REFERATE

Darstellungen und Hilfsmittel

DOI 10.1515/apf-2016-0017

Jean-Luc Fournet/Anne Tihon, *Conformément aux observations d'Hipparque: le Papyrus Fouad inv. 267 A* (Publications de l'Institut orientaliste de Louvain, 67). Louvain-la-Neuve: Peeters, 2014. IV+190 S. ISBN 978-90-429-3021-6/978-2-7584-0203-9. 50,00 €.

This fascinating volume is devoted to a single unprovenanced papyrus, consisting of roughly half of a codex leaf. Practically the whole column width is preserved on both sides, but the top and bottom of the leaf are gone, so that we have two passages of just over thirty lines of more or less continuous text separated by a gap of roughly the same length (or less) as either passage. The text comprises examples of various astronomical calculations involving the Sun and referring to a specific date, characterized as a "nativity" (γένεσις), namely AD 130 November 9, which might have been contemporary with the composition or, perhaps more likely, a plausible birthdate for an adult. The elliptical and somewhat incoherent character of the text, together with some serious errors that look authorial, suggest that this is a student's record of lessons that were delivered too rapidly for the writer to keep up. The informal hand can only be roughly dated to the second or third century AD, and is consistent with the hypothesis that the papyrus is an autograph. It is certainly hard to imagine that anyone else in antiquity would have benefited from having a copy of this text, grateful though the modern historian may be for it.

For through the fog of the writer's limited understanding we can discern gleams of precious information about otherwise unattested astronomical theories and practices in the second century. Although approximately contemporary with Ptolemy, the writer, or his teacher, relied not on Ptolemy's works but on other lost astronomical tables that, as can be inferred from their use in the examples, had some points of resemblance to Ptolemy's but also surprising differences; yet the tables for calculating the Sun's position on a given date are said, just as Ptolemy says about his own, to have been founded on the second century BC observations of Hipparchus.

To take one example of the divergences, whereas Ptolemy constructs his solar theory and tables on the basis of a single kind of solar year, the "tropical year" (measured from one solstice to the next of the same kind, but also considered by Ptolemy to be the period of solar anomaly), the tables to which the papyrus refers involved three kinds of year: the tropical year, the sidereal year (the interval between successive conjunctions of the Sun with a star), and a year equalling 365 $^{1}/_{4}$ days whose astronomical meaning is unclear – and disturbingly, in separate calculations both the sidereal and tropical years seem to have been treated as if they were equal to the period of anomaly. (This may have resulted from a misunderstanding on the part of the teacher.) Again, the epoch date of Ptolemy's tables is the Era Nabonassar (in 747 BC, used in the *Almagest*) or the Era Philip (in 324 BC, used in the *Handy Tables*), both being epochs preceding any likely date for which computations might be required but not by an excessive interval. The calculations on the recto of the papyrus are referred *en passant* to the Era Philip, but the actual epoch date of the tables was 37500 ($= 2^2 \times 3 \times 5^5$) Egyptian years *before* the Egyptian year 159/158 BC, in which Hipparchus made some of his solar observations. This type of *aiōn* constituting a numerologically motivated vast period encompassing various astronomical cycles – in the present instance, the three varieties of year (cf. the note below on recto ll. 24–30) – appears to have been the target of Ptolemy's scornful remarks at *Almagest* 3.1 (ed. Heiberg 1.203). The tables employed in the calculations on the verso, however, concerning data dependent on the Sun's position such as the lengths of seasonal hours, were much more like Ptolemy's.

The poor physical condition of much of the papyrus – the verso in particular is badly abraded – combined with the discontinuities of the writer's exposition have made this a very difficult text to transcribe accurately, let alone to understand, but the editors have spared no pains to provide a reliable edition and comprehensive commentary. The format of the commentary is not easy on the user; separate sections are devoted to notes on the text, notes on the translation, astronomical commentary, extended "complementary" notes, and an "annex" by Raymond Mercier (in English) on reconstruction of some of the lost tables and of the underlying solar theory (or rather theories). The deliberative and exploratory approach of the main commentary is suited to a text that contains so much unfamiliar material, but a reader working through the papyrus's text from beginning to end has to consult several parts of the book simultaneously, and sometimes basic information (such as the equivalents of the Egyptian dates in the papyrus according to our chronology) takes longer to find than one might wish. This is the only major criticism I have of this fine work of scholarship on one of the most important new texts relating to ancient science to have come to light in recent years.

Notes on specific passages.

Recto, **l. 10**, ἀπ' ἀρχῆς συντάξεως τοῦ κανόνος is rendered as "depuis le commencement de la table de la *Syntaxe*," and interpreted as an allusion to a presumed treatise called, like Ptolemy's *Almagest*, σύνταξις, which supposedly contained the solar tables used in the examples. This would be harsh grammar even for our writer, whereas the more natural rendering, "starting from the epoch of the table's construction," makes good sense in the context. For a parallel, see Ptolemy, *Almagest* 3.1 (ed. Heiberg 1.208), ἡ σύνταξις τῆς κατὰ μέρος κανονοποιίας.

ll. 18–20. The date of the worked example is given first as Hadrian year 15, Hathyr 11 in the civil calendar, then according to the old Egyptian calendar (on which the solar tables were based) as Choeac 20/21 (κʹ εἰς τὴν καʹ), 9th seasonal hour of the night. The *day* Hadrian 15, Hathyr 11 in the civil calendar was unambiguously equivalent to Choeac 19 in the old calendar (and to AD 130, November 7). The old calendar date in the papyrus, expressed using the standard double-date form for nocturnal dates, is unambiguously equivalent to the night between November 8 and 9, and this is the date actually used in the subsequent calculations. The commentary (pp. 64–65) tries to rescue the date equation by supposing that the writer or his teacher assumed that the civil date Hathyr 11 began with sunset of November 7, so that at least the part after midnight of Hathyr 11, defined in this manner, would fall within November 8. This does not resolve the problem, however, since the old calendar date belongs to the following night, within November 9, and in any case it would mean that the writer perversely considered the daytime that anyone else would have called Hathyr 11 to be Hathyr 10. (The date equation in the horoscope *P.Lond*. 1.130, cited as a parallel, is a straightforward case of the night being counted as belonging to the following day in both the civil Egyptian and the Roman calendar.) I think it is safe to assume that either the civil date was miswritten in the papyrus or the teacher botched the conversion.

ll. 24–30. The calculations of the Sun's mean motion in the middle column of the tabulated calculations, that is, according to the "intermediate" type of year, have an internal inconsistency (noted on pp. 78 and 155) that has prevented the editors from obtaining an exact reconstruction of the underlying mean motion table. Arithmetical consistency with the numbers preserved in ll. 26–30 requires that the first two places in l. 25 (the mean motion in 7000 Egyptian years) must be 75;11 or 75;12 (plus the unwritten 6995 complete circles of 360°). The delta in the reading ọδ is certain, but this has to be a scribal or arithmetical error. (Curiously, another substitution of an erroneous delta for an expected epsilon occurs in the last place of the leftmost column of calculations, l. 29, cf. p. 77.) The second place is read as simply β, but I suspect that a preceding iota has been lost to abrasion. Since the third place in the papyrus is zero, we can adopt a corrected value 75;12,0° for this line. This value, when added to the 6995 complete circles, turns out to be divisible by 7000 to yield an annual mean motion that has a terminating fraction in sexagesimals, 359;45,12,57,36° (decimal 359.7536°), which is the exact basis of the lost mean motion table. From it we can derive the mean motion for 775 years as 169;2,24°, giving us the mostly obliterated final letter in l. 26 as delta (consistent with the trace). We likewise derive the mean motion for 30000 years as 168;0,0° exactly, agreeing with the preserved zero in the final place that is effectively all that remains of l. 24. Finally, if we total the mean motion for the "aeon," 37500 Egyptian years, we obtain exactly 120;0,0° plus 27474 complete circles.

Since the exactly reconstructed mean motion table for the left column of the calculations according to the sidereal year give the total motion for 37500 years as 120;0,0° plus 37473 complete circles (cf. Table I, p. 156), it is clear that the rates of mean motion for both the sidereal and the "intermediate" years were carefully chosen so that over one aeon they would diverge by exactly one circle of 360°. (This relation between the two rates is also strong confirmation that the above reconstruction of the intermediate mean motion table is correct.) Moreover, the mean sidereal motion for one Egyptian year, 359;44,38,24° (decimal 359.744°) is exactly divisible by 365 in sexagesimals so that the daily motion has a terminating value, 0;59,8,9,36°, and this is surely deliberate too. In order to obtain rates of mean motion with these special properties, the author of the tables would have had to accept small alterations in the assumed year lengths; hence the year length implied by the sidereal table is 365 $^{1}/_{4}$ + 1/(102 $^{2}/_{3}$) days where the text at recto l. 7 gives 365 $^{1}/_{4}$ + $^{1}/_{102}$ days, and the year length implied by the intermediate table is a minuscule fraction less than 365 $^{1}/_{4}$ days.

The rightmost column of mean motion calculations, based on the tropical year, has lost most of the lower order digits, but arithmetical consistency sets rather tight bounds for the underlying annual rate of motion, within which the value 359;45,24,28,48° (decimal 359.7568°) would give a total mean motion over the aeon of 37474 complete circles plus 240°, so that the tropical year motion would diverge from the intermediate year motion by exactly a third of a circle. This reconstruction (from which it is possible to restore the lost numerals in lines 24–28) seems practically certain. The implicit tropical year length close to 365 $^{1}/_{4}$ – $^{1}/_{307}$ days, whereas recto l. 5 gave it as 365 $^{1}/_{4}$ – $^{1}/_{309}$ days (p. 77).

In his annex, Mercier has given one reconstruction of the sidereal table in agreement with the known rate of sidereal motion (Table I), two alternate speculative reconstructions of the intermediate table (Tables II and III), and three of the tropical table (Tables IV–VI). Table VI is based on the annual tropical rate of 359.7568° argued for above, although oddly he does not remark on the resulting motion over the entire aeon that provides the strongest reason for adopting it. Neither of his reconstructions of the intermediate table corresponds exactly to the annual rate of 359.7536° deduced above. His table for precession (Table VII) is based on a rate of 1° in 72 $^{1}/_{8}$ years, which is in agreement with Tables I and VI and thus with the correct values for the sidereal and tropical mean motions.

Alexander R. Jones (New York)*

Stefanie Schmidt, *Stadt und Wirtschaft im Römischen Ägypten. Die Finanzen der Gaumetropolen* (Philippika. Altertumswissenschaftliche Abhandlungen. Contributions to the Study of Ancient World Cultures 76). Wiesbaden: Harrassowitz 2014. 320 S. ISBN 978-3-447-10276-6.

Gemeinhin basieren Studien zur Wirtschaft auf universellen Theoriekonzepten, die geographische wie kulturelle Spezifika und Entwicklungen nicht oder nur in sehr unzureichender Weise mit einbeziehen. Diesem bereits seit längerem bekannten Manko versucht die jüngere Wirtschaftsgeschichte zu begegnen, indem sie ihren Fokus auf einen geographisch

* **Kontakt:** Alexander R. Jones, Institute for the Study of the Ancient World, 15 East 84th Street, New York NY 10028, USA, <alexander.jones@nyu.edu>