

PTOLEMY IN THE RENAISSANCE

Abstract

Among the works written by, or attributed to, Claudius Ptolemy (ca. 100 - ca. 170 A.D.) those which enjoyed the most welcoming reception in the Renaissance were: [1] the *Almagest*; [2] *De Analemmate* [3] *Planetary Hypotheses*; [4] *Quadripartitum* and the (spurious) *Centiloquium*; [5] *Geography*; [6] *Planisphaerium*; [7] *Optics*; [8] *Harmonics*; and later [9] *Phaseis* and [10] *On the Criterion (of Truth) and the Commanding-Faculty* with the *Canobic Inscription*.

Impact and legacy

Among the works written by, or attributed to, Claudius Ptolemy (ca. 100 - ca. 170 A.D.) those which enjoyed the most welcoming reception in the Renaissance were: [1] the *Almagest*; [2] *De Analemmate* [3] *Planetary Hypotheses*; [4] *Quadripartitum* and the (spurious) *Centiloquium*; [5] *Geography*; [6] *Planisphaerium*; [7] *Optics*; [8] *Harmonics*; and, later, [9] *Phaseis*, and [10] *On the Criterion and the Commanding-Faculty*, with the *Canobic Inscription*.

[1] The impact that Ptolemy's resurgence had in the Renaissance was deep and wide in the fields of astronomy and cosmology. His *Almagest* (the *Μεγίστη Μαθηματικὴ Σύνταξις*) regained an unparalleled centrality in the studies between the middle of the 15th and the middle of 16th century. At first, however, the *Almagest* was studied in small circles by specialists, who became soon aware of the unreliability of Gerard of Cremona's translation from the Arabic (Toledo, 1175). So, between the twenties and the forties of the fifteenth century, Ptolemy started to be (re)studied with reference to the original text in Constantinople: John Chortasmenos left a lot of notes and calculations on his copy of the *Almagest*; Bessarion hand-copied the *Commentary* by John Alexandrinus; Gemistus Pletho studied the one by Theodore Metochites (cf. Rigo 1991). The intrinsic difficulty of the text and the mathematics within were made more accessible for students on various occasions, as, for instance, by the anonymous *Almagestum Parvum*, which restated an abridged form of Ptolemaic astronomy in the style of Euclid's *Elements* (Zepeda 2015), or by Giovanni Bianchini's *Flores Almagesti* in 1446-1456, which following Ptolemy's footsteps unclosed innovative ways for the computation of stellar coordinates and mathematical astronomy in general (Van Brummelen 2018). In the West, however, such a re-discovery begun precisely in 1451, when Pope Nicholas V commissioned a translation of the *Almagest* from Greek into Latin to George of Trebizond from a manuscript that belonged to Bessarion's library. The Cretan scholar completed the requested translation by the end of that year; he also completed and attached his demanding *Commentary* to that work, where he diffusely criticized the historical *Commentary* by Theon of Alexandria to restore Ptolemy's original text against subsequent misunderstandings. Even though George of Trebizond tried to get recognition and promote his work in Venice, Rome, Naples, Istanbul, and Budapest, his anti-Theonian *Commentary* became the target of a harsh polemical campaign that the cardinal Bessarion instigated against him (Steiris 2010), first exploiting the negative evaluation of that endeavor provided by the papal reviewer Jacopo Cremonese, and then appointing Peurbach (soon succeeded by Regiomontanus) to discredit in print such a "heterodox" interpretation of Ptolemy's astronomical work. As requested, Peurbach started to compose an *Epitome* of the *Almagest* (*Epytoma in Almagestum*) in 1460-'61, which was then completed by Regiomontanus in 1462. Eventually, Regiomontanus wrote also a second text by Bessarion's incitement – the *Defensio Theonis contra Georgium Trapezuntium* (the early 1460s - 1474 ca.), where not only he criticized his polemical target, but also tried to solve what he considered as inconsistent or fictitious in Ptolemy's work (Shank 2002). Here, between the lines of the polemic, one can read the insurgence of novel astronomical ideas, such as those dealing with the order, distance, motions of the planets, and the overall cosmic dimension, arising both from needed revisions of the *Almagest* and the collimation of its content with other sources of consultation, as notably with Campanus da Novara's *Theorica planetarum* (Shank 2020). Significantly, Regiomontanus' epitome was later used by Copernicus as a reference handbook in his studies, often even in preference to the *Almagest* itself (Swerdlow - Neugebauer 1984, p. 51). Both in his *Commentariolus* and the *De Revolutionibus Orbium Coelestium* (1543), however, Copernicus shows his assiduous familiarity with Ptolemy's *Almagestum*. As it has been said, "Copernicus had studied the *Almagest* very carefully indeed. For the *De Revolutionibus* is the *Almagest*, book by book and section by section, rewritten to incorporate the new Copernican theory, but otherwise altered as little as might be." (Boas 1962: 74). Although Copernicus criticized Ptolemy's lunar

model (Goddu 2010: 154), his star catalog is entirely based on the data of the *Almagest*. That catalog would have been updated only in 1598 by Brahe's *Stellarum Inerrantium Restitutio* (Graßhoff 1990). Indeed, much of the Sixteenth-century astronomy can be described as the attempt to improve or correct Ptolemy's observations (as, for instance, his views on the alleged path of the Sun, cf. Swerdlow 2010). As time passed, improvements were observational as much as philological. The first complete Latin translation of the *Almagest* was published in 1515. Grynaeus and Camerarius emended the Greek for the *editio princeps* of the text in 1538. Reinhold published a commented Greek-and-Latin edition of the first book of the *Almagest* as a handbook for Wittenberg students in 1549 (*Ptolomei Mathematica Constructionis*, later printed as *Regulae artis mathematicae*), where however he stuck to the traditional geocentric hypothesis notwithstanding Copernicus' proposal (Omodeo-Tupikova 2013).

[2] While some years later also Ptolemy's work on the mathematics on the sundials (the *De Analemmate*) was published in a commented edition by Commandino in 1562, Scholastic thought maintained its conservative approach on the astronomical subject, both in teachings and in print. To mention one of the most telling account, the Jesuit Christoph Clavius defended the validity and the reality of the Ptolemaic cosmological system from the first to the last edition of his much influential commentaristic textbook on Sacrobosco's *Sphere* (1570/1612) against competing models, also resorting to sophisticated forms of logical reasonings (Haddad 2009). The Renaissance "*amor Almagesti*" did not fade away overnight.

[3] Ptolemy's *Planetary Hypotheses* were valorized in parallel with the major astronomical work. They were translated by Matthias Bergius and completed by a different (anonymous) translator before 1587; another anonymous version circulated as *De suppositione planetarum* before 1595; and finally, John Bainbridge, appointed professor of astronomy at Oxford, published their translation under the title of *De planetarum hypothesibus liber* together with the Greek text (London 1620).

[4] In Renaissance times Ptolemy also returned to be a protagonist of the cultural debate in the field of astrology. A direct confrontation with his original lesson was initially pursued to bypass the Medieval and Arabic tradition, whose hermeneutical, Neoplatonic, and sometimes magical accents no longer matched the interest of its new students (Faracovi 2014: 87). A higher competence in the technical aspects of astronomical predictive models and a renewed philological sensibility prompted the need of new translation as conducted directly from the Greek text of Ptolemy's works. That was what happened for both the *Quadripartitum* or *Tetrabiblos*, and for the *Centiloquium* or *Karpus* (or *Fructus*), which was generally believed to be authentic (up to the Caradano's recognition of its spuriousness provided in his commentary of 1554). The first who translated the *Centiloquium* into Latin was much probably George of Trebizond around the middle of the 15th century. His translation was later published in Rome by Luca Gaurico (in 1540), but anticipated in print by the translation with a "naturalizing" commentary of Giovanni Pontano (Naples, 1512). While in Naples, George of Trebizond completed the first translation of the *Quadripartitum* in 1451 for his astrological and prophetic aims (Steiris 2010: 192-194). Conrad Heingarter wrote a commentary on that work in 1477 and Giorgio Valla another one in 1502. Pico della Mirandola took some arguments from Ptolemy's works, *Quadripartitum* included, and turned them against astrology *tout court*. To this end, he frequently and deliberately undermined Ptolemy's authority in his *Disputationes adversus astrologiam divinatricem* (posthumously published in 1496), where he even retranslated and contrastively commented some Ptolemaic passages at the service of his anti-astrological campaign (Rutkin 2020). Nonetheless, Ptolemy's *Quadripartitum* remained a common and widespread textbook in the university syllaba of mathematics, medicine, and natural philosophy courses for more than another century (in Bologna, Padua, Ferrara, and Pisa, among other places). A more systematic translation of the first two books of that four was begun by Joachim Camerarius on a Greek text that he newly established in 1535, and eventually took over and completed by Antonio Gogava in 1548. In 1553-54 Philipp Melanchthon revised and corrected the Greek text provided by Camerarius, retranslated all the four books into Latin, and then published the new version adding his own commentary, with the aim of bringing astrology back to its original purity. Furthermore, in 1574 circa Valentin Nabod completed another translation with commentary, and later (after Conrad Dasypodius's additional translation of 1578) he published a work, namely his *Enarratio elementorum astrologiae* (Cologne, 1560), where he discussed Ptolemy's astrology in detail too. In the expanded editions of his *Speculum astrologiae* (1581 and 1583) Francesco Giuntini translated and commented at length Ptolemaic astrological works among other authorities on the matter. During the academic year of 1585-86, Filippo Fantoni was still reading, commenting and teaching upon Ptolemy's *Quadripartitum* (Rutkin 2010). Confrontation after confrontation, astrology was reformed, rather than undermined, on a more subject-informed basis through the returning to a more philological understanding of Ptolemaic and pseudo-Ptolemaic works. As a sign of long-term persistence, we still find a new technical, commented edition of Ptolemy's *Quadripartitum* in 1658: it was published by Placido Titti in Padua, namely in the place where Galileo has been working fifty years before. (See Hasse, Juste, van Dalen, *et al.* 2016- for a more comprehensive overview of the Latin reception of the astrological and astronomical Ptolemy).

[5] The process of enhanced understanding of Ptolemy's *Geography* was a major intellectual event of the Renaissance (Gautier Dalché 1999: 286), too. That work provided a realistic worldview of the inhabited lands and also offered geometrical and mathematical methods to fill the extant gaps in the geographical knowledge of the terraqueous globe. Moreover, that worldview was consistently integrated in the "greater picture". For, "thanks to its astronomical basis, the *Geography* fitted into the cosmographic pattern of the Renaissance thought, since it underscored the points of interdependence between the organization of the celestial and the terrestrial map: Ptolemy's *Geography* confirmed the [mathematical] correlation between the constant motion of the stars and

sublunary world” (Shalev 2011: 9).

That work, however, was not completely forgotten by the Western scholarship before the formal (re)acquisition, or “reexhumation”, of the Greek text from Byzantium at the end of the fourteenth century (Pastoreau 2012; Gautier Dalché 1999). Interest in its regard was mainly kept alive from late antiquity and early middle ages (Islamic elaboration included) for the spatial coordinates of cities and places there specified, which were often used for astrological “geo-localization” of heavens’ influences on the earth and, in turn, for sanitary prognostications (Id. 2009). After all, “Ptolemy’s *Geography* was construed as a work belonging to the cosmic system described in the *Almagest*, and thus it came to be used from astrological purposes. This use is explained by the close association between the toponymic lists of the *Geography*, with their coordinates, and the equivalent synoptic lists in Ptolemy’s basic astrological manual, the *Handy Tables*.” (Shalev 2011: 10). Aside from this, early humanists as Petrarch and Boccaccio were very much interested in identifying places that were mentioned with neglected toponyms by ancient authors, so that the past works on geography were taken in the highest consideration also for such an antiquarian daintiness (Gentile 2013).

The text of Ptolemy’s *Geography* was searched and retrieved in Constantinople by the Byzantine philologist Maximus Planudes in 1295. Following the indications within the text, he managed to have the no longer extant maps done anew and donated a copy of the recreated manuscript to the emperor Andronikos II Palaiologos (Dilke 1987: 268). The cardinal Bessarion wanted it to be copied in a luxury illuminated version (now in Marciana Library, Venice, as *Marc. Gr.* 31). However, the first entrance of Ptolemy’s *Geography* in Italy happened in 1397, when the Constantinopolitan ambassador and erudite scholar Manuel Chrysoloras came in Florence. He was invited in quality of teacher by the humanists Coluccio Salutati, Palla Strozzi, and/or Jacopo Angeli. He brought many books with him for his assignment. Among them, there was a manuscript code, whose bounded collection of scientific treatises contained a transcription of the *Geography*, or *Guide to Cartography* – as the original title reads there. He intended to use it as textual support for teaching the Greek language. The literal Latin translation of the book was begun by Chrysoloras himself, but the project was taken over by his student Iacopo Angeli da Scarperia in 1401 and brought to an end in 1409 while he was in Rome. Once completed, the translation was dedicated to the pope Alexander V under the given title of *Cosmographia*. That Latin translation was later judged inadequate, imprecise, and incorrect on many aspects, nonetheless it lasted in use as the only one available for more than a century. From that moment onwards, however, the text underwent a long and non-linear process of “cultural *transfert*” made of subsequent transformations, adaptations, corrections, interpolations, appropriations, remakes, and distortions (Vagnon 2003) across Europe. Such a complex process, almost paradoxically, started with the quest for philological fidelity with respect to the text itself.

Niccolò Niccoli, Paolo dal Pozzo Toscanelli (who also commented the *Almagest*) and the humanist circle that gathered in the halls of the Monastery of St. Mary of Angels in Florence prompted the revival of Ptolemaic studies in regard to the recovered text, focusing in particular on its toponomastic nomenclature. Among them, Francesco di Lapacino and then Domenico Buoninsegni translated the place-names that they found in the attached maps with the purpose of identifying with precision *where* the classic authors set the stages of their ancient narratives. The text of Andrea da Barberino’s chivalric poem *Guerrin Meschino* (1410/1420) bore early traces of vulgarized Ptolemaic place-names arguably with the only purpose of tickling the Florentine audience’s imagination with the sound of exotic and far destinations. It is clear, then, that still at this time Ptolemy’s *Geography* was mainly consulted as a reference source of ancient and almost-forgotten toponymes, if not a fictional travel guide or an object of wonder. In dedicating his translation to the Pope, however, Angeli remarked the importance of more technical aspects as peculiarly emerging from the Ptolemaic text, such as the notion of scale, mathematical imaging, spatial coordinates, bidimensional projection or flattering transposition from sphericity besides the implicated methods, etc. also and foremost for astronomical and astrological purposes. It was not by chance that Pierleone of Spoleto, physician of Lorenzo de’ Medici, kept Ptolemy’s *Geography* close together with the *Almagest* and the *Quadripartitum* in his personal library. The issue about how to represent the earthly globe on a bidimensional surface was particularly discussed in France, as notably by Pierre d’Ailly’s *Compendium Cosmographie* (1410/’15), by Guillaume Fillastre’s *Commentary on Pomponius Mela* (1417), and by Jean Fusoris’ *Traité de cosmographie* (1432). All these works implemented the transmission of Ptolemy’s *Geography* on many aspects, with new information as well as with the newly recovered old one. At the same time in German-speaking countries, the interest in the *Geography* was mainly driven by astronomical and astrological requirements, as can be appreciated by the works of Johannes von Gmunden and Georg Münstinger. It was thanks to the work of Johannes Stöffler and his student Sebastian Münster in Tübingen that the study of the *Geography*, conducted in an astronomical context, merged with the technical expertise of mapmaking.

For, Ptolemy’s *Geography* came also with 26 regional maps and a map of the *oecumene* or known inhabited world. These maps were soon reproduced and updated, starting with the work of the painter Pietro del Massaio, who operated in Florence as his humanist fellows. They were eventually improved on many aspects and integrated with new ones (the so-called “*carte nouvelle*” or *tabulae moderne*), also on the basis of Claudius Clavus’s and Nicholas of Cusa’s early maps of nordic European countries, by Nicolaus Germanus in the copy of *Cosmographia* that he made while in Florence for Borso d’Este, the Duke of Modena, Reggio and Ferrara (1467). A selection of city-maps was also added in his later editions, that were all dedicated to Pope Paul II. Francesco Berlinghieri, on the contrary, preferred to maintain a more conservative approach in the cartographic section of his vernacularly rhymed *Septe giornate della Geographia* (Florence 1482, but for fifteen years in the making), more in accordance with the

philological fidelity pursued by Toscanelli's circle. Ptolemaic maps started to adorn the pages of luxury, large-format copies of *Cosmographiae* as well as hanging on the walls of *studia* and Wunderkammern (Van Duzer 2014).

An isolated, hybrid case that stands out from the *Geography*'s Florentine reassessment course is constituted by a Venetian code from 1436/1450 ca., in which the Ptolemaic toponomastic, confronted with Plinian nomenclature, was maintained upon new nautical maps of costs (Milanesi 1996; see also Cattaneo 2004). Analogously, the seamen Andrea Bianco in his *Atlas* (1436) supplemented the Ptolemaic world map both with a circular *mappamundi* and portulan maps of coastlines that originated from his maritime expertise. Fra' Mauro's *Mappamundi* (1448/1453) criticized the Ptolemaic model without subjection, contrasting the inherited prospect with reported experience and marine cartography in use at that time, in order to devise a more inclusive representation of the known world. On the other hand, Battista Guarini's *De ordine docendi ac studendi* (1459) claimed that it was impossible to study geography without the aid of the "*pictura Ptolomei*". Heinrich Hammer (or Martellus) followed the improved projection system of Germanus in his three manuscripts of Ptolemy's *Geography*, where he also inserted historical-geographical notes taken from other past authorities, such as Pliny and Marinus of Tyre. Flavio Biondo declared that the geographical knowledge provided by Ptolemy had to be all but complete (1453). Cyriacus of Ancona and Gemisthus Pleton claimed that the form and the size of the inhabited world as described by the *Geography* was improvable at least: the former concluded thus by the way of his field explorations, while the latter by comparison with Strabo's testimony. In such a general revisionist context, Christopher Columbus obtained copy of the first Latin edition of the book (the Vicenza *princeps* edition of 1475) that was printed without the maps, so that he could also critically consider Ptolemy's continental distances while he was drawing his own maps and planning his epoch-making voyage (Dilke 1992). Therefore, Ptolemy's *Geography* indirectly contributed to the persuasion that the maritime distance between Europe and Asia was not so wide to be not traversed.

Thus, despite the monumentality of the standing model, new factors were increasingly exerting much pressure for a radical reconsideration of the newly recovered Ptolemaic geographical paradigm, as – to list just some of them – witnesses from incoming native travelers contradicting the texts, the consequent contradiction arising with the presumed inhabitability of the torrid zone and the austral hemisphere of the earth, inconsistencies gradually appreciated in the *Geography*'s text itself, new and more precise positioning data provided by astronomers and nautical explorers, the rediscovery of different and antecedent authorities as sources of geographical knowledge besides Ptolemy, the spread of new travel writings and reports. Renaissance cartographers slowly realized with dismay that Ptolemy could have been "wrong" too. It has been aptly remarked, however, that "the movement of critical reception of the *Geography* must not be interpreted as the improvement of Ptolemy as conducted in accordance with his own model" (Gautier Dalché 2009: 337 our transl.; see also Id. 2007: 285-287), so that its history should not be re-told, as often done in the past, as a progressive approximation to the present ideal of "exact" spatial representation.

The history of the reception of Ptolemy's *Geography* would have been much different though if Regiomontanus managed to publish all the works that he intended to print on the topic, as he declared in 1473, such as his textual notes against Angeli's translation, his own new postilled translation, a *Descriptio totius habitabilis notae* with maps and finally the *Commentaria magna in Cosmographiam Ptolemaei* with an explanation on the use of the *meteoroscopium*, the instrument that Ptolemy used to measure geographical latitude and longitude (Malpangotto 2008: 151-153). The Veronese humanist Domizio Calderini revised Angeli's first translation, edited the Latin text from various manuscripts and corrected some of its mathematics; his work was completed and published by the Benedictine Arnold Bucknick (Rome 1477). In 1506 Bernardus Sylvanus emended the text of *Geography* and retouched its numbers for better consistency, although he did not attribute any mistake to Ptolemy but to rather his manuscript tradition.

A telling example of the process of re-definition of the Ptolemaic geographical model is the "terrestrial theory" as illustrated by Lopo Homem's *Mappamundi* in Miller's *Atlas* (1519): here the Atlantic Ocean is showed as a *land-enclosed* sea, just like the Indian (open) sea was conceived by Ptolemy's *Geography*, i.e. a basin, or an enormous lake, entirely surrounded by terrestrial regions (see Fig. 1). In fact, the lands found on the other side of the Atlantic were identified as being part of Asia, so at this stage, the tendency was to "close" the margins of the watermass both at its Northern edge and Southern one in accordance with the Ptolemaic idea of the earth as *Orbis conclusus* (Relaño 2003). The Ptolemaic belief of terrestrial continuity was a principle not easy to dismiss before Ferdinand Magellan's and Juan Sebastián Elcano's voyage of circumnavigation of the earth (1519-1522).



Fig. 1 Lopo Homem, *Mappamundi. Hémisphère portugais*, in “Atlas Miller” (1519).
Bibliothèque nationale de France, Ge D 26179 Rés. Central round selection [Public domain image].

Willibald Pirckheimer retranslated Ptolemy’s *Geography* for the first time after the one made by Angeli more than a century before (Strasburg 1525), perhaps also consulting Regiomontanus’ unpublished drafts for his task. Peter Apianus published the *Cosmographiae introductio, cum quibusdam Geometriae ac Astronomiae principiis ad eam rem necessariis*, that can be considered the first printed handbook for teaching and learning the rudiments of Ptolemaic geography (Ingolstadt 1529; Venice 1533). The first critical edition of the Greek text was the one compiled by Erasmus shortly after (Basel 1533).

Giambattista Ramusio’s *Delle Navigazioni e Viaggi* (3 voll., Venice 1550 and ff.) paved the way for a new, or “substituted”, Ptolemy to face the unprecedented expansion of the geographical subject. Portuguese literary works as Luís Vaz de Camões’s *Os Lusíadas* (1572) and F. Mendes Pinto’s *Peregrinação* (1616, posthumous) shared the same transitional nature: while grounding their descriptions in a Ptolemaic setting of the world, they transcend the Ptolemaic text and lead their readers to places that were unknown to Ptolemy and his epigones too (Gunn 2018).

The end of the Renaissance *fortuna* of Ptolemy’s *Geography* can be conventionally established with the work of Gerard Mercator, who neatly distinguished modern maps from the Ptolemaic ones in different volumes as independent representations of the geographical space (1578).

[6] A peculiar intersection between the Ptolemaic system of geographical projection and the figurative arts can be seen in the Renaissance study of perspective. Leonardo da Vinci devised his *prospettografo* with the third method of projection described by Ptolemy’s *Geography* (Valerio 2012), while Leon Battista Alberti developed his “pre-cartesian” organization of the pictorial composition according to the same principles of spatial coordinates and perspectival reticulation (Veltman 1980). A similar converge of interest can be seen also in Federico Commandino’s edition of Ptolemy’s *On Flattering the Sphere* or *Planisphaerium* (Venice 1558), where he added a study on linear perspective at the end of his commented translation.

[7] Ptolemy’s *Optics* was less known than Euclid’s *Optics* in the Renaissance because it survived only in an incomplete Latin translation made in the 12th century by Eugene of Sicily from a no longer extant Arabic version. Roger Bacon, however, treated Ptolemaic optics as complementary with Euclidean and Arab (Alhacenian) optics and he was not the only one who adopted such a syncretistic approach to the matter. A second reason why the *Optics* did not have the impact that would have deserved was probably due to the fact that it seemed too much sophisticated to its readers, covering also the subjects of catoptrics (on light reflection) and dioptrics (on light refraction) with empirical examples or experiments but without proper mathematical understanding. Attempts to replicate those experiments, however, were tried (e.g. by Leonardo) in order to figure out the underlying theory, also thanks to the improved glass technology later available. Christoph Scheiner’s and Christiaan Huygens’ experimental explanation for binocular vision can be traced back to Ptolemy’s text as well by the way of Ibn al-Haytham (Rayanaud 2016). Moreover, Ptolemy endorsed the “extromissive” theory of vision, according to which the line of sight physically starts from the eye – a theory that was often studied in detail but that not everybody was inclined to accept. In Renaissance artists and painters took advantage of a couple of modeling techniques (aerial perspective and

perspective from an elevated viewpoint) that Ptolemy reported in his *Optics* (II, 123-125) as geometrical tricks to create the illusion of *trompe-l'œil* depth in bi-dimensional representations. “Of Ptolemy’s *Optics* – it has been concluded – we currently know of 15 manuscript-versions, 11 of them dating from after the fifteenth century... [T]he *Optics* was being reproduced at this time not out of historical interest but out of a continuing lively interest in its theoretical content... In fact, publication of Ptolemy’s *Optics* was contemplated twice (but never brought to fruition) during the Renaissance, once by Regiomontanus, in the later fifteenth century, and once by Georg Hartmann, in the early sixteenth” (Smith 2001: 156 and n.20). It should be mentioned also that Moerbeke’s translation of an apocryphal work on mirrors wrongly attributed to Ptolemy (known as *De speculis*) was printed in Venice in 1518 together with other texts on optics. The manuscript version of that text was used, besides Ptolemy’s *Optics*, by Witelo as a reference for his influential *Perspectiva*. Kepler himself developed his basic refraction theory from Witelo, Alhacen, and other perspectivists, who in turn ultimately derived their tabulations from Ptolemy.

[8] Next, Ptolemy’s *Harmonics* regained an equal, if not even superior, *fortuna*. The text, with the comment by Porphyry, was originally recovered in Byzantium around the 10th century, and then it probably arrived in Italy through Venetian collectors in the 15th century. A copy of Ptolemy’s “Musica”, i.e. *Harmonics*, was spotted by Ambrogio Traversari among the library shelves of Vittorino da Feltre in Mantua as early as in 1433. Giorgio Anselmi’s *De Musica*, which appeared one year later, betrays a direct or indirect knowledge of Ptolemy’s *Harmonics* in regard to the theory of musical harmony within the cosmos.

Ptolemy’s *Harmonica* had been read in manuscript by Ficino, as it seems from his epistle *De rationibus musicae* (1484 ca.), in particular in the passage where he projected the diatonic scale upon the circle of the zodiac (Boccardo 2000, 128; cf. Melisi 2013).

Giorgio Valla in the third book of his *De expetendis et fugiendis rebus opus* (1501) quoted Ptolemy on musical matters. Carlo Vargulio criticized Ptolemaic harmonics in the introductory essay of his Latin translation of Plutarch’ *De Musica* (1507).

At the end of the 15th century, Franchino Gaffurio (or Gafori) commissioned the translation of Ptolemy’s *Harmonica* from Greek to Nicolò Leonicensis, that was eventually presented to Pope Paul III by Gian Giorgio Trissino. Previously Gaffurio had just mentioned Ptolemy as a referential authority in his *Theorica musicae* (1492, rev. ed.), but at that time he could not have a proper understanding of the text –as proved also by the early and inaccurate interpretation of the primary source that was provided in his *Practica musicae* (1496). Nonetheless, his *De harmonia musicorum instrumentorum opus* (written in 1500 and published in 1518) was closely modeled on Ptolemy’s *Harmonics*, from which he even developed some ideas about the relation between the sounds produced by the spheres and the resonances of corresponding parts of the human soul (so that astrology, music, and psychology turned out to be intimately related). References to the Ptolemaic harmonic relation of the cosmos and its arithmetical/musical arrangement can also be found in Francesco Zorzi’s *De harmonia mundi totius* (1525).

In his *Musica theorica* (1529), the autodidact Ludovico Fogliano developed a theory of intonation, alternate to the Pythagorean one, grounded on the diatonic syntoton (intense or syntonic tuning) of Ptolemy’s *Harmonics*, as Pietro Aaron did in his *Libri tres de Institutione Harmonica* (1516) before him and Nicola Vicentino in his *L’antica musica ridotta alla moderna prattica* (1555) after them.

In his *Istituzioni harmoniche* (1558) – one of the most original and influential texts of the history of music – the Venetian maestro di cappella Gioseffo Zarlino established that tonal system as the new theoretical basis for Western tuning. The adoption of Ptolemy’s diatonic syntonon permitted Zarlino to resolve the main problem of Renaissance music, both by reforming from within the Pythagorean-Boethian tradition and by adapting it to the musical praxis of the time. Consequently, the ancient Ptolemaic musical ratios and nomenclature were adopted as the referential standard intonation, and they are still in use up to today (Haar 2006: 26-27).

In those years the name of Ptolemy appears in the publishing plan of translations (or re-translations) of ancient and modern musical writings as set by the Accademia Veneziana della Fama.

One of his students was Vincenzo Galilei, who studied Ptolemy’s musical theory as well and compared it with alternative ones. In his *Dialogo della musica antica et della moderna* (1581) he engaged a dispute against his teacher, where the point of contention was also the use of Ptolemy’s tonal system in vocal music. (Later Zarlino replied in his learned *Sopplimenti musicali* (1888), making there clear to have extensively read and reviewed Ptolemy and other musical sources of antiquity in his life-long studies on the matter).

Girolamo Mei, one of the best-informed Renaissance scholars on ancient Greek music, wrote that: “[among all the ancient authors who wrote on the musical science] I have resolved to take as my foundation Ptolemy, for I judge him to be the more exhaustive and conclusive of all”, although his surviving work – as he recognized – was still unavailable in its entirety (*Letter to P. Vettori*, 21 February 1562; see Palisca 1986: 265-266). But that very year Antonio Govara published a Latin translation of Ptolemy’s *Harmonicorum Libri III*. Accordingly, in his *De modis musicis antiquorum* (circulating as a manuscript in Florence from 1573) Mei restored the Ptolemaic tonal system on new philological bases and against long-repeated Boethius’ misunderstanding.

Giovanni de’ Bardi in his *Lecture in defence of Ariosto* (1583) quoted Ptolemy to support the thesis that music is defined by verse, rhythm, and pitch, and so should have been the lyrics of true poetry.

After the Latin translation provided by Antonio Gogava (1562), Ercole Bottrigari claimed to have completed an Italian translation of Ptolemy’s *Harmonica* in 1597 together with other ancient musical writings (although those texts are not extant).

Descartes’ *Compendium musicae* (1618) is Ptolemaic in its essence. The long-term impact of Ptolemy’s

theory of harmonical proportion (syntonic diatonic) as applied to cosmology reaches up to Kepler's *Harmonice Mundi* (1619), where the latter improved the original musical-based consonance with his own theory of geometrical congruity. Even in Riccioli's *Almagestum Novum* (1651), specifically in book IX, sec. 5: "*De Systemate Mundi Harmonico*", the relation was still discussed at length. Finally, in his *Philosophical Origins of Gentile Philosophy* (1683) Newton accused Ptolemy and other gentile philosophers of having mystified the original Pythagorean wisdom that on the contrary had properly disclosed the secret of the harmony of the spheres, though in form of myth.

[9] The French Jesuit Denis Petau translated Ptolemy's *Phaseis* and published them under the title of *De apparentiis inerrantium et significationibus* as part of his *Uranologium* (Paris 1630), together with his *editio princeps* of the Greek text in two columns.

[10] The astronomer and mathematician Ishmaël Bullialdus retrieved Ptolemy's *On the Criterion and the Commanding-Faculty* and the *Canobic Inscription* while he was working at the Royal Library of France. He completed their Latin translation, and edited it in parallel with the original text, as *De iudicandi facultate et animi principatu* and *Inscriptio Canobi ad ipso consecrata* (Paris 1633). He published these works by Ptolemy, and in particular the former, with the declared intent of opposing Descartes' physicalist psychology (Long 1988: 178-179).

Cross-references

- Astronomy
- Geocentrism
- Astronomical Tables
- Astronomical Instruments
- Astrology
- Geography
- Cartography
- Geometry
- Perspective
- Music (Harmonics)
- Truth, criterion of
- Copernicus
- Leonardo
- Columbus

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