

From a Heavenly Arabic Poem to an Enigmatic Judaeo-Arabic Astrolabe

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Abstract

Since the sole surviving astrolabe with engraving in Judaeo-Arabic came to light at an auction in 1988 the inscription on the rim has troubled researchers for it appeared to make little sense. We show here that the inscription is a corrupt version of a 10th-century poem compiled by the astronomer-mathematician-poet Abū Iṣḥāq Ibrāhīm al-Ṣābi' for the ruler 'Aḍud al-Dawla when the scholar presented him with an astrolabe; this poem appeared in several manifestations between Baghdad and al-Andalus over the centuries, of which our astrolabe presents the most distorted version. There is also a problem with the plates, the latitudes underlying the markings often being at variance with what is stated on them. The difficulty of dating the astrolabe and assigning it to either of al-Andalus or the Maghrib is discussed.

The astrolabe is an icon of the universe. It is a two-dimensional model of the three-dimensional universe that one can hold in one's hand or put in one's pocket.¹ Many medieval astrolabes are objects of great beauty; they

¹ On the astrolabe in the Islamic context see the articles "Aṣṭurlāb" by Willy Hartner in *Encyclopaedia of Islam*, 2nd edn., and "Astrolabes, Quadrants and Computing Devices" by D. A. King in *Encyclopaedia of Islam*, 3rd edn., also King, *In Synchrony with the Heavens*,

are in fact scientific works of art. It is hardly surprising that over the centuries they have occasionally inspired poets.

Our study begins with a tiny astrolabe and a brief poem from the rich cultural scene of late-10th-century Baghdad and concludes with a larger astrolabe from the days of limited *convivencia* between Arabs and Jews in al-Andalus ca. 1300.² The latter piece is engraved with a Judaeo-Arabic inscription that has troubled scholars for some 20 years. In fact, for the three authors, that inscription, once understood, opened the door to the story of the much earlier astrolabe from the Islamic East. In this paper we tell our story the other way round, that is, in chronological order. For reasons that we hope will become clear to the reader, we first investigate the poem in minute detail.

1. Abū Ishāq Ibrāhīm al-Šābi' and his gift of an astrolabe and a poem to 'Aḍud al-Dawla

The Būyid ruler (*amīr al-umārā*) 'Aḍud al-Dawla was a liberal, though exacting, patron of the learned and of poets, and compiled poetry himself. As Joel Kraemer has written, “under his vigorous rule the age of the Renaissance of Islam reached its resplendent summit”.³ Born at Isfahan in 324 H [= 936] he became ruler of Fārs in 338 H [= 944] and received the *laqab* 'Aḍud al-Dawla in 351 H [= 962]. He was a staunch Shī'ī and erected a tomb over the grave of Imām 'Alī at Najaf and a shrine over the grave of Imām al-Ḥusayn; he himself was buried nearby. By the time of his death in 372 H [= 983] he ruled most of Southern Iran and also the province of al-'Irāq. His court in Shiraz was the world of poets as renowned as the transient al-Mutanabbī and established astronomers such as 'Abd al-Raḥmān al-Šūfī.

XIIIa, on astrolabes as historical sources. On the astrolabe in the Jewish context see Gandz, “The Astrolabe in Jewish Literature”, and the various studies on astrolabes with Hebrew inscriptions listed in Appendix C. On medieval European astrolabes see King, *Astrolabes from Medieval Europe*.

² *Convivencia* is the title of an exhibition on Jews, Muslims and Christians in medieval Spain that was held in New York in 1992: see *New York 1992 Exhibition Catalogue*. We use the term al-Andalus to refer to that part of the Iberian Peninsula that was under Muslim domination at any given time.

³ See the articles “‘Aḍud al-Dawla” by H. Bowen, and “Buwayhids or Būyids” by Cl. Cahen in *Encyclopaedia of Islam*, 2nd edn.; also Kraemer, *Humanism in the Renaissance of Islam*, pp. 272-285.

Abū Ishāq Ibrāhīm ibn Hilāl al-Šābi' was a member of a distinguished family of Sabians which had been influential in scholarship since the days of the celebrated Thābit ibn Qurra in 9th-century Baghdad.⁴ Born in that city in 313 H [= 925], he is well known to Arab scholarship, medieval and modern, for his letters and poems: he was a very prolific poet, so that, for example, the published version of al-Tha'ālibī (see below) has some 70 pages of his verse. Abū Ishāq is also well known to the history of Islamic mathematics for his impressive correspondence with his colleague in Shiraz, Rustam ibn Wayjān al-Qūhī.⁵ He worked in Baghdad at the court of the Abbāsīd Caliph al-Mu'ī' and of the Būyids Mu'izz al-Dawla, 'Izz al-Dawla, 'Aḍud al-Dawla, Ṣamṣām al-Dawla and Bahā' al-Dawla. He never converted to Islam, even when 'Izz al-Dawla tempted him with the office of *wazīr*. He fell out of favour with 'Aḍud al-Dawla as a direct result of inter-family strife amongst the *amīrs*, and was imprisoned by the *wazīr* al-Muṭahhar ibn 'Abdallāh in 367 H [= 978]. 'Aḍud al-Dawla ordered his release on November 24, 371 H [= 981],⁶ and Abū Ishāq died in 384 H [= 994].

It is already known that Abū Ishāq made astronomical instruments for Qābūs ibn Wushmagīr, Ziyārid ruler of Ṭabaristān and Jurjān.⁷ In particular, he made a plane astrolabe, a spherical astrolabe and an armillary sphere. We are in the dark as far as the details of where he made them and how they were conveyed to Qābūs.⁸ Our poet also gave that ruler a present of seven pens (*aqlām*), with three lines of poetry likening them to the seven geographical climates (*aqālīm*).⁹ Abū Ishāq made a little astrolabe for 'Aḍud al-Dawla, which he presented together with three lines of poetry – this we shall discuss below. He further gave the *amīr* an astronomical

⁴ See Sezgin, *GAS*, II, p. 592, also pp. 595 and 627, and V, p. 314, and the article "al-Šābi', 7. Abū Ishāq Ibrāhīm" by F. C. de Blois in *Encyclopaedia of Islam*, 2nd edn., and p. 673 for his family tree. A useful overview of his life is Madelung, "Abū Ishāq al-Šābi'", esp. pp. 17-19, with references to the primary sources and earlier secondary sources (Chwolson, Bürgel and Khan).

⁵ Berggren, "The Correspondence of Abū Sahl al-Kūhī and Abū Ishāq al-Šābi'".

⁶ Madelung, *op. cit.*, p. 18.

⁷ See the article "Qābūs ..." by C. E. Bosworth in *Encyclopaedia of Islam*, 2nd edn.

⁸ Sayılı, *The Observatory in Islam*, p. 158, quoting Bahā' al-Dīn ibn Isfandiyār, *Ta'rikh-i Ṭabaristān*, I, pp. 144 and 146, also Charette, "Locales", p. 133.

⁹ See, for example, Yāqūt, *Mu'jam al-udabā'*, Cairo, ca. 1936-38, XVI, p. 225.

handbook with tables (*zīj*)¹⁰ and a treatise on geometry (*risāla handasiyya*),¹¹ neither of which has survived. It is also known that ‘Aḍud al-Dawla was the recipient of other instruments: ‘Abd al-Raḥmān al-Šūfī made a silver celestial globe for him,¹² and ‘Abd al-Jalīl al-Sijzī mentions several non-standard astrolabes that he made for his patron.¹³ Also, Abū Ishāq presented an astrolabe for ‘Aḍud al-Dawla’s son, Šamsām al-Dawla, which was also accompanied with a poem.¹⁴

Our story took place at a festival, referred to in the poem as *Mihrajān ‘aẓīm*, “the great festival”. Perhaps this was the autumn festival of *Mihrajān*, the old Iranian festival, falling in autumn on Mihr 16, and corresponding to *Nawrūz* in the spring.¹⁵ Or perhaps it was the (lesser? certainly lesser known) festival of *Mihrajān ‘aẓīm*, falling on Mihr 21.¹⁶ Or maybe it was simply a large celebration, and here the birthday of ‘Aḍud al-Dawla in the *solar* calendar comes to mind, for it is recorded that on this day he organized sessions with astrologers and poets, as well as his highest functionaries, and received presents restricted to one gold *dīnār* and one silver *dirham*.¹⁷ It should be borne in mind that the notion of *taḥwīl al-sana*, the change from one solar year to the next, determined by the moment of birth of an individual, was of prime importance for astrological reasons.¹⁸

¹⁰ al-Tha‘ālibī, *Yatīmat al-dahr*, 1934 edn., II, p. 255. On *zīj*es see the article “Zīj” by D. A. King & J. Samsó in *Encyclopaedia of Islam*, 2nd edn. (A survey of over 250 *zīj*es compiled between the 8th and the 19th century is being prepared by Dr. Benno van Dalen.)

¹¹ al-Tha‘ālibī, *ibid.*

¹² Sayılı, *op. cit.*, pp. 106-107; the article “al-Šūfī” in *DSB* by Paul Kunitzsch; and Charette, “Locales”, p. 133.

¹³ Charette, *Mathematical Instrumentation*, pp. 66-67 and 73, and *idem*, “Locales”, p. 133.

¹⁴ al-Tha‘ālibī, *Yatīmat al-dahr*, 1934 edn., II, pp. 257-258.

¹⁵ *Mihrajān* was celebrated in those Muslim societies with Iranian connections up to the Mongol invasions of the mid 13th century. See the article “Mihradjān” by J. Calmard in *Encyclopaedia of Islam*, 2nd edn., esp. pp. 18-19, also the article “Nawrūz” by R. Levy / C. E. Bosworth. See also al-Bīrūnī, *Chronology*, pp. 222-223 (Arabic), 207-209 (English).

¹⁶ *Ibid.*, pp. 223 (Arabic), 209 (English). In his introduction to astronomy and astrology al-Bīrūnī calls this *al-mihrajān al-akbar*: see al-Bīrūnī, *Astrology*, pp. 181-182.

¹⁷ al-Tanūkhī, *Nishwār al-muḥāḍara*, pp. 88-92, esp. p. 92. On the coinage see the articles “Dīnār” and “Dirham” by George C. Miles in *Encyclopaedia of Islam*, 2nd edn.

¹⁸ Numerous “nativity books” have been preserved, containing astrological predictions for each annual *taḥwīl* for certain rulers, and there is a growing corpus of studies on this corpus of literature. See Elwell-Sutton, *The Horoscope of Asadullāh Mīrzā*, and “A Royal Tīmūrid Nativity Book”; Keshavarz, “The Horoscope of Iskandar Sultan”; Burnett & al-Hamdi, “Zādānfarrūkh al-Andarzaghar on Anniversary Horoscopes”; and Tourkin, “Medical Astrology in the Horoscope of Iskandar-Sultān” and “A Royal Safavid Nativity Book”.

‘Aḍud al-Dawla also introduced two (surely minor) festivals of rather local significance.¹⁹

We may presume that the Būyid rulers held some kind of special audiences on the *yawm al-mihrajān*, in order both to receive gifts and to grant favours. As Ann Lambton wrote in 1994: “References to gifts to the ruler at festivals in the Būyid period ... are rare. But it is likely that such gifts were given and received.”²⁰ The astrolabe and poem of Abū Ishāq provide a perfect example, but it is not the only one. Whilst still in custody (*al-ḥabs*) he gave ‘Aḍud al-Dawla a present simply referred to as a *mihrajāniyya*, accompanied with one Sasanian Khusrāw *dirham*.²¹

The events behind our story may have taken place in the year 371 H [= 981]. As noted above, Abū Ishāq was released from prison on November 24 of that year, and the festival of Mihrajān would have been around September 18. Since we cannot be sure that Abū Ishāq’s gift to the *amīr* actually secured his release, we cannot be certain that our story occurred in 981.

It is clear that Abū Ishāq was not part of the audience that particular year, whenever it was, because he was in prison, or at least under house arrest. But he certainly presented a double gift, and surely hoped for his freedom in exchange. Abū Ishāq presented a miniature astrolabe the size of a *dirham*,²² that is, some 2.5 cm in diameter, executed with remarkable dexterity, to ‘Aḍud al-Dawla, or, if not to him, to one of his *wazīrs*, accompanying his gift with three brilliant lines of poetry in *basīṭ* meter.²³ In these verses, he states that because of the eminence of the dedicatee, the earth would not be sufficient as a gift, so the recipient would receive instead (a model of) the universe. Possibly the double gift so pleased the *amīr* that he had Abū Ishāq released, as one of our sources relates.²⁴

The 15 surviving astrolabes from 8th-, 9th-, and 10th-century Baghdad have diameters between 8.5 cm and 18 cm.²⁵ The smallest surviving Islamic astrolabes are from 17th-century Isfahan and Lahore: they are about 5

¹⁹ al-Bīrūnī, *Chronology*, p. 230 (Arabic), 217 (English). The festivals of a week’s duration began on Farwardīn Serosh (day 17) and Ābān Hurmuz (day 1).

²⁰ Lambton, “Pīshkash: Present or Tribute?”, p. 146.

²¹ al-Tha‘ālibī, *Yatīmat al-dahr*, 1934 edn., II, p. 256.

²² See n. 17 above.

²³ On Arabic metrics see, for example, the article “‘Arūd” by Gotthold Weil in *Encyclopaedia of Islam*, 2nd edn.

²⁴ Namely, al-Ḥuṣṣī’s *Jam‘ al-jawāhir*, 1953 edn., p. 307.

²⁵ These are described in detail in King, *In Synchrony with the Heavens*, XIIIb-c.

cm in diameter. The smallest surviving astrolabe from medieval Europe is 5.9 cm in diameter, but there is a smaller one from the same Italian workshop illustrated in remarkable detail in a Flemish painting (associated with Jan van Eyck).²⁶ From the story of Abū Ishāq we now know that such miniature astrolabes were made in earlier centuries, notably, in this case, the 10th.

2. The sources for the story

Once the first author (MAZ) had recognized the poem on the Judaeo-Arabic astrolabe (see §4), he turned to an Arabic book on the history of astronomy by Yaḥyā al-Shāmī that is based primarily on literary sources, and there he found the poem taken from two medieval sources (al-Tha‘ālibī and Yāqūt).²⁷ He then consulted Dr. Sadek Abusoleman who was in possession of a CD-ROM *al-Mawsū‘a al-shi‘riyya*, “The Encyclopaedia of Arabic Poetry”, and who graciously provided references to a total of eight medieval literary sources – see Appendix A.

We continue with a statement, surely incomplete, about the various authors who mentioned the astrolabe *cum* poem. All of the authors are well-known litterateurs, so that, for example, they all are featured in the *Encyclopaedia of Islam*, 2nd edn. Published versions of their original statements are gathered in Appendix A. Here we shall see the way in which the story moved from Baghdad to Ifīrīqiya (Kairouan) and to al-Andalus (Cordova).

The religious and literary scholar al-Rāghib al-Iṣfahānī, who worked in the circle of Būyid *wazīrs* in Isfahan and died early in the 11th century, is perhaps our earliest source.²⁸ He mentions our story in his *Muḥāḍarāt al-udabā’ wa-muḥāwarāt al-shu‘arā’ wa-l-bulaghā’*. However, he is disappointing: he cites only the last line of the poem, stating that al-Ṣābi’ had written it to one of his friends, to whom he had given an astrolabe.

²⁶ See *ibid.*, II, pp. 545-574, esp. 572-574.

²⁷ al-Shāmī, *‘Ilm al-falak*, p. 112, where the gifts to ‘Aḍud al-Dawla are mentioned, quoting Yāqūt, and p. 156, where the same gifts are given to the *wazīr* al-Ṣāhib ‘Abbād, also quoting the same reference to Yāqūt.

²⁸ On al-Ḥusayn ibn Muḥammad known as al-Rāghib al-Iṣfahānī see Sezgin, *GAS*, II, p. 83, and the article “al-Rāghib al-Iṣfahānī” by E. K. Rowson in *Encyclopaedia of Islam*, 2nd edn.

His later contemporary, al-Tha‘ālibī of Nishapur,²⁹ b. 350 H [= 961], d. 429 H [= 1038], in his *Yatīmat al-dahr*, cites the whole poem, stating that the author had presented it on the day of *Mihrajān* together with an astrolabe for ‘Aḍud al-Dawla.

About the same time, al-Ḥuṣrī,³⁰ in Kairouan, a flourishing centre of culture, wrote in his *Zahr al-ādāb* that ‘Aḍud al-Dawla had imprisoned Abū Ishāq in spite of his excellence in writing and his importance in eloquence, and confiscated all of his assets without having him harmed physically. Then on the day of *Mihrajān*, Abū Ishāq gave ‘Aḍud al-Dawla an astrolabe the size of a *dirham*. With this gift he wrote the three lines, to which al-Ḥuṣrī adds three more lines in a different meter: these cannot be original. Al-Ḥuṣrī in his *Jam‘ al-jawāhir*, a continuation (*dhayl*) of his earlier work, recorded the same story about the astrolabe and the poem noting only that Abū Ishāq was under arrest (*mu‘taqil*) at the time, but adding the more significant news that ‘Aḍud al-Dawla was so pleased (with the double gift) that he had him released from prison (*sijn*).

Our next source chronologically is the *Bahjat al-majālis* of the 11th-century Cordovan scholar Ibn ‘Abd al-Barr.³¹ He mentions that the astrolabe was the size of a *dirham* and that it was carefully executed (*muḥkam al-ṣan‘a*), and that it was presented to ‘Aḍud al-Dawla. The three lines of the poem are presented.

One more source merits our attention, namely, the *Mu‘jam al-udabā’* of the celebrated early-13th-century historian and geographer Yāqūt,³² not least because it throws a spanner in the works as far as the connection to ‘Aḍud al-Dawla is concerned. Yāqūt states that Abū Ishāq had given an astrolabe, the size of a *dirham* and carefully executed, to ‘Aḍud al-Dawla.

²⁹ On Abū Maṣṣūr ‘Abd al-Malik ibn Muḥammad ibn Ismā‘īl al-Tha‘ālibī see Sezgin, *GAS*, II, pp. 440-441, and the article “al-Tha‘ālibī, Abū Maṣṣūr” by E. K. Rowson in *Encyclopaedia of Islam*, 2nd edn.

³⁰ On Abū Ishāq Ibrāhīm ibn ‘Alī al-Ḥuṣrī al-Qayrawānī, born at al-Ḥuṣr near Kairouan, fl. Kairouan, d. in al-Manṣūriyya in 413 H [= 1022], see Sezgin, *GAS*, II, pp. 82-83, and the article “al-Ḥuṣrī, I” by Ch. Bouyahia in *Encyclopaedia of Islam*, 2nd edn.

³¹ On Abū ‘Umar Yūsuf ibn ‘Abdallāh Ibn ‘Abd al-Barr al-Namarī al-Qurṭubī, born Cordova 368 H [= 978], died Játiva in 463 H [= 1070], see Sezgin, *GAS*, II, p. 85, and the article “Ibn ‘Abd al-Barr” by Ch. Pellat in *Encyclopaedia of Islam*, 2nd edn.

³² On Yāqūt al-Ḥamawī al-Rūmī, born in Hama in 574 or 575 H [= 1179], died in Aleppo in 626 H [= 1229], see Sezgin, *GAS*, II, p. 97, and the article “Yāqūt al-Rūmī” by Cl. Gilliot in *Encyclopaedia of Islam*, 2nd edn. Our story is mentioned in his *Mu‘jam al-udabā’*, Cairo edn., ca. 1936, II, p. 34. We have not consulted the 1993 edition of this great work by Iḥsān ‘Abbās.

However, he also inserts an aside to the effect that the grandson (of Ibn Ishāq) had written in his *Kitāb al-Wuzarā'* that Abū Ishāq had given the astrolabe to al-Muṭahhar ibn ʿAbdallāh, a *wazīr* of ʿAḍud al-Dawla.³³ This is surely the book with this title by the celebrated historian Abu ʿl-Ḥusayn Hilāl al-Ṣābiʿ, the grandson of Abū Ishāq,³⁴ who need not have reported the story if it had nothing to do with *wazīrs*. On the other hand, the family story may have already been modified.

Three later Arabic sources – the Egyptians al-Nuwayrī and al-Ibshīhī and the Syrian Bahāʾ al-Dīn al-ʿAmilī – contribute nothing of consequence to our quest for the original poem.³⁵

3. The poem

We here present the poem in what we think is the most likely form for the original, mentioning variant readings in the published versions some of which we prefer to dismiss. We dare to undertake this unorthodox procedure because we surely have far more control over the possible variant readings than any of the sources we have just mentioned. Also some of these variant readings are inappropriate. Alas we cannot establish the exact words of the poem because some of the readings are equivalent to each other and they all scan properly.

We label the doubtful words, which are underlined, as follows:

أهدى إليك (1a) <u>بنو الحاجات</u> (1b) <u>واحتفلوا</u>	في مهرجان (1c) <u>عظيم</u> (1d) <u>أنت تعليه</u>
لكن عبدك إبراهيم حين رأى	(2a) <u>سمو</u> <u>قدرك</u> (2b) <u>عن شيء</u> (2c) <u>يساميه</u>
لم يرض بالأرض (3a) <u>يهديه</u> إليك (3b) <u>فقد</u>	أهدي لك الفلك (3c) <u>الأعلى</u> (3d) <u>بما فيه</u>

Most of the variants – shown in Tables 1a and 1b – could have resulted from the errors of medieval copyists or of modern editors or printers.

Some variants are worthy of comment. (1c) *jadīd*, “new”, does not really seem appropriate, because this would not be used for a “new” birth-

³³ See Madelung, “Abū Ishāq al-Ṣābiʿ”, p. 18.

³⁴ See the article “Hilāl ibn Muḥassin ibn Ibrāhīm al-Ṣābiʿ” by D. Sourdél in *Encyclopaedia of Islam*, 2nd edn. This work has not survived in its entirety; the published version (al-Ṣābiʿ, *al-Wuzarā'*, 1958 edn.) mentions the gift and the poem only in the editor’s introduction (p. iv), but without stating a source.

³⁵ We have not been able to locate the story in al-Nuwayrī’s multi-volume *Nihāyat al-arab* (on which see Sezgin, *GAS*, II, p. 83). For the other two sources see al-Ibshīhī, *al-Mustaṭraf*, p. 302, trans., II, p. 86; and Bahāʾ al-Dīn al-ʿAmilī, *al-Kashkūl*, pp. 511-512.

day of the *amīr*; (1d) *anta tublīhi* or *anta mublīhi* from IVth form *ablā*, “to put to the test”, makes no sense in this context.

This seems to be the closest we can come to the charming poem in all its simplicity:

أَهْدَى إِلَيْكَ بَنُو الْحَاجَاتِ / الْأَمَالِ وَاحْتَفَلُوا / وَاحْتَشَدُوا / فِي مَهْرَجَانِ عَظِيمٍ / جَدِيدٍ أَنْتَ تُعْلِيهِ
لَكِنَّ عَبْدَكَ إِبْرَاهِيمَ حِينَ رَأَى سُمُوً / عَلُوً قَدْرَكَ عَنْ شَيْءٍ يُسَامِيهِ / يُبَارِيهِ / يُدَانِيهِ
لَمْ يَرْضَ بِالْأَرْضِ يُهْدِيهَا إِلَيْكَ فَفَدَّ أَهْدَى لَكَ الْفَلَكَ الْأَعْلَى بِمَا فِيهِ

The following is our translation:

“The petitioners / *those hoping* (for your intercession) gave you presents whilst they celebrated / *gathered together* on the day of the great / *new* autumnal festival / *birthday*, over which you presided (with your greatness).

But your servant Ibrāhīm, when he saw the grandeur of your status over all that might compete with it, / *when he saw that there was nothing that could compete with the grandeur of your status*, was not satisfied with giving you the Earth, and so he presented you with (a model of) the highest sphere together with all that is within it.”

Only one of our sources, the *Mustaṭraf* of the early-15th-century Egyptian al-Ibshīhī, has been translated into a European language. As a tribute to the little-known French orientalist G. Rat we cite his translation of the poem,³⁶ which enables us to see how he thought it was to be understood:

“A l’occasion du Mihragān (fête des équinoxes d’automne) les fils de riche famille [translating *amlāk*] se sont solennellement réunis et t’ont fait un présent que tu daigneras accepter;
Mais ton serviteur Ibrāhīm, voyant que l’élévation de ton rang permettait point de t’offrir un objet qui approchât de cette grandeur,
N’a pas jugé que la terre fut un cadeau assez digne de toi; aussi t’apporte-t-il en présent la sphère céleste avec ce qu’elle contient.”

In any case, Abū Ishāq ingeniously elevates the status of the astrolabe to represent the entire universe, which is contained within the outermost sphere, that is, the sphere responsible for the apparent daily rotation of the universe.³⁷

³⁶al-Ibshīhī, *al-Mustaṭraf*, trans., p. 86.

³⁷ See the article “al-Falak” by Willy Hartner in *Encyclopaedia of Islam*, 2nd edn.

		1a	1b	1c	1d	2a	
1	al-Rāghib al-Iṣfahānī	CD*	—	—	—	—	
2	al-Thaʿālibī	Cairo, 1934	بنو الآمال	واحتفلوا	جديد	أنت مبلية	علو
3a	al-Huṣrī, <i>Zahr al-ādāb</i>	Cairo, 1969	بنو الحاجات	واحتشدوا	عظيم	أنت تعليه	سمو
3b	al-Huṣrī, <i>Jamʿ al-jawāhir</i>	Cairo, 1953	بنو الحاجات	واحتشدوا	عظيم	أنت تعليه	سمو
4	Ibn ʿAbd al-Barr	Cairo, 1962	بنو الحاجات	واحتشدوا	عظيم	أنت تعليه	سمو
5	Yāqūt	Cairo, 1936-38	بنو الحاجات	واختلفوا	عظيم	أنت مبلية	علو
	Yāqūt	Beirut, 1993	بنو الحاجات	واحتفلوا	جديد	أنت مبلية	علو
	Yāqūt	(al-Shāmī)	بنو الحاجات	واختلفوا	عظيم	ليس ببلية	علو
6	al-Nuwayrī	CD*	بنو الآمال	واجتهدوا	جديد	أنت تلبية	سمو
7	al-Ibshīhī	Beirut, 1981-82	بنو الأملاك	واحتفلوا	جديد	أنت تلبية	سمو
8	al-ʿĀmilī	Beirut, 1983	بنو الأملاك	واجتهدوا	جديد	أنت تلبية	سمو
	Judaeo-Arabic astrolabe	—	[بنو الحاجات]	واحتفلوا	عظيم	أنت تعليه	سمو

Table 1a: Table of variants

* We could not find the reference in the published edition.

		2b	2c	3a	3b	3c	3d
1	al-Rāghib al-Iṣfahānī	—	—	يهديها	وقد	الأعلى	وما
2	al-Thaʿālibī	عن شيء	يدانيه	مهداة	فقد	الأعلى	بما
3a	al-Ḥuṣrī, <i>Zahr al-ādāb</i>	عن شيء	يساميه	يهديها	فقد	الأعلى	بما
3b	al-Ḥuṣrī, <i>Jamʿ al-jawāhir</i>	عن شيء	يساميه	يهديها	فقد	الأعلى	بما
4	Ibn ʿAbd al-Barr	عن شيء	تساميه	يهديها	فقد	الأعلى	بما
5	Yāqūt	لا شيء	يساميه	يهديها	فقد	الأعلى	بما
	Yāqūt	لا شيء	بياريه	يهديها	فقد	الأعلى	بما
	Yāqūt	لا شيء	يساميه	يهديها	فقد	الأعلى	بما
6	al-Nuwayrī	عن شيء	يساميه	يهديها	فقد	الأعلى	بما
7	al-Ibshīhī	عن شيء	يدانيه	يهديها	وقد	الأعلى	بما
8	al-ʿĀmilī	عن شيء	يساميه	يهديها	فقد	الأعلى	بما
	Judaeo-Arabic astrolabe	عن شيء	[يجاريه]	يهديها	فقد	الأقصى	بما

Table 1b: Table of variants

4. The Judaeo-Arabic astrolabe inscription

“Die ungelösten Probleme halten einen Geist lebendig und nicht die gelösten.”
Erwin Guido Kolbenheyer (1878-1962).

For some years the second author (DAK) has been fascinated by, and troubled by an astrolabe with inscriptions in Judaeo-Arabic, that is, Arabic in Hebrew script³⁸ – see Appendix B. The interpretation of the main inscription around the rim – see fig. 1 – has caused scholars some problems during the last 20 years, we suspect because they did not consult Prof. Joshua Blau, the scholar who has written most on this subject.³⁹ Whilst Jews usually compiled poetry in Hebrew, the use of Judaeo-Arabic for classical Arabic poetry is also documented. Particularly important in this regard are some in the writings of Judah ben Solomon al-Ḥarīzī (1165-1225), who was born in al-Andalus and travelled to Egypt and Syria.⁴⁰

We should mention that Judaeo-Arabic was used by Jewish scholars for all manner of literary forms, including – and this is not generally known – astronomy. We have, for example, a Judaeo-Arabic manuscript of Ptolemy’s *Almagest*.⁴¹ But there are more examples that one could cite,⁴² and as Y. Tzvi Langermann has written:⁴³

“This underappreciated type of transmission has a twofold significance: (1) the choice, quantity, and other information associated with transcriptions reveal valuable information concerning the cultural and intellectual interests

³⁸ See the article “Judaeo-Arabic” by Joshua Blau in *Encyclopaedia of Islam*, 2nd edn., and his books *The Emergence and Linguistic Background of Judaeo-Arabic* and *A Grammar of Mediaeval Judaeo-Arabic* (in Hebrew), also Benjamin Hary’s articles “Adaptations of Hebrew Script” and “The Importance of the Orthography in Judeo-Arabic Texts”.

³⁹ See Blau, *Emergence of Judaeo-Arabic*, pp. 230-232, on the topic of poetry between Arabic and Hebrew.

⁴⁰ See the article “al-Ḥarīzī, Judah ben Solomon” by Aharon Mirsky & Avrum Stroll & Angel Saenz-Badillos in *Encyclopaedia Judaica*, 2nd edn. For another example see Langermann, “A Judeo-Arabic Poem Attributed to Abu Hamid al-Ghazali”.

⁴¹ On MS Paris BNF heb. 1100, copied in 1380 and 1475 in Calatayud, see Kunitzsch, *Der Sternkatalog des Almagest*, I, pp. 6-8.

⁴² For an example of a 14th-century Judaeo-Arabic manuscript preserving an Arabic text lost in the original see Castells & Samsó, “Seven Chapters of Ibn al-Ṣaffār’s Lost *Zīj*”. On another work in this manuscript see Goldstein, “The Survival of Arabic Astronomy in Hebrew”, pp. 34-35.

⁴³ Langermann, “Transcriptions of Arabic Treatises into the Hebrew Alphabet”, p. 247.

of various Jewish communities; (2) in more than one instance, transcriptions have preserved texts or versions of texts that are otherwise unknown.”

The astrolabe that concerns here, formerly in the possession of Dr. Tommaso Franco of Vicenza, first appeared in 1988 at an auction of important Judaica held by Christie’s of Amsterdam.⁴⁴ It was purchased by Dr. David Khalili for his collection of Islamic art and scientific instruments in London and was described again in the 1997 catalogue of his collection dealing with instruments.⁴⁵ The basic technical description in both cases was by the late Francis Maddison.

⁴⁴ See *Christie’s 1988 Catalogue*, pp. 88-95 (lot 247).

⁴⁵ See *Khalili Collection Catalogue*, I, pp. 214-217 (no. 124).

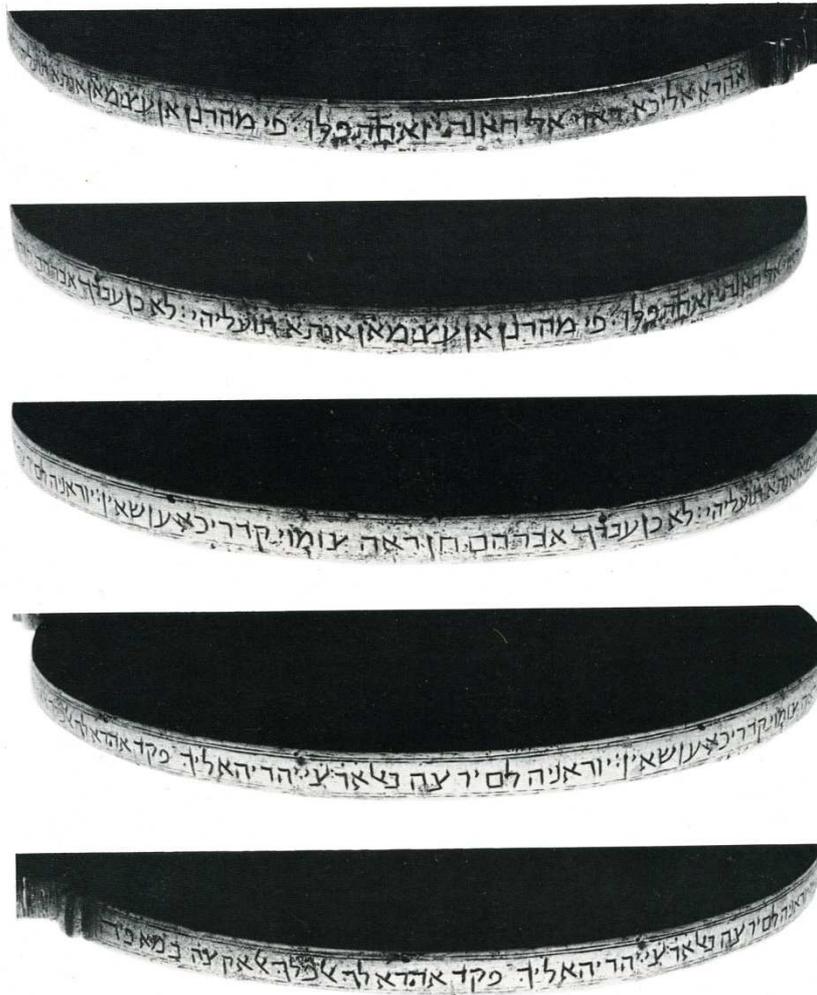


Fig. 1: The enigmatic inscription around the rim
of the Judaeo-Arabic astrolabe featured in Appendix B.
[Photos from the archives of the Institute for History of Science, Frankfurt.]

Previously it has been assumed that the Arabic equivalent to the inscription on the rim of this piece was in “Middle Arabic”, essentially a simplified version of Classical Arabic corresponding more to the way people actually spoke. As we shall see, we are dealing with features of Judaeo-Arabic (namely, nunation) that are well documented, but which the second author (DAK) had forgotten from a seminar on Judaeo-Arabic by Prof. Joshua Blau at New York University *ca.* 1980.

The Hebrew letters are in Sephardic square script.⁴⁶ A special ligature, standard in Hebrew for אל (*al-*) is sometimes used for the Arabic article ال (*al-*); this is here represented by אל underlined. As far as we are aware, the script has never been compared with that on contemporaneous Jewish metalwork.

The text reads:

אהדא אליכא דאוי אלהאגתי ואחתפלו : פי מהרגן אן עצימאן אנתא תועליהי :
 לאכן עבדך אברהם חן ראה צומוי קדריכא ען שאין : יוראגיה
 לם ירצה באלארצי יהדיה[א] אליך פקד אהדא לך אלפלך אלקצה במא פיה

and the corresponding Arabic – which is not always easy to determine – is:

اهدا اليكا داوي الحاجتي واحتفلو : في مهرجن ان عظيمان انتا توعليهي :
 لاكن عبدك ابرهم حن راه سوموي قدريكا عن شاين : يوراجيه
 لم يرضه بالارضي يهديها اليك فقد اهدا لك الفلك الاقصه بما فيه

The correspondence of Hebrew and Arabic letters is shown in the following table:

General remarks: for the Arabic letter combination ال (*al*) sometimes a ligature is used; this is here represented by אל underlined. Sometimes a dot specifies a letter – (e.g. א and א̣); in these cases the dot is always written above the letter on the instrument.

⁴⁶ We quote the *Christie's 1988 Catalogue*, p. 94, where the reference was to a catalogue of dated Hebrew manuscripts (Sirat & Beit-Arié).

א	ا, أ, إ, ي, ـ	י	ي, ـ, ـ	ק	ق
ב	ב	כ	ك	ר	ر
ג	ج	ל	ل	ש	ش
ד	ד, ذ	מ	م	ת	ت, ث
ה	ה, ی, ـ	נ	ن	אל	ال
ו	و, وا, ـ	ס	–	אן	–
ז	–	ע	ع	יך*	–
ח	ح	פ	فا		
ט	–	צ	س, ص, ض, ظ		

Table 2: Hebrew letters and their Arabic equivalents
(according to the poem).

* יך only appears in שאיך. The י apparently belongs to the word, not to the *tanwīn*.

In the Christie's catalogue, the entirety of the Arabic text could not be determined, but a first attempt at interpreting it and rendering it in English was made by Resianne Smidt van Gelder-Fontaine:⁴⁷

“May it show to you the things which need to be paid attention to, in ... that you are great who have lifted it. But your servant Abraham ... your fate from something ... was not satisfied with the country it shows you, [for] it has shown you the furthest star by means of its content.”

The second author (DAK) has inspected the instrument in London and looked at photos of the instrument several times over the years, and also tried several times to make sense of the inscription:⁴⁸

⁴⁷ Christie's Amsterdam 1988 Catalogue, p. 94.

“Someone in your debt gave you a gift and rejoiced in two glorious celebrations. You will make it great (?). But your servant Abraham, when he saw your worth compared with anything that he might show (?), he would not be happy with giving you the earth. So he has given you the furthest sphere (of heaven) and (all) that is in it (*i.e.*, all that is represented on this astrolabe).”

In the 1997 Khalili collection catalogue, an additional English rendition of the inscription by the Semitist Geoffrey Khan was presented:⁴⁹

“People in need granted [this] to you as a gift and celebrated in a great festival ... But your servant Abraham Ḥen saw that your power transcended what is seen. He was not satisfied with the earth and gives you it as a gift, by which also far-reaching dominion has been given to you.”

One of the things that the second author (DAK) learned in Franz Rosenthal’s Classical Arabic seminars at Yale was that if a modern translation of a medieval text made sense, it might convey what the author intended. If the translation does not make sense, either the text is corrupt or we have misunderstood it. If the text as we have it is corrupt, then perhaps one can emend it and produce a translation that makes more sense. We do this at our peril, for it can be the height of arrogance to think that we know more about medieval Arabic than some medieval author or scribe. In this case, we are dealing with a Judaeo-Arabic text that is clearly in the same hand as the remaining inscriptions on the astrolabe. The “text” is as was intended by the engraver of the astrolabe. We should be very careful about trying to correct it, unless what we can produce is a cohesive text that makes some sense.

In the Spring of 2006 we discussed the inscription in our Arabic Scientific Manuscripts seminar, at which the three authors were the sole participants. There emerged a better reading of the Arabic after we recognized that Arabic *tanwīn* for the endings of an indefinite noun in the oblique case and a modifying adjective – that is, the ending *-in* – were written consonantly as Judaeo-Arabic ן . This is a curious but well-documented feature of Judaeo-Arabic, even when representing Middle Arabic, which tends to suppress nominal and adjectival endings.⁵⁰

⁴⁸ In Section 6.5.1 of his unpublished (and incomplete) catalogue of medieval astronomical instruments: see King, “An ordered list of European astrolabes to *ca.* 1500”, no. XII in *idem*, *Astrolabes from Medieval Europe*.

⁴⁹ *Khalili Collection Catalogue*, p. 214, n. 8.

⁵⁰ See especially Blau, *Emergence of Judaeo-Arabic*, pp. 167-187: “Vestiges of *Tanwīn* in Judaeo-Arabic ...”.

We then realized that we were dealing with a Judaeo-Arabic (JA) text based on *Classical Arabic* (CA) rather than Middle Arabic (MA). It was the first author (MAZ) who then recognized that we were dealing with poetry. Since in this paper we have already dealt with the poem, we now approach the Judaeo-Arabic inscription from a different point of view, since it is rare that one can know ahead of time more or less what a medieval text is trying to tell us.

First, it seems that we are dealing with a limited genre of JA writing. Of all of the numerous uses of JA, the writing of Arabic poems in Hebrew script is not common.⁵¹

In this case, we determine the original Arabic of this version of the poem as follows:

أَهْدَى إِلَيْكَ دَوُو الْحَاجَاتِ وَاحْتَفَلُوا	فِي مَهْرَجَانٍ عَظِيمٍ أَنْتَ تُعْلِيهِ
لَكِنَّ عَبْدَكَ إِبْرَاهِيمَ حِينَ رَأَى	سَمُو قَدْرِكَ عَنْ شَيْءٍ يُجَارِيهِ
لَمْ يَرْضَ بِالْأَرْضِ يُهْدِيهَا إِلَيْكَ فَقَدَ	أَهْدَى لَكَ الْفَلَكَ الْأَقْصَى بِمَا فِيهِ

The following three words in the version on the Judaeo-Arabic astrolabe are not in the textual tradition:

دَوُو, *dhawī* (for [دَوُو, *dhawū*]), instead of بِنُو, *banū*,
 يُجَارِيهِ, [*yujārīhi*], for incorrect يُرَاجِيهِ, *yurājīhi*, instead of
 various alternatives; and
 الْأَقْصَى, *al-aqṣā*, instead of الْأَعْلَى, *al-a'lā*.

Nevertheless, the meaning is identical to what we presented in §3.

Whether or not this JA text is unique of its genre, we should exploit it for what it can tell us. Firstly, the following general features are worth noting:

Arabic short vowels are sometimes but not always transcribed with an א, ו or ם as if they were long vowels. Such usage seems to be unrelated to the stress in the verse. When there is a final possessive pronoun, both final short vowels can be thus rendered, as in JA קדריכא, for CA قَدْرِكَ, *qadrika*.

Arabic final *alif maqṣūra* is rendered by JA א or ה, as in JA אהדא for CA أَهْدَى, *ahdā*, and JA אלאקצא for CA الْأَقْصَى, *al-aqṣā*.

⁵¹ See n. 39 above.

Arabic nunation is rendered by JA אן, unless the last consonant is a י, in which case it seems to be rendered in JA by an additional ך.

Hebrew צ serves to represent Arabic ض, ص, ظ, and even, surprisingly, س, on one occasion.

Many of the individual words merit comment:

JA דאוי is incorrect for CA or even MA دَوِي, *dhawī*, and the correct CA would be دَوُو, *dhawū*. (One could argue that the use of دَوِي for دَوُو is the *only* concession to MA in the entire text.)

JA אלהאגתי, for CA الْحَاجَّة, *al-hājati*, which does not scan properly, is an error for the plural אלהאגתי, CA الْحَاجَات, *al-hājāti*, which does.

JA מהרגן is an error for مَهْرَجَان, *mihrajān*, CA from the Persian.

The אן after, and even separated from, JA מהרגן [אן] is the nunation, that is, the CA ending *-in*. The same applies for the אן added in the next word, JA עצימאן for CA عَظِيم, *'azīm*⁵².

There are two cases when significant short vowels (the *damma* on the first consonant of present-tense verbs of form III and IV) are made long: thus JA תועליה and יוראגיה (*sic*) for CA تُعَلِيهِ, *tu'līhi*, and [يُجَارِيهِ], *yujārīhi*. However, the ו is not used in JA יהדיה [א] for CA يُهْدِيهَا, *yuhdīhā*, (see below).

JA הן is an error for הין, representing CA حِين, *hīna*.

JA שאין is a misrepresentation of CA شَيْءٍ, *shay'*⁵², the oblique nunation apparently represented by ין. The form שיאן would be more consistent with the other examples noted above.

JA יוראגיה suggests يُرَاجِيهِ, *jurājīhi*, for the Arabic, but this is a verb that does not exist. We are dealing with an error for יוגאריה, corresponding to CA يُجَارِيهِ, *yujārīhi*.

JA לם ירצה with the additional final ה for CA لَمْ يَرْضَ, *lam yarda*, is possibly what Blau has discussed under “pseudo-correct usages of lam”.⁵²

JA [א] יהדיה for CA يُهْدِيهَا, *yuhdīhā*. By mistake, the final א has been combined as one letter with the initial א of the next word.

⁵² Blau, *Grammar of Mediaeval Judaeo-Arabic*, §205.

One word breaks all the rules: CA *سُمُو*, *sumūwa*, has become JA צומוי .

Last and not least, in order to scan properly, the Hebrew name אברהם *Avrāhām*, written with consonants א ב ר ה מ, must be rendered in Arabic with two “visible” long vowels such as are not found in the Hebrew written form but which do appear in Arabic *إِبْرَاهِيم*, *Ibrāhīm*.⁵³ In other words, the engraver was not willing to compromise the correct Hebrew spelling of this name.

Our Judaeo-Arabic text is interesting in that it does not – as previously maintained – represent “Middle Arabic” in Hebrew script. Rather it renders with a multiplicity of inconsistencies a poem written in the Classical Arabic of the “Golden Age”. Various questions arise:

Was the engraver of this astrolabe called Abraham and did he choose this text simply because his name was in it?⁵⁴ (In other words, if he had been called Moshe, would he *not* have engraved this text?) The question is complicated by the fact that he might not have been the first person to engrave such an inscription on an astrolabe.

To what extent did our craftsman know that what he was copying corresponded to classical Arabic poetry? We suspect that he was simply copying a more sophisticated astrolabe with Judaeo-Arabic inscriptions, which in turn might have been copied from *an Islamic astrolabe engraved with a variant form of the Arabic poem*. We further suspect that the Arabic poem was *dictated* to the first person to pen it in Hebrew characters or to engrave it on an earlier astrolabe. It was surely not first dictated in the form in which it has come down to us. In the first version there were presumably six colons to mark the pauses; our astrolabist has two of these in the right places in the first line and one more in the wrong place in the second. It seems unlikely that he knew what he was copying. It just seemed like a good idea at the time.

We mention here that the inscriptions on the plates on this astrolabe do not correspond to the astronomical markings on the plates: see further Appendix B. Thus the instrument is useless for any serious astronomical purposes. But this was not necessarily the purpose of the astrolabe anyway. Also, the distinctive rete design is intimately related to that of a Catalan astrolabe from *ca.* 1300, also preserved in London: see again Appendix B. Thus, for example, the design of the Catalan astrolabe, with

⁵³ On the orthography see Jeffery, *Foreign Vocabulary of the Qur’ān*, pp. 44-46.

⁵⁴ Not unreasonably the astrolabe is listed under the maker’s name as Abraham in the forth-coming *Répertoire des facteurs d’astrolabes et de leurs œuvres* of A. Brieux and Francis Maddison.

its beautiful quatrefoil, is far more sophisticated than the design of this derivative piece. To put it bluntly, by the high standards of medieval Islamic instrumentation and certain – but by no means all – instruments made in medieval Europe, the maker was somewhat incompetent.

Three brief and unhelpful accounts of the Judaeo-Arabic astrolabe have appeared in catalogues of exhibitions in Berlin in 1992 and Speyer in 2004, then in 2005 at the Institut du Monde Arabe in Paris.⁵⁵ This last exhibition, on the “âge d’or” of Arabic science, was written up in an article by the Paris-based journalist Ann Morrison in *Time* (Nov. 13, 2005) in which an article on Islamic science had an imposing image of this “Spanish golden astrolabe made in 1300” on a double-page. (The image and the caption were provided by the Institut du Monde Arabe).⁵⁶ A subsequent issue of the magazine (Dec. 19) had a letter from a reader in Jerusalem: “the gold astrolabe you pictured does not bear Arabic script but is in Hebrew. Could you explain why??” *Time* responded with the following, compiled by a London-based researcher:

“Fourteenth century Spain was populated by Muslims, Christians and Jews, who exchanged cultural and scientific knowledge. The astrolabe was an Arab invention [*sic*], but the devices are inscribed in many different languages — Arabic, Latin, Greek, Hebrew — depending on the craftsman or intended owner. The one we showed just happens to be inscribed in Hebrew [*sic*].”

Part of a more complex answer is that the poem on the brass Judaeo-Arabic astrolabe was first compiled by a well-known scholar who just happened to be called Ibrāhīm.

5. Concluding remarks

With the sources that we have mentioned above, we have accompanied the poem and the story of its presentation from Baghdad to al-Andalus, from one of the most dazzling courts of the Islamic East to a milieu in the Islamic West in which it could eventually become known to a Jewish astrolabist who would consider it worth engraving on his own astrolabe.

Poems engraved on or associated with early astrolabes are rather rare. The only poem engraved on a surviving Islamic astrolabe before *ca.* 1500

⁵⁵ See Appendix B.

⁵⁶ See Morrison, “Ahead of their Time”, for the webpages featuring the article and the subsequent enquiry.

is on a geared astrolabe made in Isfahan in the early 13th century.⁵⁷ Persian astrolabes after *ca.* 1500 are, however, often engraved with poems.⁵⁸ The sole surviving Byzantine astrolabe, from 1062, bears a Greek poem describing the astrolabe as “an icon of the universe”. This inspired the German astronomer Regiomontanus to engrave a Latin poem on his 1462 astrolabe for Cardinal Bessarion with a hidden message that the astrolabe is “a work that describes the rotation of the heavens”.⁵⁹ We know of no other early astrolabes that are associated with poems, in spite of the fact that the notion of the astrolabe as “the mirror of the universe” is suggestive even to those who might not understand the technicalities of the instrument.⁶⁰ There are, however, medieval sources in which the virtues of the astrolabe and other instruments are extolled in poetry.⁶¹ Furthermore, on late Iranian astrolabes we often find a hemistich from the *Gulestān* of the 13th-century poet Sa’dī that reflects what all scholars might hope of their work: “The aim of this engraving is that it should remain after us.”⁶²

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⁵⁷ Gunther, *Astrolabes*, I, pp. 118-120, no. 5.

⁵⁸ See François Charette in *Greenwich Astrolabe Catalogue*, pp. 243, 256, and also n. 60 below.

⁵⁹ Regiomontanus’ epigram is arranged as an acrostic with hidden messages in various vertical axes, some of which relate to the Byzantine astrolabe of 1062. All this is discussed in detail in King, *Astrolabes and Angels, Epigrams and Enigmas*.

⁶⁰ On the astrolabe as a “mirror of the universe” see King, *In Synchrony with the Heavens*, II, pp. 575-611, esp. pp. 590, 592, 596, etc. For a 17th-century astrolabe from Muslim India with a poem mentioning this see Schmidl, “Ein Astrolab aus dem 17. Jahrhundert”, pp. 294-295.

⁶¹ For just one example, see al-Husri, *Zahr al-ādāb*, Cairo, *ca.* 1925 edn., I, p. 92, amidst poems by the 10th-century poet Abu ’l-Faḥḥ Kushājīm on various other astronomical and geodetic instruments.

⁶² See the references to Charette in n. 58 above.

Appendix A

Attestations of the poem (by MAZ)

1 *al-Ḥusayn ibn Muḥammad al-Rāghib al-Iṣfahānī*

Muḥāḍarāt al-udabā' wa-muḥāwarāt al-shu'arā' wa-'l-bulaghā' (محاضرات
(الأدباء ومحاورات الشعراء والبلغاء):

وكتب الصابىء إلى بعض أصدقائه وقد أهدى له اصطرلاب :

لم يرض بالأرض يهديها إليك وقد أهدى لك الفلك الأعلى وما فيه

2 *Abū Maṣṣūr 'Abd al-Malik ibn Muḥammad al-Tha'ālibī*

Yatīmat al-dahr (يتيمة الدهر), Cairo, 1934 edn., vol. 1, p. 255:

وكتب في يوم مهرجان مع اصطرلاب أهداه إلى عضد الدولة :

أهدى إليك بنو الآمال واحتفلوا في مهرجانٍ جديدٍ أنتَ مئليهِ
لكنَّ عبدك إبراهيم حين رأى علوَ قدرِكَ عن شيءٍ يدانيهِ
لم يرضَ بالأرض مهداةً إليك، فقد أهدى لك الفلكَ الأعلى بما فيه

3 *Abū Ishāq Ibrāhīm ibn 'Alī al-Ḥuṣrī al-Qayrawānī*

(a) *Zahr al-ādāb wa-thamar al-albāb* (زهر الآداب وثمر الألباب), Cairo, 1969,
2nd edn., vol. 1, p. 391:

وكان أبو شجاع فناخسرو عضد الدولة قد نكب أبا إسحاق الصابىء على تقدمه في الكتابة ومكانه
في البلاغة واستصفى أمواله من غير إيقاع به في نفسه فأهدى إليه في يوم مهرجان أسطرلاباً في
دور الدرهم ، وكتب إليه : البسيط :

أهدى إليك بنو الحاجات واحتشدوا في مهرجانٍ عظيمٍ أنتَ تُعليهِ
لكنَّ عبدك إبراهيم حين رأى سموَ قدرِكَ عن شيءٍ يُساميهِ
لم يرضَ بالأرض يُهديها إليك فقد أفدى لك الفلكَ الأعلى بما فيه
ومستدير معجم التقسيم منتسب الأشكال والرسوم
دبره فكر امرىء حكيم فصاغه في صغر التجسيم
مساوياً للفلك العظيم مقتطعاً لسائر النجوم

(b) *Jam' al-jawāhir fī 'l-mulaḥ wa-'l-nawādir* (جمع الجواهر في الملح والنوادر), Cairo, 1953, edn., pp. 306-307:

الصابي وعضد الدولة

وأهدى الصابيء إلى عضد الدولة في يوم مهرجان اصطرلاباً بقدر الدرهم ، وكتب معه وكان حينئذ معتقلاً :

أهدى إليك بنو الحاجات واحتشدوا	في مهرجانٍ جديدٍ أنت تبلييه
لكنَّ عبدك إبراهيم حين رأى	سموّ قدرك عن شيءٍ يساميه
لم يرض بالأرض يهديها إليك فقد	أهدى لك الفلك الأعلى بما فيه

فرضي عنه وأخرجه من السجن

4 *Abū 'Umar Yūsuf ibn 'Abdallāh ibn 'Abd al-Barr al-Namarī al-Qurtubī Bahjat al-majālis wa-uns al-mujālis wa-shaḥn al-dhāhin wa-'l-hājīs* (بهجة) (المجالس وأنس المجالس وشحن الذاهن والهاجس), Cairo, ca. 1962, edn., vol. 1, pp. 287-288:

أهدى أبو إسحاق بن هلال الصابي إلى عضد الدولة في يوم مهرجان اصطرلاباً على قدر الدرهم محكم الصنعة وكتب إليه :

أهدى إليك بنو الحاجات واحتشدوا	في مهرجانٍ عظيمٍ أنت تعليه
لكنَّ عبدك إبراهيم حين رأى	سموّ قدرك عن شيءٍ تساميه
لم يرض بالأرض يهديها إليك فقد	أهدى لك الفلك الأعلى بما فيه

5 *Yāqūt al-Ḥamawī al-Rūmī*

Mu'jam al-udabā' (معجم الأدياء), Cairo, 1936-1939, edn., vol. 2, p. 34:

قال : وأهدى أبو إسحاق الصابي إلى عضد الدولة في يوم مهرجان إصطرلاباً بقدر الدرهم محكم الصنعة وكتب إليه (وفي كتاب الوزراء لحفيده : أنه أهدى الإصطرلاب إلى المطهر بن عبد الله وزير عضد الدولة وكتب إليه) بهذه الأبيات :

أهدى إليك بنو الحاجات واختلفوا	في مهرجانٍ عظيمٍ أنت مبلييه
لكنَّ عبدك إبراهيم حين رأى	علوّ قدرك لا شيءٍ يساميه
لم يرض بالأرض يهديها إليك، فقد	أهدى لك الفلك الأعلى بما فيه

6 *Shihāb al-Dīn Aḥmad ibn ‘Abd al-Wahhāb al-Nuwayrī*
Nihāyat al-arab fī funūn al-adab (نهاية الأرب في فنون الأدب):

وقال أبو إسحاق الصابي، وقد أهداه في مهرجان إلى مخدمه :

أهدى إليك بنو الأمل واجتهدوا	في مهرجان جديد أنت تبليه
لكنك عبدك إبراهيم حين رأى	سمو قدرك عن شيء يساميه
لم يرض بالأرض يهديها إليك	فقد أهدى لك الفلك الأعلى بما فيه

7 *Shihāb al-Dīn ibn Muḥammad al-Ibshīhī*
al-Mustatraf fī kull fann mustatraf (المستطرف في كل فن مستظرف), Beirut,
 1981-1982, edn., p. 302:

وأهدى الصابئي إلى عضد الدولة اسطرلابا في يوم المهرجان وكتب إليه يقول :

أهدى إليك بنو الأملاك واحتفلوا	في مهرجان جديد أنت تبليه
لكن عبدك إبراهيم حين رأى	سمو قدرك عن شيء يدانيه
لم يرض بالأرض يهديها إليك وقد	أهدى لك الفلك الأعلى بما فيه

8 *Bahā’ al-Dīn Muḥammad ibn Ḥusayn al-‘Āmilī*
al-Kashkūl (الكشكول), Beirut, 1983, edn., pp. 511-512:

أهدى أبو إسحاق الصابي في يوم المهرجان لعضد الدولة اسطرلاباً في دور الدرهم وكتب معه هذه الأبيات :

أهدى إليك بنو الأملاك واجتهدوا	في مهرجان جديد أنت تبليه
لكن عبدك إبراهيم حين رأى	سمو قدرك عن شيء يساميه
لم يرض بالأرض يهديها إليك فقد	أهدى لك الفلك الأعلى بما فيه



Fig. 2: The front of the Judaeo-Arabic astrolabe.
[All images from the archives of the Institute for History of Science, Frankfurt.]



Fig. 3: The rete with its distinctive design. Compare the Catalan rete shown in fig. 7.



Fig. 4: The mater with its markings for Tunis.

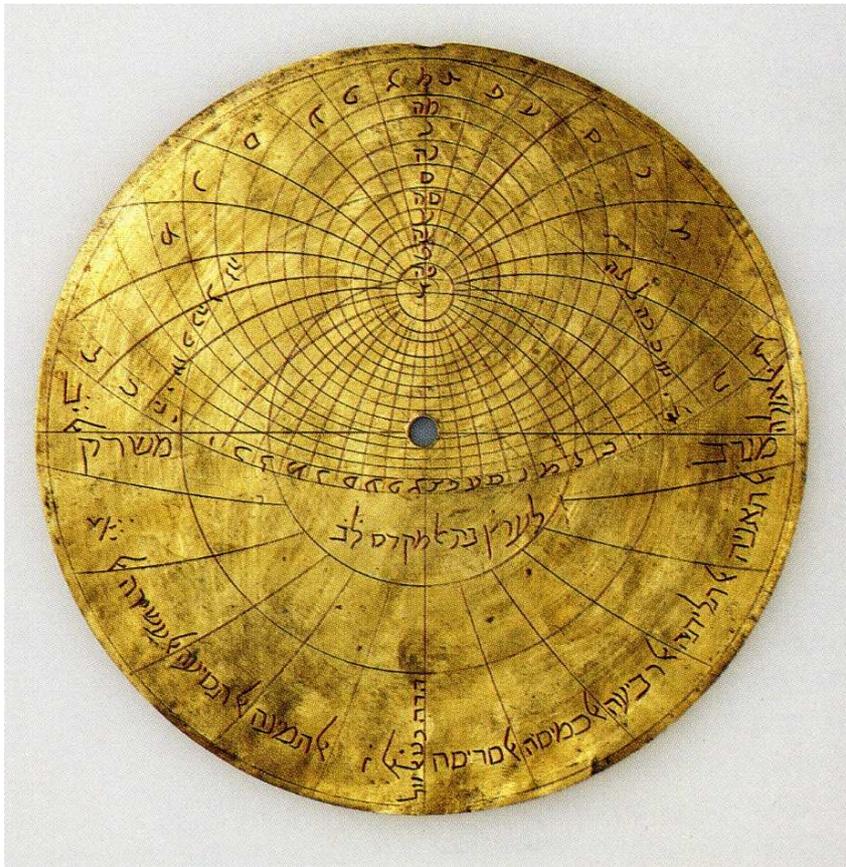


Fig. 5: The plate with markings for Jerusalem.
Note that the peg at the top has been broken off
so that the plate cannot be properly fixed inside the mater.

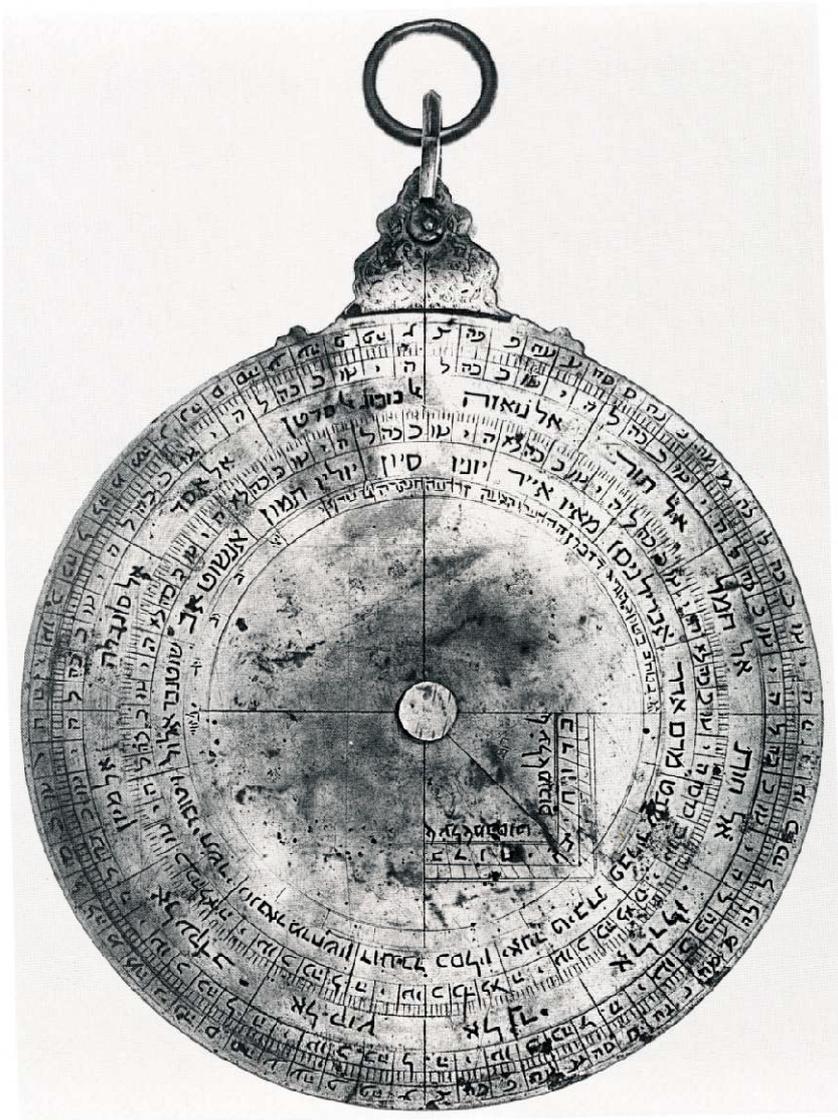


Fig. 6: The back of the Judaeo-Arabic astrolabe with the standard markings of a Western Islamic astrolabe.

Appendix B

The Judaeo-Arabic astrolabe (by PGS)

International Instrument Checklist:	#3915
Collection:	Nasser D. Khalili Collection, London
Maker:	unsigned
Place:	most probably al-Andalus, although the Maghrib is also a possibility
Date:	undated, <i>ca.</i> 1300 (?)
Material and Size:	brass, diameter 184 mm, thickness 11 mm
Exhibited:	Berlin 1991, Speyer 2004, Paris 2005
Descriptions:	<i>Christie's 1988 Catalogue</i> (with a full set of photos), p. 88-95; <i>Khalili Collection Instrument Catalogue</i> , p. 214, no. 124; <i>Berlin 1992 Exhibition Catalogue</i> , pp. 269-271; <i>Speyer 2004 Exhibition Catalogue</i> , pp. 242-243; <i>Paris IMA 2005 Exhibition Catalogue</i> , p. 102. (The entries in the exhibition catalogues are very short and of no scientific value.)

This is the sole surviving astrolabe with Judaeo-Arabic inscriptions. All indications seem to us to point to an Andalusian provenance *ca.* 1300, but it is impossible to prove this.⁶³

1 *The engraving*

All the inscriptions, in square Sephardic, are transliterated here according to the following schemes:

General remark: sometimes for the Arabic letter combination Al (*al*), that is, the definite article, a ligature is used; this is here represented by al under-

⁶³ If it could be shown that the piece postdates 1500, the provenance would probably be Maghribi.

lined; and sometimes a dot specifies a letter on the instrument – (for example, א and א); in these cases the dot is always written above the letter.

א	’, ā	ו	w, ū	מ, מ	m	ר	r
ב	b	ז	z	נ, נ	n	ש	sh
ב	v	ח	ḥ	ס	s	ש	ś
ג	g	ט	ṭ	ע	‘	ת	t
ג	gh	י	y, ī	פ, פ	p	ת	th
ד	d	כ	k	פ, פ	f		
ד	dh	ך, כ	kh	צ, צ	z		
ה	h	ל	l	ק	q		

Table 3: Standard transliteration scheme of the Hebrew alphabet.

ء	’	د	d	ط	ṭ	م	m
ا	ā	ذ	dh	ظ	ẓ	ن	n
ب	b	ر	r	ع	‘	ه	h
ت	t	ز	z	غ	gh	و	w, ū
ث	th	س	s	ف	f	ي	y, ī
ج	j	ش	sh	ق	q		
ح	ḥ	ص	ṣ	ك	k		
خ	kh	ض	ḍ	ل	l		

Table 4: Standard transliteration scheme of the Arabic alphabet.

א	أ, إ, ئ, ا, ي, ى, َ	ט	ط	פ	ف
ב	ب	י	ي, ى, َ	צ	س, ص, ض, ظ
ג	ج, غ	כ	ك, خ	ק	ق
ד	د, ذ	ל	ل	ר	ر
ה	ه, ی, ة, اء, َ	מ	م	ש	ش
ו	و, وا, ُ	נ	ن	ת	ت, ث, (؟)
ז	ز	ס	س, ص	א	◌ -
ח	ح, ه, (؟)	ע	ع	ן	◌ -

Table 5: Hebrew letters and their Arabic equivalents (based on all of the inscriptions on the astrolabe).

א	א	ד	ד	ט	ט	מ	מ	י	י
א	ה, א	ז	ז	ظ	צ	נ	נ	ئ	و
ב	ב	ר	ר	ع	ع	ה	ה	◌ -	ן, א, ַ
ג	ג, ט, ת	ז	ז	غ	ג	ו	ו		
ד	ת	ס, צ	ס, צ	ف	פ	י	י		
ה	ג	ש	ש	ق	ק	ة	ת, ה		
ו	ח	ص	ס, צ	ك	כ	ى	א, ה		
ז	כ	ض	צ	ل	ל	َ	א		

Table 6: Arabic letters and their Hebrew equivalents (based on all of the inscriptions on the astrolabe).

2 *The numerals*

The numerals are in the standard Hebrew alpha-numerical notation. There are, however, two exceptions: To avoid the Tetragrammaton J-H-W-H the numbers 15 and 16 are usually written as 9+6 and 9+7.⁶⁴

א	1	ט	9	ס	60
ב	2	י	10	ע	70
ג	3	טו	15	פ	80
ד	4	טז	16	צ	90
ה	5	כ	20	ק	100
ו	6	ל	30	ר	200
ז	7	מ	40	ש	300
ח	8	נ	50		

Table 7: Standard numerical values of the Hebrew letters.

3 *The mater*

The *throne* of the astrolabe appears to be a separate piece attached to the mater. Its front, back, and outer rim are decorated with a floral ornament that is polished in parts by use. On both sides of the throne, the rim of the mater is slightly and not symmetrically enlarged by two small humps. The *suspensory apparatus* consists of a shackle and a ring. The shackle resembles a mauresque arc. Its lower, rectangular part is also decorated with floral ornament. The shackle is connected to the mater by a rivet decorated with a star. The ring is plain. The *limbus* bears an alphanumerical scale for each five degrees, always written completely – *i.e.*, units, tens, and hundreds – with short strokes for the subdivisions for each 1°. On the outer rim a poem is inscribed (see the main text). The *inside of the mater* is engraved with astrolabic markings that will be discussed below together with the plates.

⁶⁴ See, for example, the article “Alphabet, Hebrew. Letters Used as Numbers” by David Diringer in *Encyclopaedia Judaica*, 2nd edn., p. 726b, and Ifrah, *Histoire universelle des chiffres*, I, pp. 528-529, and pp. 284-285 of the German version.

The *back of the mater* bears the following scales from the outer rim inwards:

- * four *altitude quadrants* comprising for each 5° a scale starting at the east-west-line and going up to 90° near and opposite the throne, and inside a scale with a short stroke for each 1°;
- * a *zodiacal scale* sharing the scale with a stroke for each degree with the altitude scales, and comprising a scale for every five degree from 5 to 30 for each sign, and the names of the zodiacal signs; in the box of Cancer אֶלְבוּרוֹג (i.e., البروج – *the zodiacal signs*) is added as a heading. The names of the signs are standard, but the Hebrew engraving is slightly different to that on the rete (see below).⁶⁵

	astrolabe	Arabic	
1	אל חמל	الحمل	Aries
2	אל תור	الثور	Taurus
3	אל גואזה	الجوزاء	Gemini
4	אֶלְסֶרְטָן	السرطان	Cancer
5	אל אסד	الأسد	Leo
6	אל סונבלה	السنبلة	Virgo
7	אל מיזן	الميزان	Libra
8	אל עקרב	العقرب	Scorpio
9	אל קויז	القوس	Sagittarius
10	אל גדי	الجدي	Capricorn
11	אל דלו	الدلو	Aquarius
12	אל חות	الحوت	Pisces

Table 8: The zodiacal signs on the back.

⁶⁵ See the article “Mintakat al-burūdj” by Willy Hartner & Paul Kunitzsch in *Encyclopaedia of Islam*, 2nd edn.

- * a *concentric calendrical scale* comprising a scale with a stroke for each day, a scale with complete alphanumerical inscriptions for every 5 days from 5 to 28, 30 or 31 days according to the length of the month, and a scale with the names of the Julian and Hebrew month in one box:⁶⁶

	Julian months astrolabe	number of days	Hebrew months astrolabe
3	מרס March	31	אדר Adar
4	אבריל April	30	ניסן Nisan
5	מאי May	31	אייר Iyyar
6	יוניו June	30	סיון Sīwan
7	יוליו July	31	תמוז Tammūz
8	אגשוט August	31	אב Ab
9	שוטנבר September	30	אילול Elūl
10	ויטובר October	31	תשרי Tishrī
11	נובאר November	30	מרחשון Markheshwan
12	דוגנבר December	31	כסליו Kislēw
1	יאניר January	31	טיבת Ṭēbeth
2	פבריר February	28	שבט Shebaṭ

Table 9: The month names on the back.

⁶⁶ On the names of the Julian months on Andalusī astrolabes see Maier, “Monatsnamen”, pp. 254-267.

- * an *incomplete scale for the lunar mansions* with partial inscriptions (the second half is empty), the names of the lunar mansions are standard:⁶⁷

	astrolabe	Arabic*	
1	א נטח (?)	ا- النطح	1 – <i>al-naṭḥ</i>
2	ב בטון	ب- البطين	2 – <i>al-buṭayn</i>
3	ג תוריא**	ج- الثريا	3 – <i>al-thurayyā</i>
4	ד דברן***	د- الدبران	4 – <i>al-dabarān</i>
5	ה הקעה	ه- الهقعة	5 – <i>al-haq'a</i>
6	ו הנעה	و- الهنعة	6 – <i>al-han'a</i>
7	ז דרעה	ز- الذراع	7 – <i>al-dhirā'</i>
8	ח נתרה	ح- النثرة	8 – <i>al-nathra</i>
9	ט טרף	ط- الطرف	9 – <i>al-ṭarf</i>
10	י	ي	10
11	יא (?)	يا	11
12	יב	يب	12
13	יג	يج	13
14	יד	يد	14
15	טו	طو	15

Table 10: The lunar mansions on the back.

* The dot of the נ in א נטח is below the letter.

** Or תוריא with the number in Arabic?

*** Or דברן ?

- * a *shadow box* in the lower right quadrant to base 12 (digits) bearing the inscriptions אַלְצֶל אֶלְמַנְכוּס (*i.e.*, الظل المنكوس – *the vertical shadow*), and אַלְצֶל אֶלְמַבְסוּט (*i.e.*, الظل المبسوط – *the horizontal shadow*) and labelled in steps of two units in Hebrew alpha-numerical.

⁶⁷ See the article “Manāzil” by Paul Kunitzsch in *Encyclopaedia of Islam*, 2nd edn.

The vernal equinox on the solar scale is on 14th March. This date corresponds to the year 1079 in the astronomical, and to the year 1143 in the civil calendar.⁶⁸ Taking into account some inaccuracies the period covered could be from 1015 to 1205. But these dates should not be taken too seriously as a date for the astrolabe. There are several main reasons for the unreliability of the date of the vernal equinox taken from an astrolabe:⁶⁹

- * the ability of the maker to deliver the accuracy he seeks, and
- * the ability of the researcher to read off the date the maker intended,
- * the use of an earlier epoch rather than an exact date,
- * the differences in the beginning of the day in the civil and the astronomical calendar (at midnight and at midday), and
- * the saw-tooth pattern of the movement of the point of Aries on account of the leap year,
- * the use of out-of-date texts and tables by instrument makers – and, one may add,
- * the tradition of copying earlier instruments.

At present we know five instruments where the vernal equinox is on March 14, but only three of them are dated:

- * the astrolabe made by Ibrahīm ibn Sa‘īd ibn al-Sahī in Toledo in 460 H [= 1067/68] (#118),⁷⁰
- * the astrolabe made by Abū Bakr ibn Yūsuf in Marrakesh in 605 H [= 1208/09] (#124),⁷¹
- * a *quadrans novum* dated 1415 (#2111),⁷²
- * a later Western astrolabe made by ‘Uthmān ibn ‘Abdallāh al-Ṣaffār (#1077),⁷³ and
- * an early, but undated and unsigned French astrolabe (#420).⁷⁴

In brief, as is the case with many medieval instruments, the date of the vernal equinox does not help us much.

⁶⁸ See Michel, *Traité*, pp. 139-140.

⁶⁹ See Turner, “Dating Astrolabes”, pp. 548-551.

⁷⁰ Price, *Checklist*, p. 363.

⁷¹ *Ibid.*

⁷² Turner, “Dating Astrolabes”, p. 552.

⁷³ Price, *Checklist*, p. 363.

⁷⁴ King, *In Synchrony with the Heavens*, XV, p. 888.

4 *The rete*

The *ecliptic ring* is inscribed with the names of the zodiacal signs, their names are standard, but the Hebrew writing is slightly different to the engravings on the mater.⁷⁵

	astrolabe	Arabic	
1	אל חמאל	الحمل	Aries
2	אלתור	الثور	Taurus
3	אלגואה	الجوزاء	Gemini
4	אלסראטן	السرطان	Cancer
5	אלאסד	الأسد	Leo
6	אלסונבלה	السنبلة	Virgo
7	אל מזאן	الميزان	Libra
8	אל עקרב	العقرب	Scorpio
9	אל קאוזן	القوس	Sagittarius
10	אל גדי	الجدي	Capricorn
11	אל דלו	الدلو	Aquarius
12	אל חות	الحوث	Pisces

Table 11: The zodiacal signs on the rete.

The *equinoctial bar* is counter-changed symmetrically four times, on both sides of the ecliptic as well as in between the ecliptic, more or less in the middle between the centre and the ecliptic.

The *lower equatorial bar* is simple and plain. A rectangular frame is integrated in the upper part of the rete. It fits in the space between the equinoctial bar and the upper part of the frame of the ecliptic circle. It has two extensions, a simple incomplete trefoil in the middle of the top and circumferences of a quarter of a circle where the lower ends of the frame are connected with the ecliptic. A similiar, but much more elaborate frame

⁷⁵ See the article “Mintakat al-Burūdj” by Willy Hartner & Paul Kunitzsch in *Encyclopaedia of Islam*, 2nd edn.

is featured on the Catalan astrolabe of the Society of Antiquaries in London (#162; see fig. 7), which also seems to date from *ca.* 1300.⁷⁶

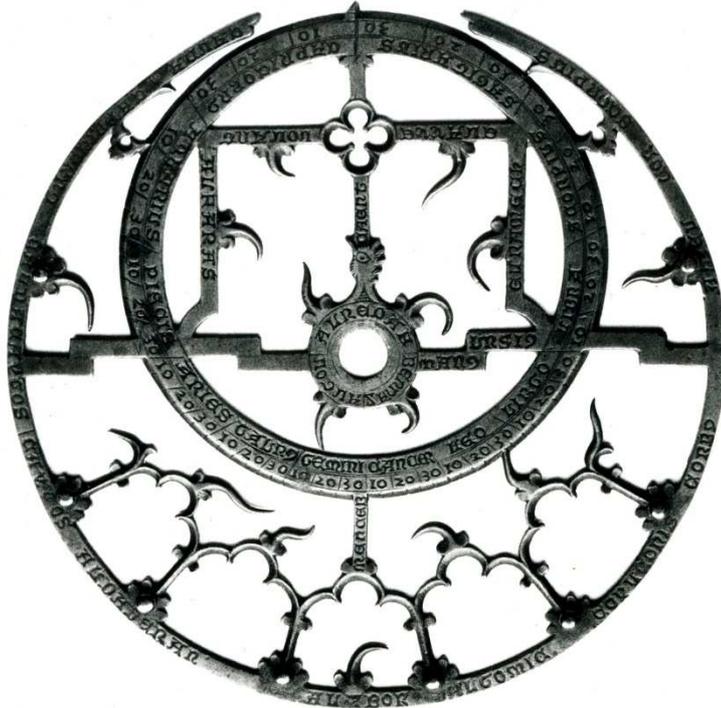


Fig. 7: The design of this rete on a Catalan astrolabe from *ca.* 1300 is of a type that inspired the Judaeo-Arabic rete. The quatrefoil and the “rectangular” frame in the upper ecliptic ring of the former are less carefully worked on the latter. [Image from the archives of the Institute for History of Science, Frankfurt.]

The 26 *star pointers* are dagger-shaped. Their bases are perforated – some of them still contain one or three silver inlays – and have smooth edges.

⁷⁶ See fig. 7 and King & Maier “Catalan Astrolabe”, pp. 679 and 713.

	astrolabe	correct Arabic	modern designation	A ⁷⁷ / B ⁷⁸ / C ⁷⁹	
1	צהר קיטוס	ظهر قيطوس	ظهر قيطوس	ζ or π Cet (?) ⁸⁰	– / a8 / IV 1 (?)
2	ראסגול	راسغول	رأس الغول	β Per (Algol)	– / a14 / IV 2
3	עיוק	عيوق	العَيُوق	α Aur (Capella)	47 / a20 / IV 5
4	דבארן (!)	دبارن	الدبران	α Tau (Aldebaran)	69 / a18 / IV 3
5	רגלאגואוה*	رجلاجوزاء	رجل الجوزاء	β Ori (Rigel)	251a / a19 / IV 6
6	מנכבגואוה*	منكبجوزاء	منكب الجوزاء	α Ori (Betelgeuze)	158 / a22 / IV 7
7	עבור	عبور	العبور	α CMa (Sirius)	289a / a23 / IV 8
8	גומיסה	غوميصاء	الغُميصاء	α CMi (Procyon)	290a / a25 / IV 9
9	ידדוב	يددوب	يد الدب	ι UMa (?) ⁸¹	– / a28 / IV 10
10	שוגע	شوجع	الشجاع	α Hya	– / a29 / IV 11
11	רגלדוב	رجلدوب	رجل الدب	μ UMa (?) ⁸¹	– / a28 / IV 13
12	קלבאלאסד	قلبالاسد	قلب الأسد	α Leo (Regulus)	– / a30 / IV 12
13	גנחאלגוראב**	جنحالغوراب	جناح الغراب	γ Crv	– / a36 / IV 14
14	אעזל***	اعزل	الأعزل	α Vir (Spica)	269 / a39 / IV 15
15	סמידראמיח	سميكراميح	السماك الرامح	α Boo (Arcturus)	270 / a41 / IV 17
16	עונוקאלחאיה	عونوقالحاية	عنق الحية	α Ser	– / 196 / IV 19
17	פכה (?)	فكة	الفكّة	α CrB	85 / a45 / IV 18
18	קלבאלעקרוב	قلبالعقرب	قلب العقرب	α Sco (Antares)	216a&b / a48 / IV 20
19	אלחוא	الحواء	الحواء	α Oph	– / a51 / IV 21
20	נציר וקיע	نسير وقيع	النسر الواقع	α Lyr (Vega)	195a / a53 / IV 22

⁷⁷ According to Kunitzsch, *Sternnomenklatur, passim*.

⁷⁸ According to Kunitzsch, *Sternnamen, passim*.

⁷⁹ According to Kunitzsch, *Sternverzeichnisse*, esp. pp. 31-33: type IV is probably of Spanish provenance, compiled by Johannes Hispalensis (Toledo, mid 12th c.).

⁸⁰ Probably mistaken for صدر قيطوس – *šadr qaytūs* (π Cet)? Or is متن قيطوس – *matn qaytūs* another name for ظهر قيطوس – *zahr qaytūs* which we find at this place on the Andalusī astrolabe of Muḥammad ibn Fattūḥ al-Khamā'irī (#130)? See also note 82.

⁸¹ *yad al-dubb* and *rijl al-dubb* seem to belong to a Western Islamic tradition: On one of the astrolabes (#123 = #1167) made by Ibrāhīm ibn Sa'īd ibn al-Sahlī those two stars are engraved; *rijl al-dubb* (μ UMa) is also listed on the Andalusī astrolabe of Muḥammad ibn Fattūḥ al-Khamā'irī (#130); more examples in Kunitzsch, “Three Dubious Stars”, pp. 66-69.

	astrolabe	correct Arabic	modern designation	A ⁷⁷ / B ⁷⁸ / C ⁷⁹
21	אלנציראֶלְטֵאִיר	النسير الطائر	α Aql (Altair)	194a / a54 / IV 24
22	רדף רדף (?)	الردف	α Cyg (Deneb)	248 / a56 / IV 25
23	זהדאלפרס (?)	ظهر الفرس	α or ε Peg or α And (?) ⁸²	– / a63 or a1 / –
24	דנב אֶלְגֵדִי	ذنب الجدي	δ Cap	– / a59 / IV 26
25	מנכב פרס	منكب الفرس	β Peg (Scheat)	– / a62 / IV 27
26	דנב קאיטוס	ذنب قيطوس	β oder ι Cet ⁸³	– / a62/a4 / IV 29

Table 12: The names on the star pointers.

* Or אֶלְגֵאוֹזָה ?

** Or גנהאֶלְגֵורֵאב ?

*** The star pointer is broken.

5 The plates

The astrolabe mater contains three plates for specific latitudes; additional astrolabic markings are engraved on the mater itself. These show the standard inscriptions:

- * at the east-west line: מִשְׁרֵק (i.e., مشرق – *sunrise*) (left part) – מִשְׁרֵק on the plates for Cairo and Jerusalem –, and מִגְרֵב (i.e., مغرب – *sunset*) (right part);
- * at the north-south line: הדה כט אֶלְזוֹל (i.e., خط الزوال هذا – *this is the line of midday*) (opposite the throne) – אֶל (?) is omitted on the plate for Sijilmasa.

⁸² Probably mistaken for سرّة الفرس – *surrat al-faras* (α And)? Or is ظهر الفرس – *zahr al-faras* another name for the more common الفرس متم – *matn al-faras* (see Kunitzsch, *Sternnamen*, pp. 176-177, no. 122 and p. 85, no. a63; and also note 80 above, where a possible change from ممتن قيطوس – *matn qaytūs* to ظهر قيطوس – *zahr qaytūs* is discussed), although ظهر الفرس – *zahr al-faras* (γ Peg) appears only in al-Battānī? See also Kunitzsch, *Almagest*, p. 257, no. 224.

⁸³ βι Cet are the southern and the northern stars in the tail of the whale. „Obwohl im Orient Šūfī ausdrücklich ι als Astrolabstern bezeichnet hatte, wird auch dort gelegentlich β benutzt [...]“ (Kunitzsch, *Sternnamen*, p. 66-67, no. a4 and a6); Stautz, *Untersuchungen*, pp. 53 and 60 also identifies *dhanab qaytūs* with ι Cet.

The azimuths are engraved for each ten, and the almukantarar for each five degrees, both labelled in Hebrew alpha-numerical.

The hour lines are labelled as ordinals (up to ten) and Hebrew alpha-numerical (7, 11 and 12) because of less space in these cases with exception of the mater M, where *seven* is written in words.

1	אלאולה	الأولى
2	אלתאניה*	الثانية
3	אלתליתה**	الثالثة
4	אלרביעה	الرابعة
5	אלכמיסה***	الخامسة
6	אלסדיסה†	السادسة
7	אל צ‡	السابعة
8	אלתמינה††	الثامنة
9	אלתסיעה‡	التاسعة
10	אלעשירה‡‡	العاشرة
11	אל יא	
12	אל יב	

Table 13: The hours on the plates.

* (‡) אלתאנה on plate 1a.

** אלתלתה on plate 1a.

*** אלכמסה on plate 1a.

† אלסדסה on plate 1a.

†† אלסבעה on plate M; missing on plate 1b (?); אל צ on plate 3b.

††† אלתמנה on plates 1a, 1b, and 3b.

‡ אלתסיעה on plates 1a, 1b, and 3b.

‡‡ אלעשרה on plates 1a, 1b, and 3b.

The plates are made for places in al-Andalus and the Maghrib engraved with לערץ (*i.e.*, لعرض – *for the latitude of*) followed by the name of a city and the corresponding geographical latitude written in Hebrew alpha-numerical. But they seem to be confused: The values engraved on the plates differ from the values roughly counted by using the altitude lines.

To explain the discrepancy in the geographical latitudes, it seems conceivable that the maker used a list of latitudes of various localities. After preparing the plates he combined the wrong inscriptions with them. In any case, this confusion means that the instrument is useless for practical purposes. Plates 1 and 2 are less carefully engraved than M and 3. This suggests that the instrument was made in Seville or Cordoba or possibly even in Tunis.

	astrolabe		cities	φ (stated)	φ (actual)
1a	סגלמסה כט	سجلمسة كط	Sijilmasa	29°	≈ 29°
2a	מסר ל	مصر ل	Cairo	30°	≈ 32°
1b	מרכוש לא	مركوش لا	Marrakesh	31°	≈ 30°
2b	בת אלמקדס לב	بت المقدس لب	Jerusalem	32°	≈ 29°
M	תונוס לז (?)	تونوس لז	Tunis	37° (?)	≈ 36°
3a	שבליה לז ונצף	شبلية لז ونصف	Seville	37:30°	≈ 40°
3b	כורדבה לח ונצף	كوردبة لح ونصف	Cordova	38:30°	≈ 37°

Table 14: The geographical information on the plates.

6 *The Alidade*

The *alidade*, the pin, and the horse are missing.

7 *Summary*

Although the Judaeo-Arabic astrolabe is neither dated nor signed, it provides us with several hints at the place and time of its making.

First, the design of the *rete* features elements of Andalusí or Maghribí style (for other examples see below in the appendix):

- * an equinoctial bar counter-changed symmetrically four times,⁸⁴
- * a circle between the equatorial bar and the rim,⁸⁵
- * the bases of the star pointers decorated with silver inlays,⁸⁶ and
- * a rectangular frame in the upper part of the rete.⁸⁷

Second, the *calendrical scale* on the back of the astrolabe is typically Western Islamic.⁸⁸ But the combination of the Julian and the Hebrew month names in one box does not provide further information, rather it raises new questions: Why are the lengths of the solar months of the Julian calendar also applied to the lunar months of the Hebrew luni-solar calendar? Besides it appears to be rather strange to combine the Hebrew luni-solar calendar with the Julian – pure – solar calendar in such a scale. Most of the time inbetween, the Hebrew 19-year leap cycle is not in synchrony with the Julian calendar.

Third, the *star list* used is similar to a list compiled by Johannes Hispalensis in Toledo in mid-12th c. that is based on Arabic sources. The Catalan astrolabe of the Society of Antiquaries in London (#162) that has a similar square frame in the upper part of the ecliptic, has only 20 star pointers, beside others *man⁹ ursi⁹* for *manus ursinus (sic!)* (يد الدب).

⁸⁴ King, *In Synchrony with the Heavens*, XV, p. 874-875: "This arrangement (the counter-changes on the horizontal bar – PGS) is found on seven 11th-century Andalusi astrolabes (including #1099), and some later, but still early European instruments (#428 from France; #191, a composite piece of uncertain origin(s), but with a rete possibly reworked from an Andalusi one; and #558 of uncertain provenance." and *ibid.*, note 135: "[...] The two earlier Andalusi astrolabes, #110 and #4024, have simpler (single) counter-changes, which is already a development beyond the straight bars on the earliest Eastern Islamic astrolabes." *Munich Catalogue*, p. 145: "[...] 20 vollständigen oder teilweise erhaltenen westislamischen Astrolabien, die aus der Zeit vor dem Jahr 1100 stammen. Der Äquinoktialsteg der Rete dieser Stücke ist in der Regel vierfach versetzt."

⁸⁵ King, *In Synchrony with the Heavens*, XV, p. 875: "A small circle similar to the one at the bottom of this rete is found already on 11th-century Andalusi astrolabes (such as #116 and #123) and on some astrolabes of al-Khamā'irī of Seville ca. 1220 (such as #130, #139 and #153), as well as on #4182, made in Fez ca. 1320 [...]. On the Andalusi piece #154, dated 638 H [= 1240/41], this circle is replaced by a quatrefoil, which may have been the original design. Only on one other European astrolabe, #420, a very early piece of uncertain provenance (ca. 1200, if not earlier), does this small circle reappear. However, it also features on the astrolabe illustrated in the 13th-century *Libros del saber de astronomía* of Alfonso X."

⁸⁶ See King, *In Synchrony with the Heavens*, XV, p. 889.

⁸⁷ See fig. 7 and note 76.

⁸⁸ See King, *In Synchrony with the Heavens*, 2005, XV, p. 888.

Fourth, the cities mentioned on the *plates* include two Andalusi cities (Seville, Cordova) and three Maghribi ones (Sijilmasa, Marrakesh, and Tunis). Plates M for Tunis, and 3a and 3b for Seville and Cordoba are more carefully engraved than the other plates pointing to a maker working in one of those three cities.

It is difficult to connect the use of Judaeo-Arabic on the Iberian Peninsula with the long history of the *reconquista*. The rule of thumb that the more the Jewish communities came under Christian rule, the less Judaeo-Arabic was used, is rather weak.⁸⁹ But nevertheless this could point to a *terminus ante quem* – in 1492 Granada, the last stronghold of the Muslims on the Iberian Peninsula, was conquered.⁹⁰ If the astrolabe is later than *ca.* 1500 then it is rather of Maghribi than Andalusi provenance.

The Judaeo-Arabic astrolabe seems to have been copied from an Andalusi piece around 1300.⁹¹ But it is fruitless to speculate if this original was inscribed with Arabic or Hebrew letters. Some of the mistakes found on the astrolabe could be explained by a possible scenario in which the instrument-maker wanted to copy an Andalusi astrolabe, but could neither read Arabic nor write it. Possibly the inscriptions were dictated to him. This suggestion would explain his way of writing the Arabic in Hebrew letters as it is, for example, one letter been used for four different sibilants, or endings written as separate words.⁹²

⁸⁹ The article “Judaeo-Arabic Literature” by Abraham Solomon Halkin in *Encyclopaedia Judaica*, 2nd edn., p. 536: “In Spain, Christendom’s final victory over Islamic power in 1212 led to the gradual elimination of Arabic from Jewish life in favor of the Romance languages in daily intercourse, and of Hebrew in writing. During the 11th and 12th centuries, the continuous shift of the Jewish population from Andalusia to Christian territory, where Arabic had never been the dominant language, accelerated the abandonment of Arabic. However, knowledge of the language remained essential for the translation of texts on philosophy and logic, medicine, mathematics, and astronomy into Hebrew, Latin, and Spanish.”

⁹⁰ The article “Naşrids, 1. History” by J. D. Latham in *Encyclopaedia of Islam*, 2nd edn.; Córdoba was conquered by Ferdinand III (1199-1252) in 1236, Sevilla in 1248 (see the articles “Kurtuba” by C. F. Seybold & M. Ocaña Jiménez, and “Ishbīliya, 1. History” by J. Bosch-Vila in *Encyclopaedia of Islam*, 2nd edn.).

⁹¹ Also Maier & King, “Catalan Astrolabe”, p. 681: “There is a degenerate quatrefoil on the rete of the astrolabe with inscriptions in Judaeo-Arabic (#3915), which is a clear indication that there was a quatrefoil on the Islamic astrolabe from which it was copied.”

⁹² Contradictory to this hypothesis of a presumable dictation is the general knowledge of Arabic scientific literature among educated Jews (see Blau, *Emergence*, p. 36: “[...] the common basis of Arabic and Judaeo-Arabic culture was provided by philosophy and science”). Probably the writing of דבארן for *al-dabarān* contradicts the scenario of dictating because it looks like a writing or copying mistake.

We should bear in mind that this particular piece made by a Jewish craftsman is surely one of many that were constructed with Judaeo-Arabic inscriptions, but it is the only one to have survived the vicissitudes of time. It remains a precious testimonial to the scientific *convivencia* in medieval al-Andalus.

Appendix C

List of astrolabes with Hebrew inscriptions (by DAK)

(1)-(3) Besides the piece with Judaeo-Arabic inscriptions, there are three Hebrew astrolabes with quatrefoil decoration, clearly Spanish,⁹³ the first and second well made and elegantly decorated and probably 14th century, the third less carefully worked and probably 15th century. No comparative study of the three pieces has been conducted yet.

(1) #158 – London, British Museum, inv. no. 93 6-16 3 – Gunther, *Astrolabes of the World*, II, p. 304 (no. 158 “Spanish Jewish”); brief description in *London BM Catalogue*, pp. 113-114 (no. 328: “Spanish-Moorish”!).

(2) #3906 – Paris, J. Kugel collection, formerly Portugal, private collection – detailed description in Bandeira Ferreira, “Astrolábio hebraico”. (Star-names in a mixture of Hebrew and Judaeo-Arabic.)

(3) #159 – Chicago, Adler Planetarium, inv. no. M-20 – Gunther, *Astrolabes of the World*, II, p. 304 (no. 159); detailed descriptions in Goldstein, “Hebrew Astrolabe”, and *Chicago AP Catalogue*, pp. 58-60 (no. 7: “Europe”, “c. 1550”). (Additional markings on plates for Paris and Bologna.)

On the quatrefoil decoration on (1) and (3), see King, *In Synchrony with the Heavens*, XVII-4.

(4) An astrolabe from 14th-century Toledo (?) with inscriptions by a Jew, a Christian and a Muslim – #4560 – present location unknown – detailed descriptions are in King, “An Astrolabe from 14th-Century Christian Spain

⁹³ The second author (DAK) has previously argued that these may be Italian. The main reason was that on #159 the names of the cities Paris and Bologna were engraved on two of the plates in a later hand. (The astrolabes are certainly not French.) However, the names of the Julian months, as well as the use of some Judaeo-Arabic star-names on #3906, betray a Spanish provenance.

with Inscriptions in Latin, Hebrew and Arabic”, and *idem*, *In Synchrony with the Heavens*, XV.

(5) A medieval European astrolabe with the inscriptions on the back of the mater in Hebrew – #621 – Munich, Deutsches Museum, inv. no. 5178 – detailed description in *Munich Catalogue*, pp. 161-176 (no. 2).

(6) An Andalusī astrolabe with a replacement rete bearing crudely-engraved Hebrew star-names – #2572 – Washington, National Museum of American History, inv. no. 318178 – see *Washington NMAH Catalogue*, pp. 174-177 (no. 2572), and Goldstein & Saliba, “Astrolabe with Hebrew Star Names”, also Lacerenza, “Il ragnò ebraico dell’astrolabio di Ibn al-Sahlī”.

(7) An astrolabe of uncertain date and provenance with Maghribī Arabic and additional Hebrew and Latin inscriptions – #4590 – Palermo, private collection (?) – unpublished.

(8) A medieval English astrolabe, possibly from Oxford, with an owner’s mark in Hebrew – #293 – London, Science Museum, inv. no. 1880.26 – Gunther, *Astrolabes of the World*, II, pp. 469-471 and pl. CXXVIII (no. 293).

(9) Additional geographical inscriptions in Hebrew are found on an 11th-century Andalusī astrolabe – #116 – Berlin, Deutsche Staatsbibliothek, Preußischer Kulturbesitz, Orientabteilung, inv. no. 6567 (Sprenger 2050) – Woepcke, “Arabisches Astrolabium”, also Gunther, *Astrolabes of the World*, I, pp. 251-252 (no. 116).

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