A Greek Planetary Table

Worp, K.A.; Neugebauer, O.; Sijpesteijn, P.J.

ÉGYPTE GRÉCO-ROMAINE

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RECENTLY the Library of the University of Amsterdam acquired a large collection of items, many of which have script upon them (1). Among them there is a wooden tablet (Tabula Amstelodamensis Inv. No. 1 ; 13.5 × 5.2 cm.). The tablet is fully preserved at the right-hand side and partly so at the top and bottom where we find boarders of 0.7 cm. in width. The tablet is 0.3 cm. thick. Originally the tablet was presumably filled with wax. Remnants of wax are still to be found in several places. The present text, however, has been written directly on the wood. The lines around columns II/III and under line 55 are in red ink. The provenance of the tablet is unknown.

When we finished our transcription of the text, which we dated on palaeographical grounds to the later IIIrd century A.D. (2), we realized that we were dealing with an astronomical text. We therefore consulted the universally acknowledged authority in this field and we are very grateful that Professor Neugebauer sent us the « translation » of and notes on this text.

(1) Cf. our article « *Greek Texts in the Possession of the Amsterdam University Library* », forth-coming in *TAAANTA* 8-9 (1977) 100 ff.

(2) The scribe of this tablet was accustomed to writing. The handwriting may be compared with that of Plates 14 and 50 in E. G. TURNER, *Greek Manuscripts of the Ancient World* (1971).

TAB. AMST. inv. nº 1. IIIrd CENT. A.D.

1 (ἔτους) α Θ]ο̣̣θ̣̣
2]
3]
4]α
5].
6]
7]χ̣
8]δ
9]δ
10]ε̣
11]ς
12]ζ̣
13]η
14]θ̣
15]ι
16].ια
17].α
18].α
19 ι]θ̣ β
20].χ̣
21].δ̣
22]β ε
23 κ]ζ ς
24]κ̣β ζ
25]ιζ η
26]. ιε̣̣ θ
27 <ι> ιγ θ
28 κ ι
29 κθ ια
30 ια β ια
31 κγ ιβ
32 κ̣γ ιβ
33 <ι β> ιη α
34 α α α
35 β ς β
36 α̣ ς γ
37 β η β
38 γ ζ γ
39 δ ιδ δ
40 ε α ε
41 ιη ς
42 ς η ζ
43 ζ ε ς
44 η δ ζ
45 ιη η
46 θ θ θ
47 ιδ ι
48 ι ε ια̣
49 ια ιγ ι
50 ιβ δ ια
51 ι ιβ
52 ε ε α̣
53 (ἔτους) β Θο̣̣θ̣̣
54 α ιζ α
55 ιβ ε α
56 α̣ ια̣ α
57 ιβ κγ α
58 α κα ιβ
59 δ ζ α
60 η α ιβ
61 θ κβ α
62 ια κδ β
63 ιβ ε γ
64 α ς β
65 λ̣ γ
66 β̣ κε δ
67 γ κ ε
68 δ ιη ς
69 ε ιβ ζ
70 ς θ η
71 ζ κα η
72 η ια η
73 θ κ̣ θ
74 ι ιδ θ
75 ια ς θ

Mercury

34	1	1	1	year 1
35	2	6	2	
36	1	6	3	
37	2	8	2	
38	3	7	3	
39	4	14	4	
40	5	1	5	
41		18	6	
42	6	8	7	
43	7	5	6	
44	8	4	7	
45		18	8	
46	9	9	9	
47		14	10	
48	10	5	11	
49	11	13	10	
50	12	4	11	
51		10	12	
52	ε	5	1	

Jupiter

5	[		] 1	year 1
6	[		] 1	
56	1	11	1	year 2
57	12	23	1	

Venus

17	[1		] 1	year 1
18	[2		] 1	
19	[3	1]9	2	
20	[4	14]	3	
21	[5	9]	4	
22	[6]	2	5	
23		[2]7	6	
24	[7]	22	7	
25	[8]	17	8	
26	[9]	15	9	
27	<10>	13	9	
28		20	10	
29		29	11	
30	11	2	11	
31		23	12	
32		23	12	
33	<12>	18	1	
64	1	6	2	year 2
65		30	3	
66	2	25	4	
67	3	20	5	
68	4	18	6	
69	5	12	7	
70	6	9	8	
71	7	21	8	
72	8	11	8	
73	9	20	9	
74	10	14	9	
75	11	6	9	

Mars

7	[		] 3	year 1
8	[		] 4	
9	[		] 4	
10	[		] 5	
11	[		] 6	
12	[		] 7	
13	[		] 8	
14	[		] 9	
15	[		] 10	
16	[		] 11	
58	1	21	12	year 2
59	4	7	1	
60	8	1	12	
61	9	22	1	
62	11	24	2	
63	12	5	3	

Saturn

2	[			]year 1
3	[			]
4	[		]	1
54	1	17	1	year 2
55	12	5	1	

The text in question is a planetary table of a type well known in the Roman imperial period (both Greek and Demotic) (1). It gives for the five planets the dates of entry into the consecutive zodiacal signs. In

(1) Cf. the list given in O. NEUGEBAUER, *Hist. of Ancient Math. Astron.* (1975), II p. 787f.

the present text both months and signs are denoted by numbers from 1 to 12 (1). Example (lines 40 to 43) :

(month) 5	(day) 1	(the planet enters sign) 5
	(day) 18	(the planet enters sign) 6
(month) 6	(day) 8	(the planet enters sign) 7
(month) 7	(day) 5	(the planet returns into sign) 6

At the beginning of a section *a a a* may occur, indicating that the planet was inside of sign 1 at the beginning of the year.

Since we have only a little less than one half of the tablet we may assume that the complete table carried five columns, one year being tabulated in two columns. Hence we have to assume one more « page » of five columns in order to accomodate five whole years. The present tablet began with a year which we call « year 0 » and ended with the first column of year 2.

The planets are arranged in the order Saturn - Jupiter - Mars - Venus - Mercury, in sections clearly marked by separating lines. In our discussion we shall follow the opposite order because we need the longest preserved sections for the determination of basic parameters.

Mercury, year 1 (lines 34 to 52)

The graph reveals many scribal errors. A correct sequence is represented by lines 40 to 45, and 47 to 52. This suffices to determine the position of the sun within very narrow limits.

Most of the remaining lines, however, show many errors :

line	expected	text	
34	1 1 1	same	
35	*1* *16* 2	2 -6 2	
36	*2* *8* 3	*1* *6* 3	
37	*3* *7* 2	*2* *8* 2	
38	3 *27* 3	*3* -7 3	(cf. preceding lines)
39	4 14 4	same	
46	9 *1* 9	9 *9* 9	

(1) Once an epagomenal day occurs (line 52), denoted by *ε*.

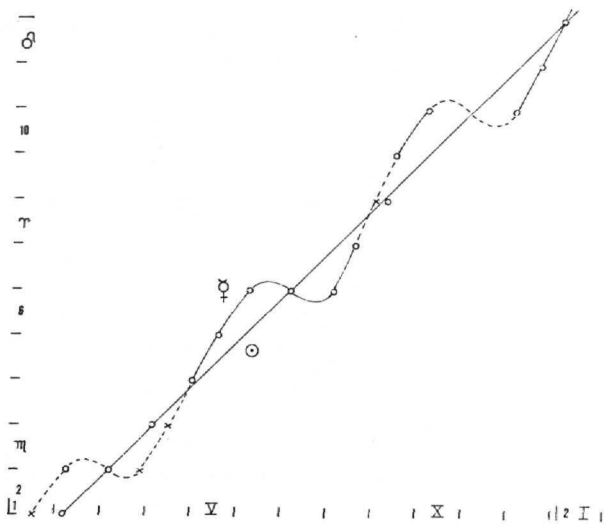

FIG. 1. — Mercury, year 1

Venus, years 1 and 2 (lines 17 to 33, 64 to 75)

The zodiacal sign 1 in the first line (17) is suspect since one should have a retrograde motion in 12. Therefore also the next line (18) cannot be securely restored, though sign 1 is correct. Then follow eight positions (19 to 26) which agree excellently with the linear motion of Venus as morning star. The same holds for the eight positions (lines 33, 66 to 70) for the evening star phase.

Between these two sections lies the region near superior conjunction. There we find six positions listed (27 to 32) where only three entries occur (signs 10, 11, and 12) :

line	expected	text
27	10 *13* 9	0 -3 9
28		20 10
29	29 11	same
30		11 2 11
31	11 23 12	
32		23 12

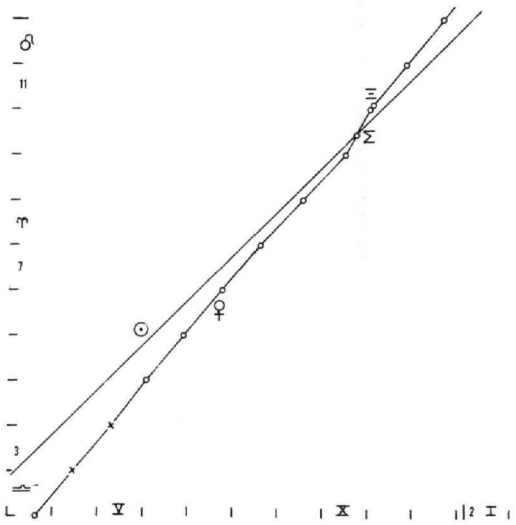

Fig. 2. — Venus, year 1.

The first line at the top of the column (32) repeats the last line from the preceding column (31). But there remain two entries (28 and 30) which cannot represent crossings over into a new sign. The only suggestion I can make is a reference to the phases of the last visibility as morning star, first visibility as evening star. At any rate the graph shows clearly that the transition from morning star to evening star is only artificially connecting two independent branches of computations. This seems to indicate two patterns : one ending at last visibility, the other beginning at first visibility. Such a procedure is quite in line with what we know about the arithmetical templates used for the construction of primitive planetary tables.

A similar situation prevails near inferior conjunction (lines 71 to 74). The last line (75) agrees with the beginning of the next linear section. We have again four entries where one needs only two crossings of boundaries between signs :

line	expected	text
71		7 21 8
72	8 11 *7*	8 11 *8*
73		9 20 9
74	10 14 *8*	10 14 *9*

It is clear that no crossing into a sign is possible at the dates given in lines 71 and 73. These dates could, however, suggest the dates for the first and last visibility, or for stations or maximum elongations. Again the only possible explanation seems to be recognition of phases.

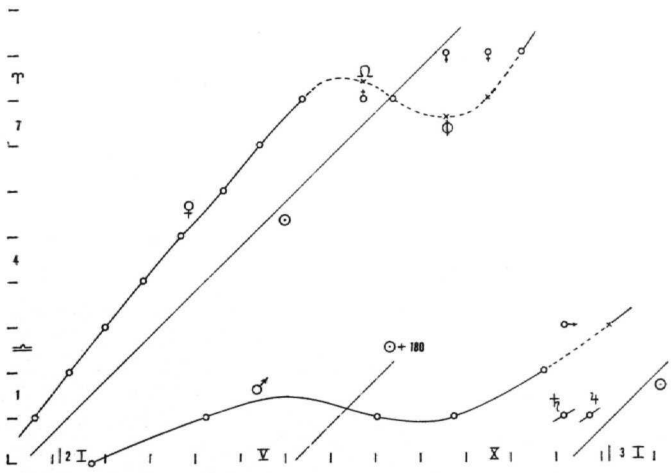

FIG. 3. — Venus, Mars, Saturn and Jupiter, year 2.

Mars, years 1 and 2 (lines 7 to 16, 58 to 63)

For year 1 is not enough preserved to allow any restoration of the dates. In year 2 we find a retrograde arc in agreement with the solar positions resulting from the data of Mercury and Venus. Only the last

entry (63) is an obvious error, giving month 12 instead of the epagomenal days. Hence Mars, Venus, and Mercury represent a consistent set of data.

Saturn and Jupiter, years 1 and 2 (lines 1 to 4, 53 to 55 and 5,6, 56, 57)

All one can conclude from the entries for year 2 is that the two outermost planets must be in near conjunction with each other and with the sun. Consequently both must be in direct motion. But there are serious difficulties with the signs which are always given as α. If the planet enters in direct motion sign 1 in month 12 it cannot have entered it also in the preceeding month 1 nor can the same sign be entered once more even earlier. Hence the data for the two outermost planets are unreliable, a fact which deprives us of the most effective element for the dating of the text.

The first line in the last column (and probably a similar line for year 1 [line 1]) can be combined with the next lines : « Year 2, Thoth, (i.e. month) 1 (day) 17 (entering sign) 1. » (lines 53 and 54)

Dating

The positions of the two inner planets determine within narrow limits the positions of the sun. In this way one finds that « sign 1 » is the sign entered by the sun in month 1. This makes it virtually certain that « sign 1 » is Virgo, a norm also attested in several similar tablets.

If one accepts the positions of Saturn and Jupiter close to the sun in sign 1 one can easily show (1) that only three dates are possible, namely A.D. 94, 153 and 213, 153 being the best. No other dates are possible for many centuries before 94 and after 213.

For none of these dates Mars and the inner planets are in the proper places. Since, however, we have reasons to distrust the data for Saturn and Jupiter one can try to find the proper date for Venus and Mars (2). Since the phases of Venus have a period of 8 years and occur on 5 symmetrically located points of the ecliptic (which rotate very slowly

(1) Using the tables by Tuckerman (Amer. Philos. Soc., Memoirs 59, 1964).

(2) Mercury would only play a role for the sharpening of a good solution found for the other planets.

backwards) one can again determine all dates for which Venus has, e.g., the proper position for its retrogradation in year 2. Since Mars is retrograde in the same year one can exclude many possibilities for Venus and remains with two dates, A.D. 41 and 276. In neither case one has really good agreement but one can consider them at least as remote possibilities. The year A.D. 276 could be « year 2 » of Probus.

Thus we have come to the result that for no year in the historically possible centuries exists an astronomically satisfactory date for our table (1).

Brown University O. NEUGEBAUER
University of Amsterdam P. J. SIJPESTEIJN - K. A. WORP

(1) Attention should be drawn to the spelling *Θόθ* (lines 1 and 53) which is most unusual and for which we have not found a parallel.