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AN ASTRONOMICAL TABLE FROM MEDINET MADI (NARMUTHIS)*

Narmuthis 4.7 by 8.3 cm 2nd century?

The fragment, apparently broken on all sides (though the badly frayed top 2 cm may contain some margin), is written in black ink in a black tabular framework; the back is blank. Two columns are preserved, containing (i) names of zodiacal signs, sometimes abbreviated, and (ii) numerals. A double ruling to the right of col. ii probably indicates that any further columns lost to the right contained a separate set of data.

	i	ii	
	Κ̣ρ̣ι̣ο̣ῦ̣	[η] κ̣ [¯]	
	Ταύ̣ρ̣ο̣υ̣	κ̣η κ̣ [¯]	
	Καρκί(νου)	ϛ μ [¯]	
	Λέον(τος)	ϛ μ ¯	
5	Παρθέ(νου)	ιδ ις μ	
	Ζυγοῦ	κα ϛ μ	
	[Τοξότ(ου)]	[κ] ¯ ¯	
	[Ἰχθύων]	[ιβ ε] ¯	
	[Ταύρου]	[ι ν] ¯	

5. ιδ ις μ: error for ια ϛ μ

* [Il frammento (*P. Narm.* 22.11.1998) è stato recuperato il 22 novembre 1998 nel corso dello scavo condotto a Medinet Madi dalle Università di Pisa e Messina. Si ringrazia Edda Bresciani e Rosario Pintaudi per l'edizione in questa sede].

This is a specimen of an "epoch table", a list of computed positions and dates of a particular phenomenon of one of the heavenly bodies[1]. The preserved columns give the position (longitude) of the heavenly body expressed in the normal way as zodiacal sign, degrees, and sexagesimal fractions of a degree (minutes and seconds of arc). Other lost columns, probably to the left, gave the year, month, and day of the corresponding occurrences of the phenomenon, probably in the Egyptian calendar.

The heavenly body can be identified by the intervals of longitude ("synodic arcs") from one phenomenon to the next. In this table the longitude progresses from line to line by from one to three zodiacal signs. This is characteristic of Mars, which has a mean synodic arc of approximately 409°, i.e. one full revolution around the zodiac plus 49°.

All previously identified epoch tables for the planets were found at Oxyrhynchus[2]. Like the planetary tables from Oxyrhynchus, this one was computed using a version of a Babylonian arithmetical method or algorithm for calculating the longitudes and dates of the phenomena[3]. The best attested Babylonian algorithm for Mars' phenomena is the one known as System A, which was used to compute the planet's first and last visibilities and first stationary points. In System A, the synodic arc is functionally dependent only on the planet's longitude. For example, for any phenomenon occurring in Cancer, the synodic arc is 30°. The fact that from line 3 to line 4 of our papyrus the longitude progresses exactly 30° suggests a connection with System A. However, the remaining longitudes cannot be generated by the System A rules.

The explanation turns out to be that our papyrus tabulated occurrences of one of the other phenomena of Mars that was not computed directly using System A. These phenomena are acronychal rising (i.e. rising at sunset, close to opposition with the sun), and second stationary point. In Babylonian tables for Mars, the longitudes of these phenomena were calculated by a so-called retrogradation scheme that yielded the progress (or actually regress, since the planet is moving retrograde between the two stationary points) since the first stationary point as a function of the longitude at the first stationary point.

Our papyrus fragment does not preserve any of the longitudes of the first stations, but by trial and error one can look for a sequence of first

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[1] Jones 1999a, v. 1, 35-37 and Jones 1999b, 305-310.

[2] *P. Oxy. astron.* 4152-4161 in Jones 1999a; *PSI* inv. 1-2 in Jones 2007.

[3] Neugebauer 1955, v. 2, 279-315 and Jones 1999a, v. 1, 17-33.

stationary points from which the longitudes in the papyrus could have been computed using either a known Babylonian retrogradation scheme or some other simple rule. There seems to be only one plausible solution to this problem: the longitudes in the papyrus were derived by subtracting a constant 6;40° from the longitudes of the first stationary points. This is a simpler rule than any of the Babylonian schemes. The constant is too small to describe the entire retrogradation from first to second stationary point (which varies from about 11° to about 20°), and thus our longitudes must be acronychal risings. The following table gives the reconstructed sequence of first stationary points along with the resulting acronychal risings. The only discrepancy with the papyrus is in line 5, where the scribe must have misread an alpha as a delta followed by an iota[4].

	First stationary point		*Acronychal rising*
Line	*Synodic arc*	*Longitude*	*Longitude*
1		Aries 15°	Aries 8;20°
2	50°	Gemini 5°	Taurus 28;20°
3	38;20°	Cancer 13;20°	Cancer 6;40°
4	30°	Leo 13;20°	Leo 6;40°
5	34;26,40°	Virgo 17;46,40°	Virgo 11;6,40°
6	40°	Libra 27;46,40°	Libra 21;6,40°
7	58;53,20°	Sagittarius 26;40°	Sagittarius 20°
8	82;5°	Pisces 18;45°	Pisces 12;5°
9	58;45°	Taurus 17;30°	Taurus 10;50°

Mars repeats its acronychal rising at roughly the same longitudes every 32 or 47 years. Within the first two centuries of our era, the longitudes in our papyrus agree reasonably well with Mars' actual acronychal rising in A.D. 32-49, 79-96, 111-128, and 158-175. The fit for this latest range of dates is perhaps the best; the following table compares the approximate sidereal longitudes of Mars' acronychal risings for these years with the longitudes in the papyrus[5]:

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[4] In a separate article I intend to discuss at a more technical level the retrogradation scheme of this papyrus and the related *P. Oxy. astron.* 4159a.

[5] Dates are those on which, at midnight at Alexandria, the sun was closest to 176.5° east of Mars, which is the mean elongation of Mars' acronychal risings in Babylonian observational texts; see Hollywood & Steele 2004, 152. Longitudes have been converted from

Date	*Longitude (modern theory)*	*Longitude (papyrus)*
158 Sept. 23	Aries 5°	Aries 8;20°
160 Nov. 11	Taurus 26°	Taurus 28;20°
162 Dec. 19	Cancer 4°	Cancer 6;40°
165 Jan. 21	Leo 8°	Leo 6;40°
167 Feb. 26	Virgo 13°	Virgo 11;6,40°
169 April 8	Libra 24°	Libra 21;6,40°
171 June 8	Sagittarius 23°	Sagittarius 20°
173 Aug. 27	Pisces 10°	Pisces 12;5°
175 Oct. 26	Taurus 8°	Taurus 10;50°

References

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tropical to sidereal by adding 3°, which is approximately correct for papyrus tables of this date; see Jones 1999a, v. 1, 343.