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Astronomy

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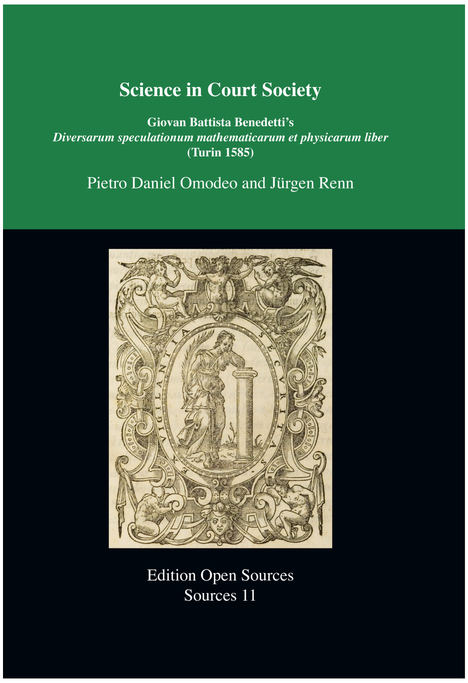

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Chapter 6
Astronomy

6.1 Benedetti as an Astronomer

Benedetti's astronomical considerations are not systematic. They are scattered throughout the volume in different sections. In spite of the difficulty of ordering them and obtaining an overview, they were very much appreciated among his contemporaries. Apart from Kepler's eulogy of Benedetti's ingenuity, the broad European success of the astronomical parts of this work is documented in other references. A few years after the publication of the *Diversae spaeculationes*, Brahe must have had a copy of it in Denmark, as he quoted it extensively and accurately on two occasions. In his correspondence with Landgrave William IV and the Hesse-Kassel court mathematician Christopher Rothmann, he referred to Benedetti's observation of the light of Venus reflected on the part of the lunar disc not presently enlightened by the sun:

> In fact, I sometimes saw that Venus illuminated in a rather sensible manner that part of the Moon that was most distant and opposed to the Sun, although the Moon is by far more distant from Venus's circuit than the comet. I remarked that the Venice patrician Giovanni Battista Benedetti, the most excellent philosopher and mathematician, noted something similar in that erudite work which he wrote on mathematical and physical speculations. At the end of an epistle to a certain Savoy baron, Filiberto, he says: "[…] that the part of the Moon which is deprived of the Sun's light is sometimes partially illuminated by Venus's light. I observed this often and showed it to many people."[1]

Brahe quotes this passage correctly from Benedetti's letter to Baron Emanuele Filiberto Pingone "*De Luce, Lumine, et Colore, De obiectu oculi, De lumine Lunae, et Rubedine nubium*" (On light, lumen, and color; on the eye's object, on the lunar lumen, and the redness of the clouds).[2]

A second long direct quotation of Benedetti can be found in Brahe's book on the nova of 1572, which was part of the *Astronomiae Instauratae Progymnasmata*, posthumously published in Prague in 1602.[3] The Danish astronomer here praised Benedetti as a "philosophus et mathematicus inprimis excellentem," and his work as "praeclarum Opus." He entirely reproduced Benedetti's letter and diagrams on the star in Cassiopeia.[4] This letter

[1]Brahe 1919, 172: "Veneris enim Stella, visa est mihi aliquando eam partem Lunae, quae a Sole aversa erat, et ipsi obiecta, satis sensibiliter illuminare, utut Luna longe remotius a Veneris circuitus distiterit, quam Cometa. Simile quid Ioannem Baptistam Benedictum, Patricium Venetum Philosophum et Mathematicum inprimis excellentem, animadvertisse reperio, in erudito illo Opere, quod de Mathematicis et Physicis speculationibus inscripsit. Sic enim in fine Epistolae, ad Baronem quendam Sabaudarum Philibertum scribens, ait: '[…] quod pars Lunae lumine Solis destituta, a lumine Veneris aliquantulum illustratur, quod ego saepe vidi, et multis ostendi.'"

[2]Benedetti 1585, 256–257.

[3]Brahe 1916, 251–253.

[4]Benedetti 1585, 371–374.

was directed against Annibale Raimondo—an author whom Brahe also criticized—and demonstrated that the nova appeared above the sublunary sphere. Brahe commented:

> Here follows the epistle which I referred to. It is taken from the aforementioned book by [Giovanni] Battista Benedetti alongside the demonstrative diagrams offered by the same author. Afterwards I will consider others, who discussed that star [i.e., the nova of 1572] in an extraordinarily incompetent manner. This [quotation from Benedetti] (as mentioned) will cast light on these issues through a synthetic and wise geometrical truth, so that no significant doubt will survive.[5]

Another reader of the *Diversae speculationes* was the English scholar of magnetism William Gilbert. In *De mundo nostro sublunari philosophia nova* (New Philosophy on Our Sublunary World, written about 1600 but published long after the author's death, in Amsterdam in 1651), he in fact discussed Benedetti's views on the spots on the surface of the moon, in a chapter trying to determine which parts of it were seas and continents.[6] It is evident that the *Diversae speculationes* had a wide European circulation, and that the astronomical part attracted the attention of many scholars dealing with mathematical and physical issues.

Benedetti's treatment of astronomical matters ranges from the calendar reform to the nova of 1572, sundials, and astrology. We would like to focus on a special issue: Benedetti's defense of ephemerides, *Defensio ephemerides*, and the quarrel that motivated its writing. This defense of ephemerides figures as one of the epistles of the *Diversae speculationes*. It is the Latin translation of an Italian letter, *Intorno ad alcune nuove riprensioni… contra alli calculatori delle effemeridi* (Letter in the Form of a Discourse… Addressed to the Illustrious Mr Bernardo Trotto Concerning Some New Criticism and Corrections against the Ephemerides Calculators, Turin, 1581), addressed to Trotto, which Benedetti had already published when a heated quarrel on the reliability of ephemerides burst out in Turin between 1580 and 1581. In the following pages we will give an account of these facts.[7]

6.2 The Controversy over the Reliability of Ephemerides

The ephemerides controversy began with the publication of Altavilla's *Animadversiones in ephemeridas* (Remarks against Ephemerides, Turin, 1580). This lesser-known author from Vicenza intended to denounce the inexactitude of all existing astronomical computations.[8] For this purpose he compared predictions and horoscopes cast using different sets

[5]Brahe 1916, 251: "Nunc igitur epistolam, quam pollicitus sum, subiungam, verbotenens e praedicto Baptistae Benedicti libro desumptam, una cum demonstrationum delineationibus, quas ipse author assignavit. Deinde ad caeteros qui de hac stella nimis incompetenter, sententiam tulerunt, calamum dirigam. Ex quo (uti dixi) haec adeo succinte et scite geometricam veritatem redoleant, ut nullum, quod alicuius sit momenti, super esse queat, dubium."

[6]W. Gilbert 1651, 173: "Luna maculas quasi ostendit substantiae et peripheriae differentia: ita Tellus erga Lunam maculas repraesentat, terrarum continentium minus relucentium; aquarum vero et Oceani, propter laeviorem et luminis apprehensivam naturam magis splendentem. […] Non enim maculae Lunae existunt a partibus Lunae magis perspicuis, ut Iohannem Benedictus contendit, in quibus lumen non reflexum sed penetrans nobis occultatur." See Pumfrey 2011, 193–203.

[7]Section 6.2 is a revision of Omodeo 2014a, chap. 3.8–9 and chap. 6.3 of Omodeo 2014a, chap. 4.7.

[8]This Benedetto Altavilla could be the same person involved many years later, in 1606, in a gunpowder plot in Venice; he pretended to have discovered it by astrological means and was tortured by the Venice authorities in order to obtain information about the perpetrators. Cf. L. P. Smith 1907, vol. 1, 364–365.

of tables and ephemerides. In particular, he pointed out that ephemerides diverged from each other even more than the astronomical tables, Alfonsine or Copernican, from which they were derived. In his opinion, this fact undermined the reputation of astronomy in general, regardless of whether its cause was the inaccuracy of the compilers (*calculatores*) or the inexactitude of the tables themselves: "We consider nothing to be more odious than an unreliable person who is regarded by many as trustworthy."[9] Altavilla declared himself unwilling to decide between Alfonsine or Copernican computations. However, he himself was probably interested in the cosmological issue, judging by the fact that the *Animadversiones* were introduced with a poem by Pandolfo Sfondrati in favor of a new world system with the earth in motion.[10]

Altavilla had established by observation that both Alfonsine ephemerides and Johannes Stadius's Copernican computations were in disagreement with the heavens. Still, Stadius's computations proved to be in better agreement with the heavens. The reference to Stadius is not casual, since the Flemish astronomer had been a protégé of duke Emanuele Filiberto of Savoy, as one can read in the *Ephemerides novae* of 1556, where the author gave himself the title "mathematician to the King [of Spain] and the Duke of Savoy" (*Regius et Ducis Sabaudiae mathematicus*). Altavilla listed predictive errors of Ptolemaic astronomers (Regiomontanus, Stöffler, Leowitz) as well as those of post-Copernican ephemerists (Stadius and Giuntini). This led him to skepticism toward predictions in general: "You see, dear reader, how reliable ephemerides are."[11] Altavilla invited scholars (*magistri*) to trust only their eyes and to correct astronomy through observational campaigns with no regard for any authority: "Posterity should learn how dangerous it is to blindly adhere to the opinions of the ancients without [perfecting the art through] daily observations of the heavens, and to prefer their opinions to truth."[12]

The *Animadversiones* were soon followed by a second publication in Italian: *Breve discorso intorno gli errori dei calculi astronomici* (Brief discourse on the mistakes of astronomical calculations, 1580). A poem by a certain Francesco Onto of Pinerolo, inserted as a preface to the *Breve discorso*, made its polemical target explicit: "Altavilla has unveiled the astrologers' fallacy, as they think to cast certain [astrological] judgments about our lives relying on flawed ephemerides."[13] Altavilla's criticism was directed mainly against astrology, whose validity he considered to be doubtful due to the inaccuracy of predictions. His argumentative strategy was no different than that of Pico della Mirandola in books 8 and 9 of the *Disputationes in astrologiam divinatricem* (Disputations against divinatory astrology, 1496): an attack on mathematical astronomy aimed to discredit astrological forecasting. Altavilla even claimed that astrologers and ephemerists should renounce their activity, as they were not capable of superseding the flaws of their discipline: "Since it is impossible for the scholars in those sciences (especially those who are not capable of using the tables) to renounce ephemerides, and they know that they will encounter irremediable errors, they should be forced to abandon their studies."[14]

In his second publication, the *Discorso*, Altavilla complained that many scholars (who were not named) pretended to ignore his criticism. He explained that the decision to write another booklet, this time in Italian instead of Latin, originated from the desire to reach readers outside academic and scholarly circles, probably also at the Savoy

[9] Altavilla 1580a, f. A2*r*.
[10] See Omodeo 2008b and Omodeo 2012a.
[11] Altavilla 1580a, *Conclusio*.
[12] Altavilla 1580a.
[13] Altavilla 1580b, 2.
[14] Altavilla 1580b, 4–5.

court: "In these few pages, I aimed at demonstrating not only to the learned man, but also to everybody else, that the errors [of the ephemerides] are worthy of consideration."[15] He first reassessed the inadequacy of Alfonsine tables and Alfonsine ephemerides (those of Peuerbach, Prugnerus, Bianchini, Regiomontanus, Stöffler, Schöner, Gaurico, Pitati, Simi, Carelli, Moletti, Leowitz, and others). He moreover stressed the superiority of the Copernican tables in order to show the inconsistency of some unnamed Turin ephemerists who used Alfonsine ephemerides for their predictions although they claimed to prefer Copernicus. To illustrate this inconsistency, he analyzed some astrological figures on the basis of Stadius's and Giuntini's tables. In the last section Altavilla turned on the Copernican ephemerists, denouncing the excessive difference between computations based on Stadius and Giuntini: "And the difference between one computation and the other is really great and monstrous."[16]

This attack on the reliability of astronomical computations and astrology provoked negative reactions both at the university and at the court. Altavilla thus felt compelled to challenge his critics to an academic debate on August 14 and 15, 1581, announcing it through a broadside that is still preserved in the libraries of Turin, along with copies of his *Animadversiones*.[17] The public dispute concerned the theory of Mars for which, as one reads, some scholars blamed him. He maintained, in fact, that Mars cannot stay in a zodiacal sign for more than two months, considering that its entire revolution lasts twenty-four months. He argued that ephemerides are wrong if they forecast that it would spend six or even seven months in the same zodiacal constellation. This incorrect opinion presented the court mathematician and philosopher Benedetti with an occasion to intervene and criticize Altavilla on this and other issues related to astronomical theory, computation, and astrological prediction.

Soon after Altavilla's public dispute, Benedetti published an epistle "on some recent remarks and emendations directed against ephemerists" (Turin, 1581). At the beginning, Benedetti indicated Altavilla's intentions: "I assume […] that his intention was only to demonstrate that [different] ephemerides assigned a different place to the planet at the same point of time […] and that, as a consequence, they offer no certain ground on the basis of which the future can be judged or predicted."[18] In his account, Benedetti rejects Altavilla's complaint that Copernican and Alfonsine ephemerides diverge from each other more than the tables from which they are derived. He assures the reader that "the people who calculated have been very accurate and trustworthy" (*i calcolatori sono stati diligentissimi e fedeli*) and they are exact in their calculations, although some minor and accidental mistakes can occur.[19]

Moreover, he accuses Altavilla of misunderstanding Ptolemy's astrology, interpreting it in light of Abu Ma'shar and Al-Qabisi (*Alcabitius*). In particular, Altavilla draws from these sources the rule of the "triplicity" of the conjunctions of Jupiter and Saturn, according to which these planets meet four times in the same three astrological signs, or trine, before they can meet in the next trine. However, although the mean motions of two planets should meet in the triplicity sign, nonetheless their "real" motions (those observed and calculated by the ephemerides upon which astrological predictions rely) may meet elsewhere. This is an obvious consequence of planetary theory. In fact, it distinguishes between "mean" motions, which correspond to the revolutions of the deferents, and "real" motions, which

[15] Altavilla 1580b, 3.
[16] Altavilla 1580b, 6.
[17] In Turin: Biblioteca Nazionale di Torino, coll. Q.V.191, and Biblioteca Reale di Torino, coll. G.25.12.
[18] Benedetti 1581, 5.
[19] Benedetti 1581, 6.

correspond to observable phenomena and are the product of moving epicycles. Benedetti calculates the period of triplicity to be 794 years and 138 days, whereas the Arabs on whom Altavilla relies overestimated it at 960 years.[20] He furthermore remarks that Altavilla neglected planetary theory by criticizing those who let Mars run too fast or too slowly along the signs of the zodiac. Simple observations would show the correctness of the theory according to which the planet can remain in the same sign for six or even seven months. Benedetti explains that the amplitude of Mars's epicycle accounts for its complex phenomenology, in particular the long period of retrograde motion. On this account, he reports an observational campaign accomplished between 1565 and 1566 in order to check Stadius's ephemerides:

> Yet, he [Altavilla] dared too much, seeking to reprimand so many talented ancient and modern men who, as is required by diligent observers of the heavens, checked with their own eyes these appearances of Mars as well as of the other [planets]. From those [observations], they were forced to "imagine" such a large [Martian] epicycle. By contrast, he has never observed the motions of either this or any other planet, but rather limited himself to look at what is written in the ephemerides. In fact, if he had at least said that he observed Mars's journey for a certain period, and that he found that the others' opinion was false, he would have at least given some "color" to his opinion. In my assessment, however, if he had made an observation of the path of Mars, he would not have held the contrary view. In fact, the truth is the following: in every revolution of its epicycle, Mars in the lower part of its epicycle always stays many months (six or seven, or more) in a twelfth [*duodecatemerio*] of the zodiac. I observed this many times, for instance, in the years 1565 and 1566. First, consulting Stadius's ephemerides, I found that Mars would finish its retrograde motion on about 12 January 1566, in 16° of Gemini, and that, equally, Mars would be in the same place on the last day of August 1565, before it began its retrograde motion. Second, I found that, after that retrograde motion, on 11 April 1566, Mars would be in 16° of Cancer, so that it would take [Mars] seven months and eleven days [to move] those thirty degrees, from 16° of Gemini to 16° of Cancer. After these computations, I took the instruments and got ready to make a test. And I found that the last night of August of the year 1565 Mars was in the aforesaid 16° of Gemini, as Stadius had noted. I then made observations every week, in order to see the retrograde motion, and I saw that, at about the end of October, the [planet] began its retrograde motion and that retrograde motion lasted until January (or about January) 1566. I later observed the position of that planet on 11 April, and I found it in 16° of Cancer, that is, the place where Stadius had located it. Thus, my experience confirmed Stadius's computations and I found that he was not mistaken. In the same manner, everybody can ascertain the truth every two years by carrying out observations.[21]

Benedetti thus demonstrated not only the theoretical incompetence of his opponent, but also his lack of empirical verification. Altavilla's appeal to base astronomy using observation backfired. Benedetti challenged his opponent to observe Mars's backward motion in Cancer which, according to Stadius's tables, would begin on November 20, 1582 and

[20] See Bonoli 2012, 49–55.
[21] Benedetti 1581, 17–19.

last until the end of February 1583. He furthermore observed that everyone familiar with planetary theory would understand the reasons for the orbit of Mars and other planets. For the theory, he added, it did not matter whether one relied on Ptolemy's *Almagest* or on the "*Rivolutioni de gl'orbi celesti* dell'eccellentissimo Copernico."[22] Of course they were only equivalent as far as the understanding of a system of deferents and epicycles was concerned, but not in their general hypotheses, since Benedetti himself tended toward heliocentrism.

As to the difference between Leowitz's and Stadius's computations, Benedetti traced this back to the contrast between the theories underlying the Alfonsine and the Copernican tables. Nonetheless, he ensured that ephemerides never diverged by more than three degrees. Thus, if Altavilla detected greater discrepancies, this was due only to false computations. Benedetti added that Stadius's superiority over Leowitz was a consequence of him employing better parameters. He advised Altavilla to always rely on the most recent observations and tables.[23] In fact, he judged the progress of astronomy to be such that more recent tables would inevitably be superseded by new ones, augmented and perfected through new observations, just as Copernicus had superseded Alfonso's astronomers. Divergence between ephemerides was not a shortcoming, but a necessary and desirable sign of the advancement of knowledge and predictive accuracy.

As a courtier expert of mathematics, Benedetti defended the validity of some astrological figures that Altavilla criticized in his second published work, *Breve discorso*. These horoscopes had probably been cast by somebody that he knew well. Altavilla complained that some astrological figures had not been calculated on the basis of Copernican tables. Benedetti replied that it was not always necessary to use the best tables for predictions, especially if a generic horoscope was expected and if the astrologer had no Copernican tables to consult. He showed, moreover, that Altavilla himself was not able to employ Giuntini's tables properly and made mistakes of computation. He concluded: "And such monsters [those denounced by Altavilla] are not generated by different tables or ephemerides but, instead, they are the offspring of this author."[24] He added as a remark: "As to the difference of the Sun according to Copernicus and Alfonso, no learned man, [expert] in these sciences, ignores it, and, as a consequence [everybody knows] the different place [assigned to it] in the heavens during the annual revolutions."[25] In 1581, the general views of *De revolutionibus* were so well known in Benedetti's environment that he deemed it unnecessary to expand on them in the context of a polemic on the accuracy of heavenly computations. The cosmological implications of these different hypotheses were not addressed explicitly in this dispute. However, the defense of mathematical astronomy could not avoid a reference to Copernicus as a source for tables (Reinhold, Stadius, Giuntini) and theory. In this context, "Copernican" and "not Copernican" are expressions that merely mean "based on Copernican tables" or not. Altavilla's criticism would have been more effective if it had been directed against astrological beliefs as such, rather than attempting to show the inconsistency of the mathematical basis of astrology without sufficient preparation. On the other hand, Benedetti, in his *Lettera*, focused on the mathematical aspects and cautiously avoided expanding on ethical issues related to astrology.

Altavilla never responded to the court mathematician who had rebutted his arguments so forcefully. The epilogue to their quarrel was the inclusion of a Latin translation of the

[22] Benedetti 1581, 20.
[23] Benedetti 1581, 32–33.
[24] Benedetti 1581, 37.
[25] Benedetti 1581, 37–38.

Lettera, as *Defensio ephemeridum* (A defense of Ephemerides), in Benedetti's *Diversae speculationes*.[26]

6.3 The System of the World

Benedetti did not limit himself to considering astronomy from a computational point of view, but also expanded on cosmological aspects. The epistle "De fine corporum coelestium, et eorum motu" (On the Aim of Celestial Bodies, and their Motions),[27] addressed to Pingone, bears witness to his interest in cosmology and his realist interpretation of Copernicus's hypotheses. Benedetti remarks that it is not reasonable (*si [...] humanam rationem sequi volueris*) to believe that the heavens were created only for the sake of terrestrial life, "as these [celestial] bodies are divine, uncountable, and endowed with the greatest dimensions" (*cum ea corpora sunt divina, in numero incompraehensibilia, maximis magnitudinibus, et motibus velocissimis praedita*).[28] This absurdity can be avoided, as Benedetti claims, if one accepts the planetary doctrine of Aristarchus and Copernicus:

> […] this will hardly be believed by those who embrace the doctrine of Aristarchus of Samos and Nicolaus Copernicus. Following their approach it is impossible to make them believe that the rest of the universe has no other aim than to rule over this center of the lunar epicycle [the earth] (to use their way of speaking).[29]

Although he speaks in the third person, as if he were reporting the views of someone else, these are his own views. He is inclined to accept the Copernican system or some variation of it, as the following pages of the letter and the force of the arguments show. Firstly, he assumes a principle of cosmological homogeneity according to which there is no reason why other planets should not be subjected to alterations (*ab ortu, et interitu*), as the Aristotelians suppose. The peripatetic argument that no change in the heavens was ever observed is not valid, because the distance does not permit verification of whether there is any life or alterations on distant bodies (*unde etiam fieri potest, ut in coelo sint particulares alterationes, quae a nobis tamen, qui ab illis longe distamus, non compraehendantur*).[30] Benedetti even surmises that other planets are moons reflecting the solar light to dark planets invisible to us.[31] He ascribes this opinion to the followers of Copernicus. This is a free interpretation on his part. Perhaps he aimed to explain the epicyclic motions of other planets through an analogy with the lunar epicycle around the earth. Benedetti also rejects Ptolemaic and Aristotelian arguments against terrestrial motion. Following Copernicus (*De revolutionibus* I 8), he stresses that the axial rotation avoids the otherwise enormous motion of the fixed stars: "which is eliminated by the rotation of the Earth about its axis (as they say) as it is sufficient to receive the light and the influences of the [celestial] bodies."[32] Moreover, the annual revolution respects the dignity of the "divine body of the

[26]Benedetti 1585, 228–248, "Defensio ephemeridum."
[27]Benedetti 1585, 255–256.
[28]Benedetti 1585, 255.
[29]Benedetti 1585, 255: "[…] id etiam minus putabunt hii, qui opinionem Aristarchi Samii, et Nicolai Copernici sequuntur, quorum ratione fieri non potest, ut credant eius, quod ex universo reliquum est, alium finem non habere, quam regimen huius centri [Tellus] epicycli Lunaris, ut illorum more loquar."
[30]Benedetti 1585
[31]The same thesis is presented in Benedetti 1585, 195–196.
[32]Benedetti 1585, 255–256: "quae quidem omnia [phaenomena], cum simplici gyro terrae circa suum axem (ut dicunt) tolluntur, quod sufficit ad recipiendum lumen, et influentias illorum corporum."

Sun" (*divinum corpus solare*), which stands still at the center of the planetary circles.[33] Note Benedetti's astrological concern. In the final passage of his letter, he reassesses Copernicus's objection to Ptolemy's view of how bodies suspended in the air are affected by terrestrial motion:

> Ptolemy's objections are not valid for them [astronomers who assume that the earth moves]. As they say, every part maintains the nature of the whole, apart from the fact that the air and water circumscribing the earth receive the same natural impulse of motion [*impetum motus*]. This is slower the further the air is distant from the earth. According to the same doctrine, there is no necessity that the place of the fixed stars has (either convex or concave) superficial boundaries.[34]

According to this passage, the air close to the earth is transported by the motion of the planet and slows down the more it is distant from it. The fixed stars are placed in a motionless air whose place (*locus*) has no boundaries, either convex or concave.

In a letter to the courtier Capra, Benedetti confronts the issue of the form of the heavens.[35] This is said to be a sphere encompassed by infinite space. Accordingly, Benedetti distinguishes between *spacium* (space) and *coelum* (heavens), a distinction that can be traced back to Stoic cosmology or to the more recent views of Marcellus Palingenus Stellatus. The idea of the infinity of space beyond the starry vault can be found also in Patrizi's *Nova de Universis Philosophia* (1591).[36]

Furthermore, Benedetti rejects the existence of material spheres with the role of transporting the planets:

> That you do not accept that distinction of spheres, which was well-established in the past, but rather that you believe that the whole is a continuum accommodating the stellar bodies, this is not new. In fact, some philosophers of solid doctrine were of the same opinion.[37]

The motion of celestial bodies is accompanied by that of transparent bodies similar to vapors (*fumi*). Their motion is the cause of the apparent sparkling of the most distant stars.[38] The sparkling of the new star in Cassiopeia in 1572 bears witness to its great distance above the moon, which Benedetti also demonstrates through geometry.[39]

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[33]Benedetti 1585, 256.

[34]Benedetti 1585: "Rationes autem a Ptolomeo in contrarium adductae apud ipsos, nullae sunt, quia quaelibet pars (ut inquiunt) retinet naturam totius, praeterquam quod aer, et aqua, quae ipsam terram circundant, plane eundem naturalem impetum motus obtineant, qui tanto lentior est, quanto longius distat aer, ab ipsa terra, secundum etiam talem opinionem, nulla necessitas, ut locus fixarum terminaretur aliquibus superficiebus, convexa scilicet, et devexa."

[35]Benedetti 1585, 285–286, "De motu molae, et trochi, de ampullis, de claritate aeris, et Lunae noctu fulgentis, de aeternitate temporis, et infinito spacio extra Coelum, Coelique figura."

[36]For Benedetti's correspondence with Patrizi, see Claretta 1862.

[37]Benedetti 1585, 411: "Quod eam distinctionem orbium, quae iam invaluit, non teneas, sed putes totum esse quoddam continuum excipiens corpora stellarum, novum non est, nam nonnulli solidae doctrinae philosophi idem confuerunt."

[38]Benedetti 1585, in the section entitled "Disputationes de quibusdam placitis Arist[otelis]," n. 38: "Occultam fuisse gravissimo Stagiritae causam scintillationis stellarum," 186: "Scintillatio ergo stellarum, neque aspectus nostri ratione, neque alicuius mutationis earundem stellarum, sed ab inaequalitate motus corporum diaphanorum mediorum nascitur, quemadmodum clare cernitur, quod si inter aliquod obiectum, et nos, aliquis fumus, qui ascendat, intercesserit, videbimus obiectum illud quasi tremere. Hoc autem tanto magis fiet, quanto magis distabit obiectum ab ipso fumo; unde admirationi locus non erit, si stellas fixas magis scintillare, quam errantes cernamus. Lumen stellae ad oculum nostrum accedens, perpetuo per diversas diaphaneitates penetrat, medio continuorum motuum corporum mediorum, unde continuo eorum lumen variatur, et hoc in longitudinis magis, quam in propinquis stellis apparet."

[39]Benedetti 1585, 371–374.

One of the books of the *Diversae speculationes* entails a discussion and a refutation of Aristotelian physical and celestial theses *de motu*. It has the rather neutral title *Disputationes de quibusdam placitis Arist[otelis]* (Disputations on Some Opinions Held by Aristotle) but it is indeed an attempt to revise basic concepts of natural philosophy such as *locus* (place) and *tempus* (time). We shall deal with this issue in detail in the next section. For now, it is important to anticipate that this anti-Aristotelian section entails Benedetti's most explicit defense of Copernican planetary hypotheses. Another remarkable thesis of these *Disputationes* on Aristotle is the statement of a principle of relativity according to which planets appear to us as we appear to them:

> Aristotle did not consider that one could affirm the same about the Earth as seen from great distance. There is no doubt that, even if the Earth had the light of the Sun and somebody tried to observe it from the eighth sphere, he would not be able to perceive it. In fact, those celestial bodies that are said to be of the first magnitude and that are believed to be more than a hundred times bigger than the Earth look just like points.[40]

Benedetti supports the plurality of worlds as well (*Minus sufficienter explosam fuisse ab Aristotele opinionem credentium plures mundos existere*). Every planet should be regarded as another Earth with its elements and natural places: "If those worlds existed, each of them would have its own center and its own circumference and the earths and fires would have an inclination towards the centers and the circumferences of their worlds, respectively."[41]

[40]Benedetti 1585, 197, "Disputatio XXXIX, Examinatur quam valida sit ratio Aristotelis de inalterabilitate Coeli: Aristo[teles] non consideravit, quod similiter de terra dici posset, quando ipsa ita eminus prospiceretur, imo absque dubio putandum est, quod si terra luce Solis praedita esset, et aliquis ipsam ab octavo orbe vellet videre, nullo pacto cerneret, cum sidera illa quae primae magnitudinis vocantur, et quae plusquam centies maiora ipsa terra putantur non nisi ut puncta videantur."

[41]Benedetti 1585, 195: "Si essent dicti mundi, eorum quilibet suum proprium centrum, suamque propriam circunferentiam haberet, terraeque et ignes haberent inclinationem ad centra circunferentiasque suorum mundorum."

6.4 Appendix: An Assessment of Benedetti's Horoscopes (by Günther Oestmann)

For the recalculation of a historical horoscope, the same methods and means the author had at his disposal must be employed, that is, the use of modern parameters or tables is not allowed.[42] In the following disposition, planetary positions are rendered in ecliptic longitude (degrees ; minutes) for each zodiacal sign (0–30°), geographical coordinates likewise in degrees ; minutes, and time in hours ; minutes. Latitude is denoted as φ.

6.4.1 Nativity Cast by Benedetti for Duke Carlo Emanuele I of Savoy

January 11, 1562 (Julian date), 16;23 p.m., φ = 45°; Planetary positions according to the *Prutenicae Tabulae* by Erasmus Reinhold (1551).

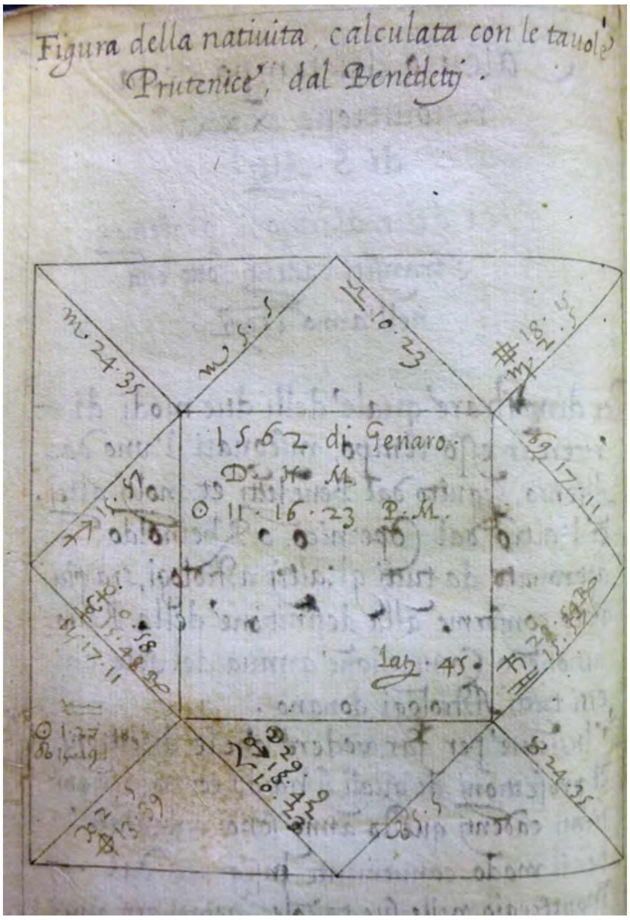

Figure 6.1: The horoscope cast by Benedetti for Duke Carlo Emanuele I of Savoy. This was calculated with the Prutenic tables, as transcribed by Bartolomeo Cristini in *Revolutione trentesima prima del Serenissimo Signore il Signor Carlo Emanuel Duca di Savoia corrente dell'anno 1592 con ogni diligenze et fedeltà calculata et decchiarata secondo le migliori intelligenze de più principali autori dell'astrologia giundiciaria*, Turin. (Biblioteca Nazionale Universitaria: Coll. N VII 10, f. 11*v*)

[42]Here a convenient, unfortunately little-known computer program created by Peter Schiller especially for the needs of historians has been used. See Schiller 2001. There is not sufficient room here for a detailed analysis of the choice of appropriate historical parameters; for a concise description, see Oestmann 2002 and Eade 1984, 1–103.

Carlo Emanuele I of Savoy was born in the Castle of Rivoli (c. 15 km west of Turin) on January 12, but here the "noon epoch" is indicated in the manner commonly used by astronomers/astrologers: the date changes at 12:00 local time, and the hours are counted from there to 24—contrary to civil use, where sunrise or sunset often marked the change of day. With the proliferation of mechanical clocks in the late Middle Ages, the date change at midnight gradually became predominant and hours were counted from 1–12.[43]

The geographical coordinates of the nearest town to Turin listed in the *Catalogus locorum* in Reinhold's *Prutenicae Tabulae* is Venice, which is 0 h 50 m (12;30) west of Königsberg, the reference meridian of the Prutenic tables. In Petrus Apianus's *Cosmographicus liber* (1533), the following specifications are given: Turin 30;30 and Königsberg 42;16 east of the island Porto Santo near Madeira (f. XLII*r*, XXXIX*r*) → the difference of longitude is 11;46 (modern value: 12;46). In the following recalculation, a longitude of 12;00 west of Königsberg has been assumed:

Table 6.1: Planets

Planets	Original Source	Recalculation
Sun	1;27 Aq	1;27 Aq
Moon	29;09 Ar	29;16 Ar
Saturn	28;54 Ge retrograde	28;55 Ge
Jupiter	[missing]	21;02 Ta
Mars	18;42 Ar	18;41 Ar
Venus	0;58 Cp	0;58 Cp
Mercury	15;48 Cp retrograde	15;48 Cp
Lunar node (asc.)	15;19 Aq	15;16 Aq

Table 6.2: Houses

Houses (Regiomontanus)	Original Source	Recalculation
X	10;23 Li	10;16 Li
XI	5;05 Sc	4;59 Sc
XII	24;35 Sc	24;32 Sc
I	15;57 Sa	15;54 Sa
II	17;11 Cp	17;07 Cp
III	2;05 Pi	1;58 Pi
Lot of Fortune (Night)	18;15 Vi	18;05 Vi
Lot of Fortune (Day)	13;39 Pi	13;43 Pi

The Lot of Fortune (*Pars Fortunae*; named for the Roman goddess of luck and wellbeing) is calculated in diurnal charts by subtracting the ecliptic longitude of the sun from the

[43] For details, see Bilfinger 1888, 262–286 and Ginzel 1914, 94–96.

longitude of the moon. Then the difference is added to the longitude of the Ascendant: Lot of Fortune = Ascendant + Moon – Sun. For nocturnal charts, the calculation is Ascendant + Sun – Moon.

Although this is a night-time birth chart, Benedetti has marked the Lot of Fortune for night and day.

The sign and degree occupied by the moon when crossing the ecliptic from southern to northern latitude is the ascending node (*Caput Draconis*). When the moon is moving in the opposite direction (crossing the ecliptic from north to south), the point of intersection is called the South Node (*Cauda Draconis*). The nodes are not fixed, but have a retrograde movement (a complete revolution of the nodes in the ecliptic takes 6798 days/18.61 years). To both points (which are important in the interpretation of a chart), the strength of a planet has been assigned. The Dragon's Head is considered beneficial, the Dragon's Tail malefic. (In Hindu astrology, the ascending node is called *Rāhu* and the descending node *Ketu*; both are considered malefic planets.[44].)

Benedetti forgot to inscribe Jupiter. Apart from this flaw everything has been calculated accurately.

6.4.2 Revolution or Solar-Return Horoscope

January 21, 1592 (Gregorian Date), 23 h 15 m 30 s p.m., φ = 45°.
Geographical coordinates of Turin according to Petrus Apianus in *Cosmographicus liber* (1533): f. XXXV*r* – Toledo 9;04 East of Porto Santo; f. XLII*r* –Turin 30;30 → 21;26 East of Toledo (the reference meridian of the Alfonsine tables).

Table 6.3: Planets

Planets	Original Source	Recalculation (Alfonsine tables)	Recalculation (Prutenic tables)
Sun	1;27 Aq	2;08 Aq	1;12 Aq
Moon	9;27 Ta	11;20 Ta	8;12 Ta
Saturn	7;29 Ca retrograde	10;30 Ca	7;30 Ca
Jupiter	11;44 Sa	10;31 Sa	11;42 Sa
Mars	3;05 Ar	4;23 Ar	3;00 Sa
Venus	25;09 Sa	23;00 Sa	25;08 Sa
Mercury	9;36 Aq	5;43 Aq	9;25 Aq
Lunar node (asc.)	4;54 Ca	5;05 Ca	4;53 Ca

[44] See Hartner 1938, 131–134

Table 6.4: Houses

Houses (Regiomontanus)	Original Source	Recalculation I (φ = 45;00; 23;15 p.m.)	Recalculation II (φ = 45;00, 23;17 p.m.)
X	21;00 Ca	20;30 Cp	20;59 Cp
XI	1;00 Aq	10;36 Aq	11;11 Aq
XII	17;00 Pi	16;26 Pi	17;18 Pi
I	10;49 Ta	9;56 Ta	10;43 Ta
II	15;00 Ge	14;36 Ge	15;08 Ge
III	5;00 Ca	4;18 Ca	4;45 Ca
Lot of Fortune (Day)	18;49 Le	16;55 Le	17;44 Le

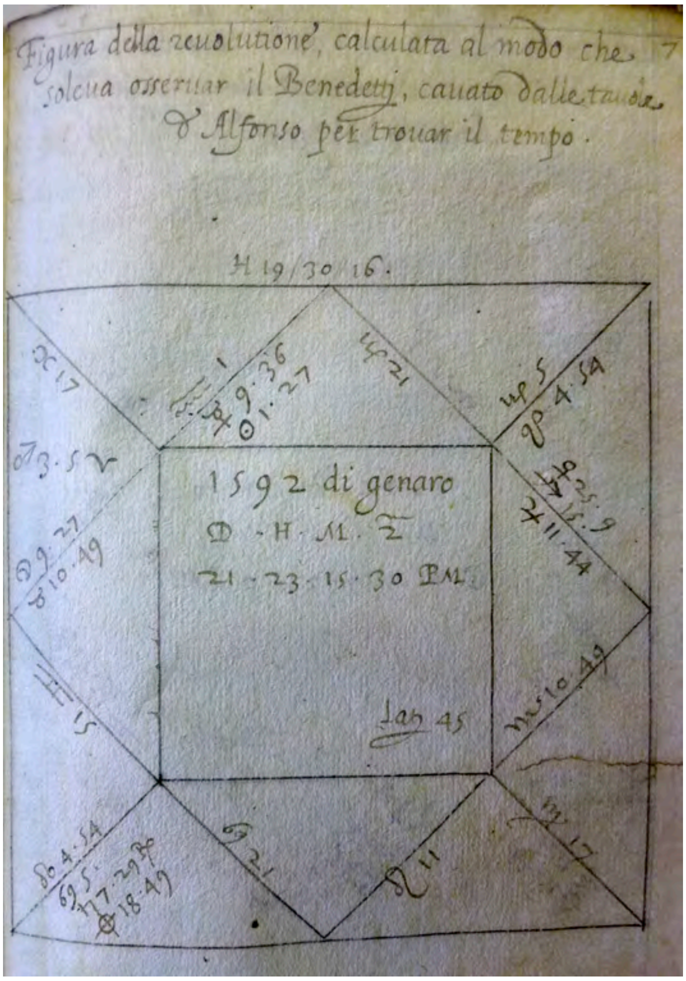

Figure 6.2: Benedetti's horoscope for Carlo Emanuele I, calculated with the Alfonsine tables, as transcribed by Cristini in *Revolutione trentesima prima* (1592), f. 12*r*. (Biblioteca Nazionale Universitaria di Torino, coll. N VII 10)

The second of Benedetti's horoscopes to be considered is also taken from Bartolomeo Cristini, *Revolutione trentesima prima del Serenissimo Signore il Signor Carlo Emanuel Duca di Savoia corrente dell'anno 1592 con ogni diligenze et fedeltà calculata et decchiarata secondo le migliori intelligenze de più principali autori dell'astrologia giundiciaria*, Turin, Biblioteca Nazionale Universitaria: Coll. N VII 10, f. 12*r* (Figure 6.2).

This is a chart constructed for the moment in which the sun returns to the degree and minute of its longitude at nativity (i.e., transiting the position of the "natal" sun) for the respective location. A revolution horoscope indicates the course of events during the ensuing year.

Contrary to Benedetti's caption (*Figura della revolutione [...] cavato dalle tavole d'Alfonso per trovar il tempo*), he has obviously used the Prutenic tables for calculating the planetary positions of this chart. But the moon's position is off by c. 1°, and the cusps of the houses deviate somewhat. Calculating with a time of 23;17 p.m. gives a reasonably good compliance, however. The cusp of house XI (1;00 Aq instead of 11 Aq) is most likely a scribal error.

It is noteworthy that minutes for an arc are only provided for the first house (i.e., the ascendant). For the other cusps, only whole degrees are noted. Benedetti simply cut off the minutes, which was a common rounding procedure at his time.

6.4.3 Natal Horoscope of Giovanni Battista Benedetti

> August 14, 1530 (Julian Date), 13 h 13 m p.m., Venice; planetary positions according to the Alfonsine tables. Geographical coordinates of Venice according to Petrus Apianus (1533): Toledo 9;04 East of Porto Santo (f. XXXV*r*); f. XLII*r*: Venice 32;30, Latitude φ = 44;50 → 23;26 East of Toledo (the reference meridian of the Alfonsine tables).

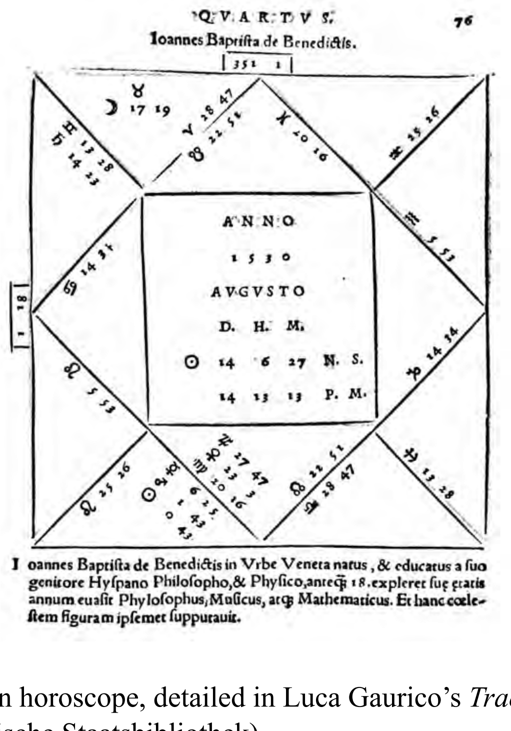

Figure 6.3: Benedetti's own horoscope, detailed in Luca Gaurico's *Tractatus astrologicus* (1552, f. 76*r*). (Bayerische Staatsbibliothek)

Table 6.5: Planets

Planets	Original Source	Recalculation
Sun	0;43 Vi	0;42 Vi
Moon	17;19 Ta	15;02 Ta
Saturn	14;23 Ge	14;23 Ge
Jupiter	27;47 Vi	27;46 Vi
Mars	1;43 Vi	1;45 Vi
Venus	23;03 Vi	23;02 Vi
Mercury	6;25 Vi	6;25 Vi
Lunar node (desc.)	22;51 Ar	22;52 Ar

Table 6.6: Houses

Houses (Regiomontanus)	Original Source	Recalculation
X	20;16 Pi	20;14 Pi
XI	28;47 Ar	28;36 Ar
XII	13;28 Ge	13;17 Ge
I	14;34 Ca	14;23 Ca
II	5;53 Le	5;46 Le
III	25;26 Le	25;23 Le

Apart from the moon's position (which is about 2° off) the horoscope is correct. In all three horoscopes the houses have been constructed according to the so-called "rational method," commonly—but erroneously—attributed to Regiomontanus:[45] Circles of position joining in the north and south point of the observer's horizon are laid at distances of 30° through the celestial equator, thus giving unequal sections of the ecliptic. This method of house division was widely used by astrologers during the sixteenth and seventeenth centuries.

[45] It was already known in the Maghreb in the eleventh century, see Kennedy 1996, 543. For a profound treatment of the history of house division, see North 1986, although the way this text coins new designations is awkward and may lead to confusion.