COPERNICUS
and the Astrologers

by Robert S. Westman

Dibner Library Lecture
December 12, 2013

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About the Author

Robert S. Westman is Professor of History and a founding member of the Science Studies Program at the University of California, San Diego. From 1969 to 1988, he taught in the Department of History at UCLA. In 1976-77, he was awarded a fellowship from the Guggenheim Foundation and was Visiting Fellow in the Department of History and Philosophy of Science at Cambridge University. In 2011-12, he was the Huntington Dibner Distinguished Fellow in the History of Science and Technology.

His book, *The Copernican Question: Prognostication, Skepticism and Celestial Order* (Berkeley: University of California Press, 2011), was honored in June 2015 at a special symposium sponsored by the Henry E. Huntington Library. A Chinese translation of *The Copernican Question* is in progress.

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Foreword

Robert S. Westman's essay, "Copernicus and the Astrologers" is based on the 20th annual lecture presented on December 12, 2013, by the Dibner Library of the History of Science and Technology. It is a fitting topic because the Dibner Library has 15 editions and translations of Copernicus' works, and the Smithsonian Libraries as a whole houses 51 volumes about him, his colleagues, and his times. In addition to the works by Copernicus, the Dibner Library's collection is one of the top, nationally known libraries to foster research in the history of science and technology from the Renaissance and Early Modern Period through the 19th century. The Library's 35,000 rare books and 2,000 manuscript groups cover mathematics, engineering, transportation, chemistry, physics, electricity, astronomy and much besides. Many of them are now available digitally through the Smithsonian Libraries' website at library.si.edu/digital-library/natural-and-physical-sciences.

In his book, *The Copernican Question: Prognostication, Skepticism and Celestial Order* (2011), Westman argues that war, epidemics and the rise of print culture in the second half of the fifteenth century fostered conditions favorable to the production of astrological publications, a development that coincided with a proliferation of astrological prognosticators at princely courts, municipalities and universities. The movement to reform astronomical theory, which began at Vienna and spread to Krakow, was driven principally by a desire to improve the quality and success of astrological forecasting. Copernicus was exposed to this reformist literature as early as his studies at Krakow and later at Bologna where he lived with and assisted the university's leading astrologer, Domenico Maria Novara, and where the foundations of astrology also came under withering attack from the Florentine intellectual prodigy, Giovanni Pico della Mirandola. In his Lecture, here presented in an expanded and extensively-documented version, Westman

brings new and surprising evidence to bear on his thesis, important materials for which are to be found in the Dibner Library.

The Smithsonian Libraries encompasses a network of 21 specialized libraries, open to the public and readily available to researchers, scholars, scientists, historians, students, and those who seek to have questions answered. Spread among the museums and research centers of the Smithsonian, from Washington, D.C. to the Republic of Panama to New York City, and to Edgewater and Suitland, Md., these libraries advance knowledge on a global scale by serving the Smithsonian's research and education enterprise and by presenting their collections and expertise broadly through the Internet. One digital example is the *Heralds of Science*, the 200 items that Bern Dibner collected and which form the nucleus of his generous gift to the Smithsonian. The Heralds are those works that Mr. Dibner felt were the most significant titles in the formation and development of Western science and technology. They can be seen and enjoyed by everyone at library.si.edu/heralds-of-science.

Bern Dibner (1897-1988) made his gift on the occasion of the U.S. Bicentennial in 1976. A man of exceptionally wide-ranging intellectual abilities and interests, Dibner arrived in 1904 as part of the great immigration of 1880-1924 that brought many Russian Jews to America. Trained in electrical engineering at the Polytechnic Institute of Brooklyn, Dibner built a considerable fortune through his company, the Burndy Corporation, while cultivating a lifelong interest in the history of science and technology by assembling a collection of rare books, manuscripts, portraits and medals.

For more information on the Dibner Library of the History of Science and Technology, visit library.si.edu/libraries/dibner.

Nancy E. Gwinn
Director, Smithsonian Libraries
July 1, 2016

A Contentious Image

In 1973, conferences celebrating the five-hundredth anniversary of the birth of Nicolaus Copernicus were held all over the world—including an event at the Smithsonian Institution.[1] Earlier celebratory events of this sort not infrequently projected onto the historical figure of Copernicus sensitive issues of national identity associated with Poland's forced partitioning in the late eighteenth century. Such anxieties and concerns preoccupied historians with questions like: Did Copernicus consider himself a German or a Pole? Or, how should his name be spelled?[2] On other occasions, however, he served as a symbol of hope in a time of desperation. In 1943, with Poland under the dark shadow of Nazi occupation, Albert Einstein spoke at a special Copernicus event organized by the Kosciuszko Foundation in New York City. Thirty years later, in the middle of the Cold War, Polish historians of science anticipated that 1973 would be a prime occasion to improve scholarly contacts with the West. An international organizing committee placed high priority on bringing scholars to Poland from Western countries. One of the organizers was Owen Gingerich, an astronomer at the Harvard-Smithsonian Center for Astrophysics, who had developed a deep interest and considerable expertise in the history of astronomy and who became well known for his prolific and fundamental contributions, one of which was his remarkable thirty-year hunt for surviving copies of Copernicus's major work, *De revolutionibus orbium coelestium*.[3]

In *The Book Nobody Read*, where Gingerich describes some of his adventures in tracking down these copies, a chapter opens with a personal anecdote from the 1973 Polish Copernicus Quinquecentennial: "Two distinguished scholars had been assigned a private limousine to get them from Warsaw to Copernicus' birthplace, Toruń. Edward Rosen, the dean of Copernican studies, and Willy Hartner, Europe's leading historian of the exact sciences, emerged from the car no longer on speaking terms. [During the journey] Hartner had had the audacity to suggest that Copernicus and [his first disciple, Georg Joachim] Rheticus could have discussed astrology."[4] I vaguely remember when Rosen and Hartner stepped out of their limo but, unlike Gingerich, I did not appreciate the depth of the altercation, nor could I have possibly anticipated that forty years later their disagreement would provide a telling anecdote for this presentation.

Commenting retrospectively on this contentious episode, Gingerich observed that "Copernicus lived in an era when astrological ideas permeated academia" at all the institutions where he studied—Krakow, Bologna, Padua, and Ferrara.[5] Similarly, Rheticus, the young astronomical practitioner who had come to visit the aging Copernicus in 1539—and lived with him for over two years—was deeply conversant with astrological practice. In 1535, he had composed a general oration on astrology at the University of Wittenberg; in the early 1540s, he published several astrological prognostications; but, most famously, he and Copernicus developed a sufficiently trusting relationship that the older man allowed the younger to write—and publish—a brief description of his theory. Gingerich thus concluded with Hartner that "Rheticus and Copernicus must certainly have discussed the subject [of astrology]."[6]

For his part, Rosen was unquestionably well aware that astrology was widely practiced but, contrary to Hartner, he believed that

Copernicus was exceptional in not pursuing the subject. And his views, first expressed in 1939, remained fixed until his final publication on the subject: "Did Copernicus believe in astrology?" he asked. "This is an extraordinary aspect of Copernicus's mentality. He lived in an age when many of those in power as well as of [*sic*] those on the lower rungs of the social ladder believed in astrology. He [Copernicus] did not."[7] Thus, in 1941, when Rosen taught a course on the history of science at Columbia University—attended by Bern Dibner—this is surely the position he would have held.[8]

Still later, Thomas Kuhn put forward much the same view in his classic and influential 1957 study, *The Copernican Revolution*: "It may even be significant that Copernicus, the author of the theory that ultimately deprived the heavens of special power, belonged to the minority group of Renaissance astronomers who did not cast horoscopes."[9] And in 1961, Alexandre Koyré observed that "from the time of Ptolemy to that of Campanella there was a firm alliance between astronomy and astrology." He then added: "Rosen is right; compared with his predecessors and successors—Peurbach and Regiomontanus, Tycho Brahe and Kepler—Copernicus never seems to have engaged in astrological predictions. Are we therefore justified in concluding that he did not believe in them? Possibly, but not certainly."[10] A solution to the question of Copernicus's possible involvement with astrology then seemed to reach an impasse because nothing turned up—neither references to conversations between Copernicus and Rheticus nor anything written by Copernicus himself. The episode thus easily lends itself to historiographical disagreement and to speculation. Indeed, approaching the question in another genre, the acclaimed author Dava Sobel recently composed a play in which she imagines what such conversations between Rheticus and Copernicus might have been like.[11]

Pandemics, War and Astrological Prognostication

In my recent book, *The Copernican Question*, I have attempted to open up the problem again, arguing that we have given insufficient weight to circumstantial evidence and to contextual considerations. In this presentation, I intend to push my argument further. To begin, both social historians of the Black Death and historians of Renaissance medicine and astrology have observed that the surge in astrological forecasting from the fourteenth century onward was one kind of response to plague epidemics—a significant, long-term, background explanation for the rise of widespread interest in the use of astrology in medical prognosis and therapeutics.[12] Recently, Ole Benedictow estimated that between 1346 and 1353 the Black Death killed about fifty million people or 60 percent of the total population of Europe—if correct, a staggering and horrifying figure.[13] Thus, at Copernicus's birth in 1473, European countries were still recovering from the massive demographic, political, economic and cultural consequences of the previous century. And further plague hot spots continued to erupt until the early eighteenth century. As late as 1665, Isaac Newton was forced to leave Cambridge because of a flare-up of the plague. Simply put, episodes of plague were a constant, yet unpredictable presence in the lives of ordinary people throughout Europe—including all the figures who contributed to what many historians call the Scientific Revolution.

A long-held modern theory was that the disease was caused by the bacterium *Yersinia pestis*, spread by fleas, quickly and easily transported along commercial routes by ship and horse transport. More recent explanations for plague persistence are founded on a microbiological consensus: when fleas infected with *Y. pestis* can no longer find preferred hosts (black rats), they silently "spill over" into reservoir hosts (notably great gerbils and marmots)

and subsequently "explode" into the human population as the "maintenance population" of rodents dies off.[14] But for ordinary people confronted with the spectacle of mass death, the obvious explanation lay in God's displeasure with human sinfulness; and for many—although not all—physicians, the best explanatory resource lay in the baleful conjunction of evil planetary influences.

Yet the Black Death was not the only pandemic to invade Europe. In 1494, two years before Copernicus arrived in Bologna to continue his studies, the French King Charles VIII led a massive army of thirty thousand soldiers into Italy. In September 1494, the French reached Florence and drove out the ruling Medici family; by January 1495, they had reached Rome, and a month later, the Kingdom of Naples. Charles not only upset the balance of power in the delicate alliances that constituted the Italian state-system but his troops encountered (and contributed to) a new epidemic. In the invaded regions it was often known as the "French Disease," and was so called at least as early as 1498 by a Neapolitan astrologer-physician (about whom, more later).[15] In 1530, the Veronese physician Girolamo Fracastoro (ca. 1478-1553) named the disease "syphilis."[16] A broadside publicizing the epidemic (a so-called *Pestblatt*), made at Nuremberg and now attributed to the painter Albrecht Dürer, displays an infected soldier (fig. 1). One notices above the figure a celestial sphere prominently showing the zodiac, divided into twelve signs, and below the sign of Scorpio, which governs the genitals, we find the date 1484. In that year, there was an astrologically significant conjunction of Jupiter and Saturn in Scorpio whose evil effects, so it was believed, were still being felt in 1496—something like earthquake aftershocks. The artist was greatly preoccupied by the scourge and may have contracted it himself.[17]

It is no accident, then, that physicians of the late fifteenth century and beyond who consulted the planets to foresee the course of their patients' illnesses were greatly preoccupied with war and disease. More generally, astrological prognosticators (many of whom had medical training) were concerned with predicting the political fate

Figure 1. Albrecht Dürer, image of a syphilitic man, thought to be a soldier

of both individual rulers and social groups living in a particular city or region. They used what they knew from astronomy about the planets' revolutions around the Earth and their mutual alignments, such as conjunctions of Saturn and Jupiter or eclipses of the sun and moon. And from around the 1470s, astral prognosticators began to use the new medium of print to publicize their forecasts. Astronomy predicted planetary positions in the belt of the zodiac, a zone defined as 8 degrees north and 8 degrees south of the ecliptic plane in which the sun traces its annual motion. The zodiac circle is essentially a celestial coordinate system divided into twelve 30-degree signs or segments, each sign named after an animal (e.g. ram, bull, fish) or a human figure (e.g. water-bearer). Astrology described the meanings associated with the planets' changing zodiacal configurations and the physical effects with which they were allied. The foundational texts that provided the principles for these interrelated subjects, the *Almagest* and the *Tetrabiblos*, were both composed in ancient Alexandria by Claudius Ptolemy (ca. 90-ca. 168).

In the fifteenth and sixteenth centuries practitioners typically called these two disciplines "the science of the stars."[18] Of course, this combination of disciplines and applications is a far cry from the modern tendency to associate astrology with newspaper or internet horoscopes, or with the former First Lady, Nancy Reagan, who regularly consulted an astrologer,[19] or with the quip of the famous economist John Kenneth Galbraith: "The only function of economic forecasting is to make astrology look respectable." But these anecdotes about astrology's reputation in contemporary popular culture merely call attention to the fact that the subject long ago lost the pervasive political value and social prestige it once enjoyed among European elites in the fifteenth and sixteenth centuries.

Print Culture and the Literature of the Heavens

In the century beginning roughly in the 1450s with the introduction of movable-type printing and including among major events the fall of Constantinople to the Ottomans (1453), Columbus's voyages of the 1490s and the Italian Wars (1494-98), print technology made possible an expanded literature of the heavens. It included a new genre—annual astrological prognostications for entire cities and political domains—relatively easy to understand, short and cheap to produce. Such forecasts concerned the coming year and were typically subdivided into sections devoted to social groups, such as merchants and students, individual rulers (the pope, the emperor and local princes), weather and disease. The expanding literature also included works of ancient Greek, Roman, and medieval Arabic astronomy and astrology as well as new textbooks of astronomy.

The earliest and most influential of the astronomical texts put into print was the *New Theorics of the Planets* (ca. 1472) of Georg Peurbach (1423-1461). Copernicus was one of the early beneficiaries of this burgeoning literature of the heavens, and it is generally agreed that sometime between 1491 and 1495 he was introduced to the principles of astronomy at the University of Krakow through Albert of Brudzewo's *Little Commentary on Georg Peurbach's New Theorics of the Planets*.[20] In passing, Brudzewo's work called attention to a phenomenon already recognized by Ptolemy: each planet's circuit around the stationary Earth includes an additional component of its total motion equal to the sun's mean annual revolution.[21] (Copernicus later explained this additional motion as an optical effect, a consequence of observing the planets from a moving Earth). But Brudzewo went beyond Peurbach, connecting the sun's apparent presence in the motions of each planet with its

astrological capacity to produce effects through its power to heat and illuminate.[22]

If there was a growing market for pedagogical texts of astronomy and annual prognostications, there is also a related question: Who was promoting the publication of tables of planetary positions—the data that astrologers relied on to construct their forecasts? And who sponsored the publication of the long, difficult, technical works of theoretical astronomy—exemplified by Copernicus's *On the Revolutions* and its esteemed predecessor, Johannes Regiomontanus's *Epitome of Ptolemy's Almagest*—devoted to the planetary models themselves?

In what follows, I shall focus on the social relationships and motivations that supported the practices that connected astronomy and astrology, the two main divisions of the science of the stars. The first consisted of the calculatory models and tables of numbers necessary for prognosticating planetary positions, the second with the interpretation of the forecasts' meanings and physical effects.

I begin with the widely used planetary tables of Giovanni Bianchini (d. ca. 1469). Based on tables produced in the thirteenth century under the sponsorship of the Spanish King Alfonso X (1221-1284), the historians José Chabás and Bernard Goldstein judge Bianchini's to be "the largest set of astronomical tables produced in the West before modern times."[23] Although circulated in manuscript for several decades, they were published three times between 1495 and 1553. At the court of the ruling Este family in Ferrara, Bianchini identified himself as the administrator of finances (*factor generalis*, or "general factor"). He also lectured at the university, which sustained a flourishing tradition of astrological prognostication, and where, a half-century later, Copernicus would obtain a degree in canon law.[24] Although Bianchini had earlier completed and dedicated his tables to Leonello d'Este (1407-50), in 1452 he re-presented a copy of his tables for a special occasion: the formal confirmation of the

feudal relationship between the Holy Roman Emperor Frederick III (1415-93) and Borso d'Este (1413-71) as duke of the imperial fiefs of Modena and Reggio Emilio. On the occasion, Bianchini himself was also granted a title of nobility.[25] In March 1452, Pope Nicholas V had crowned Frederick emperor, the first member of the Habsburg family to hold that position. Frederick's first step in this position was to confirm the allegiance of his vassals, rulers of lands granted them by the emperor in return for which they owed him fealty in the form of military and other kinds of obligations. To mark the investiture, an overlord might also bestow titles of nobility, as indeed he did to the duke and his astrologer.

A striking presentation scene heads up a manuscript of Bianchini's *Tables* (figs. 2,3). Composed by a court artist of the circle of Giorgio d'Alemagna (Johannes Alemanus), the latter known for his great skill as a miniaturist, it commemorates both the emperor (left) and the new ruler of Ferrara, Borso d'Este (right), succeeding his recently deceased brother Leonello. The artist portrays Bianchini kneeling and presenting his tables to the emperor, but at the same time, Duke Borso embraces the table-maker with his hands, presenting himself together with Bianchini and his book. The colors of the garments may even possess astral significance, as there is contemporary evidence that the duke chose his hues "according to the day of the month and the positions of the stars and planets."[26] One also notices that the artist represents the relationship among the emperor, the duke, and the table-maker as if contained within a circle. He has visualized the ceremony aesthetically and politically, weaving together the hierarchical social relationships so that the legs of the main figures and the arms of the courtiers overlap one another, not unlike Botticelli's famous "Three Graces."[27] The braided garland adorning the emperor's head seems to mirror these relationships. It is a scene of political order, of hierarchical authority, and also of reciprocity: at the center of the ceremony is the exchange of gifts. Bianchini's gift is a book of practical astronomy, containing numbers representing

Figure 2. Giovanni Bianchini's planetary tables

Figure 3. Bianchini presenting his planetary tables to the Emperor Frederick III

predicted times and positions to be used both by the emperor's and the duke's astrologers in managing the future. In exchange, the emperor presents the duke's vassal, Bianchini, with his herald.[28]

The tables were not published until 1495 and then again in 1526 and 1553 (although without the illustration). The first two editions are preceded by a dedication from the Krakow-educated Augustinus Moravus of Olomouč (1467-1513), the otherwise little-known promoter of the first published edition and also of the 1492 edition of the *Alfonsine Tables*.[29] Moravus is then followed by Bianchini's own earlier dedications to the emperor and to Leonello d'Este. Two exemplary passages from Bianchini's dual dedications make explicit the clear astrological purpose of the tables. The first is addressed to the emperor:

> Wisest prince, you are not unfamiliar with how profitable astrology is to men. For whereas Omnipotent God has created everything for human use, who does not know that he [has created] the motions of the stars and the times, revolutions,

> natures and properties of the heavenly [bodies] to be useful to our affairs, lest we might think and do something improvident[?] Therefore, knowledge of higher things is shown to us so that, having disclosed paths and methods of deliberation, it may reveal [i.e. forecast] winds, rains, abundance, scarcity, diseases, health, war and peace. This [knowledge of higher things] enables you to foresee the business of the kingdom, the actions of the people and the benefits of subordinates. Therefore, by the prior command and exhortation of my most illustrious prince and lord, my lord duke and marquis, I have dedicated this little work, begun many years ago, to your majesty [i.e. the emperor]. In it are contained tables of the planets and other additions which I have provided recently because of Your Serenity's departure for Rome. In the same work, you will easily understand the motions of the planets and all those [celestial] events necessary for making [astrological] judgments. You will also grasp firmly the times of those matters that pertain to deliberations of war and peace.[30]

Bianchini then opens his dedication to Leonello d'Este with an extended trope, comparing him and his rule to the sun:

> For the sun is like the leader and prince of all things and (as the natural philosophers say), the intellect of the world [*mens mundi*]; and it occupies a place in the middle of the heavens, [with] the power to procreate everything; and by the guidance of its light it renders eternal the fires of the planets and the other stars, distributing various forces among the elements; [and] it accomplishes the generation and corruption of all living beings and causes the same through the aspects—now strong (increasing the forces of these things), now feeble, weakening [the forces]. The causes [of generation and corruption]—sometimes of heat, at other times of dryness and, contrariwise, sometimes of cold, sometimes of humidity—lie open broadly for consideration in the workings of the stars. [But] the sun, I say, is most certainly the originator of all good and bad things,

> of peace and war. Because it pleases the sun that the stars which run around it rapidly, as if fleeing, surpass it with marvelous speed, when these same [stars] have passed by, their revolution slowing down and, in a certain sense, their empire declining, either they are dragged [along] by their strength and power or (if it may be strongly preferred), long after having taken their pledge [to continue], they may indeed fall into reverse.[31]

In this ornate passage, characteristic of the rhetoric of courtly dedications, Bianchini appeals to the sun, like the prince, as the central power in its domain, the heavens. The sun produces effects through the mediation of the other planets, that is, by means of the four sensory qualities it activates or bestows on them and which they, in turn, distribute to the elements and, thence, to all living beings. The planets not only receive and transmit the sun's force, but they also move variably with respect to it. Bianchini thus appropriated the solar image, paying homage, at once, to two powerful rulers while providing them with practical columns of numbers that usefully represented the planets' changing positions, the logically necessary precondition for determining their effects.

Bianchini made his tables sufficiently attractive to celestial practitioners that the tables were copied in whole or in part by the most prominent celestial practitioners of the fifteenth century prior to their first publication in 1495. Among those who copied all or parts of the tables were the court astrologer to the Emperor Frederick III, Georg Peurbach and his pupil Johannes Regiomontanus (1436-1476), as well as the young Nicolaus Copernicus, who transcribed only the tables of latitudes for the three superior planets, probably between 1493 and 1495.[32] Copernicus is known to have possessed the 1492 edition of the *Alfonsine Tables* and he would have had good reason to consult the first published edition of Bianchini or the later 1526 version, produced by the astrologer Luca Gaurico, although no such direct evidence survives. But here it will suffice to establish that Bianchini himself presented the tables explicitly as a resource of court astrology and, decades later, his publishers saw no reason to exclude the astrologically motivated dedicatory apparatus.

Figure 4. Regiomontanus, *Epitome of the Almagest* (*Epytoma in almagestum*), frontispiece illustration and motto: *Altior incubuit animus sub imagine mundi* ("The higher soul incubated under the image of the world")

The Astrological Presentation of Regiomontanus's *Epitome*

In 1496, the year after Bianchini's tables were published for the first time, a German printer in Venice (Johannes Hamman of Landau) issued what historians generally regard as the most important work of theoretical astronomy of the fifteenth century, Regiomontanus's *Epitome of Ptolemy's Almagest* (fig. 4).[33] This work provided an improved summary of Ptolemy's *Almagest*, designed to make Ptolemy's work more usable, sometimes by developing implications of Ptolemy's planetary models that were only implicit, sometimes by introducing original innovations. It was the product of a famous authorial collaboration, begun in Vienna by the aforementioned Peurbach and completed after his death by his student Regiomontanus. But, Regiomontanus died before being able to publish the *Epitome*, and the project did not reach print until more than twenty years later—its production effectively representing another step in a string of collaborations. When the book finally appeared, above the printer's emblem, the colophon bore the date August 31, 1496.

But there is a surprising feature of this book that has a bearing on our central theme and which, until now, has attracted little scholarly analysis. To date, I have identified six copies that contain a letter, unpaginated but clearly meant to be published at the beginning of the main text.[34] This letter is separately dated August 15, also at Venice—two weeks before the main text appeared in print. The Dibner Library owns the book but, like the copies found in most libraries, the letter is absent.[35] The whereabouts of the copy Copernicus used is also unknown.[36]

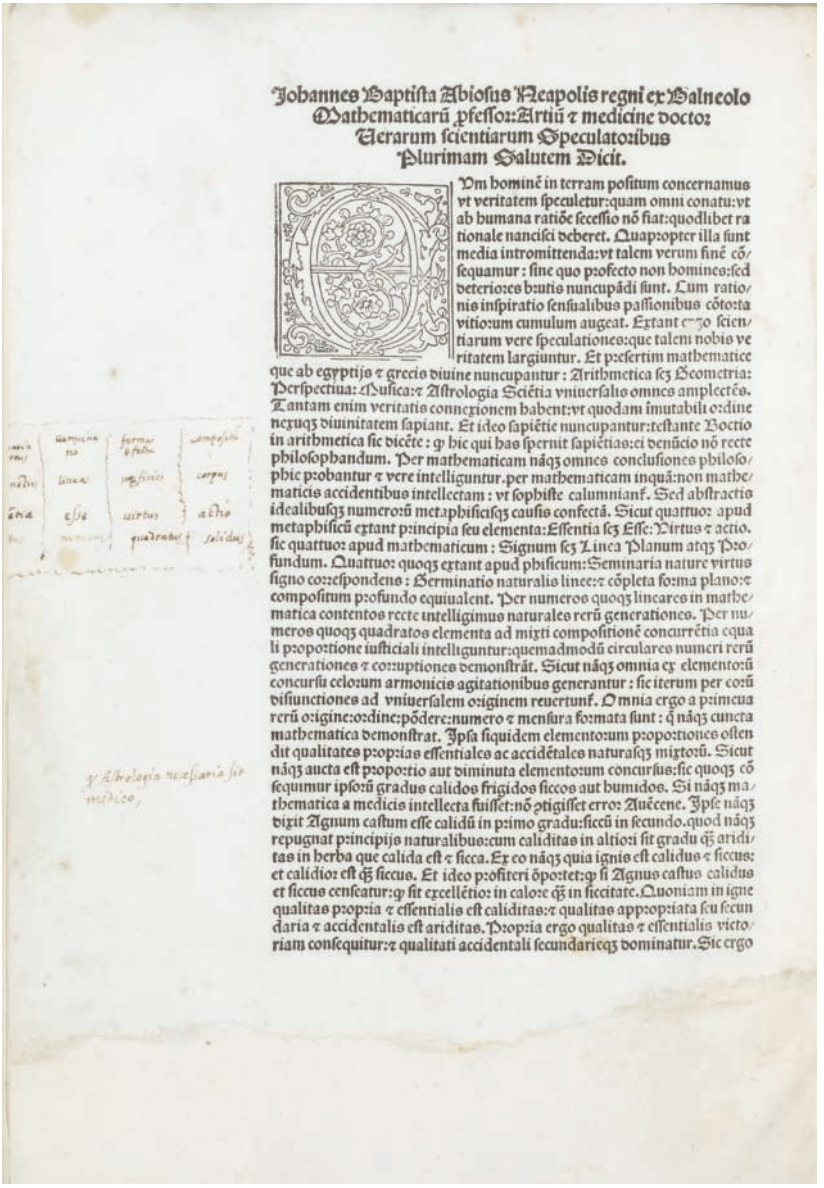
The letter is of considerable importance for two reasons: First, it sheds new light on the motives and circumstances for the publication of the *Epitome of the Almagest*, some twenty years after Regiomontanus's death; and, secondly, because we know for certain

that Copernicus used Regiomontanus's work extensively, and it was significant in establishing his own early understanding of Ptolemy's theories. In fact, some historians believe that Regiomontanus's *Epitome* provided the crucial insight that opened the way for Copernicus to relocate the sun at the center of the universe.[37]

The letter's author was the little-recognized Johannes Baptista Abiosus (Ital., Giovan Battista Abiosi; also Abioso).[38] The heading describes him with the title, "Professor of the Mathematical Arts and Doctor of Medicine, from Bagnoli in the Kingdom of Naples."[39] His birth and death dates are unknown but his publications show that he was active between the late 1480s and the 1520s.

The letter itself is an encomium to astrology, a subject Abiosus grandly characterized as the "queen of the liberal arts" (*inter scientias liberales regina nuncupabitur*) and a discipline that ought to be called "natural theology" (*Sic ergo Astrologia Naturalis theologia appellanda est*), indeed a branch of mathematics that embraces all others—arithmetic, geometry, optics, music, astronomy, medicine and natural philosophy. Going further still, he claims that "all philosophical conclusions are proved by mathematics; indeed, [they are] truly understood by mathematics, I say, not by mathematical accidents, as the Sophists falsely charge, but understood as the abstract ideas of numbers brought about by metaphysical causes."[40]

Abiosus's justification—curious-sounding to modern ears—appealed to a kind of number symbolism common among Renaissance followers of Plato and the Pythagoreans. Numbers, in this view, do not predicate objects; they have an independent existence—four*ness* rather than, say, four shoes. Thus, Abiosus's claim that astrology and all the disciplines beholden to it share four foundational principles would be to say that fourness is not a chance property of this or that collection of objects, but rather refers to their underlying unity, and even more so, their fundamental



Johannes Baptista Abiosus Neapolis regni ex Balneolo Mathematicarū pfessor: Artiū ⁊ medicine docto: Cerarum scientiarum Speculatoribus Plurimam Salutem Dicit.

Vm hominē in terram positum concernamus vt veritatem speculetur: quam omni conatu: vt ab humana ratiōe secessio nō fiat: quodlibet rationale nancisci deberet. Quapropter illa sunt media intromittenda: vt talem verum finē cōsequamur: sine quo profecto non homines: sed deteriores bruris nuncupādi sunt. Cum rationis inspiratio sensualibus passionibus cōtorta vitiorum cumulum augeat. Extant ergo scientiarum vere speculationes: que talem nobis veritatem largiuntur. Et pfertim mathematice que ab egyptijs ⁊ grecis diuine nuncupantur: Arithmetica scz Geometria: Perspectiua: Musica: ⁊ Astrologia Sciētia vniversalis omnes amplectēs. Tantam enim veritatis connexionem habent: vt quodam imutabili ordine nexuqz diuinitatem sapiant. Et ideo sapiētie nuncupantur: testante Boctio in arithmetica sic dicēte: q hic qui has spernit sapiētias: ei denūcio nō recte philosophandum. Per mathematicam nāqz omnes conclusiones philosophic probantur ⁊ vere intelliguntur. per mathematicam inquā: non mathematicis accidentibus intellectam: vt sophiste calumniant. Sed abstractis idealibusqz numeris: ū metaphisicisqz causis confectā. Sicut quattuor apud metaphisicū extant principia seu elementa: Essentia scz Esse: Virtus ⁊ actio. sic quattuor apud mathematicum: Signum scz Linea Planum atqz Profundum. Quattuor quoqz extant apud phisicum: Seminaria nature virtus signo correspondens: Germinatio naturalis linee: ⁊ cōpleta forma plano: ⁊ compositum profundo equiualent. Per numeros quoqz lineares in mathematica contentos recte intelligimus naturales rerū generationes. Per numeros quoqz quadratos elementa ad mixti compositionē concurrētia equali proportione iusticiali intelliguntur: quemadmodū circulares numeri rerū generationes ⁊ corruptiones demonstrāt. Sicut nāqz omnia ex elementorū concursu celorum armonicis agitationibus generantur: sic iterum per corū divisiunctiones ad vniversalem originem reuertunt. Omnia ergo a primeua rerū origine: ordine: pōdere: numero ⁊ mensura formata sunt: q nāqz cuncta mathematica demonstrat. Ipsa siquidem elementorum proportiones ostendit qualitates proprias essentiales ac accidētales naturasqz mixtorū. Sicut nāqz aucta est proportio aut diminuta elementorum concursus: sic quoqz cō sequmur ipsorū gradus calidos frigidos siccos aut humidos. Si nāqz mathematica a medicis intellecta fuisset: nō ptigisset error: Auēcene. Ipse nāqz dixit Agnum castum esse calidū in primo gradu: siccū in secundo. quod nāqz repugnat principijs naturalibus: cum caliditas in altiori sit gradu qz ariditas in herba que calida est ⁊ sicca. Ex eo nāqz quia ignis est calidus ⁊ siccus: et calidior est qz siccus. Et ideo proferi oportet: q si Agnus castus calidus et siccus censeatur: q sit excellētio in calore qz in siccitate. Quoniam in igne qualitas propria ⁊ essentialis est caliditas: ⁊ qualitas appropriata seu secundaria ⁊ accidentalis est ariditas. Propria ergo qualitas ⁊ essentialis victoriam consequitur: ⁊ qualitati accidentali secundarieqz dominatur. Sic ergo

Figure 5. Johannes Baptista Abiosus, letter with marginalia

reality. Put another way, to "share" a common number "proved" that the entities were derived from a common reality.[41] Thus, for Abiosus, geometry was founded on four definitions (point, line, plane, and depth); physics constructed from four elements (earth, air, water, fire); and the degrees or intensities of each element were characterized by four sensory qualities (heat, cold, humidity, dryness). And so forth. A rare, early annotator of Abiosus's letter studied and approvingly diagrammed this passage in the margin of his copy, with the conclusion: "That astrology is necessary for the physician" (fig. 5).

Abiosus also regarded astrology as foundational in another sense: It differs from all other sciences because from a chain of (allegedly) true precepts and natural causes it deduces the existence of God, the first mover.[42] Unlike all other sciences, divided by the uncertainty of many opinions, only celestial wisdom can be known with certainty.[43] For reasons to be discussed shortly, Abiosus addressed his letter to "investigators [*speculatores*] of the true sciences." The curious word "speculator" connotes someone who investigates or explores, in this case perhaps suggesting the idea of making visible hidden meanings among the planets' influences.[44]

Although Abiosus's panegyric is filled with praise for astrology's status as the ruler of the sciences, it has relatively little to say about its specific elements and certainly none of the detail and rigor to be found in Ptolemy's foundational work on the subject, the *Tetrabiblos*. But, when the letter refers readers to an earlier work by Abiosus—"our dialogue in defense [of astrology]"—it alludes not to a general work of Neopythagorean philosophy but to an extensive astrological prognostication wherein Abiosus predicts calamitous events for the years 1503, 1524, and 1702.[45]

Another clue to Abiosus's vision of the relationship between astronomy and astrology can be found in his artwork. The title page of Abiosus's 1494 *Dialogus* allegorizes "Astrologia" seated on her throne beneath the two luminaries (the sun and the moon) and the other heavenly bodies (fig. 6). The figure holds the two principal

Figure 6. *Astrologia* on her throne, flanked by unidentified figures, 1494

Figure 7. *Astronomia* on her throne, flanked by "Ptolemy, prince of astronomers" (right), and "Urania, the heavenly Muse" (left)

instruments of celestial representation and measurement—in one hand, an armillary sphere showing the heavens' fundamental coordinates, and in the other, an astrolabe for observing and measuring. The figures on either side of the throne are not identified in the banners. This incomplete state of the design might be explained by the fact that the image was borrowed—or perhaps pirated—from a slightly earlier Venetian publication in which the figure on the throne is now labeled "Astronomia," but balanced on either side by figures labeled "Ptolemy, Prince of Astronomers" and "Urania, Muse of Astronomy," the daughter of Zeus in Greek mythology (fig. 7).

The printer and engraver of Regiomontanus's *Epitome*, with whom Abiosus worked, seems to have adapted this arrangement to the frontispiece in several interesting ways. The scene is still allegorical—in this case, an imaginary encounter between ancient and modern authorities—but now, both figures have more human features. Indeed, one of them is specifically identified as the author, Johannes Regiomontanus; the other, as Ptolemy, who retains his crown but now peers down at an empty page rather than displaying the page of diagrams shown on the title page of Abiosus's astrological prognostication (fig. 6). Meanwhile, Regiomontanus is depicted in an active, explicitly didactic pose, his own book closed and appearing to instruct the ancient authority as Ptolemy peers down at what is evidently his own book. The two figures are also placed in a more natural setting with buildings and hills in the background, perhaps suggesting a contrast between the present and the past. An outsize armillary sphere replaces the throne of the earlier works, showing the zodiac belt, the zone in which the planets move and which is the main subject of the book.

An enigmatic motto frames the illustration: "The higher soul incubated under the image of the world" (*Altior incubuit animus sub imagine mundi*). Two interpretations of its meaning might be suggested—one contemplative, the other active. The first is that the intellect, that part of the soul highest and closest to the Divine, conceives its noblest thoughts while meditating on an image of the celestial world. The second is that the representation itself has the

Figure 8. Bernat de Granollachs, *Lunarium*, 1513, title page motto: *Altior incubuit animus sub imagine mundi* ("The higher soul incubated under the image of the world").

power to exert specific effects on the higher soul, a reading closer to the views expressed by the influential Neoplatonic philosopher, priest and physician, Marsilio Ficino (1433-1499).[46] Isabelle Pantin has deftly traced the genealogy of this epigraph in the illustrations accompanying works about the heavens published between 1485 and 1527 (fig. 8).[47] She leans toward the contemplative reading, suggesting an allusion to the soul's intellectual and spiritual inspiration from the heavenly spheres. But she also points to an alternative: "One wonders if it is necessary to go so far as to give to the *imago mundi* the sense of an astrological or magical image."[48] Abiosus's letter and his central involvement in the printing of Regiomontanus's text recommends an answer: that the device was meant specifically to link Regiomontanus's version of the *Almagest* to astrology, the "queen of the liberal arts."

Another question about the letter's motivation concerns its patronal context. Unlike Bianchini's *Tables*, Abiosus's 1494 prognostication and, indeed, Copernicus's *De revolutionibus*, Abiosus's letter to the *Epitome* departs from the common practice of dedicating a work to a specific patron such as we have seen with Bianchini's *Tables*. At least two possible explanations may be advanced for this absence. First, Regiomontanus himself had already included a preface to his work in praise of his patron, Cardinal Johannes Bessarion (1402-1472), the Greek expatriate who brought numerous Greek mathematical manuscripts to Europe and encouraged their translation into Latin.[49] Secondly, the political upheavals that befell the Kingdom of Naples between 1494 and 1500 posed a difficult challenge for prognosticators. Abiosus dedicated his prognostication of 1494 to King Alfonso II of Aragon, short-lived as the King of Naples (1448-1495; r. 1494-1495).[50] However, as Charles VIII's powerful armies approached Naples, Alfonso abdicated in January 1495 after just over one year on the throne. When Charles's troops entered Naples, they found a court with magnificent Moorish gardens, baths and special hydraulic waterworks that powered surprise jets of water.[51]

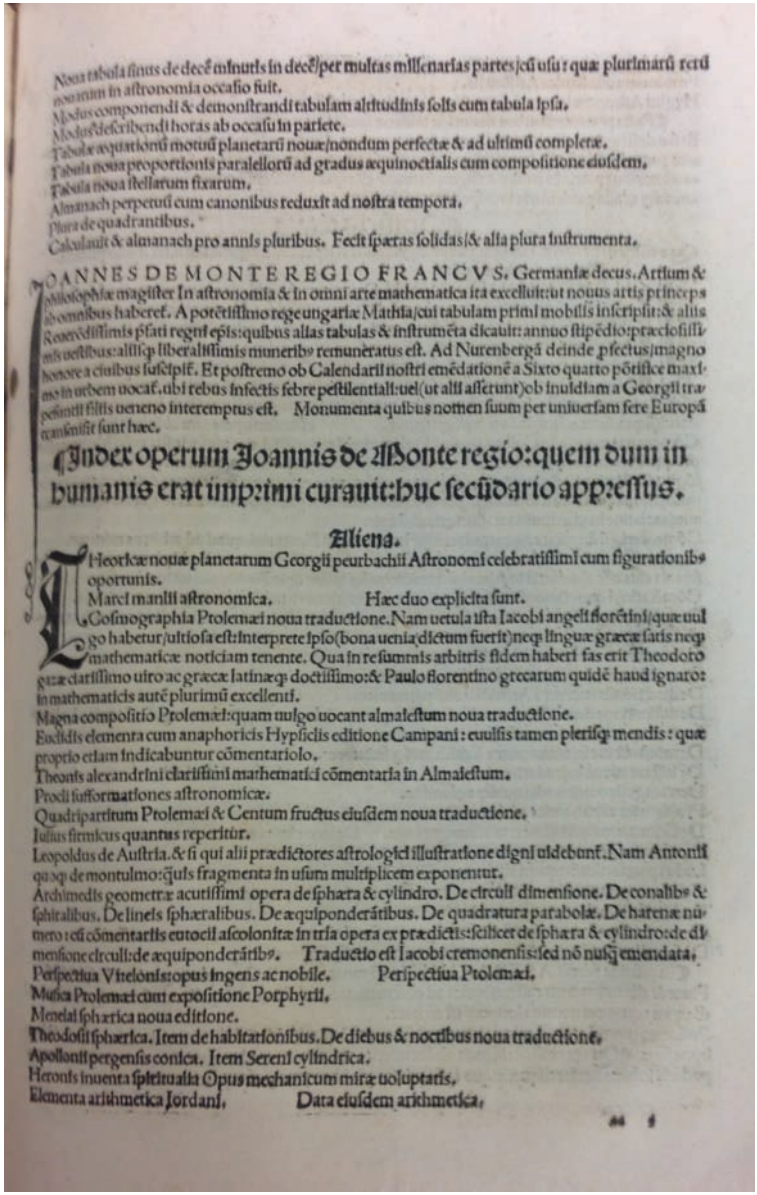
However, although Abiosus mentions to readers that he had sent an advance copy of his 1494 forecast to Alfonso (on June 4), it had failed to predict the king's misfortunes at the hands of the French invaders.[52] Moreover, by the time Abiosus composed his letter to Regiomontanus's *Epitome*, Alfonso had abdicated in favor of his son, Ferdinand II (1469-1496), who, like his father, remained on the throne for little more than one year (r. Jan. 1495-Sept. 7, 1496), that is, just three weeks after Abiosus's letter was printed (August 15).

With Alfonso's abdication and the insecure status of his successor, Abiosus's patronage relationship to the Aragonese-Neapolitan crown continued to be quite uncertain in the months both preceding and following the appearance of the *Epitome*. Another sign of this uncertainty is that Abiosus's next prognostication, published in 1498, contains no formal, patronal dedication, although it includes within the body of the work a forecast for the third (and last) Aragonese ruler of Naples, Frederick IV (1496-1501).[53] All these upheavals could reasonably explain why Abiosus carefully dedicated his letter to generic *speculatores,* thereby avoiding a risky forecast for an ephemeral monarch.

If, unlike Bianchini's tables, securing Neapolitan patronage does not explain the letter's proximate motivation, why then did Abiosus seek to include his epistle with the *Epitome*? The letter shows clearly that he believed the publication of Regiomontanus's work would enhance the *epistemic* reputation of astrology and its practitioners—improving astronomy's theoretical foundations would strengthen astrology's predictions. In this regard, he echoed the central theme of Regiomontanus's *Oration on the Dignity and Utility of the Mathematical Sciences* delivered at the University of Padua in 1464.[54] Presented before an academic audience, Regiomontanus extolled the certitude of mathematics and of the subjects built upon it in contrast to the many uncertainties of those disciplines that are not so grounded. Of these subjects, Regiomontanus singled out especially the two

parts of what he called "astronomy": "a common word that philosophers are accustomed to applying as much to the study of [celestial] motions as to the foreknowledge of [terrestrial] effects."[55] Regiomontanus then praised the latter part, which he called "divine astrology."[56] Abiosus also linked astrology to divinity as when he dubbed it "Natural Theology" and claimed that if theology works by supernatural causes, astrology works by natural ones, and that such natural causes are manifest in the orderly motions of the heavens.

Abiosus ended his letter by explaining that astrology is of such importance that he had undertaken to acquire and publish the books of those who best understand the heavens. Like Regiomontanus, who had famously established his own printing press in Nuremberg, announcing an ambitious list of works he intended to publish, Abiosus's lesser project was to put into print those of Regiomontanus's manuscripts on which he had somehow laid his hands. He explained that he had copied the *Epitome* himself, corrected the errors of the scribes, fixed the positions of misplaced diagrams and, working directly with the printers and proofreaders, he had thereby restored the text.[57] Now the full, corrected text, with its geometrical demonstrations, was available in clear Latin and, in Abiosus's opinion, it even "surpasses" Ptolemy's original.[58] After Ptolemy, Regiomontanus should be regarded as "the king of mathematics."[59] So, he effused, "let us render thanks to these remarkable Germans who have advanced or lifted up astrology in our times."[60] Finally, he also named several other manuscripts of Regiomontanus, somehow in his possession, that he intended to publish—on triangles, instruments and exercises in solving mathematical problems necessary for astronomy[61]—which he, the printer Hamman and his collaborators (Caspar Grossch and Stefan Roemer) should hasten to do so that they would not be lost in the corrupt condition of the world, especially the degradation of the sciences that Abiosus foresaw occurring in the years 1503 and 1524.[62]



Noua tabula finus de decē minutis in decē/per multas millenarias partes/ceu usu: quæ plurimarū rerū
nouarum in astronomia occasio fuit.
Modus componendi & demonstrandi tabulam altitudinis solis cum tabula ipsa.
Modus describendi horas ab occasu in pariete.
Tabulæ æquationū motuū planetarū nouæ/nondum perfectæ & ad ultimū completæ.
Tabula nouæ proportionis parallelorū ad gradus æquinoctialis cum compositione eiusdem.
Tabula nouæ stellarum fixarum.
Almanach perpetuū cum canonibus reduxit ad nostra tempora.
Plura de quadrantibus.
Calculauit & almanach pro annis pluribus. Fecit sphæras solidas/& alia plura instrumenta.

IOANNES DE MONTE REGIO FRANCVS. Germaniæ decus. Artium &
Philosophiæ magister In astronomia & in omni arte mathematica ita excelluit: ut nouus artis princeps
omnibus haberet. A potentissimo rege ungariæ Mathia/cui tabulam primi mobilis inscripsit: & aliis
reuerentissimis pfati regni epis: quibus alias tabulas & instrumēta dicauit: annuo stipēdio: præclarissi-
mis uestibus: aliisq liberalissimis muneribꝰ remuneratus est. Ad Nurenbergā deinde pfectus/magno
honore a ciuibus susceptus. Et postremo ob Calendarii nostri emēdationē a Sixto quarto pontifice maxi-
mo in urbem uocat. ubi rebus infectis febre pestilentiali: uel (ut alii asserunt) ob inuidiam a Georgii tra-
pezuntii filiis ueneno interemptus est. Monumenta quibus nomen suum per uniuersam fere Europā
transmisit sunt hæc.

Index operum Ioannis de Monte regio: quem dum in humanis erat imprimi curauit: huc secūdario appressus.

Aliena.

Theoricæ nouæ planetarum Georgii peurbachii Astronomi celebratissimi cum figurationibꝰ
oportunis.
Marci manlii astronomica. Hæc duo explicita sunt.
Cosmographia Ptolemæi noua traductione. Nam uetula ista Iacobi angeli florentini/quæ uul
go habetur/ultiosa est: interprete ipso (bona uenia dictum fuerit) neq linguæ græcæ satis neq
mathematicæ noticiam tenente. Qua in re summis arbitris fidem haberi fas erit Theodoro
gazæ clarissimo uiro ac græcæ latinæq doctissimo: & Paulo florentino grecarum quidē haud ignaro:
in mathematicis autē plurimū excellenti.
Magna compositio Ptolemæi: quam uulgo uocant almalestum noua traductione.
Euclidis elementa cum anaphoricis Hypsiclis editione Campani: euulsis tamen plerisq mendis: quæ
propriis etiam indicabuntur cōmentariolo.
Theonis alexandrini clarissimi mathematici cōmentaria in Almalestum.
Prodi suffossationes astronomicæ.
Quadripartitum Ptolemæi & Centum fructus eiusdem noua traductione.
Iulius firmicus quantus reperitur.
Leopoldus de Austria. & si qui alii prædictores astrologici illustratione digni uidebunt. Nam Antonii
quoq de montulmo: quis fragmenta in usum multiplicem exponentur.
Archimedis geometræ acutissimi opera de sphæra & cylindro. De circuli dimensione. De conalibꝰ &
sphiralibus. De lineis sphæralibus. De æquiponderātibus. De quadratura parabolæ. De harenæ nu-
mero: cui cōmentariis eutocii ascolonitæ in tria opera ex prædictis: scilicet de sphæra & cylindro: de di-
mensione circuli: de æquiponderātibꝰ. Traductio est Iacobi cremonensis: sed nō nusq emendata.
Perspectiua Vitelonis: opus ingens ac nobile. Perspectiua Ptolemæi.
Musica Ptolemæi cum expositione Porphyrii.
Menelai sphærica noua editione.
Theodosii sphærica. Item de habitationibus. De diebus & noctibus noua traductione.
Apollonii pergensis conica. Item Serenī cylindrica.
Heronis inuenta spiritualia. Opus mechanicum miræ uoluptatis.
Elementa arithmetica Iordani. Data eiusdem arithmetica.

Figure 9. Regiomontanus's tradelist of works he intended to publish, edited by the Viennese astronomer-astrologer, Georg Tannstetter, and included in the introduction to Georg Peurbach's eclipse tables, 1514. This page lists Ptolemy's *Quadripartitum* (*Tetrabiblos*) as the eighth work. The early owner of the Dibner copy has bound this work with the 1493 edition of Ptolemy's *Libri quadripartiti*.

In representing astrology as the motivating discipline for publishing the *Epitome*, Abiosus's goals resembled those expressed by Regiomontanus in his Padua *Oration*. However, by contrast with the latter, Regiomontanus's *Epitome* exactly emulates the format of Ptolemy's *Almagest* and mentions nothing about astrology either in its own preface to the *Epitome* or in the body of the work itself. For modern readers, this absence may create the misleading impression that Regiomontanus was solely concerned with planetary models and motions apart from astrological influences. But, contemporary readers whose copies contained the Abiosus letter would have formed a different impression—not identical to, but certainly not out of line with Regiomontanus's own intentions. Besides the clear centrality of astrology in his Padua *Oration*, those goals were also apparent in the tradelist of titles Regiomontanus had announced for publication at his press in Nuremberg, a list that prominently included the major astrological treatise of antiquity, Ptolemy's *Tetrabiblos* (Lat. *Quadripartitum*) (fig. 9).[63]

Copernicus and the Piconian Controversy

One of the earliest editions of the *Tetrabiblos* was published in Venice in 1493. The volume included a little library of thirteen other astrological works—an omnibus edition. Among the earliest owners of this comprehensive volume was an immediate contemporary of Abiosus at the University of Bologna, Domenico Maria Novara (1454-1504). The book's editor Girolamo Salio titled his laudatory dedication "Concerning the Nobility of Astrology" and explicitly directed his praise to Novara, "Doctor of Arts and Medicine and most excellent astrologer."[64] Salio's volume not only exalted Novara, but also clearly served him well in fulfilling the university's requirement to publish annual astrological prognostications for the city and

its rulers. Novara issued such forecasts annually between 1484 and 1504, of which thirteen are known to survive. They were published mostly in Bologna, others in Rome and Venice.[65] When the young Nicolaus Copernicus arrived in Bologna in the fall of 1496 to begin his legal studies, he took up lodging with Novara—a common sort of arrangement for impoverished students and impecunious faculty. We know exactly where the house stood. We also know from Rheticus's later report that Copernicus helped Novara in some way with his observations.[66] And, undoubtedly, he would have had access to Novara's library—including Salio's prodigious compendium of works of astrological interpretation.

Copernicus arrived about one month after the appearance of Regiomontanus's book and two months or so after a Bolognese publisher issued a massive attack on the entire foundations of astrology by the Florentine prodigy, Giovanni Pico della Mirandola (1463-1494). There can be no doubt that the astrologers were well aware of Pico's assault on their subject; but Novara, in particular, would have been especially well informed as Pico's publisher, Benedictus Hectoris (Benedetto Ettore Faelli), later issued several of Novara's own prognostications. Living close to the Venetian book market, it is also quite likely that Novara possessed Regiomontanus's *Epitome*, although at present there is no way of knowing whether or not it contained Abiosus's letter.[67]

Unlike Abiosus's generic defense of astrology in mid-August 1496, Pico's assault was detailed, harsh and unrelenting. He stressed not only the astrologers' inaccuracies but also their frequent disagreements and their unwarranted belief that the zodiac was real and capable of causing terrestrial effects. For Pico, it was merely a fiction, a construction of the human imagination. In addition, Pico attacked the Roman physician Galen's widely held theory of "critical days," according to which there is a causal connection between the occurrence of lunar phases and the crisis point of an illness.[68] And, as if that were not enough, Pico went beyond astrology to include its astronomical foundations. He

claimed that astrologers disagreed about the order of the planets and he also charged that the correspondences between the order of the planets and the four (Aristotelian) elements was arbitrary.[69] Until Pico's critique—and even after—it was standard practice for astronomer-astrologers like Abiosus and Novara to justify these and other associations simply by invoking Ptolemy's authority.

Although Ptolemy—and following him, Regiomontanus—explicitly acknowledged in the *Almagest* that the ancients disagreed about the order of Mercury and Venus, there was no such controversy mentioned in Ptolemy's *Tetrabiblos*. Setting up the foundations of astrology, Ptolemy adapted the sensory qualities associated with the elements (hot, cold, moist, dry) directly to the *order* of the planets.[70] This move is so crucial to the physical foundations of the entire conglomerate of planetary influences that it is surprising how little attention it has attracted among modern commentators. Once assigned, however, the Ptolemaic planets transport with them these qualities as they rise and set, move around the zodiac, and form different angular combinations (aspects) with one another and with different signs. One can see, easily enough, how these qualities associated with the elements—hot, cold, moist, dry—lent themselves to a language of the weather; but, an astrological physician, beholden to Galen's influential medical authority, could also use these categories to diagnose the state of the body—fevers, sweats, chills, and the critical days of crisis marking the course of a disease. The astral-elemental qualities also made possible a language of personal temperaments. Today, residues of this astral-elemental language persist in ordinary discourse: a sunny or drippy personality, a dry wit, a warm hello, a hot temper, a jovial or cold disposition, and so forth. Furthermore, all these physical qualities were capable of being made more or less intense as changes occurred in the planets' aspects or angular positions in the zodiac, moving closer or farther away, lining up in conjunctions or eclipses of the sun or moon. In Ptolemy's presentation, the association of the elemental qualities with planetary order clearly *precedes*

the planets' subsequent angular relationships and their use in practical astrology—calculating specific events at specific times. Effectively, the astronomical division of the science of the stars provided the computational models necessary for calculating the great number and variety of combinations and recombinations of angular planetary relationships. The various positions thereby produced specific effects as the preassigned physical qualities were intensified or relaxed.

In his *Disputations Against Divinatory Astrology*, Pico rejected these critical tenets on two grounds. First, he argued that all associations between planetary order and astral-elemental qualities were arbitrary and uncertain, thereby upsetting the foundational relationships established by Ptolemy in the *Tetrabiblos*. Pico might have left the matter there but characteristic of his relentless assault on the entire subject, he went on to argue that the order of the planets was also uncertain. Greek, Arabic and Jewish authorities disagreed about planetary order, he said—effectively pointing out an inconsistency between Ptolemy's handling of that topic in the *Almagest* and in the *Tetrabiblos*. In short, Ptolemy's two books failed to agree on a common principle according to which the planets were ordered.[71]

In his *Epitome of Ptolemy's Almagest*, Regiomontanus followed Ptolemy's *Almagest* in calling the ordering of Venus and Mercury with respect to the sun a "controversy" but, unlike Pico, he did not dispute Ptolemy's ordering of Mars, Jupiter and Saturn. And, as a judicious reader of Regiomontanus, that is exactly how Copernicus would have encountered the question, perhaps as early as 1497.[72] Moreover, although Copernicus does not mention Pico by name in his masterwork of 1543, we know for certain that he had read this chapter of Pico's book: in his own crucial chapter titled "On the order of the celestial orbs," Copernicus referred to evidence from Pico's work that could have come from no other place than the *Disputationes*.[73] And it was in response to Pico's severe criticism of the science of the stars, launched at just the moment that

Copernicus was entering the Bologna culture of prognostication, that he could have returned to an old theory that he and all other students would have learned at Krakow where Aristotle sets up his argument for the Earth's centrality and stability by rejecting the Pythagorean opinion.[74] Reimagining the stationary, Pythagorean central fire as the sun and treating the Earth's motions as an assumption within the setting of Regiomontanus's updated Ptolemaic astronomy, Copernicus could then have seen that there was no longer need for the additional solar motions to be attributed to the planets. Removing the annual solar component would have enabled him to answer one of Pico's objections, and thereby to find his way to a new principle of organization according to the planets' increasing periods of revolution as the distances increase with respect to the sun. And it was precisely this relationship that Copernicus emphasized in a famous passage—"a marvelous symmetry of the universe and an established harmonious linkage between the motion of the spheres and their size." It was also this logical consequence that Copernicus represented using the visual image of concentric spheres appropriated from familiar elementary astronomical texts on which, *unlike* the vast majority of such common images, he explicitly marked the planets' periods of revolution with respect to the sun (fig. 10).

Pico's assault on astrology was immediately recognized as unusually threatening. Because of his social prestige as a nobleman and his brilliant intellectual reputation as a philosopher, a collection of his shorter works, his letters, as well as his disputations against astrology appeared within two years of his untimely death. As noted previously, Benedetto Ettore Faelli, one of Bologna's major publishers, issued these editions, though he did not hesitate to profit from the sale of Domenico Maria Novara's later prognostications. "To attack astrology and its practitioners," as I have written elsewhere, "was really to attack the entire web of social and political arrangements of which they were a part, including the rulers who retained astrologers and the universities which supported the teaching of the science of the stars and made the

net, in quo terram cum orbe lunari tanquam epicyclo contineri diximus. Quinto loco Venus nono menſe reducitur. Sextum denicꝫ locum Mercurius tenet, octuaginta dierum ſpacio circū currens. In medio uero omnium reſidet Sol. Quis enim in hoc

pulcherimo templo lampadem hanc in alio uel meliori loco po neret, quàm unde totum ſimul poſsit illuminare? Siquidem non inepte quidam lucernam mundi, alij mentem, alij rectorem uo- cant. Trimegiſtus uiſibilem Deum, Sophoclis Electra intuentē omnia. Ita profecto tanquam in ſolio re gali Sol reſidens circum agentem gubernat Aſtrorum familiam. Tellus quoꝫ minime fraudatur lunari miniſterio, ſed ut Ariſtoteles de animalibus ait, maximā Luna cū terra cognationē habet. Concipit interea à Sole terra, & impregnatur annuo partu. Inuenimus igitur ſub hac

Figure 10. For Copernicus, each planet's period of revolution increases as its sphere is more distant from the central, stationary sun. Most sixteenth-century cosmic images labeled the planets but not the times to complete their circuits.

issuance of annual astrological prognostications an obligation of the resident astronomer-astrologers."[75] In fact, the year after Pico's book appeared, his old friend Girolamo Savonarola (1452-1498), the Dominican preacher who had become the leader of Florence when the French armies overturned Medici rule, incorporated some of Pico's main arguments into a popular work, written in Italian for a wider audience, that denounced astrologers as greedy and corrupt. He also rejected the zodiac as nothing but a human construction. A year later, in 1498, Savonarola was overthrown, his body hung and burned in the main piazza of Florence.[76] And, in 1512, the Medici returned to power with their astrologers. After the fall of Savonarola, an official of the Florentine chancery named Niccolò Machiavelli (1469-1527) would reflect famously on a familiar astrological theme—how princes ought to understand and manage changes of political fortune—albeit without explicit reference to planetary revolutions and influences.[77]

Much less well known today than Machiavelli is the astrological physician, Lucio Bellanti (d. 1499). In the same year as Savonarola's overthrow—and clearly motivated by his and Pico's attack against the astrologers—Bellanti published a wide-ranging defense of astrology coupled with a detailed answer to Pico.[78] It would be republished and frequently cited throughout the sixteenth century. Machiavelli, for example, referred to it in his *Discourses*. Although we have no direct evidence, the astrological prognosticator Novara and his assistant Copernicus surely must have known it. Among later owners of the book was the famed Danish astronomer Tycho Brahe.[79] However, on the specific matter of the uncertain ordering of the spheres of Mercury and Venus below the sun, Bellanti offered a reply that must have seemed problematic to Copernicus. The matter could be decided, Bellanti said, either by comparing the lengths of the radii of the two planets' epicycles or by observing the apparent sizes of the bodies of the two planets.[80] The difficulty, as Pico had already anticipated, rests in the determination of linear distances. Thus, the problem with the first argument is that the *angular* distances of Mercury and Venus from the sun, as

seen from Earth, do not determine their relative order—or linear distances—between the moon and the sun.[81] Secondly, naked eye observations could not yield significant differences in the two planets' apparent diameters. To answer Pico's objections would have required either providing new evidence about planetary distances (which Bellanti could not—and did not—do) or offering a secure, singular principle, as Copernicus would do, on which the planets could be ordered and their relative distances determined. Bellanti's later fame thus often rested on his offhand, throwaway claim—which was completely spurious—that an (unnamed) astrologer had forecast Pico's death in 1494.

During just this same period, let us recall, Copernicus was living with Novara, sometimes assisting him with his observations and beginning his own study of Regiomontanus's *Epitome*. It would be perverse to imagine that the young man was unaware of syphilis, plague, the French invasion, and the consequent political upheaval—some of which received mention in Novara's astrological forecasts.[82] However, the first we know about his new theory is from the fortunate survival of a manuscript that he composed about seven or eight years after he left Italy to return to Poland—sometime around 1510. Thereafter, he proceeded to work on the mature statement of his theory, continuing to refine its implications, but the next we hear of it is from an episode that occurred in 1533.

Copernicus in the Vatican Gardens

Johann Albrecht Widmanstetter (*Lat.* Widmanstadius; 1506-1557), an immensely learned humanist scholar and high official in the court of the Medici Pope Clement VII (1478-1534), had somehow been informed of the basic outline of Copernicus's theory, possibly through a member of Copernicus's diocesan chapter in Poland.[83] Widmanstetter made a presentation about Copernicus's theory before the pope, two

cardinals (Franciscus Ursinus and Johannes Salviatus), the Bishop of Viterbo (Johannes Petrus) and a physician (Matthias Curtius) in the Vatican gardens. Exactly how much detail about Copernicus's theory Widmanstetter had available on that occasion is not known. As a reward for his efforts, the pope presented him with a valuable Greek manuscript on which Widmanstetter recorded the names of those present.[84] Nonetheless, before any contact with Copernicus could occur, Clement VII died and Widmanstetter soon entered the service of Cardinal Nicolaus Schönberg in Rome. He must have told Schönberg about Copernicus's theory soon thereafter, because in November 1536 the cardinal wrote directly to Copernicus in Poland. He expressed obvious fascination and eagerness to see the main text, tables, and "whatever else you have that is pertinent to the subject."[85] As a further sign of his great interest, he offered to send an amanuensis to copy the manuscript. As far as is known, Copernicus did not reply, but held on to the letter and eventually placed it immediately after his book's title page, at the very least to indicate formal approval from Rome.[86]

The whole episode is well known. But there must be more to the story. Why would a pope, two cardinals, a bishop, a physician and a learned orientalist scholar have had such great interest in an astronomical theory that promised to overthrow the foundations of astronomy as taught in all the universities and accepted in all the courts of Europe? Indeed, why would Clement's successor, Paul III (r. 1534-1549), have had any concern either with Copernicus's ideas or still another new work of theoretical astronomy, the system of concentric spheres that the physician (and astronomer) Girolamo Fracastoro dedicated to him in 1538 under the title *Homocentrica*? Miguel Angel Granada and Dario Tessicini have suggested that papal and cardinalate interest in Fracastoro's work could have been motivated by interest in calendar reform as well as by the well-known astrological interests of Paul III. In an important study, they argue that Copernicus very likely knew the *Homocentrica*, and that his own prefatory letter to the pope in *De revolutionibus* (composed in 1542) was intended as a rejection of Fracastoro's approach.[87]

Further evidence points to other significant differences between Copernicus and Fracastoro that highlight a larger pattern of quite divergent responses to Pico's critique. First, unlike Copernicus, Fracastoro unhesitatingly accepted Ptolemy's ordering of Mercury and Venus, yet completely ignored the disagreements among the authorities cited by Pico, Regiomontanus, and even Ptolemy himself.[88] He offered no solution to Pico's criticism that the astrologers disagreed about the ordering of the planets. Much more important to Fracastoro was Pico's concerted attack on Galen. Indeed, Fracastoro and his publisher bundled with his *Homocentrica* a second treatise by him on Galen's "critical days"—the theory that the crisis point of a disease could be predicted by the occurrence of lunar phases. In the second work, Fracastoro explicitly followed Pico in *rejecting* the astrologers and physicians who agreed with Galen's astrological explanation.[89] Fracastoro famously extended this argument to the causes of syphilis, arguing that disease is transmitted by "seeds of contagion"—the movement of internal bodily humors rather than by external astral influences. He rejected the doctrine of the number of critical days as a matter of pure chance (*nisi forte per accidens*), a Pythagorean conceit.[90] In the end, following Pico, he contended that the proponents of the critical days doctrine were motivated either by the love of astrology or by the love of Galen (*quorum alios Astrologiae, alios Galeni amor permoveat*).[91]

In light of our earlier discussion of plague and syphilis, it is hardly surprising that the debate about whether the planets cause disease and whether the course of disease is predictable from the heavens was a topic of widespread concern among physicians in the sixteenth century. It certainly must have been a source of great interest to Copernicus as a medical student at Padua (1501-1503) and also to Matthaeus Curtius (*Ital.* Matteo Corti; 1474/5-1544), the prominent academic physician who was present when Widmanstetter delivered his remarks about Copernicus's theory in the Vatican gardens in 1533. Curtius was a traditional Galenist and physician to Pope Clement from 1523 until the pope's death in

1534.[92] Not surprisingly, he also rejected Pico's critique of astrology and of Galen.[93] This stance would have positioned him squarely against Fracastoro's theory concerning the cause of syphilis and could very well have ignited interest in Copernicus's ideas—or what little was known of them—on the occasion of Widmanstetter's presentation. Perhaps the group in the Vatican gardens believed that Copernicus's new principle of planetary order might somehow offer a more secure basis for defending astrological medicine. Such a hypothesis would account for Widmanstetter's serial successes in sparking the initial interest of Pope Clement VII, then Cardinal Schönberg, and also Clement's successor, Paul III. The latter was the same pope to whom Copernicus eventually dedicated his book and who was regularly advised on astrological matters by Luca Gaurico—the same Gaurico who had produced the 1526 edition of Bianchini's tables and who was in Padua during Copernicus's medical studies there.[94]

Widmanstetter himself was clearly well informed about the medical and astrological issues at stake. He owned two copies of Fracastoro's *Homocentrica* published with its accompanying treatment of Galen's theory of critical days (figs. 11, 12 and 13).[95] And he was certainly aware of the Pico-Bellanti controversy, as he also owned a first edition of Bellanti's reply to Pico (fig. 14). Among the books from his library, at least four astrological prognostications are known, one of which was personally inscribed to him by its author.[96] Another is a vernacular German *practica* for 1542 by Anton Brelochs, a work typical of the literature of annual astral forecast in this period (fig. 15).[97] In addition, Widmanstetter annotated Peter Apianus's *Astronomicum Caesareum* (1540), famous for its multicolored, moving paper disks (known as *volvelles*) and threads—essentially, an early computer that enabled a reader to calculate planetary positions (and horoscopes) by manipulations right on the page.[98] One of Widmanstetter's most extensive annotations pointedly concerns a section that Apianus devoted to Galen's critical days. Altogether, this evidence leaves no doubt that

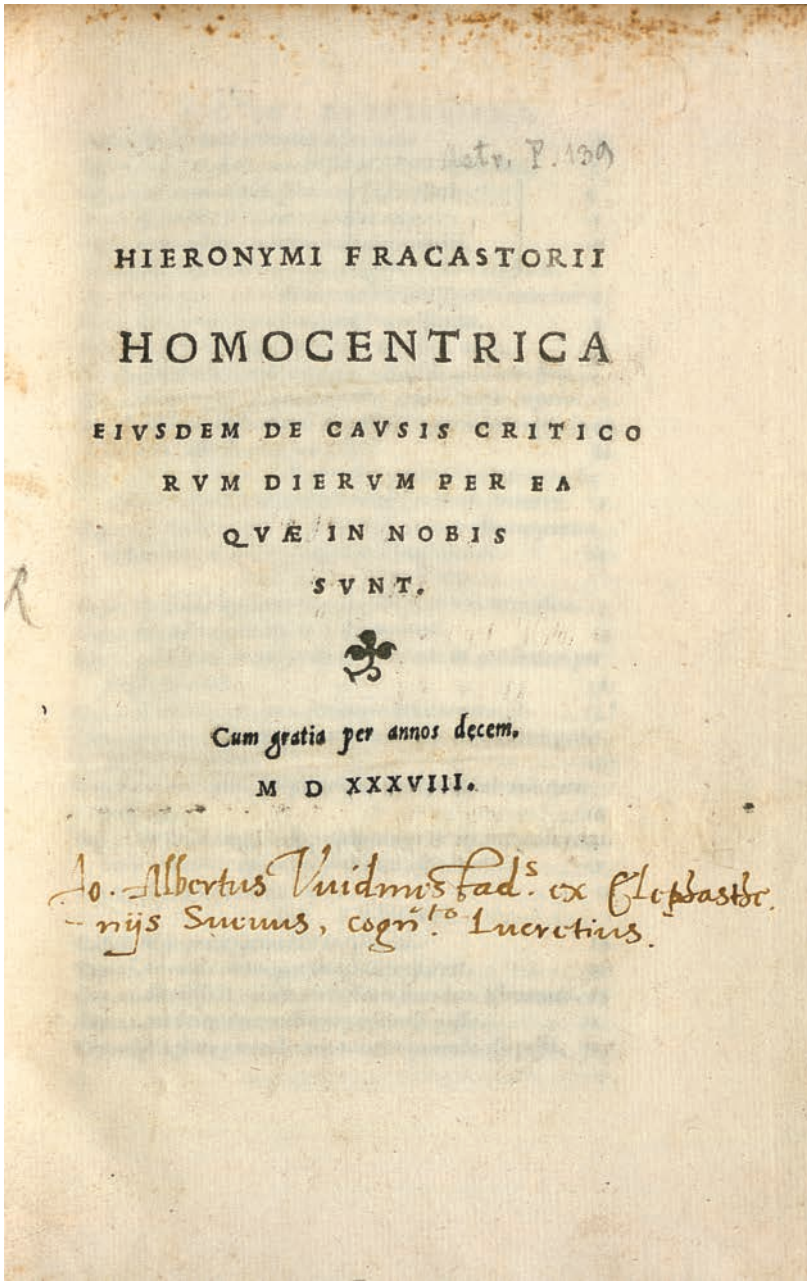
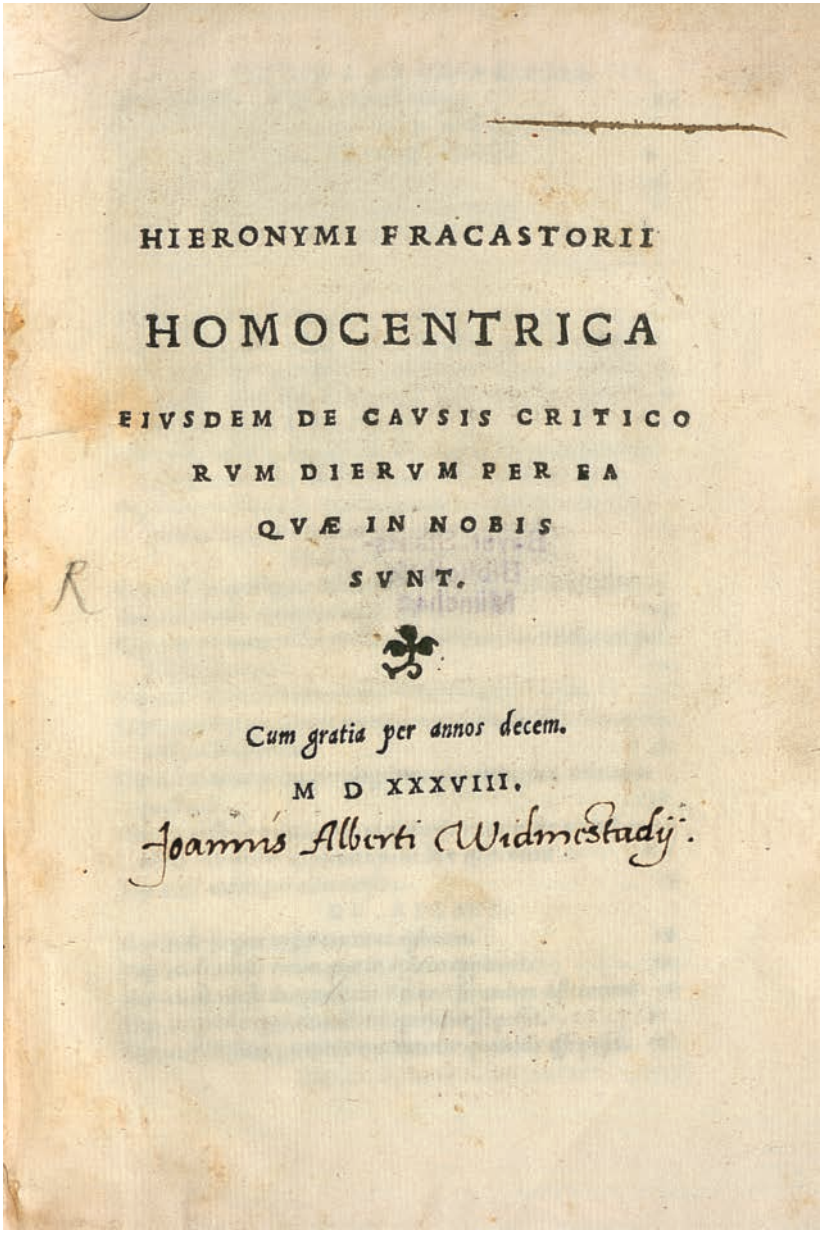


Figure 11. Girolamo Fracastoro, *Homocentrica*, 1538, copy 1. Provenance of Johann Albrecht Widmanstetter


HIERONYMI FRACASTORII

HOMOCENTRICA

EIVSDEM DE CAVSIS CRITICO

RVM DIERVM PER EA

QVÆ IN NOBIS

SVNT.

Cum gratia per annos decem.

M D XXXVIII.

Joannis Alberti Widmestadij.

Figure 12. Girolamo Fracastoro, *Homocentrica*, 1538, copy 2. Provenance of Johann Albrecht Widmanstetter

Figure 13. Portrait of Fracastoro from *Homocentrica*

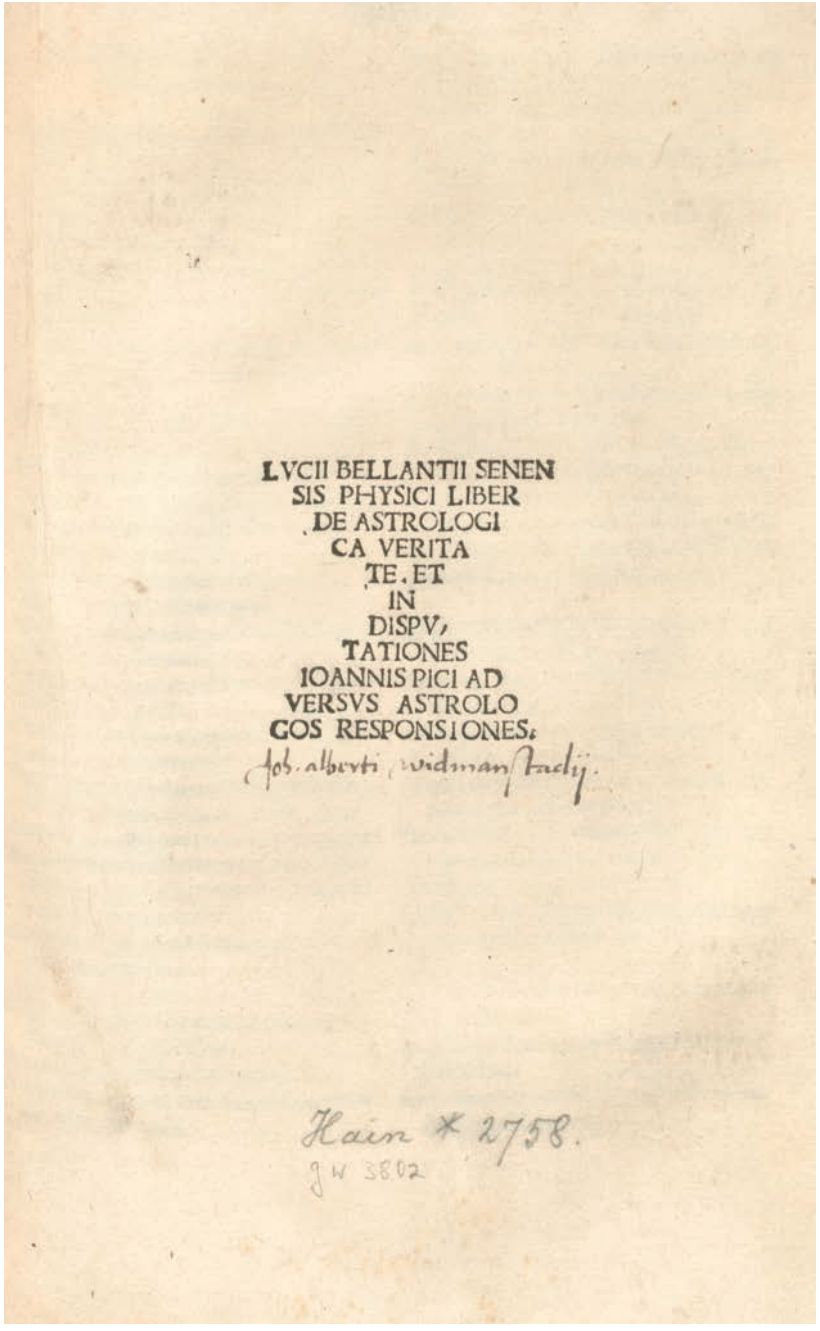


Figure 14. Lucio Bellanti, *Liber de astrologica veritate*, 1498. Provenance of Johann Albrecht Widmanstetter

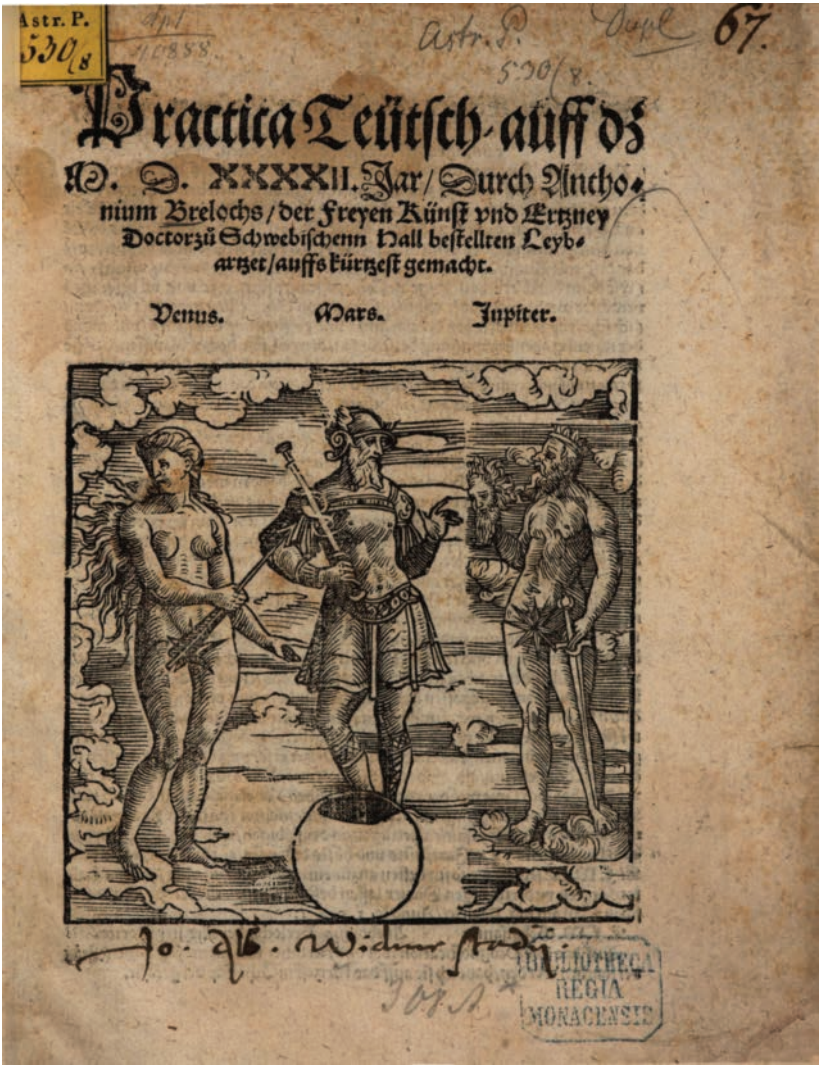


Figure 15. Anton Brelochs, *Practica Teutsch auff d[a]z 1542 Jar*, 1541. Provenance of Johann Albrecht Widmanstetter

Widmanstetter aligned himself with the defenders of astrology in the Piconian controversies.[99] But, in spite of Widmanstetter's apparently ceaseless promotion of Copernicus's ideas, Rome's efforts to obtain a copy of the manuscript of *De revolutionibus* did not bear fruit. Indeed, when the printed book finally did arrive at the papal court, another of Paul III's advisors, Giovanni Maria Tolosani (1479-ca.1549), sharply denounced it for its violation of Aristotelian physical principles and its even more dangerous conflict with Holy Scripture.[100] Tolosani's decisive rebuke of *De revolutionibus*, against which (the deceased) Cardinal Schönberg's letter obviously failed to offer protection, could explain why nothing further about Copernicus was heard from Widmanstetter—even as defenses of lunar influence on critical days and attacks against Fracastoro and Pico continued at the papal court.[101]

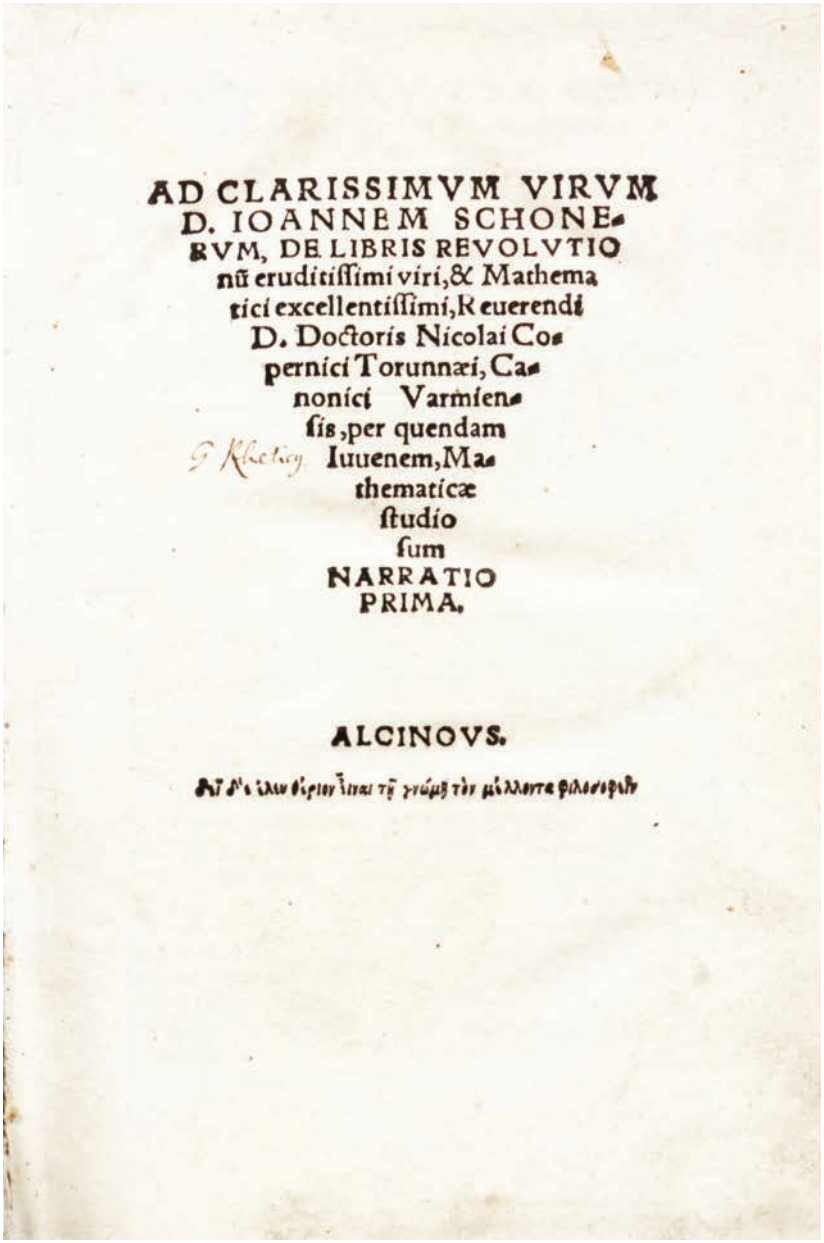
Copernicus, Rheticus, and the Nuremberg Connection

Whatever reasons Copernicus had for delaying the publication of his masterwork—even with supportive prodding from Rome—he finally overcame his reservations upon the arrival of Rheticus, the talented young mathematician and astrological prognosticator from the University of Wittenberg, the place where Martin Luther himself taught. Rheticus quickly won Copernicus's confidence, he was allowed to study the coveted manuscript, and he was further permitted to write up a short description of it. Thus, with Copernicus's clear and evident approval, the *Narratio prima*, or *First Account*, appeared very quickly in Gdańsk in 1540, and then again in 1541 from a different publisher in Basel. The success of the *Narratio prima* clearly overcame Copernicus's remaining hesitations, and thus it was that Rheticus was entrusted with the manuscript of *De revolutionibus* in order to have it published in Nuremberg.[102]

But why Nuremberg? The usual answer—and it is certainly compelling—is that Johannes Petreius was a leading publisher of works concerning all aspects of the science of the stars. He could handle the complicated typesetting of the mathematical diagrams and he had an impressive record of publishing works of both astronomy and astrology. There are, however, other reasons why Nuremberg was chosen rather than, say, Basel, another important center of book publishing. Rheticus had come to Copernicus via Nuremberg where he visited for a month with Johannes Schöner (1477-1547). Schöner, like Abiosus before him, intended to publish the remains of Regiomontanus's known writings. In view of his ambitions, it is quite possible that Schöner knew the Abiosus letter and was stimulated to carry forward the project that Abiosus had begun. Nuremberg was also the city where Regiomontanus had set up his own printing operation in the early 1470s. Schöner was, in his own right, a prolific author of astrological works and well aware of Pico's critique of astrology, which he regarded as both misguided and plagiarized from earlier sources. And there is further evidence that Rheticus shared Schöner's critical views about Pico.[103] Whatever previous contacts between Copernicus and Nuremberg may have existed, there can be no doubt that Rheticus significantly deepened the connections.[104]

The Dibner Library includes a volume dating to Schöner's active period. Nuremberg associations are prominent. It contains ten separately published works, seven issued by Johannes Petreius, all bound together by an early owner, with dates ranging from 1533 to 1540.[105] The first item in the collection is Rheticus's *Narratio prima* (1540), the printed dedication of which is explicitly directed to Schöner, and containing what Bern Dibner believed was "the very copy which Rheticus sent to Schöner."[106] Unfortunately, based upon my own inspection, this conclusion is difficult to sustain from the binding and sparse annotations alone (fig. 16). One might expect Rheticus to have inscribed a personal dedication, as seems to have been his general practice, but in this case one finds only the name "G Rheticus," inked onto the title page (fig. 17).[107]

Figure 16. Rheticus-Schöner, bundled copy, binding, front cover


AD CLARISSIMVM VIRVM
D. IOANNEM SCHONE-
RVM, DE LIBRIS REVOLVTIO
nũ eruditiſſimi viri,& Mathema
tici excellentiſſimi,Reuerendi
D. Doctoris Nicolai Co-
pernici Torunnæi, Ca-
nonici Varmien-
ſis,per quendam
Iuuenem,Ma-
thematicæ
ſtudio
ſum
NARRATIO
PRIMA.

ALCINOVS.

Figure 17. Georg Joachim Rheticus's *Narratio prima*, 1540, title page

Nonetheless, the volume is still of considerable importance because it allows us to see that the owner—possibly Schöner's son Andreas or his successor, Joachim Heller—regarded the *Narratio prima* as belonging together with nine other works in which astronomy and astrology predominate.[108] The collector's decision would have been consistent both with Schöner's views and interests and with the spirit of Rheticus's declaration in the *Narratio* directly linking Copernicus's theory to the defense of astrology against Pico: "If [my teacher's] account of the celestial phenomena had existed a little before our time, Pico would have had no opportunity in his eighth and ninth books of impugning not merely astrology but also astronomy."[109]

This important passage strengthens my contention that Copernicus and Rheticus had not merely *discussed* astrology, but that Rheticus regarded Copernicus's proposal as providing a robust answer to Pico's objections to the astronomical foundations of astrology—just the sort of response that Bellanti had been unable to offer in 1498. Morever, the enthusiasm and adulatory tone of Rheticus's style, the liberal references to Copernicus's contemporaries, and the vivid and recurring images and analogies of harmony that provided some metaphysical grounding for the new planetary arrangement contrast markedly with the cautious approach of the master's own work. *De revolutionibus*, in contrast, was modeled after the *Almagest*, careful to avoid explicit engagement with Holy Scripture, cautious not to stray further than necessary into questions of natural philosophy, and silent in sidestepping open encounter with the Piconian controversies. Compared to Rheticus's rhetoric, such controversial matters bubbled invisibly just beneath the surface of *De revolutionibus*, leaving only traces to be wrestled over by scholars of a much later time.

Thus, before *De revolutionibus* appeared in 1543, one might think of Rheticus's book as a preview for the masterwork, approved by Copernicus but presented in the voice of his earnest disciple—a summary and foregrounding of its main claims and arguments,

even tying one of the earth's motions suggestively to a world-historical prophecy and openly positioning the new theory within the Piconian controversies.[110] Like Bianchini's dedication and Abiosus's letter, the *Narratio prima* served as an introduction, a "first report," functioning something like an extended substitute for a preface or letter of dedication to the main work.[111] Addressed to Johannes Schöner, Regiomontanus's most recent and vigorous promoter, Rheticus may also have been evoking Abiosus's praise of Regiomontanus as "king of mathematics" when he described Copernicus as "in every field of knowledge and in mastery of astronomy not inferior to Regiomontanus. I rather compare him to Ptolemy, not because I consider Regiomontanus inferior to Ptolemy, but because my teacher shares with Ptolemy the good fortune of completing, with the aid of divine kindness, the reconstruction of astronomy which he began, while Regiomontanus—alas, cruel fate—departed this life before he had time to erect his columns."[112]

Later publishers recognized the natural relationship between the first and the second works. When Copernicus's book appeared in a second edition at Basel in 1566, Rheticus's *Narratio prima* was bundled after *De revolutionibus*, typographically reset from the 1541 issue, seamlessly reconstituting the two works as a new kind of product, the pages of the first continuously paginated with those of the second.[113] Once again, thirty years later, Michael Maestlin (1550-1631) regarded the *Narratio prima* as a work of such value as an introduction to Copernicus's book that he prepared a new edition that was published together with the aggressively Copernican *Mysterium cosmographicum* (1596) of his star pupil, Johannes Kepler. And Kepler became the first Copernican fully to develop Rheticus's vision of a heliocentric system joined with a finely articulated response to Pico's war on the astrologers.[114]

Summary and Final Reflections

Historical evidence is never as complete as one would like, not least in the present case. If historians of ancient Greece and Rome must constantly work with fragmentary remains, the absence of full evidence in the first century of print should neither surprise nor occasion total epistemic surrender. For there is, as I have shown, more of consequence about Copernicus and astrological culture than previously recognized—enough, indeed, to allow us to form a coherent and compelling picture.

From the mid-fifteenth to the mid-sixteenth century, a pattern of similar practices is evident in the production of several major works of theoretical and practical astronomy. Authors and editorial intermediaries, always with astrological concerns and justifications, were variously involved in moving works of theoretical and practical astronomy into print. In his prefatory material, Giovanni Bianchini explicitly wrapped the political interests of the major rulers he served in astrological images, causes and effects. Much later editors of Bianchini's *Tables*, like Luca Gaurico and Augustinus Moravus, retained the original astrological-political associations. Again, Johannes Abiosus's letter promoted Regiomontanus's *Epitome of the Almagest* as both fortifying astrology and surpassing Ptolemy's astronomy. Georg Joachim Rheticus, living at the time with Copernicus and having full access to the author's manuscript, inscribed his synopsis of *De revolutionibus* to Johannes Schöner, the Nuremberg astrological practitioner, globemaker, manuscript collector, and publisher of Regiomontanus's works, while positioning Copernicus's theory as a completion of the foundations laid by Ptolemy and a reply to Pico's astronomical and astrological objections. Finally, efforts at the highest levels of the Catholic Church to shake loose Copernicus's manuscript appear to have been motivated by the hope that the new theory might have some bearing on the controversy sparked

by Pico's trenchant criticisms of Galen's critical days. Thus, more than forty years after Edward Rosen and Willy Hartner emerged from their heated discussion in a Polish state limousine, the question they were debating might better be framed: *Where did Copernicus stand in the Piconian controversies?*

Notes

1. For the history and politics of these celebrations, see Owen Gingerich, "The Copernican Quinquecentennial and Its Predecessors," *Osiris* 14 (1999): 37-60. For the Smithsonian symposia, see Owen Gingerich, ed., *The Nature of Scientific Discovery* (Washington, DC: Smithsonian Institution Press, 1975).

2. Poland was divided by the Russian Empire, the Kingdom of Prussia, and the Habsburg Monarchy. See Paul Robert Magocsi, *Historical Atlas of East Central Europe* (Toronto: University of Toronto Press, 1993), p. 71. The Germanic version of Copernicus's name was even of concern to Hitler, whose preference for "Kopernikus" caused that spelling to appear in May 1943 on postage stamps commemorating the four-hundredth anniversary of the astronomer's death. See Gingerich, "The Copernican Quinquecentennial and Its Predecessors," 44-46; see also Robert S. Westman, "Zinner, Copernicus and the Nazis," *Journal for the History of Astronomy* 28 (1997): 259-70.

3. Owen Gingerich, *An Annotated Census of Copernicus'* De revolutionibus *(Nuremberg, 1543 and Basel, 1566)* (Leiden, Holland: Brill, 2002).

4. Owen Gingerich, *The Book Nobody Read* (New York: Walker, 2004), 186.

5. Ibid., 186-87.

6. Ibid., 189.

7. Edward Rosen, *Copernicus and the Scientific Revolution* (Malabar, FL: Krieger, 1984), 111. "I know of no evidence indicating that Copernicus shared the astrological views of Rheticus," Edward Rosen, *Three Copernican Treatises* (New York: Dover, 1959), 123; Edward Rosen, *On the Revolutions of the Heavenly Spheres* in Nicolaus Copernicus, *Complete Works* (London: Macmillan, 1978), 2: 344.

8. See I. Bernard Cohen, "Obituary. Edward Rosen (1906-1985)," *Journal for the History of Astronomy* 17 (1986): 150-53. According to Cohen, Dibner agreed to fund Rosen to produce an English translation of Copernicus's *De revolutionibus*, which would be published by the Burndy Library; Cohen was to translate Galvani's treatise on electrical forces in muscular motion.

9. Thomas S. Kuhn, *The Copernican Revolution: Planetary Astronomy in the Development of Western Thought* (Cambridge, MA: Harvard University Press, 1966), 94; (Kuhn refers to Rosen, *Three Copernican Treatises*, 287).

10. Alexandre Koyré, *The Astronomical Revolution: Copernicus-Kepler-Borelli* (New York: Dover Publications, 1971), 94.

11. Dava Sobel, *A More Perfect Heaven: How Copernicus Revolutionized the Cosmos* (New York: Walker, 2011).

12. Ole Benedictow, *The Black Death, 1346-1353: The Complete History* (Rochester, NY: Boydell); Jon Arrizabalaga, John Henderson, and Roger French, *The Great Pox: The French Disease in Renaissance Europe* (New Haven, CT: Yale University Press, 1997); Anthony Grafton and Nancy Siraisi, "Between the Election and My Hopes: Girolamo Cardano and Medical Astrology," in *Secrets of Nature: Astrology and Alchemy in Early Modern Europe*, ed. William R. Newman and Anthony Grafton (Cambridge, MA: MIT Press, 2001), 79f; Robert S. Westman, *The Copernican Question: Prognostication, Skepticism and Celestial Order* (Berkeley: University of California Press, 2011), 25.

13. Benedictow, *The Black Death*, 382-83. In *The Copernican Question*, I cite a much more conservative, but no less disturbing estimate of 25-33% (25).

14. Ann G. Carmichael, "Plague Persistence in Western Europe: A Hypothesis," in *Pandemic Disease in the Medieval World. Rethinking the Black Death*, ed. Monica H. Green (Kalamazoo, MI: Medieval Press, 2015), 157-192; also valuable is Green's editorial introduction to *Pandemic Disease in the Medieval World*, 9-26.

15. Johannes Baptista Abiosus, *Divinus tractatus terrestrium et celestium trutina artem exhibens:ut elementorum alterationes praecognoscantur, et eorum portenta et sublimem venerorum philosophorum medicinam pandens:et multorum annorum uaticinia regumque negotia:& mundi conquassationem:&noui prophetae aduentum* (Treviso: n.p., February 5, 1498), 10: "gallici seu pustulosi morbi"; "morbus gallicus," 39-40.

16. Girolamo Fracastoro, *Syphilis, seu Morbus Gallicus* (Verona: Stefano Nicolini, 1530).

17. See Colin Eisler, "Who Is Dürer's 'Syphilitic Man'?," *Perspectives in Biology and Medicine* 52 (2009): 57.

18. For fuller discussion of this term, see Westman, *The Copernican Question*, 34-43.

19. See William R. Newman and Anthony Grafton, "Introduction: The Problematic Status of Astrology and Alchemy in Premodern Europe," in *Secrets of Nature*, 1-3.

20. At Krakow, Copernicus could only have known the work in manuscript; although completed in 1482, it was first published in 1494 and reissued in 1495 (*Commentaria utilissima).*

21. This average or mean motion in the sun's longitude is accounted for by an epicycle for each of the three superior planets (Mars, Jupiter, and Saturn) and a deferent circle for Mercury and Venus. For an excellent discussion, see James H. Evans, *The History and Practice of Ancient Astronomy* (New York: Oxford University Press, 1998), 337-39. To assist visualization, interested readers should consult the beautiful and very helpful planetary animations of Dennis Duke, "Ptolemy's Cosmology," accessed on October 24, 2015, https://people.sc.fsu.edu/~dduke/ptolemy.html.

22. Westman, *The Copernican Question*, 61. For recent discussion of Brudzewo's view on the status of the planetary spheres, see Peter Barker, "Albert of Brudzewo's *Little Commentary on George Peurbach's 'Theoricae Novae Planetarum'*," *Journal for the History of Astronomy* 44 (2013): 125-48; André Goddu, *Copernicus and the Aristotelian Tradition* (Leiden, Holland, and Boston: Brill, 2010).

23. José Chabás and Bernard R. Goldstein, *The Astronomical Tables of Giovanni Bianchini* (Leiden, Holland, and Boston: Brill, 2009), viii.

24. Ibid., 13; Lynn Thorndike, "Giovanni Bianchini in Paris Manuscripts," *Scripta Mathematica* 16 (1950): 5.

25. For useful biographical details, see N.M. Swerdlow, "Regiomontanus on the Critical Problems of Astronomy," in *Nature, Experiment, and the Sciences*, ed. Trevore H. Levere and William R. Shea (Amsterdam: Kluwer, 1990), 192-93n7.

26. See Werner Gundersheimer, *Ferrara: The Style of a Renaissance Despotism* (Princeton, NJ: Princeton University Press, 1973), 106-07.

27. The Botticelli comparison is made by Werner Gundersheimer, "Clarity and Ambiguity in Renaissance Gesture: The Case of Borso d'Este," *Journal of Medieval and Renaissance Studies* 23 (1993): 16. Images of Botticelli's *La Primavera* are now easily found online.

28. Gundersheimer points to the artist's representation of the duke as displaying his power through the gesture of his hands, which contain and embrace Bianchini ("Clarity and Ambiguity in Renaissance Gesture").

29. Also known as Augustin Käsenbrot of Olomouč, he studied at Krakow from 1484 to 1488 where he might well have encountered Albert of Brudzewo. Dedications to both works (1492 and 1495) are signed, "From the school of Padua" (*Ex gymnasio patauino),* thus antedating by several years Copernicus's studies at that same institution (1501-03). Like Copernicus, he also obtained a doctorate in canon law from Ferrara. While still at Krakow, Copernicus owned a copy of the *Alfonsine Tables.* Alfonsus X, *Tabulae astronomicae alphonsinae* (Venice: Johannes Hamman, 1492); Paweł Czartoryski, "The Library of Copernicus," *Studia Copernicana* 16 (1978): 366.

30. Giovanni Bianchini, *Tabulae astronomiae* (Venice: Simon Bevilacqua, June 10, 1495), fol. i2: "Non enim ignores princeps sapientissime quantus hominibus sit astrologie fructus. Nam cum deus omnipotens omnia humanis usibus creauit: quis est qui nesciat motus stellarum et celestium tempora: cursus: naturas: proprietates rebus nostris utilitatem adducere: ne aliquid improuidi nos cogitaremus: et faceremus. Itaque superiorum notitia nobis monstrata est: quae consiliorum vias et rationes demonstrate: ventos: pluuias: ubertatem: sterilitatem: morbos; sanitatem: bella: pacem aperiat. Itaque factum est ut subditorum commodis: populorum factis: regni negocijs prouidere possis. Itaque prefati illustris principis et domini domini mei ducis Marchionisque et comitis iussu et exhortatione ductus: hoc opusculum tue maiestati dicaui multis ante annis inchoatum. In eo continentur planetarum tabule et alique additiones: quas post tue serenitatis ad urbem Romam discessum tua causa nuper adiunxi. In eodem opera planetarum motus: et omnia illorum accidentia ad iudicandum necessaria facilime cognosces. Comprehendes etiam tempora earum rerum que pertineant consilijs pacis et belli."

31. Ibid., fol. i3: "Sol enim ut est dux omnium atque princeps: et (ut phisici dixerunt) mens mundi: et procreandarum omnium rerum auctorita medium celi obtinet locum; et luminis sui moderatione: ceterarum stellarum ac syderum ignes perpetuos reddit: quibus varias in elementa vires impartiens: animatorum omnium generationem corruptionemque peragit. eosdemque per aspectus nunc fortes (eorum vires augens) efficit: nunc minuens imbecilles. Cuius rei causa modo caliditatis: modo siccitatis; contraque modo frigitatis: modo humiditatis effectrices astrorum operationes: intuentibus latissime patent. Sol inquam bonorum omnium ac malorum: pacis ac belli certissimus auctor est. Cum soli placet sydera que eum celeriter tanquam fugientia percurrunt ab eo pretereuntur celeritate mirabili. Eademque preterita: cursumque tardantia: et imperium suum quodammodo renunetia: vi sua ac potestate

vel inuita trahuntur: vel (si id forte maluerit) longe post se relicta pignora: illa quidem ac retrorsum cadentia efficiuntur."

32. Grażyna Rosińska, "Identyfikacja 'szkolnych tablic astronomichnich' Kopernika," *Kwartalnik historii nauki i techniki* 29 (1984): 637-44; Bernard R. Goldstein and José Chabás, "Ptolemy, Bianchini and Copernicus: Tables for Planetary Latitudes," *Archives internationales d'histoire des sciences* 58 (2004): 453-73; Chabás and Goldstein, *Astronomical Tables of Bianchini*, 14-15; Goddu, *Copernicus and the Aristotelian Tradition*, 25, 151, 161-62.

33. N.M. Swerdlow, "The Derivation and First Draft of Copernicus's Planetary Theory: A Translation of the Commentariolus with Commentary,' *Proceedings of the American Philosophical Society* 117 (1973): 425-26: "The importance of the *Epitome* not only for the study of Copernicus, but for all sixteenth- and early seventeenth-century astronomy cannot be overemphasized, nor can its virtues be sufficiently praised"; see also Evans, *History and Practice of Ancient Astronomy*, 402-03, 425

34. Biblioteca Nazionale di Firenze; The British Library; Library of Congress; Trinity College, Cambridge; The Walters Art Museum, Baltimore. Ludwik Birkenmajer examined a copy—which I count here as containing a sixth Abiosus letter—sent on loan to Krakow from the Episcopal Chapter Library of Strangnäs, Sweden, but its present location is unconfirmed (André Goddu, personal communication, July 30, 2014). Ludwik Antoni Birkenmajer, *Mikołaj Kopernik* (Krakow: Polska Akademia Umiejętności, 1900), identified the shelf no. T509, folio; Birkenmajer, *Nicholas Copernicus, Studies on the Works of Copernicus and Biographical Materials*, trans. Jerzy Dobrzycki, Zofia Piekarec, Zofia Potkowska, and Michał Rozbicki (Ann Arbor, MI: University Microfilms, 1975), 32-33. I have used the digitized copy available online from the

Library of Congress. Thorndike studied the copy in Florence, noted above. A modern facsimile of the letter is bound into the copy held by The University of Oklahoma Library, possibly made from the copy in the British Library. The earliest attention to Abiosus's letter was by Ludwik Birkenmajer, chap. 1 in *Mikołaj Kopernik*, and Lynn Thorndike, *Science and Thought in the Fifteenth Century* (New York: Columbia University Press, 1929), 144-45, although its existence was briefly noted in Ernst Zinner, *Entstehung und Ausbreitung der copernicanischen Lehre* (Munich: C.H. Beck, 1988), 214n51; again, more substantially by Lynn Thorndike, *A History of Magic and Experimental Science 5* (New York: Columbia University Press, 1923-58), 179, 220-21, 335, 341, 541; see further Sergio Bertelli's biographical entry, "Abioso, Giovan Battista," in *Dizionario Biografico degli Italiani,* vol. 1 (1960).

35. For assistance in locating some of these copies, special thanks to Lilla Vekerdy, Dibner Library of the History of Science and Technology, Smithsonian Libraries and Bruce Bradley, Linda Hall Library of Science, Engineering and Technology. For providing information on copies held in their respective libraries, I express my appreciation to Lynley Herbert, Department of Rare Books and Manuscripts, The Walters Art Museum; Kerry Magruder, Sean Richards, Melissa Rickman, Joann Palmeri, and Marilyn Ogilvie, History of Science Collections, University of Oklahoma Libraries.

36. Birkenmajer, chap. 1 in *Mikołaj Kopernik*. My thanks to André Goddu for allowing me to consult sections of his unpublished English translation of Birkenmajer's work. See also André Goddu, "Copernicus's Annotations: Revisions of Czartorski's 'Copernicana,'" *Scriptorium* 58 (2004); Czartoryski, "The Library of Copernicus."

37. See especially Swerdlow, "The Derivation and First Draft of Copernicus's Planetary Theory," 472: "It is even possible that, had Regiomontanus not written his detailed description of the eccentric model, Copernicus would never have developed the heliocentric theory."

38. Abiosus's life dates are unknown. For a recent summary of what is known about him, see Bertelli, "Abioso."

39. The town is Bagnoli Irpino. Abiosus's print identity alone does not permit confirmation of an affiliation with the university in Naples.

40. Johannes Baptista Abiosus, [*Epistola*] *verarum scientiarum speculatoribus*, in Johannes Regiomontanus, *Epytoma in almagestum* (Venice: Johannes Hamman, August 15, 1496), fol. [1]v, [unsigned]v: "Per mathematicam namque omnes conclusiones philosophi[a]e probantur et vere intelliguntur per mathematicam inquam: non mathematicis accidentibus intellectam: ut sophist[a]e calumniantur. Sed abstractis idealibus numerorum metaphisicisque causis confecta." Among the copies of which I am aware, the *Epistola* consists of two unpaginated folios inserted between the title page and fol. a2 (except for the Trinity College, Cambridge copy).

41. Abiosus's source was the sixth-century philosopher Anicius Manlius Torquatus Severinus Boethius, *De Institutione Arithmetica Libri Duo. De Institutione Musica Libri Quinque. Accedit Geometria quae Fertur Boetii,* ed. Godofredus Friedlein (Frankfurt: Minerva, 1966); Michael Masi, *Boethian Number Theory: A Translation of the* De Institutione Arithmetica (Amsterdam: Rodopi, 1983); Abiosus, *Epistola,* fol. [1]v, [unsigned]v: "Ed ideo sapienti[a]e nuncupantur: testante Boetio in arithmetica..." Boethius's work was often used in the organization of the curriculum of medieval universities. Masi, *Boethian Number Theory*, 76: "A number is a collection of unities, or a big mass of quantity

issuing from unities." For religious and "scientific" elements of the Renaissance Pythagorean tradition, see Christopher Celenza, "Pythagoras in the Renaissance: The Case of Marsilio Ficino," *Renaissance Quarterly* 52 (1999): 667-706; Michael J. B. Allen, *Nuptial Arithmetic: Marsilio Ficino's Commentary on the Fatal Number in Book VIII of Plato's* Republic (Berkeley: University of California Press, 1994). See also Jacob Klein, *Greek Mathematical Thought and the Origin of Algebra*, trans. Eva Brann (Cambridge, MA: MIT Press, 1968); also useful is Edward W. Strong, *Procedures and Metaphysics. A Study in the Philosophy of Mathematical-Physical Science in the Sixteenth and Seventeenth Centuries* (Hildesheim, Germany: Georg Olms, 1966).

42. Abiosus, *Epistola*, fol. [2]r, [a1]r: "Sic profecto Astrologia per naturales verissimas rationes primum motorem: deum scilicet optimum: magnum: eternum: atque potentissimum: sapientissimum: liberrimum: virtuosissimum: verissimum: et gloriosissimum nobis demonstrat."

43. Ibid., "Ipsa namque verissima est scientia: cum ex primis veris et prioribus comprobetur. Habet quoque genus universale et substantiale quo differt ab alijs scientijs proprium et accidens. Colligit quoque precepta rationesque verissimas ad unum finem verum tendentes. Probat quoque suas conclusiones per causam et per effectum. Omne namque demonstrationis genus amplectitur. Ipsa ergo inter scientias liberales regina nuncupabitur."

44. The word occurs in Boethius's *Geometria*, 395: "Priscae igitur prudentiae viri Pythagoreum dogma secuti, Platonicaeque auctoritatis *investigatores speculatoresque* curiosi totum philosophiae culmen in numerorum vi constituerunt."

45. Abiosus, *Epistola*, fol. [2]r, [a1]r: "ad nostrum dialogum de ipsius defensione remittimus." Abiosus refers to his *Dialogue in Defense of Astrology with a Prophecy from the Flood to the year of Christ 1702* (*Dialogus in astrologiae defensionem*).

46. D.P. Walker explains that Ficino "postulates a cosmic spirit (*spiritus mundi*), flowing through the whole of the sensible universe, and thus providing a channel of influence between the heavenly bodies and sublunar world. Since the world, as in Plato and Plotinus, is one animal, its soul, like ours, must have a 'first instrument' which transmits its powers to its body" (*Spiritual and Demonic Magic from Ficino to Campanella* [London: The Warburg Institute, 1958], p. 12). See also Brian Copenhaver, *Magic in Western Culture from Antiquity to the Enlightenment* (Cambridge: Cambridge University Press, 2015), pp. 55-58; Mary Quinlan-McGrath, *Influences: Art, Optics and Astrology in the Italian Renaissance* (Chicago: University of Chicago Press, 2013), 136-142.

47. Isabelle Pantin, "*ALTIOR INCUBUIT ANIMUS SUB IMAGINE MUNDI*. L'inspiration du cosmographe d'après une gravure d'Oronce Finé," in *Les méditations cosmographiques à la Renaissance* (Paris: Presses de l'Université Paris-Sorbonne, 2009), 73-94.

48. Ibid., 86. Although the origin of the motto is unknown, Pantin shows that it first appeared in Naples in 1485 as the frontispiece to Bernard de Granollachs's lunar tables (*Sumario dela nobilissima arte e scientia de astrologia*) and was subsequently issued in Venice in Venetian dialect in 1489-90. Thus, there was ample opportunity for Abiosus to notice it for use in his edition of Regiomontanus.

49. On the recovery of mathematical manuscripts in the fifteenth century, see Paul Lawrence Rose, *The Italian Renaissance of Mathematics: Studies on Humanists and Mathematicians from Petrarch to Galileo* (Geneva: Droz, 1976).

50. Alfonso was the cousin of King Ferdinand II of Aragon, who sponsored Columbus's voyages.

51. All this was fascinating to the French king, who left Naples with rich Neapolitan tapestries, works of art, much of the royal library, and ideas for his own gardens. On the fate of the royal library and the cultural policies of the Aragonese kings of Naples, see Jerry Bentley, *Politics and Culture in Renaissance Naples* (Princeton, NJ: Princeton University Press, 1987).

52. Johannes Baptista Abiosus, *Dialogus astrologiae defensionem cum vaticinio a diluvio usque ad Christi annos 1702.* (Venice: Franciscus Lapicidus, October 20, 1494), colophon: "Finit opus Dialogi ac vaticinij compositum per Peritissimum Doctorem Joannem Abiosum Anno Christi 1492. Transmissum tamen ac directum Inuictissimo Regi Alfonso. Die quarto Junij. 1494. Et impressum Uenetus Die. 20. octobris 1494."

53. Uncle and successor of Ferdinand II. See *Divinus tractatus terrestrium et celestium trutina*, chap. 38.

54. Johannes Regiomontanus, *Oratio Iohannis de Monteregio, habita Patavij in praelectione Alfragani*. In *Opera Collectanea. Faksimiliedrucke von neun Schriften Regiomontans und einer von ihm gedruckten Schrift seines Lehres Purbach*, ed. Felix Schmeidler (Osnabrück, Germany: O. Zeller, 1972), 43-53; for a paraphrase of this work with commentary, see N. M. Swerdlow, "Science and Humanism in the Renaissance: Regiomontanus's Oration on the Dignity and Utility of the Mathematical Sciences," in *World Changes, Thomas Kuhn and the Nature of Science* (Cambridge, MA: MIT Press, 1993), 131-68. Abiosus did not explicitly refer to the Padua oration.

55. Regiomontanus, *Oratio habita Patavij*, 51: "cuius quemadmodum generali uocabulo tam motuum speculationem quam effectuum prouidentiam exprimere solent philosophia..."

56. Ibid., *51-52*: "Te igitur diuinum Astrologiae numen appello…"

57. Abiosus, *Epistola*, fol. [2]v, [a1]v: "Quapropter cum per orbem nostris laboribus librum librorum Astrologie Johannis alemani de monte region:ac Georgij purbachij sui preceptoris comperierim: ipsumque manibus meis scripserim. Ac etiam ut tantus sapientie thesaurus non latitaret: ipsum scriptorum incorreptionibus et figurarum transpositionibus: et multarum litterarum erroribus emendaui."

58. Ibid.: "Qui namque Epithoma Johannis de monte regio et Georgij purbachij in Almagesto Ptolemei nominat. Qui tum propositionum ac etiam latina lingua claritate facile magno Almagesto Ptolemei anteponendus est: Cum omnia complectatur: que Ptolemeus in Almagesto demonstrauit. Sed tanto hoc opus Ptolemei Almagestum superat: quanto Johannes de Regio monte vir sapiens et Georgius suus preceptor post Ptolemaeum celestes motus experti fuerunt."

59. Ibid.: "Cum scienti[a]e demonstratiu[a]e non opinionibus nugisque sciantur. Preseferant ergo hi tales coram doctorum virorum conspectu: et confusi vere scient Johannem de Regio monte sapientissimum virum: et post Ptolemeum monarcham mathematice fuisse."

60. Ibid.: "Sic quoque ingentes gratie germanice genti referantur: que Astrologiam nostris temporibus erexit: librorumque impressionem comperit: quorum multitudo portendere videtur futuram maximam mundi corruptionem."

61. Ibid.: "Ego quoque Johannes Baptista Abiosus alia multa dignissima opera Johannis de Regio monte sapientissimi viri imprimenda largiar: librum triangulorum: et etiam probleumatum: et instrumenta: ut celestes motus uberrime quilibet intueri: obseruare: intelligereque recte valeat." The *Problemata* appears on Regiomontanus's *Tradelist* as "Problemata astronomica ad almaiestum totum spectantia," Regiomontanus, *Oratio habita Patavij*, *533*.

62. Ibid.: "Quare sagax natura tot et tantos libros per mundum disseminare voluit: ut in climatum corruptionibus et scientiarum iactura anno christi. 1503. et. 1524 et in alijs futuris proximis coniunctionibus penitus non amittantur."

63. Johannes Regiomontanus, *Index operum Joannis de Monte Regio: quemdum in humanis erat imprimi curauit: huc secundario appressus*, in Georg Peurbach, *Tabulae eclypsium Georgij Peurbachii. Tabula primi mobili Joannis de Monte region*, ed. Georg Tannstetter (Vienna: Johannes Winterburger, 1514), fol. 4r, p.7.

64. Salio dedication in Claudius Ptolemy, *Liber Quadripartiti Ptholomei.* With thirteen other astrological works (Venice: Bonetus Locatellus, December 20, 1493). When Copernicus lived with Novara, a copy signed by Novara was in his library. See Westman, *The Copernican Question*, 96-99.

65. A list of Novara's extant prognostications (with the exception of 1499) appears in *I Pronostici di Domenico Maria Novara*, ed. Fabrizio Bònoli, Giuseppe Bezza, Salvo De Meis and Cinzia Colavita (Florence: Leo S. Olshiki, 2012), 124. See Robert S. Westman, review of *I Pronostici di Domenico Maria da Novara* in *Bruniana & Campanelliana* 19 (2013): 581-83.

66. *Narratio prima* in *Three Copernican Treatises*, 111: "My teacher made observations with the utmost care at Bologna, where he was not so much the pupil as the assistant and witness of observations of Dominicus Maria" (*adiutor et testis observationum*).

67. Birkenmajer believed that there was some kind of connection between Abiosus and Novara, although, unfortunately, he provides no specific evidence for the claim (chap. 1 in *Mikołaj Kopernik*).

68. Giovanni Pico della Mirandola, bk. III, chap. 16 in *Disputationes adversus Astrologiam Divinatricem*, trans. and ed. Eugenio Garin (Florence: Vallechi, 1946-52), I, 322-48. For an important discussion, see Glen M. Cooper, "Approaches to the Critical Days in Late Medieval and Renaissance Thinkers," *Early Science and Medicine* 18 (2013): 552-53.

69. Pico, bk. X, chap. 4 in *Disputationes*, trans. and ed. Garin, II, 368-77. My reading of this chapter is consistent with both Garin's Italian and Swerdlow's English translations (see Swerdlow, "Copernicus and Astrology, with an Appendix of Translations of Primary Sources," *Perspectives on Science* 20 (2012) 3-9; Westman, *The Copernican Question*, 76-105; and Westman, "The Copernican Question Revisited: A Reply to Noel Swerdlow and John Heilbron," *Perspectives on Science* 21 (2013): 115-122). For Swerdlow's interpretation, unconvincing in my view, see "Copernicus and Astrology," 357-66.

70. Ptolemy, bk. I, chap. 4 in *Tetrabiblos*, trans. Frank Egleston Robbins (Cambridge, MA: Harvard University Press, 1940). Saturn, most distant from Earth, cools and dries; Jupiter heats and humidifies; Mars dries and burns; the Sun dries and heats; Venus, just below the Sun, chiefly humidifies and warms moderately; Mercury, above the Moon but below Venus, humidifies and dries; the Moon humidifies and moderately heats. Ptolemy's implicit criteria for assigning elemental qualities are clearly drawn from Aristotle's theory in which adjacent elements share one common quality and one opposite.

71. Pico, bk. X, chap. 4 in *Disputationes*, trans. and ed. Garin, II, 374.

72. For this early dating of Copernicus's study of Regiomontanus's *Epitome,* see Birkenmajer, chap. 1 in *Mikołaj Kopernik*.

73. Westman, *The Copernican Question*, 86-87.

74. Aristotle, book II, chaps. 13-14 in *On the Heavens*, trans. W.K.C. Guthrie (Cambridge, MA: Harvard University Press, 1960). Rheticus writes: "He [Copernicus] saw (as Aristotle also points out) that when one motion is assigned to the earth, it may properly have other motions, by analogy with the planets. *He therefore decided to begin with the assumption that the earth has three motions*, by far the most important of all" (my italics; *Narratio prima* in *Three Copernican Treatises*, 148).

75. Westman, "The Copernican Question Revisited," 115f.

76. See Donald Weinstein, *Savonarola: The Rise and Fall of a Renaissance Prophet* (New Haven, CT: Yale University Press, 2011).

77. For the function of astrological ideas of regularity and chance in Machiavelli's political theory, see Anthony Parel, *The Machiavellian Cosmos* (New Haven, CT: Yale University Press, 1992); and, especially, Steven Vanden Broecke, "Astrology and Politics," in *A Companion to Astrology in the Renaissance*, ed. Brendan Dooley (Leiden, Holland: Brill, 2014), 214-16.

78. Ornella Pompeo Faracovi argues that Bellanti's treatise was aimed as much against Savonarola as Pico. "Contro Pico, in difesa dell'astrologia: Bellanti e Pontano" in *Lo Specchio Alto: Astrologia e Filosofia fra Medioevo e Prima Età Moderna*. (*Bruniana & Campanelliana*. Supplementi, XXXII. Studi 11; Pisa/Roma: Fabrizio Serra Editore, 2012), 77-100.

79. For Machiavelli, see Parel, *Machiavellian Cosmos*, 24, 39; for Tycho's copy, see Westman, *The Copernican Question*, 246-47.

80. "He [Pico] does not know that there is a clear demonstration concerning the place of Mercury and Venus beneath the Sun, whether such [a demonstration] be elicited from the great size[s] of the epicycles or from the greater apparent size of these bodies." Lucio Bellanti, bk. 10 in *Lucii Bellantii Senensis Physici Liber de Astrologica Veritate; Et, In Disputationes Ioannis Pici adversus Astrologos Responsiones* (Florence: Gherardus de Harlem, 1498), 213. The present reading is a correction and revision of my earlier understanding of this passage (cf. Westman, *The Copernican Question*, 99-100).

81. For a helpful visualization of this problem, see Dennis Duke, "Ptolemy's Cosmology," accessed on October 24, 2015, https://people.sc.fsu.edu/~dduke/ptolemy.html.

82. In particular, Novara's 1499 prognostication (see Westman, *The Copernican Question*, 91-92).

83. Alexander Scultetus (1485-1564), like Copernicus, was a canon or administrative official in the Varmia cathedral chapter, once governed by Copernicus's uncle. The connection between Scultetus and Widmanstetter was suggested by Ernst Zinner, *Entstehung und Ausbreitung*, 228. A copy of Scultetus's *Chronographia, sive annales omnium fere regum, principum* (Rome, 1546), signed by Widmanstetter, is held by the Bayerische Staatsbibliothek, Munich.

84. "Clemens vij Pont[ife]x Max[imus] hunc Codicem mihi D[ono] Dedit Anno MDXXXIII Romae, post[quam] ei praesentib[us] Fr[ancisco] Vrsino, Joh[anne] Saluiato Cardinalibus, Joh[anne] Petro Ep[iscop]o Viterbien[si] et Mathaeo Curtio Medico physico in hortis Vaticanis Copernicianа[m] de motu terrae sententiam explicaui. Joh[annes] Albertus Widmanstadius cogn[omen]to Lucretius, S[erenissi]mi D[omini] N[ostri] Secretarius

domesticus et familiaris." Heribert M. Nobis, ed., VI/2, no. 212 in *Nicolaus Copernicus Gesamtausgabe* (Hildesheim, Germany: H.A. Gerstenberg, 1974-84; Berlin: Akademie Verlag, 1994-2007), 345.

85. Schönberg to Copernicus in Copernicus, *De revolutionibus orbium coelestium* (Nuremberg: Johannes Petreius, 1543), fol. ij. We do not know what other information about Copernicus's writings Widmanstetter might have possessed and transmitted to Schönberg—as, for example, an almanac based upon the Earth's motions and intended to improve the accuracy of annual prognostications (see Bernard Wapowski to Sigismund de Herberstein, October 15, 1535, VI/1 in *Copernicus Gesamtausgabe*, 186-88; cited and translated in Michel-Pierre Lerner, "Planetary Order in the Long Sixteenth Century," *Journal for the History of Astronomy* 43 (2012): 237.

86. For papal politics and Copernicus's strategic considerations in his preface to *De revolutionibus*, see Robert S. Westman, "Proof, Poetics and Patronage: Copernicus's Preface to *De revolutionibus*" in *Reappraisals of the Scientific Revolution* (Cambridge, MA: Cambridge University Press, 1990), 76-113; Lerner, "Aux origines de la polémique anticopernicienne (I)," *Revue des sciences philosophiques et théologiques* 86 (2002): 681-721; Miguel Angel Granada, "Giovanni Maria Tolosani e la prima reazione romana di fronte al 'De revolutionibus': La critica di Copernico nell'opusculo 'De coelo et elementis,'" in *La diffusione del copernicanesimo in Italia, 1543-1610*, ed. Massimo Bucciantini and Maurizio Torrino (Florence: Leo S. Olshki, 1997), 11-35; Miguel Angel Granada and Dario Tessicini, "Copernicus and Fracastoro: The Dedicatory Letters to Pope Paul III, the History of Astronomy and the Quest for Patronage," *Studies in History and Philosophy of Science* 36 (2005): 431-76; Geoffrey Blumenthal, "Diplomacy,

Patronage, and the Preface to *De Revolutionibus*," *Journal for the History of Astronomy* 44 (2013): 75-92; Westman, *The Copernican Question*, 133-40.

87. Granada and Tessicini, "Copernicus and Fracastoro," 465. The term "homocentricus" appears to have been used for the first time by Giovanni Battista Amico in 1537 (*Opusculum de motibus corporum coelestium*), and was then followed the next year by Fracastoro, who publicized the word in the title of his work. Five years later, Copernicus used the term twice in the preface to *De revolutionibus* (fol. iiiv). The word was not used in Alessandro Achillini's *De orbibus libri 4* (Bologna: Benedictus Hectoris, 1498).

88. Girolamo Fracastoro, chap. 4 in *Homocentrica: Eiusdem de causis criticorum dierum per ea quae in nobis sunt* (Venice: n.p., 1538), fols. 4v-5.

89. Cooper, "Approaches to the Critical Days."

90. Fracastoro, chap. 3 in *De causis criticorum dierum*, fol. 49v; quoted in Cooper, "Approaches to the Critical Days," 558.

91. Ibid.

92. In 1541, after lecturing at Bologna for three years, Curtius moved to the University of Pisa and became personal physician to Grand Duke Cosimo I. See *Andreas Vesalius' First Public Anatomy at Bologna, 1540: An Eyewitness Report by Baldasar Heseler together with his notes on Matthaeus Curtius' Lectures on Anatomia Mundini,* ed. and trans. Ruben Eriksson (Uppsala, Sweden: Almquist & Wiksells, 1959), 37-38.

93. I base this judgment of Curtius's views on the comments of the Bologna astronomer-astrologer Giovanni Antonio Magini:

"Matthaeus Curtius of Ticino, whose learning was so great that in all the Italian schools he always won first place for interpreting and disputing, refutes the arguments of Giovanni Pico on the second aphorism concerning critical days, explains Galen's views in book 3 of the *Critical Days* and describes the crises that occur in an illness from the Moon's motion and appearance." "Matthaeus Curtius Ticinensis, cui tanta fuit eruditio, ut in omnibus Italiae Gymnasijs interpretando, ac disputando primum semper locum obtinuerit, dum Ioannis Pici rationes in secundo Aphorismorum de diebus criticis, refellit; sententiamque Galeni ex tertio de diebus Decretorijs explicat, à Luna crises fieri in morbis ex illius curso, & aspectibus tradit," *De astrologica ratione ac usu dierum criticorum*. (Venice: Heirs of Damianus Zenarius, 1607), fol. (b 3); Pico, *Disputationes*, bk. III, chap. 16, trans. and ed. Garin, I, 322-49: "Galen's Opinion Attributing Critical Days to the Moon is Refuted." See also Thorndike, *History of Magic and Experimental Science*, V, 325.

94. Westman, *The Copernican Question*, 133-34; Mary Quinlan-McGrath, *Influences: Art, Optics, and Astrology in the Italian Renaissance* (Chicago: University of Chicago Press, 2013), 190-94.

95. Bayerische Staatsbibliothek München (hereafter BSB), shelf numbers: 4˚Astr.P.139; 4° Astr. U. 63 (both available online).

96. Nonius Marcellus de Saya de Rocha, *Prognosticon Anni 1538*. Written in Widmanstetter's hand on the title page: "In the crypt of Mr. Lorenzo, not far from Lake Bolsena, Marcellus, considered to be very skilled in Geomancy, gave me his prognostication. June, 1538" (BSB Res 4° Astr. p. 529,42); Daniel Rimpach, *Prognostico divino e famosissima* (BSB Res 4° Astr. p. 529/7); Ludovico Vitale, *Pronostico de l'anno 1537*

(BSB 4° Astr. p. 529/8); Johannes Stöffler, *Expurgatio adversus divinationum XXIII. anni suspitiones* (BSB 4° Astr. p. 528/27; with Widmanstetter's provenance). All available online; for further discussion see Hans Striedl, "Die Bücherei des Orientalisten Johann Albrecht Widmanstetter. Mit 5 Tafeln," in *Serta monacensia; Franz Babinger zum 15. Januar 1951 als Festgruss dargebracht*, ed. Hans Joachim Kissling and Alois Schmaus (Leiden, Holland: E.J. Brill, 1952), 231-33.

97. Anton Brelochs, *Practica Teütsch auff dass 1542 Jar* (Augsburg: Heinrich Stainer, 1541; BSB Res 4° Astr. p. 530/8). For general features of the *practica teutsch* genre, see Jonathan Green, *Printing and Prophecy. Prognostication and Media Change, 1450-1550* (Ann Arbor, Michigan: The University of Michigan Press, 2012), 109-30; for Italian prognostications, see Eliade Casali, "Pronostici, almanacchi, libri di ventura," in *Il linguaggio dei cieli. Astri e simboli nel Rinascimento*, ed. Germana Ernst and Guido Ciglioni (Rome: Carocci, 2012), 271-85.

98. *Astronomicum Caesareum:* Eidgenössiche Technische Hochschule Bibliothek Zürich (Rar 4287; available online; Widmanstetter's signature appears on the title page).

99. Ibid., "Primae Partis Conclusio"; see digital scan 97. It would not be surprising if, at one time, he had also owned Pico's *Disputationes* and Copernicus's *De revolutionibus*, although neither has been found among his extant books in the Bayerische Staatsbibliothek.

100. Westman, *The Copernican Question*, 195-97; Lerner, "Aux origines de la polémique anticopernicienne (I)"; Granada, "Giovanni Maria Tolosani e la prima reazione romana"; Granada and Tessicini, "Copernicus and Fracastoro."

101. See Luca Gaurico, *Super diebus decretoriis axiomata (Quos etiam Criticos vocitant) Axiomata, siue Aphorismi grandes utique sententiae breui oratione compraehensae* (Rome: Valerius Doricus, 1546). Gaurico focused his criticism of both Pico and Fracastoro on their rejection of planetary, and especially lunar, influence without disputing the order of the planets. See further Thorndike, *History of Magic and Experimental Science*, V, 260-64.

102. See Dennis Danielson, *The First Copernican: Georg Joachim Rheticus and the Rise of the Copernican Revolution* (New York: Walker & Co., 2006).

103. See Garin, *Astrology in the Renaissance*, 85-86; Westman, *The Copernican Question*, 112, 114-16; John W. Hessler, *A Renaissance Globemaker's Toolbox: Johannes Schöner and the Revolution of Modern Science* (London: The Library of Congress, 2013), 140-51.

104. As further evidence of the connection, Copernicus attributes two observations of Mercury to Schöner, although he was unaware that one of them had been made by the Nuremberger Bernhard Walther (Copernicus, bk. 5, chap. 30 in *De revolutionibus*, 169v); see Hessler, *A Renaissance Globemaker's Toolbox*, 160-2; also Swerdlow, "Annals of Scientific Publishing."

105. See Rheticus-Schöner Bundled Copy.

106. "Bern Dibner, Epilogue to Georg Joachim Rheticus, *De libris revolutionum Copernici narratio prima* (Gedani: Franciscus Rhodus, 1540), Osnabrück, Germany: Zeller, 1965, p. 12."

107. The letters "G" and "R" do not resemble either those of the hands of Rheticus or Schöner. For an image of a dedication by Rheticus on a copy of the *Narratio Prima,* see Gingerich, *The Nature of Scientific Discovery*, 412; for other convenient samples of Schöner's hand, see Hessler, *A Renaissance Globemaker's Toolbox*, figs. 81, 82, 85.

108. What appears to be a date of 1556 is barely discernible on the left side of the front binding but the number "36" clearly appears in the top row of the rollstamp binding. If the volume was bound after Schöner's death in 1547, his son, Andreas (1528-1590), who continued his father's work, would be a candidate [see Karl Heinz Burmeister, *Magister Rheticus und seine Schulgesellen: das Ringen um Kenntnis und Durchsetzung des heliozentrischen Weltsystems des Kopernikus um 1540/50* (Konstanz, Germany: UVK Verlagsgesellschaft, 2015), 535]; and also Schöner's successor, Joachim Heller (1518-1580), a former student of Rheticus and Erasmus Reinhold at Wittenberg (ibid., 278-281).

109. "Quod si talis paulo ante nostrum aetatem rerum coelestium doctrina extitisset, nullam Picus in octavo et nono libro occasionem, non solum astrologiam, sed et astronomiam impugnandi habuisset," Georg Joachim Rheticus, *De libris revolutionum Copernici narratio prima* (Gedani: Franciscus Rhodus, 1540), fol. biiiv.

110. Cf. Rosen, *Three Copernican Treatises*, 402.

111. For example, Gemma Frisius first learned about Copernicus's new theory through the *Narratio prima* and later acquired his own copy of *De revolutionibus* [Steven Vanden Broecke, *The Limits of Influence: Pico, Louvain, and the Crisis of Renaissance Astrology* (Leiden, Holland: Brill, 2003), 136, 147-49; Westman, *The Copernican Question*, 179-83].

112. Rheticus, Narratio Prima in *Three Copernican Treatises*, 109.

113. See Gingerich, *An Annotated Census*, 378-80.

114. Westman, *The Copernican Question*, 320-28.

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Figures

1. Karl Sudhoff, *Graphische und typographische Erstlinge der Syphilisliteratur* (Munich: Carl Kuhn, 1912), plate V. Smithsonian Libraries

2. Giovanni Bianchini,*Tabulae astronomiae*, MS I.147, fol. 1r. Courtesy of Biblioteca Communale Ariostea, Ferrara

3. Giovanni Bianchini, *Tabulae astronomiae*, MS I.147, fol. 1r, inset. Courtesy of Biblioteca Communale Ariostea, Ferrara

4. Johannes Regiomontanus, *Epytoma in Almagestum Ptolomei* (Venice: Johannes Hamman de Landoia [Landau], 1496), engraved title page. The Dibner Library of the History of Science and Technology, Smithsonian Libraries

5. Johannes Baptista Abiosus, *[Epistola] verarum scientiarum speculatoribus*, in Regiomontanus, *Epytoma in Almagestum Ptolomei* (Venice: Johannes Hamman de Landoia [Landau], 1496), fol. [1]v. Courtesy of the Walters Art Museum, Baltimore

6. Johannes Baptista Abiosus, *Dialogus astrologiae defensionem cum vaticinio a diluvio usque ad Christi annos 1702* (Venice: Franciscus Lapicidus, October 20, 1494), title page with woodcut illustration. Courtesy of Bayerische Staatsbibliothek, Munich

7. Johannes Sacrobosco, *Sphaera mundi* (Venice: Ottaviano Scotto, 1490), engraved title page. Courtesy of History of Science Collections, University of Oklahoma Libraries

8. Bernat de Granollachs, *Lunarium: in quo reperiunt coniunctiones & oppositiones lunae & eclypses solis & lunae* (Rome: s.n., 1513?), title page with woodcut illustration. The Dibner Library of the History of Science and Technology, Smithsonian Libraries

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