

Two Newly-discovered Astrolabes from ‘Abbasid Baghdad

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Abstract

This is the first description of two complete astrolabes from ‘Abbāsīd Baghdad. One is by the enigmatic but prolific Naṣṭūlus and datable ca. 900-930, and the other is the first known instrument of Aḥmad al-Muhandis, datable ca. 875. Both instruments and two additional incomplete ones also described here, are fully in the tradition of Abbasid astrolabes, of which close to two dozen, not all complete, are now known and published.

In the 8th, 9th and 10th centuries the scientific centre of the world was Baghdad, and the language of science Arabic. For the activities of the makers of astronomical instruments there in the late 8th, 9th and early 10th centuries we are fortunate to have a list of the names of the principal players by the late-10th-century bibliographer Ibn al-Nadīm.¹ Foremost amongst the makers in the early period was perhaps the enigmatic Naṣṭūlus, active in Baghdad from ca. 900 to ca. 930, known by two astrolabes preserved in Kuwait and Cairo. Undoubtedly the most spectacular instrument, a veritable scientific work of art, was that of the astronomer al-Khujandī, made in 984-5.

¹ *In Synchrony with the Heavens – Studies in Astronomical Timekeeping and Instrumentation in Medieval Islamic Civilization*, 2 vols., Leiden: Brill, 2004-05, II, pp. 453-455.

The earliest instruments are distinguished by their low thrones with two holes, a set of star-pointers for 17 stars on the rete, a set of plates for the seven climates (*iqḷīm*)² to make the instrument universal, no markings on the back beyond an altitude scale and an inscription and a broad alidade. Later instruments had plates for a series of latitudes and various trigonometric markings on the back.³ Those invented in Baghdad in the 9th century included the shadow square and the sine quadrant, as well as the universal horary quadrant. Towards the end of the 10th century instruments of the sophistication and beauty of al-Khujandī's astrolabe were being produced.

In 2005 I published all the 'Abbāsīd astrolabes known to me at the time, some 19 pieces altogether, not all complete.⁴ In 2008 I published another, very remarkable instrument by Naṣṭūlus: a dial relating the altitude of the sun to the time of day for the whole year.⁵

I now present two more complete 'Abbāsīd astrolabes with kūfī inscriptions that have come to light yet more recently in a private collection in Switzerland. I am grateful to the owner for allowing me to publish them and to David Sulzberger for providing digital images. Each of the pieces is so small that it could hardly have served as a serious observational instrument. However, astrolabes were as much collectors' items as practical tools. These pieces usefully supplement the corpus previously known. There is no reason to suppose they were made anywhere other than Baghdad.

A "new" astrolabe by Naṣṭūlus

The first piece (A) is a third astrolabe by Naṣṭūlus, signed in his usual way on the back of the throne, simply *ṣana'ahu Xaṣṭūlus*, "made by Naṣṭūlus",

² On the seven climates see *ibid.*, II, pp. 925-932. The climates are defined in terms of the lengths of longest daylight, increasing 13^h, 13;30, ... , 16. The corresponding latitudes are dependent on the obliquity of the ecliptic and therefore change with time.

³ On the latitudes of early Eastern and Western Islamic astrolabes see *ibid.*, II, pp. 915-962.

⁴ *Ibid.*, pp. 402-544. On the latitudes of the plates see also *ibid.*, pp. 948-950.

⁵ "An instrument of mass calculation made by Naṣṭūlus in Baghdad ca. 900", *Suhayl – International Journal for the History of the Exact and Natural Sciences in Islamic Civilisation* (Barcelona) 8 (2008), pp. 93-119 (available on the internet at www.ub.edu/arab/suhayl/).

where X is unpointed and could be read N or B.⁶ The piece is 7.6 cm in diameter, which is considerably smaller than his other known astrolabes (Kuwait: 17.3 cm, Cairo: 13.0 cm). However, we have already one 8th-century astrolabe of only 8.5 cm.⁷ The thin back is soldered onto the ring of the mater, fitting perfectly. The throne is low and has two holes and a crenulated edge; the suspensory apparatus, consisting of a horse-shoe-shaped ring and a circular one, is original. The rim of the mater is divided clockwise for each 5°, subdivided for each 1° and labelled for each 5° up to 360°. The inside of the mater is not engraved, and there is a small notch at the bottom to accommodate the two plates.

The plates serve latitudes 31°/32° and 33°/34°, and are engraved with altitude circles for each 6°. They have a cut-out at the bottom to fit on the notch on the mater. There are no missing plates. The value 33° was standard for Baghdad, at least amongst instrument-makers, even al-Khujandī, even though better values were circulating amongst the astronomers.

The rete is in the standard style of ‘Abbāsīd astrolabes. It has a handle on the lower left rim. The names of the signs of the zodiac are standard, with *al-samaka* for Pisces, as on virtually all ‘Abbāsīd astrolabes (see below for an exception). There are pointers for 17 stars, the standard number, and these are named as follows, counter-clockwise from the vernal equinox on the left: *al-ghūl* / *al-dabarān* / *al-‘ayyūq* / *rijl al-jawzā* / *mankib al-jawzā* / *al-yamāniya* // *al-sha’miya* / *qalb al-asad* // unlabelled [*al-simāk al-rāmiḥ*] / *al-fakka* / *qalb al-‘aqrab* / *ra’s al-ḥawwā* // *al-wāqī* / *al-ṭā’ir* / *al-dajāja* / *mankib al-fāras* / unlabelled [*al-khaḍīb*].

The rim of the upper back bears two altitude scales for each 5°, subdivided for each 1° and labelled for each 5° up to 90° at the top. It also is marked with the “shadow” of the alidade, which is original. The latter is relatively wide and bears a scale marked and labelled for each 5 units up to 60 on each half,

⁶ *Nasṭūlus* was the name of Muḥammad ibn ‘Abdallāh or Muḥammad ibn Muḥammad, so there is no doubt that he and his father were Muslims. The N seems certain, not least because it would somehow associate *Nasṭūlus* with the Nestorian Christians, *al-nasṭūriyyin*. *Basṭūlus*, which one might be tempted to derive from Greek *apostolos*, raises too many questions. On the whole issue, see further *In Synchrony with the Heavens*, II, pp. 471–473.

⁷ On the size of ‘Abbāsīd astrolabes see *ibid.*, II, p. 422. On 10th-century Buwayhid astrolabes the size of a *ḍinār* see also Mohamed Abu Zayed, David A. King and Petra Schmidl, “From a heavenly Arabic poem to an enigmatic Judaeo-Arabic astrolabe”, *Suhayl* 10 (2011), pp. 85–142, especially pp. 89–91 (available on the internet at www.ub.edu/arab/suhayl/).

as well as markings for the seasonal hours for a universal sundial. The fiducial line is the bisector of the alidade, and each of the two crenulated sights has a hole aligned with that axis. The pin and wedge are modern replacements. The workmanship is first class, especially for such a small instrument. The state of conservation is excellent.

We now have three astrolabes by Naṣṭūlus, of which this example is the most complete because the Kuwait piece lacks the alidade and the Cairo piece is just the mater.



Fig. A1: The front of Naṣṭūlus' "new" astrolabe.



Fig. A2: The back with the alidade.



Fig. A3: The signature.



Fig. A4: The plate for 33°, which would serve Baghdad.

An astrolabe by Aḥmad al-Muhandis

The second (B) is a similar astrolabe that is probably a few decades older than the first. It has a diameter of 6.8 cm. The thin back is perfectly welded to the ring of the mater. The rim on the front and also the entire back have suffered considerably from corrosion, and the inscription on the upper right rim is just legible. It reads: *ṣana 'ahu Aḥmad al-Muhandis*, "made by Aḥmad al-Muhandis". The title *muhandis* means geometer or engineer. This man is not mentioned by Ibn al-Nadīm, but another who was surely his son is listed: 'Alī ibn Aḥmad al-Muhandis. Like Naṣṭūlus, 'Alī is stated to have been an apprentice (*ghulam*) of Khafīf, who was himself an apprentice of Aḥmad ibn 'Isā. This last is datable to ca. 850, so that Khafīf would be ca. 875 and 'Alī would be ca. 900, like Naṣṭūlus in his earliest phase. Thus Aḥmad al-Muhandis is datable ca. 875, a couple of decades before Naṣṭūlus. No other instruments are known by him or his son.



Fig. B1: The signature of the astrolabe by Aḥmad al-Muhandis.



Fig. B2: The front of the astrolabe.



Fig. B3: The plate for latitude 36°.

The rim of the mater is divided clockwise for each 5° , subdivided for each 1° and labelled for each 5° up to 360° . The mater itself bears no original markings and there is a protruding knob at 1.8 cm below the centre to fix the plates in position. There is, however, a “shadow” of the plate for 33° skew on the mater.

The two plates serve latitudes $30^\circ/36^\circ$ and $33^\circ/42^\circ$ and there are altitude circles for each 6° . Each has a hole below the centre to fit on the protrusion of the mater.

The rete is in the same style as that of A, with a small handle at the bottom. The names of the signs on the ecliptic ring are standard, now with *al-ḥūt* for Pisces. There are pointers for 13 named stars: *al-‘ayyūq* / *al-dabarān* / *rijl al-jawzā* / *yad al-jawzā* / *al-yamāniya* // *al-sha‘miya* / *qalb al-asad* // *al-rāmiḥ* / *qalb al-‘aqrab* // *al-wāqi‘* / *al-tā‘ir* / *mankib* / *al-khaḏīb* (no pointer – position of star is on horizontal bar).

The markings on the back appear to have been an altitude scale on the upper left, divided for each 5° , subdivided for each 1° and labelled for each 5° , and the inscription on the upper right. The alidade is original and its “shadow” is found in the back. Its markings can no longer be discerned. The pin and wedge are original and the latter is split at one end to achieve a slight spring effect enabling it to fit securely.

The quality of the workmanship is excellent but slightly less so than that of *Nasṭūlus*.

A solitary plate

All that remains of a third ‘Abbāsīd astrolabe (C) is a single plate of diameter 6.2 cm (the plates on A and B are respectively 6.4 and 5.1 cm in diameter). This bears on its two sides markings for the second and third climates (*iqlīm*), stated to correspond to latitudes 24° and 30° . For Ptolemy’s value of the obliquity, $23;51^\circ$, as used by the ‘Abbāsīd astrolabists (with the exception of al-Khujandī), the latitudes of these climates with lengths of longest daylight 13;30h and 14h are actually $23;49^\circ$ and $30;21^\circ$. However, on the plates daylight is given as 13;1h and 14h. Now for latitudes 24° and 30° with obliquity $23;51^\circ$ the lengths of daylight are actually 13;31h and 13;58h. It appears that our astrolabist has mistakenly engraved “1” (alif) instead of “31” (lām-alif). (Alternatively, we could propose that the information was based on the Indian value of the obliquity, 24° , with which the latitudes would be $23;40^\circ$ and $30;10^\circ$; however, this obliquity is not attested on other early ‘Abbāsīd astrolabes.) The markings on the side for latitude 24° are

much worn and are only partially visible. Altitude circles are engraved on both sides for each 10°. The quality of workmanship is again excellent.

From textual evidence we know that Greek astrolabes had markings on the mater and three plates for the seven climates in order to make the instrument universal. The sole surviving Byzantine astrolabe, dated 1062, has markings for two of the climates. The earliest known Islamic astrolabe, from the 8th century, has plates for the seven climates. Also a 13th-century Yemeni astrolabe has a spurious 'Abbāsīd plate serving two climates.⁸



Fig. C1: The side of the plate for the third climate, corresponding to latitude 30°.

⁸ See *In Synchrony with the Heavens*, II, pp. 421, 428, 930, 948, 950.

A later astrolabe in the ‘Abbāsīd tradition

All that remains of an astrolabe in the ‘Abbāsīd style (D), but a far later production, possibly 12th or 13th century, is a mater of diameter 9.6 cm and a single plate of diameter 9.1 cm. The throne is distinctly ‘Abbāsīd in style. There are two more plates of the same size but engraved in a less elegant hand. The scale on the rim of the mater is distinguished by the small circular indentations at each 5°. There is a circular peg below the centre of the mater to accommodate the plates. The back has no markings other than the altitude scales – again a feature of some early ‘Abbāsīd astrolabes – with the same kind of indentations.

The one plate which may be original – simply because it looks older than the others and is more competently engraved – bears on one side markings for latitude 45°, with daylight stated as 15;19h, and altitude circles for each 6°. Daylight for latitude 45° is actually 15;30h for obliquity 23;51°. Daylight 15;19h corresponds to latitude 43;30° (accurately 15;18h).

On the other side there is an elaborate set of horizons. The declination scales are marked 6°-12°-18°-24°, which justifies our assumption that the maker favoured obliquity 23;51°. There are horizons for latitudes:

17°	25	33	41	49	57
19°	27	35	43	51	
21°	29	37	45	53	
23°	31	39	47	55	

an arrangement that assures that all latitudes between 17° and 57° are represented. In addition, we find markings for latitude 66;30°, suggesting a value for the obliquity of 23;30°, corresponding to the 14th century or later, with maximum daylight 24h. Furthermore, there are horizons for latitude 72°, “where Aries rises before Pisces in reverse”, with maximum daylight 75;16d, and latitude 84°, “where Taurus rises before Aries in reverse”, with maximum daylight 113d. Although horizon plates were first devised by the astronomer Ḥabash in the 9th century, plates with additional (and superfluous) information on higher latitudes are typical of the al-Kirmānī productions of the 14th century.⁹

⁹ *Ibid.*, II, pp. 761.



Fig. D1: The front of the astrolabe in the 'Abbāsīd tradition, showing the throne, the rim and the plate for latitude 45°.

The two additional plates are less carefully engraved. One bears markings for Baghdad, latitude 33°, daylight 14;13h (accurate for obliquity 23;51°), on

one side, and latitude 36° , daylight 14;30h (accurate), on the other. The markings on the other are for Mecca, latitude 21° , daylight 13;30h (accurately 13;18h; for 24° , daylight is 13;31h), and latitude 25° , with again daylight 13;30h (should be closer to 13;35h). All that can be said about the date of these components is that they are certainly post-‘Abbāsīd.

The alidade is original; it is wide in the tradition of Naṣṭūlus and has no markings other than a fiducial axis down the middle. The two sights have each a small hole near the top and a larger hole below, larger on one sight than on the other. The pin and wedge, both simple, could be original.

With these instruments, recovered only during the past few years, the corpus of known ‘Abbāsīd instruments has been extended. Who can imagine what other treasures of this kind await to be unearthed in private collections in the eastern Islamic commonwealth. In the meantime we await with anticipation some news on the oldest of these pieces, from the 8th century, which was formerly in the Archaeological Museum in Baghdad.¹⁰

¹⁰ Described in detail from defective photographs *ibid.*, II, pp. 403-437.