681

Da un diluvio di pioggia accaduto nella Città di Damasco accresciuti i fiumi, che irrigano quella Città, ne seguirono danni notabili.

In un conflitto successo nell'Armenia Maggiore frà il Principe Husreu Ali Selzuch, e li Tartari, restò il primo interfetto, & esaltato a quel Dominio il Principe Messuud Chiechiavus Ali Selzuch l'anno 682

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Fù da Calavun Sultan d'Egitto liberata dalli Franchi la Città di Mercab l'anno 684 685 686

Nacque Sultan Orhan mentre Sultan Osman Gasì suo Genitore, data nelle Campagne d'Eneghiul nella Bittinia la battaglia all'infedeli Greci, restò Trionfante, in cui però fù interfetto Ghiundus Elp Soggetto delli più qualificati, e Valorosi, che seco havesse; Spinte poi le sue Truppe all'assedio delle Città d'Affion, e Carà Hissar se l'acquistò l'anno 687 *Ottomano.*

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Calavun Sultan d'Egitto spogliò li Franchi del possesso di Tripoli di Soria.

In quest'anno la Real Prosapia d'Ali Selzuch inviò al Principe Ottomano un'Insegna Reale, con cui lo dichiarava per Principe indipendente l'anno 688

Morì il Principe Calavun Sultan d'Egitto, e fù nella sua vece esaltato il Principe Esref.

Fù privata la famiglia di Firus Sah del Dominio, che teneva nell' Indie l'anno 689

Il Principe Esref nuovo Sultan d'Egitto spogliò la famiglia di Benieiup dello Stato, e Città d'Aleppo, la quale la fece egli restaurar, e munir; Rivolte poi le sue Armi, contro Achiè, & altre Città, e Castelli posseduti dai Franchi sopra le Rippe del Mare, e spettanti alla Soria li ricuperò tutti, e fece anche abbandonare per timore la Città di Sattalia.

Principiarono gl'Infedeli Franchi l'anno Maomettano 490. à invader li Regni d'Egitto, Soria, e Palestina con fortuna tanto propitia, che si erano quasi fatti assoluti Padroni delli medesimi, se non fosse successo alla Corona d'Egitto il Principe Selahedin, con il di cui valore, & ottima condotta contrapesò le loro forze, arenò i loro progressi, e ravvivò il perduto coraggio alli Monsulmani; I di lui Successori pure calcati i suoi vestigii, seppero anche essi discacciarli dalle tante Città, e Fortezze, che s'erano acquistate l'anno 690

Fù occupata dal Sultan d'Egitto la Città di Rum sopra l'Eufrate l'anno 691

Occorse un'improviso incendio alla Città di Medina.

La famiglia d'Alizenghis fù privata del Regno di Turan l'anno 692

Morto il Principe Esref Sultan d'Egitto fù innalzato a quella Corona Chitga.

Fù spogliata la Prosapia di Attabechian del Dominio di Loristan.

Essendo il Regno di Persia oppresso d'una estraordinaria carestia decretò quel Sovrano, per sollievo del suo Popolo, che sopra una Carta quadrata si dovesse imprimer il suo Nome, e tessa quella correr in vece della primiera Moneta l'anno 693

L'esser scarsamente cresciute l'acque del Fiume Nilo, fù causa, che il Regno d'Egitto, provò una grande penuria.

Mancato di vita il Principe Cutlai Han del Regno d'Usbech fù in suo luoco esaltato il Principe Timur Han.

In questo anno tutto il Popolo del Regno di Mogul professò la Legge Maomettana l'anno 694

Li Regni d'Egitto, e Soria patirono una grande carestia.

Volendo il Principe Firus Sah tentare la ricupera delli da lui perduti Regni nell'Indie, venne nelle vicinanze del Fiume Hidaspe a giornata col suo usurpatore, in cui sacrificò colla perdita la propria vita l'anno 695

Fù spogliato un Rampollo della famiglia Chiachiviè chiamata Attebechian del Dominio, che teneva in Persia.

Fù

Fù levato dal Trono il Principe Ghisca Sultan d'Egitto, & esaltato Mansur Lacin.

L'anno 688. cominciò il Principe Ottomano impugnar il Scettro di Sovrano, e come tale nell'espugnata Città di Carà Hissar fece ch'il Cadì da lui sostituito, officiasse publicamente quell'orationi nelle Moschee, che si pratticano implorare per li Principi, che sono indipendenti, & assoluti; Però sussistendo all'hora la Real Prosapia d'Ali Selzuch, nell'auge delle sue forze, e coronata di molti Regni, e dipendendo esso da quella, non volle farsi conoscer per assoluto Sovrano sino l'anno 696. che quella Reggia famiglia rimase estinta l'anno 696 *Ottomano.*

Il Principe Ganan Han Scita, doppo haver nella Città di Tebris, formato un Magnifico dissegno per construirvi un Sepolcro Reggio, se ne partì, e lasciò in qualità di Sovrano di quel Regno il Principe Ailadin Chieicubat l'anno 697

Fù fatto strozzare il Principe Mansur Lacin Sultano d'Egitto, & a quella Corona esaltato il Principe Nassir Mehmet.

S'attaccò una fiera battaglia verso il Fiume Neilufer, che iriga la Bittinia, frà il Principe Ottomano, & il Principe Jarhissar con la perdita di questi, e schiavitù della propria figliuola l'anno 698

Spinte le sue Truppe il Principe Gasan Han de' Tartari contro la Soria, corse subito il Sultano d'Egitto con le sue al riparo, e nelle Campagne, che giacciono frà le Città di Hamus, e Seleme, incontratisi ambidue gl'Esserciti, seguì un sanguinoso combattimento, con la perdita dell'Egittio, con che il Tartaro si rese Padrone del Dominio di Damasco.

Coll'acquisto fatto dal Principe Ottomano delle Città di Eneghiul, e Bilezich nella Bittinia, si fece Padrone dispotico di tutta la Grecia Asiatica l'anno 699

In quest'anno fù instituito dal Principe Mehmet figliuolo di Calavun Sultano d'Egitto, il costume dell'invito, che si prattica anche al presente sopra le Torri delle Moschee con alta voce, acciò il Popolo all'hore destinate intervenga a far le loro divotioni, e per distinguer il giorno di Veneredì dagl'altri feriali, prescrisse, che in questo unitesi diverse voci, dovessero sopra le sudette Torri con Nobil armonia cantare, e chiamare la gente alle Moschee.

Il Principe Ali Caramano spogliò del Regno di Loristan il Principe Attabecchian l'anno 700

Si pretese in quest'anno instituir una nuova Epoca, ma questa non hebbe sussistenza.

Fù prohibito da Ibni Nime Religioso di pia vita Soriano che non si doves-

Questa è la loro Quadragesima;

dovessero in avvenire praticar certe Orationi, che s'usavan farsi la notte delli 27. della Luna di Ramasan, come contravenienti alla Maomettana Legge.

Seguì una sanguinosa battaglia frà l'Essercito dell'Han del Regno di Mogul, e quello del Principe Alladin Rè dell'Indie con la rotta total di questo.

Accadè anche nella Caramania in vicinanza di Coin Hissar frà il Bellicoso Principe Ottomano, e li Greci un fiero combattimento, in cui questi furono rotti, e fugati.

Mancarono di vita Hacchimbiemirullah Principe della Real Prosapia Abbassiana, & il Principe Ebutemì Mehmet Seriffo della Meca l'anno 701

Spinse il Principe Gasan Han de' Tartari le sue Truppe all'invasion della Soria, dove attaccate dal Sultano d'Eggito, furono vinte, e fugate.

Il Sultano d'Egitto accennato liberò dalli Franchi l'Isola d'Auret Addassi, ch'è posta in faccia di Tripoli di Soria.

In Egitto successe un terribile Terremoto.

Fù espugnata dal Principe Ottomano la Fortezza di Chipte l'anno 702

Fù oppressa grandemente l'Asia tutta dall'infettion del malcontaggioso, & un mal simile fece strage degl'Animali Bruti.

Nella Città di Hamedan mancò di vita il Principe Gasan Han de' Tartari, e fù assunto in suo luoco il Principe Mehmet Hudabendè l'anno 703 704

Il Principe Hudabende nuovo Han del Regno di Mogul, volendo colle sue Armi invader il Regno di Chillan, ricevè colà una sanguinosa rotta.

Mancato di vita il Principe Rucchnedin Sultan d'Egitto, fù convocata la Consulta dalli Principali di quel Regno, per maturare in essa la scielta del Soggetto, che si stimava conferente all'esaltatione di quella Corona, e doppo varii dibattimenti, furono in fine proposti due Principi di Reggia Prosapia, che ivi rissiedevano, l'uno Ibni Nimè Abbassiano, e l'altro Fahredin Gauriano, il quale fù preferito al primo, per la di lui maggior capacità l'anno 705

Fù spedito dal Sovrano di Barbaria sotto la condotta del Principe Jussuf Marini il suo Essercito all'espugnatione della Città di Tillimsah, e gli fù dal valore degl'assediati, in una sortita tolta la vita.

Vuol dir Caldei.

Dal Principe Ghiassedin Sovrano delli Chiurti fù spogliata la famiglia d'Aliberach del possesso del Regno di Chirman l'anno 706

Ibni Mathar seppe sì bene insinuare al Principe Hudabendè Han di di Mogul i dogmi della Setta Persiana, che l'indusse di procurare a tutto suo potere la propagatione di quella.

Riputata dalli Maomattani per Eretica, stante li molti errori ne' quali incorrono secondo la loro opinione.

Il Prencipe Ottomano si rese Padrone dell'Isola di Marmarà l'anno 707

Doppo haver li Franchi espugnata l'Isola di Rodi tenuta dalli Greci, portarono le loro Armi verso Costantinopoli contro l'Imperator Niceforo.

Dal Principe Ottomano furono occupate le Città di Leuchiè, & Ac Hissar l'anno 708

Fù nel Regno di Granata dal Principe Nassir figliuolo di Mehmet battuto l'Essercito Spagnuolo.

Eresse il Principe Hudabendè Han del Regno di Mogul nella Città di Tebris un sontuoso, e Magnifico Palaggio l'anno 709 710

Fù in quest'anno terminato il sudetto Reggio Palaggio fatto construir dal prenominato Principe Hudabende l'anno 711

Il Principe Ottomano si rese Padrone della Città di Chieivè l'anno 712

Espugnò il Principe Orhano figliuolo del mentovato Principe Ottomano l'Armigero, la Città chiamata Adriano l'anno 713

Accadè frà li Seriffi Hamas, e Ramiè fratteli nella Città della Meca una Guerra civile, nella quale rimase il primo vinto, & interfetto l'anno 714

Dal Vicegerente di Damasco fù datto il Sacco all'Isola di Malta.

Si perfettionò in quest'anno la fabrica della restauratione di Cesarea l'anno 715

Mancato di vita il Principe Hudamendè Han di Mogul fù esaltato alla Corona di quelli Regni il Principe Ebussaid il quale subito fece nascer un divieto, che nelli suoi Stati non fosse permesso l'esercitio Publico della Setta Persiana, tanto aumentata dal suo Predecessore.

Essendosi estinta la Real discendenza da Ali Selzuch, sì nella Grecia Asiatica, come in altri Regni, e Principati ch'erano commandati da Governatori ad essa subordinati, ogn'uno di questi, per la mancanza del legittimo Sovrano assunse del medesimo, il dispotico Dominio l'anno 716

Passò il Principe Ottomano con le sue Truppe nella Bittinia, e per precluder tutte le vie alla Città di Bursia, eresse nell'Eminenza d'un Colle un Forte, col quale veniva à dominarla.

Furono nel Regno di Granata dalli Monsulmani battuti li Christiani l'anno 717

Fù in quest'anno lo Stato di Zesirè da una grande carestia angustiato.

Coll'

Coll'aſſenſo dei Sogetti più ſapienti, e virtuoſi della Città di Damaſco, fù interdetto lo ſtudio dell'Aſtrologia.

La Famiglia Taclit Sahiè ſpogliò quella di Halizie delli Dominii, che poſſedeva nell'Indie l'anno 718

Venuti nel Regno di Granata nuovamente a giornata gl'Eſſerciti del Principe Bamirullah figliuolo d'Ahmer, e de' Spagnuoli, li Monſulmani col ſacrificio fatto di dodeci milla di quegli al furor della loro Sciabla, reſtarono trionfanti l'anno 719

Il Principe Timè Abbaſſiano, che concorreva alla Corona d'Egitto fù obligato alle Carceri del Caſtello di Damaſco l'anno 720 721 722 723

Li Ottomani preſero la Provincia d'Achova toccante alla Bittinia l'anno 724

La famiglia di Beni Amar cominciò a regnare nella Barbaria.

Li Ottomani nell'Anatolia occuparono le Città di Bolli, e Candri l'anno 725

Reſtò dall'eſcreſenza eſtraordinaria del Fiume Tigri dannificata tutta la Città di Babilonia.

Mancato di vita Tachitſahiè Rè dell'Indie, fù eſaltato a quella Corona Ulug Han ſuo figliuolo l'anno 726

Paſsò in queſt'anno all altro Mondo il Principe Ottomano, & il Principe Orhan, preſo ch'hebbe le Redini del Governo, portò le ſue Armi contro la Città di Burſia, e Jallach Abbat, e l'eſpugnò.

Lo ſteſſo Principe Orhan fece traſportar l'acqua, che ſcaturiva dal Monte Arifat contiguo alla Meca in quella Città l'anno 727

Furono col mezzo del perſpicace intendimento di Alladin Paſsà eſteſi li Canoni, & inſtituite le Leggi dell'Imperio Ottomano.

Da Sultan Orhan fù ſpedito in qualità di Generale Achce Coza all' acquiſto della Miſſia.

Fù da Ulug Han Rè dell'Indie battuto Chislù Han Rè del Regno di Multan l'anno 728

Sono ſtate dilatate le Mura della Meca.

La famiglia di Benizirban occupò la Corona dell'Armenia Maggiore.

Abdulrahman Generale di Sultan Orhan acquiſtò la Città d'Aidos.

Il Principe Ibni Timè Abbaſſiano, morì nelle Carceri nella Fortezza di Damaſco, dove fù rinchiuſo l'anno 729

Furono in queſt'anno dalla prudenza d'Alladin Paſsà inſtituite le diviſe del veſtir della Militia Ottomana, e comincioſſi anco far batter le Monete col nome della medeſima Caſa l'anno 730

Fù

Fù instituito l'ordine della militia de' Gianizzeri l'anno 731

La penuria grande d'acqua nella Città d'Aleppo portava non poco pregiuditio al Publico Errario, e doppo essersi tentate molte vie, per introdurvi quella del Fiume Sazur, in fine riuscì al Sultano d'Egitto in quest'anno tale intrapresa con molto vantaggio di quella Città.

Sultan Orhan l'Armigero occupò la Liconia con la Città di Nicea.

Li Seriffi della Meca ripugnarono di prestar ubbidienza al Sultan Orhano, anzi tutti unitisi contro di lui risolsero far assalir la Caravana de' Pellegrini, che dalli suoi Stati s'incaminava alla visita della Meca, e distruggerli tutti con il loro Capo principale l'anno 732

Sotto la condotta del General Suleiman Passà gl'Ottomani si resero Padroni delle Città di Mudurlì, e Ghioimuch l'anno 733

Cominciò la famiglia di Alimuzaffer a regnare in Persia.

Fù occupata dagl'Ottomani la Città di Ghiemleich l'anno 734

Gl'Ottomani espugnarono le Città di Pollicastri, Carassi, e Pergamo l'anno 735

Gl'Ottomani presero la Città di Tuslà essistente sulle sponde del Mare Bianco, e nella Città di Bursia fondarono una Magnifica Moschea. *Cioè delle Saline.*

Mancato di vita il Principe Ebussaid figliuolo di Hudabendè Han di Mogul fù esaltato a quel Trono il Principe Erhan.

Trovandosi sette fratelli della Real famiglia d'Alizenghis, & havendo questi smembrato l'Imperio, che godeva il Padre in sette Dominii, venne la loro primiera grandezza, & auttorità molto a scemarsi l'anno 736

Gl'Ottomani occuparono la Frigia.

La Casa di Bihdaran cominciò come Sovrana a reger il Dominio di Sebrevar.

Doppo haver il Principe Hassan Ilhaniè acquistato il Regno de' Parti, passò all'impresa di quello di Babilonia, & Armenia Maggiore l'anno 737

Gl'Ottomani occuparono la Caria, & le Città di Armudilì, & Anahor l'anno 738

La Città di Tripoli di Soria fù rovinata dalle scosse d'un Terremoto.

Passarono all'altro Mondo in Cairo li Principi Mustagfi, e Suleiman fratelli discendenti dalla Real Prosapia Abbassiana l'anno 739

Furono da un prodigioso fuoco calato dal Cielo incenerite la maggior parte delli Castelli, e Città attinenti allo Stato di Damasco baizan, e doppo haverli regnato tre Principi di questa discendenza settanta sei anni, rimase priva dell'ottocento, e tredici.

L'anno 750 La Zellaviana dominò il Regno di Masinderan, e doppo haverlo posseduto sette Principi di questa schiata cento, e cinquanta anni, li fù levato del novecento, e nove.

L'anno 760 Quella di Beni Abdulvad si rese Padrona del Regno di Tillimsan, e doppo haverlo dominato tre Principi di quel stipite trentacinque anni, ne fù spogliata del settecento, e novanta cinque.

L'anno 771 La famiglia Tamerlana Georgiana occupò li Regni di Semercanda, e dell'Indie, e vi regnarono in essi successivamente vinti quattro Principi di questa schiata.

Cioè del Rè Tamerlano.

L'anno 773 Quella di Chiezurat s'acquistò la Corona del Dominio di Chiezurat, e doppo haverla posseduta quattordeci Principi di questa discendenza cento, e novanta sette anni, la perdè del novecento, e settanta.

L'anno 774 La Servaniana si rese Sovrana nel Dominio di Servan, e doppo haverlo regnato otto Principi di questa discendenza cento, e settanta un'anno, li fù levato del novecento, e quaranta cinque.

L'anno 777 La Caracoiunlì dominò il Regno di Diarbecchir, e doppo haverlo posseduto quattro Principi di questa famiglia novanta sette anni lo perdè dell'ottocento, e settanta quattro.

L'anno 780 Quella di Zulcadriè s'acquistò il Regno di Marras, e doppo haverlo dominato dieci di quei Principi cento, e quaranta un anno, ne fù privata del novecento, e venti.

L'anno sudetto Quella di Beni Ramasan s'impadronì del Dominio d'Adena, e doppo haverlo goduto otto di quei Principi cento, e novanta anni, li fù levato del novecento, e settanta.

L'anno 783 La Nation Circassa si fece Sovrana nelli Regni d'Egitto, e Damasco, e doppo haverli regnato vinti quattro Principi di quella Natione cento, e quaranta anni, nè rimase priva nel novecento, e venti tre.

L'anno 809 La famiglia di Accoiunlì occupò la Corona di Azerbaisan, e doppo haverla posseduta nove di quei Principi novanta nove anni, li fù levata nel novecento, e otto.

L'anno 839 Quella di Sebicchiè nella Città di Semercanda si fece Sovrana del Regno de' Sciti, e doppo haverlo dominato dieci sette Principi di quella Prosapia duecento, e dieci sette anni, ne fù spogliata nel mille, e cinquanta sei.

L'anno 858 Quella di Ali Tahir occupò il Dominio di Jemen, e doppo haverlo regnato quattro Principi di quella discendenza sessanta

cinque

cinque anni, venne a perderlo nel novecento, e venti tre.

L'anno 876 Quella di Beni Vetas s'impadronì del Regno di Fes, e doppo haverlo dominato sette di quei Principi settanta nove anni, fù privata del novecento, e cinquanta cinque.

L'anno 890 Li Principi del Regno di Ghillan, doppo haverlo otto di quei Principi posseduto cento, e trentacinque anni, ne furono spogliati nel mille, e venti cinque.

L'anno 906 La famiglia Ismailita occupò la Persia, & Azerbaizan, e vi regnarono sette Principi di quella Prosapia.

L'anno 921 La Nobil Prosapia delli Seriffi occupò la Corona del Regno di Fes, e sette Principi di quel stipite successivamente la possederono.

L'anno 953 Quattro Principi della discendenza di Imamam Saidie dominarono l'Arabia Felice.

L'anno 957 Cinque Principi della Prosapia Chieumers occuparono il Trono delli Regni di Rustemdar, e Taberistan.

In somma si raccoglie dalle Croniche antiche, e moderne, che furono regnati vinti sei Dominii da seicento, e cinquanta Principi prima delli Monsulmani, e che da questi furono occupati cento, e dieci Regni, lo Scetro de' quali fù successivamente con dispotica Sovranità impugnato da mille duecento, e quindeci Principi Maomettani, onde in tutto si calcolano cento, e trenta sei frà Regni, e Provincie, e mille ottocento, e settanta cinque Sovrani.

Descrittione degl' Imperatori Ottomani.

SUltan Osman figliuolo d'Odogrul chiamato il Propagator della Legge Maomettana nacque l'anno 657, fù esaltato al Trono nel 699, e doppo haver regnato anni 27 mancò di vita nel 726 *Ottomano.*

Sultan Orhan figliuolo d'Osman detto pure il Propagator, nacque l'anno 680, fù portato al Trono nel 727, e doppo haver regnato trenta sette anni morì nel 761

Sultan Murad figliuolo d'Orhan l'Eroe nacque l'anno 726, fù incoronato nel 761, e doppo haver regnato trenta un anno morì nel 791

Sultan Baiasit detto il Fulmine figliuolo di Sultan Murad Han, nacque l'anno 761, fù assonto al Trono nel 791, e doppo haver regnato quatordeci anni passò all'altro Mondo nel 805

Sultan Mehmet Han figliuolo di Sultan Baiasit Han il Fulmine, nacque l'anno 781, fù incoronato nel 816 e doppo haver regnato otto anni morì nel 824

Sultan Murad Han figliuolo di Sultan Mehmet Han, nacque l'anno

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DEMOTIC HOROSCOPES

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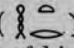
While working on Demotic astronomical texts, I sorely felt the need of palaeographical resources for astronomical symbols. Spiegelberg's attempt in this direction appeared to be incomplete and occasionally unreliable.[1] Moreover, since several of the documents are horoscopes, one could hope to obtain more definite chronological information about the palaeographical material in question by dealing with these texts astronomically. This resulted in finding a very close relationship between five of these horoscopes—so close that a join of one of Spiegelberg's and one of Sir Herbert Thompson's ostraca could be made. As to palaeographical problems, already Spiegelberg assumed a connection between medieval zodiacal and planetary symbols and Demotic forms. This hypothesis is in itself very plausible[2] but very difficult to prove in detail. I hope to have succeeded at least in one particular case, the sign ♎, opening a new possibility to explain the origin of such a symbol. For the majority of signs the main difficulty consists in the complete lack of epigraphic studies in this field as far as Greek papyri and medieval manuscripts are concerned.

Before going into details, I wish to express my warmest gratitude to Dr. G. R. Hughes of the Oriental Institute of the University of Chicago. I owe to him many very valuable suggestions and corrections in my readings and translations. He furthermore drew my attention to the two ostraca published by Thompson and to the papyri Cairo 31222 and 50143. The discovery of the symbol □ for Saturn is one of his results. Finally, Dr. Hughes investigated the approximately 2500 Demotic ostraca in the Oriental Institute with respect to astronomical texts and succeeded in finding one new horoscope, which is published here with the kind permission of the Oriental Institute.

[1] Spiegelberg [3] Pl. IV twice shows the "knife" as the symbol of the zodiacal sign "Leo," although it means "Leo" only once, but "Mars" in the second text (see below Pls. 2 and 4).

[2] As early as 1708, B. de Montfoucon speaks in his *Palaeographia Graeca* (p. 373) about the Egyptian origin of the astronomical symbols, at this time, of course, without any actual epigraphical evidence.

§ 1. Horoscopes

1. Beside the five ostraca discussed below, only one additional horoscope in Demotic writing is known to me, namely, horoscopic notices on a coffin-lid discovered by Brugsch in 1857 at Luxor.[3] The lid shows inside a large figure of Nut surrounded by pictures of the twelve zodiacal signs. Among these signs, the names of the planets are indicated in cursive writing, obviously later additions of the purchaser of the sarcophagus, the priest *Ḥeter* (), indicating the constellations on the day of his birth. These notes are as follows:[4]

u.	{ *ḥr-p-štꜣ n* / *ḥr-pꜣ-kꜣ n my* }	Jupiter (and) Saturn in Leo
v.	*pḫwy n tꜣ* ♍ *ḥr-tšr*	end of ♍: Mars
w.	*šbk tꜣ ḏl.t*	Mercury in Scorpius
x.	above Scorpius: *pꜣ rʿ-ḥʿ*	the ascendant
y.	between Scorpius and Sagittarius: *pꜣ nṯr dwꜣ*	the morning star
z.	above Sagittarius: *nty ꜣt⟨ḥ⟩*	

u. *n*: both *n* refer to *my*, written only once because of lack of space.—v. ♍: written by ideogram only.—v. *pḫwy*; w. *ḏl.t*: these readings were suggested to me by Dr. Hughes.—x and z: reading very doubtful.

Such a complete horoscopic constellation is amply sufficient to determine its date within the narrow limit of some days;[5] the result is 93 A. D., middle of October.[6] Because we know that the owner died at the age of 31½ years,[7] the horoscope must have been written at the latest in the beginning of the year 125 A. D.

2. We turn now to a uniform group of Demotic ostraca, which will henceforth be cited by the following abbreviations:

[3] Brugsch, Rec. I Pl. 34 and 35 and ZDMG **14** (1860) p. 15 ff.

[4] Citations u, v, . . . etc. according to Brugsch.

[5] A simple graphical method proved to be very useful to find in a few minutes the year in question.

[6] The calculated longitudes for 93 A. D. Oct. 16 are: Jupiter in ♌ 11, Saturn in ♌ 21, Mars in ♍ 25, Mercury in ♎ 18 (instead of ♏), Venus in ♐ 11. About 3 or 4 degrees should be added in order to get Egyptian longitudes (cf. Neugebauer [1] p. 230).

[7] Brugsch [1] p. 16.

Os. 1 Chicago M. H. 3377 (see below Pl. 1)
Os. 2 Strassburg (Spiegelberg [3] p. 150)
Os. 3 upper part: coll. Thompson 1 (Thompson [1] Pl. 28)
lower part: Strassburg (Spiegelberg [3] p. 149)
Os. 4 Strassburg D 270 (Spiegelberg [2] col. 223/224)[8]
Os. 5 coll. Thompson 2 (Thompson [1] Pl. 28).

[8] Cf., furthermore, Müller [1] and [2]. Oefele [1] p. 24 contains a rather phantastic treatment of Os. 4 which does not deserve serious consideration.

The most complete form is represented by Os. 3 which gives not only the planetary constellation but accounts for the influence of all twelve zodiacal signs. Os. 1, 2 and 4 restrict themselves to the first part only; Os. 5 is only fragmentarily preserved.

3. The parallelism between these horoscopes is made evident by the following transliteration, with the exception, of course, of the lower part of Os. 3 and the differences due to the special constellation in each case.—The use of modern symbols for the zodiacal signs indicates that only the ideograms are used in the text.

Os. 1.

1. *ḥꜣ.t sp* 43
2. *tpy ꜣḫ.t św* 16(?) *pꜣ ṯy* 8-*t n*
3. *pꜣ hrw iʿḥ n*(?)
4. *pꜣ rʿ n tꜣ* ♍ *śbk*
5. *iʿḥ n pꜣ kꜣ* 21
6. *pꜣ rʿ-ḫʿ pꜣ nty ꜣtḥ ḥr-dš*
7. *pꜣ rʿ-ḥtp nꜣ* ♊
8. *pꜣ šy p.t tꜣ* ♍
9. *tꜣ dꜣ.t nꜣ tbty.w*
10. *swšp n* 10 *tꜣ ḏl ḥr-pꜣ-kꜣ tꜣ ihy.t*

10a. *ḥr-pꜣ-št*

11. *pꜣ swšp n wnm pꜣ mꜣy*
12. [*pꜣ sw*]*šp n wbt*(?) *pꜣ mw*
13. *pꜣ twr n wnm tꜣ* ♍
14. *pꜣ twr wbt*(?) *pꜣ ḥr-ʿnẖ*
15. *pꜣ ʿ sḥn ʿnẖ pꜣ ḥr-ʿnẖ*

Os. 2.

1. *ḥꜣ.t-sp* 4-*t* II *ꜣḫ.t św* 9 *pꜣ ṯy* 11-*t rhwy*
2. *pꜣ rʿ n tꜣ iḫy*
3. *iʿḥ n pꜣ kꜣ n* 16 *ḥr-dš*
4. *pꜣ*(?) *rʿ-ḫʿ n*(?) *tbty.w*
5. *pꜣ rʿ-ḥtp n*(?) ♍ *n*(?) *ntr dwꜣ*
6. *pꜣ šy p.t pꜣ nty-ꜣtḥ*
7. *pꜣ šy dꜣ.t nꜣ* ♊
8. *pꜣ swšp n* 10 *tꜣ ḏl*
9. *pꜣ swšp n wbt*(?) *pꜣ mꜣy*
10. *pꜣ swšp n wnm pꜣ mw*
11. [*pꜣ t*]*wr* [*n*] *wnm tꜣ* ♍

destroyed

Os. 3.

1. *ḥꜣ.t-sp* 4-*t* III [*pr*]*.t* 1 *pꜣ ṯy* 4-*t n rhwy* ...
2. *pꜣ rʿ n nꜣ tbty.w ḥr-pꜣ-št*
3. *iʿḥ n pꜣ nty ꜣth*...
4. *pꜣ rʿ-ḫʿ tꜣ iḫy*
5. *pꜣ rʿ-ḥtp pꜣ isw*
6. *pꜣ šy p.t pꜣ gnḥḏ*
7. *tꜣ dꜣ.t pꜣ ḥr-ʿnẖ ḥr-pꜣ-kꜣ*
8. *pꜣ swšp n mtr* [*nꜣ*] ♊
9. *pꜣ swšp n wbt*(?) *n* (?) [*tbt*]*y*
10. *pꜣ swšp n wnm tꜣ* ♍
11. *pꜣ twr n wnm pꜣ isw*
12. *pꜣ twr wbt*(?) *pꜣ mw pꜣ mꜣy*
13. *pꜣ ʿ sḥn ʿnẖ* [*tꜣ*] *ḏl*
14. *tꜣ dny.t śn pꜣ nty-ꜣtḥ*
15. *tꜣ dny.t it pꜣ ḥr-ʿnẖ*
16. *tꜣ dny.t šry pꜣ mw śbk*
17. *tꜣ dny.t ḫne nꜣ tbt.w*
18. *tꜣ dny.t sḫne pꜣ isw*
19. *ʿ sḥn mt pꜣ kꜣ ḥr-dš*
20. *tꜣ dny.t ntr nꜣ* ♊
21. *pr ntr.t*(?) *pꜣ gnhḏ*
22. *pꜣ šy pꜣ mꜣy*
23. *pꜣ sšr tꜣ* ♍

Os. 4.

1. *ḥꜣ.t-sp* 21 III *šmw św* 13 *pꜣ ṯy* 7-*t* [*n pꜣ hrw*]
2. *pꜣ rʿ n pꜣ gnḥḏ śbk*
3. *iʿḥ n pꜣ nty ꜣtḥ n* 1
4. *pꜣ rʿ-ḫʿ tꜣ iḫy*
5. *pꜣ rʿ-ḥtp pꜣ isw*
6. *pꜣ šy p.t pꜣ gnḥḏ*
7. [*pꜣ*] *šy dꜣ.t pꜣ ḥr-ʿnẖ*
8. *pꜣ swšp n mtr nꜣ* ♊
9. *pꜣ swšp n wnm nꜣ tbty.w*
10. [*pꜣ s*]*wšp n wbt*(?) *tꜣ* ♍
11. [*pꜣ t*]*wr n wnm pꜣ isw*
12. [*pꜣ twr*] *wbt*(?) *pꜣ mꜣy pꜣ* [ʿ]
13. [*sḥn ʿn*]*ḫ tꜣ ḏl*

The following translation consistently substitutes modern names for the planets and zodiacal signs, even where the Egyptian expressions are very different, as "Horus the bull" for Saturn etc.

Os. 1.

[1] Year 43
[2] month I, day 16(?), 8 o'clock of
[3] the day. The moon in(?)
[4] The sun in ♍ (and) Mercury.
[5] The moon in Taurus 21°.
[6] The ascendant: Sagittarius (and) Mars.
[7] The descendant: ♊
[8] The lake of the sky: ♍
[9] The Dwat: Pisces
[10] The middle *swšp*: Scorpius (and) Saturn. Libra [10a] Jupiter
[11] The right (= western) *swšp*: Leo.
[12] [The] left (= eastern) *swšp*: Aquarius
[13] The right (= western) *twr*: ♍
[14] The left (= eastern) *twr*: Capricornus.
[15] The house of provision of life: Capricornus.

Os. 2.

[1] Year 4, month II, day 9, 11 o'clock in the evening.
[2] The sun in Libra.
[3] Moon in Taurus 16° (and) Mars.
[4] The ascendant: Pisces.
[5] The descendant: ♍ (and) Venus.
[6] The lake of the sky: Sagittarius.
[7] The lake of the Dwat: ♊
[8] The middle *swšp*: Scorpius.
[9] The left (= eastern) *swšp*: Leo.
[10] The right (= western) *swšp*: Aquarius.
[11] [The] right (= western) *twr*: ♍

destroyed

Os. 3.

[1] Year 4, month VII, (day) 1, 4 o'clock in the evening . . . .
[2] The sun in Pisces (and) Jupiter.
[3] Moon in Sagittarius 1°(?)
[4] The ascendant: Libra.
[5] The descendant: Aries.
[6] The lake of the sky: Cancer.
[7] The Dwat: Capricornus (and) Saturn.
[8] The middle *swšp*: ♊
[9] The left (= eastern) *swšp*: Pisces.
[10] The right (= western) *swšp*: ♍
[11] [The] right (= western) *twr*: Aries.
[12] [The left (= eastern)] *twr*: Aquarius(!) Leo.
[13] The house of provision of life: Scorpius.
[14] The part of the brother: Sagittarius.
[15] The part of the father: Capricornus.
[16] The part of the child: Aquarius (and) Mercury.
[17] The part of (?): Pisces
[18] The part of the fate: Aries.
[19] The house of provision of death: Taurus (and) Mars.
[20] The part of god: ♊
[21] The house of the goddess: Cancer.
[22] Psais: Leo.
[23] The evil spirit: ♍

Os. 4.

[1] Year 21, month XI, day 13, 7 o'clock [of the day].
[2] The sun in Cancer (and) Mercury.
[3] Moon in Saggittarius 1°
[4] The ascendant: Libra.
[5] The descendant: Aries.
[6] The lake of the sky: Cancer.
[7] [The] lake of the Dwat: Capricornus.
[8] The middle *swšp*: ♊
[9] The right (= western) *swšp*: Pisces.
[10] [The] left (= eastern) *swšp*: ♍
[11] [The] right (= western) *twr*: Aries.
[12] [The] left (= eastern) [*twr*]: Leo. The [house]
[13] [of provision of li]fe: Scorpius.

Os. 1. 2. 16(?): Reading of 10 clear; it follows a group which is either 5, 6 or 8. The position of the moon, given in line 5 as ♉ 21, would be exactly correct if one would read 16.—3. *iʿḥ*: mention of the moon here (cf. line 5) seems to be meaningless.—3. *n*(?): The photograph shows at the end of this line a dark stroke. Dr. Hughes, however, carefully inspected the original and found that the "sign" in question is not ink at all but only a small depression in the surface of the clay. There follows, however, a short stroke of ink (like *n*) immediately after *iʿḥ*.—10. *swšp*: no traces of *pꜣ* visible. —10. 10: cf. the same writing for *mtr* in Os. 2 line 8. —10a: Written between lines 10 and 11.—14. *twr wbt*: without *n*, as in Os. 3 line 12.

Os. 2. 1. 4-*t*: *t* omitted by Spiegelberg.—1. *ꜣḫ.t*: Spiegelberg reads *šmw*, which is astronomically excluded because, according to line 2, the sun was in Libra.— 1. 11-*t*: Spiegelberg reads 11 *n*.—1. *rhwy*: 11 o'clock "in the evening" could be understood as 11th hour of the daytime i. e. one hour before sunset. In Os. 3, 1 however, occurs 4 o'clock "in the evening" which must be the 4th hour of the night. Hence *rhwy* must be interpreted as "night."—4. *pꜣ*(?): looks like an *r*.—4. *n*(?): merely a point.—5. *n*(?): merely a point.—5. *ntr dwꜣ*: Spiegelberg reads *n*(?) *tu-ntr*.—8. *n*: omitted by Spiegelberg.—8. 10: 10 = *md* stands here for *mtr*, as Spiegelberg [3] p. 150, note 4 remarks. Cf. Os. 1, line 10.— 9 ff. *n*: disregarded by Spiegelberg.

Os. 3. 1. [*pr*].*t* 1: Thompson reads *pr ss* 1. Both *pr.t* and *ꜣḫ.t* would be compatible with the remains but the reading *ꜣḫ.t* is eliminated by the following line, which says that the sun stood in Pisces. The following large stroke must represent the first day (without ⊙), as is frequently the case in the planetary texts.—1. *rhwy*: cf. Os. 2, 1.—1. . . . ////: traces, probably meaningless. —3. . . . : according to photograph traces (disregarded by Thompson) which might be interpreted as *n* 1 (i. e. "first degree").—9. [*tbt*]*y*: sic, without the plural *w*.— 11, 12, 13. The break between upper (Thompson) and lower part (Spiegelberg) crosses these lines.—12. *twr wbt*: cf. Os. 1, line 14.—*pꜣ mw*: error, corrected by adding *pꜣ mꜣy*.—13. *sḥn* = provision: sic, according to Thompson; Spiegelberg read 2.—14. *šn*: this reading according to Thompson; Spiegelberg read *mwt*.—14 ff. *dny.t*: Spiegelberg *tꜣ*.—17. *ḫne* = (?): Spiegelberg translated "Trennung," probably because of the subsequent line.—18. *sḫne* = fate: cf. the discussion by Thompson [1] p. 230; Spiegelberg translated "Vereinigung."— 19. ʿ: written over *tꜣ dny.t*. 19. *sḥn*: cf. line 13.

Os. 4. 1. *św*: omitted by Spiegelberg.—13: Spiegelberg reads 13 and translates 15.—7-*t*: left-hand part of the numeral is broken off.—3. *n* 1: disregarded by Spiegelberg.—8 ff. *swšp*: Müller [2] col. 9 proposes to read only *swš*, considering the last sign as determinative. Spiegelberg [3] p. 150, note 1 opposes this assumption.—8. *nꜣ* ♊: Spiegelberg *pꜣ* (?) *kꜣ* but correct in [3] Pl. IV.—9. *nꜣ*: Spiegelberg *pꜣ*.—12. *pꜣ* [ʿ]: *pꜣ* disregarded by Spiegelberg.

4. From these four ostraca we can derive the following scheme according to which they were composed. The first step consists in giving the date (regnal year, month, day and hour) and the position of the sun, the moon and the planets. The next part consists in giving the four "κέντρα," the three "*swšp*" and the two "*twr*." The "κέντρα" are the rising and setting signs (*rʿ-ḫʿ* and *rʿ-ḥtp*) and the lake of the sky and Dwat, respectively.[9] The *swšp* correspond to the ἀποκλίματα of Greek astrology,[10] i. e. the signs inclined in the direction of the daily rotation, thus preceding the three upper κέντρα by 30 degrees. The "left-" and "right-hand" *twr*'s define a parallel line to the left and right *swšp* (cf. Fig. 1). I do not know the Greek analogue to this latter concept, except that the two *swšp* constitute the corners of a "trigonon." The last step consists in enumerating the "houses" in their relationship to the zodiac in its special position at the given moment. The first house is not repeated because it is the ascending sign, already mentioned before. The next sign is

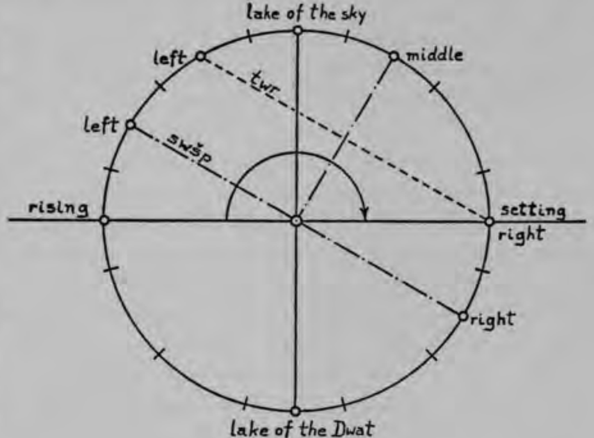


Fig. 1.

the ʿ *sḥn ʿnḫ* "house of provision of life"[11] (the "*lucrum*" of classical astrology); the knowledge

[9] This fact was recognized already by Thompson [1] p. 228 and has been confirmed independently and based on entirely different textual material (commentary to the Nut-picture in the cenotaph of Seti I and the tomb of Ramesses IV) by Lange-Neugebauer [1] p. 57 ff.

[10] Cf. e. g. Bouché-Leclercq AG p. 273 and Thompson [1] p. 231.

[11] Thompson [1] p. 230. Cf. Bouché-Leclercq AG p. 280 ff. or Boll-Bezold SS p. 62 f. See furthermore the new text Gundel, Dek. p. 410.

of this sign determines the rest according to the known scheme, which is therefore only once completely given (Os. 3), while the other ostraca restrict themselves to the ' *sḥn 'nḫ* alone. Not one of these ostraca indicates the conclusions drawn from these elements.

There exist different small discrepancies between this general scheme and the text in the ostraca. Ostraca 2 and 3 interchange "right" and "left" in indicating the *swšp*'s but give the *twr*'s correctly. Ostracon 1 turns all *swšp*'s and *twr*'s 90 degrees towards the east, obviously by erroneously calling the left hand *swšp* the "middle" one and then modifying all the rest accordingly. All these errors, however, are only due to carelessness and do not disprove the above-given rules.

5. We turn now to the problem of dating the four ostraca. The easiest case is No. 1, where the regnal year 43 points to Augustus as the only possibility. This is fully confirmed by the planetary positions (cf. the table given on p. 120). The position of the moon (♉ 21), however, can only be accounted for if we interpret the dates in terms of the Alexandrian calendar, using "Julian years," and not as dates in the Old-Egyptian wandering year which would give a totally different value (♒ 22) for the moon's longitude.

Os. 3 is also easy to date because the positions of both of the slowly moving planets, Jupiter and Saturn, are given. Here again the position of the moon shows that the Alexandrian calendar was used. All positions given in the text accordingly agree perfectly with modern calculation for the year Tiberius 4 = 18 A. D.

More difficult is the dating of the two remaining ostraca because of missing information about the two outer planets. In Os. 4 the regnal year 21 points to Augustus or Tiberius. Assuming Augustus, the moon does not agree with the sign Sagittarius, regardless of whether we use the Egyptian or Alexandrian calendar. Tiberius 21, however, brings the moon into the right place if we interpret the date in the Alexandrian calendar. Sun and Mercury then also become correctly placed.

Os. 2 requires a longer discussion. From the positions given for the sun (♎) and the moon (♉ 16), it follows that the moon must be about three days after opposition. Assuming the Alexandrian calendar, we find October 3 (± 1 day) as the date of full moon. Investigating all regnal years 3[12] and 4 between, say, 40 B. C.[13] and 160 A. D. as to full-moon dates we find that only Tiberius 3, Domitianus 3 and Hadrian 4 remain possibilities. All these dates are, however, ruled out by considering Mars, which is far from ♉ in all these dates. We are, therefore, forced to abandon our assumption of Alexandrian calendar and to interpret the date as Egyptian. Doing so, we obtain perfect agreement with the text for the year Tiberius 4 not only so far as sun and moon are concerned but also for Venus and Mars.

The table on p. 120 shows the results obtained. Comparing text and calculation, one must keep in mind that the Egyptian limits of the zodiacal signs must not necessarily coincide with ours (true vernal point); as a matter of fact, the Demotic planetary tablets show that 4° or 5° should be added to calculated values in order to get Egyptian longitudes.[14] In the given dates, (a) means Alexandrian calendar, (e) Egyptian, (j) Julian.

The small deviations in the case of moon (daily movement from 11 to 15 degrees!) and Mercury are easily accounted for, because all these horoscopes are of course based on calculation and not on actual observation.

The fact that three of these ostraca use the Alexandrian calendar and one the Egyptian is in itself of interest. It shows on the one hand how early the Augustan new order was adopted by Egyptian scribes, and on the other hand, how unstable the calendarical rules were. This is underlined by experience with other texts. The Alexandrian calendar is the basis for the Stobart planetary tables, covering the years from 71 A. D. to 143 A. D., but the Egyptian calendar is employed both in the planetary tables of Pap. Berlin 8279, written after 42 A. D., and in the moon tables of Pap. Carlsberg 9, written after 144 A. D.[15] That Ptolemy and his successors (from Pappus and Theon to Copernicus) base all their calculations on Egyptian years is well known.

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[12] The reading 3 would be even better than 4. The same sign form occurs, however, as 4 in the date of Os. 3 and in Pap. Carlsberg 9.

[13] Among the approximately 50 published horoscopes on Greek papyri and ostraca, the oldest is from 4 B. C. (P. Oxyrh. No. 804; erroneously printed A. D. instead of B. C.), and only five belong to the first cent. A. D.

[14] Cf. Neugebauer [1] p. 230.

[15] Cf. Neugebauer [1] p. 229 and Neugebauer-Volten [1] p. 398.

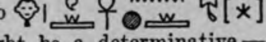
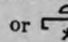
		Os. 1		Os. 2		Os. 3		Os. 4	
		text	calcul.	text	calcul.	text	calcul.	text	calcul.
☉		♍	♍ 19	♎	♎ 1	♓	♓ 5	♋	♋ 12
☾		♉ 21	♉ 22	♉ 16	♉ 24	♐ 1(?)	♏ 29	♐ 1	♐ 21
☿		♍	♎ 4			♒	♓ 18	♋	♋ 6
♀				♍	♍ 5				
♂		♐	♐ 27	♉	♉ 6	♉	♉ 23		
♃		♎	♎ 18			♓	♓ 11		
♄		♏	♏ 15			♑	♑ 12		
date	text	(Augustus) 43 I(a) 16 8^h d.		(Tiberius) 4 II(e) 9 11^h n.		(Tiberius) 4 VII(a) 1 4^h n.		(Tiberius) 21 XI(a) 13 7^h d.	
	equiv.	+ 13 IX(j) 13		+ 17 IX(j) 26		+ 18 II(j) 25		+ 35 VII(j) 7	

6. The dates obtained in the preceding section show that all four ostraca give horoscopes for men living in the first half of the first century of our era. As to the place of origin, Os. 1 was found in the campaign of the Oriental Institute of the University of Chicago during 1929/30 at Medinet Habu. Os. 4 was purchased in 1899 by Spiegelberg in Gurna,[16] Os. 2 and the lower part of Os. 3 ten years later by Wreszinski in Luxor.[17] This makes it very probable that all four texts were written by the same man at Medinet Habu.

It is possible that also the last horoscope, Os. 5, belongs to the same group, but it is too badly preserved to be dated. One can read the following:[18]

1 [pꜣ rʿ] n pꜣ kꜣ ▨▨▨
2 [iʿḥ n] pꜣ kꜣ 17(?) ▨▨▨
3 [pꜣ rʿ]-ḫʿ pꜣ ḥr-ʿnḫ ▨▨▨
4 pꜣ rʿ-ḥtp pꜣ gnḥḏ ... ▨▨▨
5 pꜣ šy tꜣ p.t tꜣ ♎
6 pꜣ šy tꜣ dꜣ.t
7 pꜣ iswe ♏
8 ▨▨▨ pr(?) pꜣ šy ▨▨▨
9 ▨▨▨ pr(?) pꜣ] šp-šy ▨▨▨

[The sun] in Taurus ▨▨▨
[Moon in] Taurus 17°(?) ▨▨▨
[The] ascendant: Capricornus ▨▨▨
The descendant: Cancer
The lake of the sky: ♎
The lake of the Dwat:
Aries. ♏
▨▨▨ house(?) of šy.t
▨▨▨ house(?) of] šp-šy.t

1. *n*: omitted by Thompson. — 2. 17(?): omitted by Thompson; according to the preceding ostraca one would expect *n* before the number-sign. — 3. *ḥr ʿnḫ*: written in hieratic signs corresponding to  — 4. ....: strokes which might be a determinative. — 5. ♎: written in hieratic, probably ending  or  as Dr. Hughes recognized. — *dꜣ.t*: Thompson thought that the latter part of the line did not belong to the word *dꜣ.t*, as dots in his transcription indicate. Dr. Hughes, however, pointed out to me that we have here only a full spelling of *dꜣ.t*. — 7. Thompson hesitatingly read *my*, but Dr. Hughes recognized that *iswe* becomes clear if one eliminates the long tail of the sign *šy* reaching down into line 7 from line 6.

16 Spiegelberg [2] col. 223 note 1.

17 Spiegelberg [3] p. 149.

18 Cf. Thompson [1] p. 232 f.

Lines 1 to 7 indicate beside the positions of sun and moon the four *κέντρα* ♑ ♋ ♎ ♈. One should now expect the three *swšp* ♐ ♊ ♍, but line 7 mentions without explanation ♏, which would be the left *twr*. Also the two following "houses," mentioned in the two last lines (8 and 9), do not fit into the regular scheme as given by Os. 3.

§ 2. The date of origin of Egyptian astrology and the symbol ♎

7. It is well known that there is no trace of astrology in Egypt before the Hellenistic period. Moreover, as Kroll pointed out,[19] the doctrine going under the name of Nechepso and Petosiris reflects circumstances in Egypt and Syria existing in the middle of the second century B. C. It seems possible, however, to discover traces of a phase approximately a hundred years older by using the relationship between the zodiac and the Egyptian calendar established in ostracon D 521 of the Strassburg collection, published 1902 by Spiegelberg.[20] This text is as follows:

1 *pꜣ wn pꜣ 5 syw ꜥnḫ ḥr-pꜣ-kꜣ pꜣ syw*
2 *pꜣ rꜥ pꜣy ḥr-dš pꜣ syw mꜣe-ḥs pꜣy*
3 *sbkꜣ pꜣ syw tḥwty pꜣy pꜣ ntr-twy*
4 *ḥr sꜣ is.t pꜣy ḥr-pꜣ-šte pꜣ syw imn pꜣy*
5 *pꜣ rn n pꜣ 5 syw ꜥnḫ irm ntrw nb*
6 *r ir rnw ḏrw . . . pꜣ wn nꜣ syw nty sr*
7 *pꜣ ibd* 12 . . . II *pr.t pꜣ isw* III *pr.t pꜣ kꜣ*
8 IV *pr.t nꜣ ḥtrw tpj šmw pꜣ knhḏ*
9 II *šmw pꜣ mꜣe* III *šmw tꜣ rpy*
10 IV *šmw tꜣ iḫy.t tpy ꜣḫ.t ḏlꜣ*
11 II *ꜣḫ.t pꜣ* ▨▨▨ III *ꜣḫ.t pꜣ ḥr-ꜥnḫ*
12 IV *ꜣḫ.t pꜣ* (?) *n pꜣ mw*
13 *tpy pr.t nꜣ tbt.w*
14 *dmd syw* 12 *pꜣ ibd* 1[2 ▨▨▨]
15 *r pꜣ ibd*

2. *mꜣe ḥs*: "the fierce lion" = god Αρμινσις (cf. Spiegelberg [1] col. 8 note 3 and WB II p. 12).—3. *sbkꜣ*: the Stobart tablets alternate between *sbk* and *sbky*; cf. Neugebauer [1].—4. *Ḥr sꜣ is.t*: Greek Αρσιησις (cf. WB III, 123).—5. *pꜣ rn*: Spiegelberg *r*(?) *pꜣ rn*, but I do not see any trace of *r*.—5. *ntrw*: Spiegelberg *nꜣ ntrw*.—6. *ḏrw* . . . : read by Spiegelberg *imw* who translated "deren Namen darin sind (?)." Müller [1] 135 proposed the translation "die damit benannt werden." The group which follows *ḏrw* is unintelligible to me.—6. . . . : Spiegelberg read "*is*(?)" and translated "das sind," as he did in line 14. In the latter place, however, one must read "*dmd*" = "total, sum," which gives no sense here (Hughes).—6. *sr* spread (among): this translation according to Müller [1], 135: "welche verteilt sind (ⲥⲏⲣ) [auf (ⲉ) (?)] die 12 Monate." There is, however, nothing destroyed either at the end of line 6 or at the beginning of line 7 which could justify the restoration of the necessary [ⲉ]. Spiegelberg translates "die kreisen (?) in den 12 Monaten."—7. . . . : sign for "namely" heading lists; cf. Griffith, Ryl. III p. 420. Spiegelberg read *is*(?) but gave no translation.—7. *pr.t*: Spiegelberg *šmw* (twice).—7. *isw*: Spiegelberg *isw* "die Wage"; corrected by Müller [1], 135.—8. *pr.t*: Spiegelberg *šmw*.—8. *šmw*: Spiegelberg *pr.t*.—9. *šmw*: Spiegelberg *pr.t* (twice).—10. *šmw*: Spiegelberg *pr.t*.—10. *tꜣ ꜣby.t*: Spiegelberg *nꜣ sti*(?), corrected in his article [3] to *tꜣ ꜥbi*. The whole group is written above signs crossed out by the scribe.—11. *pꜣ* . . . . : signs carefully crossed out by the scribe. Spiegelberg [3] p. 148 and Pl. IV gave a restoration of the original signs but I am not able to recognize a single trace of them.—12. *pꜣ* (?) *n pꜣ mw*: Spiegelberg's reproduction of this passage in [3] Pl. IV contains three errors: the sign after the first group is not the star but a long vertical line with a cross in its middle (crossed out?); the following *n* is missing (nothing being destroyed); the star at the end is omitted. The first part of the first group is crossed out by the scribe. Müller [1] 135 proposes the reading *ššw*; Spiegelberg opposes this reading (OLZ 5, 136 note 1 and [3] p. 148 note 3). Perhaps, it was the intention of the scribe to cancel the whole group before *pꜣ mw* (cf. Os. 4 line 10 and Os. 3 line 6, both of which have only *pꜣ mw*). 13. *pr.t*: Spiegelberg *šmw*.—14. *dmd*: Spiegelberg read *is* and translated "das sind." For *dmd* see Griffith, Ryl. III 412 and Sethe, Bürgschaftsurk. p. 167 ff. [Hughes].—15. *r pꜣ ibd*: ignored in Spiegelberg's translation.

Translation:

1 List of the 5 living stars: Horus the bull (= Saturn), it is the star
2 of Re. Horus the red (= Mars), it is the star of the fierce lion.
3 Sbg (= Mercury), it is the star of Thoth. The morning star (= Venus),
4 it is Horus, son of Isis. Horus of the secret (= Jupiter), it is the star of Amun.
5 These are the names of the 5 living stars together with all gods
6 constituting their names. The list of the stars which are spread (among)
7 the 12 months, viz.: VI Aries. VII Taurus.
8 VIII Gemini. IX Cancer.
9 X Leo. XI Virgo.
10 XII the horizon (= Libra). I Scorpius.
11 II [Sagittarius]. III the goat-faced (= Capricornus).
12 IV the (?) of the water (= Aquarius).

[19] Cf. RE **16**, col. 2160-2167 or Cumont EA p. 39; cf. also the graphical representation in Gundel, Dek. p. 92.

[20] Spiegelberg [1] and Müller [1], [2]. Spiegelberg assumed the date of first cent. A. D. but earlier than Os. 4 (horoscope for 35 A. D.) which he placed into the second cent. A. D. (Spiegelberg [2], 225).

[13] V Pisces.
[14] Total 12 stars, 1[2] months, [one star]
[15] to the month.

The above given list of the five planets follows the order

♄ ♂ ☿ ♀ ♃

which separates the evil planets ♄ and ♂ from the benevolent ♀ and ♃ by the doubtful ☿ — an idea also expressed in the younger Babylonian order.[21] There now follows a coordination of months and zodiacal signs in which the first month coincides with ♏. This indicates the use of the Egyptian calendar, because during Roman times the sun never stands in Scorpius during the first months of the Alexandrian calendar. In the Egyptian calendar, however, Scorpius coincides with the path of the sun in 250 B. C., a coincidence which holds to a continuously decreasing degree during the following century.[22] The list given here corresponds therefore to a situation of the third century B. C.

8. Accepting this conclusion, a problem might find its solution which otherwise seems to be without possibility of explanation, namely the denomination of the sign ♎ as "horizon" (*ꜣḫ.t*) in all our Demotic sources,[23] known to us as the "balance." It is well known, on the other hand, that the Greeks usually combined the two neighboring signs, Scorpius and Libra, into one great configuration of a scorpion, calling one half (the ♏) the "body" the other half (♎) the "claws" (*χηλαί*) of the scorpion.[24] The name *ζυγός* "(beam of the) balance," Latin "libra," appears rather late in Greek literature: only once in Hipparchus' writings (ca. 150 B. C.),[25] more frequently in Geminus (first cent. B. C.) and afterwards, but more in Roman works than in Greek.[26]

On the other hand, the constellation "balance" is already known in Old-Babylonian times, but in the series "*mul-apin*" also the equivalent "sting of the scorpion" appears.[27] The cuneiform ephemerids from the Seleucid period keep "balance" (*rín*) and "scorpion" (*gír-tab*) strictly separated.[28] The latter statement holds equally for the Egyptian representations of the zodiac, the earliest preserved examples being at Dendera (time of Tiberius). In the pictorial representations a clear balance is always given and nothing like a "horizon." How can this contradiction be explained?

I think one must first try to discover a reasonable motive for calling a zodiacal sign "horizon." Such a reason can be found in the special situation which is assumed by the correspondance between zodiacal signs and months, given in ostracon D 521, discussed above, where the sun is supposed to travel in "Scorpius" during the first month of the Egyptian calendar. From this assumption follows, namely, that the preceding sign "balance" was rising heliacally at the beginning of the year —sufficient reason, indeed, to be called "(being in the) horizon." Such an emphasis on the quality of a constellation to indicate the beginning of the civil year by its heliacal rising would certainly be nothing surprising in Egypt; moreover this sign is, so to speak, the "Horoscope" of the year.[29]

If one considers this explanation of the name "horizon" as plausible, one can accept the fol-

[21] The Babylonian order is ♃ ♀ ☿ ♄ ♂; cf. Boll [1]. In Egypt we have the following orders: according to *synodic period* in the planetary tables (cf. Neugebauer [1]), according to "*houses*" in the Hathor temple of Dendera (outer hypostyle; Porter-Moss VI p. 49) and according to "*exaltations*" in the same temple (eastern Osiris-chapel; Porter-Moss VI p. 99), as discovered by Boll (Sphaera p. 232 ff.). Cf. furthermore the article "Hebdomas" by Boll in RE **7** col. 2547-2578.

[22] Cf. Neugebauer [1] p. 246.

[23] Müller [1] and [2] assumed an erroneous etymology which substituted *mby.t* by *ꜣḫ.t*. But this is in itself very unlikely and contradicts both spelling and ideogram in all texts. Cf. Spiegelberg [3] p. 147 note 6.

[24] This distinction, e. g., frequently in the Tetrabiblos (cf. e. g. I, 9 ed. Robbins p. 50/51). There exists even a glyptic representation of the claws alone, namely on a reused block in the Panhagia Gorgopico or Hag. Eleutherios church in Athens. Cf. G. Thiele, Antike Himmelsbilder (Berlin 1898) p. 57 ff. and L. Deubner, Attische Feste (Berlin 1932) p. 248 ff. esp. Pl. 40 no. 41. The date of this frieze is uncertain; Deubner quotes arguments for dates from the third cent. B. C. to the third cent. A. D.

[25] Ed. Manitius p. 222, 9. This passage is therefore considered as suspicious.

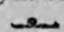
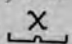
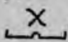
[26] Cf. the articles "Libra" and "Scorpios" by Gundel in RE **13**, 116-137 (1926) and **A 3**, 588-609 (1927); furthermore the article "Sternbilder" in Roscher GRM **6**, 963-967 (1937) by Boll and Gundel.

[27] CT 33, 2 obv. II, 11 *mulzi-ba-an-na si mulgír-tab*. Cf. Jensen [1].

[28] This follows from all moon and planetary tablets published by Kugler and is only confirmed by unpublished material. The "sting of the Scorpion" appears, however, in the horoscope AB 251 obv. 3 (Thompson CBL plate 2).

[29] One might remark that the decans are called the 36 *ὡροσκόποι* in P. Brit. Mus. No. 98 line 15 (Kenyon GP I p. 128).

lowing outline of the development. When, during the third cent. B. C., Babylonian and Greek astrological concepts were introduced into Egypt, the more or less precisely defined belt of 36 decanal configurations was replaced by the twelve zodiacal signs.[30] The Greek names were translated into Egyptian, but since the "Scorpio" extended over *two* twelfths, it was felt so inconvenient that the Babylonian order Scorpius-Libra was adopted so far as pictorial representations are concerned. Simultaneously, the horoscopic character of this star group leads to an original Egyptian name which is the only one preserved in Demotic documents.

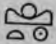
9. The further development can be traced with a much higher degree of certainty than the beginnings. Since Roman times,[31] astrology became in Egypt what we understand today by this word, deeply influencing the life both of the native and the Hellenistic-Roman population. Undoubtedly, every astrologer was familiar with the Egyptian symbols for the zodiacal signs and the planets, and it is therefore not surprising to find Egyptian forms used as sigla in the professional writings. Obviously, the Hieratic-Demotic sign [32] in this way became a representation for the Greek "claws of the Scorpion." We have, however, a very interesting bit of evidence that  still was pronounced "χηλαί." Hephaistion of Thebes, an astrological author of the 4th cent. A. D. says:[33] Τὸ δέ μετὰ τὴν Παρθένον δωδεκατημόριον ὠνόμασαν οἱ παλαιότεροι πάντες ζυγόν καὶ τοῦτον σημεῖον ποιοῦνται τόδε ≏, ὁ δὲ Πτολεμαῖος χηλὰς καὶ τὸ σημεῖον αὐτοῦ τοιόνδε  "All the older ones called the sign after Virgo the Balance and used the following symbol: ≏; Ptolemy, however, called it the claws and used the sign ." The statement about the use of the words "balance" and "Claws" gives, as we have seen, the inverse order; but the essential point in our discussion is the fact that the combination of the "horizon" and the abbreviation χ for χηλαί existed at least as early as the 4th century A. D. or even actually in Ptolemy's time, the very period of some of our Demotic astronomical texts. That this combination of the two symbols was not an isolated incident is proved by the fact that it is actually used in one of the codices of the Tetrabiblos, namely in the Cod. Vatican 208[34] written in the XIVth cent.[35] Hence we have at least one thousand years of continuous tradition down to Hephaistion. His testimony finally bridges the short gap to the extant Demotic papyri and ostraca. On the other hand, the Greek terminology was more and more replaced by Latin, in which "*libra*" always was the preferred notation. So it happened that the sign ≏ was not only called but also was interpreted as the picture of a balance—which is still the explanation in common use today.

§ 3. The Zodiacal and Planetary Symbols

10. If one wishes to investigate the history of the medieval and modern symbols used for zodiacal signs and planets, then the signs used in Demotic documents are undoubtedly the earliest known symbols—cuneiform ideograms like *ḫun, múl,* etc. are of course out of the question.[36] However, to follow the history of these sigla into Greek and Latin documents meets the greatest difficulties, not so much by lack of documents but by the combined efforts of classical scholars in virtually extinguishing all traces of the palaeographical situation. The astronomical symbols have been treated with the greatest disregard, symbols being

[30] The earliest representation of the zodiac in Egypt known to me is the ceiling in the temple of Khnum north-west of Esna (about 200 B. C.; cf. Porter-Moss VI p. 118).

[31] It might be repeated that there exists, at least to my knowledge, not a single horoscope in Egypt (either in Greek or Demotic) earlier than 4 B. C.! (Cf. above note 13.)

[32] The second line in ≏ might have its origin in forms like  Cf., e. g., P. Cairo 50143 (Spiegelberg DD II Pl. 59).

[33] CCAG **8**, 2 p. 43 (P 57, 1). This codex was written in the XVth cent. (cf. CCAG **8**, 2 p. 11, No. 21).

[34] I owe photocopies of the pages 150 r., 151 v. to the courtesy of the Library of the University of Michigan; they correspond to ed. Boll-Boer p. 73, 22-76, 33 and ed. Robbins p. 152-158.

[35] This codex belongs to family γ according to Boll-Boer p. xiv (codex B = codex A Robbins).

[36] Agnes M. Clerke says in the article "Zodiac" on p. 998 of the 11th ed. of the Encyclopaedia Britannica (1911): The origin of the zodiacal symbols "is unknown; but some, if not all of them, have antique associations. The hieroglyph of Leo, for instance, occurs among the symbols of the Mithraic worship" quoting "Lajard, Culte de Mithra Pl. 27 fig. 5" where a Babylonian cylinder seal is published. This seal (which, of course, has no relationship whatsoever to the worship of Mithra) is republished by E. Douglas Van Buren AfO **9** (1933/34) p. 168 fig. 4 (I owe this quotation to Miss E. Porada). The symbol in question (looking like the modern symbol for the ascending node) is, however, shown by Mrs. Van Buren to be a symbol of the goddess Ninḫursag and has no relation to the configuration "Leo."

replaced by words and vice versa. It is therefore absolutely impossible to give today more than a few examples accidentally collected from published photographs. I was not even able to verify a statement of Cumont that the zodiacal symbols "sont déjà employés dans les papyrus et remontent au moins à l'époque hellénistique." [37] The earliest forms of the planetary symbols known to me [38] are taken from

(I) Cod. Laur. 28, 34 fol. 132v. (XI-th or X-th cent.) [39]

and the zodiacal signs from

(II) Cod. Vatican. 1594 fol. 155r. (IX-th cent.). [40]

For more recent forms I used

(III) Cod. Paris. 2424 fol. 189r. (XIV-th cent.) [41]

(IV) Cod. Vatican. 208 fol. 150v., 151r. (later XIV-th cent.) [42]

but I must repeat that these examples can by no means be considered as more than mere accidentally selected forms.

11. The Demotic sources used in the following sign-lists will be quoted as follows:

(1) to (5) Ostraca 1 to 5; horoscopes; [43] (Medinet Habu about 50 A. D.).

(6) Ostracon D 521 [44]

(7) P. Berlin 8279; planetary tables (Fayum; after 42 A. D.) [45]

(8) P. Cairo 31222; [46] astrological.

(9) Coffin of *Ḥeter*; horoscopic inscription (Thebes, about 120 A. D.) [47]

(10) Stobart tablets; planetary tables (Thebes, after 134 A. D.) [48]

(11) P. Carlsberg 9; moon tables (Fayum, after 144 A. D.) [49]

(12) P. Carlsberg 1; Nut and decans (Fayum) [50]

(13) P. Berlin 8345; astrological treatise (Fayum) [51]

(14) P. Cairo 50143; [52] astrological fragment. [53]

The above list seems to be complete so far as published Demotic [54] sources are concerned. [55] They are closely related to the Ptolemaic-Roman monumental representations and to the vast Greek astrological literature. The only Demotic text which refers to the totally different *original* Egyptian "astronomical" concepts known to us from the royal tombs of the XIXth and XXth Dynasty is the P. Carlsberg 1. It seems to me of importance to emphasize very strongly that the astronomical as well as the religious and social back-

[37] Daremberg-Saglio, Vol. V p. 1046 b note 3 but without citation.

[38] The examples quoted by V. Gardthausen, Griechische Palaeographie II (2nd ed., Leipzig 1913) are even as late as the XVth cent. Only the symbols for sun and moon (☉ and ☾) are very frequent in astrological papyri. A list of zodiacal and planetary symbols from Greek manuscripts of unknown date can be found in the plate attached to the article "Abbréviations grecques copiées par Ange Politien" by H. Omont in the Revue des études grecques 7 (1894) p. 81-88.

[39] CCAG 1 (cod. 12) plate. For the date, cf. p. 70 note 1. Horn-d'Arturo [1] attempted to derive the planetary and other symbols from the Hindu-Arabic numerals applied to the almost complete conjunction of all planets in the year 1186. This hypothesis is disproved by the date of the codex mentioned.

[40] Peters-Knobel [1] Pl. IV. This is the first page of Ptolemy's star catalogue, ed. Heiberg, opera I, 2 p. 38, 1 to p. 44, 15.

[41] Tannery, Mém. sci. IV Pl. I (between p. 356 and 357).

[42] Cf. above note 34.

[43] Above p. 116 and 120.

[44] Above p. 121.

[45] Neugebauer [1] p. 212 ff. and Pls. 17 ff.

[46] Spiegelberg DD II Pl. 129.

[47] Above p. 115.

[48] Neugebauer [1] p. 221 ff. and Pls. 23 ff.

[49] Neugebauer-Volten [1].

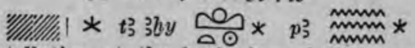
[50] Lange-Neugebauer [1].

[51] Spiegelberg DPB Pl. 97.

[52] Spiegelberg DD III Pl. 59.

[53] What I am able to read is only

pȝ ntr mḥ 6 swgȝ pȝy



The constellation at the beginning of the second line must be either Gemini or Pisces because of the determinative |. Gemini, Libra and Aquarius are known from the Tetrabiblos (I, 18 ed. Robbins p. 86/87) as constituting the triplicity (τρίγονον) of Mercury and it is therefore evident that we have here the same arrangement. Mercury is the sixth "planet" only if one counts from outside and includes the sun. To call the planets θεοί is not rare in Greek; e. g., P. Brit. Mus. No. 130 speaks about "the movement of the seven gods" (Kenyon GP I p. 133, 7 f.).

[54] All these texts contain many Hieratic sign forms, included here.

[55] [After the preparation of this manuscript, Dr. Hughes discovered the symbol for Sagittarius also in P. Cairo 31222 (text (8) of our list). In lines 3 and 5 occurs the upturned arrow in a form similar to (7) I, 4 in our Pl. 3, but with the added star determinative. In line 1, the star determinative is almost completely gone, but the preceding signs are probably to be read *pȝ nty ȝtḥ*, as Dr. Hughes observes.]

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ground of the Hellenistic material is at least as different from the Egyptian material of the New Kingdom (and its predecessors of the Middle Kingdom) as from the Babylonian sources. The world of Hellenism is in every respect a world of its own, being much more the beginning of the medieval world than the conclusion of the ancient.

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CCAG. Catalogus codicum astrologorum graecorum, Bruxelles, Lamertin, 1898 ff.

CT. Cuneiform texts from Babylonian tablets etc., in the British Museum.

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QS. Quellen und Studien zur Geschichte der Mathematik, Astronomie und Physik.

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PLATE 2

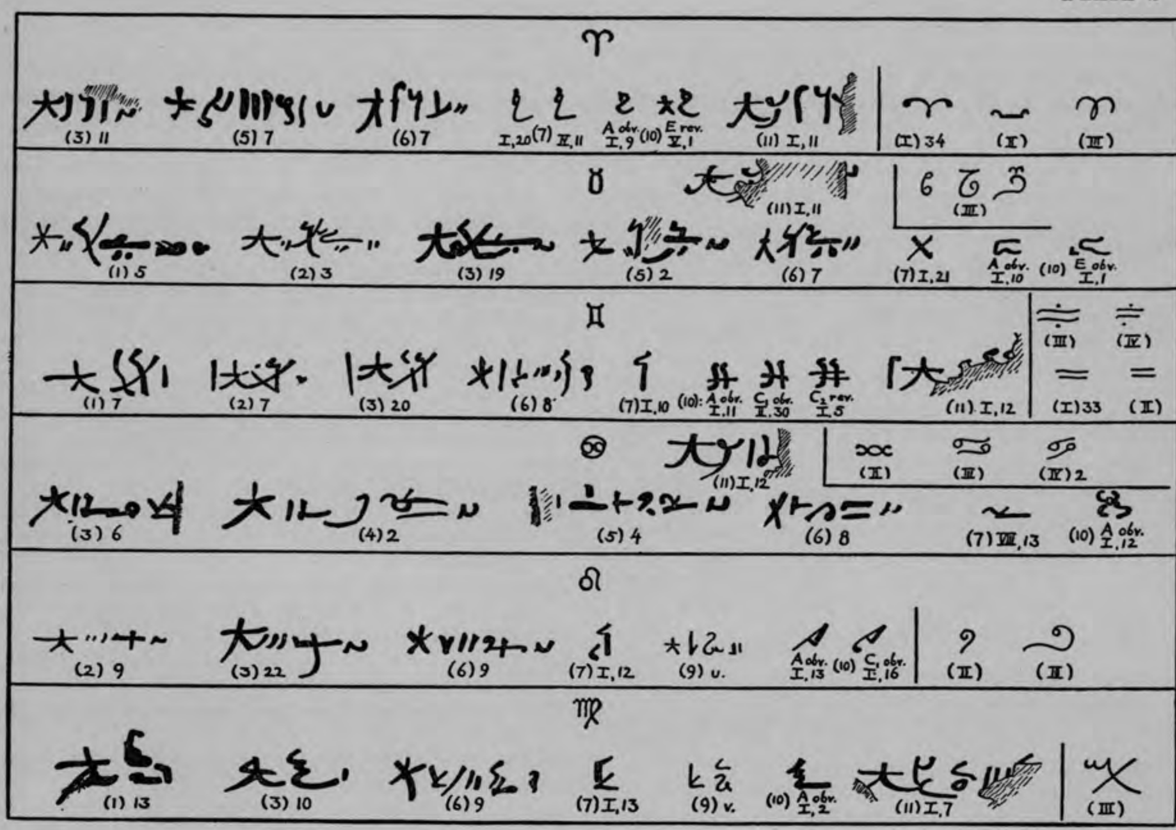


PLATE 3

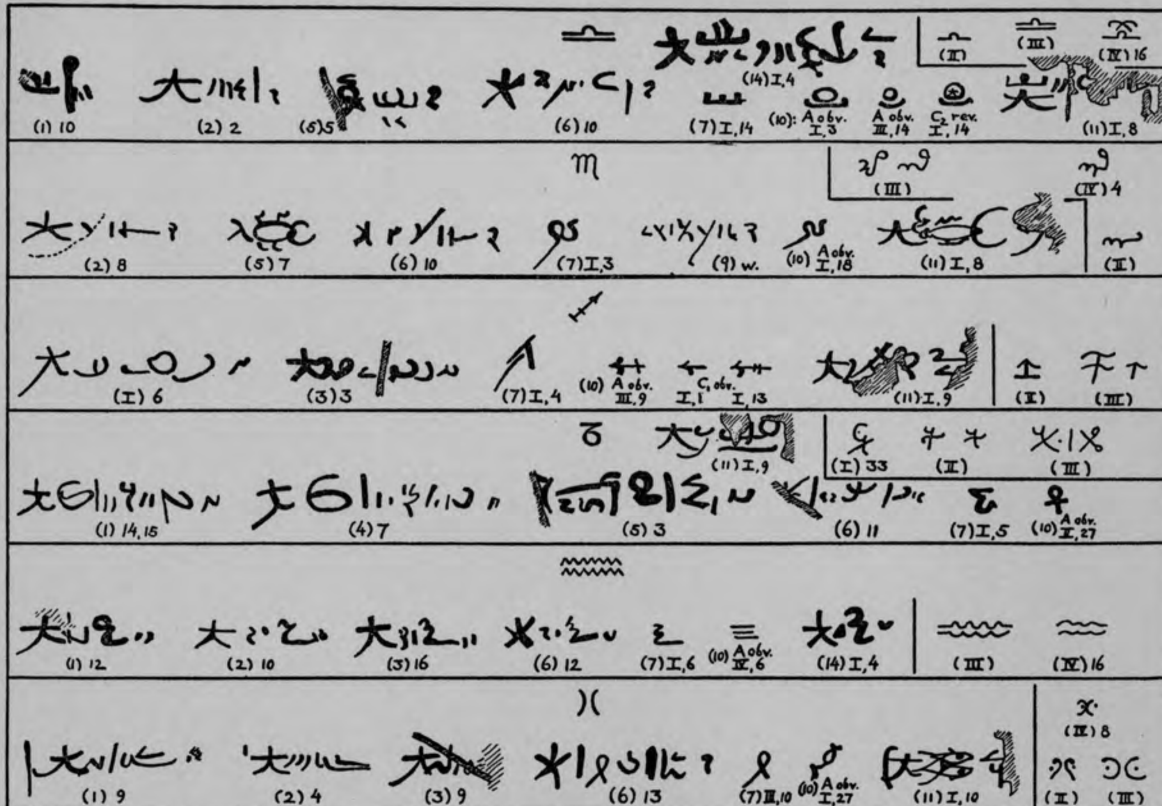
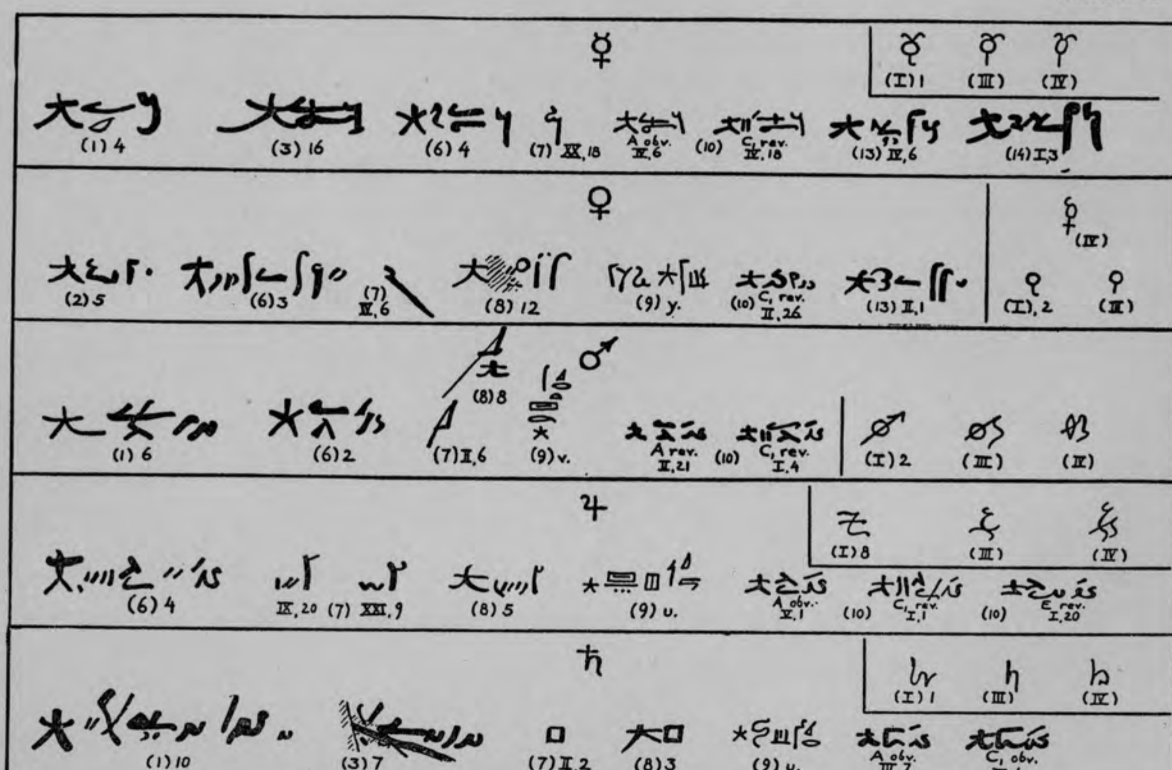


PLATE 4



WATERMAN, I, p. 21.

LETTER 24
Mardukshakinshum to King Esarhaddon

In regard to (the fact) that on this, the thirteenth day, sun and moon were seen together, there are rites pertaining to it which are to be performed. Let Nabugamil come that I may instruct him, that he may perform (them); and to Arad-Amu (give orders) that he also may assist.

WATERMAN, I, p. 27.

LETTER 36
Ishtarshumeresh to King Esarhaddon

If it please the king, let them set up the royal images in the temple on the right and left of the god Sin (?); and at the same time let them station the images of the sons of the king my lord before Sin. Sin the lord of the crown, every month without ceasing, rising and setting, for the prolongation of days, the strengthening of the throne and the bestowal of his power upon the king my lord, will not forsake the side of the king (?) ....

WATERMAN, I, p. 39.

LETTER 50
Akkullanu to King Esarhaddon

Let me hear of the welfare and the health of the king my lord by a reply to my letter.

In regard to the appearance of the moon and sun in conjunction and its signification, in the month Tebet, the fourteenth day ....
Rev. .... will appear and the misfortune of the land of Akkad ... Elam and the land of Amurru.

When a storm bursts in the month Tebet, it will be an eclipse of the lands.

WATERMAN, I, p. 53.

LETTER 78
Balasi and Nabuaheriba to King Ashurbanipal (?)

The king our lord is long-suffering. One day has passed that the king has denied his appetite, (and) has not eaten a morsel. "How long" (runs) his inquiry. The king may not eat food today. The king (feels himself) a poor serf. Were it the beginning of the month, the moon would appear. (The king speaks), saying, "Release me. Rev. Have I not waited (long enough)? It is the beginning of the month, I will eat food, I will drink wine." Now is Jupiter (perhaps) the moon?

WATERMAN, I, p. 55.

LETTER 81
Nabuaheriba to King Esarhaddon

To the king my lord, your servant Nabuaheriba. May it be well with the king my lord. May Nabu (and) Marduk be gracious to the king my lord.

The thirteenth day the gods appeared together.

WATERMAN, I, p. 67.

LETTER 100
Tabshar-Ashur to King Sennacherib (?)

Regarding that which I sent from the palace, saying, "Let them cross the rivers. Let them proceed to the city of Birte. Let them make a ferry," now Arbailai the third mounted messenger has spoken, saying, "The river Tigris is in flood (?) I can not .... advance .... with the riding horses over it and before me I have sent.

WATERMAN, I, p. 95.

LETTER 137
Zakir to King Ashurbanipal (?)

On the fifteenth day of the month Tebet in the middle watch, there was an eclipse of the moon. It began on the east (side) and turned to the west. The evil disturbance, which is in the land of Amurru and its territory, is its own harm.

WATERMAN, I, p. 97.

LETTER 141
Nabua to the King

Rev. We keep the watch. On the fourteenth day the sun and moon appeared together.

WATERMAN, I, p. 107.

LETTER 157
Ishtarduri to King Sargon

Exceedingly much rain has fallen. The harvest is auspicious. May the heart of the king my lord be of good cheer.

WATERMAN, I, p. 163.

LETTER 241
Ashurbelusur to the King

Fifty oxen, lambs ...... which for Babylon ..... are levied upon us annually, in the month Nisan we have given them. The king my lord has spoken, saying, "Deliver them in the month Tishri." Just now the cattle and the lambs are being brought in. Because of the cold and the (condition of the) streams, they have not delivered them. According as the king also has spoken, in the month Tishri we have given them. Now we are bringing down the lambs. They are rounding them up according as the king my lord speaks, and when the king comes to Babylon, I shall come with a chariot for the purpose of greeting the king.

WATERMAN, I, p. 187.

LETTER 276
Kudurru to King Esarhaddon

After the king my lord went to the land of Egypt, in the month Tammuz an eclipse took place. There were none of my men left among them for the protection of the land of Assyria. It scattered them right and left.

WATERMAN, I, p. 209.

LETTER 302
Proclamation of King Ashurbanipal (?) to Nabusharaheshu

In regard to the horses of the former contingent of which you have written: "It is made up and within the month Adar we shall send it," come. If the governor acts craftily we shall devastate. In the midst of the month Shebat we wrote: Rev. "In every attack of the cold, i. e., in cold wind, in the cold they would die." About the middle of the month Shebat we sent again (?): "For the month Adar they will bring them. He will come that they may come, that they may arrive in the month Nisan."

WATERMAN, I, p. 241.

LETTER 346
The Scribes of Kakzi to the King

The watch of Sin we have kept. On the fourteenth day, the moon and sun were seen together. It is well. Rev. May Nabu and Marduk be gracious to the king. On account of the levy of compulsory service, the watch of the king we cannot continue. The official ....

WATERMAN, I, p. 245.

LETTER 353
Balasi to the King Esarhaddon

In regard to the raven, of which the king my lord has written, if a raven brings anything into a man's house, that man's hand will attain "something that is not." If a falcon or a raven drops something it has taken, at the house, or before the man (himself), that house will have a way--"way" means riches. If a bird drops at a man's house meat or (another) bird Rev. or anything it has taken, that man will live sumptuously.

WATERMAN, I, p. 247.

LETTER 355
Balasi to King Esarhaddon

. . . As to the signification of the name of the months--how this is--one is not equal to another. In succession Rev. they receive their signification, thus it is if it is complete. The signification, that is, of the earthquake is this: since it has taken place, let them perform whatever the rites are for an earthquake.

WATERMAN, I, p. 249.

LETTER 356
Balasi to King Esarhaddon

. . . If it is not agreeable to the king during this month, (then) in the month Nisan, at the beginning of the year, in case the moon completes its course (on the thirtieth day) in the month Nisan, let him enter into the presence of the king.

WATERMAN, I, p. 251.

LETTER 359
Adadshumusur to King Esarhaddon (?)

In regard to the image of the king, of which the king my lord has written, saying, "How many days should it abide?" in expectancy of the eclipse of the sun we manned the watch. The eclipse of the sun did not take place. Now if on the fifteenth day the gods Rev. are seen together, on the sixteenth day let it come for a possession. Now if it is pleasing to the king my lord, let it complete one hundred days.

WATERMAN, I, p. 253.

LETTER 361
Adadshumusur and Arad-Ea to the Planter

Our service now is in Nippur (?). I of the itinerary and Arad-Ea Rev. serve before Enlil, we enter into the shrine. The rites of the month Elul (?) with the (ordinary) rites I have performed. The burnt-offering I have burned. We have made the atonement. To the kalu priest, who is here, accompanied by a conjurer, I have entrusted (the matter). I have given him command as follows, "Tarry six days (then) carry out the atonement according to this instruction."

WATERMAN, I, p. 283.

LETTER 407
Nabuaheriba to King Esarhaddon

This is a day of sinister import, I could not send a blessing. The eclipse drew off from the east unto the west. Everything has been regular. The planets Jupiter (and) Venus stood within the eclipse until it set them free. It is favorable for the king my lord. Rev. It is evil concerning Amurru. Tomorrow the report of the eclipse of the moon I shall forward to the king my lord.

WATERMAN, I, p. 295.

LETTER 423
Ishtarnadinaplu (?) to King Ashurbanipal

To the king my lord, your servant Ishtarnadinaplu (?), the chief of the shrine of the scribes of the city of Arbela. May it be well with the king my lord. May Nabu (and) Marduk be gracious to the king my lord.

On the twenty-ninth day I kept the watch. Rev. On account of the appearance of clouds, we did not see the moon. (Dated): the month Adar, the first day, before the first day.

WATERMAN, I, p. 299.

LETTER 432
The Keeper of the Shrine to the King

To the king my lord, your servant, the keeper of the shrine (?) of the city of Arbela. May it be well with the king my lord. May Nabu (and) Marduk be gracious to the king my lord.

On the thirteenth (?) Rev. in the morning watch, the eclipse took place.

WATERMAN, I, p. 305.

LETTER 437
Mar-Ishtar to King Ashurbanipal

The eclipse of the moon approaches, the gods are (nigh). It will not apply to the land. If it is acceptable to the king my lord, as formerly let him appoint an overseer (?) for the shatammu officials. Let him bring the regular offering before the shrine, on the day of the feast, for the welfare of the house.

WATERMAN, I, pp. 329, 331.

LETTER 470
.... to King Esarhaddon

Akkulanu has reported, saying, "When the sun arose, it came to pass that an eclipse took place of about two fingers (in width)." It has no releasing incantation. It is not the same as with the moon. If you command, its signification I shall write down and cause it to be brought to you.

WATERMAN, I, p. 337.

LETTER 477
.... to the King

In regard to the eclipse of the sun, of which the king has written, saying, "Will it take place or will it not take place? Send a definite reply," the eclipse of the sun as well as that of the moon does not occur at my command.
Rev. The sign is not clear and I am cast down. I do not understand it. Now because of the (period of) the month, a watch of the sun is (kept) and the king (is concerned) about it, and I have sent to the king regarding it, saying, "Let the king consider also, how it is and how it is not."

WATERMAN, I, p. 355.

LETTER 506
Ashipa to King Ashurbanipal (?)

Rev. With respect to the straw of which the king my lord has written, in the month Tammuz a heavy rain fell (and) the second officer (and) all the city rulers came down. Straw was laid down and wine was set forth. As much as there was they gave (to them).

WATERMAN, I, pp. 359, 361.

LETTER 514
Bel(?)iddina to the King

. . . The king my lord has shown favor to his servant, saying, "Before Sin the rites a second time on this day I am to perform," on the morrow I shall complete (them). A sacrificial lamb without blemish before Sin I shall bring, for the king my lord I shall pray.

WATERMAN, I, p. 365.

LETTER 519
Ishtarshumeresh to King Esarhaddon

When Mars on its return course from the head of Leo passes over Cancer and Gemini, this is its signification: End of the rule of the king of Amurru. This (also) is not of a definite series. It is unfavorable. It signifies: Since recently the location of the position of Mars has changed, that indicates evil. Since it has completely changed its later position, its significance cannot be otherwise.

And with respect to Jupiter, when it is thus, if it turns aside clearly from the breast of Leo, (and) passes away from this, in the series it is written: "When Jupiter advances on Regulus and has put (?) him behind--or as Regulus advances on him and has put him in his broadest part, (and) stands with him, so another will rise up and kill the king, and seize the throne."

This signifies: Since recently the location of the position of Jupiter has changed, it indicates evil. Since it has completely changed its later position, its significance cannot be otherwise.

In case there be a servant of the king (who speaks) concerning this, that it is naught, then as for me, declare before the king my lord: Saturn is alone favorable this month but (even this) is not completely so. And regarding that which the king my lord has written, saying, "Watch in order that no evil take place," so I keep watch. Whatever it is (that happens) I shall send to the king my lord.

WATERMAN, I, p. 401.

LETTER 565
.... to the King

Jupiter stands behind the moon. This is its signification: When Jupiter stands behind the moon, there will be hostility in the land.

WATERMAN, I, p. 439.

LETTER 629
Mar-Ishtar to King Esarhaddon

This eclipse, which took place in the month Tebet, pertains to the land of Amurru. The king of the land of Amurru will die. His land shall be reduced, a second time it shall be destroyed. An army will at once be against Amurru. Whoever speaks to the king my lord (about) the land of Amurru or the land of the Hittites or the land of Sutu, or again of the land of Chaldea, whoever brings to the king my lord this sign against the kings of the land of the Hittites or the land of Chaldea Rev. or the land of Aribi, it is well. The king my lord shall attain his wish.

WATERMAN, I, p. 457.

LETTER 657
Adadshumusur to King Ashurbanipal

As for the eclipse of the sun, it did not take place. It is over. The planet Venus is approaching the constellation Virgo. The appearance of the planet Mercury is approaching. Great wrath will come. Adad has opened his mouth. May the king my lord know.

WATERMAN, I, p. 465.

LETTER 671
Ishtarshumeresh to King Ashurbanipal

On the twenty-ninth day we kept Rev. the watch. We did not see the moon.
(Dated) the second day of the month Tammuz in the eponym year of Belshunu, governor of the city of Hindanu.

WATERMAN, I, pp. 467, 469.

LETTER 679
Akkullanu to King Esarhaddon

The planet Mars has entered the path of Enlil. It was observed at the feet of Gemini. It appeared faint. It was high. On the twenty-sixth day of Iyyar I observed until it was high, thereupon I sent its signification to the king my lord.

As for the planet Mars, when Gemini approaches there will be war in Amurru, brother will slay his brother in the palace.

WATERMAN, I, p. 473.

LETTER 687
Balasi to King Esarhaddon

Rev. In regard to the watch of the sun, of which the king my lord has written, it is (now) the month of the watch of the sun. On the second there is its watch. On the twenty-sixth day of Marcheshvan (and) on the twenty-sixth day of Kisleu we shall keep the watch. Accordingly we shall keep the watch of the sun for two months.

WATERMAN, II, p. 21.

LETTER 744
Mar-Ishtar to King Ashurbanipal

On the twenty-seventh day the moon disappears. On the twenty-eighth, twenty-ninth, (and) thirtieth days we kept the watch of the eclipse of the sun. It passed by, the eclipse did not take place. On the first day the moon appears, the (opening) day of the month Tammuz is fixed.

In regard to Jupiter, of which formerly I wrote to the king my lord, saying, "It appears in the path of Rev. Anu, in the region of the star Sibzianna, it is low in the haze (?); I do not understand it," they spoke, saying, "It is in the path of Anu, its signification I shall send to the king my lord." Now it is lifted up, it is understood, it stands below the constellation of the Chariot in the path of Enlil. In relation to the Chariot, it is surely cast down. Its signification I have completed, but the signification of Jupiter, which is in the path of Anu, about which I wrote earlier to the king my lord, I have not completed. May the king my lord know.

WATERMAN, II, p. 37.

LETTER 765
Belnasir to the King

In regard to the watch of the moon, there was no eclipse. On the eighteenth day an eclipse of the sun took place. In the eighth month there will be an eclipse of the moon.

WATERMAN, II, p. 73.

LETTER 816
Nabushumiddin to the Planter

On the fourteenth day the watch of Sin we kept. Rev. The eclipse of the moon took place.

WATERMAN, II, p. 75.

LETTER 818
Nabua to the King

The watch we have kept. On the fourteenth day the moon and sun appeared together.

WATERMAN, II, p. 75.

LETTER 821
Nabua to the King

On the thirteenth day we kept the watch. At the same time that a cloud covered the sun, a cloud likewise covered the moon. On the fourteenth day moon and sun were seen together.

WATERMAN, II, p. 75.

LETTER 822
Nabua to the King

We kept the watch on the thirteenth day, when the moon and sun appeared together.

WATERMAN, II, p. 75.

LETTER 823
Nabua to the King

On the twelfth day we kept the watch. On the thirteenth day moon and sun appeared together.

WATERMAN, II, p. 77.

LETTER 826
Nabua to the King

On the thirteenth day (and) the fourteenth day, we kept the watch. On the fifteenth day moon (and) sun appeared together.

WATERMAN, II, p. 77.

LETTER 827
Nabua to the King

On the twenty-ninth day we kept the watch. We saw the moon.

WATERMAN, II, p. 77.

LETTER 829
Ishtarnadinaplu to King Ashurbanipal

To the king my lord, your servant Ishtarnadinaplu, the chief of the shrine of the scribes of Arbela. May it be well with the king my lord. May Nabu, Marduk, (and) Ishtar of Arbela be gracious to the king my lord.

On the twenty-ninth day Rev. we kept the watch. On account of the appearance of a cloud, we did not see the moon.

First day of the month Shebat, eponym year of Belharranshadua.

WATERMAN, II, p. 87.

LETTER 842
Ahulu... to the King

. . . On the fifth day of second Adar I shall go forth from Dur-Sharrukin. Before the month Nisan, the face of the king may I see (?).

WATERMAN, II, p. 103.

LETTER 869
.... to the King

Regarding that which the king my lord has written, this night in the morning watch (is) its watch. The eclipse will take place in the morning watch.

WATERMAN, II, p. 113.

LETTER 881
Baushumiddin to the King

In regard to the watch, of which the king my lord has written, as for the moon, the eclipse was not seen. As for the watch, cause an order to come up Rev. from the king my lord; let them proclaim it. On the fifteenth day, god will be seen with god.

WATERMAN, II, p. 123.

LETTER 894
Adadshumusur to King Esarhaddon

I saw the moon on the thirtieth day; it was high. When on the thirtieth day, directly it is high, according as it continues on the second day, if it is pleasing before the king my lord, Rev. let the king wait before the city of Asshur, and thereupon let the king my lord establish the day. Accordingly the king my lord (will speak), saying, "Why do you not observe, thereupon I .... to ...... the scribe ...... the dominion .... days ..... before .... to ......

WATERMAN, II, pp. 123, 125.

LETTERS 895
Belushezib to King Ashurbanipal

Rev. The signs and the ..... officials, the sign of the eclipse. In the month Adar and in the month Nisan it came. I have reported everything to the king my lord and although (?) the king has not abandoned the freeing incantations from the eclipse, which are performed in order to offset any sin whatever, the great gods who dwell in the city of the king my lord overcast the sky and did not permit (me) to see the eclipse. May the king my lord know that this eclipse is not against the king my lord nor his land. May the king rejoice. In the month Nisan, Adad upholds peace. The grain, to be grown, will not be reduced.

WATERMAN, II, p. 163.

LETTER 956

....

In regard to the duration of the year of which the king spoke, saying, "The month Elul decided (?) the dividing (?) .... the king my lord in regard to Rev. .... knows the ... day of the month Tashritu, the man who is weak will clothe himself. On the eighth day the gate of ..... according as the month Shebat .... the way was seen (?) ..... of Dur ..... when Anu and .... what ..... let the king my lord decide. From the hands of Marduksharusur and the body-guard official seek a trustworthy man. He .... the smith ....

WATERMAN, II, p. 181.

LETTER 976

.... to King Ashurbanipal (?)

To Darisharru, to .... to Aradilu, to Kisir-Ashur, to ...... let the king my lord promulgate the command. We have come, let them put (?) their hands to the task. Unto the shepherd of the sacrificial lambs of the city of .... he will accomplish nothing ..... The king my lord knows how their hands .... one day the people .... Rev. the abode (?).

WATERMAN, II, pp. 197, 199.

LETTER 1006

Munnabite to King Ashurbanipal

The report of the eclipse I have not caused the king my lord to hear from my own lips; I have, however, written instead (and) sent it to the king my lord.

Regarding the eclipse, its evil up to the very month, day, watch, and exact point where it began and where the moon pulled and drew off its eclipse--these pertain to its evil. The month Sivan is Amurru and a decision is given to Ur. Its evil (applies to) the fourteenth day, of which they declare: "The fourteenth day is Elam." The exact point where it began we do not know, the area of its eclipse drew off toward the southwest. It is evil for Elam and Amurru. From the east and north, according as it is bright, it is propitious for Subartum and Akkad. One says of it that it augurs favorably.

. . . Now the omen is favorable and the heart of the king my lord may be of good cheer. Jupiter stands in the eclipse; it signifies peace for the king; his name will be honorable and unique .....

WATERMAN, II, p. 207.

LETTER 1015
Tabsilesharra (?) to King Sargon (?)

To the king my lord, your servant .... May it be well with the king my lord. May Ashur and Ninlil be gracious to the king my lord.

In regard to the ravens, of which the king my lord has written, saying, "Send when the ravens tarry (?) ..... help is destroyed" ... (?) he is proud (?), saying, at the appointed time his rebellion will go forth for him. Since a letter from the palace has not come to me, Rev. I sent by ..... the city .... a report .... the ravens .... help is destroyed. He is proud(?), saying, "At the appointed time it will go forth for him, will he not cause him to revolt?"

WATERMAN, II, p. 243.

LETTER 1069
....

.... We have observed. Regarding the moon's halo I have written to the king my lord. In regard to the watch of the eclipse of the moon, of which the king my lord has written .... its watch ..... Beleriba ..... of the sun is large .... Rev. .... words ...... these ... proceeded .... the months .... its watch now of the month Kisleu we keep, for the watch ....

WATERMAN, II, p. 251.

LETTER 1080
....

.... the earth quaked ...... its interpretation is after this fashion: When the earth quakes in the month Sivan, the overthrown ruin sites shall be inhabited, Rev. by the word of Enlil. Regarding the eclipse, when it is evil, let them seek, let them remove, let whoever goes into Nineveh .... in order that they may lift up (?) ....

WATERMAN, II, p. 255.

LETTER 1087
.... to the King

The lambs continually (?) which the king my lord, for the temples, gathered in one flock (?), to the city of Iaru .... Rev. not .... in the palace ...... saying, "A woman .... I spoke (?) ...... and went (?) ..... now ...... saying .....

WATERMAN, II, pp. 255, 257.

LETTER 1089
.... to King Ashurbanipal

. . . Our hands are lifted up Rev. toward the king our lord. In the present month Iyyar let the king our lord send us troops for campaigning, and the land to that of the king will turn and we your servants shall live. Many peoples set their faces against the king their lord, but they give heed to the troops of the king, to the campaigning of the troops; and may the king our lord and his army quiet the confusion and bloodshed. The land of the Pukudu and the Gurasimmu will wait upon the welfare of the king our lord ......

WATERMAN, II, pp. 269, 271.

LETTER 1106
Nabuushabshi (?) to King Ashurbanipal

. . . And the king my lord well knows, since the king gave the Sealand to Nebuchadrezzar my brother. This is not well pleasing to Belibni the heir of Nebuchadrezzar. He hates us for this reason. He speaks abusive words. The king should not give heed to the words of his mouth ..... a man, they connect with Nebuchadrezzar, as a servant they fear ..... of the father of the king in Uruk they seize him .... his word (?) extend. Now .... the chief of the storehouse of the Sealand ..... his face before the king .... with me .... a word ....

WATERMAN, II, p. 275.

LETTER 1113
.... to the King

The king my lord has sent, saying, "The planet Mars has been observed. Why have you not reported?" The planet Mars is visible in the month Ab, behold it is with the constellation Libra. At the left it is dark. It is approaching. Rev. When it draws near it, I shall send its omen to the king my lord. That which is now seen is the planet Mercury in the constellation Capricorn. Regarding Mars ....

WATERMAN, II, pp. 291, 293.

LETTER 1134
.... to the King

..... one life of the evening against .... When a star on any day, this .... the land will have an enemy .... the twenty-ninth day of the month Iyyar from .... this word until the ... day whenever this is established ..... of Shamash is fallen. According to this is its interpretation .... and you know ..... I do not know ..... the king of the land, Shamash with him ...... The king fears the king of Akkad .... the flesh of (?) his life that is cast down (?), as we hear ...... is not. He has spoken of the failing of the brightness, saying, "Is it not an eclipse, and the failing of the brightness of the eclipse is extreme. Its sign is Rev. exceedingly unfavorable. Mars is inclosed in the constellation Capricorn. It is brilliant (?). The brightness is great, it is lifted up. According to this is its interpretation .... The constellation Capricorn ...... is favorable.

WATERMAN, II, p. 295.

LETTER 1137
Nabua to the King

The watch we keep. On the fifteenth day the sun and moon appeared together.

WATERMAN, II, pp. 295, 297.

LETTER 1140
.... to the King

.... propitious ..... the gods they fear ..... propitious. The favorable days of which the king my (!) lord has spoken, (are) the tenth, the fifteenth, the sixteenth, the eighteenth, the twentieth, the twenty-second, the twenty-fourth, (and) Rev. the twenty-sixth, a total of eight days of the month of Iyyar--which are propitious for making requests (and) reverencing the deity. (Of these,) the tenth day is favorable for judgment, the fifteenth day (for) carrying out an attack, the sixteenth day (for) rejoicing the heart, the eighteenth day (for) interpreting the future (?), the twentieth day let him slay a serpent (?), the twenty-second day one may make a journey, the twenty-fourth day is good (?) for making (?) a request (?) ....

WATERMAN, II, p. 305.

LETTER 1156
.... to the King

On the twenty-ninth day we kept the watch. Rev. We observed the moon.

WATERMAN, II, pp. 309, 311.

LETTER 1168
....

. . . which I seized ..... day, the sixth day, the .... day, the thirteenth day, the ... day, the thirteenth day, ... day, the twenty-fourth day, the ... day, the thirtieth day are favorable. These favorable days ...... a rest day .... let him write, we have done it ...... which we do .... now (?) .... and my god ....

WATERMAN, II, p. 327.

LETTER 1195
.... to King Ashurbanipal

The message is as follows: Tammariti, king of Elam, his men .... will they make a raid, a vicious attack upon the territory of Assyria? Is the message true (and) reliable? ...... From this day, the first day of this month Adar, of this year unto the first day of the coming month ...... of the current year, will the men with Tammariti, king of Elam, advance to make war with battle and defeat .... will they come for a raid, for a vicious attack upon the territory of Assyria or upon Nippur?

WATERMAN, II, p. 329.

LETTER 1197
.... to the King

.... from ..... of the city of .... are established. The month Iyyar, the sixth day Adad drew near, in the festal house he dwelt. The kalu priest rests. Rev. Regarding that which the king my lord ..... Adad ..... in his house ....

WATERMAN, II, p. 341.

LETTER 1214
.... to King Sennacherib (?)

In the month Tammuz, on the night of the tenth day, the constellation Scorpio approaches the moon. Its signification is as follows: When, at the appearance of the moon, the constellation Scorpio stands within its right horn, in this year locusts will swarm, they will eat up the harvest. Regarding the king of Elam, in that year they will kill him. His reign will come to an end. An enemy will attack and plunder in the midst of his land. For the king of Akkad they have lifted up, his reign will be long, as for the enemy who attacks him, the fall of his enemy will take place. In the month Tashritu on the tenth day, the planet Venus will stand in the constellation UR-GAB.

WATERMAN, II, p. 393.

LETTER 1285
..... to King Ashurbanipal (?)

. . . May Shamash, the light of heaven and earth, fix his attention to judge your faithfulness.

WATERMAN, II, p. 409.

LETTER 1305
....

..... Rev. .... unto him they restore. If he does not make an uprising against him, proceed (?). In the middle of the month Shebat do you raise it up.

WATERMAN, II, p. 457.

LETTER 1373
Belushezib to King Ashurbanipal(?)

When the moon appears on the first day, the word is established, the heart of the land will be of good cheer. When the day according to its measure is long, there will be a reign of far extended days. When the moon at its appearance wears a crown, the king will come to his supremacy.

WATERMAN, II, p. 467.

LETTER 1383
Nabuaheriba to King Esarhaddon

. . . The (present) month is favorable. This day is favorable. The planet Mercury the crown prince ..... with the star .... appears, when the planet Venus appears in (?) Babylon, the moon in the month Nisan, on any day it does not draw near, at the same time, it is favorable.

WATERMAN, II, p. 473.

LETTER 1391

....

When Shanamma stands before (or) approaches Bel, the heart of the land will be satisfied. Shanamma is Mars. There is favor for the king my lord.

When Mars culminates dimly and its brilliance becomes pale, in that year the king of Elam will be your servant. When Nergal becomes small and white in appearance, (and) like a star of heaven becomes especially dim, he will have mercy on Akkad. The forces of my army will stand and slay the enemy. The army of the enemy will not be able to stand before my army. The cattle of Akkad will lie down securely in the fields. Sesame and dates will prosper. The gods will show mercy to Akkad. When Mars appears in the month Iyyar, the enemy will be the unrighteous Umman-Manda. The Umman-Manda are the Cimmerians.

WATERMAN, II, p. 485.

LETTER 1408

....

...... and the yoke .... an eclipse of the sun will take place the ..... day the moon appeared ..... of the eleventh day ...... the moon went forth ..... the eleventh day ..... will be great, the new ..... of the twelfth day ...... the moon arose Rev. ..... the thirteenth (?) day cloudiness prevailed. The whole of the fourteenth the moon did not appear ..... the night of the thirteenth day .... the moon arose ...... the thirteenth cloudiness prevailed, it did not appear .... the night of the fourteenth day ..... the moon arose, it turned, it did not go down (?) ...... the thirteenth day ..... before the king he will come (?).

WATERMAN, II, p. 505.

LETTER 1444

.... to the King

.... to the king .... in the glow of their (?) ..... Sin the god who brings in hostility is established. In the south it is established. In the south it cleared. On the right it was beclouded. Rev. In the region of the constellation Scorpio it was beclouded. When the star KUMARU of the constellation UTU-KA-GAB-A was on the meridian an eclipse two fingers broad took place.

WATERMAN, II, p. 507.

LETTER 1448

.... to the King

When (the moon) completes the day in the month Iyyar, on the fifteenth day sun and moon will be seen together. On the thirteenth day (and) the night of the fourteenth day was the time of the watch, and the eclipse did not take place. Rev. One-seventh of the front and side was 'bitten out.' The eclipse did not take place. A word of decision I have sent to the king.

WATERMAN, II, p. 519.

LETTER 1466
.... to King Sargon

On the thirtieth day of the month Adar I entered. One day (?) ...... the people of Hubushki .... in the land of Hubushki .... Rev. .... we spoke, saying, ... Sal .... in .... the heart of ...... house of (?) .... bring.

THE VENUS TABLETS OF

AMMIZADUGA

CHAPITRE VII.

DE L'ÉPOQUE DES MOYENS MOUVEMENS DE LONGITUDE ET D'ANOMALIE DE LA LUNE.

POUR réduire ces époques au midi du premier jour du mois égyptien Thoth de la première année de Nabonassar, nous avons pris l'intervalle de temps écoulé de ce jour au milieu de la seconde des trois premières et plus proches éclipses, laquelle est arrivée, comme nous l'avons dit, la seconde année de Mardocempad, du 18 au 19 du mois égyptien de Thoth, à $\frac{1}{2}$ et $\frac{1}{3}$ d'une heure équinoxiale avant minuit, ce qui fait une espace de 27 années égyptiennes 17 jours et 11 $\frac{1}{6}$, heures à très-peu près, tant simplement qu'exactement; et en rejettant les circonférences entières, 123^d 22′ de longitude, et 103^d 35′ d'anomalie. Si nous retranchons respectivement ces quantités, des lieux du milieu de la seconde éclipse, nous aurons pour la première année de Nabonassar au premier jour du mois égyptien de Thoth à midi, le lieu moyen de la lune sur 11^d 22′ du taureau en longitude et à 268^d 49′ d'anomalie depuis l'apogée de l'épicycle, c'est-à-dire à 70^d 37′ d'élongation, le soleil, comme il a été prouvé, étant alors sur 0^d 45′ des poissons.

ΚΕΦΑΛΑΙΟΝ Ζ.

ΠΕΡΙ ΤΗΣ ΕΠΟΧΗΣ ΤΩΝ ΟΜΑΛΩΝ ΤΗΣ ΣΕΛΗΝΗΣ ΚΙΝΗΣΕΩΝ ΜΗΚΟΥΣ ΤΕ ΚΑΙ ΑΝΩΜΑΛΙΑΣ.

ΙΝΑ δὲ καὶ τὰς ἐποχὰς αὐτῶν συστησώμεθα εἰς τὸ αὐτὸ πρῶτον ἔτος Ναβονασσάρου κατ' Αἰγυπτίους Θὼθ α̅ τῆς μεσημβρίας, ἐλάβομεν τὸν ἐντεῦθεν χρόνον μέχρι τοῦ μέσου τῆς δευτέρας ἐκλείψεως τῶν πρώτων καὶ ἐγγυτέρων τριῶν, ἥτις, ὡς ἔφαμεν, γέγονε τῷ δευτέρῳ ἔτει Μαρδοκεμπάδου κατ' Αἰγυπτίους Θὼθ ι̅η̅ εἰς τὴν ι̅θ̅ πρὸ ς″ καὶ γ″ μιᾶς ὥρας ἰσημερινῆς τοῦ μεσονυκτίου. Συνάγεται δὲ οὗτος ἐτῶν αἰγυπτιακῶν κ̅ζ̅ καὶ ἡμερῶν ι̅ζ̅ καὶ ὡρῶν ἁπλῶς τε καὶ ἀκριβῶς ἔγγιστα ι̅α̅ ς″. καὶ παράκειται τῷ τοσούτῳ χρόνῳ μεθ' ὅλους κύκλους ἐποχῆς μήκους μὲν μοῖραι ρ̅κ̅γ̅ κβ′, ἀνωμαλίας δὲ μοῖραι ρ̅γ̅ λε′· ἃς ἐὰν ἀφέλωμεν τῶν ἐν τῷ μέσῳ χρόνῳ τῆς δευτέρας ἐκλείψεως ἐποχῶν, ἑκατέραν ἀφ' ἑκατέρας οἰκήσεως, ἕξομεν εἰς τὸ πρῶτον ἔτος Ναβονασσάρου κατ' Αἰγυπτίους Θὼθ α̅ τῆς μεσημβρίας, ἐπέχουσαν μέσως τὴν σελήνην, κατὰ μὲν μῆκος, ταύρου μοίρας ι̅α̅ κβ′, ἀνωμαλίας δὲ ἀπὸ τοῦ ἀπογείου τοῦ ἐπικύκλου μοίρας σ̅ξ̅η̅ μθ′, ἀποχῆς δὲ δηλονότι μοιρῶν ο̅ λζ′, ἐπειδήπερ καὶ ὁ ἥλιος εἰς τὸν αὐτὸν χρόνον ἀπεδείχθη τῶν ἰχθύων ἐπέχων μοίρας ο̅ με′.

ΚΕΦΑΛΑΙΟΝ Η.

ΠΕΡΙ ΤΗΣ ΔΙΟΡΘΩΣΕΩΣ ΤΩΝ ΚΑΤΑ ΠΛΑΤΟΣ ΜΕΣΩΝ ΠΑΡΟΔΩΝ ΤΗΣ ΣΕΛΗΝΗΣ ΚΑΙ ΤΩΝ ΕΠΟΧΩΝ ΑΥΤΩΝ.

ΤΑΣ μὲν οὖν τοῦ μήκους καὶ τῆς ἀνωμαλίας περιοδικὰς κινήσεις, καὶ ἔτι τὰς ἐποχὰς αὐτῶν, διὰ τῶν τοιούτων ἐφόδων συνεστησάμεθα· ἐπὶ δὲ τῶν κατὰ πλάτος, πρότερον μὲν διημαρτάνομεν καὶ αὐτοὶ συγχρώμενοι κατὰ τὸν Ἵππαρχον τῷ τὴν σελήνην ἑξακοσιάκις μὲν καὶ πεντηκοντάκις ἔγγιστα καταμετρεῖν τὸν ἴδιον κύκλον, δὶς δὲ καὶ ἡμισάκις τὸν τῆς σκιᾶς καταμετρεῖν κατὰ τὸ ἐν ταῖς συζυγίαις μέσον ἀπόστημα. Τούτων γὰρ ὑποκειμένων, καὶ τῆς πηλικότητος τῆς ἐγκλίσεως τοῦ λοξοῦ κύκλου τῆς σελήνης, οἱ τῶν κατὰ μέρος αὐτῆς ἐκλείψεων ὅροι δίδονται. Λαμβάνοντες οὖν διαστάσεις ἐκλειπτικὰς, καὶ ἀπὸ τοῦ μεγέθους τῶν κατὰ τοὺς μέσους χρόνους ἐπισκοτήσεων τὰς ἀκριβεῖς κατὰ πλάτος ἐπὶ τοῦ λοξοῦ κύκλου παρόδους, ἀφ' ὁποτέρου τῶν συνδέσμων ἐπιλογιζόμενοι, διά τε τῆς ἀποδεδειγμένης κατὰ τὴν ἀνωμαλίαν διαφορᾶς, ἀπὸ τῶν ἀκριβῶν παρόδων τὰς περιοδικὰς διακρίνοντες, οὕτω τάς τε κατὰ τοὺς μέσους χρόνους τῶν ἐκλείψεων ἐποχὰς τοῦ περιοδικοῦ πλάτους εὑρίσκομεν, καὶ τὴν ἐν τῷ μεταξὺ χρόνῳ μεθ' ὅλους κύκλους ἐπουσίαν.

Νῦν δὲ χρησάμενοι χαριεστέραις ἐφόδοις, καὶ μηδενὸς τῶν πρότερον ὑποτεθειμένων ἐπιδεομέναις, πρὸς τὴν τῶν

CHAPITRE VIII.

DE LA CORRECTION DES MOYENS MOUVEMENS DE LA LUNE EN LATITUDE ET DE LEURS ÉPOQUES.

NOUS avons établi tout à la fois par ces méthodes les mouvemens périodiques tant de longitude que d'anomalie, ainsi que leurs époques ; mais pour celles de la latitude, nous avons mal fait de supposer avec Hipparque, que le disque de la lune est la 650ᵉ partie de l'orbite de cet astre, et qu'il est contenu deux fois et demie dans le cercle de l'ombre, quand elle est à sa moyenne distance lors des conjonctions. Car cela supposé, ainsi que la quantité de l'inclinaison de l'orbite de la lune, les limites de ses éclipses sont données. En prenant donc les intervalles des éclipses, et en calculant par la grandeur des obscurations au milieu de chaque éclipse les mouvemens vrais en latitude sur l'orbite inclinée depuis l'un des nœuds, et distinguant par la différence que donne l'anomalie, les mouvemens périodiques d'avec les mouvemens vrais, nous trouvons les lieux de la latitude périodique, au milieu du temps de la durée de chaque éclipse, ainsi que le point où la lune s'est avancée dans l'intervalle d'une éclipse à l'autre, en outre des circonférences entières qu'elle a parcourues.

Aujourd'hui par des méthodes plus faciles qui n'ont pas besoin des suppositions précédentes, pour obtenir ce que l'on

Each Egyptian eclipse date is chalked red, and marks the hours only which end Ptolemy's "intervals." By placing Oppolzer's Julian eclipse dates on the same longitude with Ptolemy's eclipse dates, it is then possible to count back on the calendar and determine the Julian date corresponding to the last day of each interval.

NINETEEN LUNAR ECLIPSES QUOTED BY CLAUDIUS PTOLEMÄUS

Series 1	Regnal Years 2	Leap Days from 747 B.C. to 1 Thoth in Column 4 3	Date of 1 Thoth preceding Eclipse 4	Ptolemy's Intervals from 1 Thoth, 747 B.C. to Egyptian day of Eclipse 5	Oppolzer's Corresponding Eclipse Dates (Meridian Alexandria) 6	Computation of 1 Thoth from "Ptolemy's Intervals" 7
1	1 Mardokem-pad	6	Feb 20 721 B.C. noon 1 Th	Midnight 28 days Sunset	Mar 19, 721 B.C. (No.741)* Leap noon 29 • 30 Thoth	From Mar 19 take 28 days (18+10 in Feb) = Feb 20 = 1 Thoth, 721 B.C. To Feb 20 (721) add 6 days = Feb 26, 747 B.C.
2	2 Mardokem-pad	7	ss Feb 19 ss 720 noon 1 Th	27^y 17^d $11\frac{1}{6}$ h (p.236)**	ss Mar 8 ss 720 (No.743) 18 • 19 Thoth	From Mar 8 take 17 days (7+10 in Feb) = Feb 19 = 1 Thoth, 720 B.C. To Feb 19 (720) add 7 days = Feb 26, 747 B.C.
3	2 Mardokem-pad	7	Feb 19 720 1 Th	194 days	Sept 1 720 (No.744) 15 16 Phamenoth	From Sept 1 take 194 days (31+31+30+31+30+31+10 in Feb) = Feb 19 = 1 Thoth, 720 B.C. To Feb 19 (720) add 7 days = Feb 26, 747 B.C.
4	5 Nabopolas-sar	31	Jan 26 621 1 Th	126^y 86^d 17^h (p.307)	Apr 22 621 (No.901) Leap 27 • 28 Athyr	From Apr 21 take 86 days (20+31+29+6 in Jan) = Jan 26 = 1 Thoth, 621 B.C. To Jan 26 (621) add 31 days (5+26) = Feb 26, 747 B.C.
5	7 Cambyses	56	Jan 1 523 1 Th	224^y 196^d $10\frac{1}{6}$ h (p.308)	July 16 523 (No.1056) 17 • 18 Phamenoth	From July 16 take 196 days (15+30+31+30+31+28+31 in Jan) = Jan 1 = 1 Thoth, 523 B.C. To Jan 1 (523) add 56 days (30+26) = Feb 26, 747 B.C.
6	20 Darius	61	Dec 27 503 1 Th	245^y 327^d $10\frac{1}{4}$ h (p.242)	Nov 19 502 (No.1090) 28 • 29 Epiphi	[1 Thoth, 503 B.C. From Nov 19 take 327 days (18+31+30+31+31+30+31+30+31+28+31+5 in Dec) = Dec 27 = To Dec 27 (503) add 61 days (4+31+26) = Feb 26, 747 B.C.
7	31 Darius	64	Dec 24 492 1 Th	256^y 122^d $10\frac{1}{4}$ h (p.240)	Apr 25 491 (No.1107) 3 • 4 Tybi	From Apr 25 take 122 days (24+31+28+31+8 in Dec) = Dec 24 = 1 Thoth, 492 B.C. To Dec 24 (492) add 64 days (7+31+26) = Feb 26, 747 B.C.
8	Phanostra-tus	91	Nov 27 383 1 Th	365^y 25^d $18\frac{1}{2}$ h (p.248)	Dec 23 383 (No.1275) 26 • 27 Thoth	From Dec 22 take 25 days (21+4 in Nov) = Nov 27 = 1 Thoth, 383 B.C. To Nov 27 (383) add 91 days (3+31+31+26) = Feb 26, 747 B.C.
9	Phanostra-tus	91	Nov 27 383 1 Th	365^y 203^d $8\frac{1}{4}$ h (p.249)	June 18 382 (No.1276) 24 • 25 Phamenoth	[B.C. From June 18 take 203 days (17+31+30+31+28+31+31+4 in Nov) = Nov 27 = 1 Thoth, 383 To Nov 27 (383) add 91 days (3+31+31+26) = Feb 26, 747 B.C.
10	Evander	91	Nov 27 382 1 Th	366^y 15^d $10\frac{1}{6}$ h (p.250)	Dec 12 382 (No.1277) 16 • 17 Thoth	From Dec 12 take 15 days (11+4 in Nov) = Nov 27 = 1 Thoth, 382 B.C. To Nov 27 (382) add 91 days (3+31+31+26) = Feb 26, 747 B.C.
11	54 II Calip-pic	136	Oct 13 202 1 Th	546^y 345^d 7^h (p.251)	Sept 22 201 (No.1545) Leap 16 • Mesore	[1 Thoth, 202 B.C. From Sept 22 take 345 days (21+31+31+30+31+30+31+29+31+31+30+19 in Oct) = Oct 13 = To Oct 13 (202) add 136 days (18+30+31+31+26) = Feb 26, 747 B.C.
12	54 II Calip-pic	137	Oct 12 201 1 Th	547^y 158^d $13\frac{1}{3}$ h (p.252)	Mar 20 200 (No.1546) 9 • Mechir	[B.C. From Mar 19 (200) take 158 days (18+28+31+31+30+20 in Oct) = Oct 12 = 1 Thoth, 201 To Oct 12 (201) add 137 days (19+30+31+31+26) = Feb 26, 747 B.C.
13	55 II Calip-pic	137	Oct 12 201 1 Th	547^y 334^d $14\frac{1}{4}$ h (p.253)	Sept 12 200 (No.1547) 5 • Mesore	[1 Thoth, 201 B.C. From Sept 12 take 334 days (10+31+31+30+31+30+31+28+31+31+30+20 in Oct) = Oct 12 = To Oct 12 (201) add 137 days (19+30+31+31+26) = Feb 26, 747 B.C.
14	7 Philometor	143	Oct 6 175 1 Th	573^y 206^d $14\frac{1}{3}$ h (p.350)	May 1 174 (No.1587) 27 • 28 Phamenoth	From Apr 30 take 206 days (29+31+28+31+31+30+26 in Oct) = Oct 6 = 1 Thoth, 175 B.C. To Oct 6 (175) add 143 days (25+30+31+31+26) = Feb 26, 747 B.C.
15	37 III Calip-pic	151	Sept 28 142 1 Th	606^y 121^d $10\frac{1}{6}$ h (p.351)	Jan 27 141 (No.1638) 2 • 3 Tybi	From Jan 27 take 121 days (26+31+30+31+3 in Sept) = Sept 28 = 1 Thoth, 142 B.C. To Sept 28 add 151 days (2+31+30+31+31+26) = Feb 26, 747 B.C.
16	9 Hadrian	218	July 23 124 A.D. 1 Th	871^y 256^d $8\frac{1}{12}$ h (p.240)	Apr 5 125 A.D. (No.2058) 17 • 18 Pachon	[124 A.D. From Apr 5 take 256 days (4+31+28+31+31+30+31+30+31+9 in July) = July 23 = 1 Thoth, To July 23 (124) add 218 days (8+31+30+31+30+31+31+26) = Feb 26, 747 B.C.
17	17 Hadrian	220	July 21 132 1 Th	289 days	May 6 133 (No.2071) 20 • 21 Payni	[1 Thoth, 132 A.D. From May 6 take 289 days (5+30+31+28+31+31+30+31+30+31+11 in July) = July 21 = To July 21 (132) add 220 days (10+31+30+31+30+31+31+26) = Feb 26, 747 B.C.
18	19 Hadrian	220	July 21 134 1 Th	91 days	Oct 20 134 (No.2074) 2 • 3 Choiak	From Oct 20 take 91 days (19+30+31+11 in July) = July 21 = 1 Thoth, 134 A.D. To July 21 (134) add 220 days (10+31+30+31+30+31+31+26) = Feb 26, 747 B.C.
19	20 Hadrian	220	July 21 135 1 Th	228 days	Mar 6 136 (No.2075) Leap 19 • 20 Pharmuthi	[135 A.D. From Mar 5 take 228 days (4+29+31+31+30+31+30+31+11 days in July) = July 21 = 1 Thoth, To July 21 (135) add 220 days (10+31+30+31+30+31+31+26) = Feb 26, 747 B.C.

** Claudius Ptolemäus, "Handbuch der Astronomie," Erster Band. * Th. Ritter v. Oppolzer, "Canon der Finsternisse."

G. Amadon
Finished Oct 23, 1940

SKY DIAGRAMS

1945

UNITED STATES NAVAL OBSERVATORY

WASHINGTON

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Barbara D. Scott	*Junior Operator*

[1] Absent in military service.

PIECEWORK COMPUTERS

Elsie V. Willis — Lillian Feinstein

Mary H. Mikesell

September 1944.

PREFACE

In 1943 it occurred to the Director of the Nautical Almanac Office that navigators might welcome a means of selecting celestial objects for navigation and of identifying them in the sky more readily than was possible by existing methods. Star finders in common use have serious scale distortion; they require setting; and do not show the Moon and planets. It was thought that a series of circular diagrams, showing the principal navigational objects on an azimuthal equidistant projection with center at the zenith, for different hours of the night and for different latitudes, might be useful. Accordingly, sets of experimental *Sky Diagrams* were prepared and circulated to naval activities during 1944. With the second set of diagrams there was circulated a questionnaire designed to ascertain their practical value. To date (September 1, 1944), replies have been received from 689 ships, of which all but 20 are favorable. Replies from aircraft employing celestial navigation are equally favorable. In consequence, the first regular edition of *Sky Diagrams* is being issued for general distribution. In addition, it is intended to incorporate the diagrams into the *American Air Almanac* beginning with the volumes for 1946.

J. F. Hellweg,
Commodore, U. S. Navy, Retired,
Superintendent, Naval Observatory.

Washington, *September 1944.*

These diagrams show the appearance of the sky in various latitudes at different times of the night. They are useful in selecting the most suitable stars and planets for navigation on a given flight and for identifying prominent objects at the time of observation.

The *Sky Diagrams* have four advantages over ordinary star charts and star finders:

1. They are ready for immediate use without settings or tables of any kind.
2. Planets and the Moon are shown as well as the stars.
3. True altitudes and bearings are shown on the diagrams without distortion.
4. The appearance of the sky for different latitudes and times is shown at one opening so the appearance for intermediate latitudes and times is easily visualized.

There is a series of diagrams for each month showing the sky for six different latitudes at 2-hour intervals during the night. Those for the evening hours appear on two facing pages and those for the morning on the two following. The diagrams for a given latitude are arranged in a row and show the changes in the sky during the night.

In each diagram the circular outline represents the horizon and the cross at the center the zenith. Altitudes are measured radially with a linear scale; i. e., an object one third of the way from the edge to the center has an altitude of 30°. The small circles on the diagrams are at altitudes 30° and 60°. Azimuths are measured as on the navigation chart with north at the top and east at the right. On various parts of the diagram are small curved arrows indicating the diurnal motion in that area; the length of the arrow shows the motion in one hour.

The objects shown on the diagrams are the 22 navigational stars contained in the *Astronomical Navigation Tables* (H. O. 218), the four planets Venus, Mars, Jupiter, and Saturn, the Moon, and the north and south celestial poles. The position of a star or a planet is indicated by the symbol which also shows its brightness, the magnitude scale being the same as that of the daily diagrams in the *American Air Almanac*. Near each star symbol is the number in the H. O. 218 list and near each planet symbol is its initial. The north and south celestial poles are identified by the initials NP and SP. The position of the Moon is shown by a circle with the day of the month on which it occupies that position.

The positions of the stars and planets in each diagram are indicated for the 15th of the month and will usually serve for the entire month. If it is desired to allow for the motion of the stars during the month it is necessary only to remember that a given configuration will occur at the beginning of the month 1 hour later than the time indicated, and at the end of the month 1 hour earlier. In those months during which Venus or Mars moves considerably with respect to the stars the positions for the first and last of the month are shown; the position toward the west is for the first of the month.

The Moon moves so rapidly with respect to the stars that its position at a given time of the night varies rapidly from night to night, and it is necessary to show on each diagram a succession of positions for various days of the month. Three or four such positions are indicated and those for the intermediate dates may be interpolated be-

tween those given. Since the Moon moves completely around the sky in slightly less than a month or a little over 13° in a day, it will appear on a given diagram for about half of each month. The position on the diagram for each successive night is always to the eastward, and when it disappears off the eastern edge of the diagram it will reappear on the western edge about 2 weeks later.

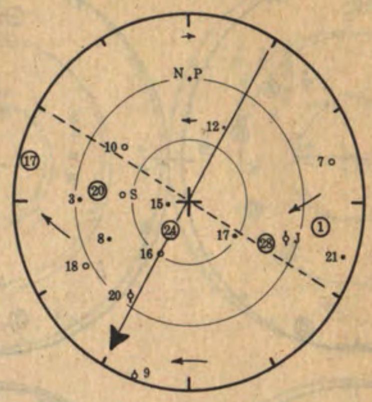
The diagrams are particularly useful in selecting the most suitable objects for a given flight.

Example 1. Select the best available objects to give a fix at 23^h LCT on Feb. 10, 1945, during a flight on a true course of 210° in latitude 30° N.

The required diagram, which is the fourth one in the bottom row on page 10, is reproduced here with the course of 210° marked on it.

1945 FEBRUARY

23^h



N30

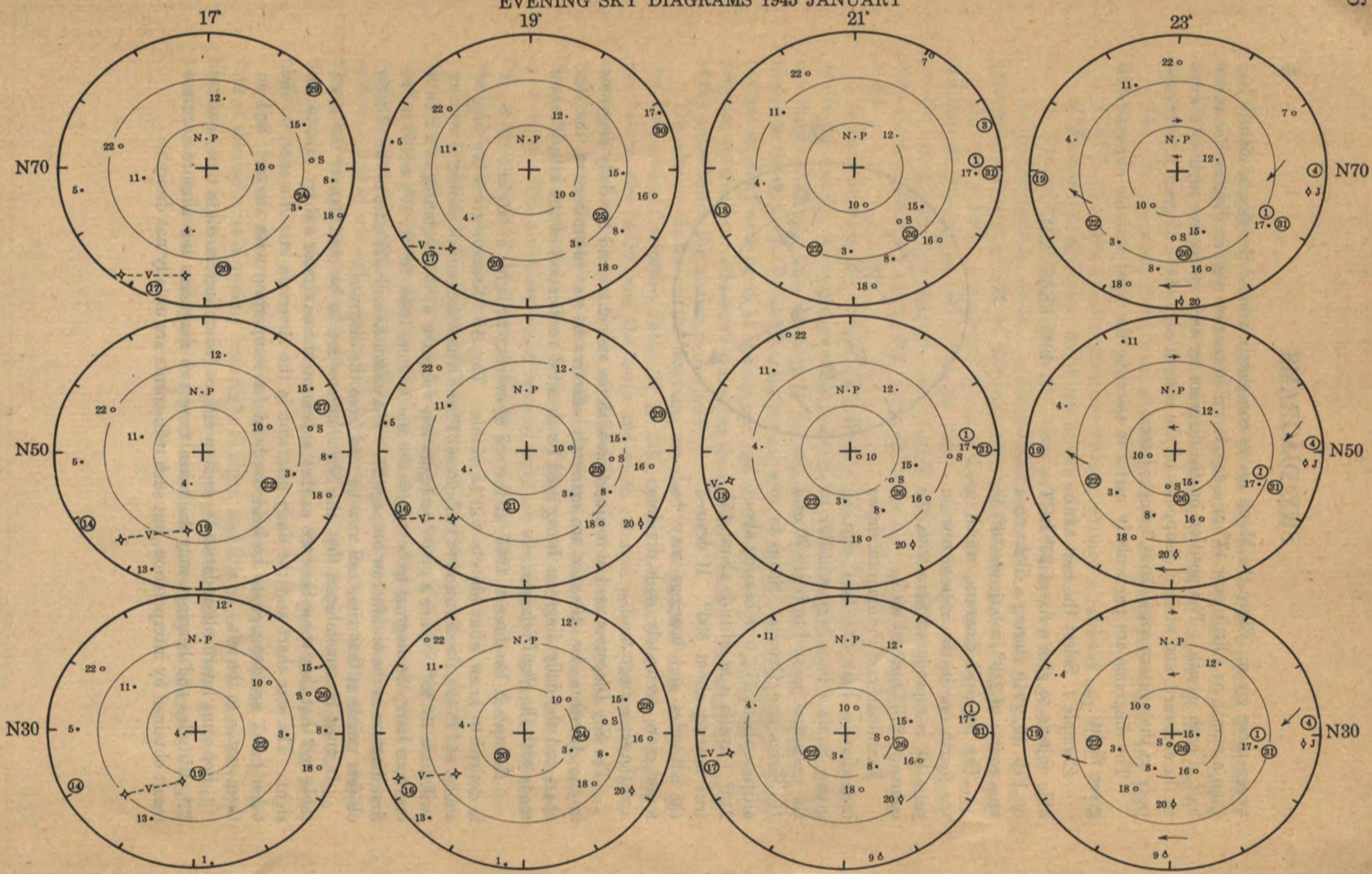
Examination of the diagram shows immediately that the best objects, giving Sumner lines perpendicular to the track and parallel to it are 20 and 10, Sirius and Capella. Sirius is in altitude about 35°, true bearing about 210°; Capella is in altitude about 45°, true bearing about 300°. If desired the altitudes and bearings may be found more accurately with dividers and the scale diagrams.

The *Sky Diagrams* used in conjunction with the star chart and the daily diagrams in the *American Air Almanac* are extremely effective in star identification, the star chart and the daily diagrams being used for detailed verification of the identification made with the *Sky Diagrams*.

Example 2. On June 1, 1945, at the end of evening twilight, in latitude 10° S., it is desired to know what objects will be visible. The *Air Almanac* gives the time of sunset as $17^h 45^m$, the duration of twilight as 23^m and hence the time of ending of evening twilight is $18^h 08^m$. Since a given configuration will occur at the beginning of a month one hour later, the diagram to be used is the one for June 1945, 10° S., 17^h, which is the first diagram in the middle row on page 27. The azimuths and altitudes of the various objects visible at that time can now be read from the diagram.

It must be remembered that the *Sky Diagrams* are to be used flat on the chart table and that they show bearings as they appear on the navigator's chart, east to the right. The star chart and the daily diagrams in the *American Air Almanac*, on the other hand, are designed to be held overhead for comparison with the sky, and on them east is to the left.

For some intermediate latitude, such as 40°, or for an intermediate time, such as 22^h, altitudes and bearings may be taken from two diagrams and a more accurate result obtained by interpolation, but such refinements are usually not desirable.



STARS

1	Achernar	12	Dubhe
2	Acrux	13	Fomalhaut
3	Aldebaran	14	Peacock
4	Alpheratz	15	Pollux
5	Altair	16	Procyon
6	Antares	17	Regulus
7	Arcturus	18	Rigel
8	Betelgeux	19	Rigil Kent
9	Canopus	20	Sirius
10	Capella	21	Spica
11	Deneb	22	Vega

PLANETS

V Venus J Jupiter
M Mars S Saturn

MOON

① Position on Jan. 1
② " " " 2

POLES

N·P North, S·P South

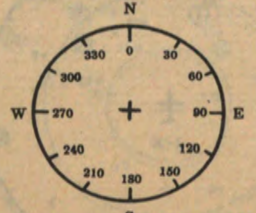
MAGNITUDE SCALE

−4 −3 −2 −1 0 1 2

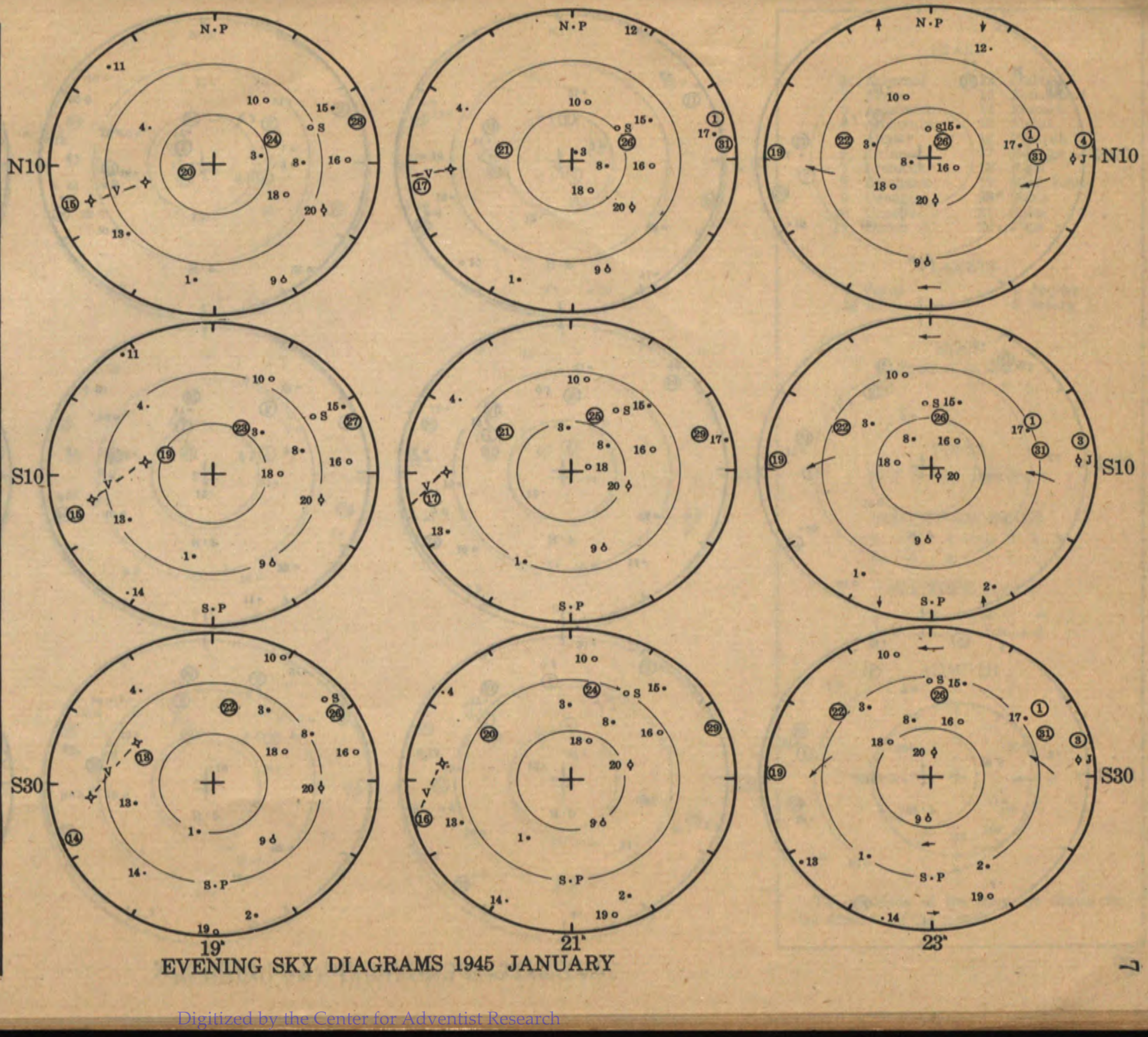
ALTITUDE SCALE

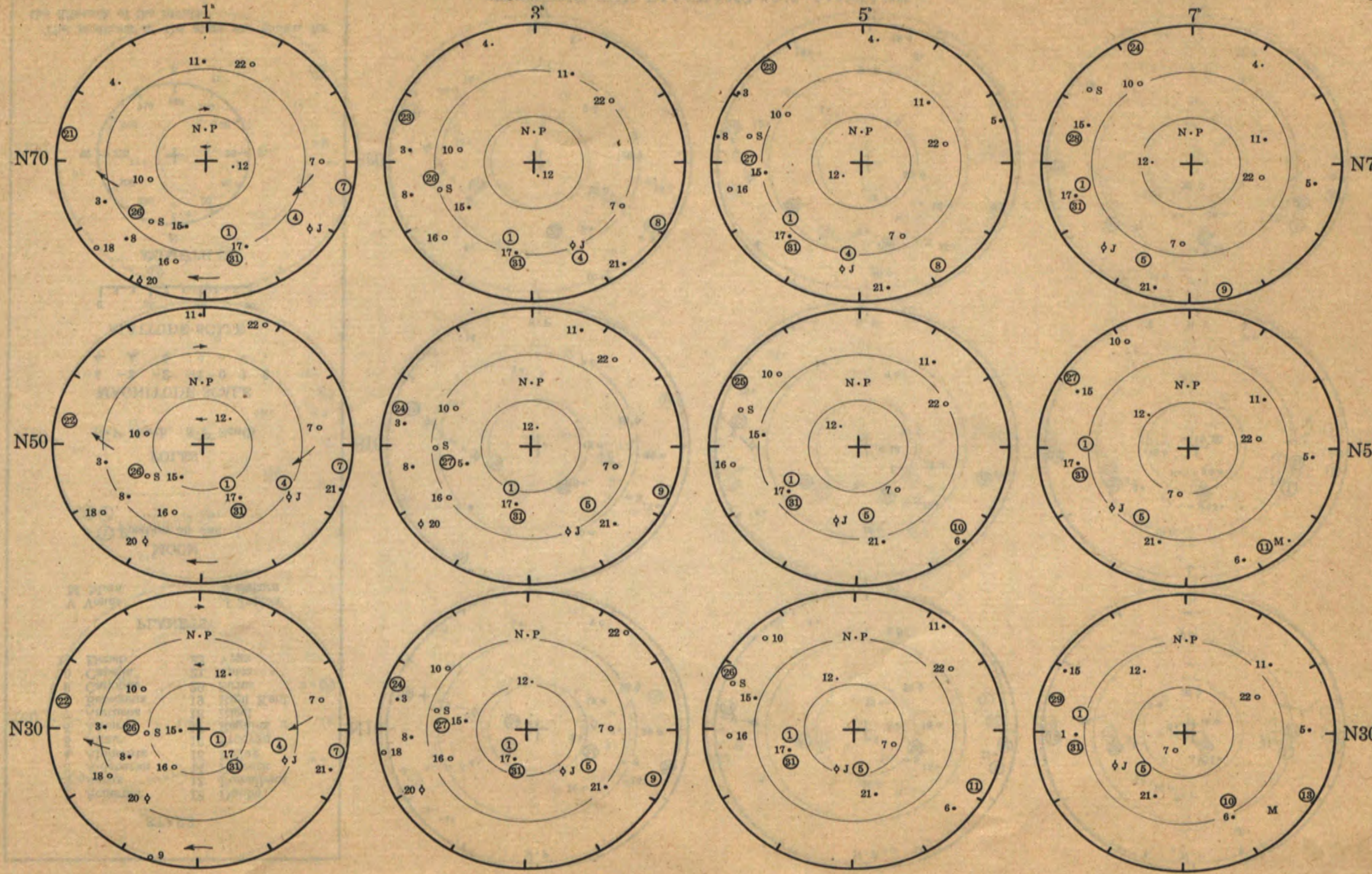
0 30 60 90

AZIMUTH

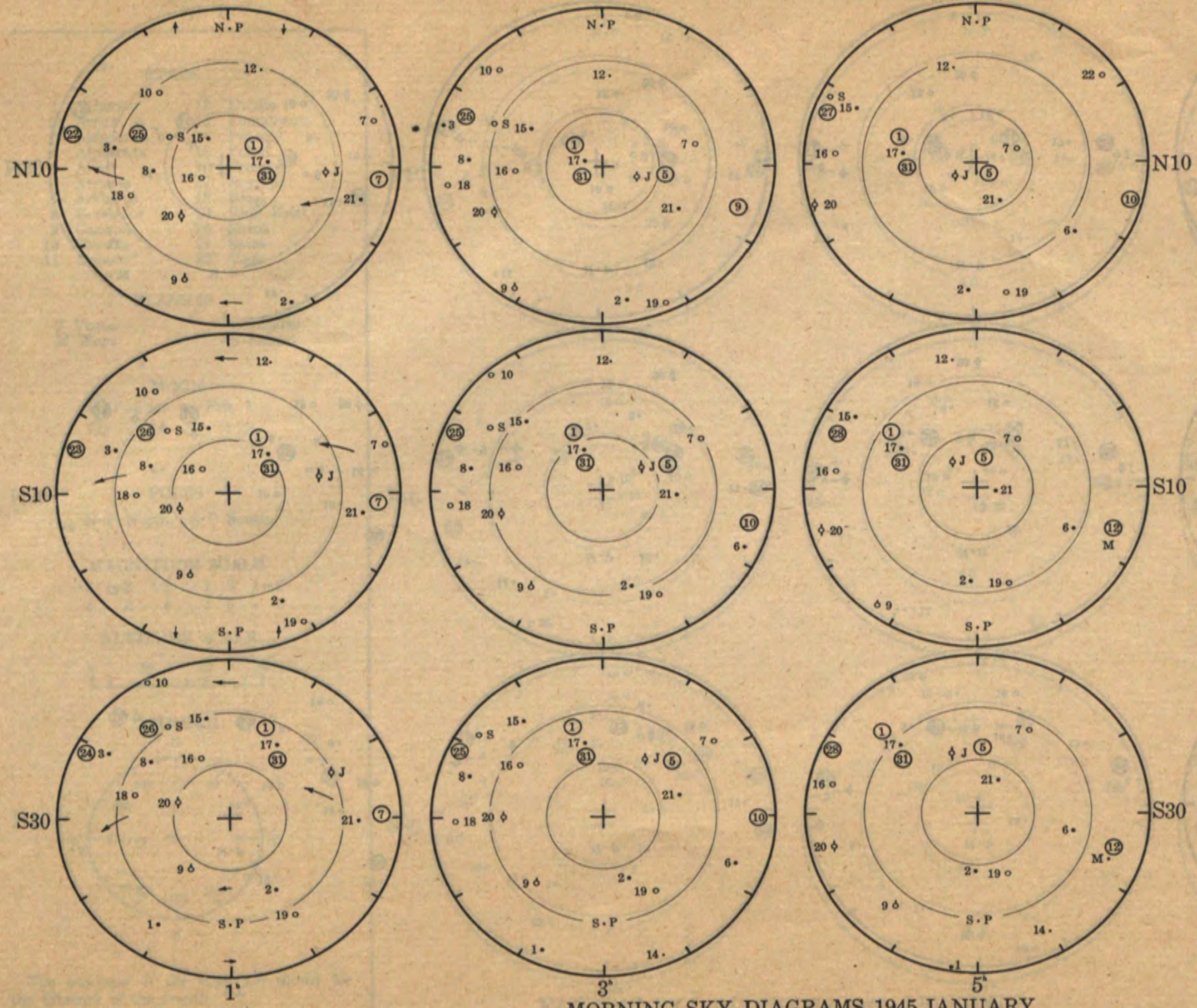


The positions of the stars are shown for the fifteenth of the month.





609403 O - 44 - 2



STARS

1	Achernar	12	Dubhe
2	Acrux	13	Fomalhaut
3	Aldebaran	14	Peacock
4	Alpheratz	15	Pollux
5	Altair	16	Procyon
6	Antares	17	Regulus
7	Arcturus	18	Rigel
8	Betelgeux	19	Rigil Kent
9	Canopus	20	Sirius
10	Capella	21	Spica
11	Deneb	22	Vega

PLANETS

V Venus J Jupiter
M Mars S Saturn

MOON

① Position on Jan. 1
② " " " 2

POLES

N·P North, S·P South

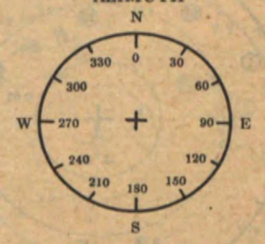
MAGNITUDE SCALE

−4 −3 −2 −1 0 1 2

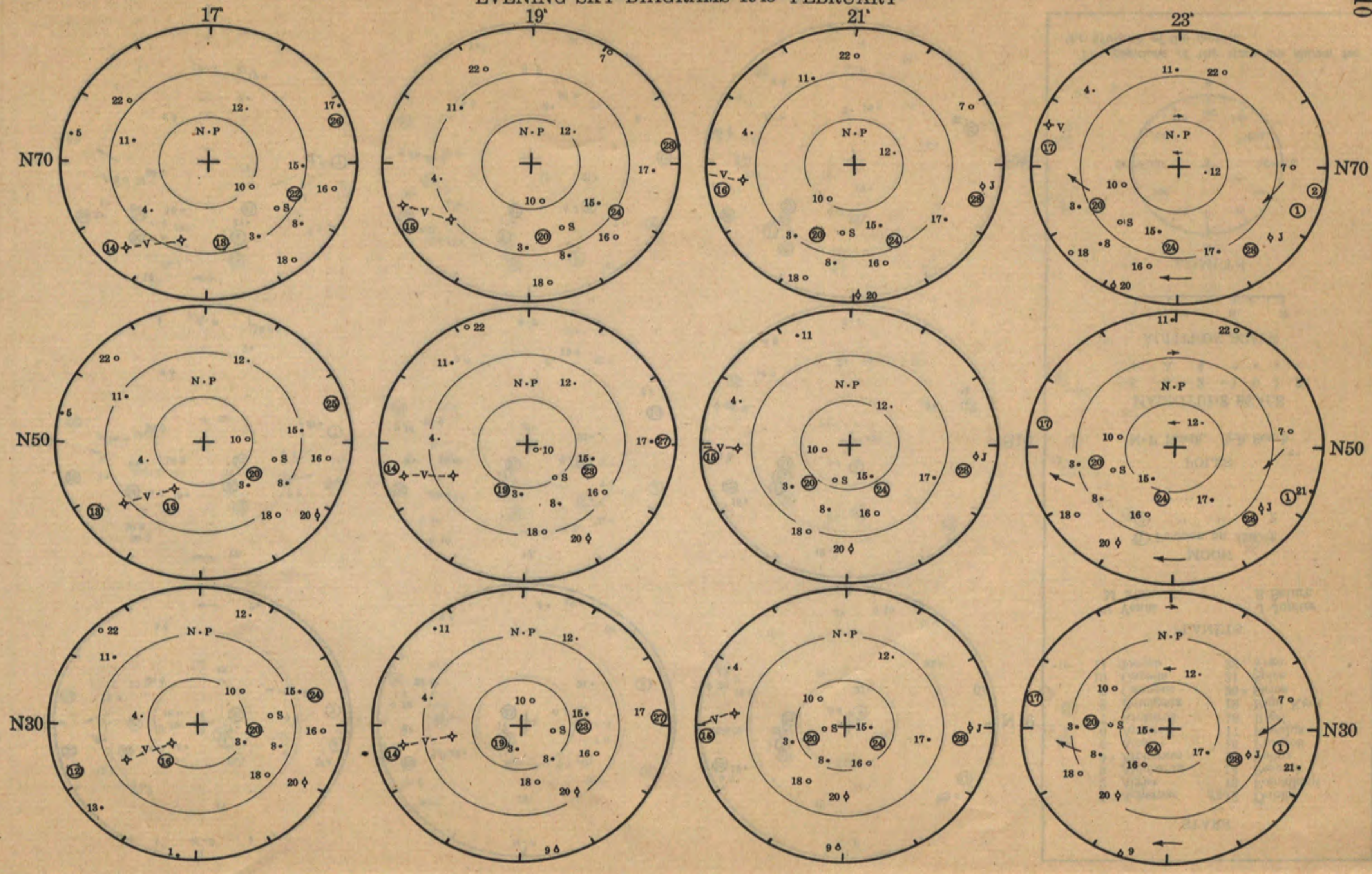
ALTITUDE SCALE

0 30 60 90

AZIMUTH



The positions of the stars are shown for the fifteenth of the month.



STARS

1	Achernar	12	Dubhe
2	Acrux	13	Fomalhaut
3	Aldebaran	14	Peacock
4	Alpheratz	15	Pollux
5	Altair	16	Procyon
6	Antares	17	Regulus
7	Arcturus	18	Rigel
8	Betelgeux	19	Rigil Kent
9	Canopus	20	Sirius
10	Capella	21	Spica
11	Deneb	22	Vega

PLANETS

V Venus J Jupiter
M Mars S Saturn

MOON

① Position on Feb. 1
② " " " 2

POLES

N·P North, S·P South

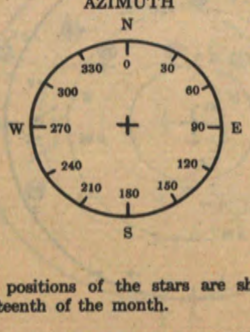
MAGNITUDE SCALE

−4 −3 −2 −1 0 1 2

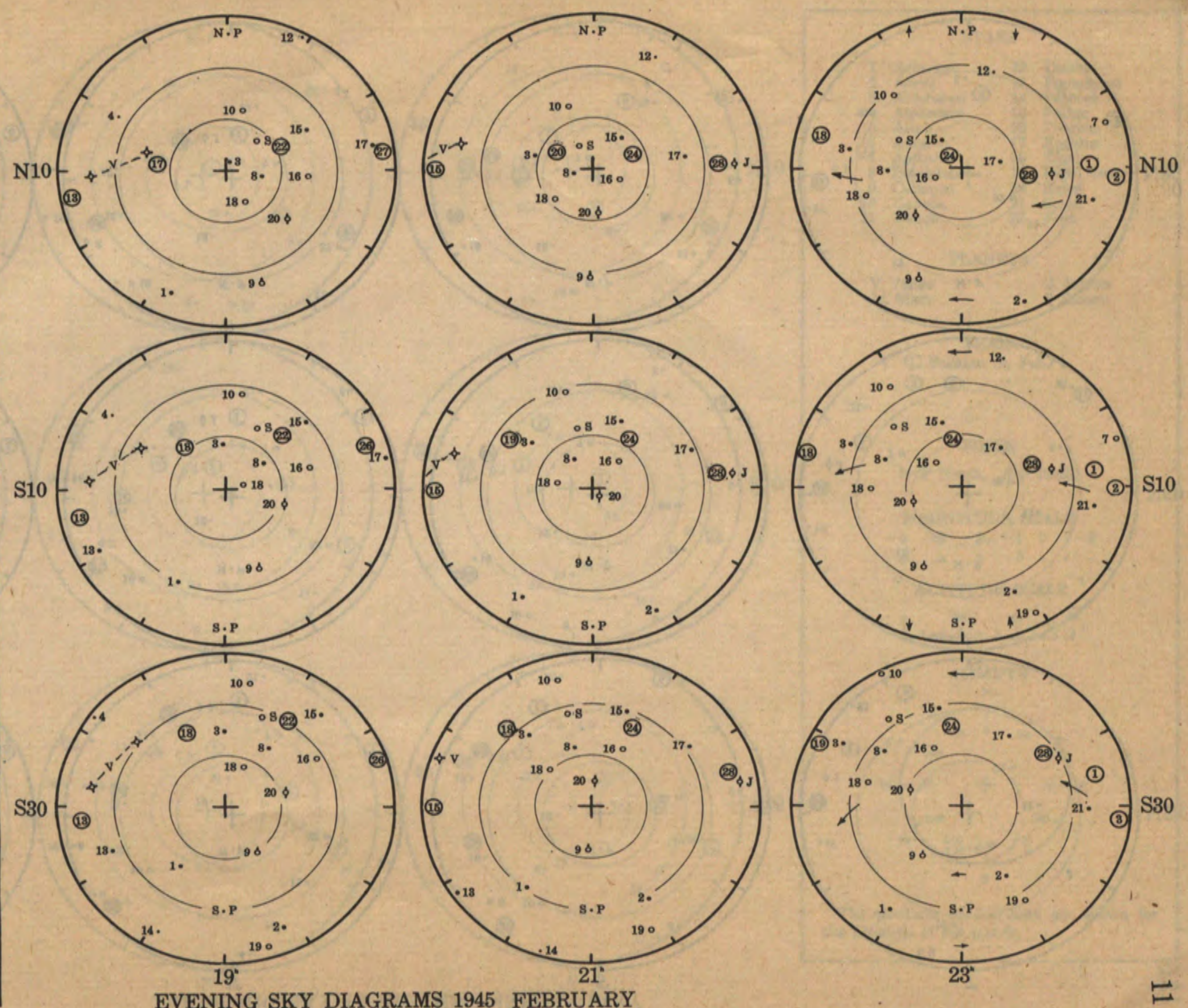
ALTITUDE SCALE

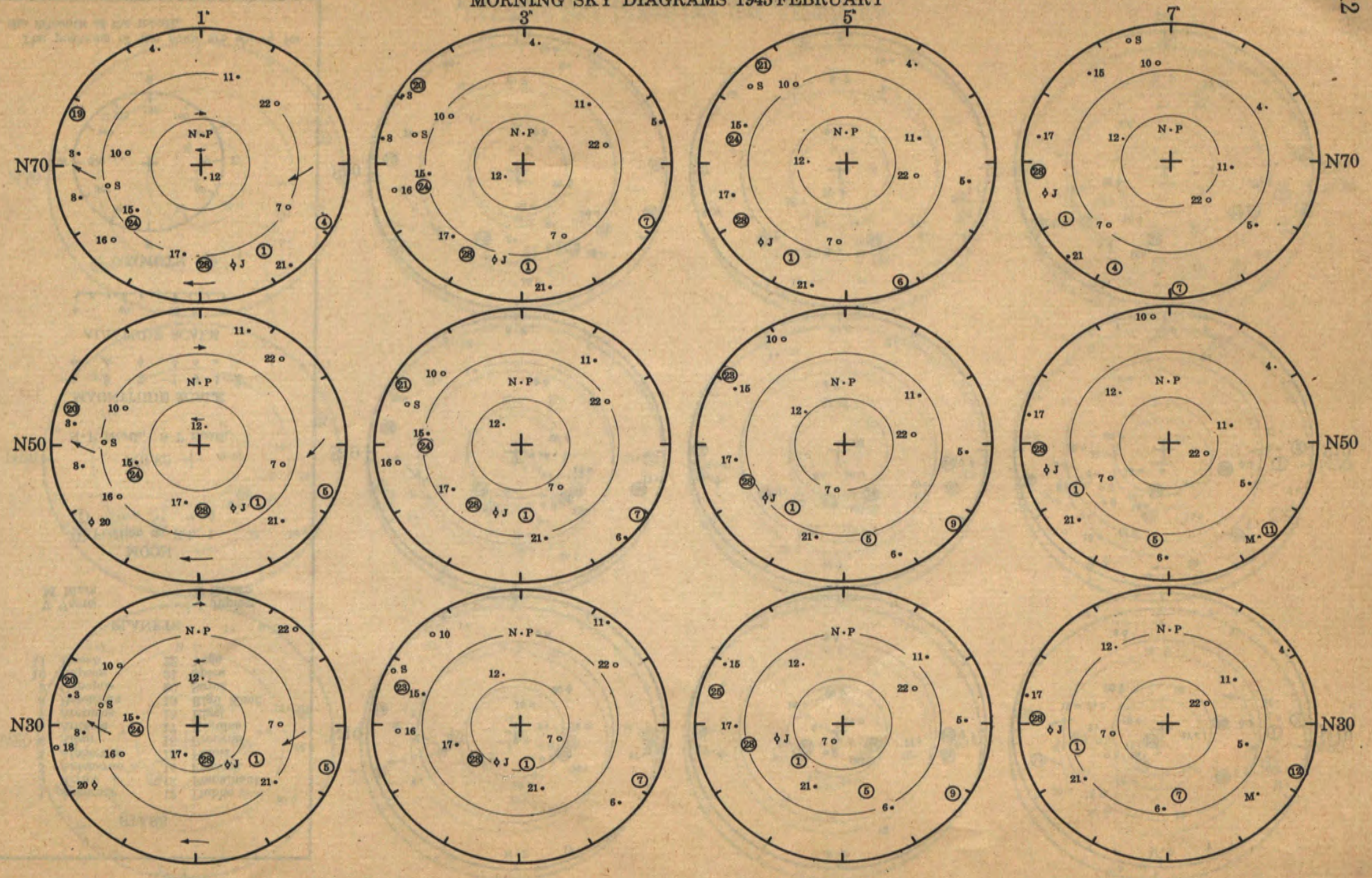
0 30 60 90

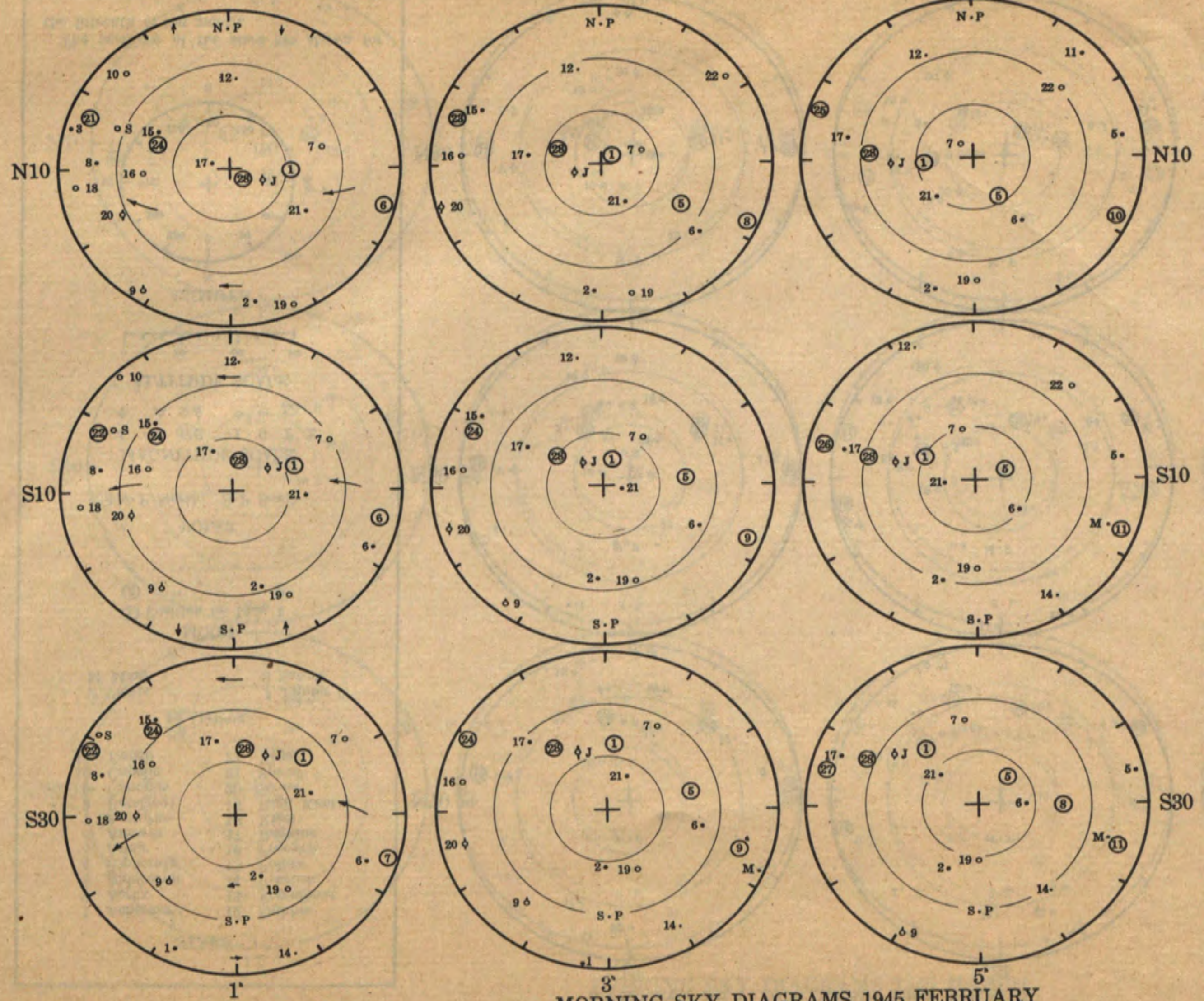
AZIMUTH



The positions of the stars are shown for the fifteenth of the month.







STARS

1	Achernar	12	Dubhe
2	Acrux	13	Fomalhaut
3	Aldebaran	14	Peacock
4	Alpheratz	15	Pollux
5	Altair	16	Procyon
6	Antares	17	Regulus
7	Arcturus	18	Rigel
8	Betelgeux	19	Rigil Kent
9	Canopus	20	Sirius
10	Capella	21	Spica
11	Deneb	22	Vega

PLANETS

V Venus J Jupiter
M Mars S Saturn

MOON

① Position on Feb. 1
② " " " 2

POLES

N·P North, S·P South

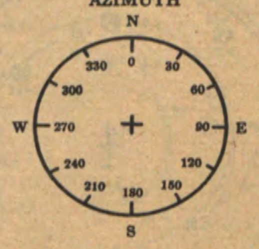
MAGNITUDE SCALE

−4 −3 −2 −1 0 1 2

ALTITUDE SCALE

0 30 60 90

AZIMUTH



The positions of the stars are shown for the fifteenth of the month.

STARS

1	Achernar	12	Dubhe
2	Acrux	13	Fomalhaut
3	Aldebaran	14	Peacock
4	Alpheratz	15	Pollux
5	Altair	16	Procyon
6	Antares	17	Regulus
7	Arcturus	18	Rigel
8	Betelgeux	19	Rigil Kent
9	Canopus	20	Sirius
10	Capella	21	Spica
11	Deneb	22	Vega

PLANETS

V Venus J Jupiter
M Mars S Saturn

MOON

① Position on Mar. 1
② " " " 2

POLES

N·P North, S·P South

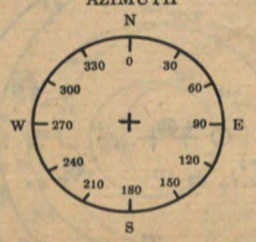
MAGNITUDE SCALE

-4 -3 -2 -1 0 1 2

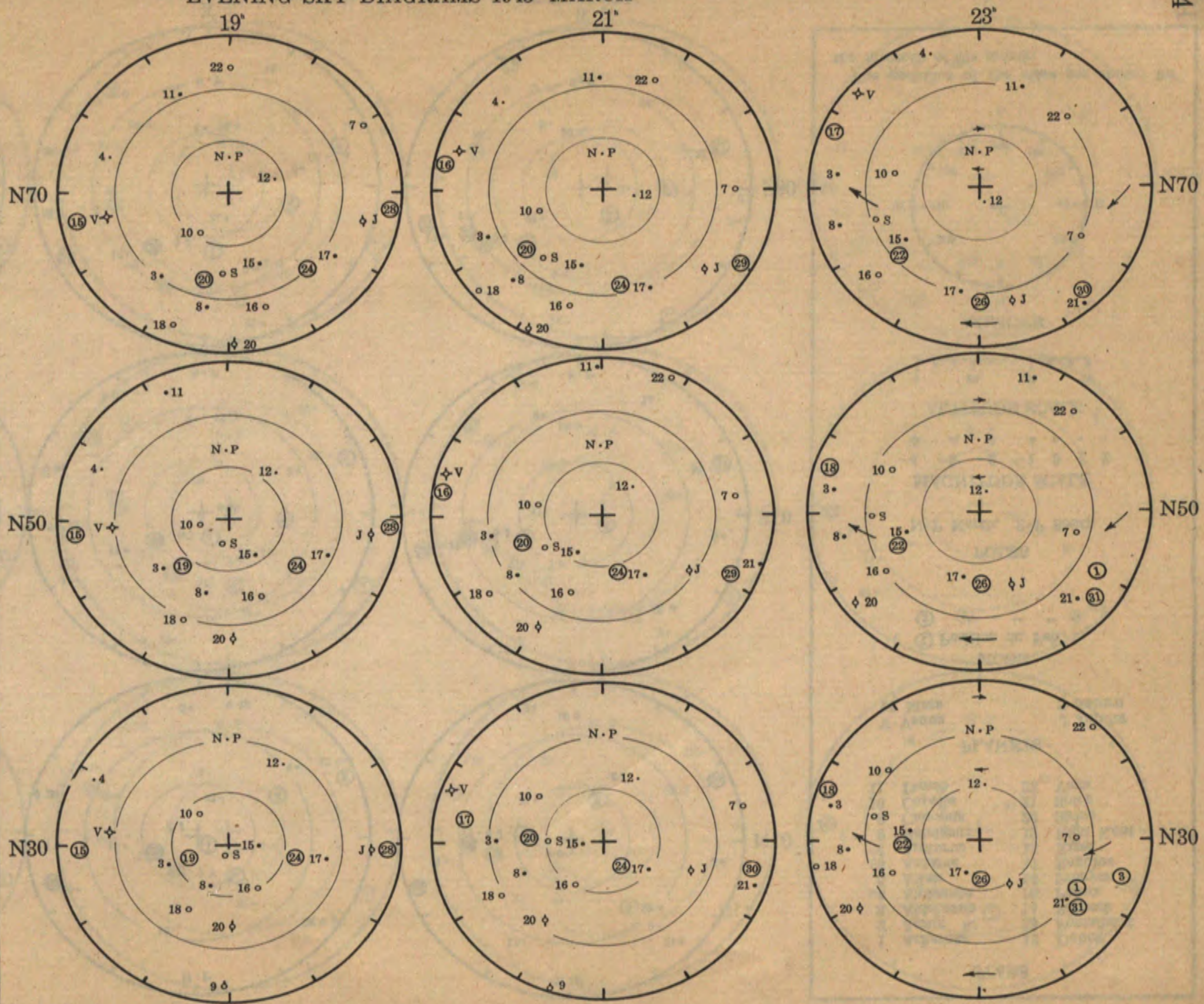
ALTITUDE SCALE

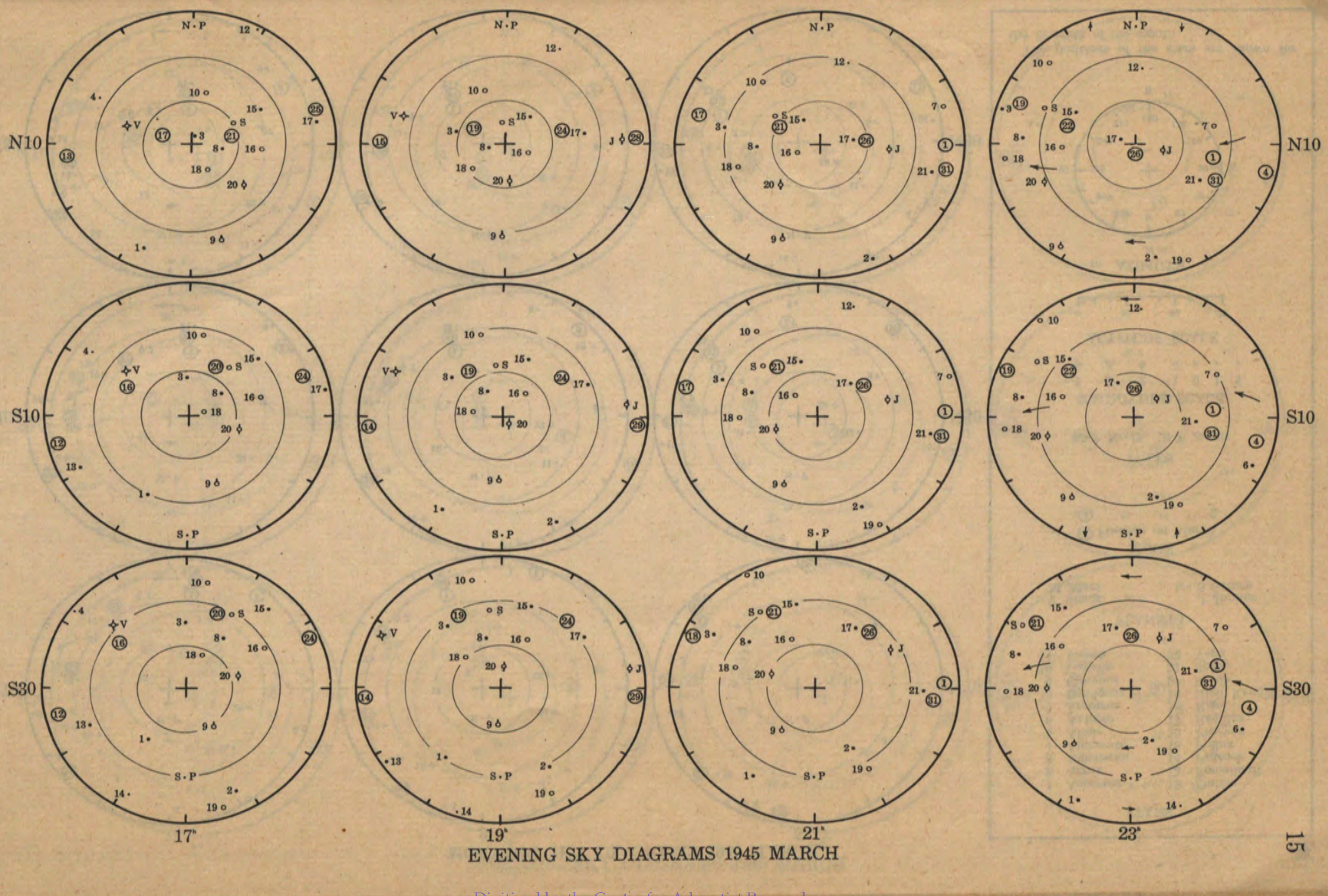
0 30 60 90

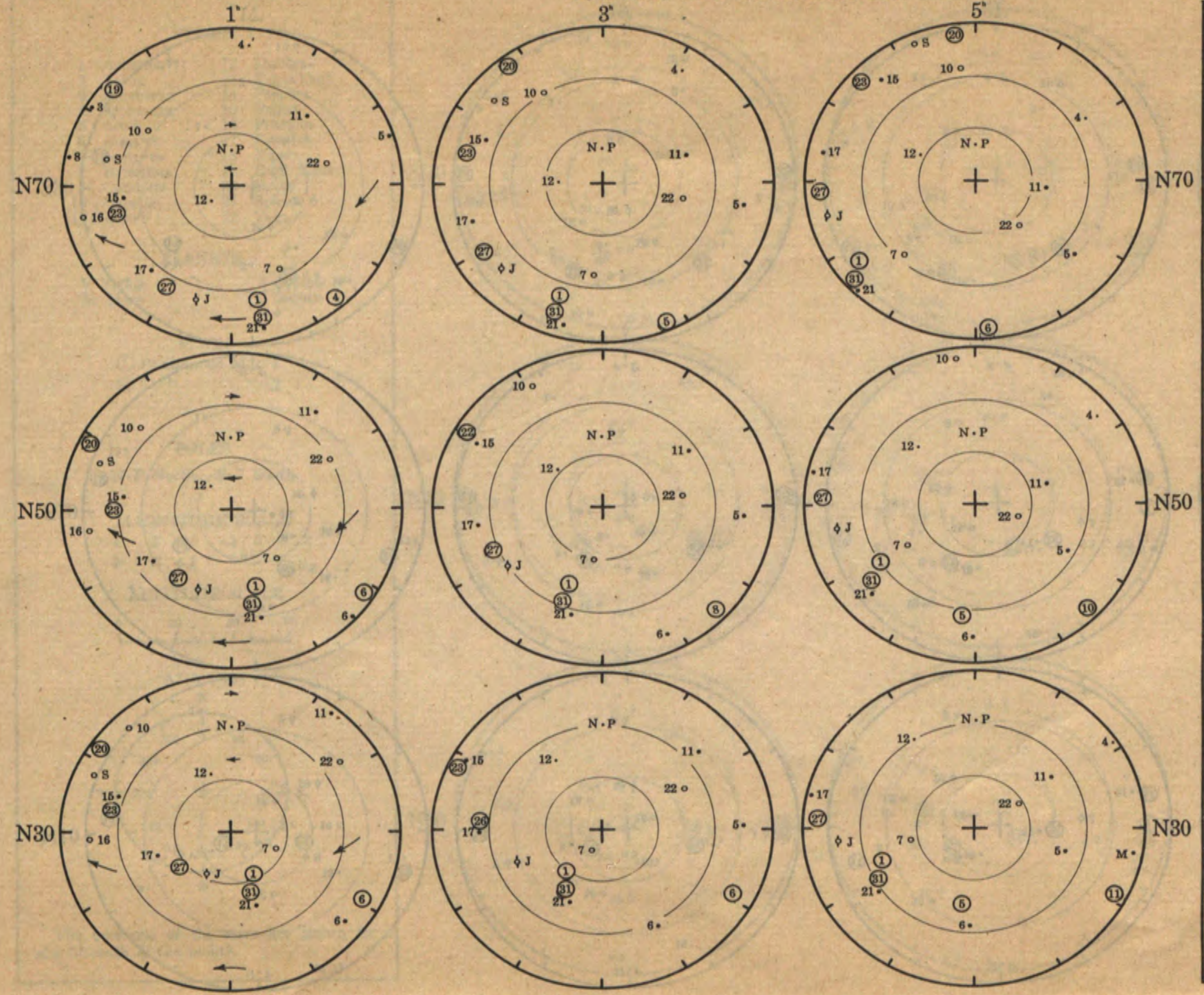
AZIMUTH



The positions of the stars are shown for the fifteenth of the month.







STARS

1	Achernar	12	Dubhe
2	Acrux	13	Fomalhaut
3	Aldebaran	14	Peacock
4	Alpheratz	15	Pollux
5	Altair	16	Procyon
6	Antares	17	Regulus
7	Arcturus	18	Rigel
8	Betelgeux	19	Rigil Kent
9	Canopus	20	Sirius
10	Capella	21	Spica
11	Deneb	22	Vega

PLANETS

V Venus — J Jupiter
M Mars — S Saturn

MOON

① Position on Mar. 1
② " " " 2

POLES

N·P North, S·P South

MAGNITUDE SCALE

−4 −3 −2 −1 0 1 2

ALTITUDE SCALE

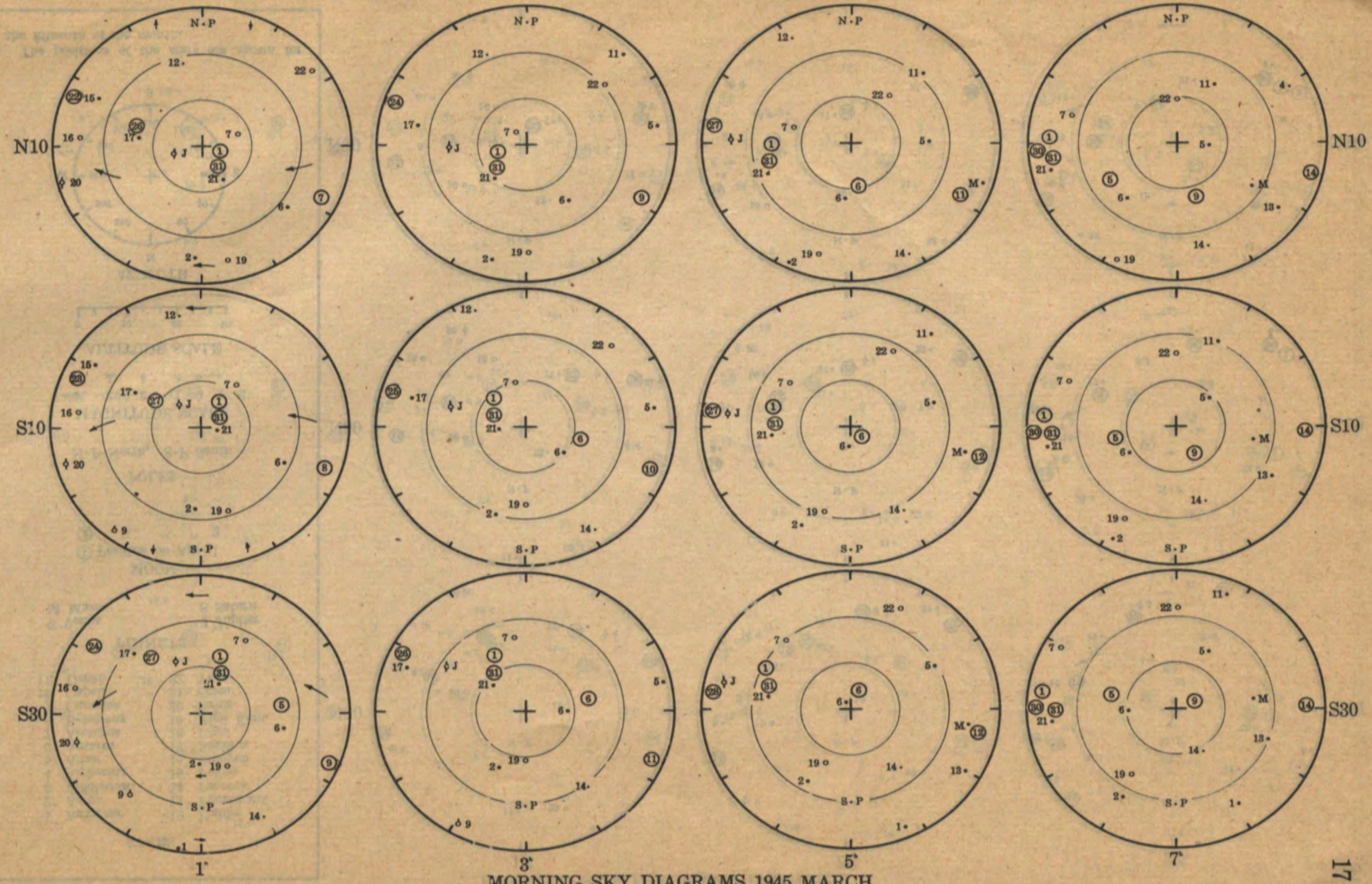
0 30 60 90

AZIMUTH

N, E, S, W; 0, 30, 60, 90, 120, 150, 180, 210, 240, 270, 300, 330

The positions of the stars are shown for the fifteenth of the month.

609403 O - 44 - 3



STARS

1	Achernar	12	Dubhe
2	Acrux	13	Fomalhaut
3	Aldebaran	14	Peacock
4	Alpheratz	15	Pollux
5	Altair	16	Procyon
6	Antares	17	Regulus
7	Arcturus	18	Rigel
8	Betelgeux	19	Rigil Kent
9	Canopus	20	Sirius
10	Capella	21	Spica
11	Deneb	22	Vega

PLANETS

V Venus J Jupiter
M Mars S Saturn

MOON

① Position on Apr. 1
② " " " 2

POLES

N·P North, S·P South

MAGNITUDE SCALE

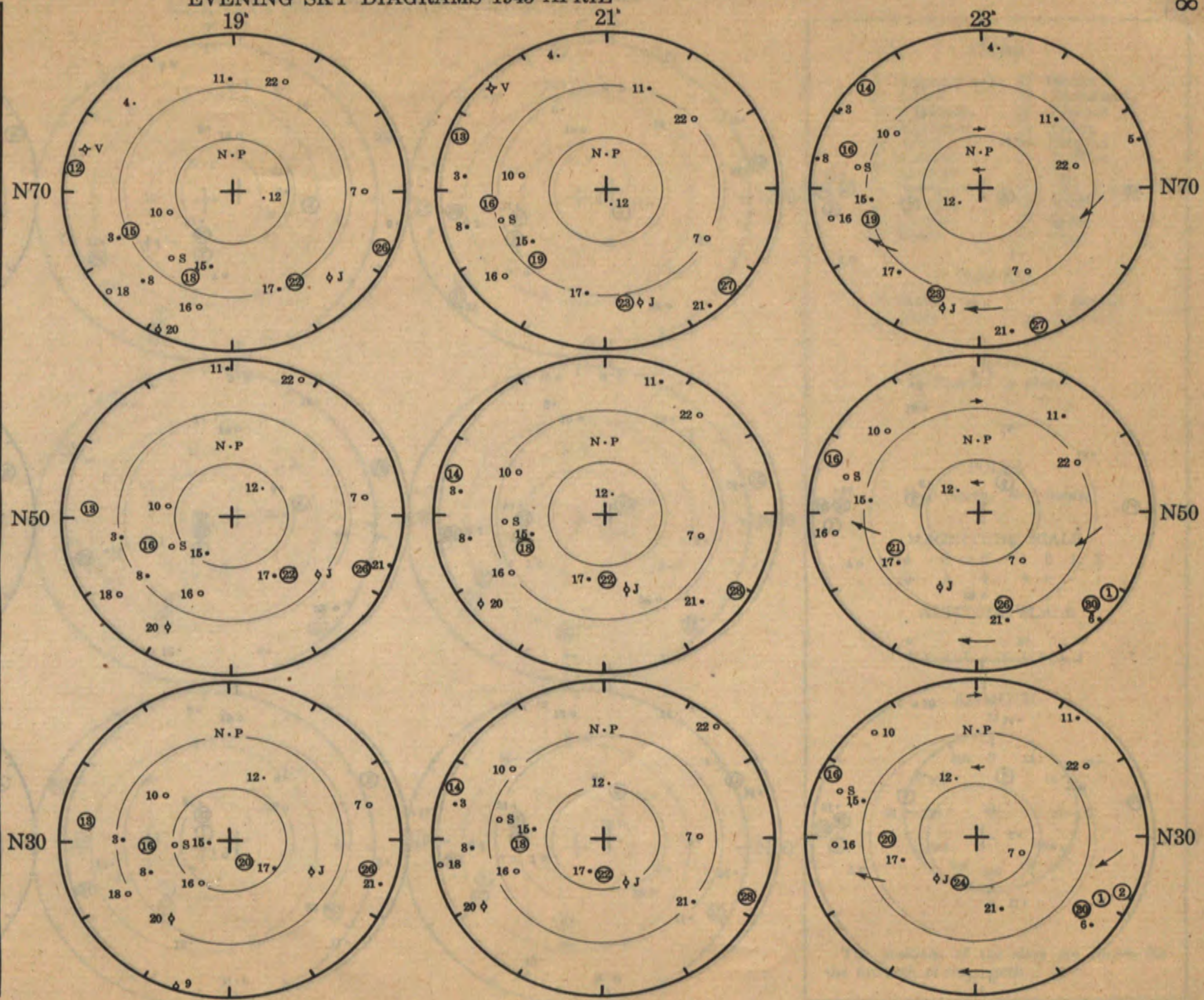
−4 −3 −2 −1 0 1 2

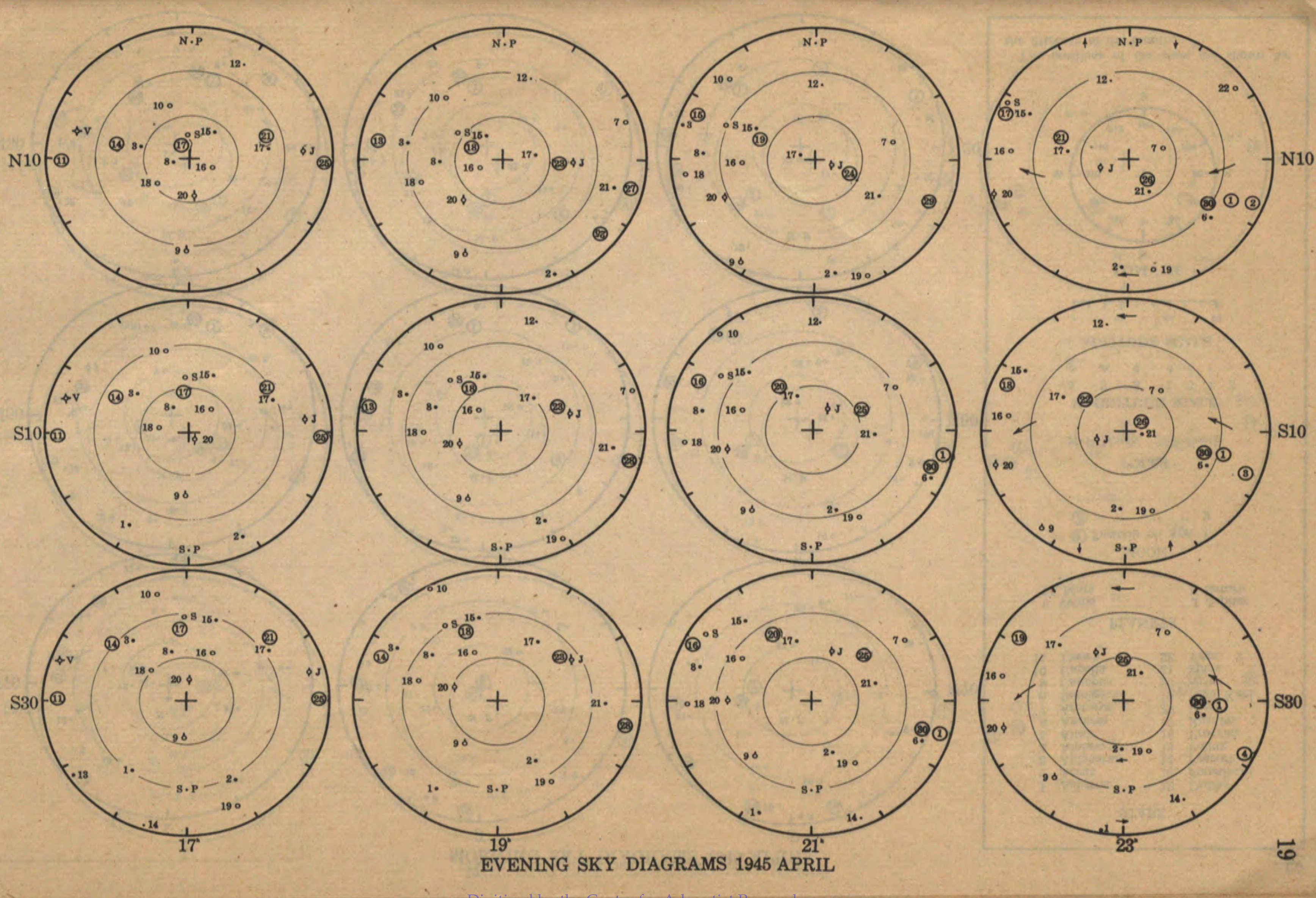
ALTITUDE SCALE

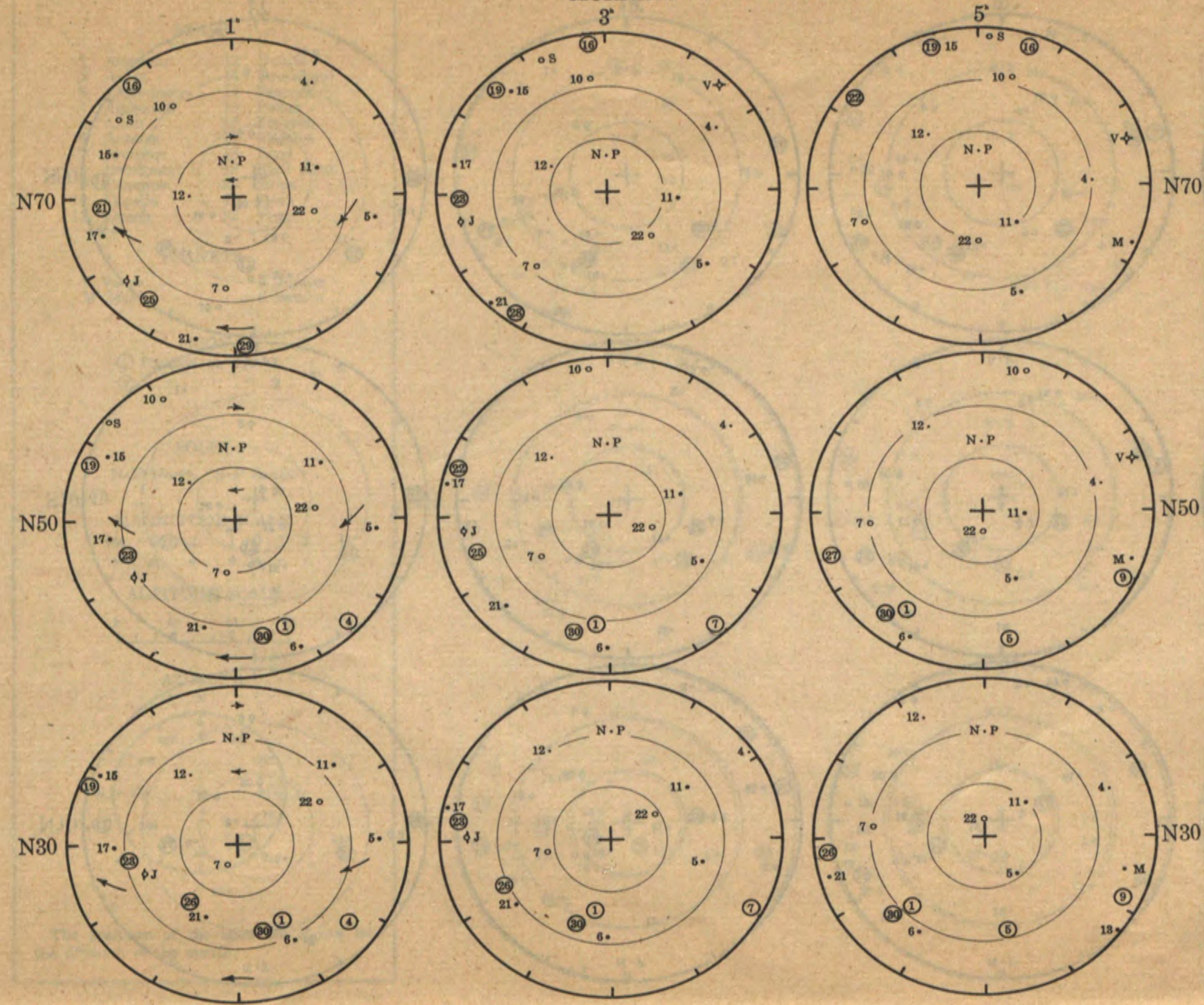
0 30 60 90

AZIMUTH

The positions of the stars are shown for the fifteenth of the month.







STARS

1	Achernar	12	Dubhe
2	Acrux	13	Fomalhaut
3	Aldebaran	14	Peacock
4	Alpheratz	15	Pollux
5	Altair	16	Procyon
6	Antares	17	Regulus
7	Arcturus	18	Rigel
8	Betelgeux	19	Rigil Kent
9	Canopus	20	Sirius
10	Capella	21	Spica
11	Deneb	22	Vega

PLANETS

V Venus J Jupiter
M Mars S Saturn

MOON

① Position on Apr. 1
② " " " 2

POLES

N·P North, S·P South

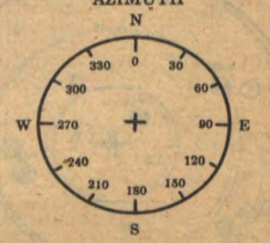
MAGNITUDE SCALE

-4 -3 -2 -1 0 1 2

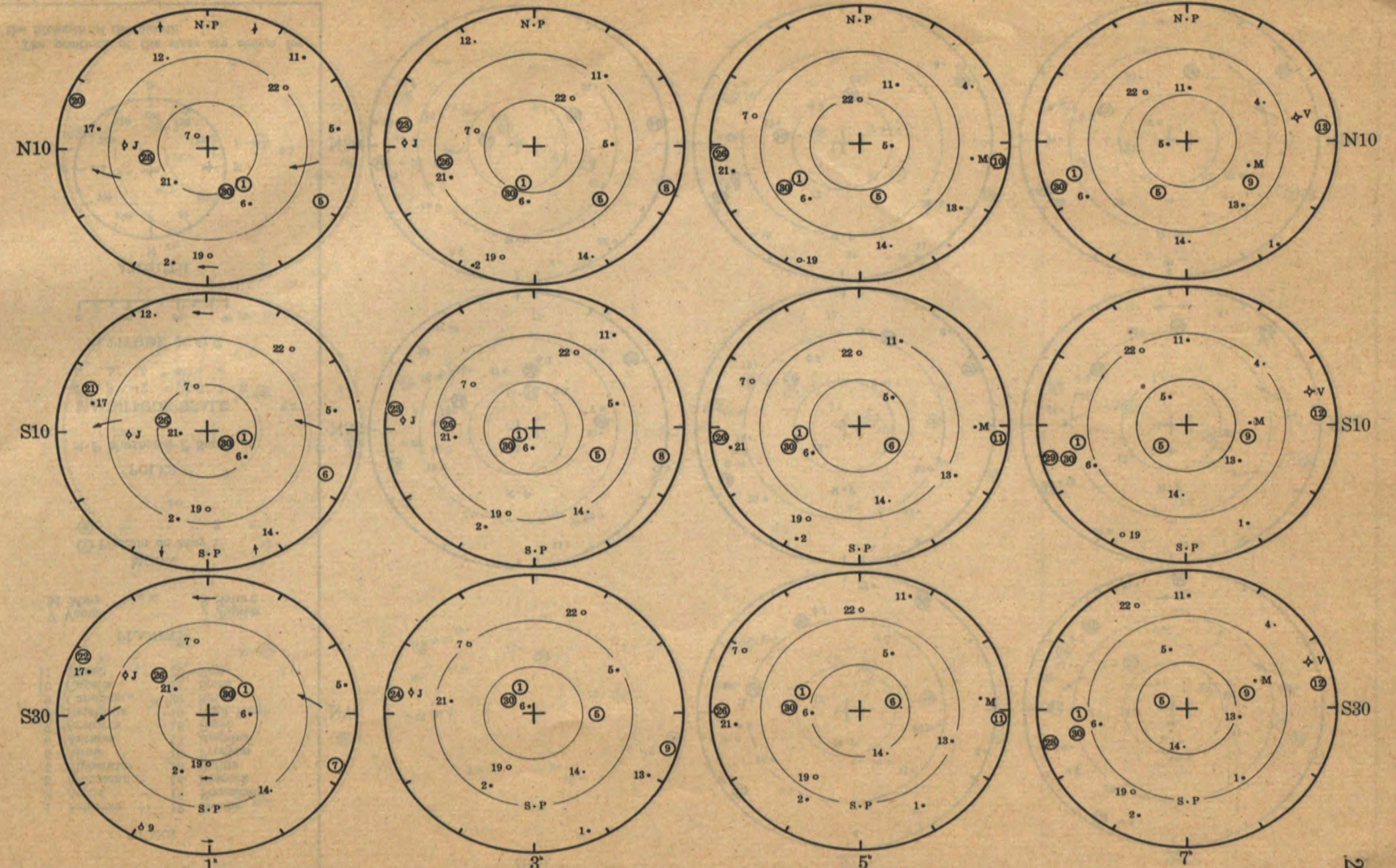
ALTITUDE SCALE

0 30 60 90

AZIMUTH



The positions of the stars are shown for the fifteenth of the month.



STARS

1	Achernar	12	Dubhe
2	Acrux	13	Fomalhaut
3	Aldebaran	14	Peacock
4	Alpheratz	15	Pollux
5	Altair	16	Procyon
6	Antares	17	Regulus
7	Arcturus	18	Rigel
8	Betelgeux	19	Rigil Kent
9	Canopus	20	Sirius
10	Capella	21	Spica
11	Deneb	22	Vega

PLANETS

V Venus — J Jupiter
M Mars — S Saturn

MOON

① Position on May 1
② " " " 2

POLES

N·P North, S·P South

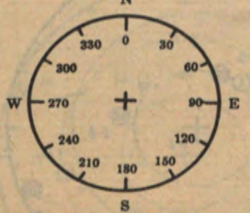
MAGNITUDE SCALE

-4 -3 -2 -1 0 1 2

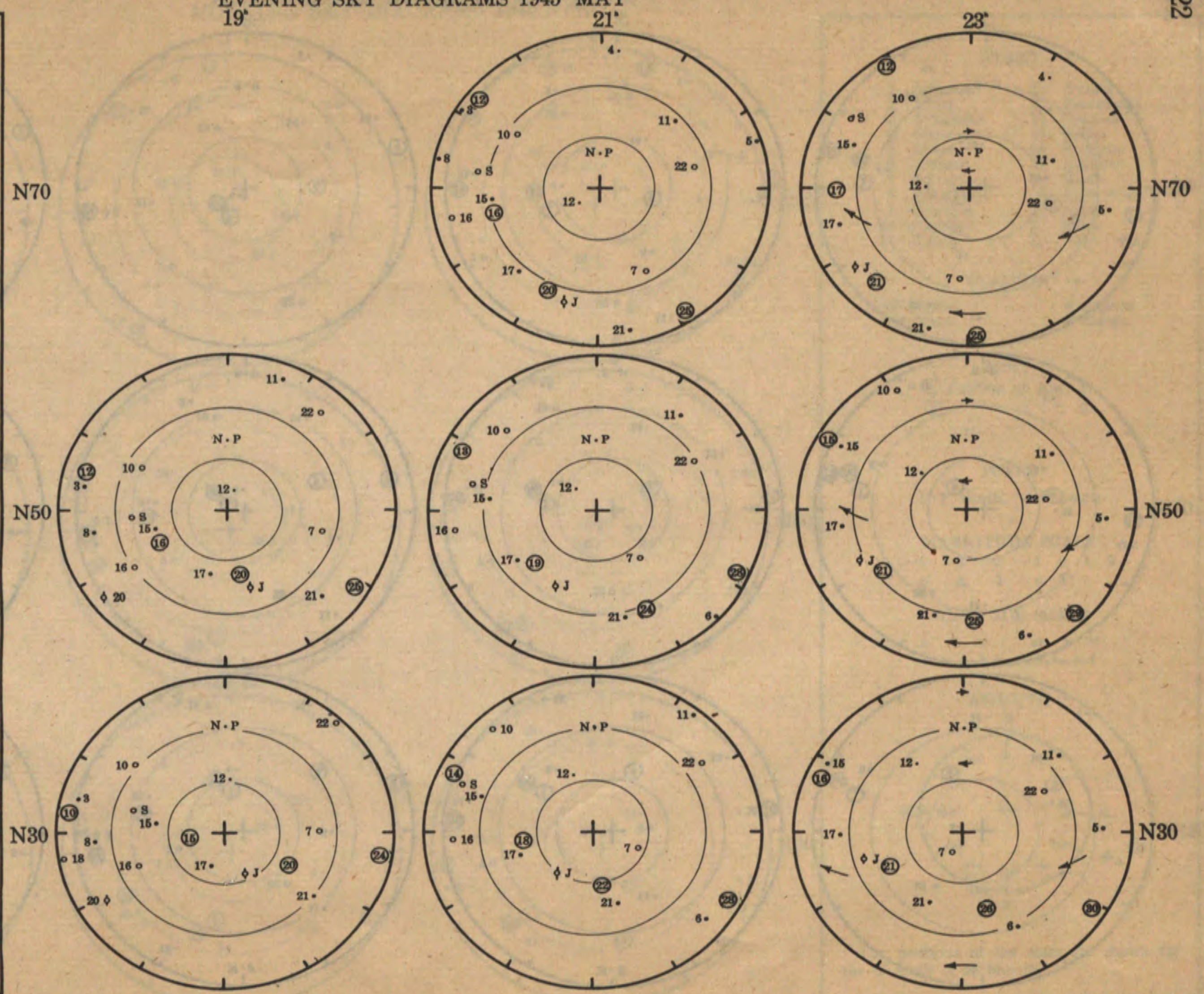
ALTITUDE SCALE

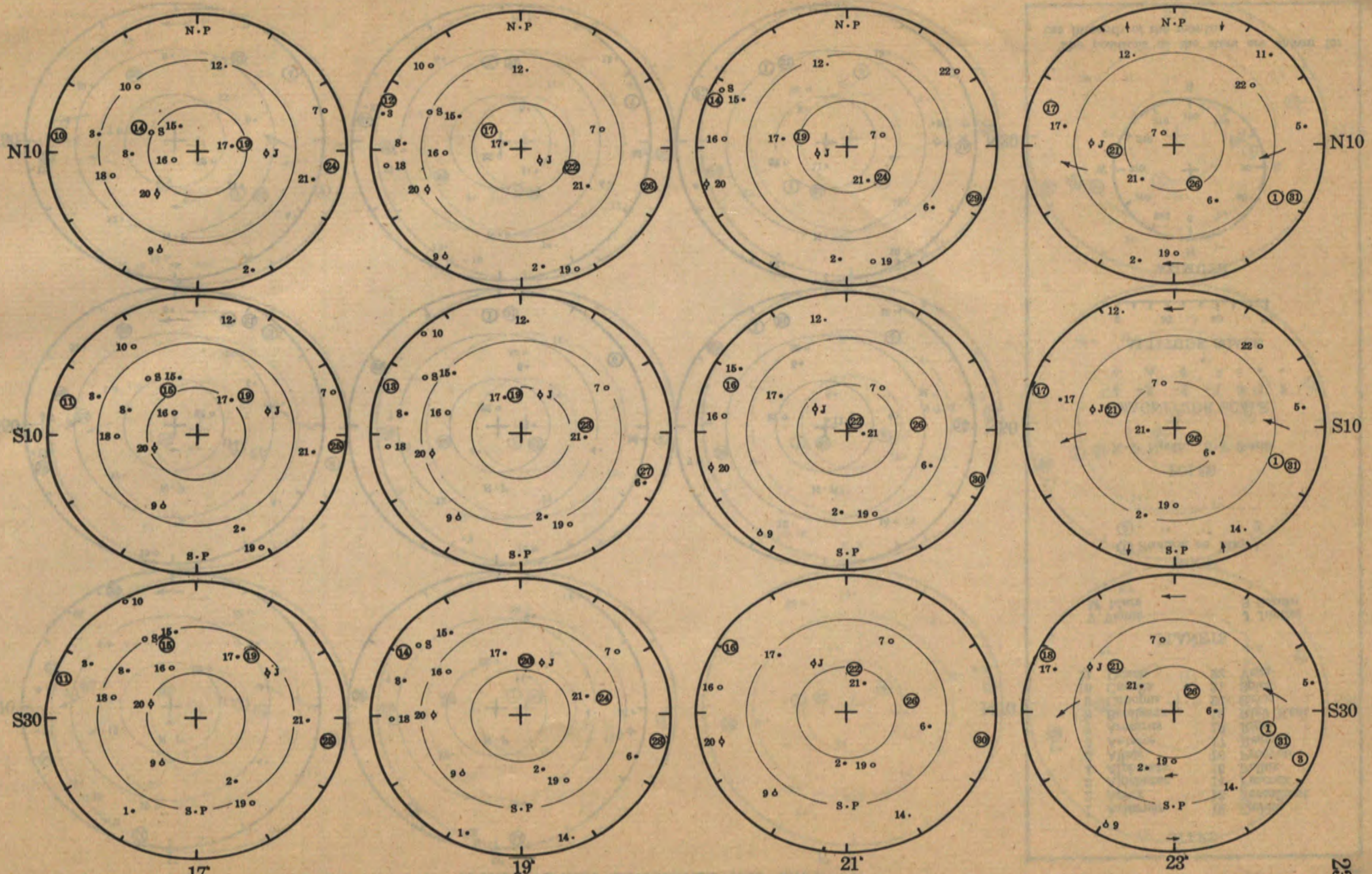
0 30 60 90

AZIMUTH



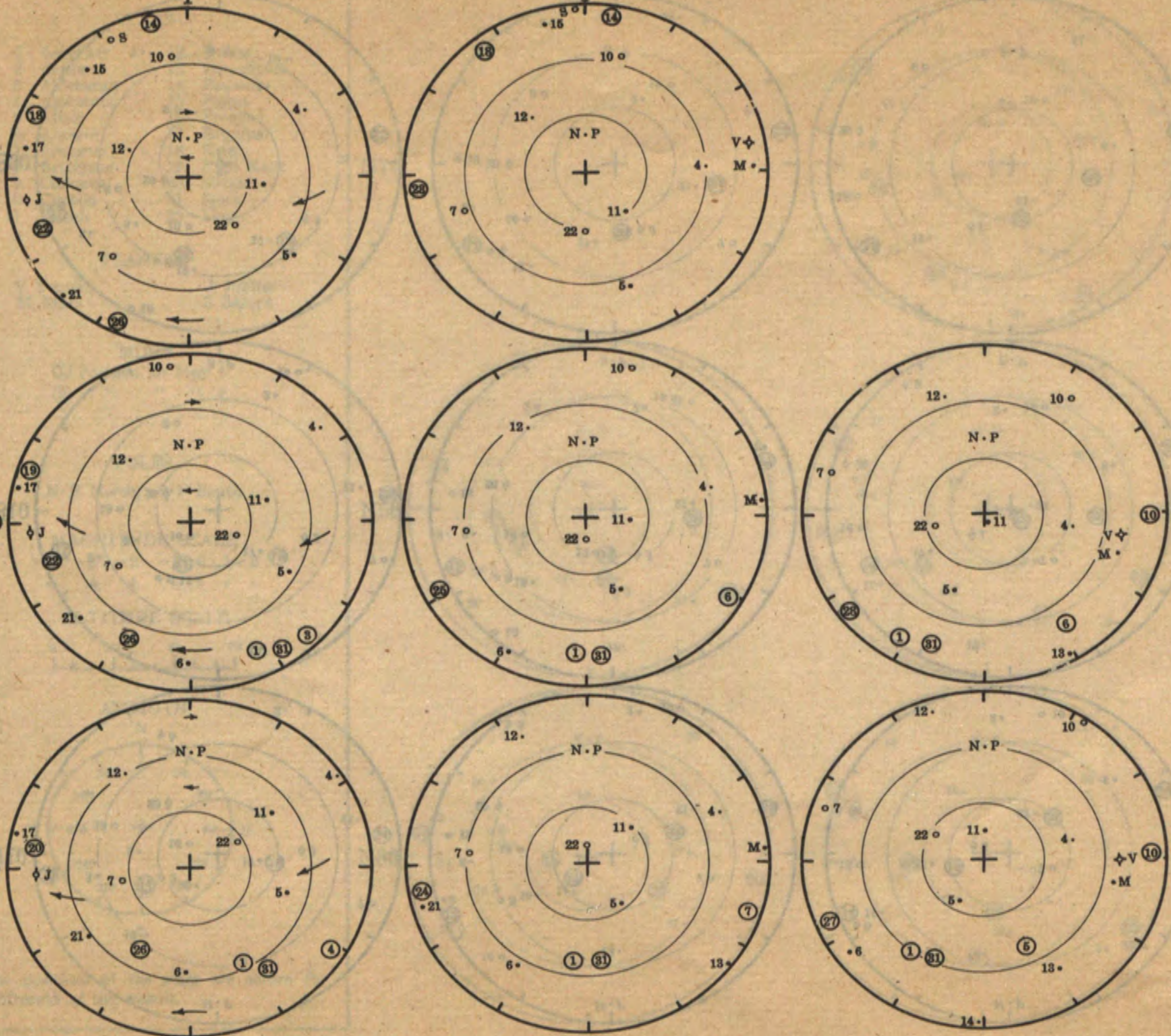
The positions of the stars are shown for the fifteenth of the month.





1ʰ 3ʰ 5ʰ

N70 N50 N30



N70 N50 N30

STARS

1	Achernar	12	Dubhe
2	Acrux	13	Fomalhaut
3	Aldebaran	14	Peacock
4	Alpheratz	15	Pollux
5	Altair	16	Procyon
6	Antares	17	Regulus
7	Arcturus	18	Rigel
8	Betelgeux	19	Rigil Kent
9	Canopus	20	Sirius
10	Capella	21	Spica
11	Deneb	22	Vega

PLANETS

V Venus J Jupiter
M Mars S Saturn

MOON

① Position on May 1
② " " " 2

POLES

N•P North, S•P South

MAGNITUDE SCALE

−4 −3 −2 −1 0 1 2

ALTITUDE SCALE

0 30 60 90

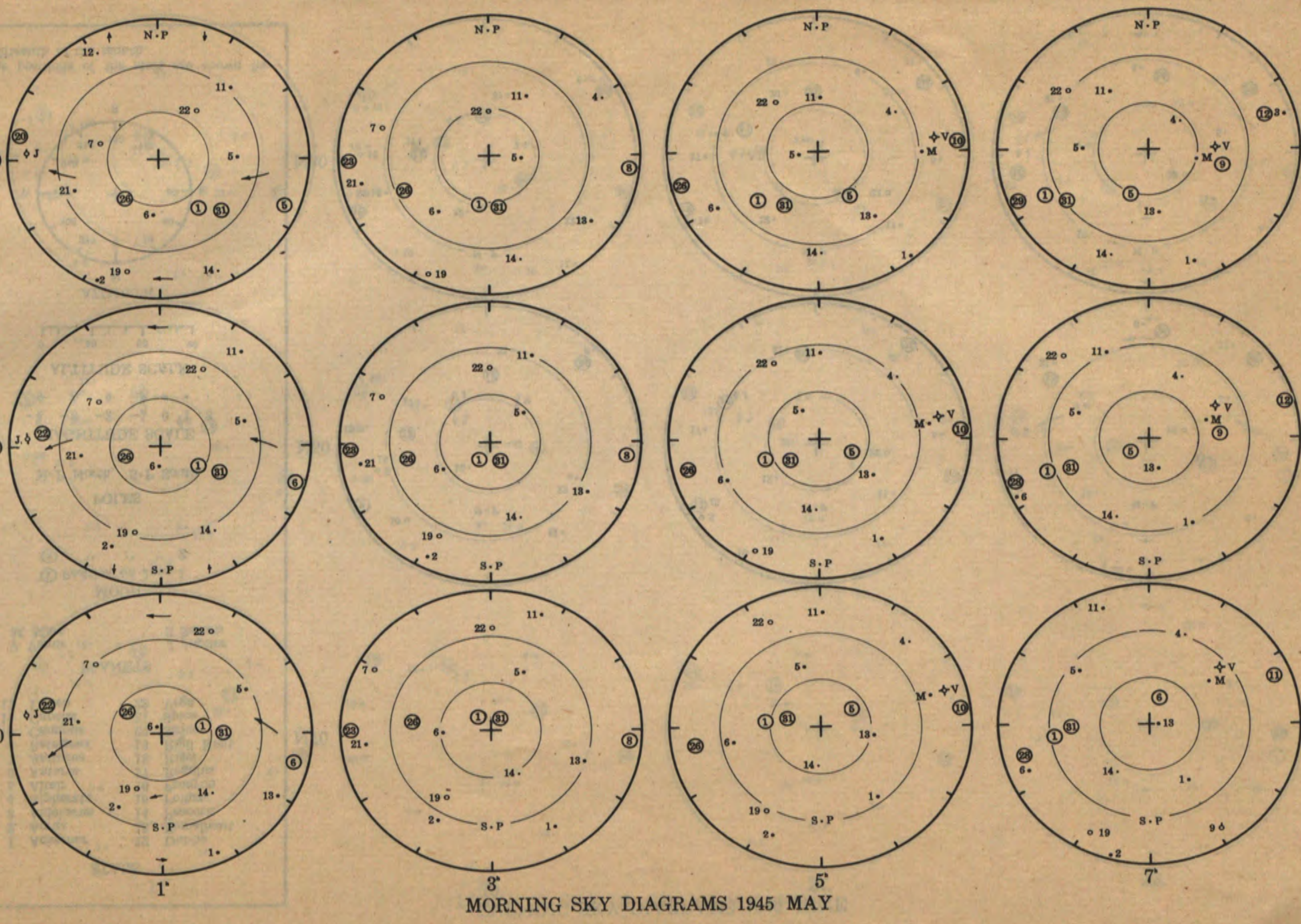
AZIMUTH

N 0 30 60 90 120 150 180 210 240 270 300 330 E S W

The positions of the stars are shown for the fifteenth of the month.

609403 O - 44 - 4

N10 S10 S30



N10 S10 S30

1ʰ 3ʰ 5ʰ 7ʰ

STARS

1	Achernar	12	Dubhe
2	Acrux	13	Fomalhaut
3	Aldebaran	14	Peacock
4	Alpheratz	15	Pollux
5	Altair	16	Procyon
6	Antares	17	Regulus
7	Arcturus	18	Rigel
8	Betelgeux	19	Rigil Kent
9	Canopus	20	Sirius
10	Capella	21	Spica
11	Deneb	22	Vega

PLANETS

V Venus
M Mars
J Jupiter
S Saturn

MOON

① Position on June 1
② " " " 2

POLES

N·P North, S·P South

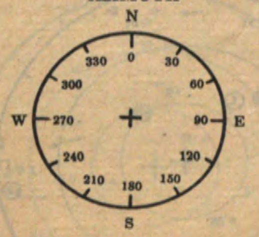
MAGNITUDE SCALE

−4 −3 −2 −1 0 1 2

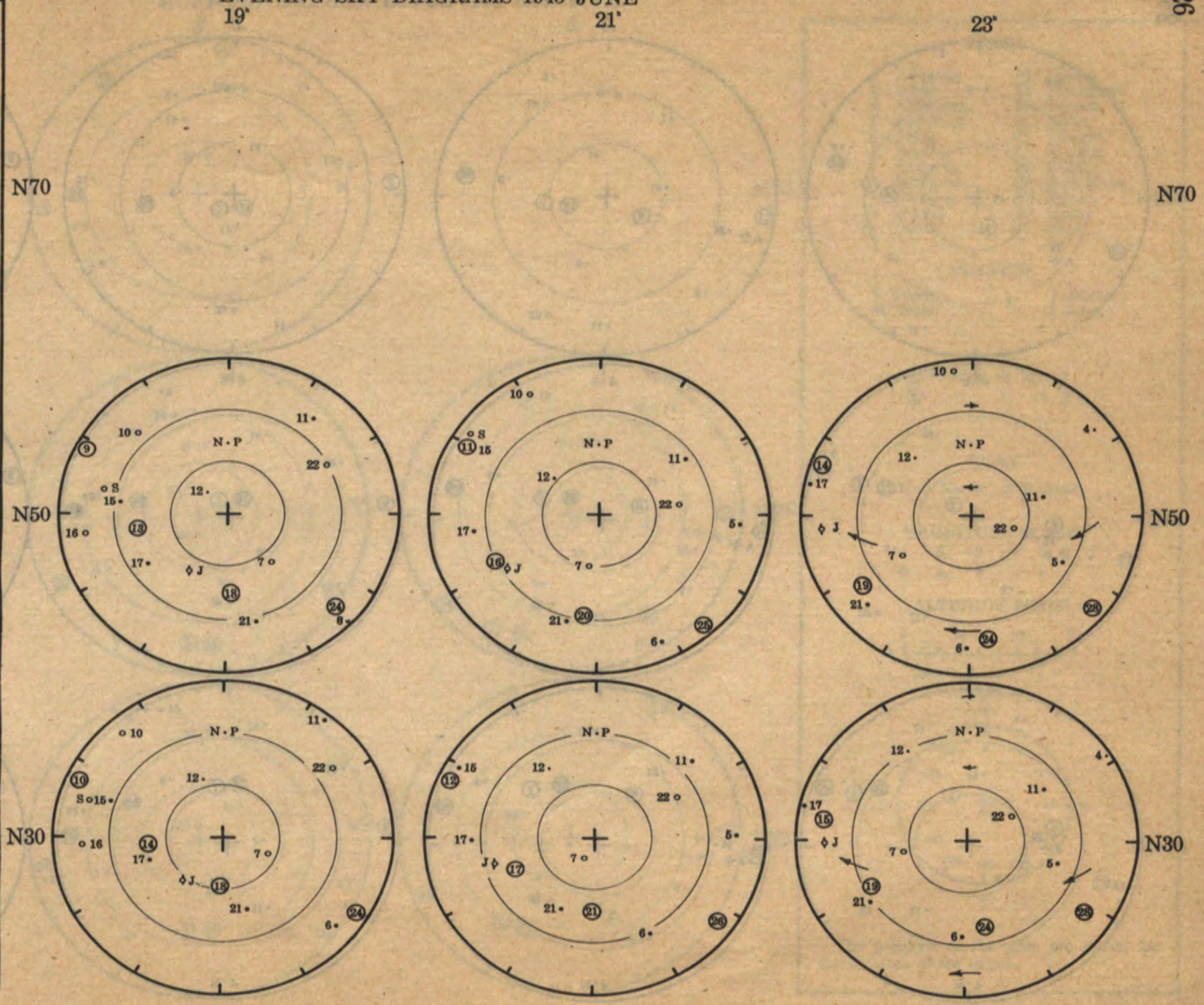
ALTITUDE SCALE

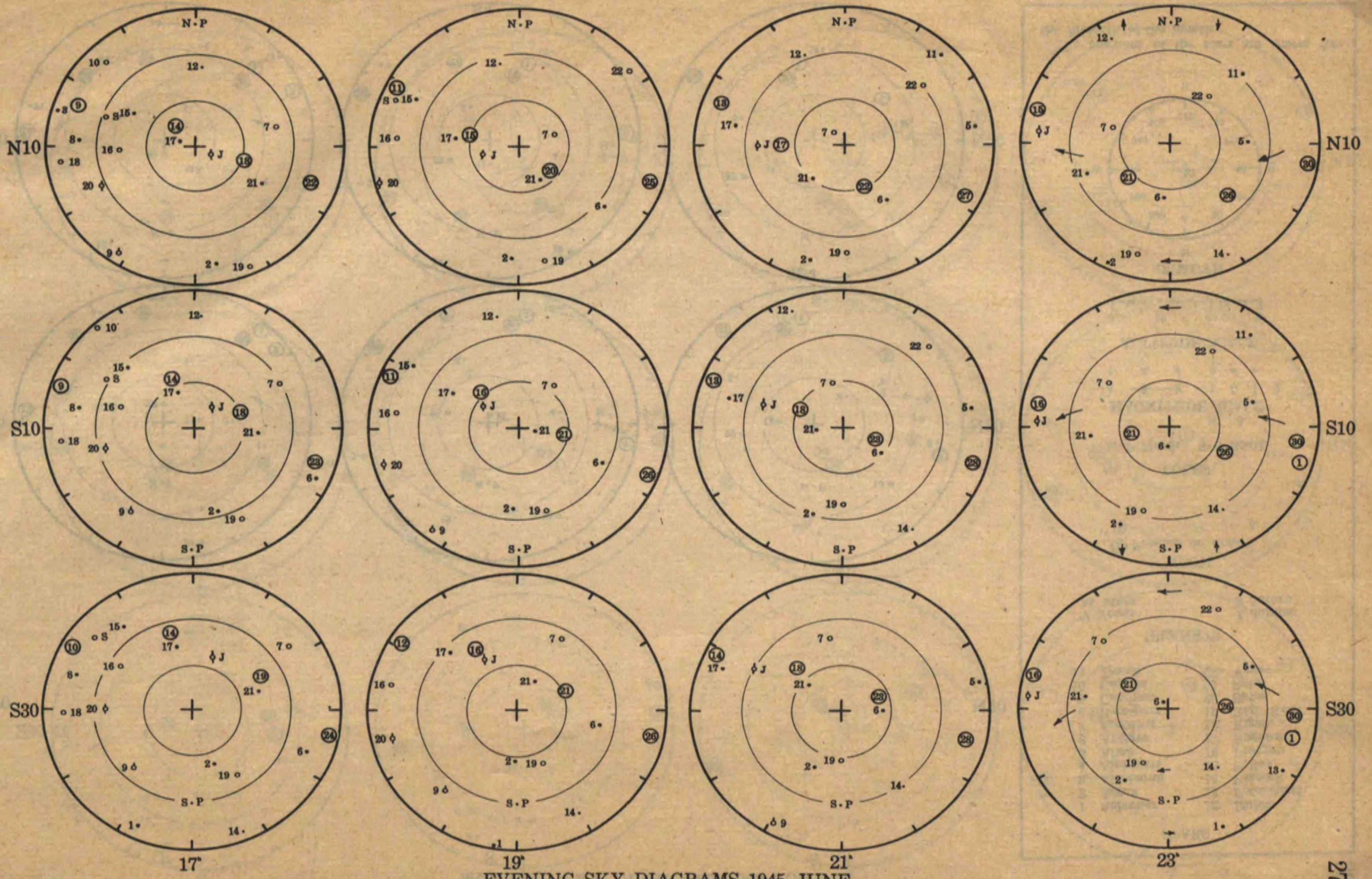
0 30 60 90

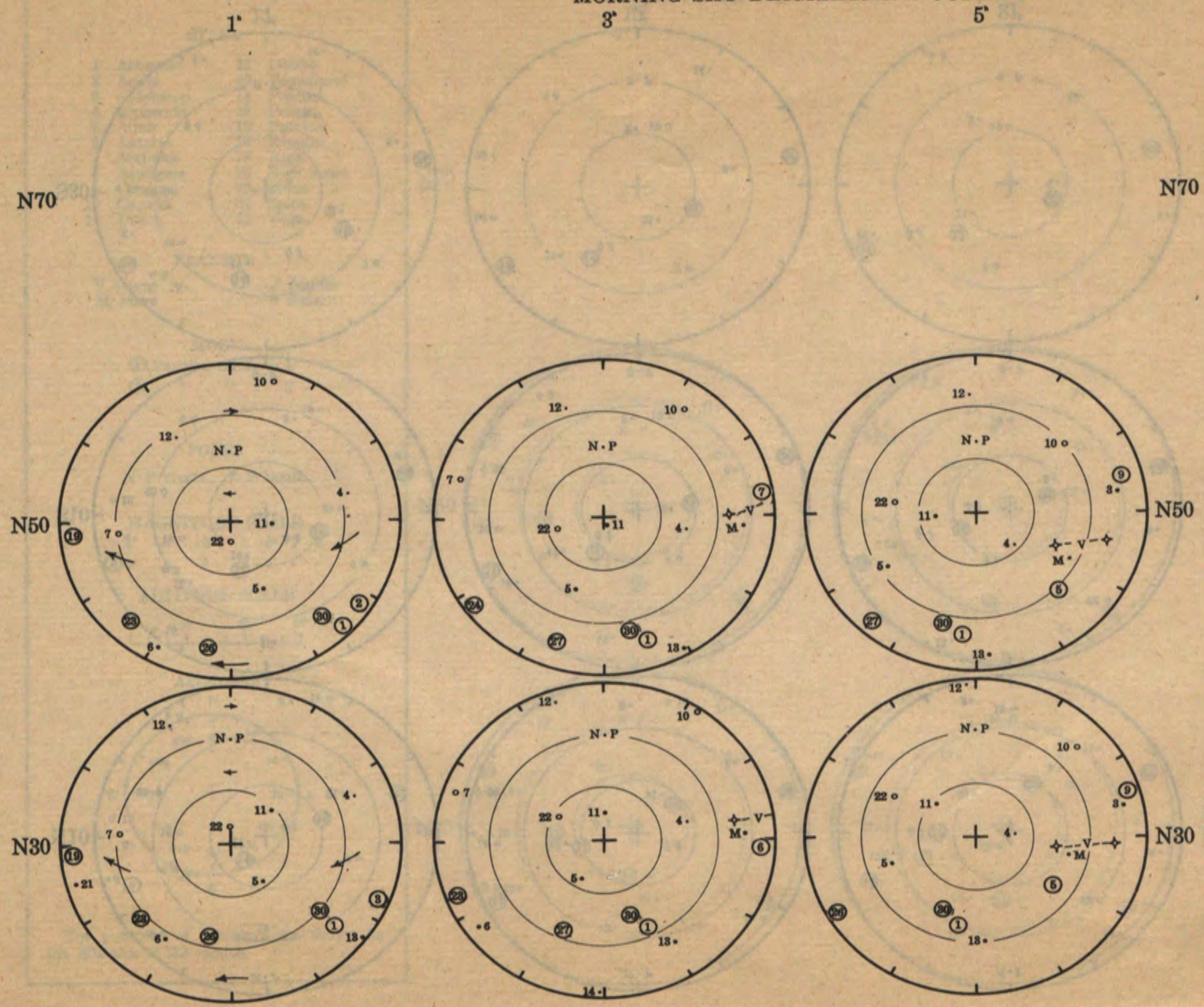
AZIMUTH



The positions of the stars are shown for the fifteenth of the month.







STARS

1	Achernar	12	Dubhe
2	Acrux	13	Fomalhaut
3	Aldebaran	14	Peacock
4	Alpheratz	15	Pollux
5	Altair	16	Procyon
6	Antares	17	Regulus
7	Arcturus	18	Rigel
8	Betelgeux	19	Rigil Kent
9	Canopus	20	Sirius
10	Capella	21	Spica
11	Deneb	22	Vega

PLANETS

V Venus — J Jupiter
M Mars — S Saturn

MOON

(1) Position on June 1
(2) " " " 2

POLES

N·P North, S·P South

MAGNITUDE SCALE

-4 -3 -2 -1 0 1 2

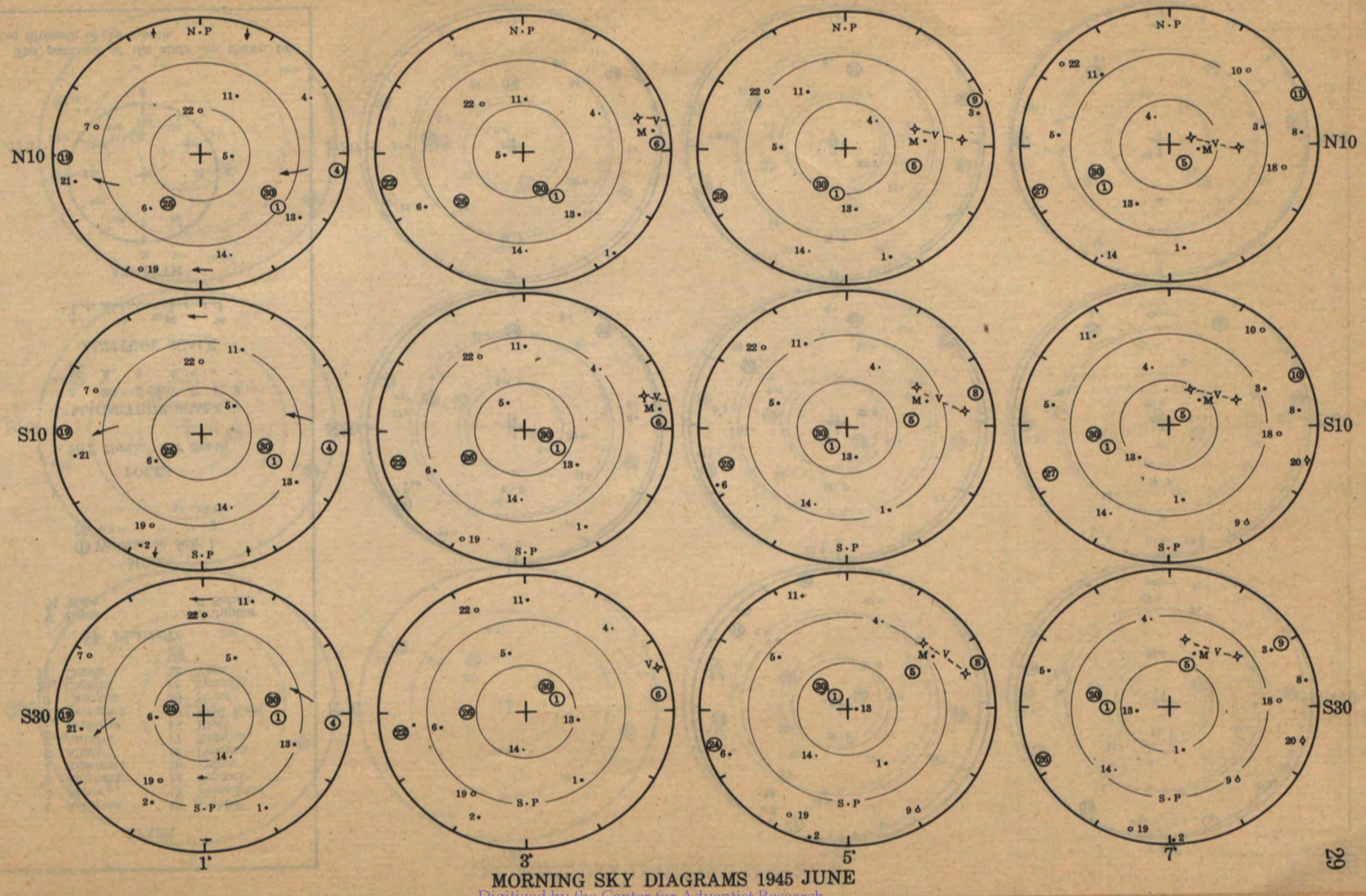
ALTITUDE SCALE

0 30 60 90

AZIMUTH

N 0 30 60 90 E 120 150 180 S 210 240 270 W 300 330

The positions of the stars are shown for the fifteenth of the month.



STARS

1	Achernar	12	Dubhe
2	Acrux	13	Fomalhaut
3	Aldebaran	14	Peacock
4	Alpheratz	15	Pollux
5	Altair	16	Procyon
6	Antares	17	Regulus
7	Arcturus	18	Rigel
8	Betelgeux	19	Rigil Kent
9	Canopus	20	Sirius
10	Capella	21	Spica
11	Deneb	22	Vega

PLANETS

V Venus — J Jupiter
M Mars — S Saturn

MOON

① Position on July 1
② " " " 2

POLES

N·P North, S·P South

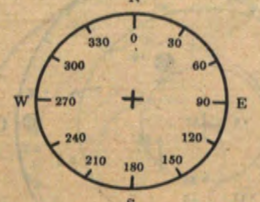
MAGNITUDE SCALE

-4 -3 -2 -1 0 1 2

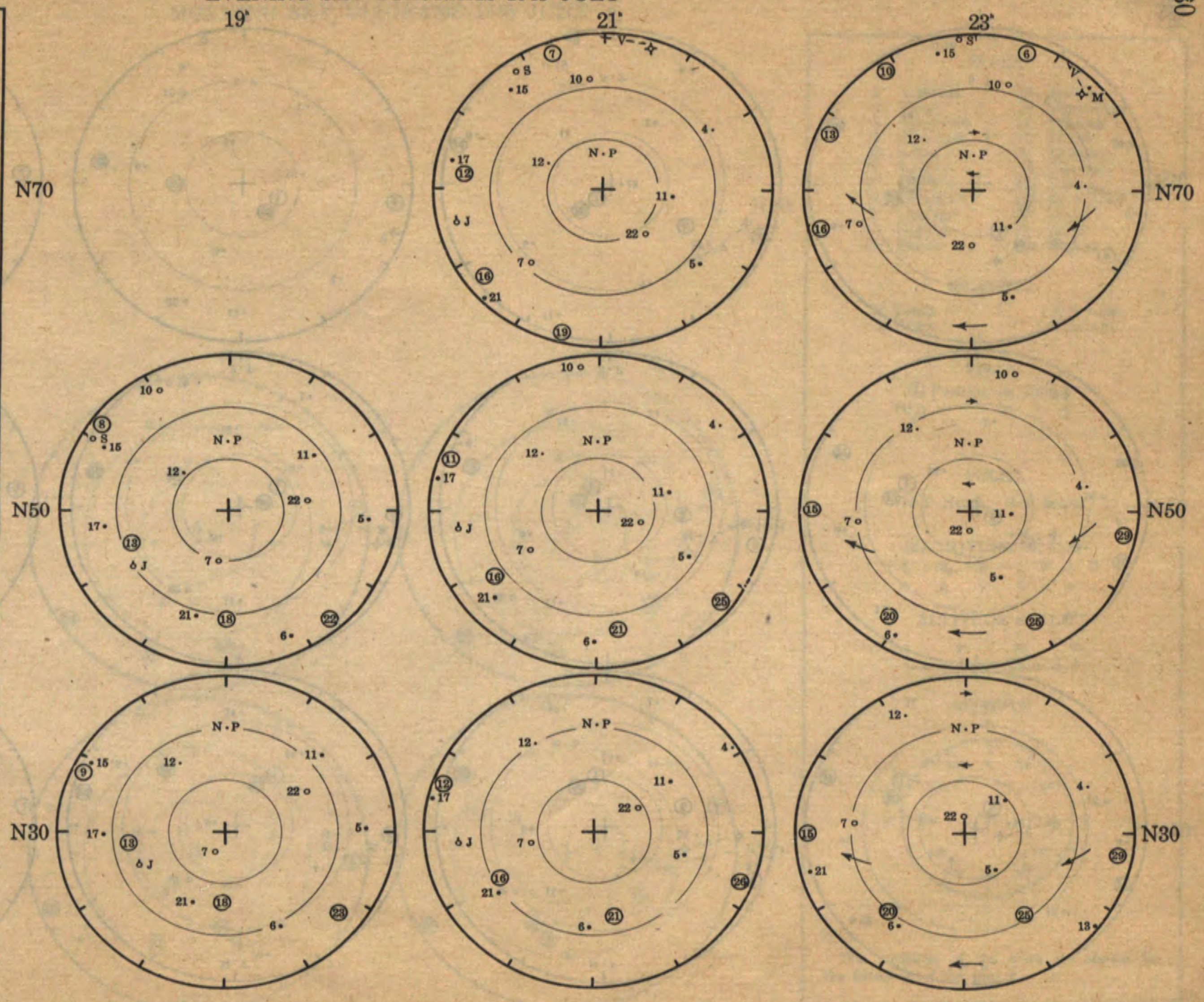
ALTITUDE SCALE

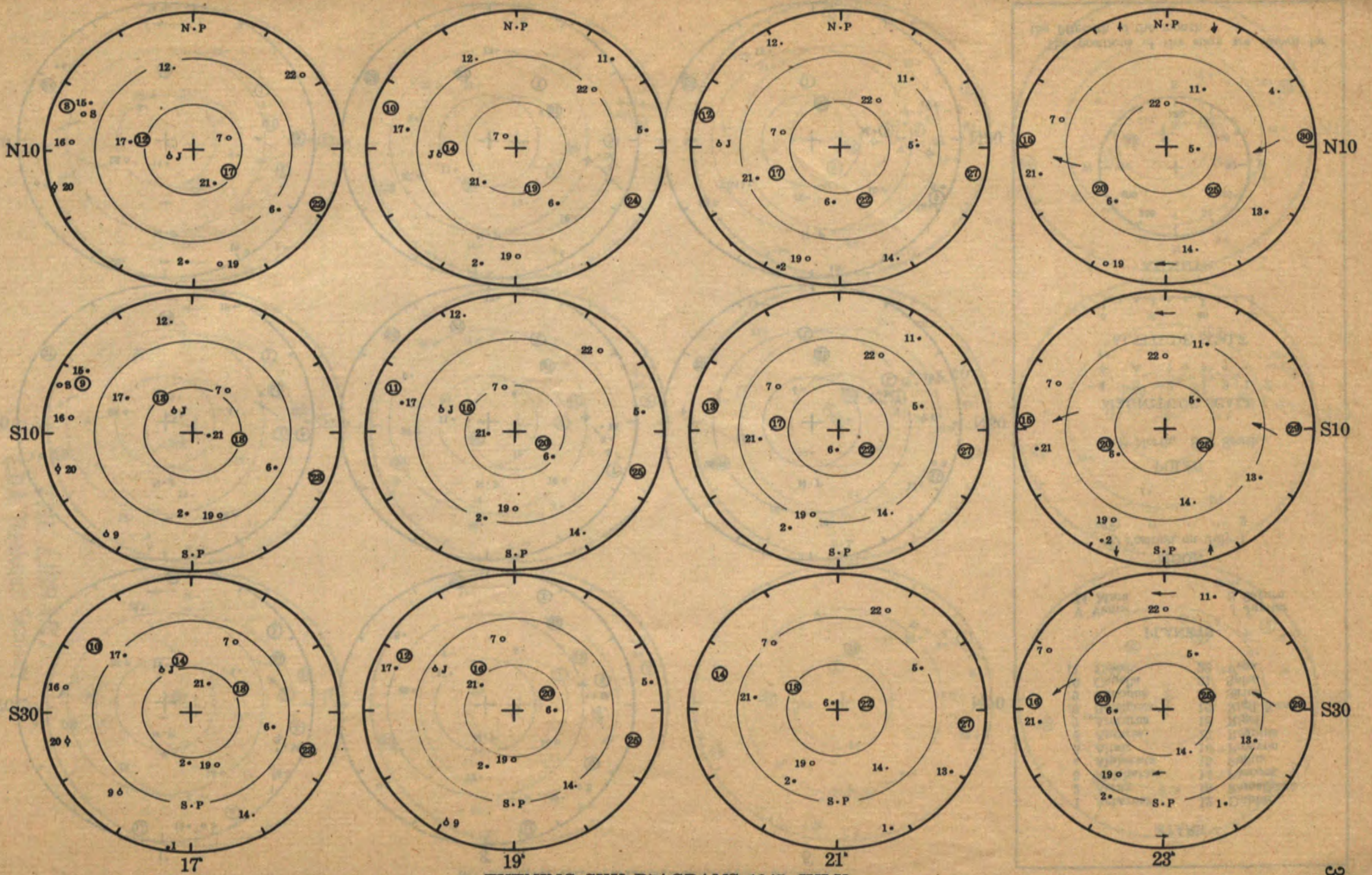
0 30 60 90

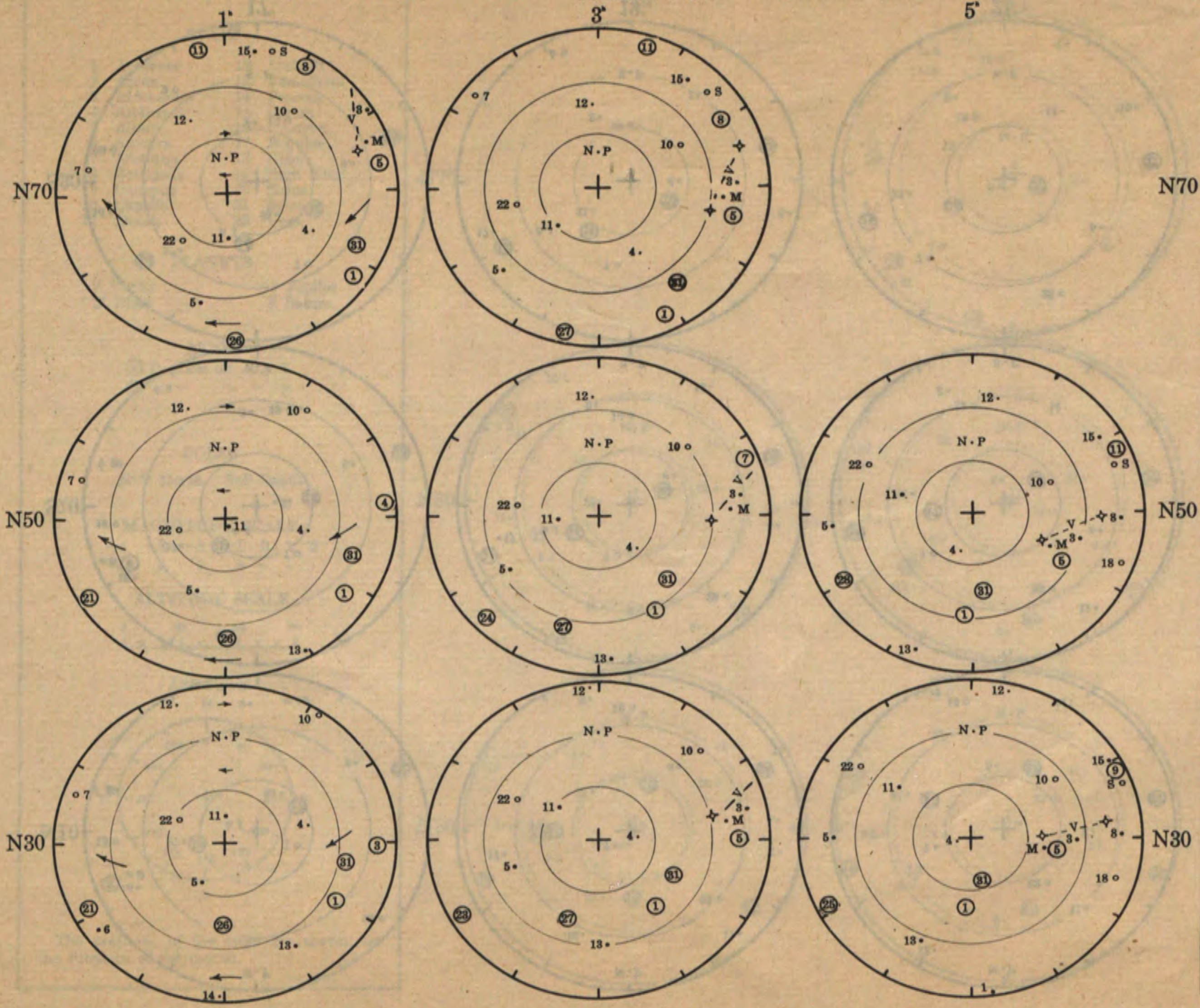
AZIMUTH



The positions of the stars are shown for the fifteenth of the month.







STARS

1	Achernar	12	Dubhe
2	Acrux	13	Fomalhaut
3	Aldebaran	14	Peacock
4	Alpheratz	15	Pollux
5	Altair	16	Procyon
6	Antares	17	Regulus
7	Arcturus	18	Rigel
8	Betelgeux	19	Rigil Kent
9	Canopus	20	Sirius
10	Capella	21	Spica
11	Deneb	22	Vega

PLANETS

V Venus J Jupiter
M Mars S Saturn

MOON

(1) Position on July 1
(2) " " " 2

POLES

N·P North, S·P South

MAGNITUDE SCALE

−4 −3 −2 −1 0 1 2

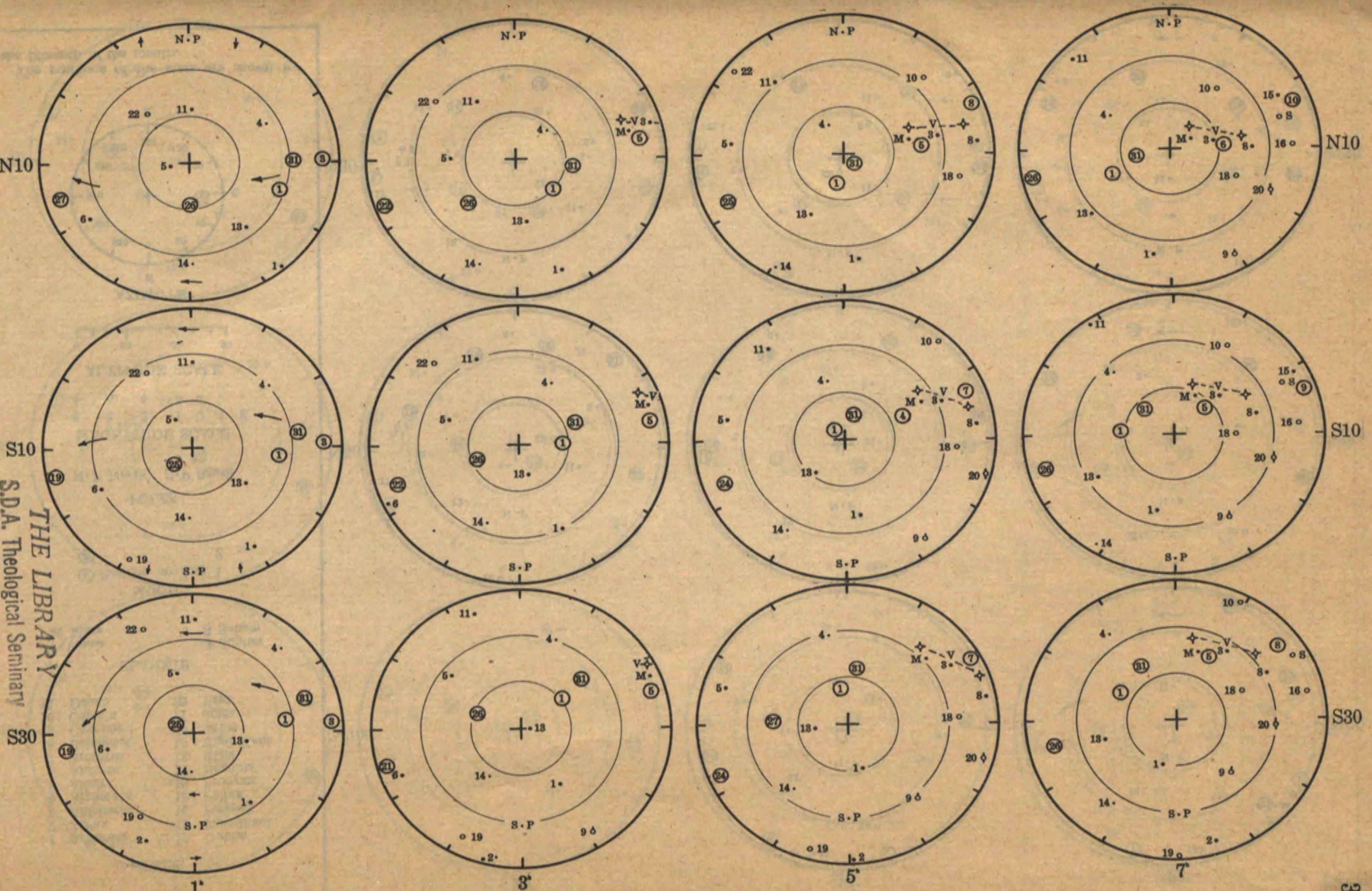
ALTITUDE SCALE

0 30 60 90

AZIMUTH

N 0 30 60 90 E 120 150 180 S 210 240 270 W 300 330

The positions of the stars are shown for the fifteenth of the month.



STARS

1	Achernar	12	Dubhe
2	Acrux	13	Fomalhaut
3	Aldebaran	14	Peacock
4	Alpheratz	15	Pollux
5	Altair	16	Procyon
6	Antares	17	Regulus
7	Arcturus	18	Rigel
8	Betelgeux	19	Rigil Kent
9	Canopus	20	Sirius
10	Capella	21	Spica
11	Deneb	22	Vega

PLANETS

V Venus J Jupiter
M Mars S Saturn

MOON

① Position on Aug. 1
② " " " 2

POLES

N·P North, S·P South

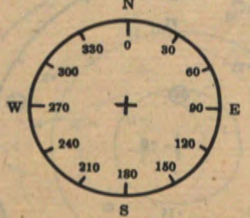
MAGNITUDE SCALE

-4 -3 -2 -1 0 1 2

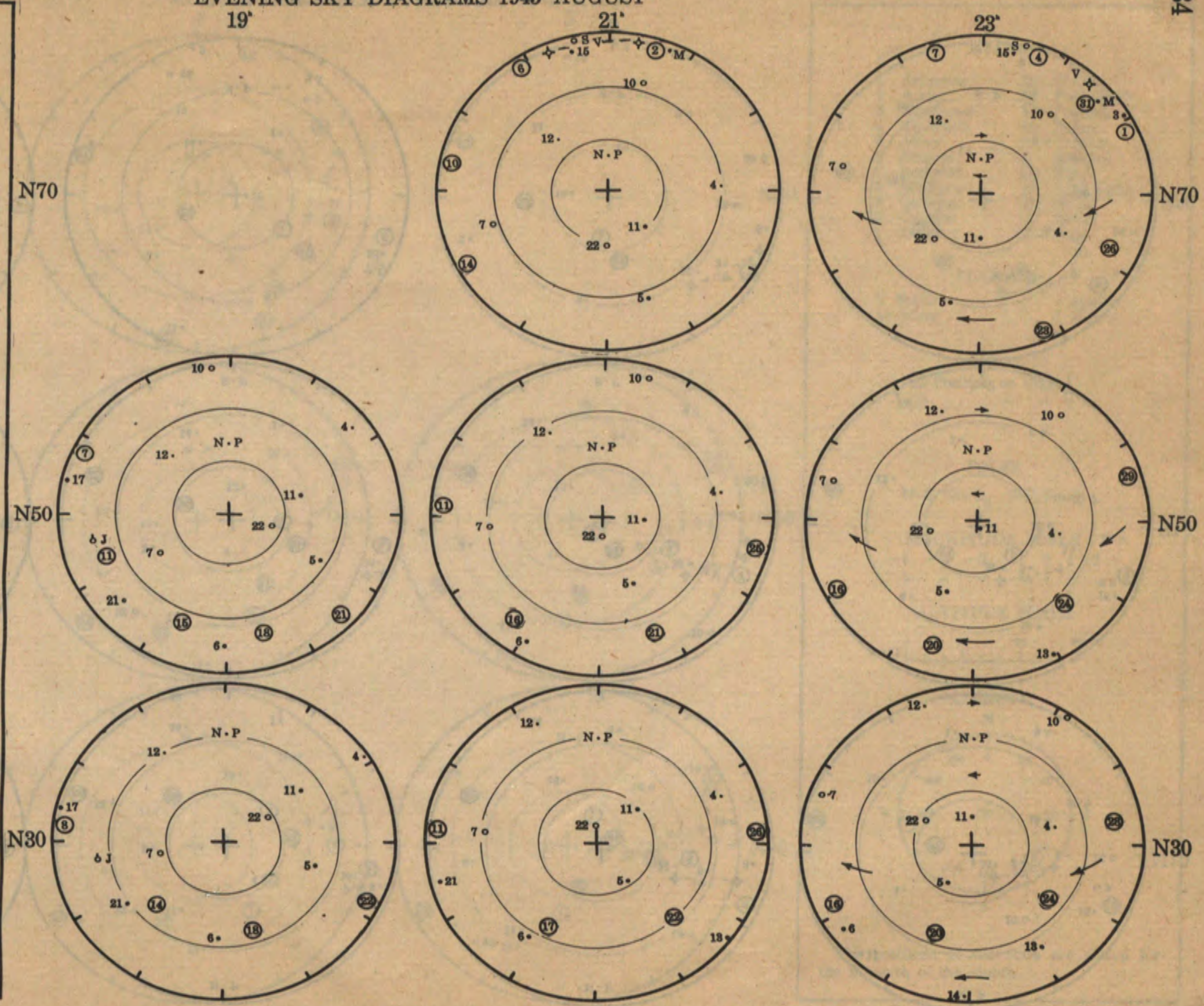
ALTITUDE SCALE

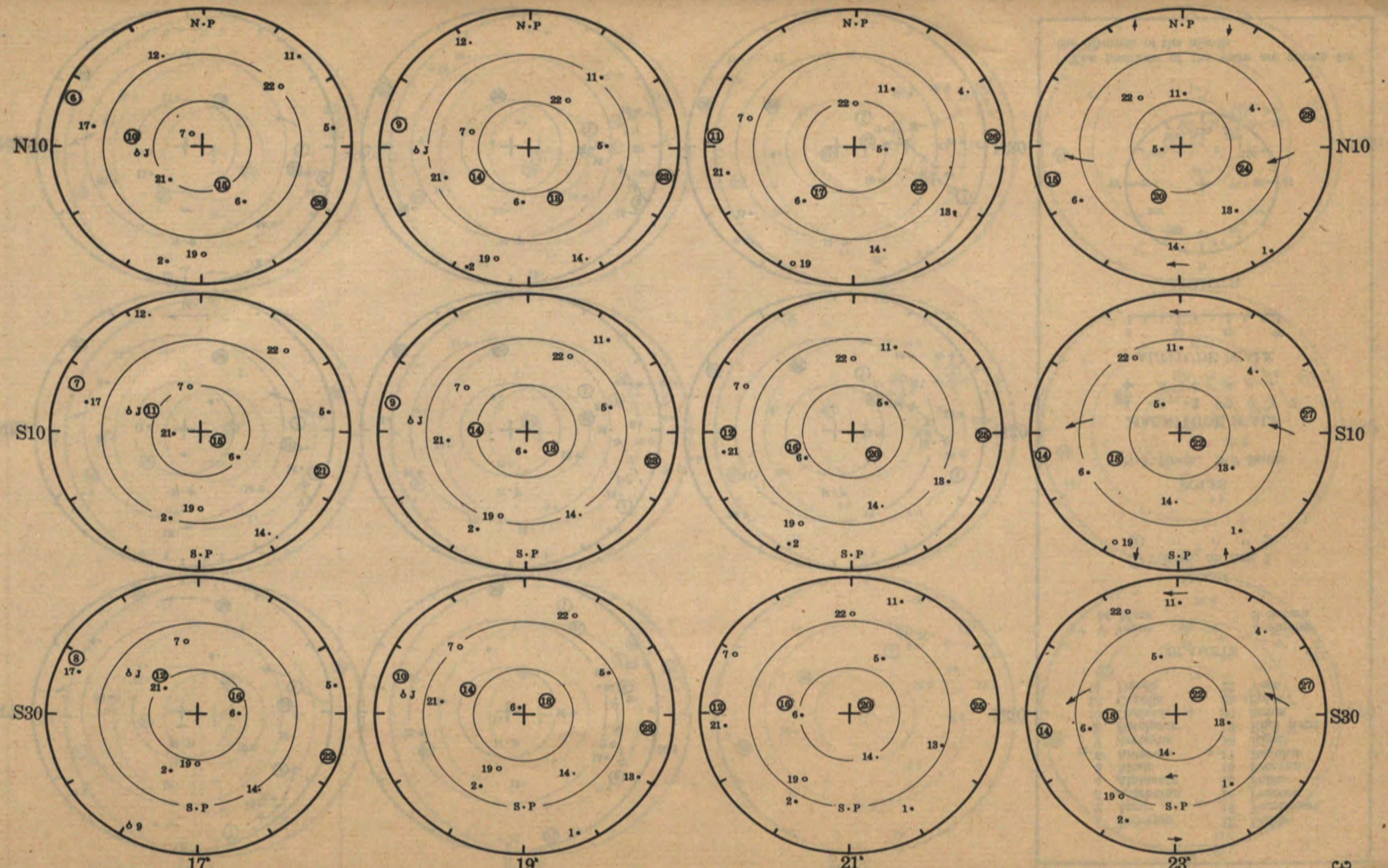
0 30 60 90

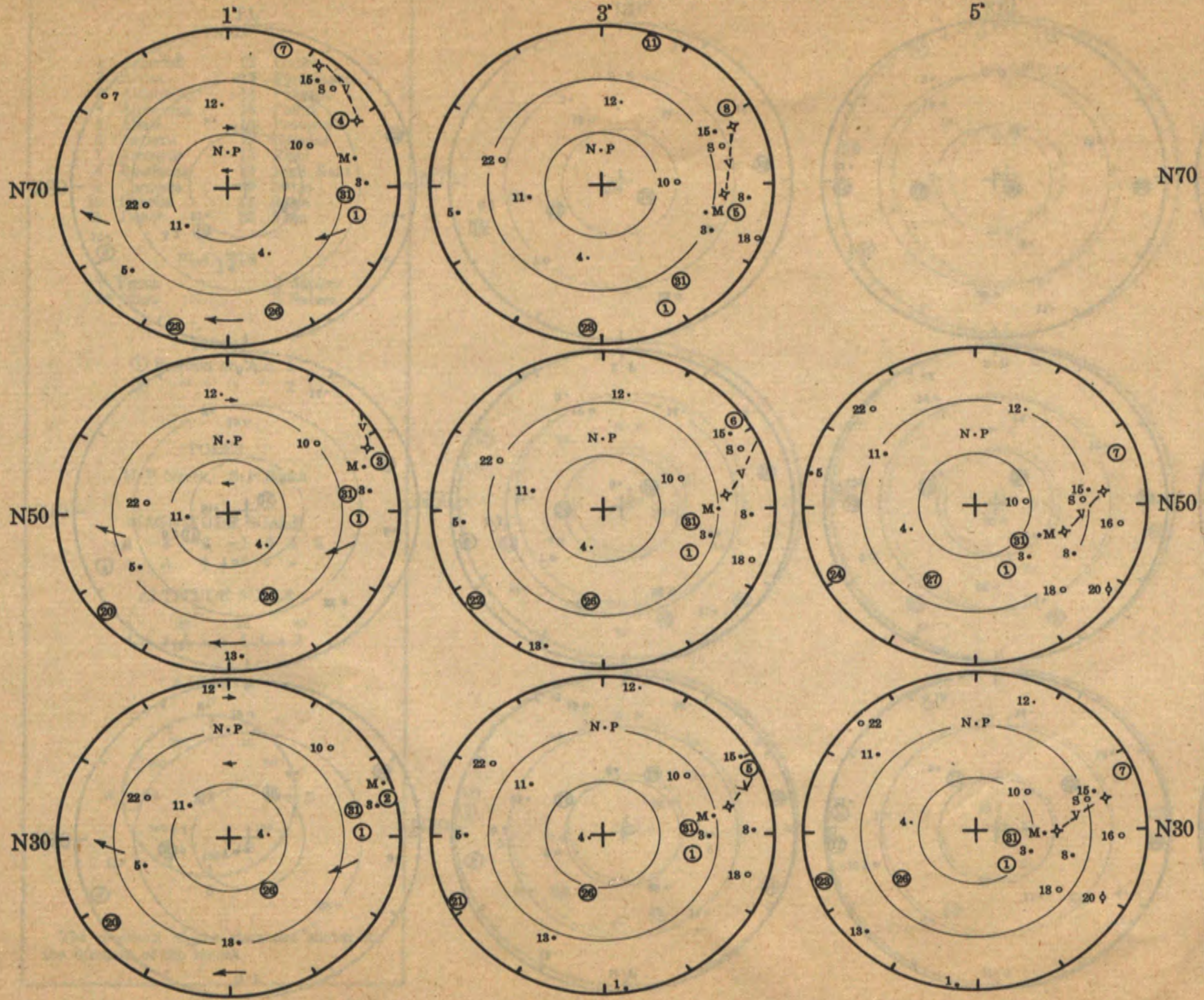
AZIMUTH



The positions of the stars are shown for the fifteenth of the month.







STARS

1	Achernar	12	Dubhe
2	Acrux	13	Fomalhaut
3	Aldebaran	14	Peacock
4	Alpheratz	15	Pollux
5	Altair	16	Procyon
6	Antares	17	Regulus
7	Arcturus	18	Rigel
8	Betelgeux	19	Rigil Kent
9	Canopus	20	Sirius
10	Capella	21	Spica
11	Deneb	22	Vega

PLANETS

V Venus J Jupiter
M Mars S Saturn

MOON

(1) Position on Aug. 1
(2) " " " 2

POLES

N·P North, S·P South

MAGNITUDE SCALE

−4 −3 −2 −1 0 1 2

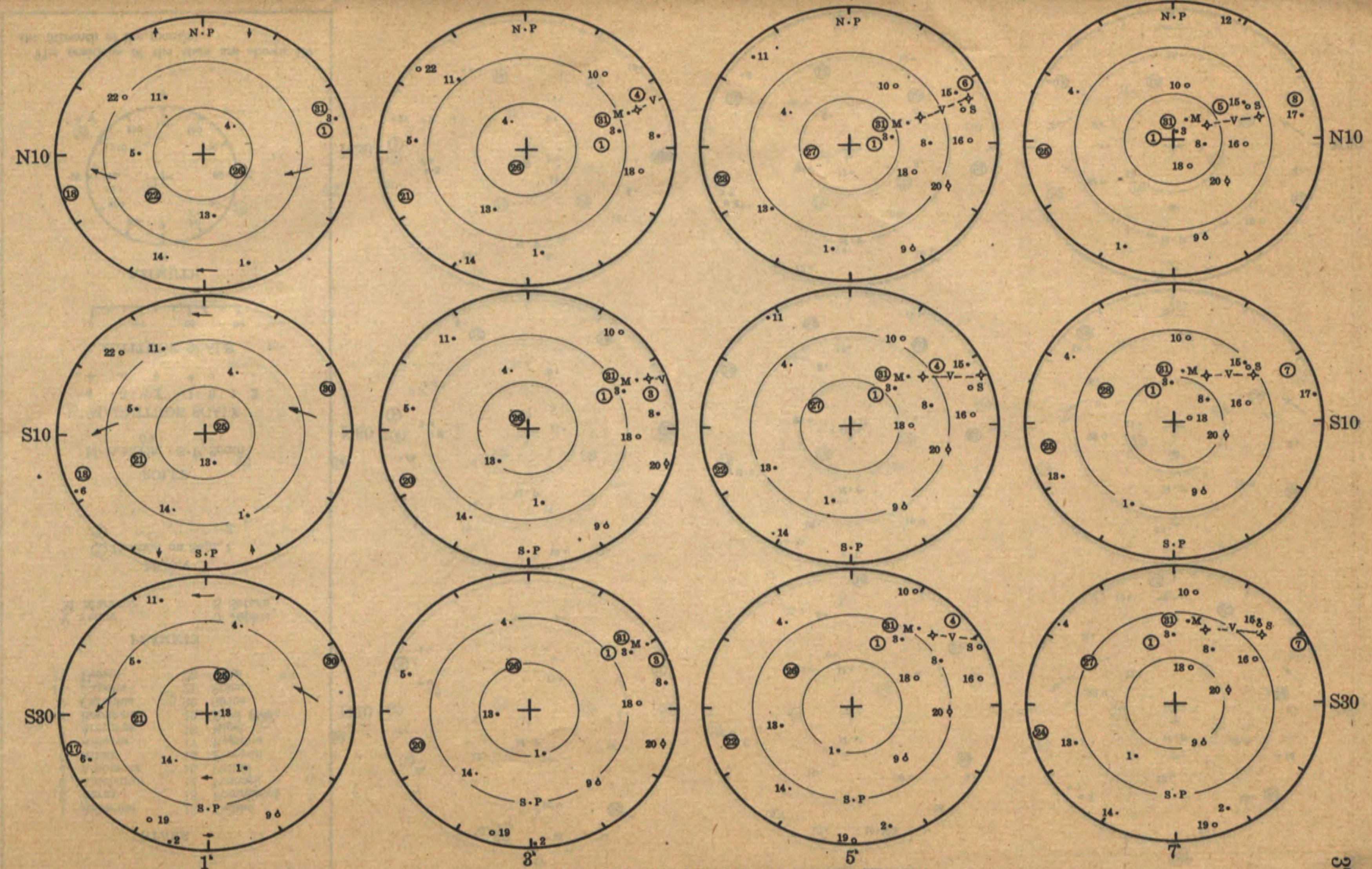
ALTITUDE SCALE

0 30 60 90

AZIMUTH

N, E, S, W; 0, 30, 60, 90, 120, 150, 180, 210, 240, 270, 300, 330

The positions of the stars are shown for the fifteenth of the month.



STARS

1	Achernar	12	Dubhe
2	Acrux	13	Fomalhaut
3	Aldebaran	14	Peacock
4	Alpheratz	15	Pollux
5	Altair	16	Procyon
6	Antares	17	Regulus
7	Arcturus	18	Rigel
8	Betelgeux	19	Rigil Kent
9	Canopus	20	Sirius
10	Capella	21	Spica
11	Deneb	22	Vega

PLANETS

V Venus — J Jupiter
M Mars — S Saturn

MOON

① Position on Sept. 1
② " " " 2

POLES

N·P North, S·P South

MAGNITUDE SCALE

−4 −3 −2 −1 0 1 2

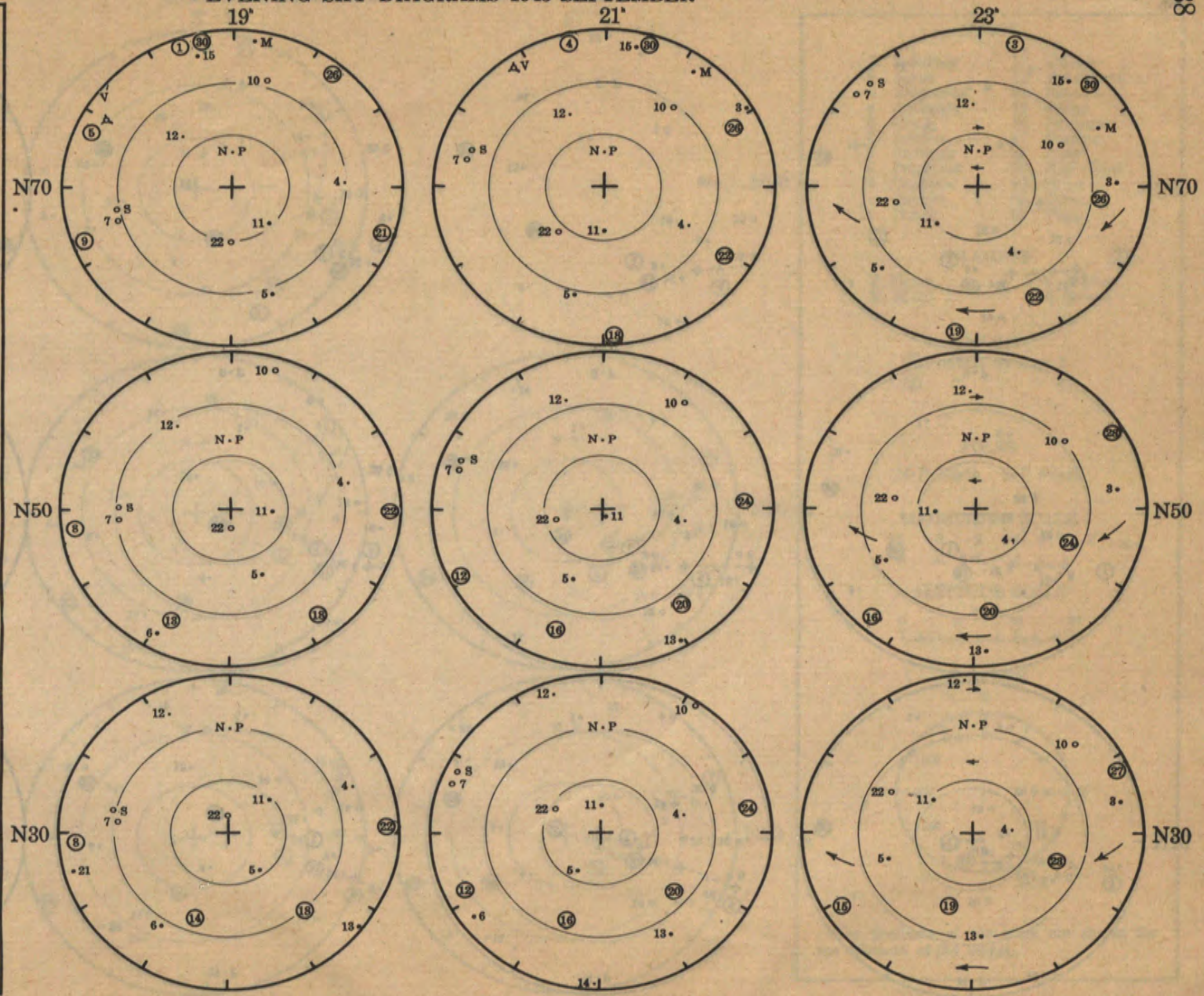
ALTITUDE SCALE

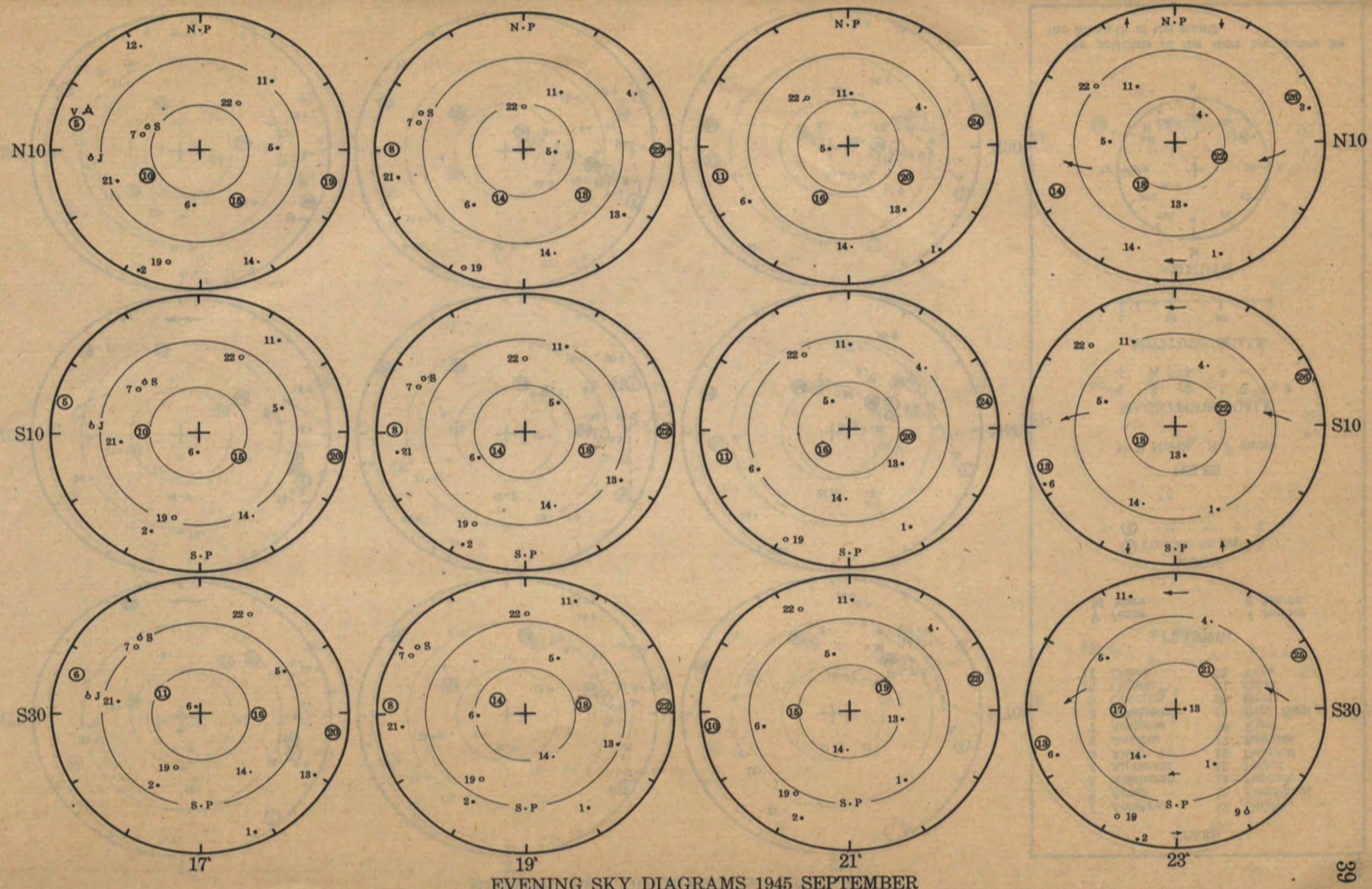
0 30 60 90

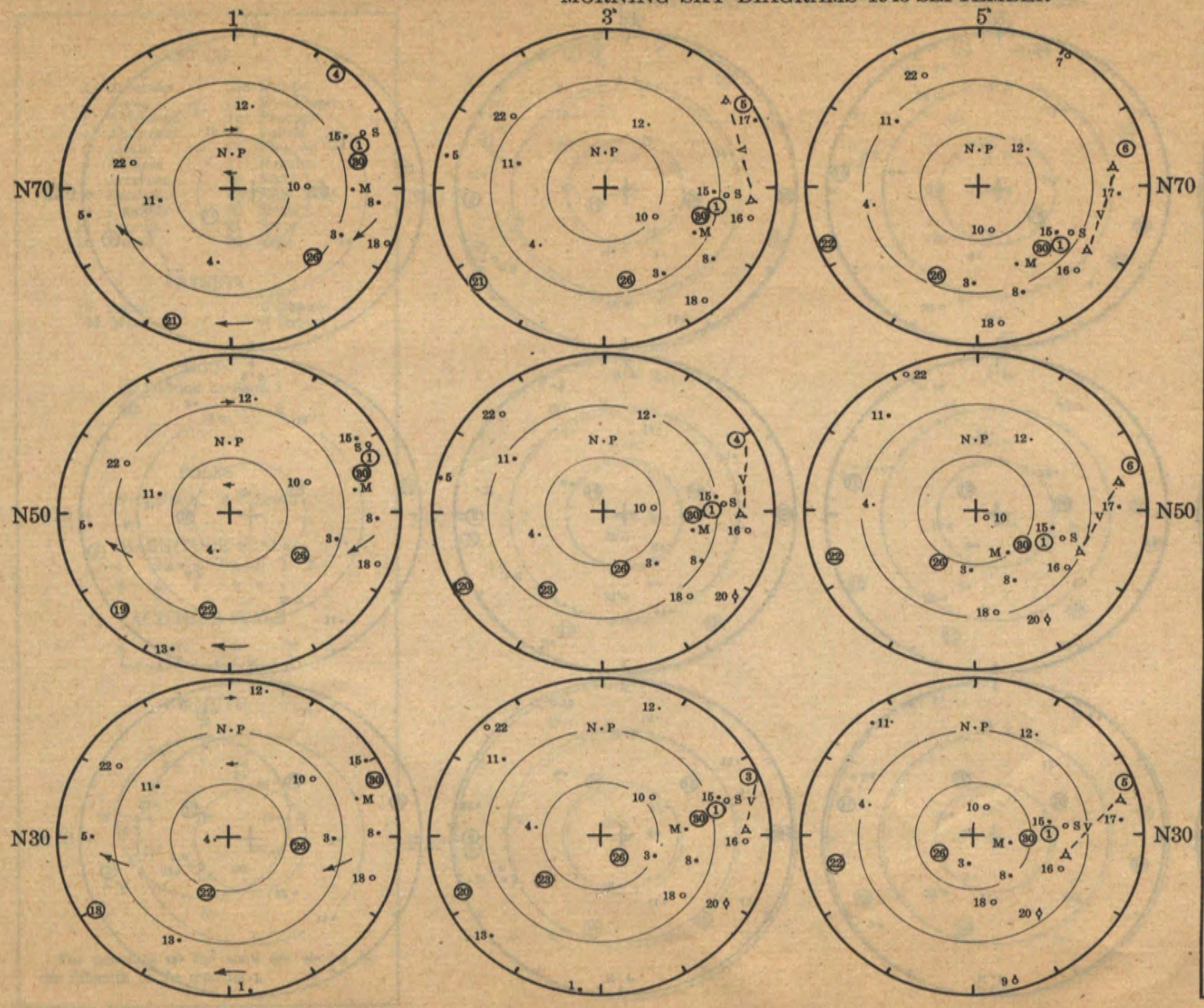
AZIMUTH

N, 0, 30, 60, 90, E, 120, 150, 180, S, 210, 240, 270, W, 300, 330

The positions of the stars are shown for the fifteenth of the month.







STARS

1	Achernar	12	Dubhe
2	Acrux	13	Fomalhaut
3	Aldebaran	14	Peacock
4	Alpheratz	15	Pollux
5	Altair	16	Procyon
6	Antares	17	Regulus
7	Arcturus	18	Rigel
8	Betelgeux	19	Rigil Kent
9	Canopus	20	Sirius
10	Capella	21	Spica
11	Deneb	22	Vega

PLANETS

V Venus — J Jupiter
M Mars — S Saturn

MOON

(1) Position on Sept. 1
(2) " " " 2

POLES

N•P North, S•P South

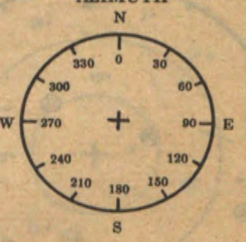
MAGNITUDE SCALE

−4 −3 −2 −1 0 1 2

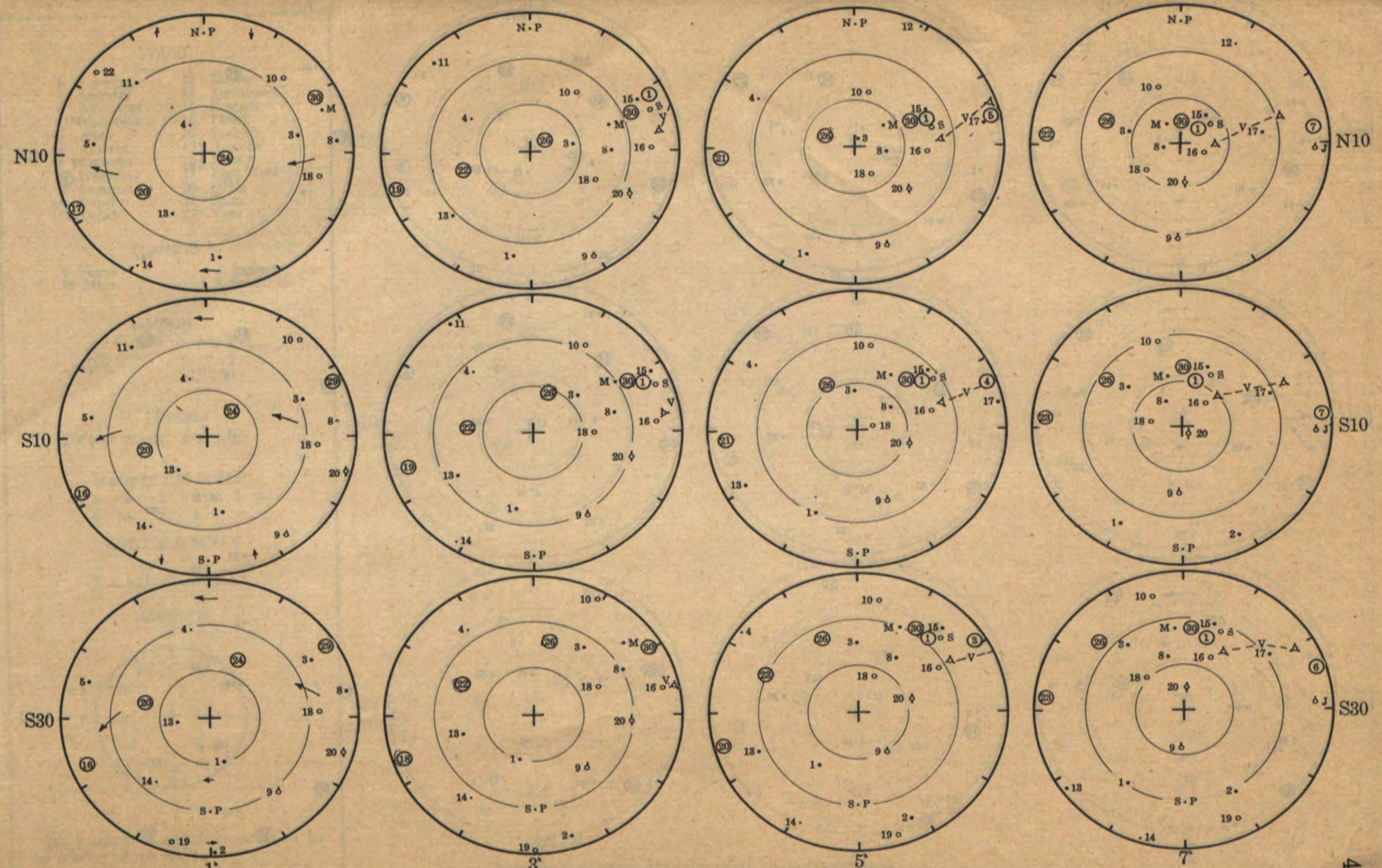
ALTITUDE SCALE

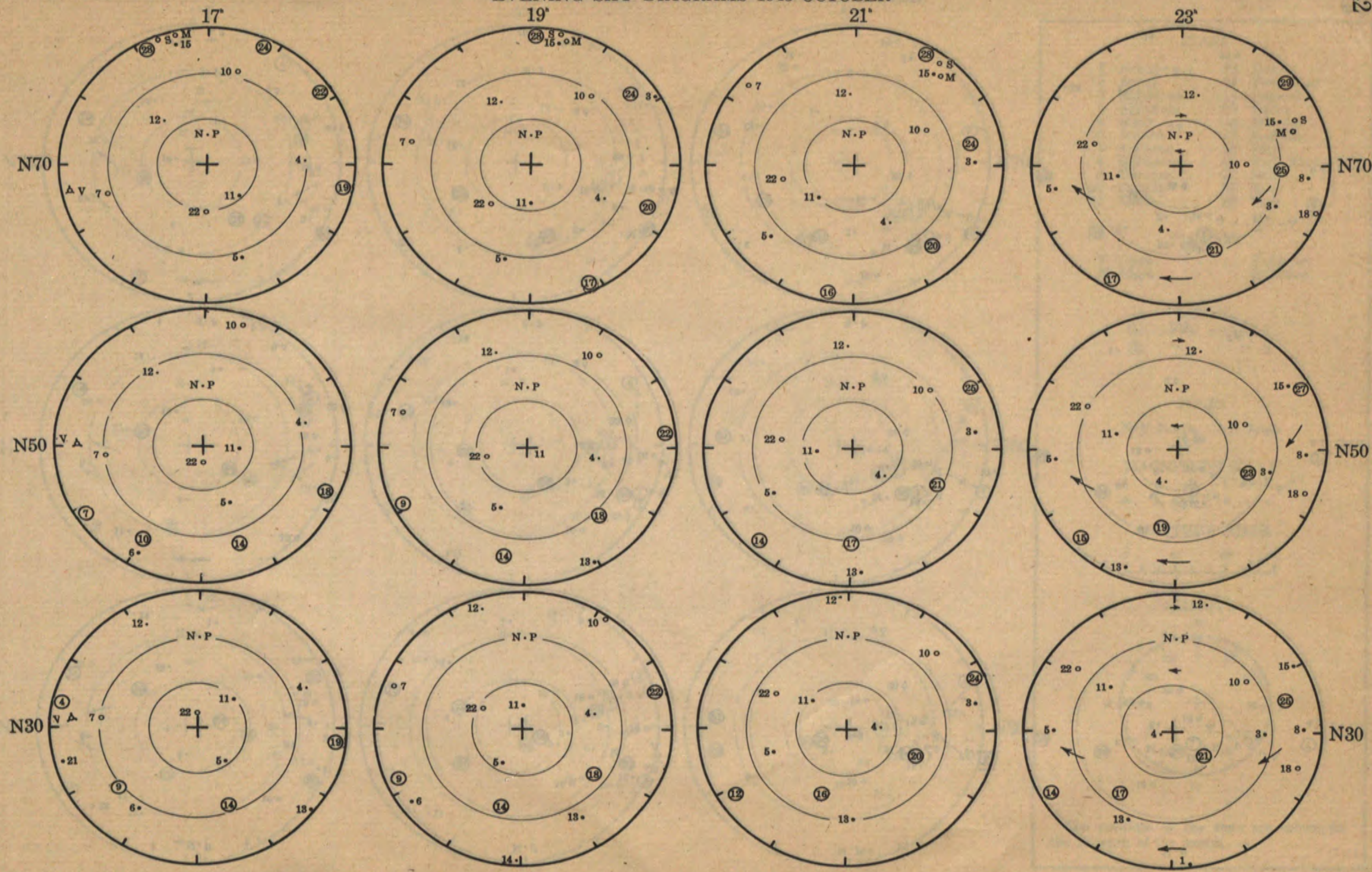
0 30 60 90

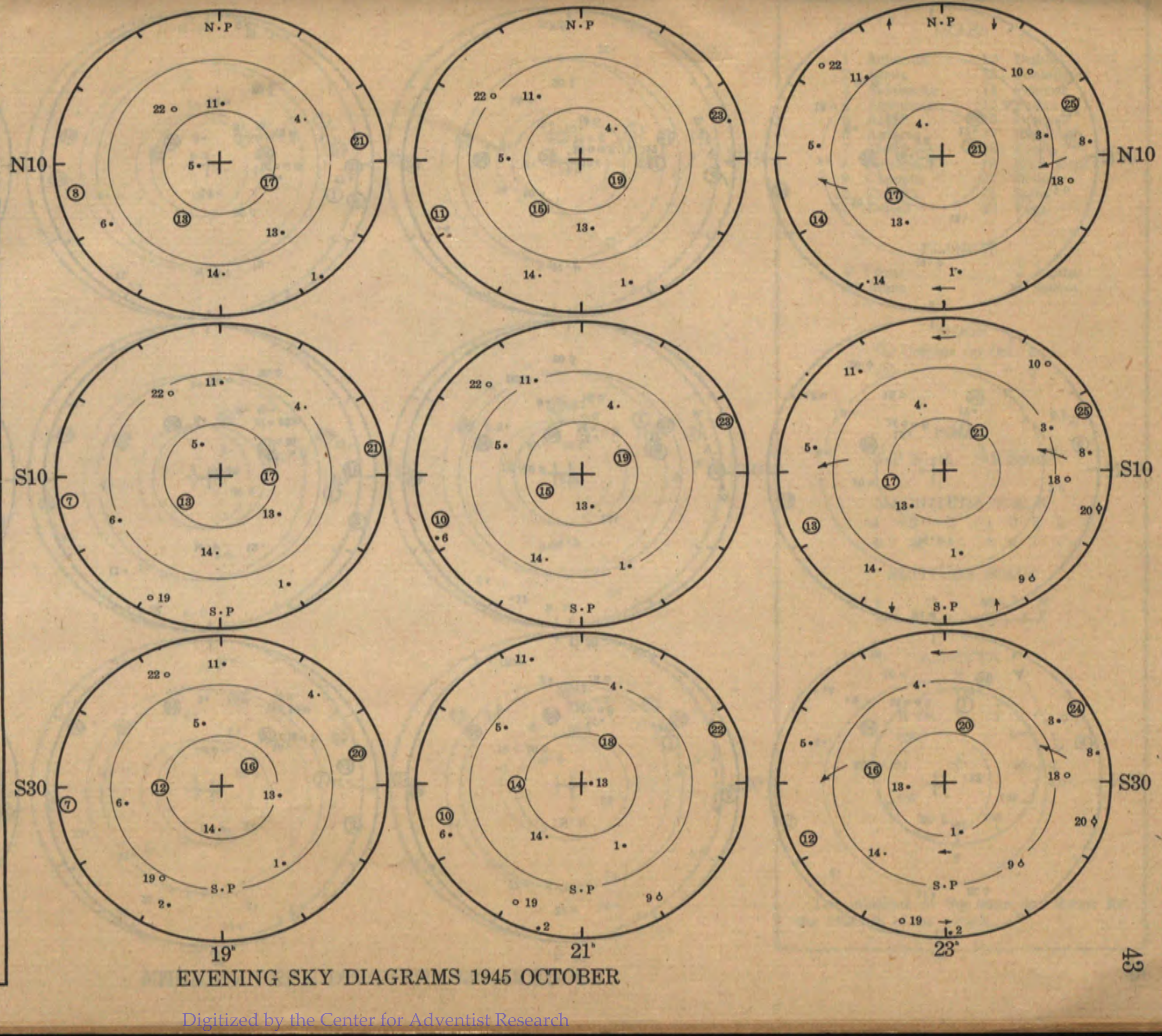
AZIMUTH



The positions of the stars are shown for the fifteenth of the month.







STARS

1	Achernar	12	Dubhe
2	Acrux	13	Fomalhaut
3	Aldebaran	14	Peacock
4	Alpheratz	15	Pollux
5	Altair	16	Procyon
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8	Betelgeux	19	Rigil Kent
9	Canopus	20	Sirius
10	Capella	21	Spica
11	Deneb	22	Vega

PLANETS

V Venus J Jupiter
M Mars S Saturn

MOON

① Position on Oct. 1
② " " " 2

POLES

N·P North, S·P South

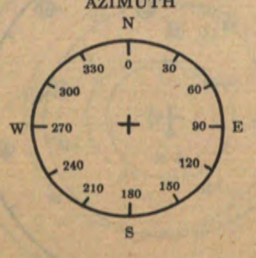
MAGNITUDE SCALE

−4 −3 −2 −1 0 1 2

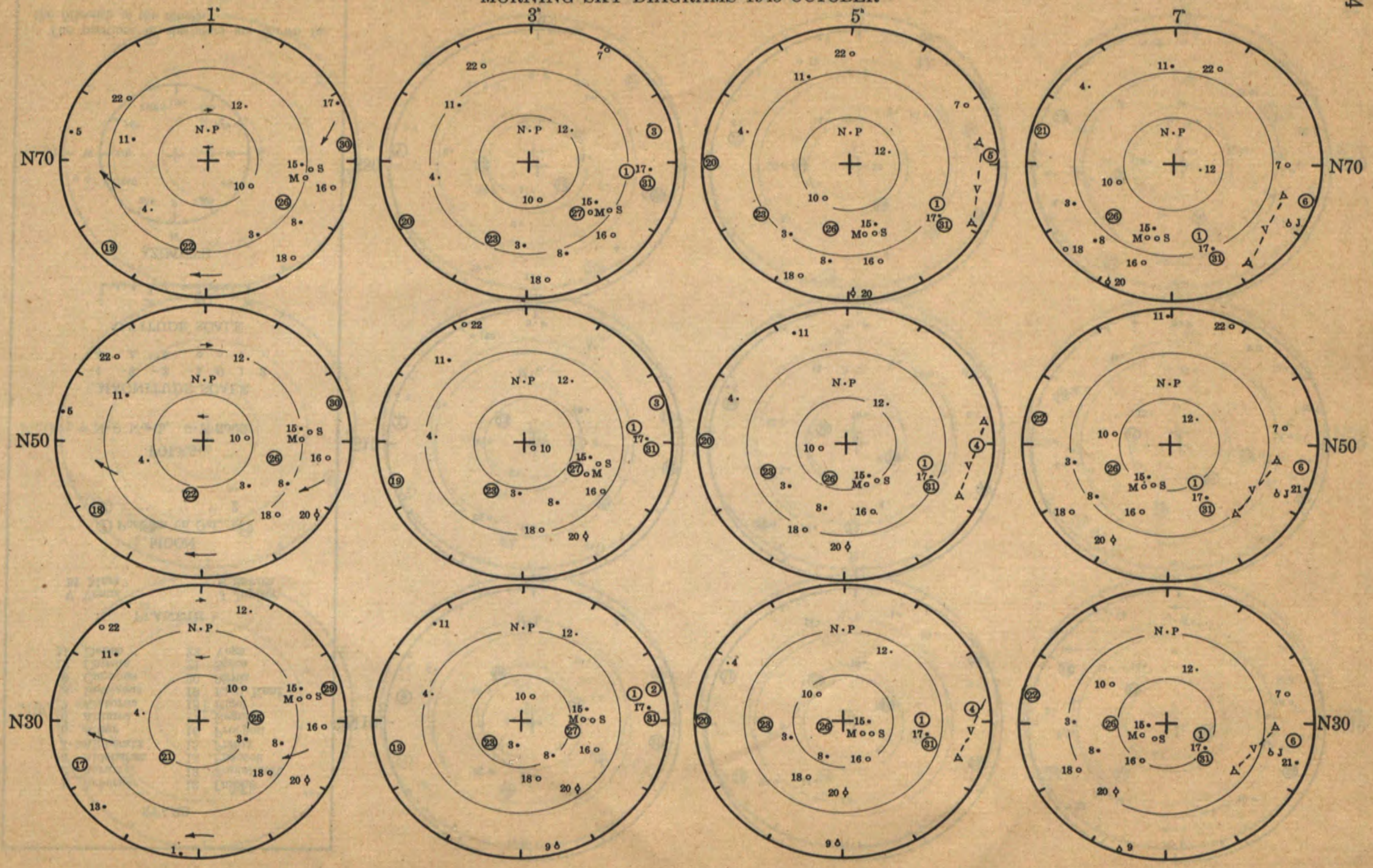
ALTITUDE SCALE

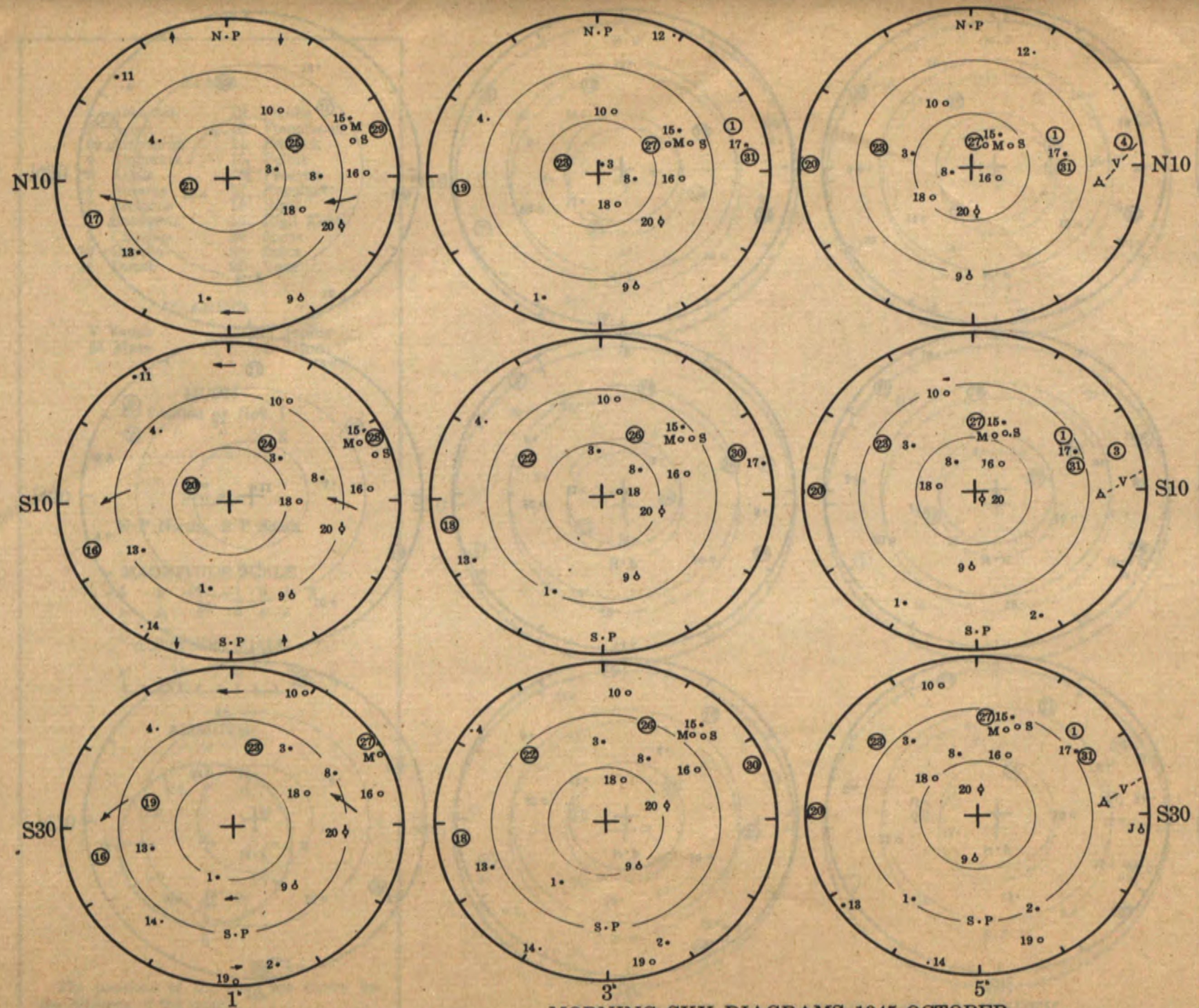
0 30 60 90

AZIMUTH



The positions of the stars are shown for the fifteenth of the month.





STARS

1	Achernar	12	Dubhe
2	Acrux	13	Fomalhaut
3	Aldebaran	14	Peacock
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5	Altair	16	Procyon
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PLANETS

V Venus J Jupiter
M Mars S Saturn

MOON

① Position on Oct. 1
② " " " 2

POLES

N·P North, S·P South

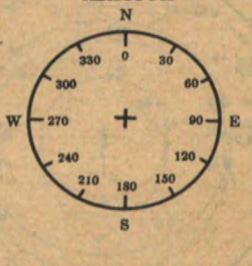
MAGNITUDE SCALE

−4 −3 −2 −1 0 1 2

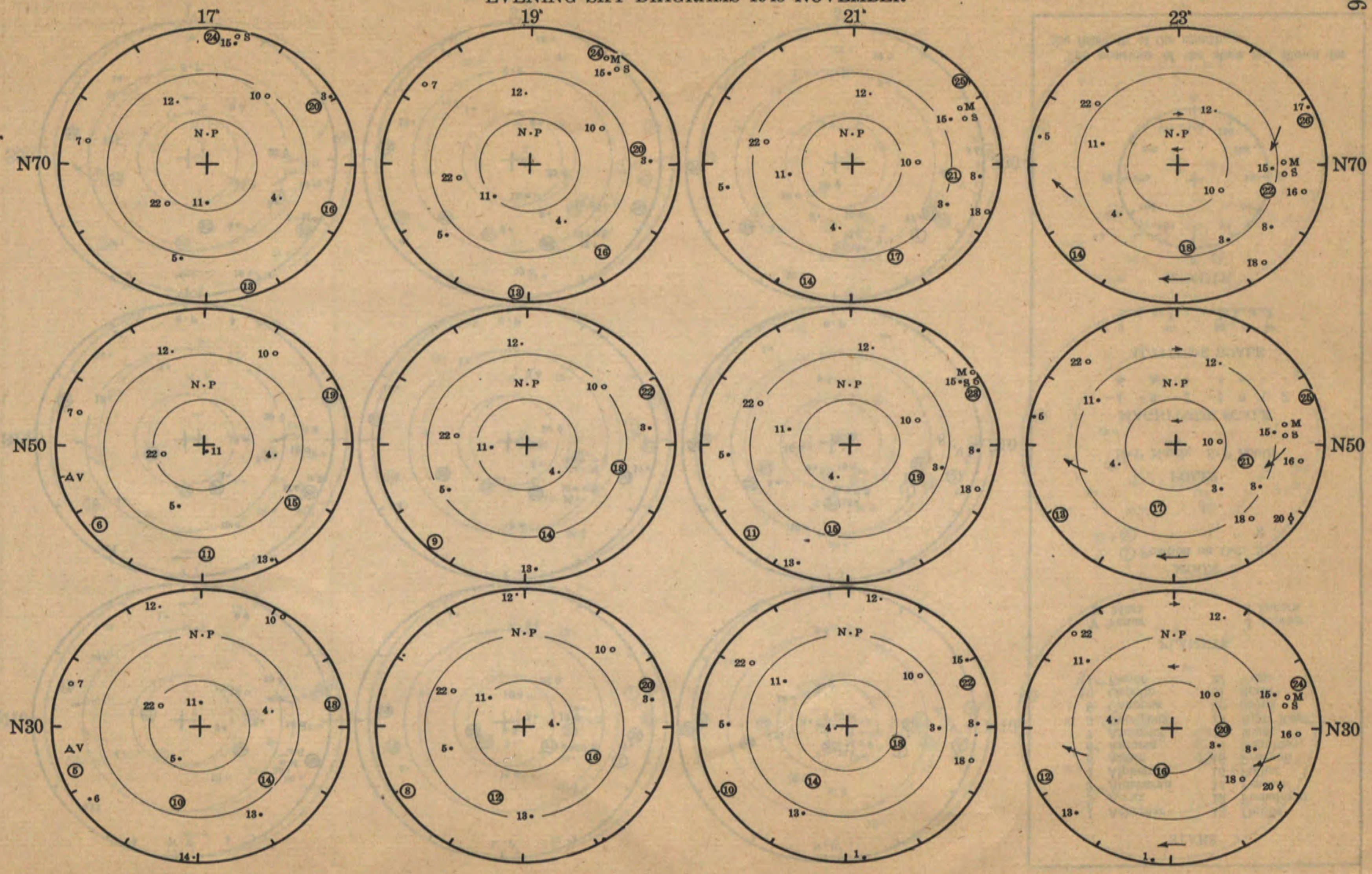
ALTITUDE SCALE

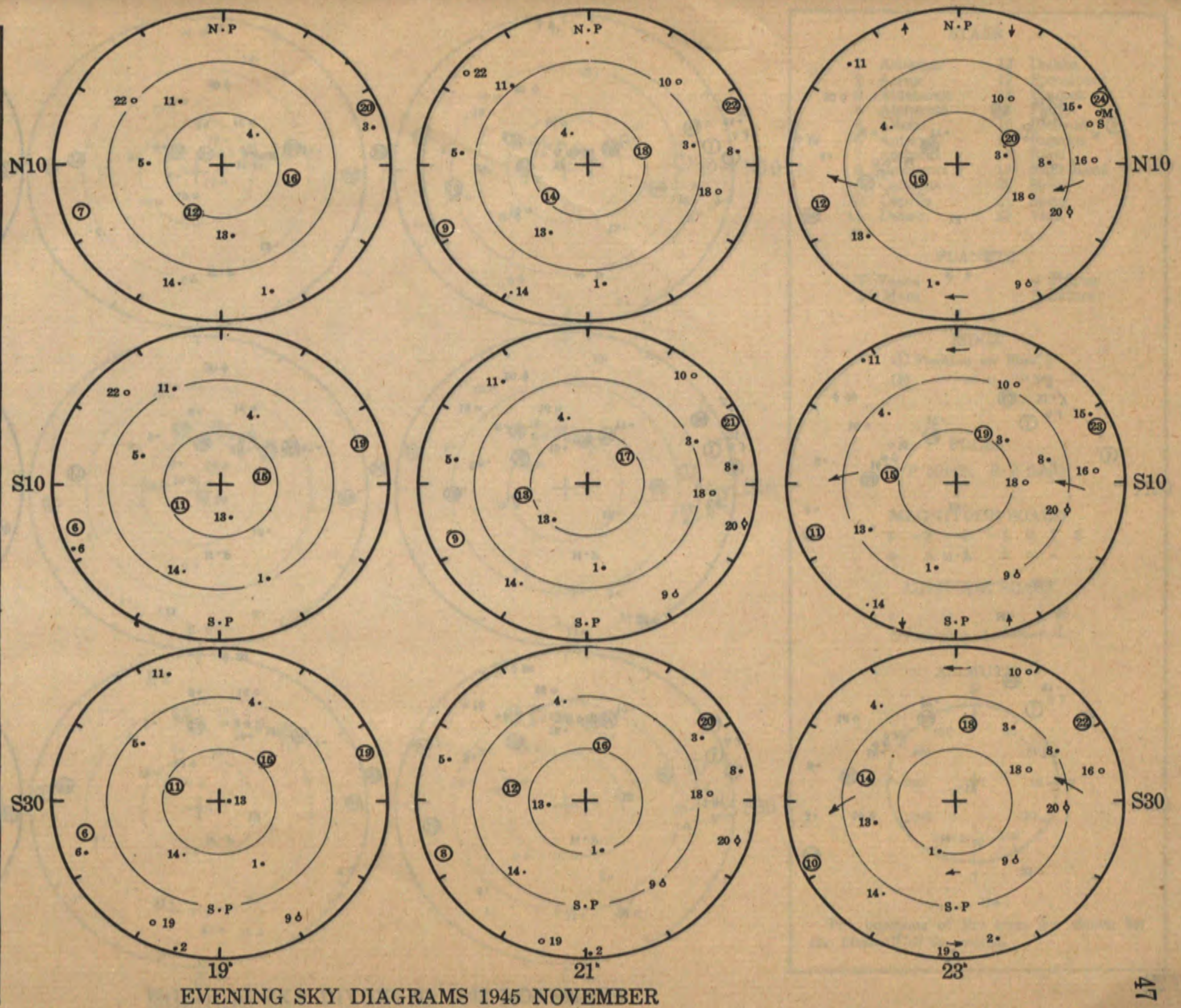
0 30 60 90

AZIMUTH



The positions of the stars are shown for the fifteenth of the month.





STARS

1	Achernar	12	Dubhe
2	Acrux	13	Fomalhaut
3	Aldebaran	14	Peacock
4	Alpheratz	15	Pollux
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8	Betelgeux	19	Rigil Kent
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PLANETS

V Venus J Jupiter
M Mars S Saturn

MOON

① Position on Nov. 1
② " " " 2

POLES

N·P North, S·P South

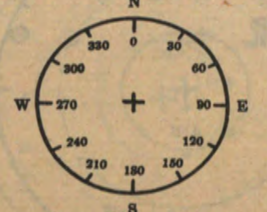
MAGNITUDE SCALE

−4 −3 −2 −1 0 1 2

ALTITUDE SCALE

0 30 60 90

AZIMUTH



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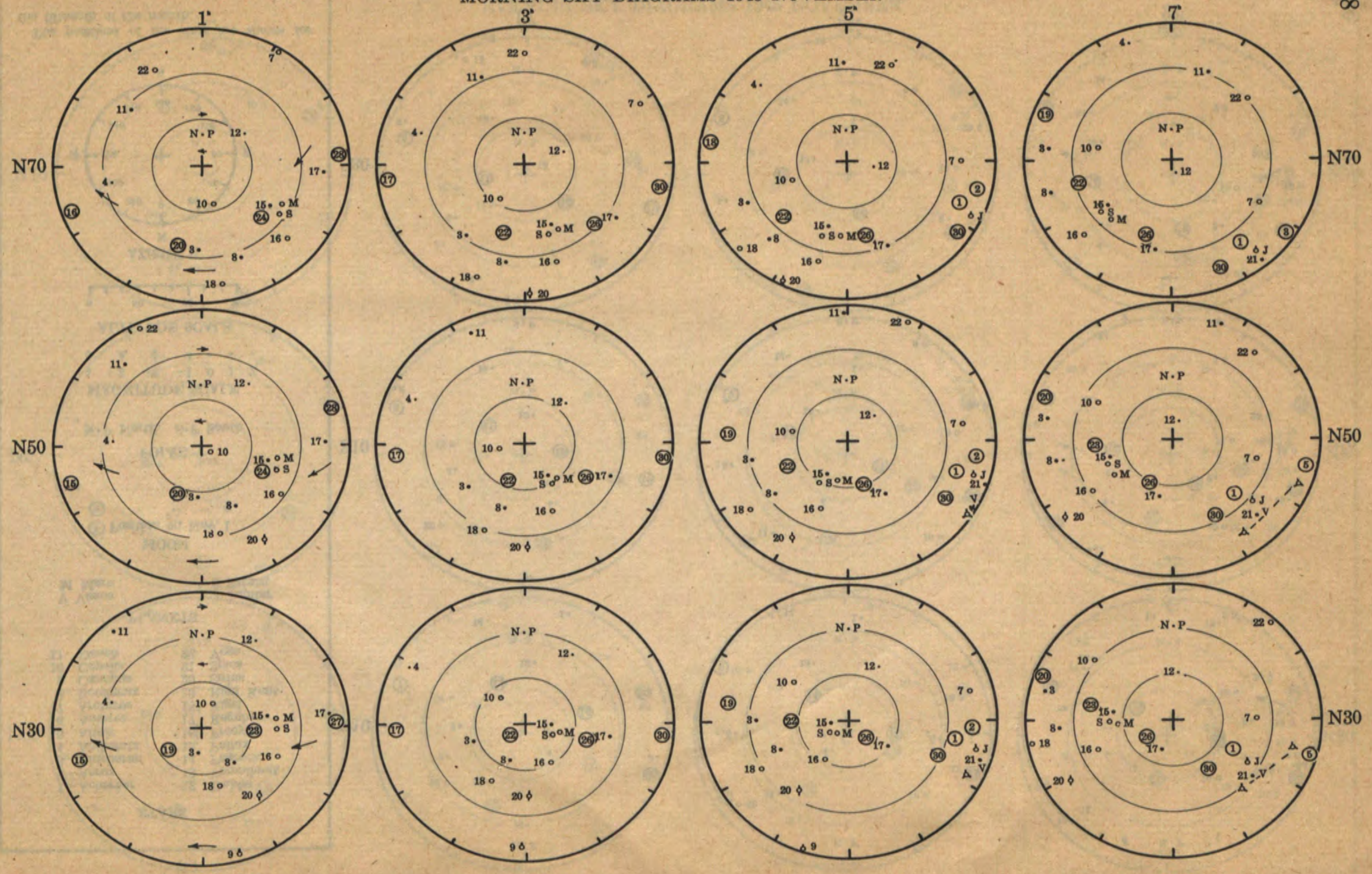

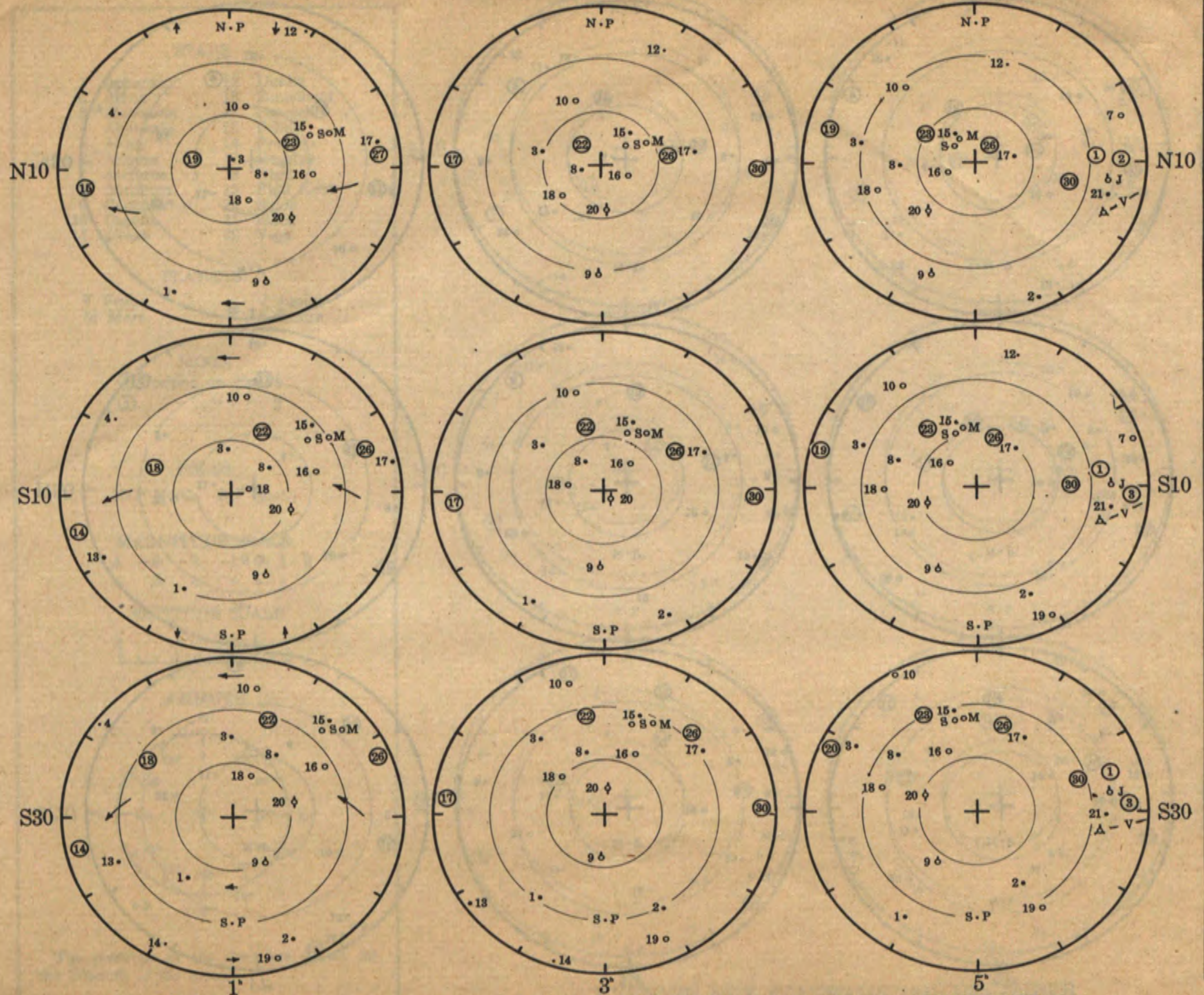

STARS

1	Achernar	12	Dubhe
2	Acrux	13	Fomalhaut
3	Aldebaran	14	Peacock
4	Alpheratz	15	Pollux
5	Altair	16	Procyon
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8	Betelgeux	19	Rigil Kent
9	Canopus	20	Sirius
10	Capella	21	Spica
11	Deneb	22	Vega

PLANETS

V Venus   J Jupiter
M Mars   S Saturn

MOON

① Position on Nov. 1
② " " " 2

POLES

N·P North, S·P South

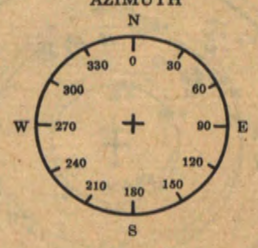
MAGNITUDE SCALE

−4 −3 −2 −1 0 1 2

ALTITUDE SCALE

0 30 60 90

AZIMUTH



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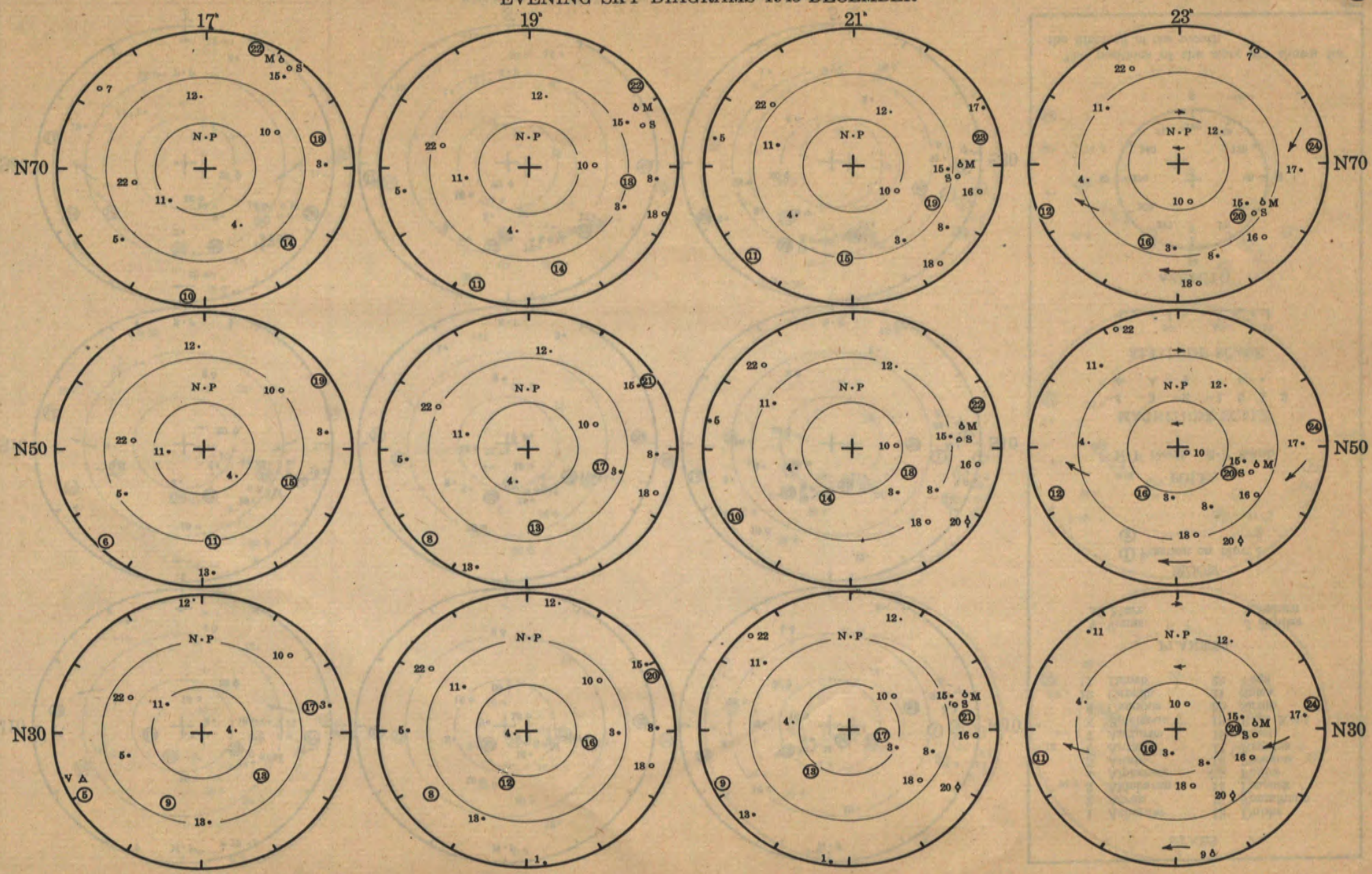

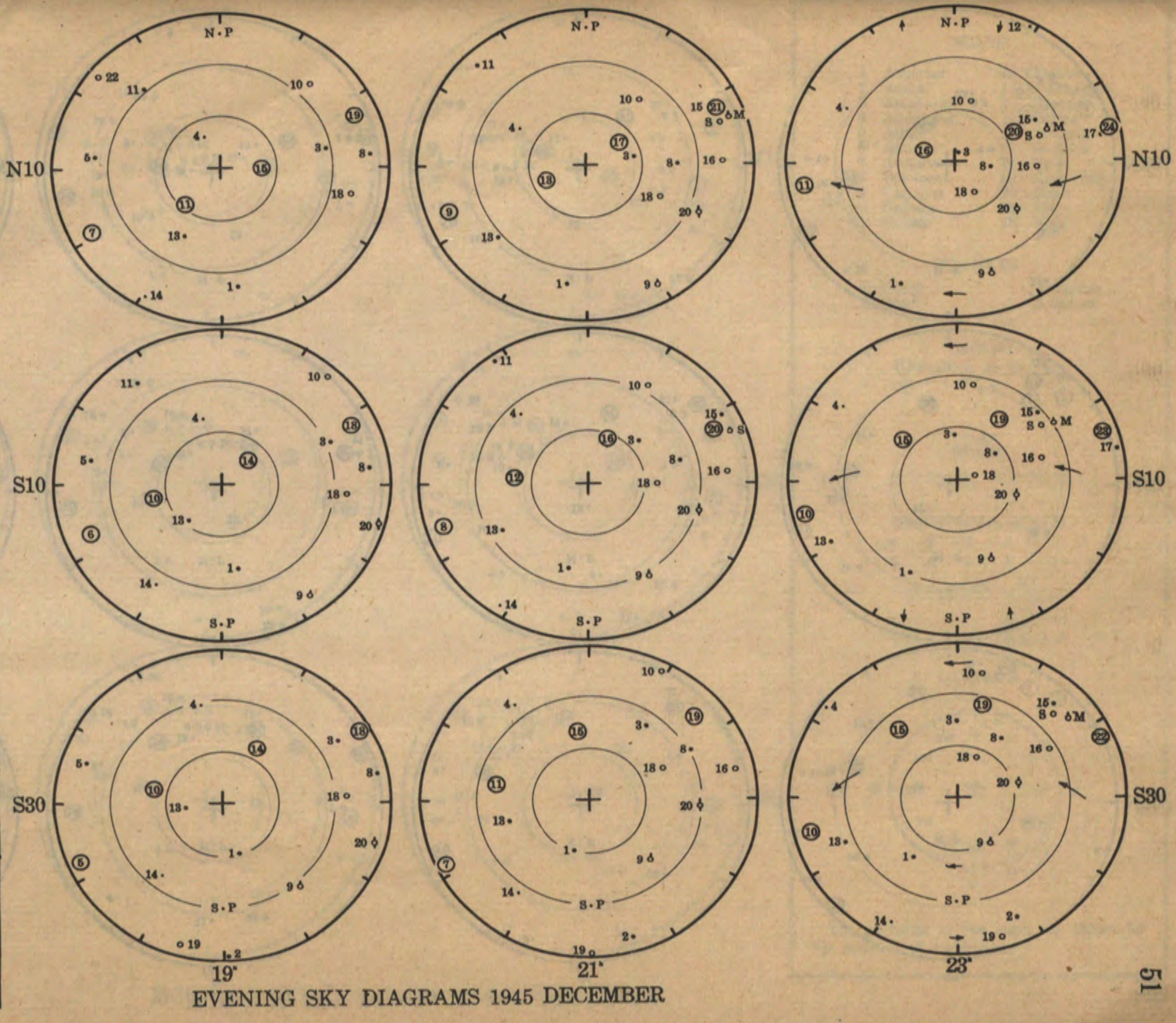

STARS

1	Achernar	12	Dubhe
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8	Betelgeux	19	Rigil Kent
9	Canopus	20	Sirius
10	Capella	21	Spica
11	Deneb	22	Vega

PLANETS

V Venus J Jupiter
M Mars S Saturn

MOON

① Position on Dec. 1
② " " " 2

POLES

N·P North, S·P South

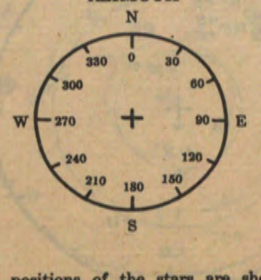
MAGNITUDE SCALE

−4 −3 −2 −1 0 1 2

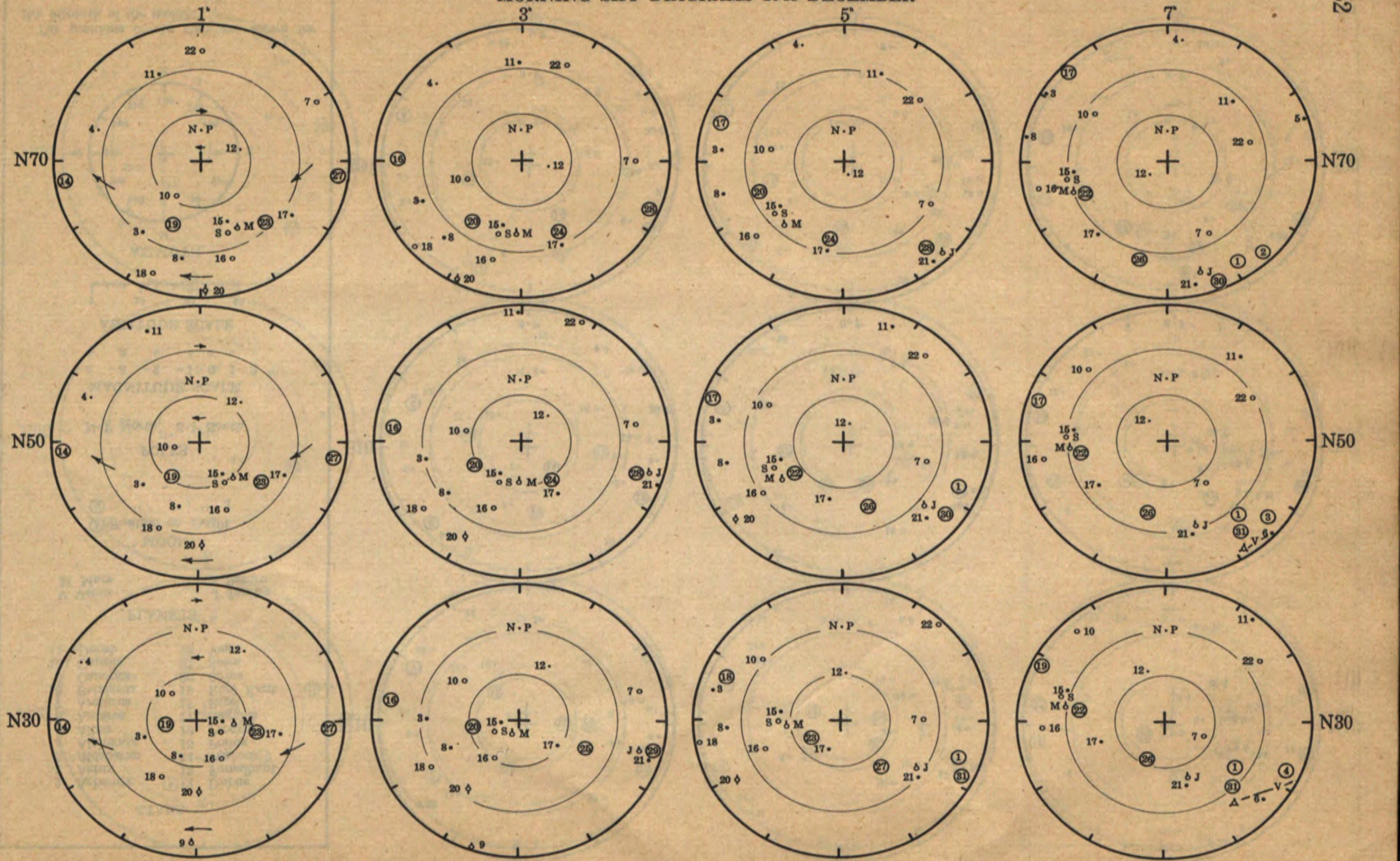
ALTITUDE SCALE

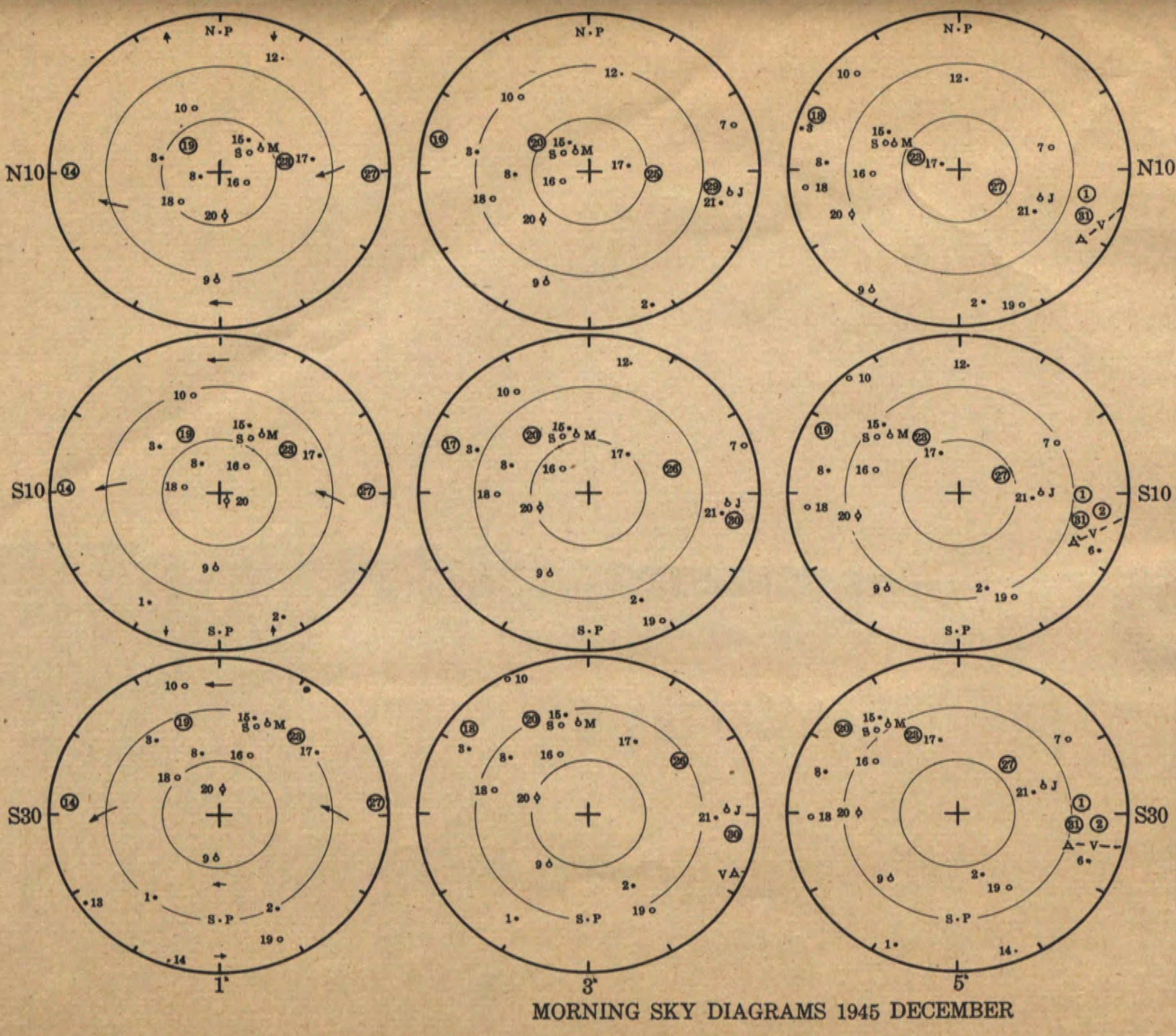
0 30 60 90

AZIMUTH



The positions of the stars are shown for the fifteenth of the month.





STARS

1	Achernar	12	Dubhe
2	Acrux	13	Fomalhaut
3	Aldebaran	14	Peacock
4	Alpheratz	15	Pollux
5	Altair	16	Procyon
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PLANETS

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MOON

① Position on Dec. 1
② " " " 2

POLES

N·P North, S·P South

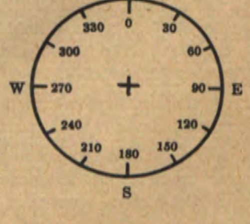
MAGNITUDE SCALE

-4 -3 -2 -1 0 1 2

ALTITUDE SCALE

0 30 60 90

AZIMUTH



The positions of the stars are shown for the fifteenth of the month.