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ON THE DATING OF THE LATIN ASTROLABE OF THE PREACHING FRIARS IN THE MUSÉE DES ARTS PRÉCIEUX IN TOULOUSE

Eric Mercier

Société Astronomique de France (CCS), 3 Rue Beethoven 75016 Paris, France.

E-mail: eric.mercier@aucadransolaire.fr

Abstract: The aim of this paper is to discuss the dating recently proposed by Davoust (2024) for the astrolabe of the Preaching Friars in the Musée des Arts Précieux in Toulouse (France). The proposed dating (1550 +/- ?) is based on an assessment of precession. I show that a detailed study of the star positions on the rete, supplemented by various scientific and historical criteria, suggests that this dating is not acceptable; in fact, it remains uncertain, but we can assume that the instrument was made one or two centuries earlier.

Keywords: planispheric astrolabe; dating; precession of equinox; medieval astronomy.

1 INTRODUCTION

Over the centuries, planispheric astrolabes have lost their accuracy due to the drift of certain astronomical parameters, the main ones being: (1) the apparent shift in the position of the stars in relation to the point gamma (precession), and (2) the shift in the Julian Calendar in relation to the seasons. Most astrolabists of past centuries, no doubt aware of these problems, took the precaution of dating their works. However, there are some undated astrolabes in collections. It is of course tempting to try and use one or other of these drifts to date these instruments. It was by using precession that Davoust (2024) proposed a date for a magnificent astrolabe preserved in Toulouse (Musée des Arts Précieux Paul Dupuy). But the method he uses is simplistic and flawed. What is more, and curiously, the paper does not mention the bibliography on the subject or the discussions that have taken place between specialists. I therefore felt it necessary to revisit the question of assessing the precession recorded on this instrument, and hence its dating.

2 DATING PLANISPHERIC ASTROLABES BY PRECESSION

Over the centuries, the ecliptic longitude of the stars change, while the ecliptic latitude remains fixed overall. By measuring this celestial coordinate of the stars on an astrolabe's rete, it is possible to determine the precession of the equinoxes and therefore, theoretically, the date of construction. This method was theorised by Michel (1947: 142–148) and systematically used by Price (1955: 249) for the first edition of the International Checklist of Astrolabes. It was then adapted to computer calculations by Torode (1989; 1992). Poulle (1956) and Dekker (1992) both vigorously opposed this method. These two authors consider that the positions of the stars on the ancient astrolabes were not established by contemporary observations, but that they were calculated when the star tables in the manuscripts were copied. But these manuscripts are riddled with errors. Poulle (1956) gives the example of Medieval European tables that use the same value of precession as tables calculated 150 years earlier. Dekker (1992), citing Kunitzsch (1980), makes the same observation for Arabic tables written 250 years apart. In addition, they both insisted on the fact that the value of the variation in precession accepted by Medieval authors was often erroneous. The ancient calculations could therefore only be wrong. For these authors, the position of the stars on Medieval astrolabes cannot tell us anything about their age.

More recent studies, based this time on the study of the instruments themselves and in particular dated instruments, have made it possible to qualify this conclusion. A comparison between the position of the stars on the rete and the expected position (calculated by modern means for different moments in the past) shows that:

(1) The stars on Eastern Arab–Muslim astrolabes are generally placed very imprecisely, and no dating based on their positions is possible (Mercier, 2018a; Stautz, 1996).
(2) The study of dated Maghreb–Andalusian astrolabes reveals numerous errors in the position of stars, but these concern a limited number of stars whose corrupted coordinates seem to have survived the centuries. The majority of stars are generally well placed, and no systematic drift, which would indicate that precession has not been properly taken into account, can be detected. On dated astrolabes, the position of these stars makes it possible to calculate a date of manufacture close to that inscribed on the instrument (often less than 50 years apart; Mercier, 2018a; 2018b).
(3) Medieval European astrolabes generally contain the same stars as the preceding instruments, which underlines their com-

mon dependence on the star list of the Maslama al-Majriti treatise (see Kunitzsch, 1966). On the astrolabes of this group, the stars are generally imprecisely located (Stautz, 1996) and here again no dating based on their positions is possible.

(4) European astrolabes from the sixteenth century onwards, including the instruments of the 'Flemish School' (Van Cleempoel, 2002), bear witness to the emancipation of European astronomy from Arab–Muslim science. The stars were no longer those of the Arab–Muslim tradition, and the précision of their location was very good (Stautz, 1996; Torode, 1992).

As a result, and particularly since the work of Dekker (2013: Figure 4.9), which showed an excellent account of precession on Arab–Muslim celestial globes from the medieval period, scholars have stopped categorically rejecting the dating of astrolabes by precession (see, for example, Strano, 2017, Mercier, 2018b, and Dekker, 2024).

3 DATING THE ASTROLABE OF THE PREACHING FRIARS

The aim of the paper by Davoust (2024) was to date the instrument using the positions of the stars. As the stars are not named on the instrument, Davoust had to identify them on the basis of their positions. He therefore drew up a list of *a priori* possible stars (reference stars) and postulated that each pointer represents the nearest star that can be found on the reference list. As he himself points out, the list of astrolabe stars he has drawn up in this way does not include some of the stars most frequently represented on astrolabes of all periods (Davoust, 2024: Figure 7). In fact, this approach of recognising the stars of the rete on the basis of their position had already been used by Torode (1989), but it is open to criticism because it amounts to considering *a priori* that the implantation errors are small and that it is the nearest star in the reference list that is targeted by the pointer. However, the study of Medieval rete suggests the opposite, as errors are often significant (Mercier, 2018a; Stautz, 1996).

In fact, the stars on Medieval Arab–Muslim astrolabes, like those on European astrolabes, are very generally those on the list in Maslama el-Majreti's treatise. If the astrolabe of the Preaching Friars was indeed inspired by an Arab–Muslim astrolabe, the list of 'reference stars' that was used corresponds to this list. The manuscript transmission of this treatise throughout the Middle Ages, whether Arabic–Muslim or Latin, explains why several versions exist, although they remain very similar (see Laffitte, 2012; Poulle, 1956; Samso, 2000; Vernet and Catala, 1965; and above all Kunitzsch, 1966, who has studied the different 'types' and their evolution). Table 1 shows the changes in attribution that I suggest, based on Maslama el-Majreti's list. There are 14 of them, to which must be added four stars that I have not been able to identify.

Figure 1 shows the expected positions of the 30 identifiable stars according to the period. These positions form 'strings of points'. These points correspond to increasingly recent positions in the counter-clockwise direction. It should be noted that an increment of one century (equidistance of the points of a 'strings of points') corresponds, on the astrolabe studied, to a very small variation in the position of the pointer (var-

Table 1: List of stars in the astrolabe studied here (see Davoust, 2024: Figure 5) with the attributions of this author and the suggested modifications taking into account the list of Maslama el-Majreti. It should be noted that four pointers remain unattributable.

No.	Davoust (2024)	This study		Davoust (2024)	This study
1	Alpha Cassiopeiae	Beta Cassiopeiae	18	Gamma Ursa majoris	Alpha Ursus maj.
2	Beta Ceti	Iota Ceti	19	Gamma Corvi	*idem*
3	Beta Andromedae	?	20	Alpha Virginis	*idem*
4	Alpha Persei	*idem*	21	Eta Bootis	Alpha Bootis
5	Gamma Eridani	Pi Ceti	22	Epsilon Virginis	?
6	Alpha Tauri	*idem*	23	Alpha Coronae Borealis	*idem*
7	Alpha Aurigae	*idem*	24	Beta/Delta Scorpii	Alpha Scorpii
8	Beta Orionis	*idem*	25	Sigma Herculis	?
9	Alpha Orionis	*idem*	26	Alpha Herculis	Alpha Serpentis
10	Alpha Canis majoris	*idem*	27	Alpha Ophiuchi	*idem*
11	16 Lyncis	Alpha Geminorium	28	Delta Cygni	Alpha Lyrae
12	Alpha Canis minoris	*idem*	29	Theta Aquilae	Alpha Aquilae
13	Beta Cancri	Alpha Cancri	30	Alpha Cygni	*idem*
14	Iota Ursa majoris	*idem*	31	Beta/Psi/ Rho Capricorni	Delta Capricorni
15	Alpha Hydrae	*idem*	32	Eta Pegasi	*idem*
16	Phi Leonis	Alpha Crateris	33	Bet. Pegasi /Delt. Aquarii	?
17	Xi Ursa majoris	Nu Ursus majoris	34	Alpha Pegasi	*idem*

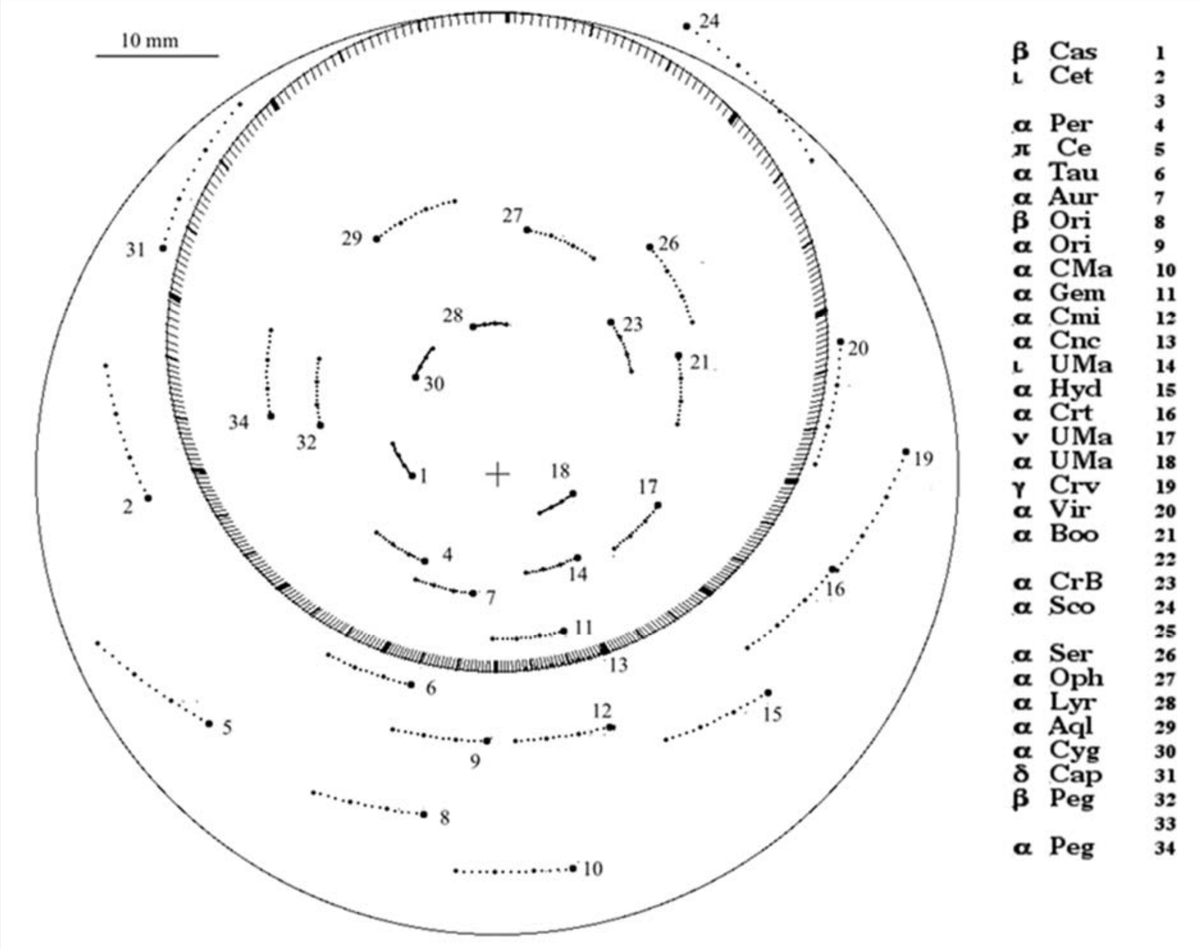

Figure 1: Diagram of the rete and expected location of the 30 identifiable stars in Table 1, according to time period. For each star, identified by its number (Table 1), the position is indicated for each new century, from 500 to 2000 AD. The years 500, 1000 and 1500 are marked by a bold dot and the year 2000 by a black disc (author's modelling).

iation of 0.3 mm for star No. 28 to 0.9 mm for star No. 5). By superimposing this image on that of the rete, we can theoretically deduce the age of the star table used to construct it. To do this, the two images need to be brought to the same scale, using the diameter of the ecliptic as a reference point (see Figure 2). But generally, and this is the case here, the instrument's ecliptic is not perfectly circular, so the superposition of the images is partly uncertain. This increases the margin of error for dating.

At this stage, two approaches are possible: we can test different dates (with any increment over a wide range of dates) and choose the one that minimises the differences in position. This is the method chosen by Davoust (2024), who obtained the date 1550. But this method, which is purely statistical, amounts to giving the same importance to stars that are obviously badly placed as to those that are not. It is clear, for example, that a rete in which half the stars indicate the fifteenth century, and the other half the seventeenth century, does not lead to the conclusion that the instrument is from the sixteenth century ... it is simply an imprecise rete that is impossible to date.

Personally, I think that before using statistics, you need to select the stars, and in particular to exclude those whose ecliptic latitudes are wrong, on the basis that if this parameter is wrong, there is no reason to think that the ecliptic longitude, which is the indicator of precession, is correct.

Figure 2 illustrates this filter and the resulting sorting. It shows

(1) Stars on the rete that have not been assigned (3, 22, 25, 33).
(2) Stars that are traditionally misplaced on medieval astrolabes (2, 5, 16, 19, 24, 26, 31) (see Mercier, 2018a) and which correspond to errors that have survived the centuries.
(3) Stars that are not positioned on a ‘strings of points’ and therefore have an ecliptic latitude error (1, 11, 13, 15, 17, 18, 20, 21, 27, 28, 29, 34).
(4) Stars positioned on a ‘string of points’ that therefore have a credible ecliptic latitude

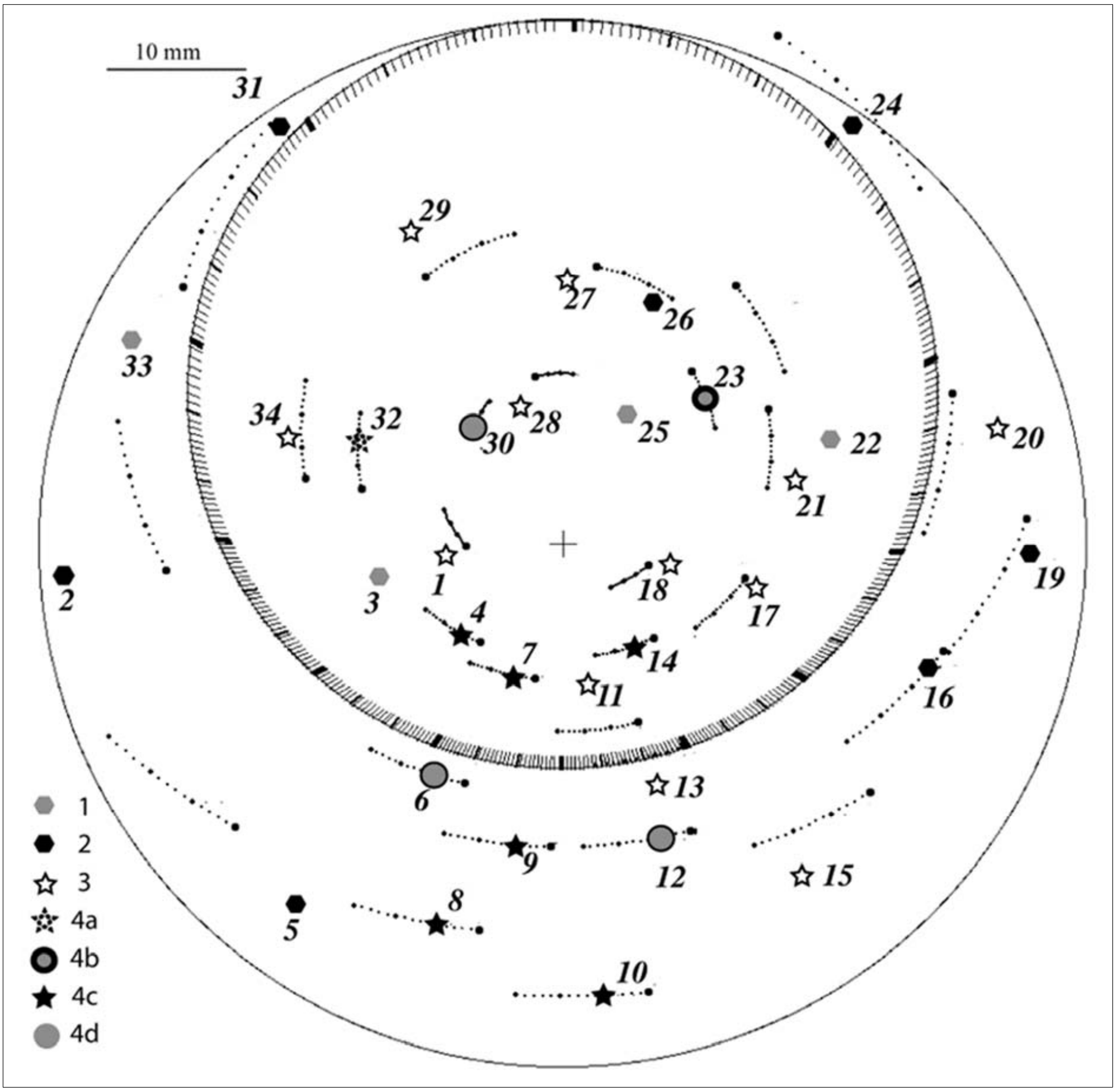

Figure 2: Comparison between the position of the stars in the rete and the 'strings of points' of possible positions expected (see text).

and whose longitude can be expected to be a date indicator. One star indicates the tenth century (4a: 32), one the fifteenth century (4b: 23), six the sixteenth century (4c: 4, 7, 8, 9, 10, 14) and three the seventeenth century (4d: 6, 12, 30).

Ultimately, only six stars are compatible with the dating proposed by Davoust (2024): the middle of the sixteenth century. These stars represent only 18% of the astrolabe's stars; 82% indicate another date or are poorly located. By way of comparison, on Maghrebo–Andalusian dated astrolabes, 40–100% of the stars provide a date compatible with that engraved on the instrument (Mercier, 2018a). My conclusion is that the rete studied here escapes scientific analysis, and dating from this part of the instrument is illusory.

4 OTHER ELEMENTS FOR DATING THE ASTROLABE OF THE PREACHING FRIARS

As several authors have pointed out (Dekker, 1992; Michel, 1947; Poulle, 1956, etc.) it is advisable to use several criteria to date an astrolabe, and limiting oneself to a single criterion is a source of error. So let's look at some of the other features of the astrolabe of the Preaching Friars that might indicate when it was made.

4.1 The Date of the Spring Equinox in the Julian Calendar

On the back of the mater, an examination of the double calendar (Julian / Zodiac) shows that the vernal equinox is located between graduations 9 and 10 of the month of March (9.5 March). On average, a Julian year does not correspond exactly to a tropical year, and there has been a drift in the date of the vernal equinox over the centuries. Theoretically, this date could be used to fix the year in which an astrolabe was made. Gunther (1932: 187), for example, states:

> The epoch of construction is accurately indicated by the day of the month of the vernal equinox, when the sun enters the first point of Aries.

The works of Michel (1947: 135–141) and Poulle (1956), summarised by Turner (2000), showed that the uncertainty reached several centuries (see also the reassessment of the method by Mercier, 2018b). This uncertainty arises from major differences in the conventions used by astrolabists to draw the graduations on their civil calendars. In addition, some astrolabists have used equinox dates that escape the previous explanation: they are simply wrong. For example, the date of 8 March Julian, which is generally compatible with the nineteenth and twentieth centuries, was already in use in 1345 (Astrolabe of Mohamed b.Fihri: Brieux et al., 2021(1): 329–330), which confirms the opinion of Poulle (1956) who considered that the moment of the equinox was very poorly known by astrolabists during the Medieval period.

4.2 Domification

The cusps of a Regiomontanus-type astrological domification are engraved on the instrument's plates. This domification was popularised in Europe by the work *Tabulae Directionum et Profectionum*, which dates from 1467. However, it was known earlier thanks to a twelfth-century Latin translation of a treatise by al-Jayyâni (eleventh century), by Gerard of Cremona (North, 1986: 35). The presence of this domification cannot therefore be used to date the instrument.

4.3 Epigraphie

The digits engraved on the various parts of the astrolabe differ from those currently in use (Figure 3). This is a typical medieval form found on Latin manuscripts from the thirteenth to fifteenth centuries, but it continued to be used alongside the modern form until the mid-sixteenth century (Hill, 1915). Here again, it is difficult to draw any chronological conclusions.

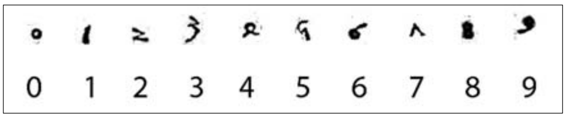

Figure 3: Digits used on the various parts of the astrolabe, Toulouse municipality, Musée Paul-Dupuy cliché E. Grimault, details of astrolabe D 005.1.1.

4.4 Pointer Shapes

The rete in general, and the pointers in particular, have a very elaborate shape that is extremely rare. In fact, very few preserved instruments are comparable in this respect. The one that comes closest is astrolabe No. 45307 in the History of Science Museum, Oxford. This instrument, which is also anonymous and undated, has been studied in detail by Hernández-Pérez (2018: 377–384). This specialist suggests a date range of 1350–1450, and describes the style as 'Hispano-Moresque', with no doubt a link to the Jewish community. This similarity in style may suggest that the two instruments come from the same workshop and date from the same period.

5 CONCLUDING REMARKS

Dating undated astrolabes is a difficult and uncertain exercise. The astrolabe of the Preaching Friars is no exception.

The use of the position of the stars on the rete is clearly illusory. This is all the more true because the stars are not named; their very identification is uncertain. Assuming, as Davoust (2024) does, that their positions are *a priori* correct and that they can be identified by their position on the rete is not acceptable. The use of a historical criterion (Maslama el-Majreti's list of stars) is not totally conclusive insofar as certain pointers could not be attributed, and above all that most of them remain far from the expected positions. In fact, the positions of the stars in this rete escape scientific analysis, either because of original inaccuracy or because of subsequent deformation of the pointers.

The other elements of dating are not conclusive either: the date of the equinox, the presence of a particular type of astrological cusp, and the style of the epigraphy are not sufficiently discriminating to advance a date or even an epoch. Only the general appearance of the rete and the pointers suggest, by comparison with an astrolabe preserved at Oxford, the period 1350–1450. But the Oxford astrolabe is also anonymous and undated, so this conclusion is highly uncertain.

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Professor Eric Mercier was born in 1956 and obtained his PhD in Geology in 1985. He was successively 'Maître de conférences' (= lecturer) at the Universities of Besançon (France) and Cergy-Pontoise (France), and in 1998 was appointed a Professor at the University of Nantes in the CNRS Laboratory of Planetology and Geodynamics.

Eric is a specialist in modelling tectonic structures. He has worked extensively in the Canadian Arctic and in the mountains of Europe and North Africa. He has been in charge of international scientific collaborative programmes, and has supervised numerous doctoral projects.

Over the past fifteen years, in parallel with his academic research Eric has been interested in the history of astronomy in general and gnomonics in particular. Since 2018, he has been in charge of inventorying and studying ancient astrolabes within the Sundial Study Group (Commission des Cadrans Solaires) of the Société Astronomique de France.

Eric has been retired since 2023, and he devotes his time to the study of ancient gnomonics, both Latin and Arab-Muslim.