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Astrologers and their Astronomy

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THAT the science of the Greeks was hobbled by the ancients' disdain for practical applications is a common refrain in modern accounts of the rise of science. The natural philosophers, like their metaphysical brethren, held that the only legitimate end of their speculations was the elevation of the soul, and so, in the words of Macaulay, 'they filled the world with long words and long beards; and they left it as wicked and as ignorant as they found it'.[1] Though drawn chiefly from Plato and Plutarch, this portrayal of Greek science finds support in certain passages where its practitioners themselves describe their work as the pursuit of divine beauty, for example Aristotle's defense of his investigations of animals (*De partibus animalium* I 5), or the opening pages of Ptolemy's *Almagest*.

Yet there are hints in Ptolemy's great treatise on the movements of the heavenly bodies that astronomy, at least, has other ends besides moral uplift. Along with the deductions of explanatory models from observations and of generalized phenomena from the models, the book contains a great deal of apparatus for predicting the precise configuration of the heavens as beheld from an arbitrary location on the earth's globe on an arbitrary past or future date. The dozens of numerical tables dispersed through the *Almagest* were the product of a labour of calculation disproportionate to the handful of times that they are actually used within the work. And Ptolemy justifies his inclusion of certain phenomena connected with eclipses and the risings and settings of stars with a cryptic allusion to their use as 'significations'.[2] The suspicion that Ptolemy contemplated some external application of his tables is reinforced by his later decision to publish a revised edition of them as the *Handy Tables* (Πρόχειροι κανόνες), accompanied by a terse instruction manual but not a word of theory.[3]

The application was, of course, astrology. Ptolemy wrote a separate work on that subject, the so-called *Tetrabiblos*, and it is instructive to read in its first chapters Ptolemy's intelligently reasoned argument that there exists a science dealing with the cause-and-effect relationship between the heavenly bodies and the world of men and other living things; and that this science, although by nature inexact in its predictions, is materially useful, contributing to the physical well-being of nations and individuals.

To what degree was this practical astrology a social reality in Ptolemy's time? What is at issue is not whether Greek astrology had a valid rationale and made correct predictions. But most of the astrological literature that has been handed down from antiquity through the medieval scribal channels, including the *Tetrabiblos* itself, is academic and theoretical. So little is said about how

[1] *Literary and Historical Essays*, 'Lord Bacon' ('Oxford Edition', 1913) i. 383.

[2] *Almagest* VI 5, 7, 11, and VIII 6.

[3] The manual is edited in Ptolemy, *Opera astronomica minora*, ed. J. L. Heiberg (Leipzig 1907) 159–85.

to adapt their general principles to specific real situations, such as the complete interpretation of an actual horoscope rather than just the significance of a particular element in it, that one is left in doubt whether the authors had any experience in applied astrology.

Real astrologers there were, however. We find them mentioned, among other places, in the historians of the Roman Empire, where they circulate among the highest levels of Roman society. One author of a surviving text on astrology was a practitioner: Vettius Valens of Antioch, a contemporary of Ptolemy's who illustrated his bizarrely-written and frequently unintelligible astrological manual with numerous authentic horoscopes that he had filed away in the course of a career spanning several decades. And lastly, we have the physical evidence of astrologers' activity in the papyri.

Composed as it is of fragments, the papyrus record has a value for the historian that increases (so to speak) exponentially with the number of papyri recovered, until at last repetitiveness begins to outweigh novelty. For astrology and astronomy in Graeco-Roman Egypt we are far from reaching such a point of diminishing returns. It is partly for this reason that the Oxyrhynchus papyri matter so much in this field. The sheer magnitude of Grenfell and Hunt's find, the chronological spread, and the fact that the site held every kind of discardable written text were all circumstances conducive to the presence of an entirely unprecedented number of astronomical and astrological papyri; and an admirable inventory has made it possible to isolate what is surely the great part of this material for study and publication.[1]

Astrological theorists subdivided their field in various ways. One classification of astrology into three kinds, adopted for example by the fifth-century writer Hephaestion of Thebes, is particularly applicable to what we find in the papyri. A first kind of astrology professes to forecast the character and destiny of an individual by interpreting his horoscope, that is, the positions of the sun, moon, and planets in their relation to the zodiacal signs and to the horizon at the time of the individual's birth. The ancient name of this practice was genethlialogy; alternatively, we may call it horoscopic astrology. A second kind, catarchic astrology, determined whether a date or time was auspicious or inauspicious, either in general or for engaging in a particular activity, according to the zodiacal positions of the heavenly bodies at the time in question. A third kind, called general astrology, used the situation of the heavenly bodies on certain astronomically significant occasions, such as eclipses, to forecast events and conditions for entire nations and regions.

It is by no means certain that all these kinds of prognostication were the province of a single expert; the term *genethlialogos*, 'interpreter of nativities', coexisted with vaguer words such as *astrologos*, *mathematikos*, implying that horoscopic astrology was a specialty as well as being the most commonly practised division. The three astrologies had this in common, however, that each kind of forecast had an astronomical component preceding and separable from the strictly astrological component. Most of the astronomical papyri from the Roman period, from Oxyrhynchus and elsewhere, can be described as astrological in motivation, though this is only evident in so far as they are directed towards obtaining precisely the data that astrological interpretation fed upon. No less than Ptolemy, the astrologers scrupulously kept their astronomy and their astrology apart.

In genethlialogy the astronomical part of the operation is the construction of the horoscope. We now can study about 130 original horoscopic documents, the majority of them from Oxyrhynchus.[2] The distribution of these according to date

[1] The specifically astronomical part of this corpus appears in A. Jones, *Astronomical Papyri from Oxyrhynchus* (Memoirs of the American Philosophical Society 233: Philadelphia 1999). This work includes all texts cited here with the P. Oxy. nos. LXI 4133–4300a.

[2] Most are collected in O. Neugebauer and H. B. van Hoesen, *Greek Horoscopes* (Memoirs of the American Philosophical Society 48: Philadelphia 1959) (28 papyri, of which 10 are P. Oxy.); D. Baccani, *Oroscopi greci* (Ricerca Papirologica 1: Messina 1992) (18 papyri, 7 P. Oxy.); Jones, *Astronomical Papyri from Oxyrhynchus* (69 horoscopes, all P. Oxy.); D. Baccani in *Analecta Papyrologica* 1 (1989) 67–77 and 7 (1995) 63–72 (17 ostraca from Medinet Madi). The first two of these works are for the most part re-editions of previously published documents.

is the best measure we have of the popularity of personal astrology in Egypt.[1] The earliest extant horoscopes belong to people born near the end of the first century BC, and the frequency increases steadily thereafter. Among the papyri excavated by Grenfell and Hunt, more than half belong to the third century of our era, whereas in the aggregate of horoscopes from other collections the peak is reached a little earlier, in the second half of the second century. The decline afterwards is rapid, and after AD 400 we have only five horoscopes. The very latest, from Oxyrhynchus, is for a man born in 508. The full meaning of this pattern will only be seen when we have a more accurate knowledge of the chronological distribution of papyri of all kinds from Oxyrhynchus and elsewhere than is now available. My suspicion is that the predominance of the second and third centuries among the horoscopes merely reflects the general pattern of survival of papyri, but that there was a real decline in late antiquity. The beginnings are more obscure. Oxyrhynchus can tell us nothing about the first century BC, and it may be that the significant sources of papyri from that century are simply of the wrong kind to have yielded traces of astrological activity. The evidence in our hands is at least consistent with the impression derived from other sources, that Greek astrology was a creation of the late second or early first century BC.[2]

The format of the papyrus horoscope, and the prerequisites for producing it, remained essentially the same through the five hundred years of which we have knowledge. The person for whom the horoscope is cast, called the 'native' in the jargon of the trade, supplied the astrologer with his date and hour of birth — one cannot help wondering how common a thing it was to know precisely when one was born, and whether the spread of astrology encouraged people to preserve this information. Most of the horoscopes surviving on papyrus begin tersely with the native's name and birthdate; and we have a number of examples of memoranda on papyri and ostraca in which only this information is recorded, without the corresponding astronomical positions. In principle one ought also to know the place of birth, since latitude affects the horizon and longitude the local time; and an astrologer such as Vettius Valens whose clientele included well-travelled personages would not neglect this element. The papyri, which never allude to the native's place of birth, attest to a more parochial approach.

The remainder of the horoscope consists of the information about the state of the heavens at the date of birth that would be used to make the astrological interpretation. This information can be grouped in three categories. First, we are always given the locations in the zodiac of the sun, moon, and the five planets Saturn, Jupiter, Mars, Venus, and Mercury. Secondly, we are always given the *horoskopos* or ascendant point, which is the location in the zodiac that is rising at the eastern horizon at the moment of birth, and sometimes also the locations in the zodiac that are setting and crossing the meridian above and below the horizon. Thirdly, we are occasionally given the locations in the zodiac of certain points of purely astrological significance, such as the point that is as far from the ascendant point as the moon is from the sun. In a few elaborate horoscopes this material is stretched out at considerable length in the form of a prose text. But there is no interpretation, not a word about what these positions imply individually or collectively about the life of the native.[3] This is a striking demonstration of the general rule of segregation between the astronomical and interpretative components of astrology.

How did the astrologer convert a given date and time into a set of astronomical positions? The importance of this question for the history of

[1] A. Jones, 'The Place of Astronomy in Roman Egypt', in T. D. Barnes (ed.), *The Sciences in Greco-Roman Society* (*Apeiron* 27.4: Edmonton AB 1994) 25–51, esp. fig. 1–2.

[2] D. Pingree, *From Astral Omens to Astrology: From Babylon to Bīkāner* (Serie Orientale Roma 78: Rome 1997) 21–9.

[3] Very few exceptions to this rule exist. The elaborate horoscope P. Lond. 98 (Neugebauer and van Hoesen, *Greek Horoscopes* no. 95) contains a long text in Greek and 'Old Coptic' apparently forecasting the course of the native's life through several periods governed each by a different planet. Brief interpretations or advice appear in *Greek Horoscopes* nos. 137c, 138/161, and 345.

ancient astronomy was first seen by Neugebauer, who undertook to collect and analyse all the ancient Greek horoscopes primarily in the hope that they would tell us something about the evolution of astronomical theory and calculation. The converse of this relation is also true, that the more we know about how astrologers did their astronomy, the closer we will be to an understanding of the conditions under which they worked and the origins of their tradition.

We had no broad picture of this side of Greek astrology until quite recently, only a few disconnected details and many guesses. Hopes of finding analytical methods for working backwards from the horoscopes to the underlying astronomical theory have on the whole not been borne out. Four fifths of the horoscopes only indicate which sign of the zodiac is occupied by each heavenly body; the few that specify degrees and minutes can give us a rough sense of the accuracy of the ancient calculations, which was generally on the order of magnitude of two or three degrees' error, but provide us with no clue to the nature of those calculations. We also had some fragments of astronomical almanacs on papyrus, and a small number of other tables and texts related to astronomical prediction, including two or three manuscripts of tables related to Ptolemy's. The entire corpus of astronomical papyri with possible astrological applications numbered about forty items, and several of these were negligible scraps.[1]

It is a curious fact that only two of these texts appeared in *The Oxyrhynchus Papyri* (XXXI **2552** and XLVI **3299**), in both cases chosen for publication primarily for reasons tangential to their original purpose — a good illustration of the unreliability of published selections as a statistical sample of the whole body of papyri retrieved by Grenfell and Hunt. The inventories of unpublished papyri at the Ashmolean Museum, supplemented by more direct searching, made it possible to identify several hundred fragments of astronomical papyri. After joins were made and scraps unworthy of publication eliminated, more than a hundred items remain.

With this enlarged documentation, we can return to the question of how the astrologer composed his horoscopes. First of all, let us finally dismiss the notion that observation played any role in this astronomical tradition. To be sure, one never took seriously the possibility that positions of heavenly bodies in a horoscope were recorded from autopsy at the date of birth: it is only in the philosophical debates on the efficacy of astrology that one meets with the fiction of the Chaldaean stargazer seated on the hilltop, ear cocked to catch the ringing of a gong announcing that a child has been born in the dwellings below. But perhaps the astrologer observed the heavens on a regular basis, and recorded the positions in an almanac for later reference? Apparently not: in all the papyri, there seems to be only one record of an observation, and that is in a fragment of a theoretical treatise probably written at Rome (LXI **4133**). Every datum that the astrologers employed was a prediction derived from theory, modelling, and calculation.

Broadly speaking, there were two options available to the astrologer. He could do the necessary calculations himself on the occasion of casting the horoscope, or he could consult an almanac. Almanacs were very common throughout the first four centuries of our era.[2] To be useful, an almanac would have to cover a lifespan or so preceding the present date, and would have to be extended from time to time. Only the motions of the five planets were recorded as a rule, presumably because the sun's course is practically the same from year to year, whereas the moon moves through the zodiac so swiftly that it would require too many tabular entries to make the exercise worthwhile. We find three standard formats of almanac, the most popular of which listed, year by year and planet by planet, the dates when the planet was computed to have crossed from one zodiacal sign to a neighbouring sign. From such a table it is easy

[1] O. Neugebauer, 'Astronomical Papyri and Ostraca: Bibliographical Notes', *Proceedings of the American Philosophical Society* 106 (1962) 383–91; Baccani, *Oroscopi greci* 34–6.

[2] For a technical description of this and other varieties of astronomical tables, see A. Jones, 'A Classification of Astronomical Tables on Papyrus', in N. M. Swerdlow (ed.), *Ancient Astronomy and Celestial Divination* (Cambridge MA 1999) 299–340.

to determine the signs occupied by the planets on an arbitrary date, but precise positions in degrees and minutes cannot be obtained.

Equipped with one of these sign-entry almanacs, and certain crude rules of thumb for estimating the zodiacal signs of the sun, the moon, and the ascendant, someone possessing negligible mathematical skills and essentially no understanding of astronomy would be in a position to compose a horoscope of the well-attested rough kind. Perhaps there were astrologers who got by with this little technical training. Others, capable of something better, probably would still have relied on almanacs when a customer was only willing to pay for a bottom-of-the-line horoscope.

In any case, it seems quite implausible that an astrologer would typically have worked out the almanac himself. Our understanding of how the almanacs were originally computed is incomplete, but we do know that some of them were based on fairly extensive calculations. There is a series of almanacs from Oxyrhynchus, dating from the third and fourth centuries, that give dates of planetary sign entries precise to the hour, calculated according to Ptolemy's *Handy Tables* (LXI 4190, 4192, 4194–4196a); how much labour went into this can only be felt by one who has gone through the steps of using the *Handy Tables* to find a single dated position of one planet. These almanacs, I imagine, must have been produced by a commercial supplier of astronomical tables. On the other hand we have overlapping almanacs that give slightly different dates for the sign entries, which shows that there was not a single agency producing them.

When an elaborate horoscope was required, the kind that gives planetary positions in degrees and minutes in the zodiacal signs, almanacs ceased to be useful, and the astrologer had to turn to other kinds of table that I call 'primary tables', in principle the same kind that the almanac compilers must have relied on. The papyri from Oxyrhynchus have shown us for the first time what these tables were; and the answer is surprising and of much historical significance.

To explain this requires a bit of background. We have always thought of Greek astronomy as having its foundation in a geometrical conception of the cosmos, and that the central problem from the time of Plato on was to account for the apparently irregular movements of the heavenly bodies in the sky as the product of a combination of simple, regular, predictable motions, especially circular revolutions. Ptolemy's astronomy, which is the only Greek astronomical system of which we had detailed direct knowledge, was of this kind, and Ptolemy's example was closely followed by Arabic and European astronomers up to the seventeenth century. Moreover, what Ptolemy, in company with a few less technical classical authors, told us about the earlier history of the science led us to believe that Ptolemy's predecessors worked with basically the same methods and assumptions. Hence it seemed obvious that the methods of astronomical prediction that existed when Ptolemy wrote were also similar to his own, that is, that they would represent in numbers the hypothetical uniform circular motions, and then use trigonometry to convert these numbers into a single angle with its vertex at the observer, representing the apparent zodiacal position of the heavenly body.

For just a century now we have been able to read the productions of a very different astronomical tradition that was practised in certain temples in Babylon and Uruk during the last three centuries BC or so.[1] The Babylonian approach was highly sophisticated and mathematical, but made no use of geometrical modelling in the Greek manner. It yielded predictions of the positions of the heavenly bodies, as well as other phenomena, by means of models that employed only the basic arithmetical operations (addition, subtraction, multiplication, and division). It became apparent that the astronomy of Ptolemy owed to the Babylonians several basic concepts and conventions, such as the zodiac, its division into degrees, and the place-value notation of fractions by sixtieths, sixtieths of sixtieths, and so on. Very soon it was also discovered that certain of the actual elements in Ptolemy's models, such as the periodicities involved in the moon's motion, were obtained somehow from the Babylonian

[1] O. Neugebauer, *Astronomical Cuneiform Texts* (London 1955).

models. The evidence suggested that Babylonian astronomy exerted a restricted though obviously significant influence on its Greek counterpart.

How the astronomy of the papyri fitted into this story was for a long time not at all clear. Neugebauer, who knew this material better than anyone, believed that the Graeco-Egyptian tradition operated on a comparatively low technical level. Then towards the very end of his life he changed his mind. He had been sent a photograph of a papyrus in private hands, which he recognized at once as part of a Babylonian table calculating full moon phenomena, written in Greek.[1]

Now Oxyrhynchus has presented us with about a dozen tables for calculating planetary positions, dating from the first through the fourth century, computed by the very same arithmetical models that the Babylonian scribes used centuries earlier (LXI 4152–4161). This was in itself astonishing: we had reason to believe that the Greeks knew something about these models, but not that they were transmitted, and persisted in use for centuries, in full working order. Only an unbroken chain of teachers and pupils, originating in Mesopotamia and somehow passing into Egypt, could account for this continuity; and that is something we must take into consideration when tracing the obscure origins of Greek astrology.

But there is more. If we are to trust the papyrus record, these Babylonian tables had no important rivals in Roman Egypt until the second century, when copies of Ptolemy's tables begin to appear with increasing frequency. There is evidence for other tables of the trigonometric sort, but it is scarce and uncertain. All appearances suggest that the original computational equipment of the astrologers was Babylonian, and that they made the transition to tables representing Greek geometrical modelling only in response to Ptolemy's *Handy Tables*, and even then it took two centuries.

We even have the good fortune to be able to observe the process on the smaller scale of a single astrological workshop.[2] In general the astronomical and astrological texts were dispersed thinly among the great mass of unpublished Oxyrhynchus papyri, and there are few instances of the same hand showing up twice or of fragments of several manuscripts filed in the same folder or in close proximity. I get the impression that there must have been very many astrologers in Oxyrhynchus over the centuries. But there is an important exception. In their last year of excavations at Bahnasa, Grenfell and Hunt seem to have come across an astrological archive, consisting of fragments of about forty manuscripts of tables, and probably also a number of astrological manuals. Some fifteen of the tables have datable contents, ranging from just after AD 200 to just after 300. The interval covered is not impossible for one astrologer, if he began with tables retrospectively covering a couple of generations, and had a long career.

The archive contains both almanacs and primary tables. Among the primary tables are five Babylonian-style arithmetical planetary tables, which seem to be among the earliest things in the archive; two that have exactly datable contents pertain to the years 206 through 235. But there are also fragments of no fewer than three copies of Ptolemy's *Handy Tables*, and also a manuscript of what appears to have been a reorganized version of the *Handy Tables*. One of the Ptolemy manuscripts, LXI 4167, was in roll form, which by the way is rather unusual, because a complete copy of the *Handy Tables* would have required about thirty metres of papyrus, and would have been unwieldy even if divided into three or more rolls. (Ptolemy laid his tables out in blocks that fit suspiciously well into uniform codex pages.) The almanacs in the archive can mostly be shown to have been computed using Ptolemy's tables. The changeover from arithmetical to trigonometrical methods seems to fall about the middle of the century, or roughly a hundred years after Ptolemy published the *Handy Tables*.

Let me resume the survey of the astronomical component of astrology with the second of

[1] O. Neugebauer, 'A Babylonian Lunar Ephemeris from Roman Egypt', in E. Leichty et al. (eds.), *A Scientific Humanist: Studies in Memory of Abraham Sachs* (Philadelphia 1988) 301–4.

[2] Jones, *Astronomical Papyri from Oxyrhynchus* i. 59–60.

the science's divisions, catarchic astrology. The investigation of auspicious and inauspicious times was, according to the astrological handbooks, a complex subject because the criteria had to be adapted to the nature of the activity in which one was about to engage. It was susceptible, however, of a radical simplification if one was satisfied with a calendar identifying the successive days as generally auspicious or inauspicious. A secondary consequence of this approach is that the astrological determination of *katarchai* ('inaugurations' of activity) could be conflated with other calendrical schemes. Petronius (*Satyrica* 30.4) describes a display in the house of Trimalchio in which a representation of 'the course of the moon' and images representing the seven heavenly bodies accompanied a peg-board calendar of good-luck and bad-luck days. I think this must have been an analogue of a variety of astronomical table very well attested on papyrus, which was known in antiquity as an 'ephemeris'.

The extant ephemerides cover an exceptionally wide chronological span, from 24 BC to AD 489. There are many little variations between them, but the basic structure is uniform. The complete ephemeris, which might cover a year or a series of years, contains one table for each successive calendrical month. The calendar in question is always either the Egyptian civil calendar or the Roman calendar. There are as many rows as the month has days. The leftmost columns of the table typically count the successive days of the month according to the main calendar of the table, and according to the other civil calendar (i.e. the Roman if the main calendar is the Egyptian, and *vice versa*), and the number of days since the preceding new moon. Next come the daily positions of the moon in the zodiac, calculated to the degree and minute for 6 pm; and on any day when the moon crosses from one zodiacal sign to the next, the time of the crossing is recorded in the next column. In the earlier ephemerides, the movements of the planets are summarized above the main table in almanac format; later, the preference was for having additional columns to the right containing the daily positions of each of the five planets and the sun.

In the very latest ephemerides, belonging to the fifth century, we find a further column identifying each day as auspicious or inauspicious. From a text on the construction of ephemerides preserved in several medieval astrological manuscripts we learn that this column was supposed to be filled according to certain rules dependent on the moon's position relative to the planets.[1] The same text recommends providing a column for weather predictions tied to the risings and settings of the stars, which has not so far turned up on a papyrus. It is obvious that the fifth-century ephemerides must have been produced in advance of the dates that they cover, in which respect they differ from the retrospective almanacs used in horoscopic astrology. But it is hardly to be doubted that the ephemerides always were directed towards catarchic astrology. There is a pretty example of this application in a personal letter from the end of the second century, LXV 4483: the writer advises his correspondent to fulfill an engagement with a friend while the moon is in Sagittarius, and he states the precise dates and times bounding this interval, obviously read off an ephemeris. The absence of explicit appraisals of the day in the earlier ephemerides is another manifestation of the reluctance of astrologers to record astrological interpretations together with the data on which they were based. On the other hand, the Roman preoccupation with calendrical days of good and ill omen may account for the otherwise inexplicable fact that ephemerides incorporate the Roman calendar as early as the first century BC.

Ptolemy devoted a large portion of his *Tetrabiblos* to general astrology, the division of the science dealing with astral influences on entire geographical regions. According to his physical rationalization of astrology, these macroscopic effects can be described and predicted much more reliably than the lives of individuals. Ptolemy's exaltation of this part of astrology does not seem to have been shared by the astrologers of the papyri, who have left us comparatively few texts relating to forecasts of approaching climatic and geopolitical

[1] H. D. Curtis and F. E. Robbins, 'An Ephemeris of 467 A.D.', *Publications of the Observatory of the University of Michigan* 6/9 (1935) 77–100, esp. 82–4.

conditions. The chief astronomical tools of general astrology appear to have been predictions of solar and lunar eclipses, and the calculated zodiacal positions of the heavenly bodies at the rising of Sirius in mid July. Like horoscopy, this is a tradition with distant Mesopotamian roots, but it also has a distinctively Egyptian colouring, and it is not altogether surprising that the Greek papyri of general astrology have close parallels in Demotic papyri. To take a single instance, a Demotic papyrus of the early first century BC from Abusir el-Melek, now in Berlin, provided our only known specimen of a canon of predictions of consecutive eclipses from the Graeco-Roman world, until a remarkably similar canon came to light among the Oxyrhynchus papyri, covering dates about 130 years later.[1]

My aim in this chapter has been to give some sense of how far our understanding of the astronomical dimension of Greek astrology, and of the history of astronomy itself, is being advanced by the study of papyri, and in particular by the documents from Oxyrhynchus. It remains only to mention that there remain in the boxes at the Ashmolean Museum a comparable number of purely astrological fragments, as yet mostly untouched, and these will in time have much to tell us about the interpretative aspect of the first science that sought to explain and ameliorate people's lives through mathematical modelling.

[1] O. Neugebauer, R. Parker, and K.-T. Zauzich, 'A Demotic Lunar Eclipse Text of the First Century B.C.', *Proceedings of the American Philosophical Society* 125 (1981) 312–27; LXI 4137.