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Andalò di Negro's *De compositione astrolabii*. A Critical Edition with English Translation and Notes

Dominique Raynaud[1], Samuel Gessner and Bernardo Mota

Abstract In this article, we publish the critical edition of Andalò di Negro's *De compositione astrolabii*, with English translation and commentary. The mathematician and astronomer Andalò di Negro (Genoa ca. 1260–Naples 1334) presumably redacted this treatise on the astrolabe in the 1330s, while residing at the court of King Robert of Naples. The present edition has three purposes: first, to make available a text missing from the previous compilations of works by Andalò di Negro (ed. Bonus 1475; Bertolotto 1892; Fornaciari and Faracovi 2005); second, to revise a privately-circulated edition of the text (Cesari 1984); third, to help disseminating one of the rare Latin texts presenting the principles of the stereographic projection which underlie the construction of the astrolabe.

Keywords astrolabe · stereographic projection · critical edition · Latin Europe

1 Introduction

The astronomer Andalò di Negro (Genoa ca. 1260–Naples 1334) came from an important Genoese merchant and ambassador family who had seigneurial rights in Liguria, but also on Cyprus, in the kingdom of Armenia and in Syria (Acre). Andalò was befriended by Hugues IV of Lusignan, king of Cyprus and Jerusalem, and had conversations with him about astronomy (De Simoni 1874: 318). Andalò acted as ambassador of the Republic of Genoa in the Orient when he was entrusted the peace negotiations with the Emperor of Trebizond in 1314. Nothing is known about his whereabouts from that time on for over twenty years. On 9th June 1334 his name resurfaces in a diploma by king Robert of Anjou, in Naples, indicating that Andalò was receiving a yearly pension of six ounces and that he had died a little earlier (De Blasiis 1908: 182).

We are led to believe that Andalò was called to the court of king Robert in the final stage of his life as a physician and astronomy professor. Boccaccio who lived in Naples from 1327 to 1341 praises Andalò di Negro for the lessons he had taught some time before 1334 (Libri 1828: 200–2; Mojon 1846: 110–15; Poggendorff 1863: 265; De Simoni 1874: 313–39;

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Boncompagni 1874: 339–70; Favaro 1876: 5–22; Narducci 1892: 21; Duhem 1916: 266–78; Thorndike 1928: 52–6; 1934: 190–204, 1949: 35–6; Cappellini 1936: 58; Glorieux 1971: 89–91; Muccillo, 1991: 126–31). Here is the quote:

> I often brought in as [an example of] an illustrious and venerable elder Andalò di Negro, Genoese, once my teacher in [the science of] the motions of the stars, and of whom you were able to grasp, excellent King, the enormous self-restraint, dignity of manners, and knowledge of the stars. As a matter of fact, he was, as he used to say, most close to you, when you were still young of age, because you were likeminded in your endeavours; and, as you could realise by yourself, he learned the motions of the stars, not only based on the rules of the ancients (as most of us do), but also (as he travelled nearly the whole world), he verified their courses through experience under any climate and on any horizon: he learned with his proper eyes, what we others learn with our ears.[1]

Andalò di Negro is the author of various mathematical and astronomical treatises. The mathematical works referred to as "Diversi tractatus mathematici Andali de Nigro de Ianua" in the catalogue of the Biblioteca Patavina (Tomasini 1639: 109–12) seem to be lost. Four treatises by Andalò deal with the astrolabe. Three of them have been printed or edited:

1. *Opus preclarissimum astrolabii compositum a domino Andalo de nigro ianuensi foeliciter incipit. Inc. Si astrolabium facere volueris primo et ante omnia fac tabulam istius magnitudinis quam vis esse astrolabium planissimam* (Andalò ed. Bonus 1475: fols. 1r–8v, reprinted in Andalò ed. Bertolotto 1892: 87–109; ed. Fornaciari and Faracovi 2005: 26–66).
2. *Practica astrolabii. Inc. Et primo de nominibus instrumenti. Nomina instrumentorum astrolabii sunt haec* (Andalò ed. Bonus 1475: fols. 9r–16r: reprinted in Andalò ed. Bertolotto 1892: 109–32; Cesari 1984*b*; ed. Fornaciari and Faracovi 2005: 67–110).
3. *De operationibus scale quadrantis in astrolabio scripte. Inc. Ad sciendum opera scale quadrantis que scala in astrolabio scribitur* (Andalò ed. Bonus 1475: fols. 16v–19r; reprinted in Andalò ed. Bertolotto 1892: 132–41; ed. Fornaciari and Faracovi 2005: 111–27).

The fourth is the object of the present edition and translation. It is titled:

4. *De compositione astrolabii. Rubr. Incipit tractatus de compositione astrolabii, et primo quid sit astrolabium, deinde ymaginationes et considerationes quas habuerunt compositores, etc. Inc. Astrolabium est pars spere depresse, etc. Expl. si in astrolabio descripti sunt almucantarath 90* (Cesari 1984*a*: pref. 1–10, ed. 11–25).

Andalò's *De compositione astrolabii* is one of the rare witnesses of the beginnings of projective geometry. In truth, there are many texts about the astrolabe, whether in the Arabic or in the Latin world, but very few are committed to explaining the stereographic projection which underlies the functioning of the instrument. In the Latin world, Andalò's treatise has no

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1. "Induxi igitur sepe generosum atque venerabilem senem, Andalo de Nigro Ianuensem, olim in motibus astrorum doctorem meum, cuius quanta fuerit circumspectio, quanta morum gravitas, quanta syderum notitia, tu nosti, rex optime; tibi enim, ut aiebat ipse, cum adhuc iuvenis esses, ratione conformitatis studiorum familiarissimus fuit, et, ut ipse vidisse potuisti, non solum regulis veterum, ut plurimum facimus, astrorum motus agnovit, sed, cum universum fere peragrasset orbem, sub quocunque climate, sub quocunque etiam orizonte, experientia discursuum certior factus, visu didicit, quod nos discimus auditu." *De Genealogiis deorum gentilium* XV, 6 (Boccaccio 1953: 760).

parallel, except perhaps with Pseudo-Māshā'allāh and Jordanus de Nemore. Notwithstanding the common attribution of the *De compositione et utilitate astrolabii* to the 8th-century Jewish Persian astronomer Māshā'allāh ibn Atharī, Paul Kunitzsch has convincingly demonstrated that this treatise was in fact a western compilation, "consisting of four or five distinct sections of different origin, none of which bear[ing] a recognizable relation to Messahalla" (1981: 56). In this anonymous text, the stereographic projection is discussed in chapters 17–18 (Thomson 1978: 180–5; Thomson 2014). Jordanus de Nemore, an author from the early 13th century otherwise unknown, deals with the properties of stereographic projection in his *Demonstratio de plana spera*. In particular, the central property that circles on the sphere project as circles on the plane is established by case distinction (Thomson 1978: com. 32-35; ed. 86-97). The latter treatise surpasses Andalò's treatise from a mathematical point of view.

The characteristics of the stereographic projection are however clearly stated by Andalò:

1. *Astrolabium est pars spere depresse forma rotunda in plano extensa*. The astrolabe is the stereographic projection of the celestial sphere on a plane parallel to the Equator.

2. *Depressa spera ubi circuli in spere erant circuli in plano*. The projection of the circles of the celestial sphere constitute circles on the plane on the equator (Fig. 1).

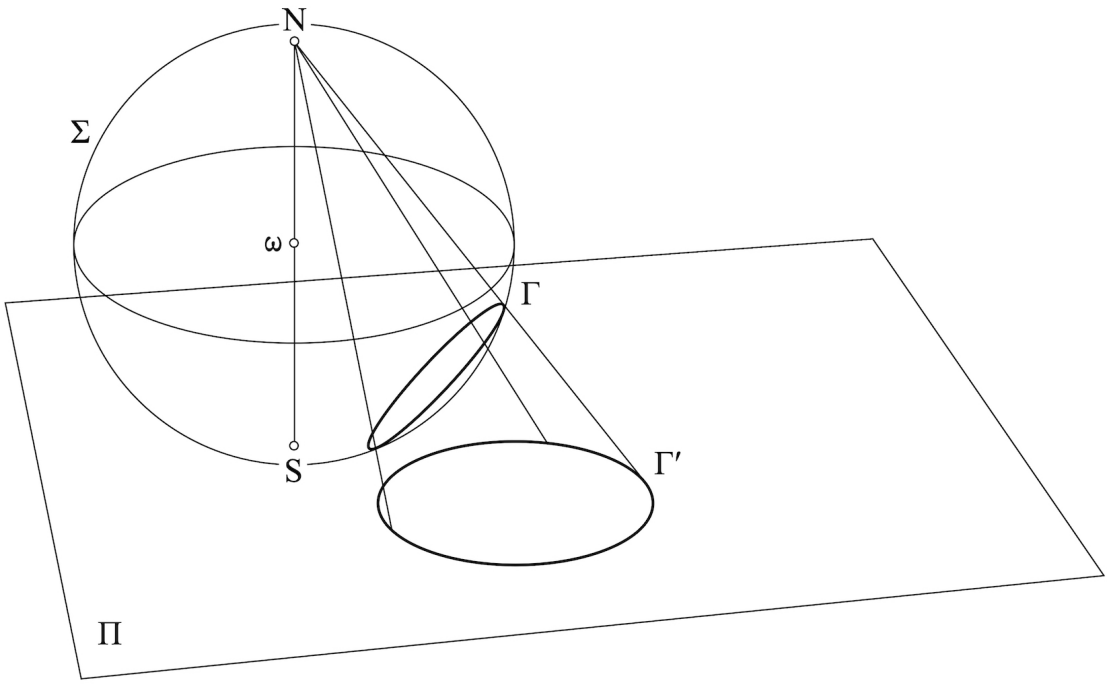

Figure 1. The fundamental property of the stereographic projection. Let there be a sphere *Σ* of center *ω* and polar axis *NS*. Let plane *Π* be parallel to the equator and tangent to the sphere at point *S*. By a stereographic projection with pole *N*, the projected image of any circle *Γ* of the sphere is a circle *Γ′* of plane *Π*.

Andalò knows this property (<4> *De lineis meridiana, medie noctis*…) but does not provide the corresponding proof. That proof, however, was presented several times throughout history, following the footsteps of Apollonius of Perga's *Conics* I.5 (Rashed 2008: 76–7): the first time, by al-Farghānī, in the *Book on the Construction of the Astrolabe* (Sergeyeva and Karpova 1978: 210–17; Lorch 2005: 31); the second time, by al-Qūhī, in *The Art of the*

Astrolabe through demonstration (Rashed 1993: 221; Abgrall 2000); finally, by Jordanus de Nemore (Thomson 1978: 86–97).

All indicates that the *De compositione astrolabii* was written during Andalò's stay at the Neapolitan court of King Robert between 1327 and 1334. This sets the redaction of Andalò's treatise between Jacob ben Makhir Ibn Tibbon's *Israel's Quadrant* (1304) and Geoffrey Chaucer's *Treatise on the astrolabe* (1391). King Robert's court may have provided very favourable conditions for the task. Andalò may have had contact there with translators of Greek, Arabic and Hebrew. It is well known, for example, that Qalonymos ben Qalonymos (Maestro Calo, 1286–ca. 1328) translated ten mathematical treatises, five of which are about conic sections. Andalò may also have benefitted from the scientific patrimony collected by the Emperor Frederick II, and brought to Naples before the two kingdoms of Sicily and Naples became separated in 1282. The Sicilian court of Frederick II was very cosmopolitan. It hosted Christian scholars, such as Michael Scot (ca. 1175–ca. 1235), the translator of al-Bitrūjī's *De motibus celorum*, to whom Leonardo Fibonacci dedicated his *Liber abaci* in 1227, and John of Palermo (fl. 1221–40), who translated into Latin a short Arabic tract on the hyperbola entitled *De duabus lineis semper approximantibus* (ca. 1240). The Sicilian court also hosted Hebrew scholars, such as Moshe ben Samuel ibn Tibbon (ca. 1195–ca. 1274), the translator of Euclid's *Elements*, Geminus's *Phenomena* and *Introduction to the Almagest*, and al-Bitrūjī's *Principles of astronomy*; also Jacob Anaṭoli (ca. 1194–1256), the son in-law and brother-in-law of Samuel ibn Tibbon, himself a translator of Euclid's *Elements*, Ptolemy's *Almagest*, al-Farghānī's *Elements of astronomy* and Averroes's *Compendium of astronomy*. There were also Arabic scholars at the court, such as Theodor of Antioch (fl. 1244), a disciple of the Mosul-based mathematician Ibn Yūnus (ca. 1156–1242), who authored treatises on conic sections and solved geometrical problems for Emperor Frederick II (Raynaud 2007). The questions that remain unsettled are related to the time and place of the writing of the *De compositione astrolabii* – most probably Naples, between 1327 and 1334 – and to the parameters used by Andalò to conceive the astrolabe. Three tests allow us to determine these parameters: the first is the latitude of the astrolabe; the second is the name of the stars, that could be taken as the footprint of an existing star catalogue; the third one is the date of the astrolabe proper, which might be deduced from the precession of the equinoxes.

Latitude. Various diagrams of astrolabe plates present in the manuscripts, although often quite rough, allow for an estimation of the latitude for which their almucantars and azimuth circles were drawn. Except for section 9 "On the length and shortness of the day", where unusual latitudes are deliberately explored[2], Andalò's treatise assumes a latitude for moderate climates. This latitude is implied in the figures of the manuscripts, as a degree value is explicitly indicated on the astrolabe plate in only one of them. The approximate value of latitude can be calculated on geometric grounds. Variant cases occur: either horizon and pole are marked on the figure, in which case the angular distance of pole and horizon ϕ directly

2. Figure 10 shows the design of a tympan for 66° 26′ 30″, latitude of the arctic circle according to the values of the Toledan tables (see Chabas and Goldstein 2012: 23). Fig. 11 shows a tympan for 69° 45′. Fig. 12 shows a tympan for 78° 30′. According to the text, these latitudes correspond to places where the Sun never sets when its longitude is in the Signs of Gemini and Cancer, or the places where the Sun never sets when it is in the four Signs of Taurus, Gemini, Cancer et Leo.

identifies the latitude; or the horizon is absent, and latitude can be deduced from the angle ϕ^* separating zenith and pole, i.e. the complement of $\phi = 90° - \phi^*$. (Fig. 2). Then we selected the best witnesses of Andalò's text (MS L: Firenze, Biblioteca Medicea Laurenziana, Cod. Ashburnham 205; MS P: Paris, BnF, Latin 10266; MS V: Vatican, Vat. lat. 5906; more details are given in the section "Manuscripts" below), we extracted the geometric characteristics from figs. 7, 8 and 9, we measured these angular distances, and tabulated the corresponding estimated values of the latitude. Even the best manuscripts only allow for very approximate measures of latitude (Table 1).

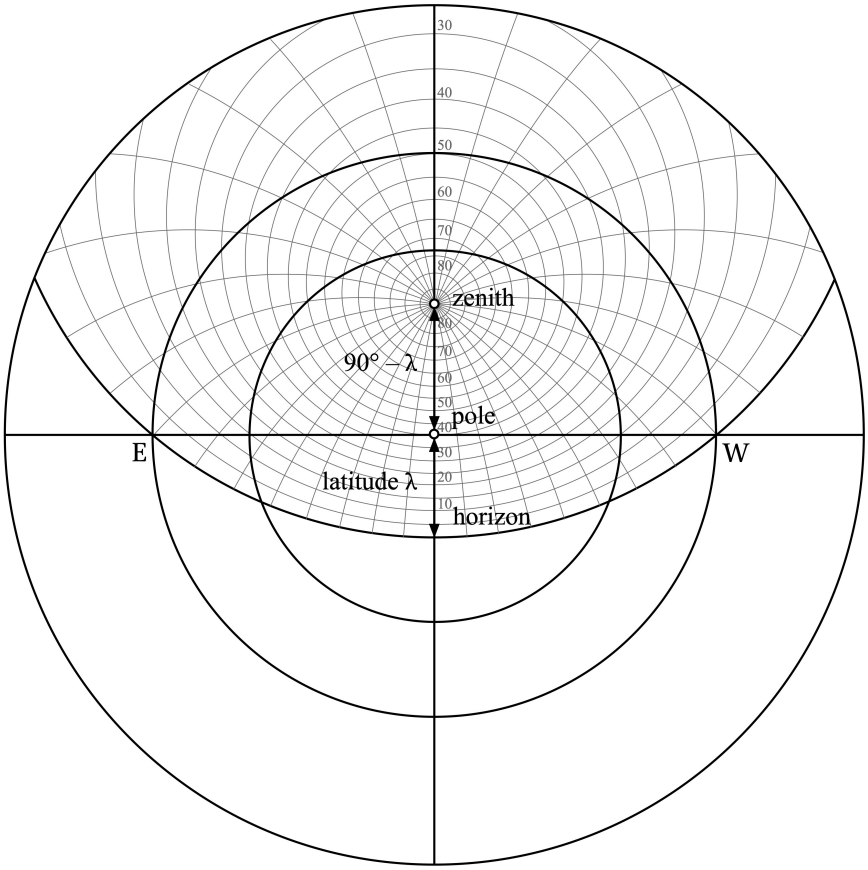

Figure 2. The typical plate of a stereographic astrolabe for a latitude of 40° N. The altitude of the pole can inferred from the scale of the almucantars. The figures in the manuscripts do not have any scales detailed enough to be of practical use. Therefore, measuring some characteristic lengths in the figure can yield the latitude. The linear distance horizon-pole *HP* in the projection is a function of latitude ϕ:

$$HP = R \cdot \tan\left(\frac{\phi}{2}\right)$$

where *R* is the radius of the equator. In MS V the horizon is lacking in the figures, but one may use the linear pole-zenith *PZ* as a function of latitude ϕ:

$$PZ = R \cdot \tan\left(90° - \frac{\phi}{2}\right)$$

	MS L	MS P	MS V
Fig. 7	42°	45°	45°
Fig. 8	—	—	40°

Fig. 9	—	40°	40°
		Mean Value	**42°**
		Written in MS P	**40°**

Table 1. An attempt to derive latitude values from the sketchy representations of plates in MS L: Firenze, Biblioteca Medicea Laurenziana, Cod. Ashburnham 205; MS P: Paris, BnF, Latin 10266; and MS V: Vatican, Vat. lat. 5906.

Latitude varies from manuscript to manuscript and also within a given manuscript between 40° to 45°, with a mean latitude $\phi = 42 \pm 3°$. Latitude 40° is inscribed on the plate for the hour lines in MS P, one of the best witnesses of Andalò's *De compositione astrolabii*. The plate design of the various MSS is expected to reflect either the figures of the source manuscript or the plate patterns familiar to the copyists. In any case, the obtained values indicate a geographical area near and somewhat north of Naples (with latitude assumed as 41° N).

Precession of the Equinoxes. The line of poles, which corresponds to the axis of rotation of the earth, varies slowly and describes a complete revolution around the pole of the ecliptic in 26 000 years. Today the North Pole points towards Polaris (α UMi), not in Andalò's time. If the pole changes, all star positions change too. The time difference from Andalò's days to ours is reflected by a movement of the sky of about 10°, an order of magnitude observable in manuscripts. To determine the epoch of the astrolabe, the stars should be first positioned on the plane of the equator according to MS L, then according to current data. The angular deviations between historical and current ecliptic longitudes are measured. All the stars named in MS L have a shift towards the east ranging from −40° to +2°, with an average of −14° 25′. This value fixes the epoch of the astrolabe to 965 A.D., i.e. three centuries before Andalò's time. It is clear that the rete serving as a model for the drawing of MS L came from an instrument made for a much earlier epoch. In view of this, it is tempting to match the date with al-Ṣūfī's *Kitāb ṣuwar al-kawākib*, a star catalog translated into Latin as Azophi's *Liber locis stellarum fixarum*. Yet, we did not proceed any further in that direction. Firstly, the rete in MS L is a rather rough sketch, which implies that the values obtained from it have to be interpreted with a large margin of error[3]. Secondly, even though the astronomers knew since antiquity that the star coordinates changed slowly over time, they could avail themselves of several methods of calculating the correction to adapt the star coordinates to a given date. Moreover, very often, astrolabe makers uncritically used star lists with outdated information about the star coordinates. Therefore, it is difficult to conclude anything precise about an astrolabe's age by simply using the star data (Strano 2017).

Star List. One single manuscript contains the representation of an astrolabe rete with labelled star pointers (MS L, fol. 78r). Given that star names and their spellings are subject to strong variation, they can be used to make conjectures about the tradition in which to place Andalò's sources, or at least, about the sources (perhaps a real astrolabe rete) inspiring the scribe of MS L. The columns of the following table (Table 2) present this information: the star name as spelled on the rete of MS L, accompanied with a transliteration of the original

3. The deletion of the star with the greatest angular deviation (delfinet, ε Del: −40°) reduces the mean precession from −14° 25′ to −12° 48′, thus fixing the epoch of the astrolabe to 925 A.D.

Arabic expression and translation; the name used by Andalò di Negro in *Tabula locorum stellarum fixarum* as edited by Bertolotto (1892: 108); the corresponding name from the famous *Toledan tables* (Toomer 1968); the corresponding name occurring in Pseudo-Māshā'allāh's *Astrolabe* (Kunitzsch 1981; Thomson 2014); the name occurring in the *Typen von Sternverzeichnissen* as categorized by Kunitzsch (1966); finally, the corresponding designation from the Bayer catalogue.

No	Star Names in MS L	Andalò di Negro's Table of Stars (Bertolotto 1892)	Toledan Tables (Toomer 1968)	Ps.-Māshā'allāh's astrolabe (nb. MSS) (Thomson 2014)	Typen I–XVIII (Kunitzsch 1966)	**Modern Name** Bayer Designation (RA; Dec) Magnitude
1	**libedenab** *dhanab al-jadī* "Tail of the Goat"	—	—	**libedeneb** (30) denebalgedi (8) cauda capricorni (5) denebaldegi (1) liberneneb (1) denebalg~ (1) denehal (1) deneba (1)	**libideneb VIII 40**, **XI 25** cauda capricorni IV 26 denebalesed XV 16 denebalix III 18 denebalgedi VI 35, VIII 44, XVII 38 denebaliged VII 26 denebelezed VI 22 denebelged II 26 libedeydop, lybe-deneb VIII 40 lidinep, liedideneba III 18	**Deneb Algedi** δ Cap (21h 47m; –16° 07′) m +2.81
2	**denecaboz** *dhanab qayṭus* "The Tail of Cetus"	denebet camuz	daneb camuz, cauda ceti	**denebcaitoz** (1) denebkaitoz (15) denebkaitos (5) denebkaytoz (5) denebkartoz (3) denebkaithos (3) deneb (3) denebkaytor (2) cauda chitor (2) denefbaychos (1) denebraitoz (1) dnebcaytoz (1) denebkaim (1) cauda ceti (1) decaytos (1) dekaitoz (1)	**denecaitoz XI 29** cauda caithot, caitoz XII 37 cauda ceti IX 26 cauda murilegi IV 29 deneb caitoz, camuz, cannir, cautuz, kan-niz XIII 29 denebcaytos XVI 2 denebcaytoz II 27 denebgait III 17 deneb kaitan XVII 44 denebkaitoz VIII 48 denebkaytoz VI 40 donet carchos VII 31	**Deneb Kaitos** ι Cet today β Cet (00h 19m; –08° 49′) m +3.56
3	**pontacay** *baṭn qayṭus* "Belly of Cetus"	—	—	**pantakay** (6) pantakai (13) panthakaythos (1) panthacayton (1) pantaketicoz (1) pantakaytoz (1) pantenkait' (1) panthakay (1) panthakai (1) pantekai (1) panth' (1)	**pacancaitoz XI 1** batenkaitoz VI 3 batncaytos XVI 3 pacacaitos VII 1 pantancalatoy, pen-ca-cartos, panta-gaitot III 16 pantenkaitoz, panthakaytor VIII 3 panthacaycon XVII 2 rathncaytoz II 20 venter murilegi IV 32	**Baten Kaitos** ζ Cet (01h 51m; –10° 20′) m +3.90
4	**menkar** *al-minkhar* "The Nostril" (of Cetus)	—	—	**menkar** (33) memkar (1) menbair (1) azerikar (1) mencar (1) menhar (1) algenip (1) mekar (1) menk (1) menc (1)	**menkar VIII 6**, VI 7, VII 4, IX 3, X 2 manus leprosi IV 4 mencar XI 3 menckar XVII 5 menkach VIII 6	**Menkar** α Cet (03h 02m; +04° 05′) m +2.54

5	**aldeba[ran]** *al-dabarān* “The Follower” (of the Pleiades)	aldebaram	**aldebaran**	**aldebaran** (37) cor tauri (4) aldeban (3) aldebanar (1) aldebans (1) atabanar (1)	**aldebaran VIII 9**, **XI 3**, I 2, II 2, V 1, VI 10, IX 4, XIII 1, XIV 1, XV 3 aldeberan XVI 13 aldeboran XIV 1 aldebran X 3 aldebrant XVII 8 aldevaran III 19 altebaran VII 2 oculus tauri IV 3	**Aldebaran** α Tau (04h 35m; +16° 30′) m +0.87 var
6	**alguze** *yad al-jauzā’* “Hand of Jauzā” (i.e. Orion)	—	—	**algeuze** (27) algenza (4) algente (2) algensasa (1) algeusa (1) algege (1) algere (1) algeu (1) algen (1)	**algeuze VIII 12, XI 6**, III 20 bedalgeuze VI 13 bedelgeuze, bedel-genze, beldergenze VII 7 bedelgenze XVII 13 cubitus geminorum IV 7 elgeuze XVI 18 humerus geminorum I 13, III, 20, XIV 4 maleuze malgeuze III 20 malkanabar V 4 menqeb elieuze II 12	**Betelgeuse** α Ori (05h 55m; +07° 24′) m +0.42 var
7	**alcabor** *al-‘abūr* “[Sirius] who has crossed [the Milky Way]”	alcare alabor	alhabor	**alhabor** (40) alchabor (1) algabor (1) alhaboz (1)	**alhabor VIII 13**, II 4, III 14, VI 15, VII 8, XIII 5 alabor I 4 alhaabor VI 14 asaare vel alhabor V 5 aschere alhabor XVII 14 brachium dextrum IV 8	**Sirius** α CMa (06h 45m; –16° 43′) m –1.47
8	**markep** *markab* “Ship”	—	—	**markep** (23) markeb (11) marchep (1) merkep (1) marke~ (1) market (1) mikel (1)	**markep VIII 16** markeb VI 17 markel VIII 16	**Tureis** ρ Pup (08h 07m; –24° 18′) m +2.78
9	**cor leonis** *qalb al-asad* “Lion’s heart”	calbo lones	**cor leonis**	**cor leonis** (48) leo (1)	**cor leonis XI 12**, I 12, IV 12, IX 11, X 12, XII 7, XIV 7, XV 13 calbalaced XVI 33 calbalacer XIII 7 calbalaze III 23 calbalesed XV 13 calbalezed VII 12 calbazen XVI 48 calbelezed VI 21 galbaiced V 7	**Regulus** α Leo (10h 08m; +11° 58′) m +1.35
10	**alfart** *al-fard* “The Solitary One”	—	alfard	**alfart** (40) alpharat (1) alfarath (1) alfarad (1) alferaz (1) alfert (1) alf~ (1)	**alfart VIII 19**, VI 20, VII 13 barta serpentis IV 11	**Alphard** α Hya (09h 27m; –08° 39′) m +2.00
11	**aschen** *al-shāhīn* “The Falcon” no pointer*!*	—	—	—	alschain alshain	**Alshain** β Aql (19h 55m; +06° 24′) m +3.71

12	**goinus** *al-janāḥ?* “The Flank” (i.e., Ribs of the Hydra)	—	—	—	unnamed	**Pleura?** ν Hya (10h 49m; –16° 11′) m +3.11
13	**algorab** *al-ghurāb* “The Raven”	aune algurab	aune algurab	**algorab** (41) ala corvi (2) alacorni (1) algor~ (1) cauda (1)	**algorab VIII 25**, **XI 14**, VI 24, IX 14, XIII 23, XVI 37, XVII 23 ala corvi IV 13 algorach VIII 25 algurab III 13, VII 15 XII 29	**Algorab** δ Crv (12h 15m; –17° 32′) m +2.58
14	**alchimuc** *al-simāk al-aʿzal* “The Unarmed”	alchimethalazel	alchimech alazel	**alchimec** (3) alchimech (15) alchimeth (10) alchimet (2) alchymech (2) alchimc (2) alazel (2) alchimoch (1) alutimech (1) alfumech (1) alramech (1) alhimeth (1) allumeth (1) althimec (1) altimeth (1) alchim (1)	**alchimech VIII 26**, **XI 15** VI 25, IX 16, XVI 40, XVII 24 alazel XIII 8 alcimec III 12 alhezer II 7 azimecalazel V 9 azimech VII 18 deposita IV 15	**Spica** α Vir (13h 25m; –11° 09′) m +1.04
15	**alcalega** *ʿunq al-ḥayya* “Neck of the Snake”	—	—	—	caput alhalba XI 21 caput alay, alhav, al-hay, alcan, alchan, alkan, alkau, alsia’, halah XII 35 capud serpentis I 21 collum serpentis IV 19	**Unuk(alhai)** α Ser (15h 44m; +06° 25′) m +2.63
16	**alcay[r]** *al-ṭā’ir* “The Flying” (Eagle)	nazel altair	vultur volans	altair (27) altayr (5) althair (5) vultur volans (3) altar (2) althayr (1) altahir (1) altaire (1) alkair (1) althar (1) alcar (1) alta (1)	**alcayr XI 23** alcair VII 24 alkair XVII 36 alkayr IX 22 altagir IX 22 altair III 4, VIII 36, XIII 11 araranathair V 16 atayr II 9 vultur volans I 9, V 24, VI 33, XVII 36	**Altair** α Aql (19h 51m; +08° 52′) m +0.77
17	**delfinet** *dhanab al-dulfīn* “Tail of the Dolphin”	—	—	delfin (22) delf (5) del (5) delfinus (2) delphinus (1) delphin (1) delfim (1) delfn (1) dlfin (1)	**delfin VIII 37**, **XI 26**, III 5, IV 23, VI 34, VII 27 delphin II 21, XI 26, XVII 37 delphiin X 19 delphyn XVI 62	**Deneb Dulfim** ε Del (20h 33m; +11° 18′) m +4.03
18	**alfardey** *anf al-faras?* “Nose of the Horse”	—	—	enifalfa (1) enifalfaz (1) musid’ eq’ (1) musida equi (1)	elmf VI 37 emf alferaç VI 37 emfelferam XVIII 39 enphelpheraz VII 28 epelferam VII 28 enfelfora, enifasfaz, enifelferaz VIII 43 enif VI 6, VIII 4, IX 2, XIII 12 eniff IX 2 enyf XVI 6 2us equs pegasus XVII 114	**Enif** ε Peg (21h 44m; +09° 52′) m +2.40

Table 2. Comparison of the star names that occur in MS L with other sources. The numbers in

parenthesis indicate the number of manuscripts that contain the indicated variant for each name. Concordances appear in bold.

The stars labelled on the astrolabe rete of MS L suggest four remarks:

1. First, the star names of the manuscript do not correspond to the 33 stars of the *Tabula locorum stellarum fixarum* published by Bertolotto (1892: 108). The variation of the terms shows that the labels in MS L cannot be explained by derivation from the *Tabula* either because they differ completely (*cor leonis* vs. *calbo lones*), or because the spelling is distinct (*alcayr* vs. *altair*).

2. The source of these names may be categorized according to the types defined by Paul Kunitzsch (1966). Among the 18 named stars on the rete represented in MS L there is a notable overrepresentation of type VIII and XI. Ten names follow a spelling that can be easily derived from type VIII; ten stars show a spelling similar to that of type XI; six among these are spelled in a way that is common to both types VIII and XI. As argued by Kunitzsch (1966: 52) types VIII and XI show strong affinity. Type VIII could be a reworked version based on III and VI made by a less competent compiler (the same star appearing some times twice under two different names). Type XI also shows signs of being a reworking of previous catalogues. The dating of XI (1223 or 1233) and of VIII (after 1246) suggests that VIII could represent an augmented version of XI.

3. In any case, it is possible to identify a match between many of the star names in MS L and those in a majority of MSS of the Pseudo-Māshā'allāh's treatise. What is more, the rete drawn in MS L (Firenze, Biblioteca Medicea Laurenziana, Cod. Ashburnham 205, fol. 78r) is of the same type as the one illustrating Pseudo-Māshā'allāh's *De compositione et utilitate astrolabii* (Cambridge, University Library, Ii. 3. 3, fol. 66v; Gunther 1929: 154).

4. An astrolabe with a similar style of star pointers, traditionally called "dagger shaped", and rete configuration is preserved at the History of Science Museum of Oxford University (Inv. no. 43504). The catalogue entry describes the unsigned instrument's style as Hispano-Moorish, using Lombard script for the star labels (with strongly differing nomenclature) and names of zodiac signs. It is dated to 1260 (Fig. 3).

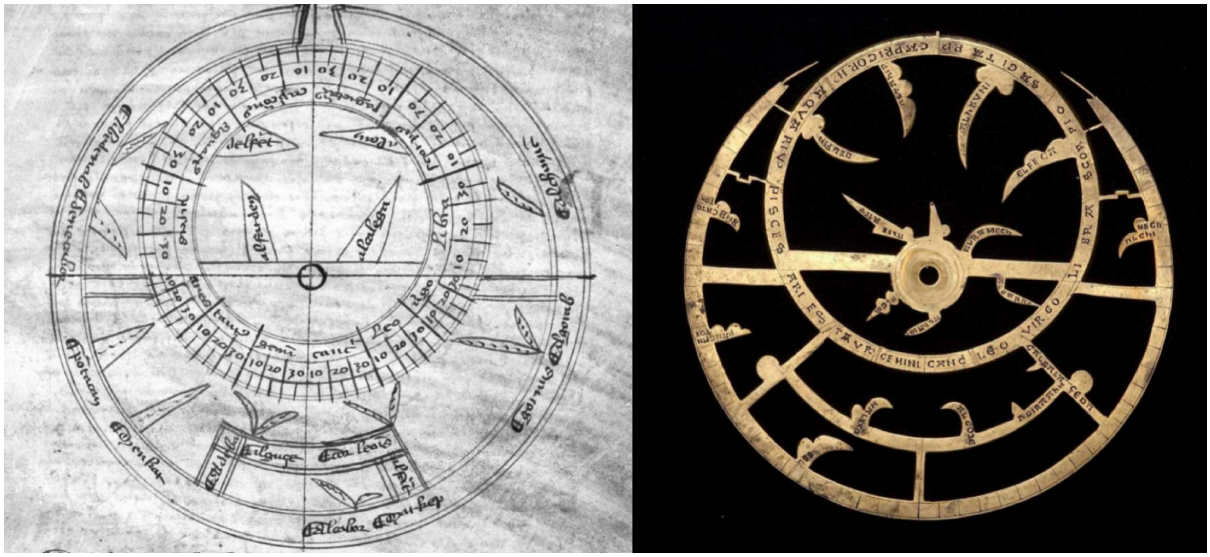

Figure 3. The star pointers as represented on Andalò's *De compositione astrolabi* MS L (left) and on

the astrolabe no. 43504 of the History of Science Museum of Oxford University.

2 Manuscripts

Andalò di Negro's *De compositione astrolabii* has been previously edited by Cesari, but this mimeograph is difficult to access[4]. On the other hand, Cesari's text was established taking MS A (Firenze, Biblioteca Laurenziana, Cod. Ashburnham 1339) as a basis, and a reference was made to other manuscripts only when "le lezioni… degli altri codici concordavano" [against MS A] (Cesari 1984*a*: 9). This contribution must be recognised for having revealed this important witness of projective methods in Latin Middle Ages; however, this private edition is not free of errors[5] and careful reading shows that the editor's work mainly consisted in correcting the text of MS A, a relatively late copy, and in substituting classical Latin forms (not present in any of the surviving copies) for the medieval ones (*aequalis/equalis, aequinoctialis/equinoctialis, orthogonaliter/ortogonaliter, sphaera/spera*, etc.) Moreover, since 1984, further witnesses have been identified – now eight at least are known – that offer better conditions to establish a critical edition. The eight known manuscripts containing the *De compositione astrolabii* of Andalò are the following:

L Firenze, Biblioteca Medicea Laurenziana, Cod. Ashburnham 205 (131), fols. 73r–78r, 14th century (The first text in this collection ends with: "Explicit Expositio Theorice planetarum edita ab inclito magistro Thadeo de Parma, et completum in 1318 anno domini, die 12 iulii, ad communem utilitatem scolarium Bononie studentium in scientia medicine)". – *Inc. Incipit tractatus de compositione astrolabii compositus a domino Andalo de nigro de Janua. Et primo quid sit astrolabium, videlicet, quas ymaginationes habuerunt compositores eius* (Kristeller 1977, I: 82). "Il codice e ricco di tavole e di disegno esplicativi, tracciati con evidente cura e precisione nei particolari" (Cesari 1984*a*: 6). The figures 1–5, 7 and 13–14 are neatly drawn, the others are lacking.

C Frankfurt am Main, Universitätsbibliothek, Ms. Carm 20, fols. 14r–17r, 1391. – *Tit. Incipit liber astrolabii compositus a domino Andalo de nigro de Janua. Et primo quid sit astrolabium, et ymaginationes eius quas habuerunt exponitores eius, 2° quomodo ponitur, 3° quomodo cum ipso operatur. – Inc. Astrolabium est pars spere depresse et in forma rotunda in plano extensa*. Diagrams 5 and 7 are sketchy and only roughly drawn.

A Firenze, Biblioteca Medicea Laurenziana, Cod. Ashburnham 1339 (1263), fols. 47ra–50vb, 15th century. – *Rubr. Incipit tractatus domino Andalo de nigro de Janua de compositione astrolabii. Et primo quid sit astrolabium. Deinde imaginationes et considerationes quas habuerunt compositores. Postea vero quomodo et qualiter debeat componi. – Inc. Astrolabium est pars spere depresse*. Empty spaces were reserved for the initials and the diagrams. The captions for figures 11 and 12 are given.

R Firenze, Biblioteca Riccardiana, Cod. 868 (L.II.N.1), fols. 4ra–7rb, 15th century. – *Catal.*

4. There are only a few rare copies of this text, which does not even appear in the Italian libraries' Union Catalog. We are grateful to Mrs. Daniela Pozzi for having kindly sent us a copy of this mimeograph (Firenze, Museo Galileo, Misc 587/29).

5. For example, line 7: artico] articolo!, line 27: que quantitas… distantia] 14 words missing; line 113: exirent linee 24] 23!; line 177: strictiores] secationes!, lines 209, 212, 227, 228, 229, 237, 238, 240, 244: existente] exeunte!, line 258: medie noctis] medietatis!, line 270: rete] recte!, line 273: capricorni] cancri!

Andali de Nigro Ianuensis, Astrolabium &c. Cod chart. in fol. Saec. XV. – Incipit tractatus de compositione astrolabii secundum dominum Andalo de nigro Januense (Kristeller 1977, I: 180). The manuscript includes twelve diagrams (1–10 and 13–14), figure 14 has no star.

S Berlin, Staatsbibliothek, Ms. lat. Fol. 596, fols. 90r–92r, 15th century. – *Incipit tractatus de compositione astrolabij secundum dominum Andalo Januense. Et primo quid sit astrolabium. Deinde ymaginationes et considerationes quas habuerunt compositores ipsius. Postea vero quomodo debeat operari* (Kristeller 1977, III: 475). The manuscript presents thirteen well drawn figures. There are no stars on the last one.

P Paris, BnF, Latin 10266, fols. 12r–19r, after 1464. – *Rubr. Incipit tractatus de compositione astrolabii. Et primo quid sit astrolabium. Deinde ymaginationes et considerationes quas habuerunt compositores. Postea vero quomodo et qualiter debeat componi. – Inc. Astrolabium est pars spere depresse, et in forma rotunda in plano extensa*. This is the only manuscript that includes all fourteen figures. Diagrams 1–7 and 9 were carefully drawn. Figures 8 and 10–14 are barely sketched.

B Vatican, Biblioteca Apostolica Vaticana, Barb. lat. 156 (IX.25), fols. 146r–147v, 15–16th century (Kristeller 1977, II: 443). – *Incipit tractatus de compositione astrolabii, secundum dominum Andalum de nigro Januense. Et primo quid sit astrolabium. Deinde imaginationes et considerationes quas habuerunt compositores ipsius. Postea quomodo quis cum eo debeat operari*. This incomplete MS ends at the beginning of the section entitled "*De lineis meridiana, medie noctis, orientalis et occidentalis*." Only diagrams 3–6 are drawn.

V Vatican, Biblioteca Apostolica Vaticana, Vat. lat. 5906, fols. 4r–13v, 1559. – *Rubr. Incipit tractatus de compositione astrolabio secundum dominum Andalo de nigro Januense. Et primo quid sit astrolabio. Deinde ymaginationes et considerationes quas habuerunt compositores ipsius. Postea vero quo modo debeat operari. – Inc. Astrolabium est pars spere depresse forma rotunda in plano extensa*. (Kristeller 1977, II: 336). The manuscript includes ten diagrams: figures 1–7, 9, and 13 were carefully drawn. Figures 8 and 9 are not accurately presented.

3 The Stemma Codicum

Three main methods have been used to build the stemma codicum of manuscripts. In the middle of the 19th century, Karl Lachmann introduced the method of "shared errors". In the 1920s, Bédier and Dom Quentin departed from Lachmann and replaced "errors" by "variant loci" with a view to taking into account the smallest details of the text. A critical test recently completed by Huygens (2001) has established the superiority of Lachmann's method over the other two methods in view of building the stemma codicum. In addition, among all types of errors found in manuscripts, long omissions are of special interest, because while the copyist can rectify one mispelled or missing word, he cannot restore a whole passage without referring to an external source. In this situation, errors pass from copyist to copyist, and "long omissions" are the most effective way to trace the progeny of a text through manuscripts. In recent years, the appearance of computer-based stemmatology has automated the most routine tasks of the stemma codicum construction (Robinson 1996). These methods are now being applied to edit both literary and scientific texts (more on this in Raynaud 2014).

Having collated the manuscripts of Andalò's *De compositione astrolabii*, all text errors have been encoded in a matrix of characters, consisting of ten taxa (the eight MSS, Cesari's edition and the out-group, which is free of error) and of as many characters as there are

omissions in the text (we have used a weighted coding system, whereby the number of words omitted is entered in the matrix) (Fig. 4).

```
      10  107
Out       0000000000 0000000000 0000000000 0000000000 0000000000 0000000000 0000000000 0000000000 0000000000 0000000000 0000000
L         0700000000 0000000000 0000000000 0000000000 0000000000 0000000000 0000000009 6940000000 0000000000 0000000000 0000000
C         0000070000 4405300000 0300000009 3600000000 0000088509 4000069000 0000009709 6940005000 0000000000 0000000300 0000000
B         0098500040 4055055550 8049009869 3000792397 6395008559 4592669337 9353959759 6949565996 3693993434 9999473397 3449998
A         0000500000 0000000000 0300000000 0000700000 0000000550 0000000007 0000000000 0000005990 0000000000 0000070000 0400000
R         0098500040 4055055550 8040009869 3000792397 0000000000 0592600337 9353000050 0009560990 3603993434 9999400090 3009998
S         0098500040 4055055550 8040509869 3637792397 0000000000 0592600307 9353950050 0009560990 3693993434 9999400090 3000000
P         8000000043 0000000000 0000000000 0000000000 0000000000 0000000000 0000000000 0000000990 0000000000 0000000000 0000000
V         0098500040 4055055550 8040000000 0000000397 0000000000 0592600337 9353000050 0009560990 3693993434 9999400090 3000000
Cesari    0000509300 0000000005 0000030000 0030700397 0090900000 0000000307 0000000000 0940000006 3000993000 0000073007 3440000
```

Figure 4. Matrix of characters

Next, we have built the stemma codicum of Andalò di Negro's *De compositione astrolabii* by using PHYLIP 3.69 (Felsenstein 2009). When the Maximum Parsimony Algorithm is applied to the previous matrix of characters, a single most parsimonious tree is found (Fig. 5).

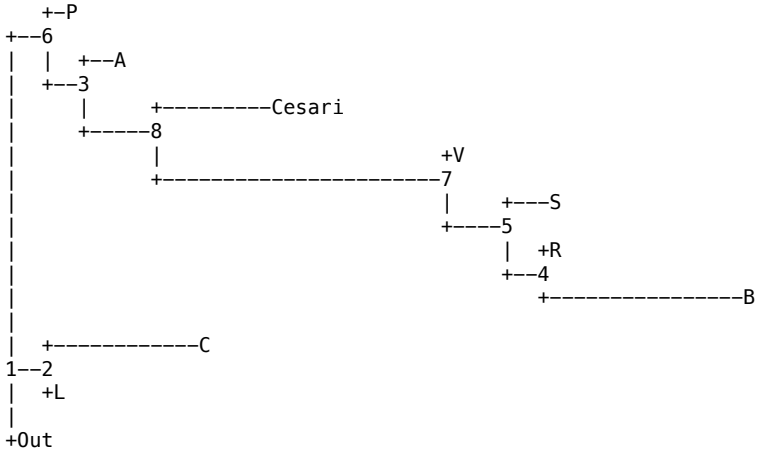

Figure 5. Stemma of the MSS

As the horizontal length of a branch is roughly proportional to the number of errors between the autograph and the manuscript, the above stemma establishes that the present edition should retain LAP as *lectiones praeferendae*, among which L is also the earliest MS of the *De compositione astrolabii*. Conceivably a great change occurred at node 8 (Fig. 5) upon which depend BRSV, with the probable decision of the copist to abbreviate the whole work. This hypothesis is further confirmed when the copist declares that he will not shorten the work regarding the matters that belong to the sphere "*Abbreviabo opus quantum ad ea que pertinent ad speram*" or when he simply abridges "*De lineis meridiana, medie noctis, orientalis et occidentalis" into "De lineis 4or principalioribus*." Finally, B is shown to be the poorest manuscript among the extant copies. However, its ranking is strongly dependent on its early ending with the sentence: "*Sequitur de lineis 4or principalioribus astrolabii*" (Section 4). To discover if B can nonetheless be a reliable manuscript before that passage, we have build another stemma through a matrix from which all errors after No. 46 are erased. Two very similar parsimonious trees are then found, and both rank B last (Fig. 6).

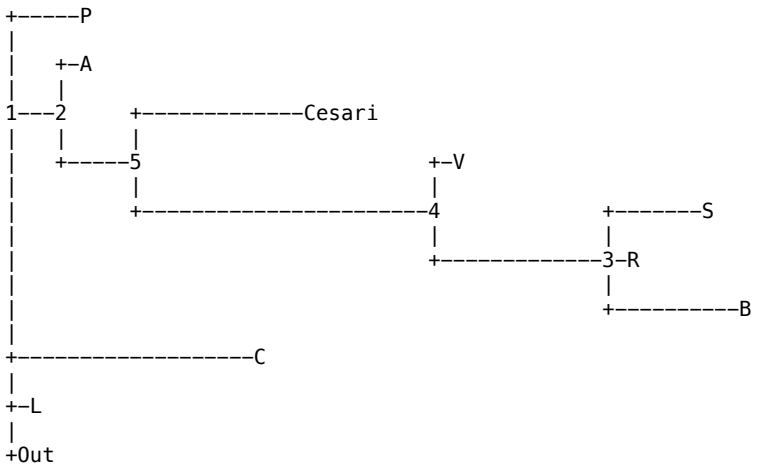

Figure 6. Stemma of the MSS up to shared error No. 46

Clearly then, B should not be used before Section 4 either, and the ranking of the MSS is virtually the same. Therefore, MSS LPA have been used in preference, rather than CVRSB, in the present edition.

4 Spelling Variants

In order to preserve the idiosyncrasies of the text, and avoid excessive complexity, we retained the most frequent of concurring spellings.

almucantarath] almucantarath LCRSP | almucantarat ARSV almucantarach A
azimut] azimut LARV | azimuth CP açimut S
cenith] cenith LRP | cenit ARSV zenith C cinit A
coluri] coluri LCBASPV | colluri R
depressa] depressa LCBASPV | deprexa R
dyameter] dyameter LCRSPV | diameter A
maiores] maiores LCBRSPV | magiores A
parallelum] parallelum LCBASPV | paralellum S palalellum R
planities] planities LCBRSPV | planicies A
proportio] proportio LCBRSPV | proporcio A
rete] rete LCRSV | rette V rethe P recthe A
secata] secata LCBRSP | septa RSV secta B segata A
zodiacus] zodiacus CARP | çodiacus SPV

5 Sequence of the Paragraphs

The following table presents the sequence of paragraphs appearing in the various copies of the *De compositione astrolabii*. The paragraph titles and sub-titles vary throughout the copies. This overview presents our decisions about keeping or eliminating them, depending on whether they appear in the best MSS L P. All variants regarding the sequence or titles of paragraphs are indicated in the critical apparatus, but are given here as a synopsis.

L **P** A C *Ces* V R S B

1. De coluris	N	T	N	N	T	T	T	T	T
2. De <circulo> equinoctiali	T	T	T	N	T	!	N	!	!
<De <circulis> parallelis cancri et capricorni>	T	!	N	T	N	N	N	N	N
<De descriptione spere>	N	T	N	N	N	N	N	N	N
3. Qualiter spera secatur et deprimitur	T	T	T	T	T	T	T	T	T
<De figuratione circulorum>	–	[7]	N	N	N	!	!	!	!
4. De lineis meridiana, medie noctis, orientalis et occidentalis	T	[6]	T	N	T	!	!	!	–
<De formatione circulorum cum quibus fiunt almucantarath>	N	T	N	N	N	N	N	N	–
<De refectione eiusdem>	N	T	N	N	N	N	N	N	–
5. De almucantarath	[11]	T	T	[11]	T	T	T	T	–
<De cenith capitis>	N[12]	T	N	N[12]	N	N	N	N	–
6. De aurora	[10]	T	T	[10]	T	T	T	T	–
7. De azimut	T	T	T	T	T	T	T	T	–
8. De horis	T	[15]	T	T	T	T	T	T	–
9. De magnitudine et brevitudine dierum	N	[16]	N	N	T	T	T	T	–
10. De ecliptica et signis zodiaci	T	[14]	T	[17]	T	T	T	T	–
11. De loco et situ stellarum fixarum	T	T	T	![16]	T	T	T	T	–
12. De polo zodiaci	T	T	T	T	T	T	T	T	–

T Section with a title | N with no title | ! with a different title | [num] Displaced section | – Omitted section.

6 Sigla

add.	addidit
ante	ante
corr.	correxit
del.	delevit
marg.	in margine
lac.	lacuna
om.	omissit
post	post
rep.	repetivit
scr.	scripsit
suprascr.	suprascripsit
trans.	transposuit
?	lectio incerta
!	sic
<>	addendum
[ ]	omittendum

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English Translation

The treatise about the composition of the astrolabe, composed by Master Andalus de Nigro of Genoa, begins. And first what the astrolabe is, then the concepts the makers came up with and the arguments they developed upon them, and finally in what manner and by which procedures it should be made.

The astrolabe is a part of the sphere flattened into a circular shape spread in a plane, as explained in the following.

<1> On the colures[1]. The astrolabe makers conceived that there were two circles in the sphere intersecting orthogonally at the poles of the world, that is at the arctic and antarctic poles. These circles divide the sphere in four equal parts, and they called them *colures*.
They conceived that one of these circles extends from the arctic to the antarctic pole thus defining the meridian line and the line of midnight. Clearly, the half [circle] which lies between the arctic and the antarctic pole and cuts the local zenith is called the meridian line, and the other half which extends from the antarctic to the arctic pole is called line of midnight.
As to the other circle, they conceived it passing through the east and the west (whose half extending from the arctic to the antarctic pole towards the east is called oriental semicircle, and the other half, the occidental semicircle).

<2> On the equator. Likewise they conceived another circle extending from east to west, at equal distance from the poles and orthogonally intersecting the abovementioned colures, which circle they called *equator* [*circulus equinoctialis*]. These three circles are among the great circles of the sphere. Now, circles traced in the following way are called great [circles]:

1. The Latin term *colurus, coluri* renders the Greek κόλουροι (γραμμαί): “truncated (lines)”. They refer to the two great circles of the celestial sphere that intersect at right angles at the poles. The first contains the two solstices, the second, the two equinoxes.

Latin Text

|L fol. 73r|C fol. 14r|B fol. 146r|A fol. 47r|R fol. 4r|S fol. 90r|P fol. 12r|V fol. 4r|

Incipit tractatus de compositione astrolabii, compositus a domino Andalo de nigro de Janua. Et primo quid sit astrolabium. Deinde ymaginationes et considerationes quas habuerunt compositores eius. Postea vero quomodo et qualiter debeat componi.

Astrolabium est pars spere depresse, et in forma rotunda, in plano extensa, ut in sequentibus declaratur.

<1> De coluris. Ymaginaverunt enim compositores astrolabii quod in spera essent duo circuli se ortogonaliter secantes in polis mundi, videlicet in polo artico et antartico. Qui circuli dividant speram in quatuor partes equales, quos appellaverunt coluros. Quorum circulorum, unum ymaginati sunt transire a polo artico in antarticum, designando lineam meridianam et medie noctis, videlicet illam medietatem, que est a polo artico in antarticum, et secat cenith regionis, appellaverunt lineam meridianam. Et aliam medietatem que est a polo antartico in articum, vocaverunt lineam medie noctis.
Alium autem circulum ymaginati sunt transire per orientem et occidentem, cuius medietatem, scilicet a polo artico in antarticum versus orientem, appellaverunt semicirculum orientis, et aliam medietatem semicirculum occidentis.

<2> De <circulo> equinoctiali. Item ymaginati sunt alium circulum transire ab oriente in occidentem, equidistantem a polis, et secantem dictos coluros ortogonaliter, quem circulum

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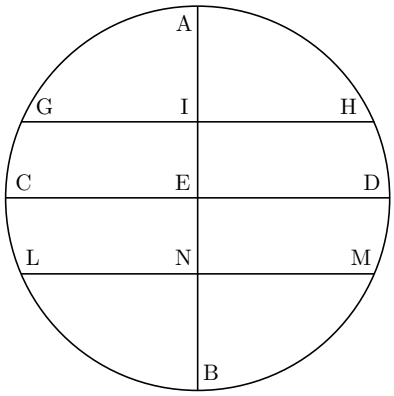
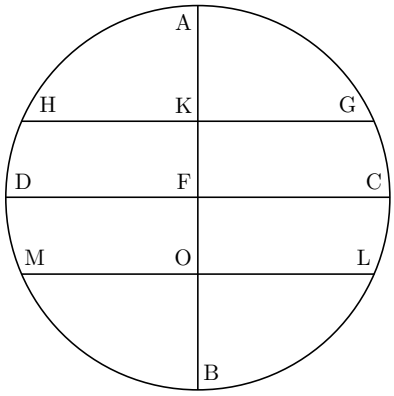
1 tractatus] *add*. Andalo de nigro de Ianua A || 1 tractatus de compositione] liber C || 1 compositus a domino] secundum dominum B R S V *Cesari* || 2 de Janua.] Januense B R S V Ianuense *Cesari* || 2 compositus ... de Ianua.] *om*. P || 2 Et primo] Primo C || 2 Deinde] videlicet quas L et C || 2 et considerationes] *om*. L C *add*. eius C || 2 quas] *om*. L || 3 compositores] exponitores C || 3 eius.] *om*. A P ipsius. B R S V || 3 vero] *om*. B || 3 et qualiter] equaliter! A quos tum eo B *om*. S V *Cesari* || 3 componi.] operari. B R S V || 3 Postea vero ... componi.] *om*. L 2o quomodo ponitur. 3o quomodo cum ipso operatur. C || 4 depresse] depressa L C deprehensae *Cesari* || 4 et in] *om*. B R S V || 5 declaratur.] dicetur. B R S V declarabitur. C || 6 De coluris.] *tantum in* P V || 6 Ymaginaverunt] Imaginati sunt B *Cesari* || 6 enim] *om*. C B || 6 compositores] componitores V exponitores C || 6 essent] *scr. del*. sunt *corr*. essent A || 6 circuli] *add*. magni B || 7 ortogonaliter] *om*. B || 7 secantes] intersecantes B || 7 polis] polos C || 7 mundi,] mondi, A || 7 videlicet] ortogonaliter B scilicet C R S V || 7 artico] articolo! *Cesari* || 7 et] *add*. in polo C in P *Cesari* || 7 circuli] *om*. B R S V || 8 dividant] divident B dividunt C P dividerent *Cesari* || 8 quatuor] 4or C B R V || 8 quos] *add*. circulos C *Cesari* || 9 antarticum] antartico C || 10 a] in A || 10 secat] cecat A segat V || 10 cenith] centro B *scr. del*. centro *corr*. cenith V || 11 meridianam.] meridiei. B A R S V *Cesari* || 11 aliam] a linea V || 11 antartico in articum] artico in antarticum C || 12 lineam] linea C || 13 et] in B R S V || 13 occidentem] *add*. et per polos mundi, S || 14 antarticum] articum V || 14 orientem] orizontem A || 15 occidentis] *add*. vero ponitur hic, quod polo antartico, cuius poli hic non describatur. C || 16 De equinoctiali.] De circulo equinoctiali. P Non quod a modum a modum] ad modo S abbreviabo opus quantum ad ea que pertinent ad speram et et] quod B dictam sunt ibi. B S V *om.* C *Cesari* || 16 Item] *om*. B R S V || 16 alium] etiam B R S V || 17 equidistantem] equidistante C

let there be conceived a diameter in the sphere such that it defines [two] points on the surface of the sphere. I say that a circle on the sphere that passes through such two points is said to be among the great circles[2].

<On the parallel circles of Cancer and Capricorn.> They also conceived two more circles, equidistant from the equator, one towards the arctic pole far from the equator by [the amount of] 23 degrees 33 minutes 30 seconds, which they called the circle of Cancer, and the other towards the antarctic pole far from the equator by the same amount, which they called the circle of Capricorn. That amount is referred to as the declination of the sun, because the ecliptic is distant by that much from the equator at its largest distance. They called these two circles "parallel circles" which are not among the great circles.



[Figure 1] The entire sphere showing the southern[3] face.



[Figure 2] The entire sphere showing the northern[4] face.

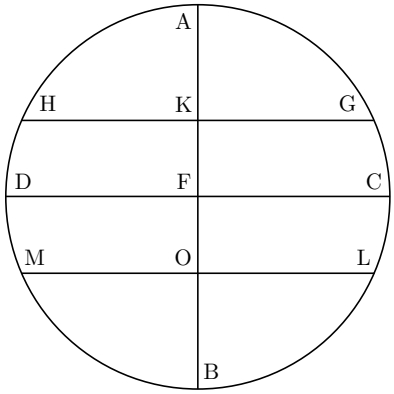
2. Instead of the paragraph on the equator MSS B, R and S have: "Note that I will abbreviate the work in as far as things that belong to the Sphere and that are explained there."

3. "Southern" means viewed from the line of mid-heaven. Due to intrinsic simplicity, Figs. 1–4 are very similar in MSS B L P R S V, except the following features. In MS L, the letters *A B* (resp. *A N* and *A O*) are in place, but the polar axis *AB* (resp. *AN*, *AO*) is not drawn. In MSS L P R S V, the tropics *GH LM* are closer to the equator *CD* than they are in reality.

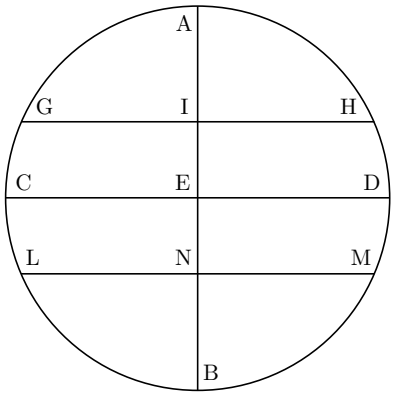
4. "Northern" means viewed from the side of the line of midnight.

vocaverunt circulum equinoctialem. Qui tres circuli sunt de circulis maioribus spere. Circuli quidem maiores dicuntur isto modo descripti, videlicet ymaginetur dyameter in spera, que faciat punctos in circumferentia spere. Dico quod circulus in spera, qui transit per ista duo puncta dicitur de circulis maioribus.

<De circuli parallelis cancri et capricorni.> Ymaginati sunt etiam duos alios circulos, equidistantes a circulo equinoctiali, unum versus polum articum longe ab equinoctiali per gradus 23 min. 33 sec. 30, quem appellaverunt circulum cancri, et alterum versus polum antarticum longe ab equinoctiali per eandem quantitatem, quem appellaverunt circulum capricorni. Que quantitas vocatur declinatio solis, quia tantum distat ecliptica ab equinoctiali in maiori distantia. Quos duos circulos appellaverunt parallelos, qui non sunt de maioribus circulis.



[Figura 1] Spera integra demonstrans faciem meridianam.



[Figura 2] Spera integra demonstrans faciem septentrionalem.

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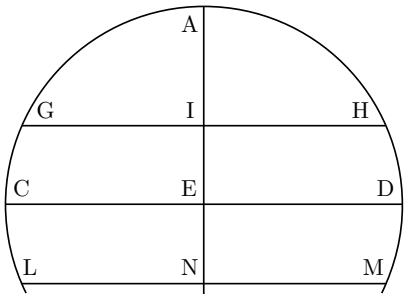
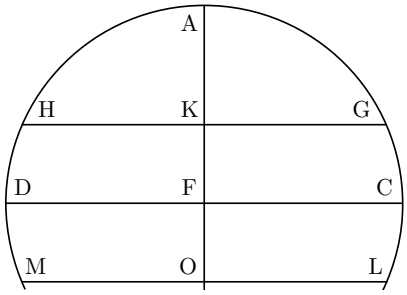
17 secantem] secantes A || 17 coluros] circulos L polos C || 18 transire ab oriente ... circulum] *om*. B R S V || 18 circuli sunt de circulis] de alius C || 19 dicuntur] *add*. in *Cesari* || 19 isto modo] hoc modo C || 19 descripti,] descriptum, C || 19 ymaginetur dyameter] imaginamur diametrum *Cesari* || 20 punctos] punctum C ponctos! A punctus P V? puncta *Cesari* || 20 qui transit … duo puncta] *transp*. qui per ista duo puncta transit C || 21 Qui tres circuli ... circulis maioribus.] omnes isti tres sunt de maioribus circulis. B R S V || 22 De parallelis … capricorni.] De circulis cancri et capricorni P *om*. B A R S V *Cesari* || 22 duos alios] *transp*. alios duos C || 22 a] *om*. A *Cesari* || 23 equinoctiali] equinoctialis B A R S V *Cesari* || 23 equinoctiali ... longe ab] *om.* C || 26 quantitas] *om.* C || 26 vocatur] *om*. A || 26 declinatio solis,] *transp*. solis declinatio, C || 26 ecliptica] acliptica! A || 26 ab] *om.* C || 26 ecliptica ab equinoctiali] *transp*. ab equinoctiali ecliptica P V || 27 Que quantitas ... distantia.] *om*. *Cesari* || 27 equidistantes a circulo ... appellaverunt parallelos] scilicet tropicum cancri et capricorni B sive tropicos cancri scilicet et capricorni R S V || 28 circulis] *om*. B || 29 *ante* Spera] *add*. Primo erit B Et primo erit R || 29 Spera ... meridianam.] *add*. Prima figura R *marg*. Figura diei. R Fig. 1] *om*. C A || 30 *ante* Spera] *add*. 2o erit B || 30 integra] *om*. L || 30 septentrionalem.] septentrionis. P || 30 Spera ... septentrionis] *add*. 2a Figura R *marg*. Ista est 2a figura in ordine quia transposui R *marg*. Figura noctis R Fig. 2] *om*. C A

<On how to describe the sphere[5].> And in order to make more understandable the things we wish to explain, we trace the diagram of the sphere [in Figs. 1 and 2] with the aforementioned circles and we write down [the letter] *A* at the arctic pole, and *B* at the antarctic pole. In the east, at the point where the colure intersects the equator, *C*. In the west, where the colure intersects the equator, *D*. In the mid-heaven, where the colure intersects the equator, *E*. In the [line of] midnight, where the colure intersect the equator, *F*. In the same way, in the east, where the colure intersects the parallel of Cancer, *G*. In the west, where the colure intersects the parallel of Cancer, *H*. In the mid-heaven, where the colure intersects the parallel of Cancer, *I*. In the midnight [i.e. north], where the colure intersects the parallel of Cancer, *K*. In the same way, in the east, where the colure intersects the parallel of Capricorn, I will write *L*. In the west, where the colure intersects the parallel of Capricorn, *M*. In the mid-heaven [i.e. south], where the colure intersects the parallel of Capricorn, *N*. In the midnight [i.e. north], where the colure intersects the parallel of Capricorn, *O*.



[Figure 3] The truncated sphere showing the southern[6] face.



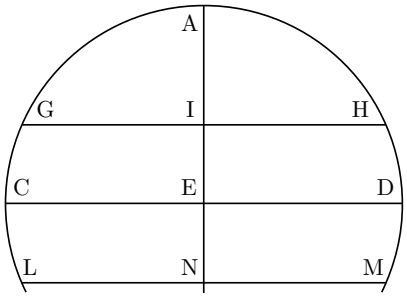
[Figure 4] The truncated sphere showing the northern[7] face.

5. This section introduces the labelling of specific points in the sphere that will be used consistently throughout the treatise.

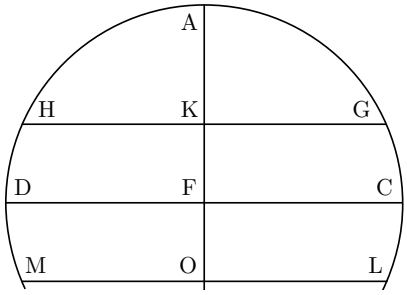
6. As above, “southern” means viewed from the meridian line.

7. As above, “northern” means viewed from the side of the line of midnight.

|L fol. 73v|L fol. 74r| <De descriptione spere.> Et ut clarius intelligantur ea, que dicere intendimus, describimus figuram spere cum dictis circulis, et describimus in polo artico A, in antartico, B. In oriente, in puncto ubi colurus secat equinoctialem, C. In occidente, ubi colurus secat equinoctialem, D. In medio celi, |P fol. 12v| ubi colurus secat equinoctialem, E. In media nocte, ubi colurus secat equinoctialem, F. Item in oriente, ubi colurus secat parallelum cancri, G. In occidente, ubi colurus secat parallelum cancri, H. In medio celi, ubi colurus secat parallelum cancri, I. In media nocte, ubi colurus secat parallelum cancri, K.
Item in oriente, ubi colurus secat parallellum capricorni scribam L. In occidente, ubi colurus secat parallelum capricorni, M. In medio celi, ubi colurus secat parallelum capricorni, N. In media nocte, ubi colurus secat parallelum capricorni, O.



[Figura 3] Spera secata demonstrans faciem meridianam.



[Figura 4] Spera secata demonstrans faciem septentrionis.

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31 De descriptione spere.] *tantum in* P || 31 Et] *om*. *Cesari* || 31 ea,] *om*. B R S V *Cesari* || 32 describimus] describemus A P || 32 que dicere intendimus, describimus] que sequntur describamus B R S V || 32 spere] sphaericam *Cesari* || 32 dictis] predictis A P || 32 dictis circulis,] *transp*. circulis predictis, B R S V || 32 et describimus] describendo B R S V || 33 in puncto] *om*. C B R S V || 33 ubi colurus ... equinoctialem,] *om*. B R S V || 33 In occidente ... D.] *om*. P || 34 medio] medietate L C || 34 ubi] *add*. alius B R S V || 34 in media nocte] *scr*. *del*. in 2a vero figura *corr*. B || 34 ubi colurus ... equinoctialem,] *om*. B R S V || 35 In media nocte ... F.] *om.* C || 35 in oriente,] *scr. del*. in media nocte *corr*. in oriente S V || 36 cancri,] *add*. scribam B A R S scribamus V scribebam *Cesari* || 36 occidente,] *scr*. *del*. medio celi *corr*. occidente, P || 36 ubi colurus ... cancri,] *om*. B R S V || 36 *ante* In medio] *add*. Et B S V || 36 ubi colurus secat ... cancri,] *om*. B R S V || 37 *ante* In media] *add*. Et S V || 37 ubi colurus secat ... media nocte] *om*. C || 37 ubi colurus secat ... cancri,] *om*. B R S V || 38 Item] *om*. C P || 38 oriente,] *add*. autem P || 38 scribam] *om*. L C || 39 secat] *om.* C || 39 ubi colurus ... capricorni,] *om*. B R S V || 39 *ante* In medio] *add*. Et R S V || 39 ubi colurus ... capricorni,] *om*. B R S V || 40 ubi colurus ... capricorni,] *om*. B R S V || 40 O.] *add*. ut patet in figuris B R S V *add*. a latere positis. B sequentibus. R || 41 *ante* Spera] *add*. Hec est figura B *add*. Hec est R || 41 secata] secta B septa R S V || 41 demonstrans] demonstratis B || 41 meridianam.] meridionalem. R V Fig. 3] *om*. C A || 42 secata] septa S V || 42 septentrionis.] septentrionalem. L S V Spera ... septentrionis.] Hec vero demonstrat faciem medie noctis. B *om*. R Fig. 4] *om*. C A

<3> How the sphere is cut and flattened. Next they conceived that the sphere was divided and cut at the parallel of Capricorn and that the whole [remainder] from the said parallel of Capricorn down to the antarctic pole was put aside, so that the sphere remained plane along that parallel of Capricorn, and they assumed that [the sphere] be laid down on some flat place upon the surface of the said parallel of Capricorn, so that the arctic pole be in the summit of the said sphere [Figs. 3 and 4].

Then they conceived that at the arctic pole there was a weight such as to flatten the sphere and to bring it into a plane and round shape. During that flattening, they conceived that the parallel of Capricorn and the whole part of the sphere extending [from it] up to the equator grew larger and spread out in proportion to the distance from the equator, because the closer a part of the sphere was to the parallel of Capricorn the more it was spread out, and the closer it was to the equator the less it was spread out.

They conceived that the equator always kept its [original] size; but that the whole part of the sphere extending from the equator up to the arctic pole was squeezed in accordance with the distance from the equator, because the closer a part of the sphere was to the arctic pole the more it was squeezed, and the closer it was to the equator the less it was squeezed. As to the circle of Cancer that lies between the equator and the arctic pole, it was squeezed in the same way, such that after being moved, in the plane it was smaller than its original shape; the equator kept always the size of its original shape, and the circle of Capricorn was larger than its original shape, such as it clearly appears in the diagram[8] having the aforementioned points.

8. See Figs. 3 and 4.

|B fol. 146v|A fol. 47v| **<3> Qualiter spera secatur et deprimitur.** Postea ymaginati sunt quod spera esset abscisa et secata in parallelo capricorni et quod a dicto parallelo capricorni usque |L fol. 74v| ad polum antarticum totum abiceretur, ita quod spera remaneret plana in ipso parallelo capricorni. Et posuerunt quod iaceret in aliquo loco plano super planitiem dicti paralleli capricorni, ita quod polus articus esset in cacumine dicte spere.

Tunc ymaginati sunt quod in ipso polo artico esset pondus aliquod, quod deprimeret speram et duceret eam in formam planam et rotundam. In qua depressione ymaginati sunt quod parallelus capricorni cresceret et dilataretur cum tota illa parte spere, que est usque ad equinoctialem secundum proportionem distantie ab equinoctiali, quia quanto pars spere fuit proprinquior parallelo capricorni, tanto plus fuit dilatata, |V fol. 4v| et quanto plus fuit prope equinoctialem, tanto minus dilatata fuit.

Circulum autem equinoctialem ymaginati sunt remanere semper in sua magnitudine. |R fol. 4v| Tota autem illa pars spere, que est ab equinoctiali usque ad polum articum, restringeretur secundum proportionem distantie ab equinoctiali, quia quanto pars spere fuit magis prope polum articum tanto plus restringebatur, et quanto magis erat prope equinoctialem, tanto minus restringebatur. Circulus vero cancri, qui est inter equinoctialem et polum articum, |C fol. 14v| similiter restrictus fuit, ita quod quando ductus fuit in plano minor fuit quam sua forma prima. Equinoctialis semper mansit in magnitudine sue forme prime, et circulus capricorni fuit maior quam sua forma prima, prout manifeste apparet in figura cum predictis punctis. |P fol. 13r|

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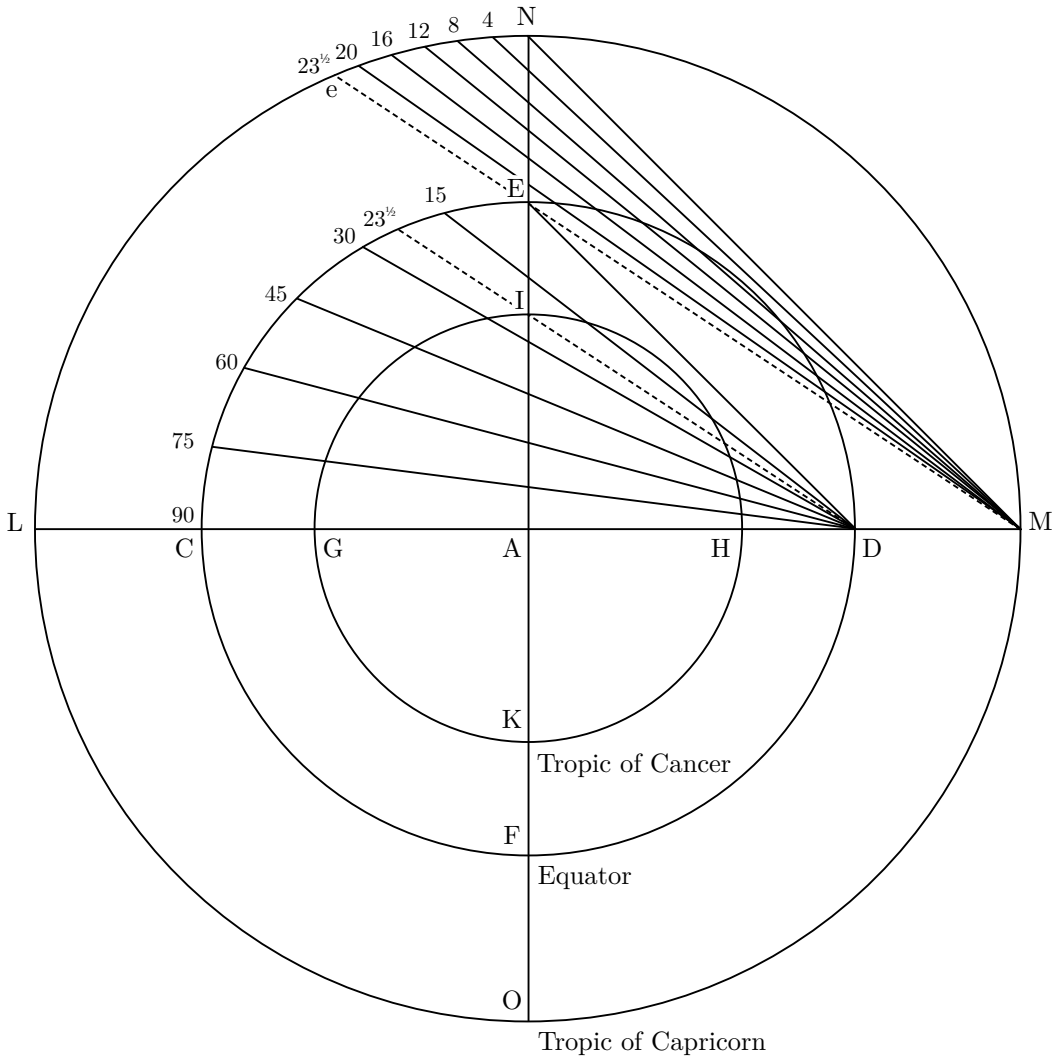
43 et deprimitur] *om.* C Qualiter spera secatur et deprimitur] *om*. *titulus ad sequenti articulo defertur Cesari* || 44 abscisa] obsisa *alia manu corr. in marg.* abscisa A || 44 et quod a dicto parallelo capricorni] *om*. A B C R S *Cesari* capricornii V || 45 ad] in B || 45 antarticum] add. per S || 45 totum] ex per totum residuum B *om*. V *Cesari* || 45 abiceretur] abijcerent P *om*. Cesari || 45 remaneret] remanetur *alia manu corr*. remaneret A || 45 in] super B || 46 plano] *om*. B R S V || 46 super planitiem] in ipsa planitie C || 47 capricorni.] *om*. B R S V || 48 Tunc] Et tunc S || 48 in] *om.* C || 48 ipso] *om*. L B S V || 48 pondus] *lac*. *alia manu add. in marg*. agens A || 48 pondus aliquod,] *transp*. aliquod pondus, L quodam pondus, C || 49 duceret] deduceret! C || 49 et duceret ... rotundam.] *om*. B R S V || 50 spere,] *om.* C || 51 equinoctialem] equinoctialis V || 51 equinoctiali,] equinoctiale, C A || 51 quanto pars spere] *transp*. pars sphaerae quanto *Cesari* || 52 parallelo] *om*. L || 52 fuit] *om*. A *Cesari* || 52 fuit prope] *transp*. prope fuit C || 53 equinoctialem] equinoctialis V aequinoctiali *Cesari* || 54 equinoctialem] *om.* C equinoctialis V || 54 remanere] remaneret V *Cesari* || 54 semper] *om*. *Cesari* || 54 ymaginati sunt remanere semper] *transp*. ymaginati sunt semper remanere L ymaginati semper sunt C || 55 usque] per tropicum cancri B || 55 articum,] *scr*. *del*. ant *corr*. articum *add*. *del*. secundum C 2m R || 56 proportionem] proportionum C || 56 quia] et C || 56 quanto] *add*. plus S || 56 quanto pars spere] *transp*. pars sphaerae quanto *Cesari* || 57 magis prope polum articum] propinquior polo artico, B R S V *Cesari* || 57 equinoctialem,] equinoctialis V equinoctiali, *Cesari* || 58 Circulus] Circulum B R V || 58 vero] autem C || 58 inter] ab C intra S || 59 ita quod] *om*. *Cesari* || 59 ductus] reductus L redactus! C dictus! A || 59 minor fuit] ita quod fuit minor *Cesari* || 59 sua forma prima.] *transp*. sua prima forma. L C forma sua prima. B A R S V *Cesari* || 60 Equinoctialis] Equinoctiale A *add*. vero B autem R S V *Cesari* || 60 sue] *om*. *Cesari* || 60 prime,] *om.* C B R S V || 60 circulus] *om*. R S V || 61 capricorni] capricornus R V || 61 fuit maior] *transp*. maior fuit P || 61 sua forma prima,] *transp*. sua prima forma, C forma sua prima, A quam sua forma prima *om*. B R S V || 61 in] *add*. hac B || 61 figura] signis A || 61 apparet in figura] *transp*. in figura apparet C || 61 cum predictis punctis.] *om*. C B || 63 a puncto] a punctis P || 63 dyametrum] dyametrem L || 63 equinoctialis] equinoctialem P || 64 dyametrum] dyametrem L || 64 capricorni.] capricornii. L Spera ... capricorni.] Spera depressa B R V S *om*. *Cesari*



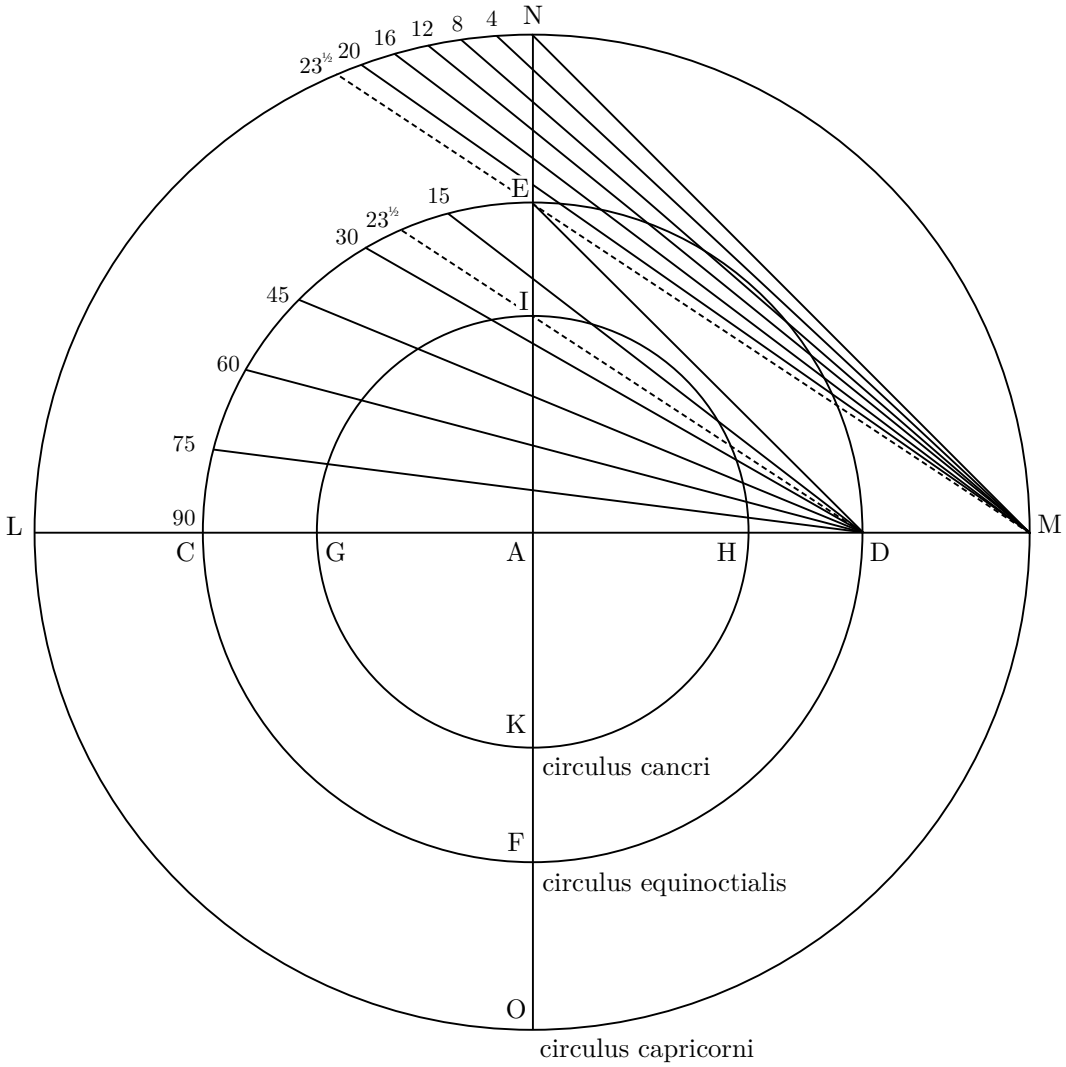
[Figure 5] The flattened sphere with the lines drawn from the point *D* over the diameter of the equator [*FE*] and with the lines drawn from point *M* [above those] over the diameter of the circle Capricorn [*EN*][9].

<On drawing the figure of the circles.> They also conceived that the sphere was depicted as above [below, Fig. 6] and with the said points, that is: that point *A*, which is the arctic pole, was on the straight line *PQ*, and that the diameter *AB* was drawn perpendicular to line *PQ*, such that point *B* was on the summit of the said sphere.

Then they drew lines from point *B*, that is from the antarctic pole, namely: one that passed through the point *M* of the sphere until reaching line *PQ,* where they marked a point, [labelled] *m* as well[10]; in the same way, from the said point *B*, they drew another line through point *L* down to line *PQ* where they marked *l*; likewise, they drew a line from point *B* that

9. Fig. 5 intends to geometrically construct the division of the line of midnight and the meridian line in the flattened sphere. It represents a preliminary step, in order to prepare the setting of the zenith and the almucantars in the following section. The approach here concentrates on practical geometrical efficiency: to avoid uncertainty in the tracing of the lines, the intersections for the southern declinations (0 to 23½ degrees) the figure uses the arc of *LOMN* and the pole *M* instead of *CFDE* and pole *D*. In MS C, Fig 5 is rudimentary. It only consists of the two axis *NO LM* and circle *NMOL*. The bundle of lines issued from *D* is represented at 10 degree intervals in MS P when it is at 15 degree intervals in MSS B L R S V. The outer bundle issued from *M* is not shown in MS B, which has only the line *ME* at 23½ degrees. The best drawn diagram is found in MS P.

10. Andalò uses twice the same capital letter (here and for the following points), we are substituting lower case letters for the second point.



[Figura 5] Spera depressa cum lineis ductis a puncto D super dyametrum equinoctialis et cum lineis ductis a puncto M in super dyametrum circuli capricorni.

65 |B fol. 147r|S fol. 90v| <De figuratione circulorum.> Ymaginati sunt etiam ut spera figurata esset ut supra et cum dictis punctis, videlicet punctus A, quod est polus articus, esset super lineam rectam PQ, et diameter AB erectus esset perpendiculariter super lineam PQ, ita ut punctus B esset in cacumine dicte spere.

Tunc produxerunt lineas a puncto B, videlicet a polo antartico unam que transiret per 70 punctum M spere usque ad lineam PQ, ibi similiter descripserunt punctum M. Item a dicto

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65 De figuratione circulorum.] *om.* C A Alia ymaginatio qualiter spera secatur et deprimitur. B R S V Qualiter sphaera secatur et deprimitur *Cesari* || 65 Ymaginati sunt etiam] Ymaginandum est C Ymaginaverunt etiam A || 65 ut] ubi B R V || 65 spera] *om.* C || 66 ut] ubi V || 66 cum dictis ... videlicet] *om*. B R S V || 66 punctus] punctum S V || 66 quod est] quod cum P || 66 articus] *scr. del.* ant *corr*. articus C || 67 lineam rectam] linea recta V || 67 PQ,] *add. del.* ita ut punctus C || 67 perpendiculariter] *add*. *del*. super perpendiculariter P || 67 lineam] linea V super lineam] *rep*. A || 67 et diameter AB ... super lineam PQ,] *om*. B || 67 ita ut] in ubi V || 68 dicte] *om*. V || 69 produxerunt] duxerunt *Cesari* || 69 a polo antartico] ad polum antarticum P A a polo artico C || 69 unam] *add*. videlicet P A || 69 transiret per punctum] transit a puncto C || 70 spere] *add*. et transiret P A || 70 lineam] punctum C || 70 lineas a puncto B ... PQ,] unam lineam a polo antartico silicet B per M dicte spere usque ad lineam PQ, B R V unam lineam a polo antartico B per M. S unam lineam a puncto B polo antartico, usque ad lineam PQ, quae transiret per punctum M, *Cesari* || 70 ibi] ibique B R V *Cesari* || 70 similiter descripserunt] scripserunt *Cesari* || 70 punctum] *om*. B R V || 70 ibi similiter ... punctum M.] *om*. S || 70 Item a dicto] Tunc adiecto C

passed through point *D* down to line *PQ* where they marked *d*; likewise, they drew a line from point *B* that passed through point *C* down to line *PQ* where they marked *c*; likewise, they drew a line from point *B* that passed through point *H* down to line *PQ* where they marked *h*; likewise, they drew a line from point *B* that passed through point *G* down to line *PQ* where they marked *g*.

Then they set the steady leg of the compass in point *A* and the moving leg in the points *h* and *g* [on *PQ*], and they traced a circle which was the circle of Cancer [on the sphere], like the lines that they traced at the said points [on *PQ*] passed through the parallel of Cancer, i.e. through the points *G* and *H* [on the sphere][11]. Likewise they set the steady leg of the compass in point *A* and the moving leg in the points *c* and *d* [on *PQ*], and they traced a circle which [on the sphere] was the circle of the equator, just like the said lines passed through the equator on the sphere. Likewise they set the steady leg of the compass in point *A* and the moving leg in the points *l* and *m* [on *PQ*], and they traced a circle which [on the sphere] was the circle of Capricorn, just like the lines passed through the points of the parallel of Capricorn on the sphere. And in this way they traced all three circles.

11. We read *per puncta*. These points are on the sphere.

puncto B protraxerunt aliam lineam per punctum L usque ad lineam PQ, ibique descripserunt L. Item a puncto B duxerunt lineam que transiret per punctum D usque ad lineam PQ, ibique descripserunt D. Item a puncto B duxerunt lineam |P fol. 14r| per punctum C usque ad lineam PQ, ibique descripserunt C. Item a puncto B duxerunt lineam, que transiret per punctum H usque ad lineam PQ, ibique descripserunt H. Item a dicto puncto B duxerunt lineam, que transiret per punctum G usque ad PQ, ibique descripserunt G.

Tunc posuerunt pedem circini fixum in puncto A, et mobilem in punctis H et G, et descripserunt circulum, qui fuit circulus cancri, sicut linee que descripserunt dictis punctis transierunt per parallelum cancri, videlicet per puncta G et H. Item posuerunt pedem circini fixum in puncto A, et mobilem super C et D, et descripserunt circulum, qui fuit circulus equinoctialis, sicut dicte linee transierunt in spera per puncta equinoctialis. Item posuerunt pedem circini fixum in A, et mobilem in punctis L et M, |V fol. 5r| et descripserunt circulum, qui fuit circulus capricorni sicut linee transierunt in spera per puncta paralleli capricorni. Et tali modo descripserunt omnes tres circulos.

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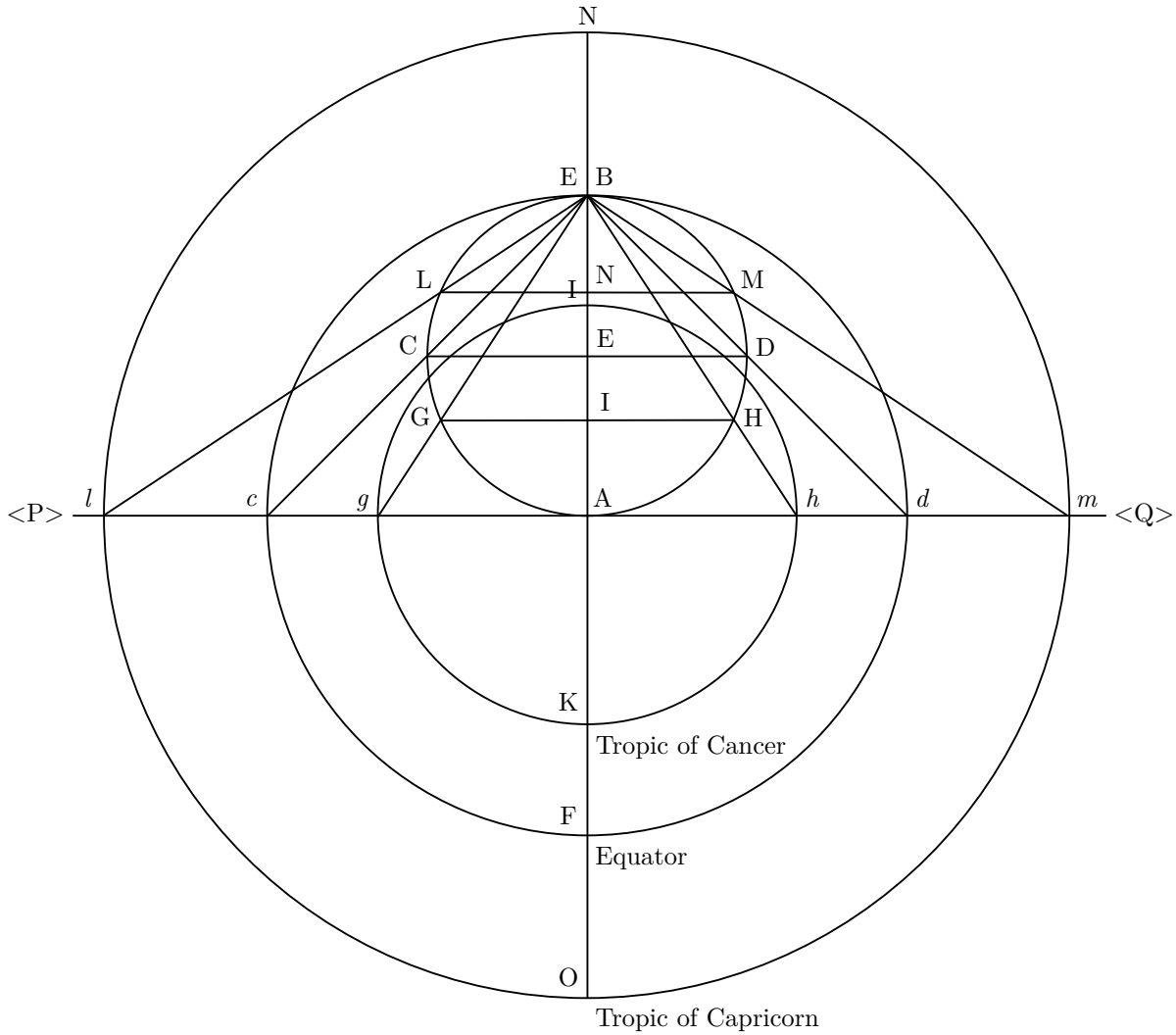
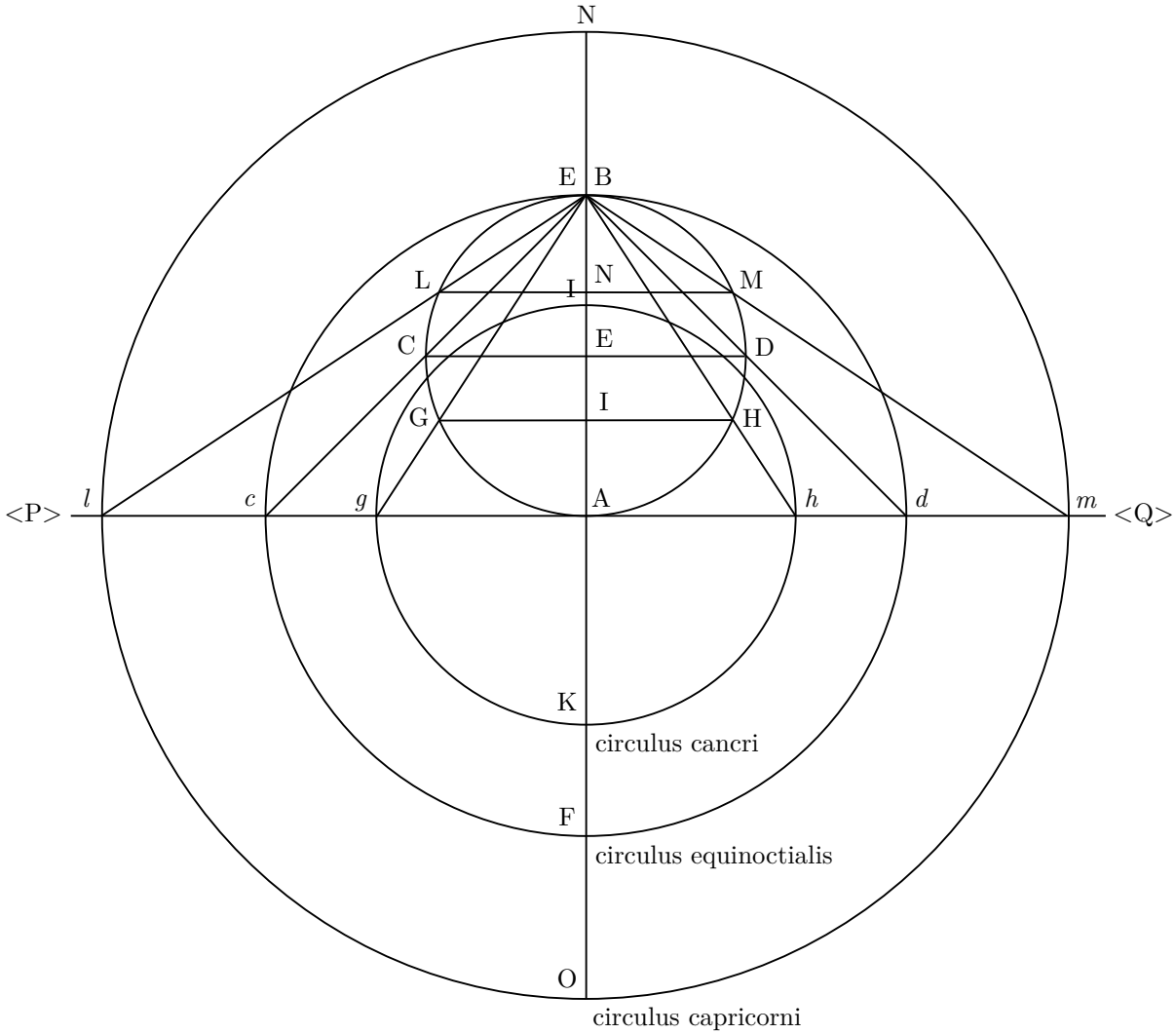
71 protraxerunt] pertraxerunt A *Cesari* proposuerunt C || 71 per punctum L] *om*. *Cesari* || 71 lineam] aliam C || 71 ibique] *add*. simili modo *Cesari* || 71 descripserunt L.] scripserunt C. *Cesari* || 71 Item a dicto puncto B ... descripserunt L.] *om*. B R S || 72 a] *add*. dicto *Cesari* || 72 lineam] aliam lineam C || 72 que transiret ... PQ,] *transp*. usque ad lineam PQ, quae transiret per punctum D, *Cesari* || 73 descripserunt] scripserunt *Cesari* || 73 Item a puncto B ... ibique descripserunt D.] *om*. B R S || 73 que transiret per punctum D ... duxerunt lineam] *om.* C || 73 per] *om*. A || 73 per punctum C] *om*. *Cesari* || 74 descripserunt] scripserunt *Cesari* || 74 Item a puncto B ... descripserunt C.] *om*. S || 74 lineam,] aliam lineam, C || 75 usque ad] super C || 75 usque ad lineam PQ, ibique descripserunt H.] *om.* A *Cesari* Item a puncto B ... descripserunt H.] *om*. B R S || 75 lineam,] aliam lineam, C || 76 PQ,] lineam PQ, C que transiret ... PQ,] *transp.* usque ad PQ, quae transiret per punctum G *Cesari* || 76 descripserunt] scripserunt *Cesari* || 76 Item a dicto punto ... descripserunt G.] Similiter fecerunt per punctum L etiam super dictam lineam PQ ubi etiam simili modo descripserunt L. (L] *scr*. K *corr*. *marg*. L. R) Item a dicto puncto B similiter ducitur aliam lineam per D, et aliam per C, aliam per H, et aliam per G. B R S V Et ubi quamlibet (quamlibet] quelibet linea B quelibet R) terminata est in lineam PQ (PQ] *add*. similiter B) similia puncta descripserunt (similia puncta descripserunt] *transp*. descripserunt similia puncta B) silicet DC, e converso. B R S V (e converso] *om*. B) || 77 circini] *scr. del*. circulum *corr*. circini C || 77 punctis] puncto C *Cesari om*. B R S V || 78 descripserunt] *add*. ut C || 78 qui fuit circulus] *om*. B R S V *Cesari* || 78 dictis punctis] dictos punctos C A P || 79 per[1]] *om.* C || 79 videlicet] *om.* C || 79 puncta] punctum C P punctos A || 79 sicut linee ... G et H.] *om*. B R S V *Cesari* || 79 pedem circini fixum in puncto A,] *om*. B || 80 et[1]] etiam B || 80 mobilem] *add*. pedem B || 80 super C et D,] in D et C, immobili non moto B || 80 descripserunt] scripserunt *Cesari* || 80 circulus] *om.* C qui fuit circulus] *om*. B || 81 dicte linee] *transp.* linee dicte C A || 81 Item posuerunt ... equinoctialis.] Posuerunt etiam mobilem pedem, fixo exeunte in A, super D et C, et descripserunt equinoctialem. R S V sicut dicte linee ... puncta equinoctialis.] *om.* B *Cesari* || 82 pedem circini fixum in A] *om*. B et[1]] *om*. A || 82 punctis] punctorum C *om*. B *Cesari* || 82 L et M,] *add*. immobili non moto B Item posuerunt ... L et M,] Item mobilem pedem in (in] posuerunt super S) M, et L fixo semper existente in A R V (L et M,] M L, *Cesari*) || 83 qui fuit ... capricorni] capricorno B V || 83 sicut] *add*. sunt *scr*. *del*. scilicet? B sunt igitur S || 83 linee] *add*. que B R S V || 83 transierunt] transirint V || 83 per] *add*. predicta B R S V || 83 capricorni.] cancri equinoctialis et parallelum capricornius. V (parallelum capricornius.] paralleli capricornii. S V) sicut linee ... capricorni.] *om*. *Cesari* || 84 omnes] hos B || 84 circulos.] *add*. ut patet in sequenti signa *alia manu corr*. figura A ut patet in sequenti figura *Cesari* De figuratione circulorum ... tres circulos] *om*. L *transp. post capitulum* De lineis meridiana, medie noctis, orientalis et occidentalis. P || 85 Figura docens ... capricorni.] Spera alia depressa. B R *transp*. Spera depressa alia. S V Fig. 6 *om*. L C A



[Figure 6] Diagram that teaches how to place the circle of Cancer, the equator and [the circle] of Capricorn[12].

<4> On the meridian, the midnight, the oriental and occidental lines. After having flattened the sphere as before, the colures, that were circles on the sphere, on the plane became straight lines intersecting each other orthogonally in centre *A*. And that half of the colure that lay between point *A* and point *N* is called ‘meridian line’. And the other half [of the colure] which lay between point *A* and point *O* is called ‘line of midnight’. And the half of the other colure [that lay] between point *A* and point *L* is called ‘oriental line’, or ‘oriental right horizon’, or ‘[oriental] right circle’. And the other half [of the other colure that lay] between point *A* and point *M* is called ‘occidental line’, or ‘occidental right horizon’, or ‘[occidental] right circle’.

12. In stereographic projection literature, the sphere *BCDA* is often placed below the projection plane *PQ*. This is not the case with Andalò, which may be a consequence of his metaphor for depressing the sphere by means of a weight set on top of it. In MSS B and R, the projections of the tropic of Capricorn *lm* and of Cancer *gh* are nearly equidistant from the projection of the equator *cd*. This does not reflect the correct geometric proportion, as the distance from the circle *lm* to the equator *cd* should be greater than the distance from the circle *gh* to *cd*. More suggestive representations are drawn in MSS P and B.



85 [Figura 6] Figura docens collocare circulum cancri, equinoctialis et capricorni.

|R fol. 5r|A fol. 48r| **<4> De lineis meridiana, medie noctis, orientalis et occidentalis.** Depressa spera, ut supra, coluri, qui in spera erant circuli, in plano, facti sunt linee recte secantes se ortogonaliter in centro A. Et appellaverunt medietatem coluri, que erat a puncto A in puncto N lineam meridianam, et aliam medietatem que erat a puncto A in puncto O lineam
90 medie noctis. Medietatem vero alterius coluri, scilicet a puncto A in puncto L appellaverunt lineam orientalem, sive orizontem rectum orientalem, vel circulum directum. Et aliam medietatem a puncto A in puncto M, appellaverunt |P fol. 13v| lineam occidentalem, sive orizontem rectum occidentalem, vel circulum directum.

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86 medie noctis,] medius medietatis? A || 86 orientalis et occidentalis] orientali et occidentali. P De lineis meridiana ... et occidentalis.] *om.* C Sequitur de lineis 4or principalioribus astrolabii. B [*finis* MS B.] De lineis 4or principalioribus. R S V De lineis rectis principalibus. *Cesari* || 87 ut supra,] ut supra et infra S ut sunt C prius P ubi V || 87 circuli,] *add.* et C || 87 facti] facto C || 87 recte] *om*. R S V *Cesari* || 88 in centro A,] in puncto A, scilicet in centro A, C || 88 appellaverunt] appellarunt A V || 88 erat a puncto A] est ab A R S V *suprascr*. A P || 89 in puncto N] in punctum N L in N R S V *Cesari* || 89 que erat a puncto A ... medietatem] *om.* C || 89 lineam meridianam ... puncto A] *om*. A || 89 in puncto O] in punctum O *add*. appellaverunt L que erat ... in puncto O] ab A in O R S V *Cesari* || 90 vero] *om*. A *Cesari* || 90 alterius coluri,] alteris coluris, V || 90 scilicet] *om*. *Cesari* || 90 in puncto L] in punctum L L a puncto A ... L] ab A in L R S V || 91 rectum orientalem,] *transp*. orientalem rectum, R S V || 91 aliam] a lineam V || 92 a puncto A] ab A R S V *Cesari* || 92 in puncto M,] in punctum M, L in M, R S V || 93 orizontem] occidentem! V || 93 vel] sive C seu R V *scr*. *del*. sive *corr*. seu S

And the outermost and largest circle is called the ‘circle of Capricorn’. And the smallest one and nearest to the centre is called the ‘circle of Cancer’. Finally, the circle that lies between these two, is called it the ‘equator’.

<On the setting of the circles by which the almucantars are made[13].> Again they conceived the sphere to be as before and to have the said circles, and that a line or chord extended from point *D* [in Fig. 5][14], where the western colure cuts the equator, to point *E*, where the southern colure cuts the equator. And likewise they conceived that 90 lines or chords extended from point *D* to any of the 90 degrees that range from *E* to *C*, which chords intersect the radius of the equator marking on this radius 90 uneven “degrees” or parts, specifically: the closer to the centre the smaller they are, and the closer to point *E* the larger. Thus I say that the part of the circle which extended from the pole, i.e. from point *A*, to the equator, in point *E*, on the resulting flattened sphere would have precisely the size that the radius of the equator had. Therefore, as the said part of the circle was divided in 90 equal parts, as a result of the flattening of the sphere, the said parts fell down on those parts or intersections made by the chords, that they [the makers] marked on the radius. For that reason they are marked unevenly on that straight line although they were equal on the circle.

<On completing the same [task].> They also conceived a chord or a line extending from point *M*, where the western colure intersects the parallel of Capricorn, to the said parallel of Capricorn, where the meridian line intersects the said parallel in point *N*. And again [they conceived] 24 lines extending to each of those 23½ degrees lying between point *N* and point *L* and intersecting part of the diameter *NO* of the parallel [of Capricorn]. I say that the part *Ne* of the circle [*LNMO*] being equally divided in 23½ parts, when the sphere is flattened, the

13. The Latin term *almucantarath* derives from the Arabic *al-muqanṭarah*: “arched”. The substantive form *al-muqanṭarāt*, litt. “the arched”, is in plural. The word refers to the series of minor circles parallel to the horizon, also known as “horizontal circles” to the astronomers. The spelling varies a lot: almucantarat, almicantarat, almucantars, etc. We chose almucantar, which allows to differentiate the singular and plural forms.

14. MS P provides the best Fig. 5. The line *M*–23 deg. 33 min. 30 sec. (on arc *NL*) passes through *E*, and *D*–23 deg. 33 min. 30 sec. (on arc *EC*) passes through *I*.

Circulum autem extremum et maiorem appellaverunt circulum capricorni, minorem vero et propinquiorem centro appellaverunt circulum cancri. Circulum autem, qui est inter istos duos, appellaverunt equinoctialem. |P fol. 14r|

<De formatione circulorum cum quibus fiunt almucantarath.> Ymaginati sunt iterum speram esse ut prius, cum predictis circulis et quod a puncto D, ubi colurus occidentalis secat equinoctialem, exiret linea sive corda usque ad punctum E, ubi colurus meridianus secat equinoctialem. Et similiter ymaginati sunt quod a dicto puncto D exirent linee sive corde 90 usque ad quemlibet ex 90 gradibus, qui sunt a puncto E usque in puncto C, que corde secant semidyametrum circuli equinoctialis, describendo super dictum semidyametrum gradus sive partes 90 inequales, videlicet quanto erant magis prope centrum, tanto erant minores, et quanto propinquiores puncto E, tanto maiores. Dico ergo quod illa pars circuli, qui erat a polo sive puncto A usque ad equinoctialem in puncto E, in depressione spere facta fuit illius magnitudinis, que erat semidyametro circuli equinoctialis. Ideo dicta pars circuli, cum fuit divisa in partibus equalibus 90, propter depressionem spere, dicte |L fol. 75r| partes |V fol. 5v| ceciderunt super illas partes sive intersecationes cordarum, quas in semidyametro descripserunt. Ideo in illa linea recta inequales describuntur, licet in circulo fuissent equales. |S fol. 91r| <De refectione eiusdem.> Ymaginati sunt etiam quod a puncto M, ubi colurus occidentalis secat parallelum capricorni, exiret corda sive linea, que iret usque ad dictum parallelum capricorni, ubi linea meridiana secat dictum parallelum in puncto N. Et similiter exirent linee 24, |C fol. 15r| euntes ad unumquemque de illis gradibus 23½, qui sunt a puncto N versus punctum L, secantes partem dyametri paralleli NO. Dico quod pars circuli NE,

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94 autem] vero R S V || 94 et] *om*. R S V || 94 circulum] *om.* C R S V || 94 capricorni,] capricornum, R S V || 94 vero] *om*. C P || 95 propinquiorem centro] *transp*. centro propinquiorem R S V || 95 appellaverunt] *om*. R S V || 95 autem] *om*. C Circulum autem,] Illum vero R S V || 95 istos duos,] eos, R S V || 96 appellaverunt] *om*. R S V || 96 De lineis meridiana ...] *transp. ante capitulum* De figuratione circulorum. P || 97 De formatione ... almucantarath.] *tantum in* P || 97 fiunt] fit P || 98 iterum speram ... circulis et] etiam R S V || 98 puncto D,] D, R S V || 98 colurus] conlurus! V || 99 equinoctialem,] equinoctiale V || 99 exiret] exirent V || 99 sive corda] *om*. R S V || 99 occidentalis secat ... colurus] *om.* C || 99 meridianus secat] *transp*. secat meridianus C || 100 equinoctialem.] equinoctiale *add*. meridianus secat equinoctialis. V || 100 dicto] *om*. L C B || 102 D] *om*. V || 100 exirent] exiret V *Cesari* || 100 sive corde 90] 9 R V 9 *alia manu suprascr*. 90 S || 101 quemlibet] quelibet V quamlibet *Cesari* || 101 ex 90 gradibus,] de 90 gradibus, L de 90, C gradum illorum 90, R S V || 101 in puncto C,] in punctum C, L A ad punctum C, C a puncto E ... puncto C,] ab E usque in C, R S V || 101 secant] secent L P || 102 semidyametrum] semidyametram A || 102 semidyametrum circuli] *transp*. dyametrum semicirculi C || 102 dictum] circuli A *om. Cesari* || 102 semidyametrum] *suprascr*. semi P || 102 super dictum ... gradus sive] *om*. R S V || 103 90 inequales,] *transp*. inequales 90, C *add*. licet in circulo sint equales, R S V || 103 videlicet] usque C R || 103 erant magis prope] *transp*. magis erant prope C erant propinquiores R S V || 103 centrum] centro C A R S V *Cesari* || 103 tanto] *add*. magis C || 103 erant] *om*. R V || 104 puncto E,] E, R S V || 104 Dico] Dicto A || 104 ergo] *om*. C || 104 quod illa pars] *marg*. L || 105 sive] *add*. a L || 105 a polo sive ... puncto E,] ab E, R S V || 105 in] *om. Cesari* || 106 semidyametro] semidyameter L P V Cesari || 106 circuli equinoctialis.] *transp*. equinoctialis circuli. C || 106 cum] que C || 107 fuit divisa] *transp*. divisa fuit *Cesari* || 107 in partibus equalibus] in partes equales P in partes R S V || 107 90,] 60! C || 107 dicte] dictas C || 108 ceciderunt super] cecidere supra V || 108 cordarum,] linearum R S *om*. V || 108 quas,] *scr. del.* quorum *corr*. quas C || 108 in] *om*. V || 109 descripserunt.] exscripserunt. R S V || 109 linea recta] *transp.* recta linea C || 109 Ideo in illa ... describuntur,] *om*. R S V || 109 describuntur ... equales.] *om.* C || 110 De refectione eiusdem.] *tantum in* P || 111 corda sive linea,] *transp*. linea sive corda, A P linea, R S V *Cesari* || 111 iret] venit C || 111 dictum] *om.* C || 112 capricorni,] *om*. R S V || 112 linea meridiana ... puncto N.] secatur in lineam meridianam in N. R S V || 113 24,] 23! *Cesari* || 113 gradibus] gradus A || 113 23½, qui sunt] 23, et C || 113 a puncto] ad punctum R S V || 114 versus punctum L,] in L, R S V || 114 partem dyametri] partes C *add*. dicti R S V || 114 paralleli NO.] parallelum, scilicet NO, que est NE. R S V capricorni NO. *Cesari* || 114 circuli NE,] NE, C dyametri, que est NE, R S V *Cesari*

said parts fall on the intersections that the aforementioned lines make on the said diameter [*NO*][15]. And just as the intersections with that diameter are unequal, so the parts of the said circle *Ne* are unequal [when put] on a straight line, and the closer they are to point *N* the larger they are, and the closer they are to point *E*, the smaller.
And I also say that the line traced from the point *M* to 23 degrees 33 minutes 30 seconds measured from point *N* towards point *L* passes directly through the equator in point E. Likewise I say that the line traced from point *D* through 23 degrees 33 minutes 30 seconds measured from point *E* towards point *C* passes directly through the parallel of Cancer, where the colure of mid-heaven intersects the said parallel in point *I*.

<5> On the almucantars. While the colures, the parallels and the equator are and must be identical on the plates of all places, however the almucantars, the azimuth and the hour [lines], however, are not the same for whatever place or plate you choose, but vary according to the variation of place, as will be explained below.
<On the zenith of the head.> Therefore the makers conceived that, whatever place they determined to make a plate or front of the astrolabe for, a line would come out from the centre of the Earth and it would go through that same place up to the firmament and end on the meridian line of that place. I say that the point where the said line ends on the meridian line is called the ‘zenith of the head’.
Thus when they wanted to make a plate for a certain place they first sought [the value of] the latitude of that place, and they conceived that the zenith of that place is that much distant from the equator along the meridian line as is the latitude of that place. Then they took one degree counted from the zenith along the meridian line on the side of the arctic pole and one on the side of the antarctic pole, in which degree they traced a circle around the zenith and equidistant from it. And they did the same at two, three and four degrees etc. tracing a circle in each degree on each side around the point of the zenith as they did for the first degree until they reached 90 degrees on each side, tracing 90 circles in such a way that the last circle falls perfectly on the horizon of that place.

15. This passage refers to Fig. 5. However, point *e*, which is the projection of *E* onto the circle *LNMO*, is not marked in the MSS.

divisa equaliter |P fol. 14v| in partibus 23½. Quando spera depressa fuit, dicte partes ceciderunt super intersecationes, quas predicte linee fecerunt |R fol. 5v| super predictam diametrum. Et sicut intersecationes ipsius dyametri fuerunt inequales, ita et partes dicti circuli NE super rectam lineam fuerunt inequales, et quanto erant propinquiores puncto N, tanto maiores erant, et quanto propinquiores puncto E, tanto minores.

Et etiam dico quod illa linea, ducta a puncto M in gr. 23 min. 33 sec. 30 a puncto N versus punctum L, transit recte per equinoctialem in puncto E. Item dico quod linea, ducta a puncto D per gr. 23 min. 33 sec. 30, a puncto E versus punctum C, transit recte per parallelum cancri, ubi colurus medii celi secat dictum parallelum in puncto I.

<5> De almucantarath. Cum coluri, paralleli et equinoctialis in tabulis cuiuscumque regionis sint et esse debeant uniformes, tamen almucantarath, azimut et hore non sunt in qualibet regione sive tabula uniformes, ymo diversificantur secundum diversitatem regionis, ut infra dicetur.

<De cenith capitis.> Ymaginati sunt ergo compositores quod, in quacunque regione in qua voluerunt facere tabulam sive faciem astrolabii, quod linea exiret a centro terre, et transiret per regionem illam usque ad firmamentum, et terminaretur in linea meridiana illius regionis. Dico quod ille punctus, in quo dicta linea terminatur in linea meridiana, vocatur cenith capitis.

Quando igitur voluerunt facere tabulam ad aliquam regionem, primo inquisiverunt latitudinem illius regionis, et ymaginati sunt quod cenith illius regionis tantum distaret in |A fol. 48v| linea meridiana ab equinoctiali, quanta est latitudo illius regionis. Tunc acceperunt gradum unum longe a cenith in linea meridiana ex parte poli artici, et unum ex parte poli antartici, in quo gradu descripserunt circulum circa cenith equidistantem ab eo. Et ita fecerunt in duobus gradibus, tribus, quatuor, etc. ex utraque parte in unoquoque gradu circulum describendo super punctum cenith, ut in primo gradu fecerunt, quousque pervenerunt ad

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115 equaliter] *om*. C || 115 in partibus] in partes C P S V || 115 23½.] 23. C || 116 predicte] dicte C || 116 predicte linee fecerunt] *transp*. fecerunt predicte linee A R S P V *Cesari om*. linee A || 116 predictam] predictum A P S V || 117 ipsius] illius A R S V *Cesari* || 117 ita] *om*. C || 117 dicti] *om*. C || 118 ita et partes ... inequales,] NC et partes circuli fuerunt equales, R S V *om. Cesari* || 119 maiores erant,] *transp*. erant maiores, R S V maiores *Cesari* et quanto erant ... maiores erant] *om*. C || 119 puncto E,] E, R V || 119 minores.] maiores. C || 120 etiam] *om*. C || 120 a puncto M] ab M R S V || 120 23] *add*. *del*. ½ S || 121 a puncto] *rep*. P || 121 a puncto N ... punctum L,] ab N versus L, R S V *om. Cesari* || 121 per] *om*. C || 121 equinoctialem] equinoctialis V || 121 in puncto E.] in punctum E. C || 121 ducta] dicta A || 121 a puncto D] a D R S V || 122 versus] usque ad C || 122 a puncto E ... punctum C,] ab E versus C, R S V *om. Cesari* || 122 per] *om*. C A || 123 colurus] *rep*. P || 123 medii celi] medie diei A R S P V *Cesari* || 123 dictum] *om.* C *Cesari* || 123 in puncto I.] in I. R S V || 124 paralleli et] parallelum V paralleli A *Cesari* || 125 regionis] *om*. A R S V *Cesari* || 125 et esse debeant] *om*. R S V *Cesari* || 125 almucantarath, azimut] *transp*. azimut almucantarath V almucantarath et azenit! C || 125 non] *om*. C || 126 regione] regionem V || 126 sive tabula] *om*. R S V sive tabule C || 126 secundum] 2m R *om*. V || 127 ut] ubi R V || 127 infra] ita C || 127 dicetur.] dicentur A docetur. R V || 128 De cenith capitis.] *tantum in* P || 128 ergo] igitur C S V *Cesari* || 128 compositores] exponitores C componitores astrolabii R S V *Cesari* || 128 quod,] *om. Cesari* || 128 quacunque] in quantumque L C omni R S V || 128 regione] regionem V || 128 in qua] *om.* C || 129 voluerunt] volueris P || 129 exiret] transiret R S V *Cesari* || 130 regionem illam] regiones illas C || 131 Dico] *rep*. V || 133 igitur] vero A R S V *Cesari* || 133 tabulam] tabula V || 134 latitudinem] latitudinis A latitudine V || 134 et ymaginati ... regionis] *om*. A *Cesari* || 134 distaret] distat C || 135 quanta] quanto C quantum P || 135 et ymaginati ... illius regionis.] *om*. R S V || 135 acceperunt] receperunt C || 136 unum] *om.* C R S V || 136 a] ad V || 136 unum] 1 R S V gr. 1 *Cesari* || 137 equidistantem] equidistante V || 138 in duobus] *om.* C || 138 in duobus gradibus ... etc.] in 2bus, 3bus, 4or, etc. R S V in duobus gradibus, in tribus, etc. *Cesari* || 138 gradu] *om*. C P *scr*. *del*. gradu *marg*. spatio? L circulo? A

Moreover, as they conceived that the sphere was divided and cut on the parallel of Capricorn, the circles that crossed beyond the said parallel did not turn out entire nor complete [on the plate], but truncated. Then they conceived the sphere flattened as before, and as the said circles were not traced around the centre, which is the [arctic] pole, but around the zenith, therefore they do not fall as [concentric] circles around the pole, but obliquely and unevenly [distributed][16].

Thus I say that when the sphere was flattened, the zenith fell on the diameter of the equator at the abovementioned intersections, i.e. at as many degrees as was the latitude of that place. As a consequence all circles around the said zenith fall from degree to degree on any intersection, according to how far any circle is away from the point of the zenith. And because on the said diameter the degrees or intersections are unequal, therefore the said circles fall unevenly [distributed] on the plate, i.e. oblique and unequal, which circles they called almucantars.

<6> On the dawn. Again they conceived that the sphere was as before and that on the sphere there was a circle parallel to the oblique horizon that remained equally distant from the horizon by 18 degrees all around. I say that, when the sun reaches the said parallel circle from the eastern side, that moment is the beginning of dawn or of morning twilight. And when it reaches the said parallel from the western side, that moment is the end of dusk or of evening twilight.

Then they conceived the sphere flattened as before and they saw that that parallel fell distant from the oblique horizon by 18 degrees towards the line of midnight.

16. The definition of “fall obliquely and unevenly” is given a few sentences below (line 170–3).

gradus 90 ex utraque parte 90 circulos describendo, |L fol. 75v| ita quod ultimus circulus pervenit recte in orizontem illius regionis.

Et quia speram ymaginati fuerunt esse abscisam et secatam in parallelo capricorni, circuli illi, qui transierunt ultra dictum parallelum non pervenerunt integri et completi, ymo abcisi.

Tunc ymaginati sunt quod spera deprimeretur ut prius, et quia dicti circuli non erant circulares super centrum poli, sed super cenith, ideo circa polum circu|P fol. 15r|lariter non ceciderunt, ymo diverse et oblique.

Dico ergo quod, quando spera depressa fuit, cenith cecidit super dyametrum equinoctialis in intersecationibus supradictis, scilicet ad tot gradus quot erat latitudo illius regionis. Et per consequens omnes circuli circa dictum cenith ceciderunt de gradu in gradum super quamlibet secationem, secundum quod quilibet circulus distabat a puncto cenith. Et quia super dictum dyametrum gradus sive intersecationes fuerunt inequales, ideo circuli predicti ceciderunt in tabulam diversi, sive obliqui et inequales, quos circulos vocaverunt almucantarath.

<6> De aurora. Ymaginati sunt iterum speram esse ut prius, et quod in ipsa spera esset circulus parallelus orizonti obliquo, equidistans ab ipso orizonte per gr. 18 ex omni parte. Dico quod, quando sol pervenit ad dictum circulum parallelum ex parte orientis, tunc est initium aurore sive crepusculi matutinalis. Et quando pervenit ad dictum parallelum ex parte occidentis, tunc est finis crepusculi serotini sive vespertini.

Tunc ymaginati sunt speram depressam ut prius, et viderunt quod parallelus ipse ceciderat longe ab orizonte obliquo per gr. 18 versus lineam medie noctis.

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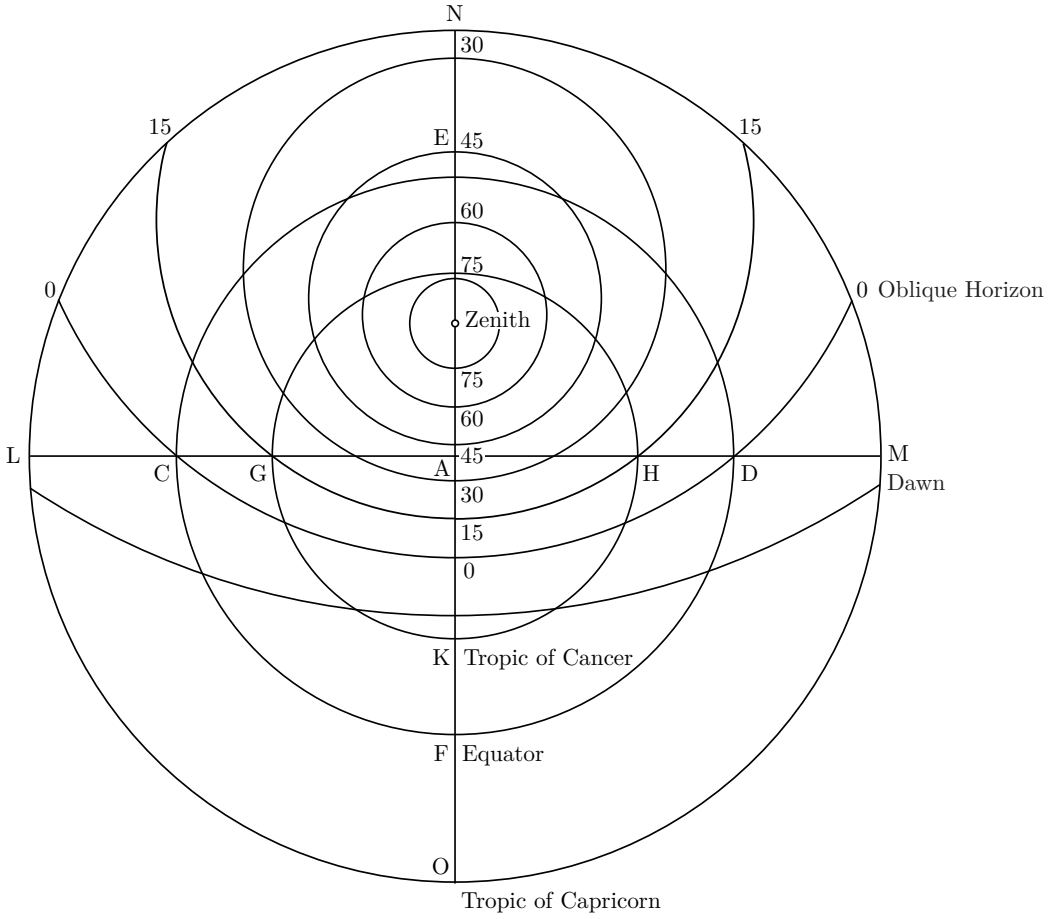
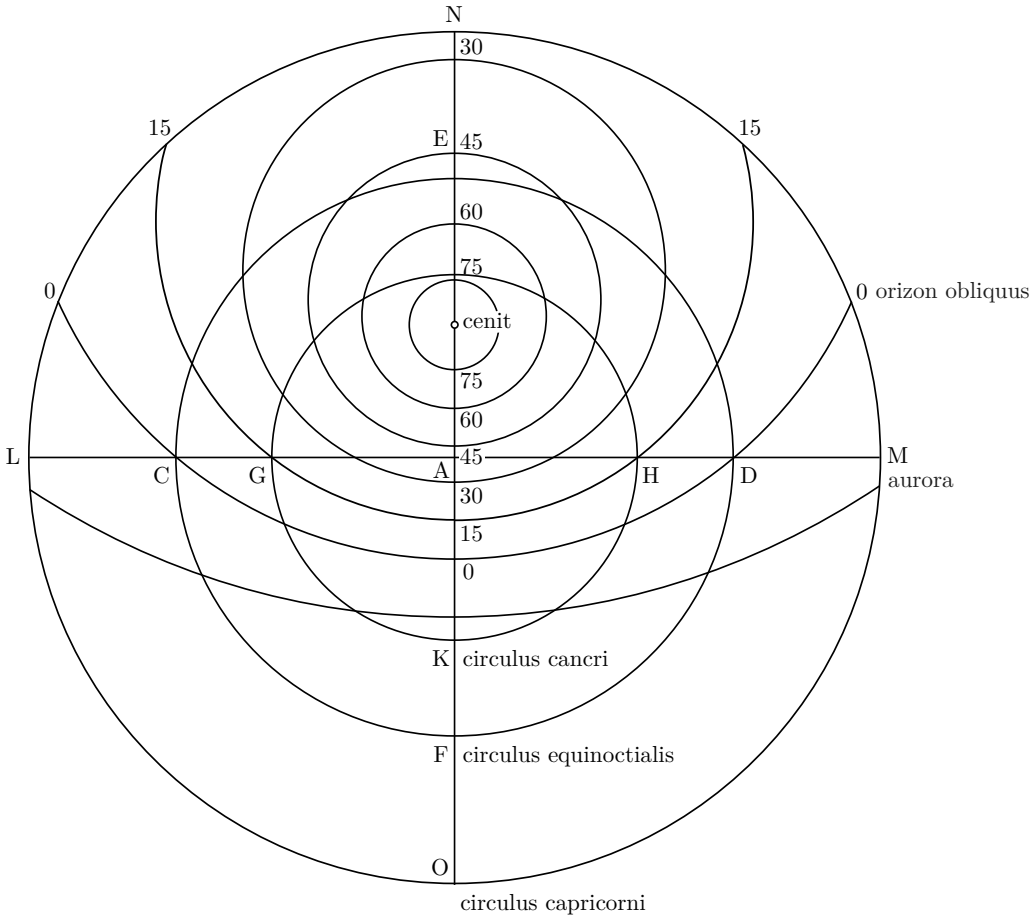
139 circulum describendo] *transp*. describendo circulum *Cesari* || 139 super ... cenith,] concentricum cenith, R S V *Cesari* || 139 ut in primo gradu fecerunt] *om*. R S V || 139 pervenerunt] venerunt C || 140 utraque] uterque A || 140 90 circulos describendo,] *om*. R S V describendo 90 circulos, *Cesari* || 140 ita] in V || 140 ultimus] ille C || 141 pervenit] *om.* C perveniret R S V *Cesari* || 141 orizontem] orizonte A *Cesari* || 142 fuerunt] sunt C speram ymaginati fuerunt] *transp*. fuerunt ymaginati speram R S V imaginati sunt sphaeram *Cesari* || 142 abscisam] absisam A || 142 abscisam ... capricorni,] *transp*. abscisam in parallelo capricorni et secatam, P fixam et sectam in circulo capricorni, R S V fixam et secatam in parallelum capricorni, *Cesari* || 143 dictum] predictum R || 143 integri] intregri A || 143 et] *om.* C || 143 ymo] sed R S V *Cesari* || 143 abscisi.] abfixi. A || 144 sunt] fuerunt A P || 144 ut] ubi V || 145 sed] videlicet A || 145 cenith] *add*. et C || 145 circa] *om*. A *add. marg*. R super dictum *Cesari* || 145 circuli non erant ... circulariter] *om*. S || 147 ergo] igitur C || 147 fuit,] est, *Cesari* || 147 cecidit] ceciderit R V || 147 equinoctialis] equinoctialem C *Cesari* || 147 in] *om. legendo* inter secationibus A || 148 intersecationibus] intersegationibus C V || 148 supradictis,] predictis, P intersecationibus supradictis,] *transp*. dictis intersecationtibus, *Cesari* || 148 ad tot] a tot C R S V || 148 gradus] gradibus S || 148 quot] quod C || 148 illius regionis.] *transp*. regionis illius. L || 148 Et] *add*. deinde *Cesari* || 149 in gradum] in gradu A *Cesari* || 150 secundum] per V || 150 puncto] *om.* R S V || 150 ceciderunt de gradu in gradum ... cenith.] *om*. C || 150 dictum] *scr. del*. dictum *corr*. dictam V dictam *Cesari* || 151 Et quia super [dictum] dyametrum] *rep*. C || 151 intersecationes] secationes A R S P V *Cesari* || 151 circuli predicti] *transp.* dicti circuli C || 152 tabulam] tabula R S V || 152 tabulam diversi,] tabula diverse, *Cesari* || 152 sive] *om*. A P et R S V *Cesari* || 152 et inequales] *om*. L || 152 De almucantarath ...] *transp*. *post capitulum* De aurora L || 153 sunt iterum] fuerunt iterum A P V etiam fuerunt R sunt etiam S *Cesari* || 153 speram esse] speram C speram esset R ut spera esset S quod sphaera esset *Cesari* || 153 et quod] *om*. C R S quando A || 153 iterum speram ... ipsa] etiam ubi V || 153 spera] *om*. S || 154 circulus] *om*. C S || 154 orizonti obliquo,] orizontis obliqui, L C obbiquo! V || 154 equidistans] qui eque distans C || 154 ipso orizonte] eo R S V || 154 ex omni parte] et tum ex parte. C || 155 quod] *om*. A <quod> *Cesari* || 155 dictum] ipsum C || 155 parallelum] *om*. R S V || 155 est] *om.* C || 156 crepusculi] *rep*. *del*. orientis, tunc est initium V crepuscoli *Cesari* || 156 crepusculi matutinalis.] crepusculum matutinalem. C || 156 Et] *om.* C || 158 Tunc] *add*. autem C etiam R S V || 158 ymaginati sunt] *transp*. sunt ymaginati L || 158 ut] ubi V || 158 ipse ceciderat longe] *transp*. ille longe ceciderat C || 159 obliquo] oliquo! P || 159 versus] usque ad C || 159 De aurora ...] *transp*. *ante capitulum* De almucantarath L C



[Figure 7] The flattened sphere with the almucantars and the line of dawn[17].

<7> On the azimuth. Again, however, they conceived the sphere in its original form and they traced circles from the point of the zenith, of which one would go through the east and west, i.e. towards east until point *C* and towards west until point *D*. Afterwards they divided the horizon: [they divided] the half that lies from the equator towards the north in 180 equal parts; and similarly, they divided the other half in the same 180 parts, and they traced 180 circles from the zenith passing through all these divisions, that amounted to 360 on both sides of the horizon, which circles they called azimuths. After this, they conceived the sphere flattened as before, and, as the said circles did not extend from the pole but from the zenith, therefore they did not fall as perpendicular [circles] on the plane, but as oblique [ones], as becomes clear in the following diagram [Fig. 8]. And, as a consequence, the divisions made equal on the horizon fall as unequal [divisions]. In such a way that the closer the said parts or

17. None of the MSS presents a complete figure that accurately reflects the text. There are several possible values for the position of the line of dawn or crepuscular line, here called "aurora". Andalò's text places this line at 18 degrees below the horizon. In MS C, Fig. 7 is rudimentary. In MS L the line of dawn is guesswork: it passes through points *L K M*, which does not correspond to 18 degrees (also in MS L, four additional curves, corresponding to azimuth circles, join the zenith to points *L C D M*; apparently the copyist added them here to avoid drawing Fig. 8). The line of dawn is lacking in MS P, but the horizon is correctly drawn (it passes through points *C* and *D* as required, which is not the case in MSS R S V) and the almucantars are full circles that cut across the circle *NMOL*. Regarding the drawing of Fig. 7 in general, in MSS R S V, the zenith coincides with the the southernmost point of the circle *GHK* which means that these diagrams are traced for a latitude of 23½ degrees. In MS P the implicit latitude is ca. 40 degrees. In MS V, the almucantars are not correctly distributed. As the altitudes of almucantars are missing in all manuscripts except in MSS R S where they are upside down, we decided to follow the usage by counting the altitude from the horizon.



160 [Figura 7] Spera depressa cum almucantarath et aurora.

|S fol. 91v|P fol. 15v|V fol. 6r| **<7> De azimut.** Iterum autem ymaginati sunt speram in sua forma prima, et a puncto cenith duxerunt circulos, quorum unus iret per orientem et occidentem, videlicet versus orientem usque ad punctum C et versus occidentem usque ad punctum D. Postea diviserunt orizontem, videlicet medietatem, que est ab equinoctiali versus 165 septentrionem in partes equales 180. Et similiter |C fol. 15v| aliam medietatem diviserunt in similes partes 180 et duxerunt circulos 180 a cenith, transeuntes per omnes istas partes, que erant ex utraque parte orizontis 360, quos circulos apellaverunt azimut. Post hoc ymaginati sunt speram depressam ut prius, et quia dicti circuli non exibant a polo, ymo a cenith, ideo non ceciderunt recti in plano, ymo obliqui, ut in figura sequenti apparet. Et per consequens 170 divisiones facte in orizonte equales ceciderunt |A fol. 49r| inequales. Ita quod quanto dicte

160 Spera ... aurora.] *om*. C V *add*. *marg*. In regione latitudinis gr. 45 facies R S Fig. 7] *om*. A || 161 Iterum] Item R S V *Cesari* || 161 autem] *om*. C R S V || 161 sunt] fuerunt L P || 161 speram] *add*. <esse> *Cesari* || 162 et] *om*. A *Cesari* || 162 a puncto cenith] a cenith R S V *add*. et *Cesari* || 162 quorum unus] unus quoque eorum *Cesari* || 162 orientem] orizontem *corr*. orientem A || 163 et occidentem,] ab occidente, C || 163 videlicet] scilicet *Cesari* || 163 occidentem] occidententem! A || 164 videlicet versus ... punctum D.] silicet per D et C. R S V || 164 diviserunt] duxerunt R || 165 septentrionem] cetentrionem! A septentrione V || 165 180.] 18! C || 165 similiter] *om*. R S V || 165 medietatem] partem C || 166 diviserunt in similes partes 180] in alias 180 partes R S V || 166 duxerunt] diviserunt P || 166 a cenith,] *om*. R V || 166 utraque] uterque A || 167 360,] *om*. S V || 167 Post hoc] Postea C || 168 depressam] *add*. <esse> *Cesari* || 168 ut] ubi V || 168 ideo] *om*. R *Cesari* || 169 plano,] planum, *Cesari* || 169 ymo] sed R S V || 169 ut] ubi V || 169 sequenti] *om*. A R S P V *Cesari* || 169 apparet.] apparebit. C || 169 Et] Dum *Cesari* || 170 inequales.] *om*. V

divisions were to the line of midnight, the narrower they became, and the shorter became the azimuth lines. And the closer they lay to the line of midday, the larger those parts became and the longer [became] the azimuth lines.

<8> On the hours. They again conceived that the sphere was in its [original] form as before, and they looked beyond the arctic pole towards the line of midnight where the outermost almucantar, which represents the horizon circle, cut the circles of Cancer, equator, and Capricorn, and at each intersection they marked a point, i.e. on the circle of Capricorn on the eastern side they wrote *P*, and on the western side they wrote *Q*. At the point of the equator on the eastern side, [they wrote] *C*; and on the western side, *D*. At the point of the circle of Cancer on the eastern side, [they wrote] *R*; and on the western side, *S*.
Then they divided the circle of Capricorn, i.e. from the point *P* to the line of midnight in 6 equal parts, writing 1 at the point of the first part, 2 at the second, 3 at the third and so on until 6. Likewise they divided the said circle from point *Q* to the line of midnight in 6 parts, setting points as before. And also in the same way they divided the equator from point *C* to the line of midnight and in the same way from point *D* to the line of midnight, writing [numbers] at the points as they did on the circle of Capricorn. In the same way they also divided the circle of Cancer from point *R* to the line of midnight and from the point *S* to the said line of midnight.

partes vel divisiones erant propinquiores linee medie noctis, tanto fuerunt strictiores, atque linee azimut breviores. Et quanto propinquiores fuerunt linee meridiei, tanto magis partes ille fuerunt latiores et linee azimut longiores.

|R fol. 6r| **<8> De horis.** Ymaginati sunt iterum speram esse in sua forma ut prius, et prospexerunt ultra polum articum versus lineam medie noctis, ubi ultimus almucantarath, qui designat circulum orizontis, secabat circulos cancri, equinoctialis et capricorni, et in qualibet secatione fecerunt notas, videlicet in circulo capricorni ex parte orientis scripserunt P, et ex parte occidentis Q. In nota circuli equinoctialis ex parte orientis C, et ex parte occidentis D. In nota circuli cancri ex parte orientis R, et ex parte occidentis S.

Deinde diviserunt circulum capricorni, scilicet a puncto P usque ad lineam medie noctis in partibus 6 equalibus, scribendo in puncto prime partis 1, in secundo 2, in tertio 3, et sic successive usque ad 6. Et similiter diviserunt dictum circulum a puncto Q usque ad lineam medie noctis in 6 partibus, facientes notas ut prius. Simili quoque modo diviserunt circulum equinoctialem a puncto C usque ad lineam medie noctis, et similiter a puncto D usque ad lineam medie noctis, scribendo in punctis ut fecerunt in circulo capricorni. Eodem etiam modo diviserunt circulum cancri a puncto R usque ad lineam medie noctis, et a puncto S usque ad dictam lineam medie noctis.

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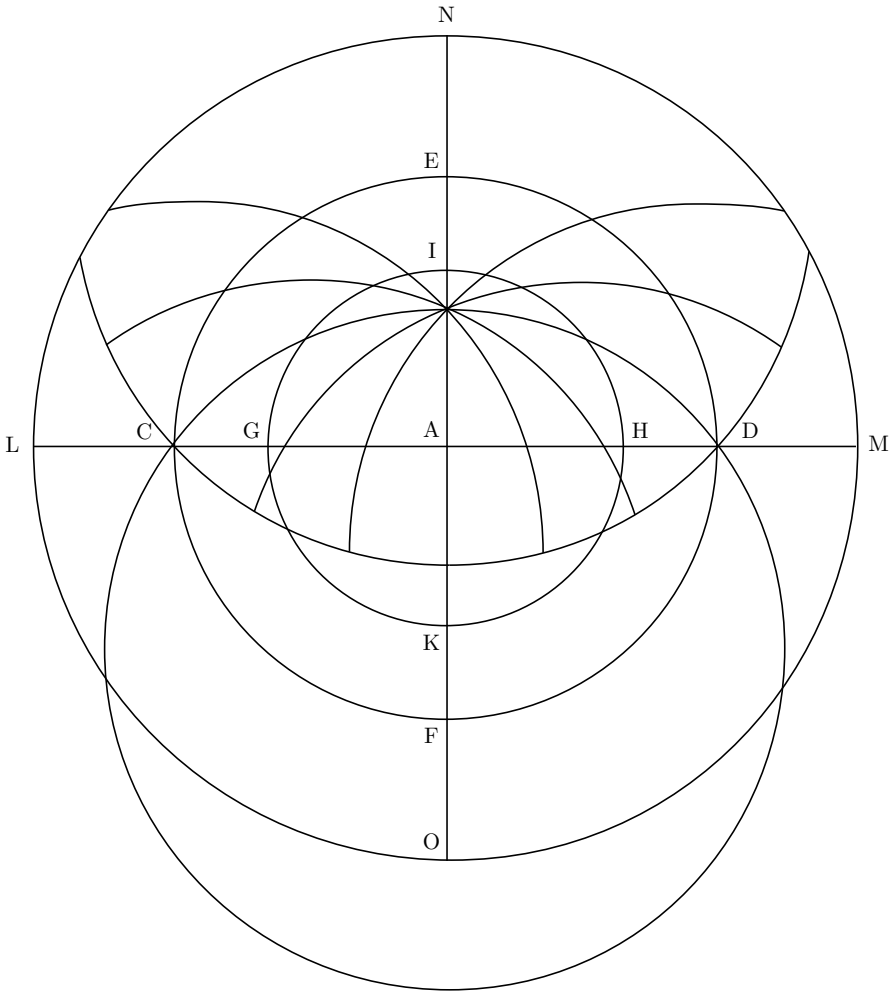
171 dicte partes ... erant] *om*. R S V || 171 propinquiores] *add*. fuerunt R S V || 171 strictiores,] scriptores! A secationes! *Cesari* || 171 atque] adque L || 171 atque linee azimut] et azimut R S V || 172 fuerunt] *om*. R S V || 172 magis] *om.* C *add*. dictae *Cesari* || 172 ille] *om*. *Cesari* || 172 tanto magis ... longiores.] dicte partes et azimut fuerunt, e converso. R S V Ita quod quanto dicte partes ... longiores] *transp*. Ita quod quanto dicte partes vel divisiones erant propinquiores linee meridiei, tanto magis partes ille fuerunt latiores et linee azimut longiores. Et quanto propinquiores fuerunt linee medie noctis, tanto fuerunt strictiores, atque linee azimut breviores. P || 174 horis.] oris. *corr*. horis. A *add*. inequalis. L || 174 Ymaginati sunt iterum] Item ymaginati sunt quod R S V Item imaginati sunt *Cesari* || 174 esse] esset R S || 174 ut] ubi R V || 174 et] <et> *Cesari* || 175 prospexerunt] perspexerunt *Cesari* || 175 medie noctis,] medie noctem, R S V || 175 ultimus] ultimo C || 176 secabat] secat C || 176 circulos] circulum P *Cesari* || 176 capricorni,] capricorno, V || 177 secatione] sectione S *add.* ad C || 177 fecerunt] *rep*. C || 177 notas,] notam, R S V || 177 scripserunt] *om.* C || 177 et] *om*. A P *Cesari* || 178 Q.] *om.* C || 178 nota] nocta A || 178 parte] partem V || 178 orientis C,] orientis R, A *scr. del*. occidentis C, *corr*. orientis C, V || 178 et] *om*. A P || 178 D.] S. A In nota circuli ... occidentis D.] *om*. *Cesari* || 179 in circulo capricorni ex parte orientis ... In nota] *om*. L C || 179 R,] *add*. et A R V || 179 In nota circuli ... occidentis S.] *om.* A <ita> fecerunt notas in circulo aequinoctialis ex parte orientis E, ex parte occidentis S. *Cesari* || 180 diviserunt] duxerunt R || 180 scilicet] *om*. R S V *Cesari* || 180 puncto] *om*. R S V || 180 P] *marg*. L || 180 ad lineam] a lineam V || 181 in partibus 6 equalibus,] in partes 6, R S V in partibus aequalibus 6, *Cesari* || 181 scribendo] describendo P || 181 prime partis] primo *Cesari* || 181 in tertio 3,] *om.* R S *Cesari* || 182 et sic successive] etc. R S V || 182 ad 6.] ad 60! C ad sex. S V || 182 ad] *add*. dictam A R S P V *Cesari* || 182 partibus] partes equales C || 183 notas] noctas A || 183 medie noctis ... ut prius.] cum predictis numeris. R S V || 183 quoque] *om*. R S V || 183 equinoctialem] equinoctialis V || 184 puncto C] *add*. videlicet ab intersecatione orizontis orientalis obliqui cum equinoctiali. L || 184 usque ad lineam] similiter ad intersecationem orientali equinoxiali in orizonte obliquo usque ad orizontem C || 184 medie noctis,] medie noctem, R S V || 184 similiter] simili modo P || 184 puncto D] *add*. scilicet ab intersecatione orizontis occidentalis obliqui cum equinoctialis. L || 184 usque] videlicet C || 185 lineam] intersecationem occidentali equinoxiali in orizonte obliquo usque ad lineam C || 185 et similiter ... medie noctis,] *om*. R S V || 185 in punctis] numeros S || 185 in punctis ut] in punctis sicud C numeris ubi R V || 185 circulo capricorni] *transp*. capricorni circulo C || 185 etiam] quoque R S V || 186 usque ad ... noctis,] *om*. R S V || 186 et] *om*. A <et similiter> *Cesari* || 187 dictam] *om.* C A *Cesari* || 187 medie noctis.] *om.* C usque ad ... medie noctis.] *om*. R S V



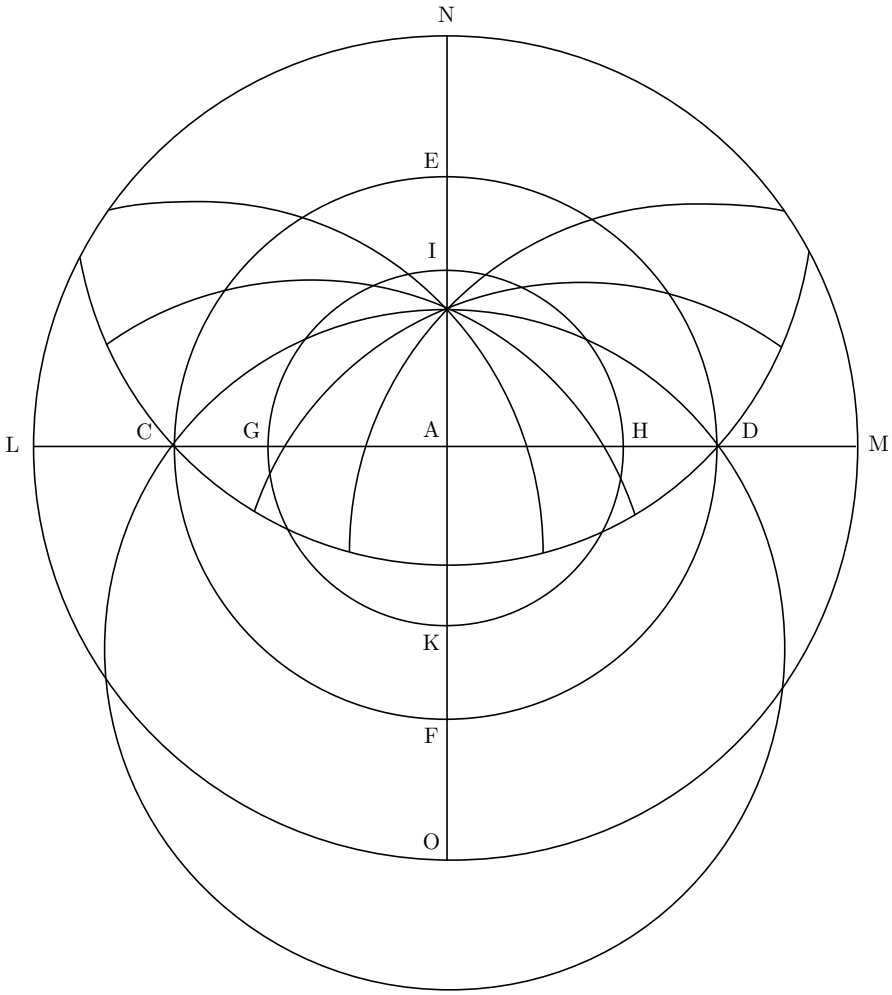
[Figure 8] The flattened sphere with azimuth lines[18].

Having done this, they traced circular lines, on both sides, from the first division [point] of Capricorn, through the first [division point] of the equator, until the first [division point] of Cancer. And they did the same from the second [division point] to the second, and from the third to the third, and so they did about those remaining. They conceived that these lines were 'the hours of the night', because the sun passes through these limits in the night[19].
(They again conceived[20] the sphere flattened as before, and, as the said lines did not descend perpendicularly from the pole, therefore they did not fall perpendicularly, but obliquely, as shown on the diagram of the hours below.) And so they made twelve hours, and they set the beginning of the first hour on the western horizon, and then [they set the beginning of] the second and the third up to the sixth, that ends on the line of midnight. And after the line of midnight, they made the seventh, the eighth, the ninth hour, and so on, until the twelfth, that ends on the eastern horizon.

18. In MS P, the diagram is rudimentary. It consists of the two lines *NO LM* and of the three circles *NMOL*, *EDFC* and *IHKG*. In MSS R S V, the azimuth lines are drawn freehand. In MS V, we detect an attempt to draw the azimuth lines with a compass, which operation failed to produce a unique intersection at the zenith point.

19. *In nocte* is a locative because the text refers to the spatial representation of the night on the astrolabe plate.

20. Here for the first time, *ymaginati sunt* is changed to *ymaginati fuerunt*. This change indicates that the sentence *Ymaginati fuerunt… ut in figura horarum infra apparet* might have been added by a copyist.



[Figura 8] Spera depressa cum azimut.

|L fol. 76r| Quo facto, duxerunt lineas circulares ex utraque parte a prima divisione capricorni per primam equinoctialis usque ad primam cancri, et ita fecerunt de secunda ad secundam, et de tertia ad tertiam, et sic de ceteris. Quas lineas ymaginati sunt esse horas noctis, quia per illos terminos transit sol in nocte.

Ymaginati fuerunt |L fol. 76v| iterum speram depressam ut prius, et quia dicte linee non veniebant recte a polo, ideo non ceciderunt recte, ymo tortuose, ut in figura horarum infra apparet. Et sic fecerunt horas 12, et inceperunt horam primam in orizonte occidentali. Postea 2am et 3am usque ad 6am, que terminatur in linea medie |V fol. 6v| noctis. Et post lineam |A fol. 49v| medie noctis fecerunt horam 7am, 8am, 9am, etc. usque ad 12am, que terminatur in orizonte orientali.

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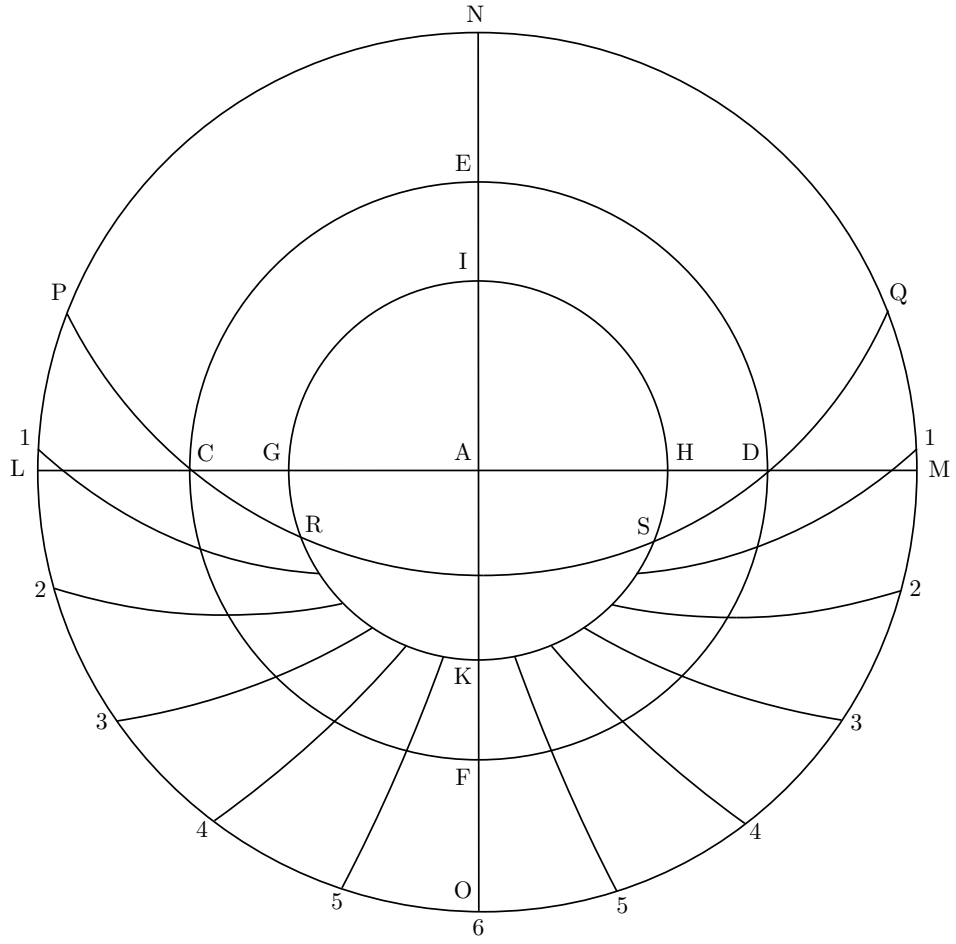
188 Spera ... azimut.] *om*. P R V *add*. cenith R Figura azimut S Fig. 8] *om*. L C A || 189 parte] partem V || 190 equinoctialis] equinoctialem C R S || 190 et] *om*. R S V || 190 secunda] 2a S V || 190 secundam,] 2am, S V || 191 tertia] *add*. usque P || 191 de tertia ... de ceteris.] ceteris aliis. R S V || 192 illos terminos] illas lineas P || 192 in] de C || 193 fuerunt iterum] sunt iterum C V *transp*. etiam sunt R S V sunt etiam *Cesari* || 193 speram] *add*. esse L || 193 depressam] *add*. <esse> *Cesari* || 193 ut] ubi R V || 193 quia] *om*. C || 194 ymo] sed R S V *Cesari* || 194 ut] ubi V || 194 infra] *om*. A R S P V *Cesari* || 195 apparet.] apparunt. V || 195 inceperunt horam primam] incepit hora prima *Cesari* || 195 occidentali.] occidentalis. A P || 195 Postea] Et postea C *add*. ea A || 196 2am et 3am] secunda <hora> et tertia *Cesari* || 196 Postea 2am ... ad 6am,] et 6a, R S V || 196 que] *om*. R S V || 196 Et post lineam] Et postea lineam A Et postea a linea *Cesari* || 197 Et post ... horam] Postea R S V || 197 8am, 9am, etc.] etc. R 9am, etc.] et 9am, L || 197 7am, 8am ... 12am,] 7a, etc. usque in 12a, S V 7am, 8am, 9am, 10am, 11am, usque ad 12am, C || 197 terminatur] termiminatur! *corr*. terminatur A

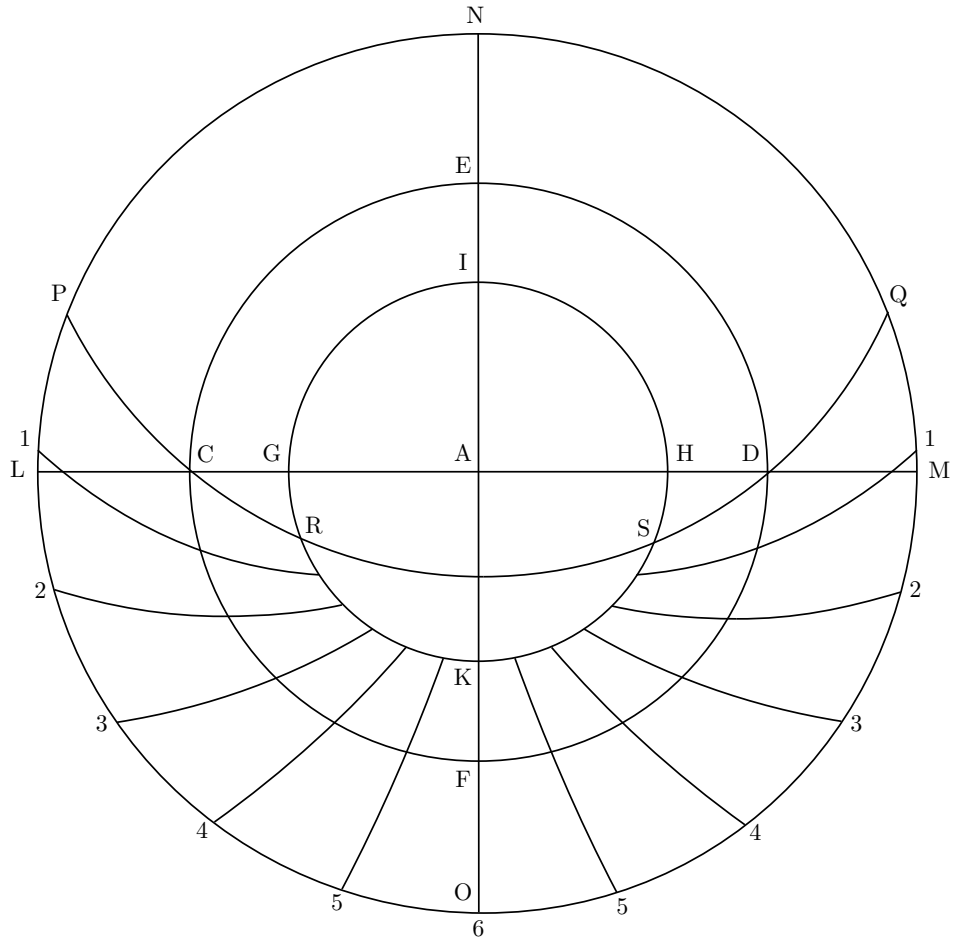


[Figure 9] Diagram of the hours[21].

<9> On the magnitude and smallness of days. In the same way they conceived the zenith of the place to be at a distance of 66 degrees 26 minutes 30 seconds from the equator, and they obtained that the horizon of that place fell on the line of midnight in the circle of Cancer, which is in point *K*. And because they could not make any division on the circle of Cancer in order to make hours, therefore they divided only[22] the equator and the circle of Capricorn by 12 divisions as above, i.e. [they divided] the equator on the side of midnight from point *C* to point *D* into 12 equal parts, and in the same way they divided the circle of Capricorn from point *P* to *Q*, and they traced circular lines from point *K* to each of the said divisions. Then they conceived the sphere flattened as before and they found out that the tracing of hours did

21. The hour lines are similarly represented in MSS P R S V: They divide the arcs of the tropics and the equator in 12 equal parts, they do not pass beyond the tropic of Capricorn *IHKG*, and the arc *PQ* (the oblique horizon) goes through the points *C* and *D*. Except in MS P, the hour lines are labelled from 1 to 6 and 6 to 1 which seems peculiar. Moreover, the points where the arc *PQ* intersects the tropic of Cancer are marked *R S* in both MSS R and S, but not in MSS P and V. Again, in MSS R S V, the tropic of Cancer and tropic of Capricorn are equally distant from the equator (on this, see note 12 to Fig. 6). In MS P the diagram is neatly drawn although it lacks some labels.

22. MS P has “only in 12 parts” but this is not the correct meaning.



[Figura 9] Figura horarum.

200 **<9> De magnitudine et brevitudine dierum.** Item ymaginati fuerunt quod cenith regionis esset longe ab equinoctiali per gr. 66 |P fol. 17r| min. 26 sec. 30. Et invenerunt quod orizon illius regionis cadebat in linea medie noctis in circulo cancri, quod est in puncto K. Et quia ad faciendas horas nullam divisionem facere potuerunt in circulo cancri, ideo diviserunt solummodo circulum equinoctialem et capricorni per 12 divisiones ut supra, videlicet
205 circulum equinoctialis ex parte medie noctis, diviserunt a puncto C usque ad punctum D per 12 partes equales. Et similiter diviserunt circulum capricorni a puncto P usque in Q, et duxerunt lineas circulares a puncto K usque ad quamlibet dictarum divisionum. Tunc

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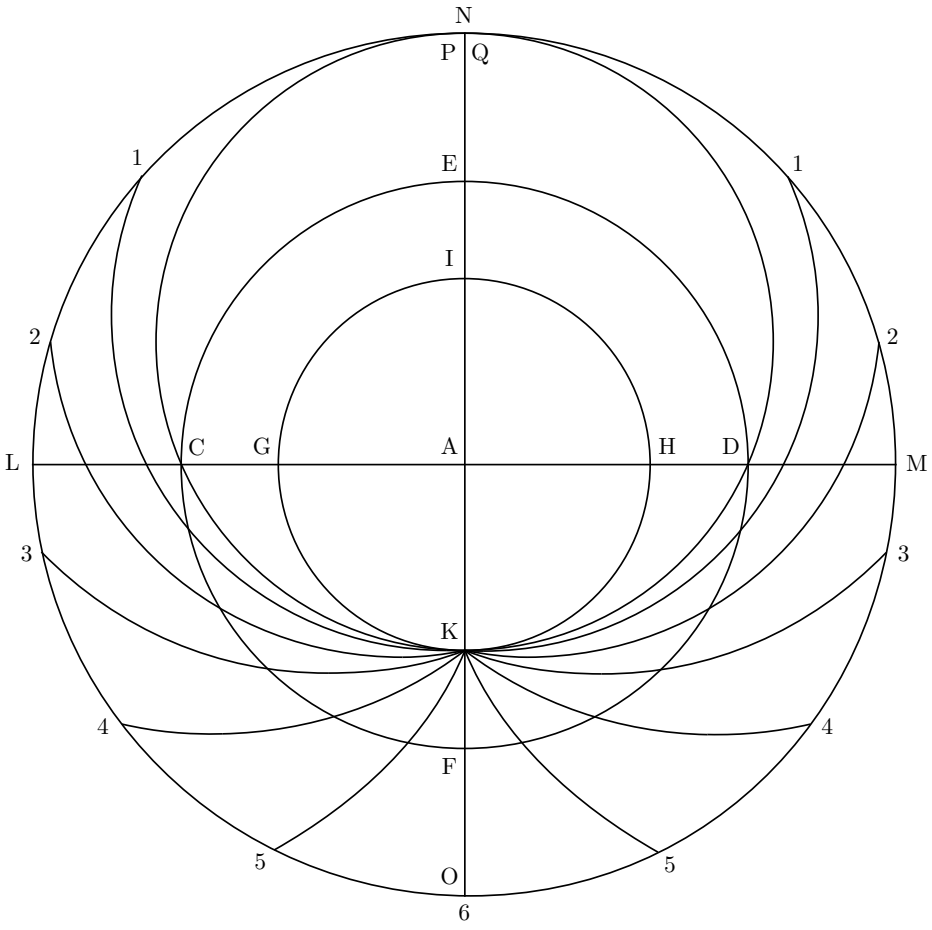
198 *ante* orientali.] *add*. in C || 199 Figura horarum.] Ista figura horarum debet esse supra ubi tale est figuram ※ R *om*. V Fig. 9] *om*. L C A || 200 De magnitudine et brevitudine dierum] *om.* C A brevitudine dierum] brevitate dierum R S *Cesari* || 200 Item] tunc C || 200 fuerunt] sunt C *Cesari* || 200 quod] *om. Cesari* || 201 esset] esse *Cesari* || 201 Et] *om*. A <et> *Cesari* || 202 cadebat] cadebant A cedebat V || 202 quod] qui P *Cesari* || 202 in^{3}] a C || 202 Et] *om*. C || 203 faciendas] faciendum C || 203 divisionem] *scr. del*. divisio *corr*. divisionem C || 203 potuerunt] poteram R S potuerant *Cesari* || 203 cancri,] *add*. qui est in puncto K, P *scr*. *del*. quod est in puncto K, S || 204 solummodo] *om*. P || 204 equinoctialem] equinoctialis L P || 204 capricorni] *add*. solummodo P || 204 per] in V || 204 12 divisiones] *transp*. divisiones 12 A || 204 ut] ubi V || 204 supra] *add*. videlicet circulum equinoctialis ex parte medie noctis, diviserunt a puncto R usque ad punctum S per 12 partes equales L C || 206 equinoctialis] equinoctiales A || 205 a puncto C] a puncto R A P || 205 ad] in A || 205 punctum D] punctum S A P || 205 12] *add*. <in> *Cesari* || 206 P] N L || 206 in Q,] ad punctum Q, C in O, L || 207 dictarum] *scr*. *del*. istarum *corr*. dictarum C || 207 videlicet circulum ... dictarum divisionum.] dictum est. R S V

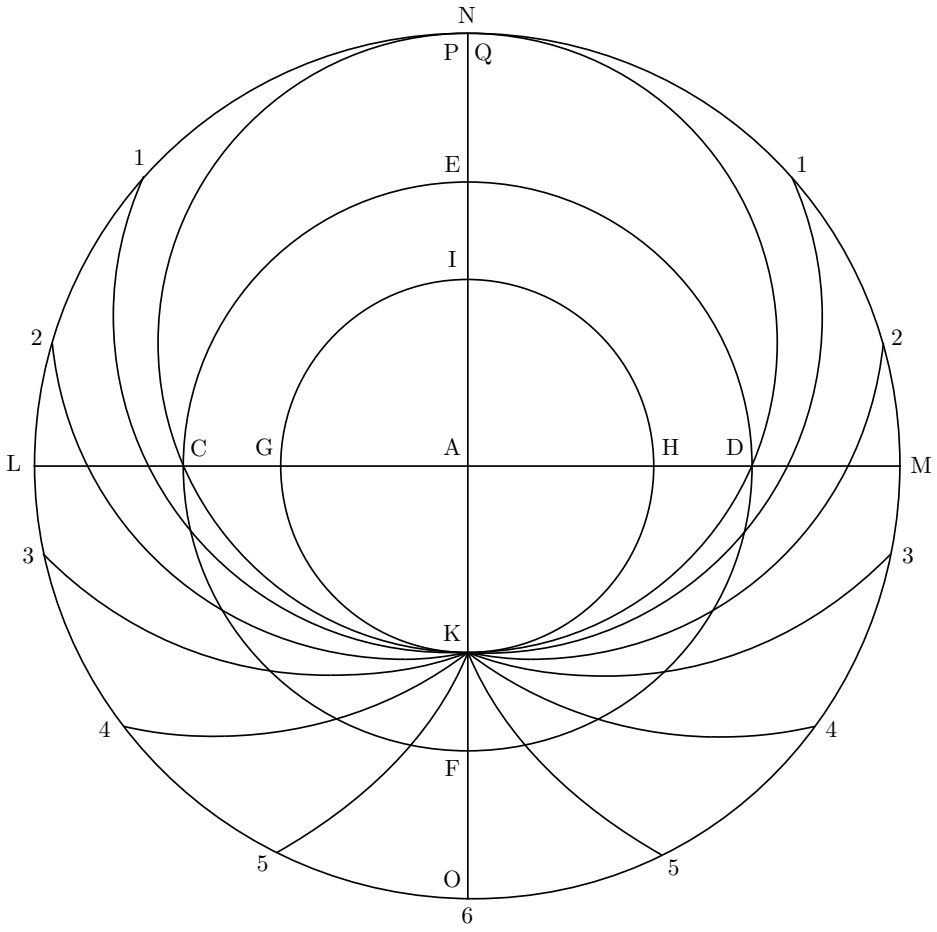
not exist on the circle of Capricorn [from *P* to *Q*] towards the pole. That is why they obtained that, over there, when the sun was at the beginning of Cancer, the day had 24 hours and there was no night, because the beginning of Cancer did not cross the horizon; therefore it did not touch any of the hours of the night, but would always run its course on that day in the area of the day. And when it was at the beginning of Capricorn, the night had 24 hours and there was no day.



[Figure 10] Diagram corresponding to the latitude 66 degrees 26 minutes 30 seconds, place where the sun appears above the earth during 24 hours when the sun is at the beginning of Cancer, and [where the sun appears] during 24 hours below the earth when the sun is at the beginning of Capricorn[23].

23. This diagram only appears in MSS P R S. However, in MS P the diagram is incomplete and does not show the hour lines. In MSS R and S are drawn free hand, more accurately in MS S. The tropic of Cancer and tropic of Capricorn are roughly equidistant from the equator in MSS R and S. The hour lines are not numbered. The text explicitly says that the hour lines are traced circularly, however, in reality the lines of unequal hours are not circular. This could explain why the copyist of MS P did not complete the Figs. 10, 11 and 12.

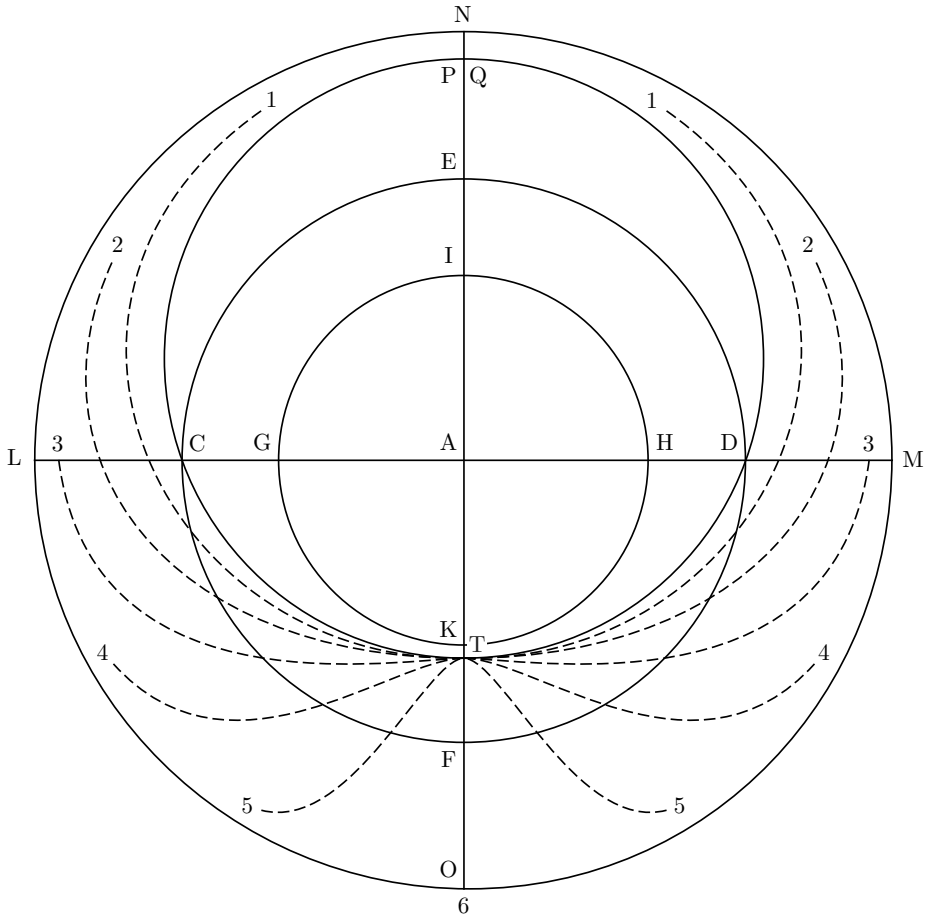
ymaginati fuerunt speram depressam ut prius, et invenerunt quod a circulo capricorni versus polum, nulla erat descriptio horarum. Ideo illic invenerunt quod, sole existente in principio cancri, dies habebat horas 24, et nichil erat noctis, quia principium cancri non transgrediebatur orizontem. Ideo non tangebat aliquam de horis noctis, sed semper in illa die per spatium diei currebat. Et, eo existente in principio capricorni, |R fol. 6v| nox continebat horas 24, et nichil erat de die.



[Figura 10] Figura latitudinis gr. 66 min. 26 sec. 30. In qua regione sol apparet super terram per horas 24 existente sole in principio cancri, et horas 24 sub terra ipso existente in principio capricorni.

208 fuerunt] sunt C *Cesari* || 208 speram depressam] spera depressa A *add*. esse *Cesari* || 208 ut] ubi R V || 208 capricorni] cancri C capricorno V || 209 erat] esset P erant V || 209 illic] *om*. C illis A || 209 sole] sol A R S V || 209 existente in] exeunte a *Cesari* || 210 dies] *rep*. R V || 211 transgrediebatur] transgrediabatur A || 211 quia principium ... orizontem.] *om. Cesari* || 211 de horis noctis,] de hore noctis, A horam noctis, *Cesari* || 211 in illa die] *om. Cesari* || 212 sed semper ... currebat.] *om*. R S V || 212 eo] ipso R S V || 212 eo existente] *transp*. existente eo C existente in] exeunte a *Cesari* || 212 capricorni,] *add.* e converso. R V *Cesari* || 212 continebat] exinebat A habebat *Cesari* || 213 horas] hore A || 213 nox continebat ... de die.] *om*. S *om*. V *legendo titulum Figure 10 ut textus add.* latitudini! gr. 66 min. 26 sec. 30, in qua regione sol apparet super terram per horas 24, <sole> exeunte a principio capricorni. *Cesari* || 214 Figura latitudinis] Latitudo A || 215 horas] hore A || 215 ipso] *om*. A || 216 In qua regione ... capricorni. *om*. R S Fig. 10] *om*. L C A V

In the same way they conceived the zenith of the place to be at a distance of 69 degrees 45 minutes from the equator and they obtained that the horizon fell on the line of midnight beyond the circle of Cancer by 4 degrees 3 minutes 30 seconds, and there they marked point T^{24}. Then they divided the equator and the circle of Capricorn by 12 divisions as above, tracing circular lines from point *T* through each of the said divisions.



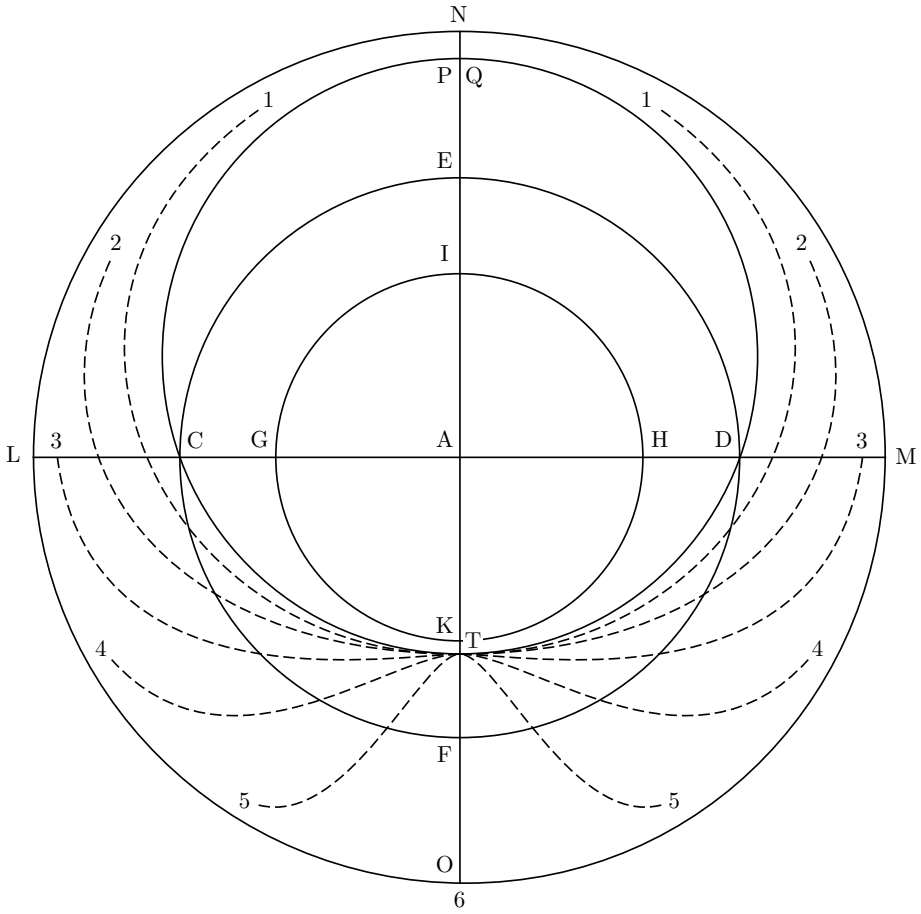
[Figure 11] Diagram corresponding to the latitude of 69 degrees 45 minutes, place where the sun appears continuously above the earth when it is between the beginning of Gemini and the end of Cancer, and where it is continuously below the earth, when it is between the beginning of Sagittarius and the end of Capricorn[25].

Then they conceived the sphere flattened as before, and they obtained that the beginning of Gemini and the end of Cancer touched the said point *T* on the line of midnight. Hence both are necessary: that, if the sun were within the said limits of Gemini and Cancer, the sun would always be visible in that [geographical] place, because then [i.e. within those limits] it

24. The value 4 deg. 3 min. 30 sec. of *KT* consistently appears in MSS L P A but it is not clear what it means. Since 90 deg. – 69 deg. 45 min. = 20 deg. 15 min., we would expect this value to be 23 deg. 33 min. 30 sec. – 20 deg. 15 min. = 3 deg. 18 min. 30 sec. If the value 4 deg. 3 min. 30 sec. were intended, then the plate would have been drawn for latitude 70 deg. 30 min.

25. This diagram only appears in MS P, but it is incomplete and does not show the hour lines. We added the real shape of the hour lines as dotted lines making them intersect at point *T*, as Andalò's text correctly explains. Note, however, that, according to the manuscript texts, the hour lines should be drawn as arcs of circles.

Item ymaginati sunt quod cenith regionis |C fol. 16r| esset longe ab equinoctiali per gr. 69 min. 45 et invenerunt quod orizon cadebat in linea medie noctis ultra circulum cancri per gr. 4 min. 3 sec. 30, et ibi fecerunt punctum T. Deinde diviserunt circulum equinoctialis et capricorni per 12 divisiones ut supra, ducentes lineas circulares a puncto T per quamlibet dictarum divisionum.



[Figura 11] Figura latitudinis gr. 69 min. 45. In qua regione sol continue apparet super terram ipso existente a principio geminorum usque ad finem cancri, et existente a principio sagitarii usque ad finem capricorni continue est sub terra.

Tunc ymaginati sunt speram depressam ut prius, et invenerunt quod principium geminorum et finis cancri in linea medie noctis tangebant dictum punctum T. Necessarium ergo fuit quod existente sole infra dictos terminos geminorum et cancri, semper appareret sol in regione illa,

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217 Item ymaginati sunt quod] Et si R S V || 217 ab equinoctiali] *om*. C || 217 per] *om*. R S V || 218 45] 29! C || 218 et invenerunt quod] *om*. R S V || 218 cadebat] caderet R S V || 218 linea] circulo C lineam L *Cesari* || 219 et ibi] ubi R S V || 219 T.] K. V *scr*. *del*. K. *corr*. T. S || 219 equinoctialis] equinoctialem L C || 219 et] *om*. C || 220 a puncto T] a punctum E P V || 221 Deinde ... divisionum.] *om*. R S V *Cesari* || 222 45.] 54. P || 222 continue] cuntinue A || 222 terram] terra A || 223 ad] in A || 224 capricorni] *scr*. *del*. cancri *corr*. capricorni A || 224 continue] cuntinue! A || 224 Fig. 11] *om*. L A R V || 225 Tunc ymaginati sunt] Et factis divisionibus et R S V || 225 speram depressam] *transp*. depressa spera R S V speram depressam esse *Cesari* || 225 et[1]] *om*. R S V || 226 tangebant] tangebat C R S V || 226 dictum punctum] *om*. R S V || 226 T.] D. C E. P || 226 fuit] est R S V *Cesari* || 227 existente] exeunte *Cesari* || 227 sole] solis A || 227 infra dictos terminos] in dictis terminis R S V || 227 geminorum] *add*. silicet R S V || 227 appareret sol] apparet sol A appareret super terram R S V *transp*. sol appareat *Cesari* || 227 regione illa,] *transp*. illa regione, *Cesari*

moves continuously within the horizon on the side of the area of the day; and that, if the sun were between the beginning of Sagittarius and the end of Capricorn, it would always be night, because, the sun being within the said limits, it continuously moves outside the horizon in the area of the night.

In the same way, they conceived the zenith of the place to be at a distance of 78 degrees 30 minutes from the equator and they obtained that the horizon [of that place] fell on the line of midnight beyond the circle of Cancer by 15 degrees 3 minutes 30 seconds,[26] and there they marked point *V*. Then they divided the equator and [the circle of] Capricorn as above. And from the said point *V* they traced circular lines through each division.

Then they conceived that the sphere was depressed as before and they obtained that the beginning of Taurus and the end of Leo touched the point *V* on the line of midnight. Hence both are necessary: that, if the sun were between the beginning of Taurus and the end of Leo, it would always appear above the earth at that [geographical] place, because then [i.e. within those limits] it moves continuously within the horizon on the side of area of the day; and that, if it were between the beginning of Scorpio and the end of Aquarius, there it would always remain hidden, because, it being there, it continuously moves outside the horizon in the area of the night.

In the same way, they conceived the zenith of the place to be under the arctic pole. And they obtained that the horizon of that place was one and the same with the equator, and that the beginning of Aries and the end of Virgo touched the horizon. Therefore it is necessary that there the sun, being between the beginning of Aries and the end of Virgo, would be continuously visible and that it would remain there always hidden [being] between the beginning of Libra and the end of Pisces.

26. By our computation this value should be *KV* = 12 deg. 3 min. 30 sec. instead of 15 deg. 3 min. 30 sec.

quia tunc continue vadit infra orizontem ex parte spatii diei. Et existente sole a principio sagitarii usque ad finem capricorni semper esset nox, quia existente sole infra dictos terminos continue vadit ultra orizontem in spatio noctis.

|A fol. 50r| Item ymaginati sunt quod cenith regionis esset longe ab equinoctiali per gr. 78 min. 30, et invenerunt quod orizon cadebat in linea medie noctis ultra circulum cancri per gr. 15 min. 3 sec. 30, et ibi fecerunt punctum V. Deinde diviserunt equinoctialem et capricornum ut supra. Et a dicto puncto V duxerunt lineas circulares per quamlibet divisionem.

Tunc ymaginati sunt speram deprimi ut prius, et invenerunt quod principium tauri et finis leonis in linea medie noctis tangebant punctum V. Ideo necessarium fuit, quod, sole existente in principio tauri usque ad finem leonis, semper appareret super terram in regione illa, quia tunc continue vadit infra orizontem ex parte spatii diei. Et eo existente a principio scorpionis usque ad finem aquarii, semper occultaretur ibi, quia eo ibi existente, continue vadit ultra orizontem in spatio |P fol. 17v| noctis.

Item ymaginati sunt quod cenith regionis esset sub polo artico. Et invenerunt quod orizon illius regionis erat unum et idem cum |L fol. 77r| circulo equinoctialis, et quod principium arietis et finis virginis tangebant orizontem. Ideo necessarium fuit quod sol continue ibi appareret, ipso existente a principio arietis usque ad finem virginis, et a principio libre usque ad finem piscium semper ibi occultaretur.

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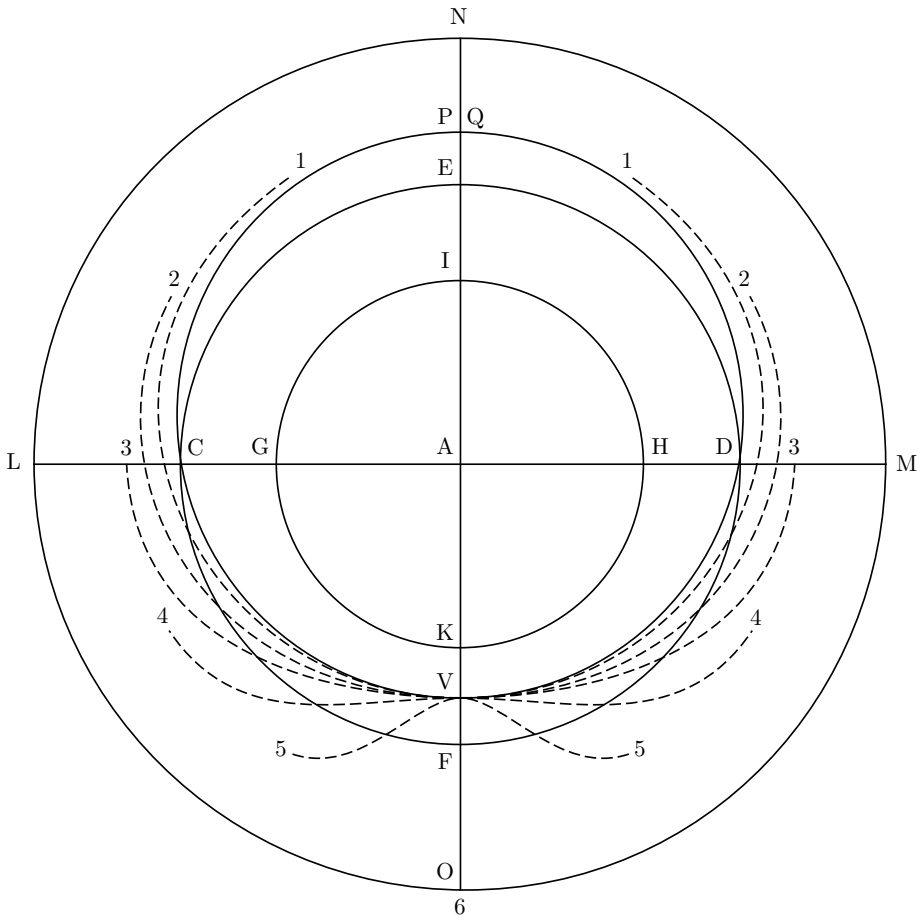
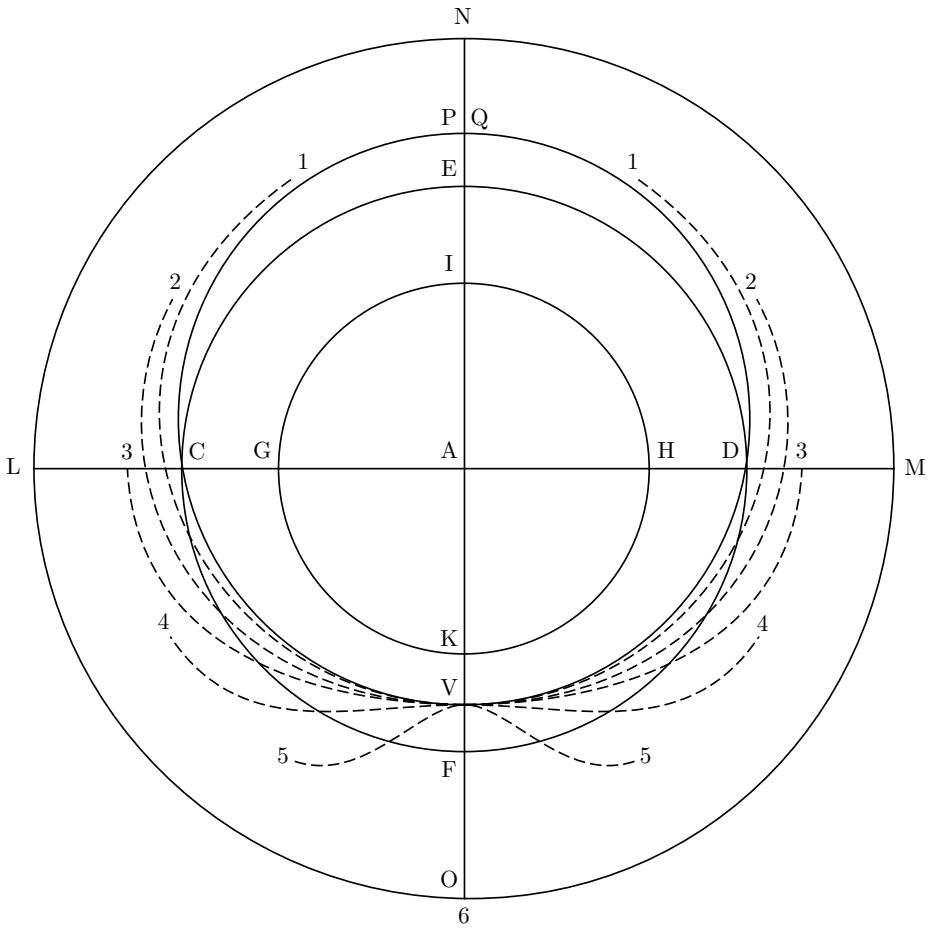
228 quia] quod A *Cesari* || 228 tunc] et V || 228 continue] cuntunue! A *om*. C *add*. <sol> *Cesari* || 228 infra] in C || 228 spatii] *om*. C || 228 existente] exeunte *Cesari* || 228 sole a] in R S V || 229 existente] exeunte *Cesari* || 230 continue] cuntinue! A || 230 vadit] vadet A || 230 semper esset ... noctis.] e converso. R S V || 231 Item ymaginati sunt quod] Et si R S V || 231 longe] *om. Cesari* || 231 longe ab equinoctiali per] *om*. R S V || 231 78] 98! C || 232 30,] *add*. depressa spera cum divisionibus predictis, R S V || 232 et invenerunt quod] *om*. R S V || 232 cadebat] cadit R S V || 232 linea] linee A lineam L *Cesari* || 232 in linea medie noctis] *om*. R S V || 233 et ibi fecerunt] ubi sit R S V || 233 V.] D. C P || 233 capricornum] <circulum> capricorni *Cesari* || 234 puncto V] puncto D P || 235 deprimi] depressam <esse> *Cesari* || 235 principium tauri] *transp*. tauri principium C || 236 tangebant] tangebat C P V || 236 V.] D. C P Deinde diviserunt equinoctialem ... punctum V.] *om*. R S V || 236 sole] solis A || 237 Ideo ... existente,] quod punctum tangetur R S V || 237 in] a R S V existente in] exeunte a *Cesari* || 237 ad finem] a finem V || 237 semper appareret] semper apparet A et tam erit dies R S *scr*. *del*. et tunc *corr*. et tam erit dies V semper appareat *Cesari* || 237 tunc] *om*. C || 238 continue] contunue! A || 238 orizontem] orizonte A || 238 ex parte spatii diei.] per spatium diei. C in regione illa ... diei.] quantum sol stabilitur in predicto spatio silicet a principio tauri usque ad finem leonis eadem de tam, ut dictum est in precedenti. R S V || 238 Et] *om*. C || 238 eo[1]] *om*. R S V || 238 Et eo existente] *transp*. Et existente eo A P Et <sole> exeunte *Cesari* || 238 a principio] ad finem! C || 238 scorpionis] scorpioni A || 239 aquarii] *scr*. *del*. sagitarii *corr*. aquarii L || 239 occultaretur ibi] erit nox. R S V *Cesari* || 239 eo[2]] *om*. A P *Cesari* || 240 existente,] exeunte, *Cesari* || 240 continue] *om*. L quia eo ibi existente continue] quia semper C || 240 vadit] *add*. ibi C || 242 illius] illis A || 242 illius regionis] *om*. C || 242 equinoctialis,] equinoctiali, A || 242 et[2]] *om. Cesari* || 243 virginis] geminorum *add*. et A P V || 243 tangebant] tangebat P V || 243 continue ibi] *transp*. ibi continue C || 244 appareret,] apparet A appareat, *Cesari* || 244 existente] exeunte *Cesari* || 244 ad finem] in finem C || 244 a[2]] *om*. A || 245 ad finem] in finem C || 245 quia eo ibi existente ... ibi occultaretur.] Et si polus articus esset cenith regionis, circulus equinoctialis est orizon illius regionis, quod tangit principium arietis et finis virginis, et ideo per istos 6 menses est ibi continue dies. Et per alios 6 continue nox figuras istarum horarum non pono, quia non est necesse, sufficit enim precedens ex centro, quod sit cenith est in puncto in parallelo cancri. Ita eorum cenith ponatur extra secundum, quod plus vel minus est latitudo regionis. R S V



[Figure 12] Diagram corresponding to the latitude of 78 degrees 30 minutes, place where the sun appears continuously above the earth when it is between the beginning of Taurus and the end of Leo, and where it is continuously below the earth, when it is between the beginning of Scorpio and the end of Aquarius[27].

<10> On the ecliptic and the signs of the zodiac. In the same way they conceived that the sphere was as before, and they conceived a circle passing through east and west and intersecting the equator in the points where the colure that passes through east and west intersects the equator, the said circle passing also through the parallels of Cancer and Capricorn, i.e. at the points where the colure of midday and midnight intersects the said parallels. They called this circle the ecliptic, which is one of the great circles. They divided this circle in 12 equal parts which they called the signs: Aries, Taurus, Gemini Cancer, Leo, Virgo, Libra, Scorpio, Sagittarius, Capricorn, Aquarius, Pisces, placing the beginning of Aries in the east at the point where the colure intersects the equator, namely on the side of the north, and the end of Pisces on the side of the south. But at the point where the colure of

27. This diagram only appears in MS P, but it is incomplete and does not show the hour lines. We added the real shape of the hour lines as dotted lines making them intersect at point *V*, as Andalò's text correctly explains. Point *V* is represented farther apart from *K* than *T* in the previous Fig. 11.

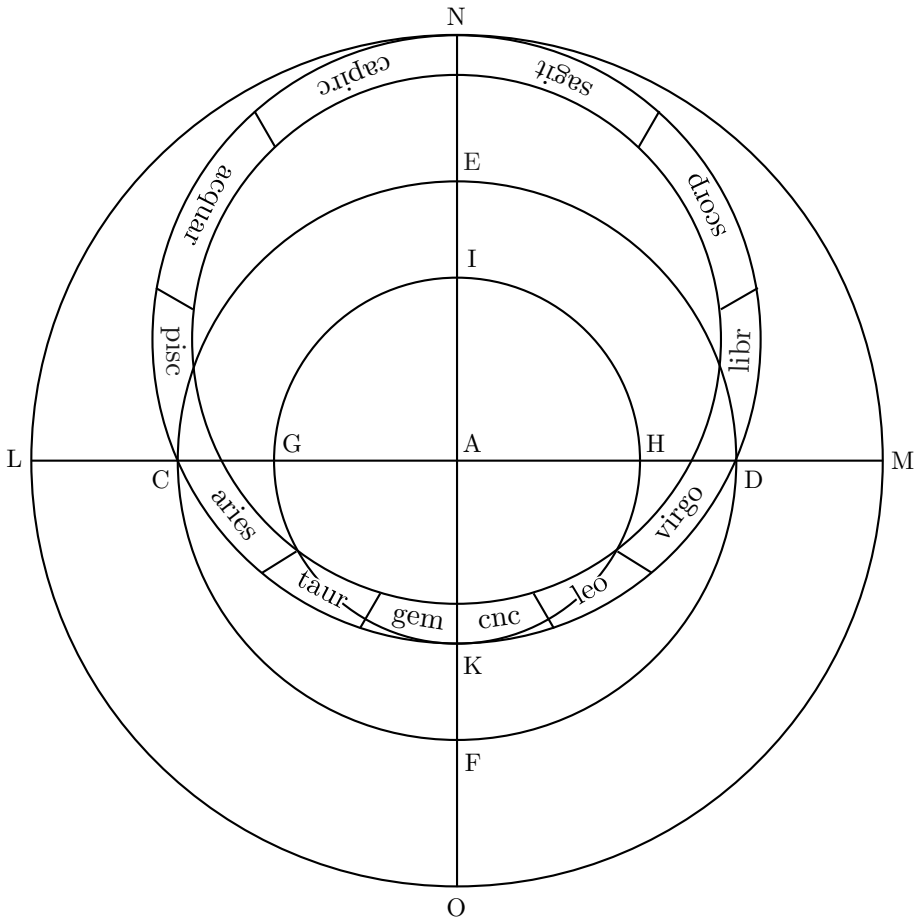


[Figura 12] Figura latitudinis gr. 78 min. 30. In qua regione sole continue apparet super terram ipso existente a principio tauri usque ad finem leonis, et existente a principio scorpionis usque ad finem aquarii continue est sub terra.

|S fol. 92r|P fol. 18r|V fol. 7r| **<10> De ecliptica et signis zodiaci.** Item ymaginati sunt speram esse ut prius, et ymaginati sunt circulum, transeuntem per orientem et occidentem secantem equinoctialem in punctis ubi colurus, qui transit per orientem et occidentem, secat equinoctialem, et transeuntem dictum circulum per parallelos cancri et capricorni, scilicet in punctis ubi colurus medie diei et medie noctis secat dictos parallelos. Quem circulum vocaverunt circulum ecliptice, qui est de circulis maioribus. Quem circulum diviserunt in 12 partes equales, quas appellaverunt signa, videlicet aries, taurus, gemini, cancer, leo, virgo, libra, scorpio, sagittarius, capricornus, aquarius, pisces, ponentes principium arietis in oriente, in puncto ubi colurus secat equinoctialem, scilicet ex parte septentrionis, et ex parte meridiei

246 Fig. 12 *om*. L C A R S V || 250 esse] *om*. C || 250 ut] ubi R *marg*. ubi V || 250 speram esse … ymaginati sunt] *om*. A *Cesari* || 250 orientem] *scr*. *del*. orizontem *corr*. orientem A || 250 orientem et occidentem] *transp*. occidentem et orientem *Cesari* || 251 secantem] secante C *om*. V || 251 equinoctialem] equinoctialis C V || 251 qui transit] pertransit A || 251 et] *add*. per *Cesari* || 252 equinoctialem] equinoctialis V || 252 et] *om*. P || 252 transeuntem] transeunte per A || 252 per] *om*. C dictum circulum per] *om. Cesari* || 252 parallelos] parallelum V || 252 scilicet] *om*. R S V || 253 colurus] *om*. V || 253 medie diei] meridiei R S || 253 medie die et] *om. Cesari* || 253 dictos parallelos.] *transp*. parallelos dictos. A *Cesari* || 254 circulum] *om*. A || 254 est] *add*. enim *Cesari* || 254 circulis maioribus.] *transp*. maioribus circulis. R S V || 254 Quem] *add*. quidem R S V *Cesari* || 255 appellaverunt] vocaverunt C || 255 signa,] *add*. et *Cesari* || 255 cancer,] *scr*. *del*. etc. C || 256 aries, taurus ... pisces,] aries, taurus, etc., A R S P arietis, tauri, etc. V *Cesari* || 256 oriente,] orientem, P V *Cesari* || 257 in] *scr*. *del*. ubi V || 257 scilicet] *om*. R S V *Cesari* || 257 et ex parte meridiei] *rep*. L

midnight intersects the parallel of Cancer they put the beginning of Cancer on the side of the west, and the end of Gemini on the side of east. At the point where the western colure intersects the equator they placed the beginning of Libra on the side of the south and the end of Virgo on the side of north. At the point where the colure intersects the parallel of Capricorn they placed the beginning of Capricorn on the side of east, and the end of Sagittarius on the side of West. The other signs fell between these according to their order.

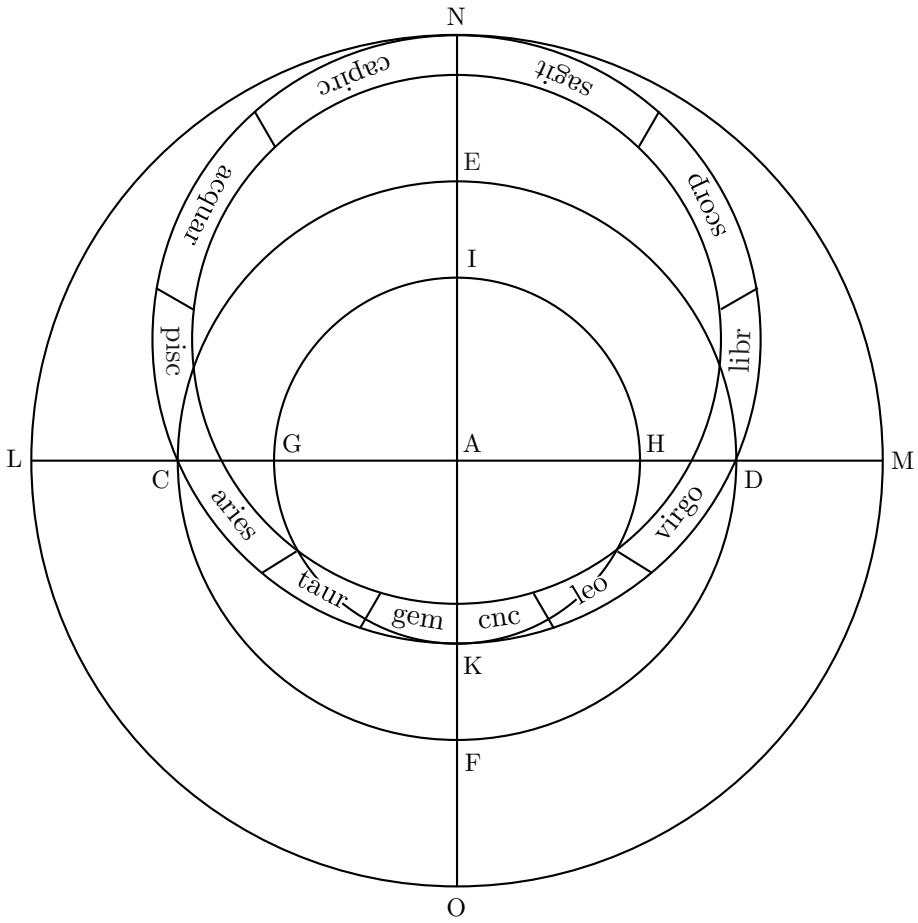


[Figure 13] The front of the astrolabe with the rete[28].

Then they conceived that the sphere was flattened as before and they obtained that the beginning of Aries was at point *C*, the beginning of Libra at point *D*, the beginning of Cancer at point K, the beginning of Capricorn at point *N*. Then they traced the diameter from point *K* to point *N*. Then they set the steady leg of the compass in middle of the said diameter such that the moving leg went through the points *C*, *D*, *K*, *N*. And thus they traced the circle that

28. This diagram is drawn in the four MSS L P R S. In MS P, there only appears a circle as a place holder. In MSS L and S, the ecliptic and the equator correctly intersect at the point separating Pisces and Aries, and the point separating Virgo and Libra. The intersection points are labelled *C* and *D* in MS S but are not labelled in MS L. In MS R the ecliptic and the equator intersect at a wrong point because the diagram is drawn freehand and lacks accuracy. In MS S, the tropic of Cancer and tropic of Capricorn are represented as nearly equidistant from the equator, which does not correspond to reality. All things considered, the most neatly drawn diagram is that of MS L.

finem piscium. In puncto, vero ubi colurus medie noctis secat parallelum cancri, posuerunt principium cancri ex parte occidentis, et finem geminorum ex parte orientis. In puncto vero
260 ubi colurus occidentalis secat equinoctialem, posuerunt principium libre ex parte meridiei et finem virginis ex parte septentrionis. In puncto autem ubi colurus secat |P fol. 16v| parallelum capricorni posuerunt principium capricorni ex parte orientis, et finem sagittarii ex parte occidentis. Alia vero signa ceciderunt inter ista secundum ordinem eorum.



[Figura 13] Facies astrolabii cum rete.

265 Tunc ymaginati sunt, quod spera deprimeretur ut prius, et invenerunt quod principium arietis erat in puncto C, principium libre in puncto D, principium cancri in puncto K, principium capricorni in puncto N. Deinde duxerunt dyametrum a puncto K in puncto N, et posuerunt pedem circini immobilem in medio dicti dyametri, ita quod pes mobilis caderet in punctis

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257 septentrionis,] septentrionem, *add*. principium tauri C septentrionali, *Cesari* || 258 finem] *alia manu marg*. faciem! V || 258 finem piscium.] piscium finem. C || 258 vero] *om. Cesari* || 258 medie noctis] medietatis R V *Cesari* ubi colurus medie noctis] *transp*. medie noctis ubi colurus C || 258 parallelum] parallelus *Cesari* || 258 cancri,] *add*. *del*. ex parte occidentis, P || 259 occidentis,] *rep*. *del*. V || 260 occidentalis] occident A occidentis P || 260 equinoctialem,] equinocialis, V || 260 principium libre] *om*. C || 261 septentrionis.] septentrionali. *Cesari* || 261 autem] vero C R S V *om*. P || 261 parallelum] parallelos L || 262 capricorni] capricorno V posuerunt principium capricorni] *om*. C || 262 ex] *ante* ex *add*. et A || 262 sagittarii] geminorum A || 263 occidentis.] occidentalis. C || 263 signa] *om*. R S V || 263 inter] intra R || 263 secundum] 2m R || 263 eorum.] *om*. C || 264 Facies ... rete.] *om*. R S P Fig. 13] *om*. C A V || 265 ut] ubi V || 266 C,] *add*. et C P || 266 principium] primum! V || 266 in puncto D,] a puncto D, A in D, R S V || 266 in puncto K,] in K, S V || 267 in puncto N.] in puncto I. AC L P || 267 in puncto N,] in puncto I, A C L P || 268 ita quod] ita ut A itaque P || 268 caderet] caderit A cadit C *Cesari* || 268 in punctis] in puncto C

they conceived being the circle of the ecliptic, from which they made the rete in the astrolabe, i.e. as far as the ecliptic and the signs of the zodiac are concerned.

<11> On the place and position of the fixed stars. They conceived the sphere to be as above, and they conceived all the stars and their places, which they wanted to include in the astrolabe, i.e. those that are between the parallel of Capricorn up to the arctic pole, because any star between the said parallel of Capricorn and the antarctic pole cannot be labelled on the astrolabe, as that part of the sphere was cropped and put aside as above[29]. Then they flattened the sphere as before and they obtained all those stars at the same latitude from the equator as they were on the sphere, and at the same longitude in the same way.
As a matter of fact if circles are drawn from the arctic to the antarctic pole, passing through the centre of the said stars and the ecliptic, I say that the degree in which they cut the ecliptic, is the degree *with* which those stars reach the middle of the sky[30] when they are on the meridian line. I don't say that a specific star is *in* that degree, I rather say that the circle that comes from the poles of the zodiac and passes through the centre of whatever star up to the ecliptic; the very sign and degree in which that circle cuts the ecliptic, that is where the star is said to be. And because the circle that comes from the zodiac and the circle that comes from the poles of the equator that intersect in the centre of whatever star do not fall on the zodiac on the same degree, but in different ones; hence a star is said to be *in* that degree, which the circle that comes from the poles of the zodiac intersects, but not that it reaches the sky *with* that degree. A star is said to reach the sky *with* that degree, which the circle that comes from the poles of the equator intersects, and not that it is *in* that degree except in two places of the zodiac, i.e. at the beginning of Cancer and Capricorn where the circle that comes from the poles of the equator and the circle that comes from the poles of the zodiac are one and the same. Given the above-mentioned circumstances[31] they made another circle in the rete of the size of the circle of Capricorn marked out on the plate. Below this circle and the circle of the ecliptic they marked out all the stars both southern and northern which are included in the astrolabe, as we intended to say in the composition [of the astrolabe].

29. MSS R, S and V have *supra dictum est*, "as explained above".

30. Per definition, the degree of the ecliptic that culminates (passes the meridian line) at the same time as a given star is the *mediatio coeli* of that star. Its *mediatio* is the point of the ecliptic having the same right ascension as the star.

31. Andalò refers to the beginning of the chapter where he states that, because of the cropping of the sphere, some stars cannot be represented on the rete; namely those that lay south of the circle of Capricorn.

CDKN. Et sic descripserunt circulum, quem ymaginati sunt esse circulum ecliptice, de quo fecerunt rete in astrolabio, scilicet quantum ad eclipticam et signa zodiaci.

|A fol. 50v|R fol. 7r| **<11> De loco et situ stellarum fixarum.** Ymaginati sunt speram esse ut prius, et ymaginati fuerunt omnes stellas et loca earum, quas ponere voluerunt in astrolabio, videlicet illas, que sunt a parallelo capricorni usque ad polum articum, quia nulla stella, que sit a parallelo capricorni predicto usque ad polum antarticum, potest in astrolabio designari, eo quod illa pars spere abscisa et abiecta fuit, ut supra. Tunc depresserunt speram ut prius, et invenerunt omnes stellas illas in ea latitudine ab equinoctiali in qua erant in spera, et in illa longitudine similiter.

Si enim ducantur circuli a polo artico in antarticum, secantes centrum dictarum stellarum et eclipticam, dico quod in quo gradu secant eclipticam, cum illo gradu ille stelle mediant celum, quando sunt in linea meridiana. Non enim dico, quod illa stella sit in illo gradu, ymo dico quod circulus, exiens a polis zodiaci, transiens per centrum cuiusvis stelle usque ad eclipticam, in quo signo et gradu secat eclipticam, ibi dicitur esse stella illa. Et quia circulus exiens a polis zodiaci cum circulo exeunte a polis equinoctialis, intersecantes se in centro alicuius stelle, non terminantur in zodiaco in eodem gradu, ymo in diversis. Ideo in illo gradu, quem intersecat circulus, exiens a polis zodiaci, dicitur esse stella non quod mediet celum, cum illo gradu. Et cum illo gradu quem intersecat circulus, exiens a polis equinoctialis |L fol. 77v| dicitur celum mediare, non quod in illo sit stella, salvo in duobus locis zodiaci, videlicet in principio cancri et capricorni, ubi circulus, exiens a polis equinoctialis cum circulo exeunte a polis zodiaci, sunt unum et idem. Supradictis occasionibus fecerunt in rete alium circulum magnitudinis circuli capricorni in tabula descripti. Infra quem circulum et circulum ecliptice

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269 CDKN.] CDKI. A C L P || 269 fecerunt] facerunt P || 270 rete] recte! R *Cesari* || 270 scilicet] *om.* C R S V || 270 eclipticam] ecliptice A || 270 et signa] et figura A in signum V || 270 scilicet quantum ... zodiaci.] *om. Cesari* De ecliptica et signis zodiaci ...] *transp. ante capitulum* De horis P || 271 De loco et situ stellarum fixarum.] De ecliptica et signis in zodiaco! C De loco et situ stellarum S V || 271 Ymaginati] Item ymaginati R S V || 271 ut] ubi R *marg*. ubi V || 272 fuerunt] sunt C *Cesari* || 272 et^{2}] ac A R S P V *Cesari* || 272 earum,] eorum, A *rep*. V || 272 quas] quando <stellas> *Cesari* || 273 a parallelo] in parallelo C a polo R S V || 273 capricorni] cancri! *Cesari* || 274 a] in C *om*. A *Cesari* || 274 designari] designatum C designare S || 275 abscisa] obsisa! A || 275 et abiecta] *om*. R S V || 276 abscisa et abiecta fuit,] *transp*. abscisa fuit et abiecta L || 275 ut^{1}] ubi V || 275 supra.] *add*. dictum est. R S V *Cesari* || 275 depresserunt speram] depressa sphaera *Cesari* || 275 ut^{2}] ubi V || 275 et^{2}] *om. Cesari* || 276 stellas illas] *om.* C || 276 ea] eam A *om*. P || 276 latitudine] latitudinem A || 276 ab equinoctiali] *om.* C in ea latitudine ab equinoctiali] *transp*. ab equinoctiali in ea latitudine *Cesari* || 276 erant in spera] erat spera C || 276 in^{4}] *om*. V || 277 longitudine] longitudinem A || 278 enim] *om. Cesari* || 278 centrum] centra S V || 278 stellarum] planetarum! C || 278 et] *add*. lineam A R S P V *Cesari* || 279 in quo gradu] cum gradu in quo R S V in gradu, in quo illae stellae *Cesari* || 279 secant] secat C || 279 cum illo gradu] deinde in illo gradu C *om*. R S V *Cesari* || 279 mediant] medient A ille stelle mediant] *transp*. mediant ille stelle R V || 280 *ante* quando] *add*. Et V *Cesari* quando] *add*. illae *Cesari* || 280 sunt in linea] *rep*. A sunt *scr*. *del*. illi *corr*. in linea V || 280 illa stella] *transp*. stella illa A R S V *Cesari* || 280 ymo] *add*. non *Cesari* || 281 dico] *om.* C stella illa ... dico] *marg*. A || 282 in quo] <sit> in *Cesari* || 282 gradu] *add*. in quo *Cesari* || 282 in quo signo et gradu ... eclipticam] *marg*. L || 282 ibi] ubi P *om*. R S V || 282 ibi dicitur esse stella illa.] *transp*. illa stella dicitur ibi esse. C || 282 circulus] circulum V || 283 exeunte] exiens C *scr*. *del*. existente *corr*. exeunte S || 284 non] *om*. A || 285 quem] in quo C in quem A || 285 circulus,] circulum, V || 285 quod] quot C || 285 mediet] *add*. *del*. et A || 286 cum] in C S P || 286 Et cum illo gradu] *om*. A *Cesari* || 286 circulus,] circulum, V || 286 equinoctialis] *add*. transiens per centrum stelle C || 287 in^{1}] *om*. A V || 287 illo] *add*. gradu A P S V *Cesari* || 287 salvo] *add*. *del*. quod C || 287 duobus] 2bus V || 287 videlicet] ut A *Cesari* || 288 capricorni,] caprcironi *Cesari* || 288 circulus,] circulum, V || 288 a polis] ad polum C || 288 exeunte] existente A || 289 sunt] est S V || 289 unum] unus S P V || 289 in rete] in retum? C || 289 in rete alium circulum] *transp*. alium circulum in rethi P || 290 tabula] tabulam V || 290 descripti.] descripta. C || 290 et] *add*. infra A S V *Cesari*

<12> On the pole of the zodiac. In the same way they conceived that the sphere was as before, and they observed how far the pole of the zodiac was from the arctic pole, and they found that it was apart by 23½ degrees and that it was on the circle that extends from the arctic to the antarctic pole and that cuts the beginning of Capricorn in the point *N* [see above Fig. 13].

When the sphere was flattened, they found out that the said point of the zodiac fell on the meridian line far from the arctic pole by 23½ degrees or by 23½ almucantars if 90 almucantars were described on the astrolabe[32].

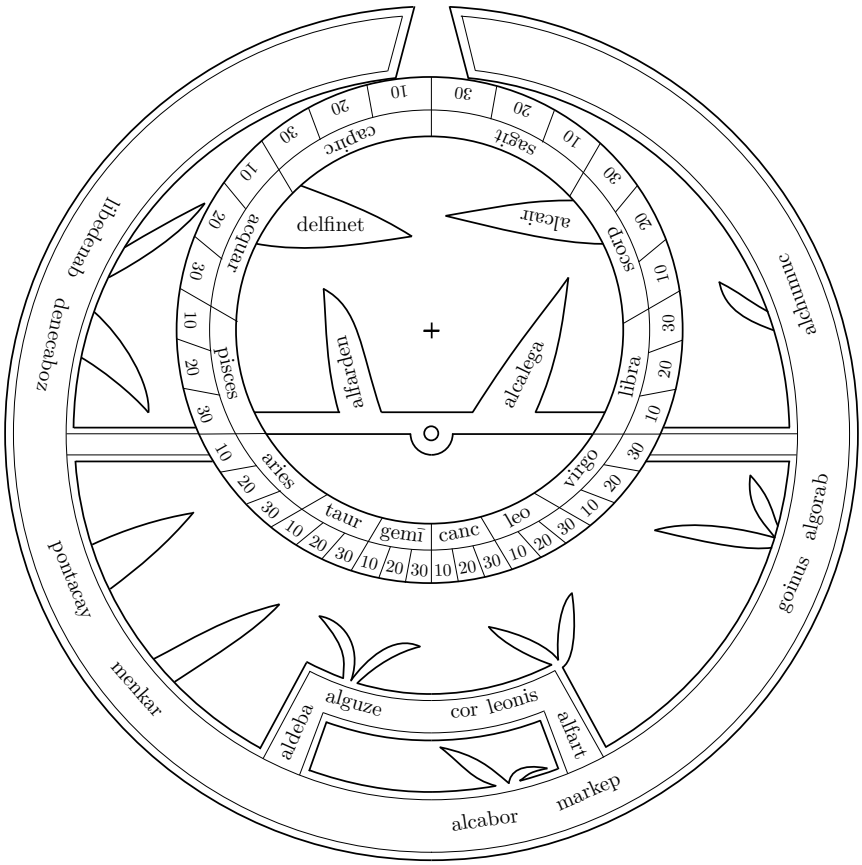
[Figure 14] Rete of the astrolabe with the stars[33].

32. MS C has alone the explicit: “Here end the concepts offered by the writers of treatises on the astrolabe”.

33. Fig. 14 is drawn in MSS L P R S V. The one in MS L is the most complete, it is the only one that includes the star pointers. In MS P, there only appears a circle as a place holder. In MSS R S V, the diagram shows the ecliptic with its divisions and the circle of Capricorn. In MSS R and S the circle of Capricorn ends in a tail and head of a serpent. In MSS L and V, the ecliptic is divided in equal parts, although in MS L the division in the northern signs are smaller than those for the southern signs; however, in reality, the divisions vary continuously as represented in the freehand diagrams of MSS R S. We have translated the star and constellation labels of MS L according to their Bayer designation.

omnes stellas descripserunt, tam meridionales quam septentrionales, |C fol. 16v| que in astrolabio continentur, ut in compositione dicere intendimus.

<12> De polo zodiaci. Item ymaginati sunt speram esse ut prius, et prospexerunt quantum distabat polus zodiaci a polo artico et invenerunt quod distabat per gr. 23½ et erat in circulo,
295 qui transit a polo artico in antarticum, secantem principium capricorni in puncto N.
Cum autem spera fuit depressa, invenerunt quod dictus polus |V fol. 7v| zodiaci cecidit in lineam meridianam longe a polo artico per gr. 23½ sive per almucantarath 23½, si in astrolabio sunt descripti almucantarath 90.



[Figura 14] Rete astrolabii cum stellis.

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291 omnes stellas descripserunt,] *transp*. descripserunt omnes stellas, A S P V *Cesari* || 291 tam meridionales quam septentrionales,] *om*. *Cesari* || 292 continentur] continetur V || 292 in] *om.* C || 292 compositione] *add*. ipsius L *Cesari* || 292 Supradictis occasionibus fecerunt in rete ... ut in compositione dicere intendimus.] *om*. R || 293 polo] polis L || 293 zodiaci.] zodiaco. V || 293 ut] ubi V || 293 prospexerunt] perspexerunt S *Cesari* || 294 gr. 23½] gr. 23 C || 295 artico] *om*. R || 295 secantem] secante A || 295 capricorni] capricorno V || 296 fuit depressa,] *transp*. depressa fuit, *Cesari* || 296 polus] circulus S || 296 lineam meridianam] linea meridiana A P || 297 artico] *scr*. *del*. artitico *corr*. artico V || 297 gr. 23½] gr. 23 C || 297 23½,] 23, C || 297 sunt descripti] *transp*. descripti sunt A P *Cesari* scripti sunt R S V || 298 almucantarath 90.] *add*. Expliciunt ymaginationes quas habuerunt exponitores et inventores astrolabii. C || 299 Rete astrolabii cum stellis.] *om*. R S P *omnes stelle desunt in figura* R S P V Fig. 14] *om*. C A