A Posy of *Almagest* Scholia

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Several manuscripts of Ptolemy's *Almagest* contain extensive marginal annotations, of which only a very small number have been published. The manuscript that has received the most attention for its scholia is the ninth-century *Vat. gr.* 1594, which I will refer to as **B** (the letter by which Heiberg designates this manuscript in his edition of the *Almagest*). **B** has two 'layers' of scholia: a set in the same hand that wrote the text of the *Almagest*, and a set in a (probably) twelfth-century hand. Mogenet showed that both sets of scholia are based in part on the late fourth-century *Almagest* commentary by Theon of Alexandria, and can be used to remedy defects in the direct manuscript tradition of Theon's commentary (Mogenet 1975).

Inevitably, however, it is the non-Theonine elements in the scholia that provoke the most interest. Thus Mogenet and Tihon have edited and expertly analysed texts from the twelfth-century layer that reveal eleventh-century Byzantine familiarity with Islamic astronomy; and Tihon has published a long note from the ninth-century layer reporting statements by Marinus (the late fifth-century disciple of Proclus) and one Symmachus concerning the Milky Way (Mogenet 1962, 1975; Tihon 1989, 1976).

More recently Pingree has argued that the ninth-century layer represents in disjointed form a commentary on the *Almagest* composed between 537 and 637, probably by someone in the Nestorian scholarly community at Nisibis (Pingree 1994). **B** is not our only source for this commentary: substantially the same set of scholia appear in the margins of the ninth-century *Marc. gr.* 313 (Heiberg's manuscript **C** of the *Almagest*) and the tenth-century *Vat. gr.* 180 (Heiberg's **D**). So far as the text of Ptolemy is concerned, **B** and **C** are apographs of the same lost manuscript, while **D** represents an

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independent and intermittently superior line of transmission. My impression, admittedly based on examination of only a handful of the scholia, is that a similar relation exists between the texts of the scholia in the three manuscripts. Quite possibly there exist other copies that ought to be taken into account in a thorough survey of the scholia (a complete critical edition seems an unlikely prospect), but my experience suggests that these three manuscripts will suffice as the basis for an intelligible provisional text.

The four scholia that I print below are the yield of a search among the scholia shared by **B**, **C**, and **D** for remarks of historical interest relating to the older (i.e., non-Ptolemy) observation reports in the *Almagest.* As it turned out, I found very little: nothing, in particular, pertaining to any of the observations in Books 1–7. The notes that I did find concern two sets of third-century B.C. observations of passages of planets by bright stars: those that are dated in the reports by the calendar "according to Dionysius," which is unattested outside these reports in the *Almagest*, and those that are dated by the calendar "according to the Chaldeans", that is according to the Babylonian lunar calendar.

For each scholion I provide the text (reporting variants but silently expanding the numerous abbreviations), a translation, and my comments and speculations.

Text 1: *Almagest* 9.7 (Heiberg 1895–1907, 2.264).
B: 189r. C: 261v. D: 207v.

Διονύσιος ἐν Ἀλεξανδρείᾳ τὰς οἰκήσεις ποιούμενος εἰώθει τὴν ὀνομασίαν τῶν μηνῶν ποιεῖσθαι ἐκ τῆς τῶν οἰκείων ζῳδίων προσηγορίας, ὥστε εἶναι τὸν Ὑδρῶνα τῷ Ὑδροχόῳ ἐστίν. τὸ δὲ ὁμοῖον καὶ ἐπὶ τῶν ἑξῆς λεγέσθω. ἀπλανῆ δὲ λέγει ὡς φησιν ὁ Πάππος ὅς ἐστι τῶν ἐν τῷ παρούρῳ τοῦ Αἰγόκερω $\overline{\beta}$ ὁ ἑπόμενος μεγέθους ὢν γ΄. ἐπεὶ οὖν οὗτος τῷ α΄ ἔτει Ἀντωνίνου ἐπεῖχεν Αἰγοκέρω μοίρας $\overline{\text{κς}}$ γ΄, πρὸ δὲ $\overline{\upsilon}$ ἐτῶν γέγονεν ἡ τήρησις––ἀπὸ γὰρ Ναβονασσάρου εἰς τὸ α΄ ἔτος Ἀντωνίνου ἐστὶ $\overline{\omega\pi\delta}$, εἰς δὲ τὴν τήρησιν ὡς φησιν ὁ Πτολεμαῖος $\overline{\upsilon\pi\varsigma}$, ὥστε εἶναι τὰ μεταξὺ ἔτη $\overline{\tau\varsigma\eta}$ ἅ ἐστιν $\overline{\upsilon}$ ἔγγιστα––εἰς ἃ μοίρας $\overline{\delta}$ κεκίνηται ὁ ἀπλανής, ἐπεῖχεν ἄρα ἐν τῇ τηρήσει τοῦ Αἰγόκερω μοίρας $\overline{\kappa\beta}$ γ΄, τὰς δὲ αὐτὰς καὶ ὁ τοῦ Ἑρμοῦ.

15 καὶ νοτιώτερος ἦν τοῦ διὰ μέσων ◦ κ̄, αἱ γὰρ γ̄ σελῆναι ἃς ἀπεῖχε τοῦ ἀπλανοῦς ὁ Ἑρμῆς πρὸς ἄρκτους μοίρας ᾱ ⌐ ἔγγιστα ποιοῦσιν ὡς τῆς μίας Σελήνης οὔσης κατὰ τὸν Ἵππαρχον ◦ λγ̄ ιδ̄ ἃς δεῖ ἀφελεῖν ἀπὸ μοιρῶν β̄ τοῦ πρὸς νότον πλάτους τοῦ ἀπλανοῦς.

Variants: 1 οἰκήσεις D (a second hand annotates γ(ράφεται) κινήσεις) κινήσεις BC | 3 τῷ om. CD | 8 Αἰγόκερω: αι BC | μοίρας om. D | 15 ◦ κ̄ bis D sed del. | 18 ◦ λγ̄ ιδ̄ B ◦ λγ̄ δ΄ CD

Translation. Dionysius, who made his abode in Alexandria, made a practice of naming the months from the names of the pertinent zodiacal signs, so that Hydron is the same as Mechir according to the Alexandrian calendar because the sun is then in Aquarius (Hydrochoos); and the same should be said for the remaining (months). He speaks of the star, as Pappus says, that is the trailing one of the (stars) in the section next to the tail of Capricorn, which has magnitude 3. So since this (star) in the first year of Antoninus was at Capricorn 26 1/3°, and the observation was 400 years earlier – for from Nabonassar to the first year of Antoninus is 884 (years), and (from Nabonassar) to the observation, as Ptolemy says, is 486 (years), so that the years between are 398, i.e. approximately 400 – and in these (years) the star has moved 4°, it therefore was at Capricorn 22 1/3° at the observation, and Mercury (was at) the same number (of degrees). And (Mercury) was 0° 20′ south of the ecliptic, since the 3 moons by which Mercury was north of the star amount to approximately 1 2/3°, assuming following Hipparchus that one moon is 0′ 14″, which one must subtract from the 2° of the star's southerly latitude.

Comment. The passage to which this note refers is the first of six 'ancient' observations of Mercury's position relative to fixed stars, by the analysis of which Ptolemy demonstrates that the apsidal line of Mercury's model is sidereally fixed. The passage is as follows:

> In the 23rd year according to Dionysius, Hydron 29, Stilbon (i.e., Mercury) as morning-star stood three moons to the north of the brightest star in the tail of Capricorn.

The note discusses in turn the identity of Dionysius, his naming convention for months, the identity of the star named in the text, and the calculation of Mercury's ecliptic longitude and latitude on the basis of the observation report.

Dionysius has always been an enigma. This man is only mentioned in the

formula "according to Dionysius" applied to the peculiar calendar dates of seven planetary observation reports in *Almagest* 9.7, 9.10, 10.9, and 11.3. Each date follows the formula "year *x* according to Dionysius, (month) *s*, (day) *d*," where *x* is counted from a year 1 that began close to the summer solstice of 285 B.C.E., and the month bears an artificial name evidently adapted from the name of the zodiacal sign that the sun traverses during most or all of the month. The observations span the interval 272–241 B.C.E., but Ptolemy does not name the observer or observers; they *could* have been made by Dionysius himself, but the formula must not be read as implying this.[1] Since Boeckh it has been generally accepted that the epoch year of Dionysius' calendar was chosen because it overlapped the Egyptian calendar year that Ptolemy Philadelphus counted as his first regnal year, and if this is correct then Dionysius presumably would have worked in Egypt (Boeckh 1863, pp. 286–289). Our scholion specifically locates him in Alexandria, and this pretty clearly reflects a tradition independent of the *Almagest.* On the other hand, the annotator's explanation of the month names and their mapping onto the months of the Alexandrian calendar of Roman Egypt (which is in fact only approximate) could easily be inferences from the information provided by Ptolemy.

The scholion goes on to cite Pappus' *Almagest* commentary for the identity of the star, which is named in the observation report differently from the star catalogue of Books 7 and 8. This is one of several explicit references to Pappus' commentary (of which only the parts pertaining to *Almagest* 5 and 6 survive) in the scholia (Tihon 1976). Pappus was quite capable of working out which stars in the catalogue must have been meant by the names in these observation reports, making use of the data Ptolemy supplies.

The reduction of the observation report to obtain Mercury's longitude is straightforward; however, the annotator also calculates the planet's latitude, which Ptolemy does not use. What is most interesting is that he converts the report's 'moon' (i.e. lunar diameter) into a degree equivalent using an (unnecessarily) precise value for the moon's apparent diameter at mean distance according, not to Ptolemy, but to Hipparchus. Ptolemy's value for the size of the moon's disk at greatest distance at syzygy – and this is the parameter used in scholia explicating other observation reports involving 'moon' – is 0;31,20° (*Almagest* 5.14), and his value at least distance at syzygy is 0;35,20° (*Almagest* 6.5), yielding a mean value of 0;33,20°. According to *Almagest* 4.9, however, Hipparchus believed that the moon's diameter at

mean distance was 360°/650, which would be 0;33,14° to the nearest second, as stated in the scholion. The divergence from Ptolemy's number is astronomically insignificant, but it is odd that an annotator would expressly revert to the Hipparchian parameter.

Text 2: *Almagest* 11.3 (Heiberg 1898–1907, 2.386).
B: 215v. C: 299v. D: 235r.

ὁ Διονύσιος ἀπὸ μεταφορᾶς τῶν ιβ ζῳδίων τοὺς ιβ μῆνας ἐκαλεῖ τριακονθημέρους ὄντας, καὶ τὰς ἡμέρας ἀπὸ τῶν μοιρῶν ὁμοίως ἐν αἷς ὁ ἥλιος ἐτύγχανε μέσως ἔγγιστα. ἦν δὲ αὐτοῦ καὶ τὸ α΄ ἔτος τῶν θερινῶν τροπῶν τῷ $\overline{\upsilon\xi\gamma}$ ἔτει ἀπὸ Ναβονασσάρου.

Translation. Dionysius named the twelve months, which had thirty days, by transference from the twelve zodiacal signs, and likewise (named) the days from the degrees at which the sun was approximately in mean motion. The first year of his Summer Solstices was in the 463rd year from Nabonassar.

Comment. The note pertains to Ptolemy's citation of a single "Dionysian" observation of Jupiter on September 4, 241 B.C.E., which provides the data for his correction of the planet's mean motions.

While the naming of the months of Dionysius' calendar after the zodiacal signs is rather obvious from the several examples in the *Almagest*, the structure of the calendar is not so straightforward a matter (in particular because there are only seven independent dates attested). The annotator's forthright declaration that the months all had thirty days is in agreement with Boeckh's reconstruction, which successfully accounts for all but one of Ptolemy's equations of Dionysian with Egyptian dates (Boeckh 1863, pp. 286–340).[2] I would be surprised if any ancient commentator had deduced uniform thirty-day months from Ptolemy's data following Boeckh's line of analysis, so if it is not a mere guess, it might at least reflect the same understanding of the calendar's operation that Ptolemy had when he translated the dates. Whether the actual Dionysian months were all of equal length is perhaps more doubtful. One consideration that argues the other way is that several of the observations do not best fit the Egyptian dates to which Ptolemy assigns them.

The name 'Summer Solstices' that is applied here and in Text 3 to Dionys-

ius' chronological system is not from the *Almagest*; again it is more likely an independent tradition than the result of analysis of the seven dates in Ptolemy. When the note indicates that year 1 according to Dionysius was in year 463 from Nabonassar, it means that the *beginning* of the Dionysian year (i.e., the summer solstice) fell within the Egyptian year Nabonassar 463, as can easily be checked from the date equivalences in Ptolemy.

Text 3: *Almagest* 11.7 (Heiberg 1898–1907, 2.419).
B: 222v. C: 309v. D: 242r.

Βαβυλωνίων τὸ α΄ πεπληρωμένον ἔτος ἔτη συνάγει ἀπὸ Ναβονασσάρου πλήρη $\overline{\text{υλη}}$, ὥσπερ καὶ Εὐκτήμονος τῆς ἐννεακαιδεκαετήριδος εἰς τὸ α΄ ἔτος συνάγεται ἔτη $\overline{\text{τιε}}$, καὶ εἰς τὸ Εὐδόξου α΄ ἔτος τῆς $\overline{\text{ιθ}}$–ετηρίδος $\overline{\text{τνγ}}$, καὶ εἰς τὸ α΄ ἔτος ἀπὸ τῆς Ἀλεξάνδρου τελευτῆς ἔτη $\overline{\text{υκε}}$, καὶ Διονυσίου θερινῶν τροπῶν εἰς τὸ α΄ ἔτος ἔτη $\overline{\text{υξγ}}$.

> *Translation.* The first completed year of the Babylonians amounts to 438 complete years from Nabonassar, just as there amount to 315 to the first year of the 19-year cycle of Euctemon, and 353 to the first year of the 19-year cycle of Eudoxus, and 425 to the first year from the death of Alexander, and 463 years to the first year of the Summer Solstices of Dionysius.

Comment. The note pertains to Ptolemy's citation of an observation of Saturn on March 1, 229 B.C.E., which is dated "in the 82nd year according to the Chaldeans, (month) Xanthikos 5, in the evening." According to the report, "Saturn was two fingers below the southern shoulder of Virgo." Like two other observations dated "according to the Chaldeans" in *Almagest* 9.7, this has been recognized to be a straightforward translation of a Babylonian report of the passage of a planet close to a Normal Star such as are found abundantly in the Babylonian astronomical Diaries and other related genres of text. The year number is therefore actually according to the Seleucid Era, and the month is a Macedonian schematic counterpart of a Babylonian lunar month.

The scholion notably refers to the era as "of the Babylonians," whereas Ptolemy does not mention Babylonians or Babylon in connection with the three observation reports. All three observations fall so in the Babylonian

and Egyptian calendar years that the difference between the Chaldean era year number and the Nabonassar era year number is always 437, in agreement with the equivalence Chaldean year 1=Nabonassar 438 given in the scholion. In fact the *beginning* of the Babylonian year S.E. 1 fell within Nabonassar 486. Perhaps the person who obtained the equivalence did not know what time of year the Babylonian year began.

The scholion continues with a short list of other cardinal years or eras, not all of which are found in the *Almagest.* The "first year of the 19-year cycle of Euctemon" obviously refers to the summer solstice of 432 B.C.E. associated with Meton and Euctemon (*Almagest* 3.1). This date fell within the Egyptian year Nabonassar 316, in agreement with the scholion's specifying 315 *completed* Egyptian years.

A "19-year cycle of Eudoxus" is entirely novel, and indeed Eudoxus is traditionally associated with the cruder 8-year calendrical cycle. Year 1 of this scheme, according to the scholion, was exactly two 19-year periods after year 1 of the Euctemon cycle, and this was surely deliberate.[3] The year in question, 394/393 B.C.E., would have fallen within or even before Eudoxus' childhood if we accept the common suppositions that Eudoxus died after Plato and at the age of 53.[4]

The "first year from the death of Alexander" is the formula employed in the *Almagest* for what one more commonly speaks of as year 1 in the Era Philip. Since the years in question are Egyptian, there should be no difficulty about whether the beginning or the end of the year is meant. However, Philip 1 is in fact Nabonassar 425, i.e. 424 *completed* years, so that the scholion has slipped into a very common confusion. The same error applies to the equivalence given for year 1 according to Dionysius (see Text 2).

Text 4: *Almagest* 11.7 (Heiberg 2:419).
B: 222v. C: 309v. D: 242r.

τοῦ βορειοτέρου ἀπάνω καὶ τοῦ νοτιωτέρου ὑποκάτω καλοῦντες οἱ Χαλδαῖοι καὶ τὸν πῆχυν ὑπέτιθεν δύο μοίρας ὡς ὁ Πτολεμαῖος ἐν τῷ περὶ παραδόξων φάσεων Ἀφροδίτης ἐπεσημάνατο.

Variant: 2 καὶ om. D

> *Translation.* The Chaldeans, using 'above' for 'to the north' and 'below' for 'to the south,' also set the cubit as 2°, as Ptolemy indicated in "On Venus' Paradoxical Phases".

Comment. The scholion refers to the same Babylonian observation report as Text 3, and is intended to explain the term 'above' as well, perhaps, as the unit 'fingers' (supposing that the reader would recognize that 1 cubit equals 24 fingers, where a 'finger' is a common Greek unit of length).

The scholion is extremely interesting because its reference to Ptolemy writing 'on paradoxical phases' cannot be identified with any passage in the *Almagest*, and indeed nowhere in his surviving works does Ptolemy discuss the magnitude of astrometrical cubits and fingers. To my knowledge no *direct* statement amounting to giving the degree equivalent of the cubit survives in any classical text aside from this scholion.[5]

The 'paradoxical phases' of Venus are without doubt the great variations in the intervals of the planet's invisibility, a topic that Ptolemy deals with in *Almagest* 13.8 together with Mercury's 'missed' phases. Nowhere in the *Almagest*, however, does Ptolemy apply the term 'paradoxical' to these phenomena, and the discussion in 13.8 makes no use of Babylonian observations involving cubits. Nevertheless the expression has a ring of familiarity, because Proclus alludes more than once in the *Hypotyposis* to writings on the 'paradoxical phases of Venus.' For example in one passage (7.18) Proclus writes:

> For also the paradoxical phases of Venus, which Ptolemy recorded (*ἀνέγραψεν*), ought to be referred to the (planet's motion in) latitude – I mean for example the fact that it makes its morning rising fastest after its evening setting close to the beginning of Pisces, with just two days intervening, and likewise in sixteen days in Virgo. And you have these things demonstrated by geometrical methods in the (text) on the paradoxical phases.

This might naturally be taken as a simple allusion to *Almagest* 13.8, and in fact a few pages above (7.9) Proclus makes an express reference to the treatment of the 'paradoxical phases of Mercury' in this chapter. On the other hand Proclus has earlier (1.22) asserted that "entire books have been handed down concerning the paradoxical phases of Venus," which cannot reasonably be taken as a reference to the comparatively brief *Almagest* chapter. The scholion only makes sense if there existed another work attributed to Ptolemy in which the visibility conditions of Venus were treated in some way involving historical observations. I think it is quite plausible that Ptolemy should have

written such a book, more likely before the *Almagest* than after it, and that this work provided a fuller and more empirical discussion of the visibility phenomena and their connection to planetary latitude than we find in the rather bald exposition of *Almagest* 13.

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NOTES

1. The same formula is employed for dates "according to Callippus," where we know that the observer was (say) Timocharis, Aristarchus, or Hipparchus.
2. A more efficient restatement of Boeckh's argument is van der Waerden 1984.
3. Similarly the summer solstice of Aristarchus reported in *Almagest* 3.1 fell in 280 B.C.,

exactly eight 19-year periods after the 432 B.C. solstice, and one of the parapegma fragments from Miletus preserves a summer solstice date in 109 B.C., exactly seventeen 19-year periods after the 432 B.C. solstice – and in fact the inscription expressly drew attention to this interval (see Jones 2000, pp. 150–2 for references and discussion).

4. On the evidence for Eudoxus' date see Waschkies 1977, pp. 34–58.
5. For astronomical uses of cubits and fingers in Greek texts see Neugebauer 1975, pp. 279, 304, 591–2. The data (computed elevations of the celestial pole for terrestrial latitudes associated with given maximum lengths of daylight) from Hipparchus' geographical work in Strabo 2.1.18 and 2.5.42 strongly indicate that Hipparchus considered 1 cubit to be equivalent to 2°.