COPERNICUS, PHILOLAUS AND THE PYTHAGOREANS

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In 1540, with Georg Joachim Rhäticus's Narratio prima, the scientific community was informed that according to Copernicus, the ancient heliocentric hypothesis attributed to the Pythagoreans could advantageously replace the Ptolemaic system (1). This report by Copernicus' disciple, which anticipated the lines of the new astronomy, was supported by quotes from ancient authors both for and against the Earth's motion that recall those of the De revolutionibus. When the volume appeared, the celebrated letter of dedication to Pope Paul III definitely established Copernicus' reputation as the restorer of the Pythagorean, or Philolaus' cosmology: a formula that had already appeared in the first attack launched in 1544 by the Dominican Giovanni Maria Tolosani, with the accusation of reviving "Pictagoricam confictam opinionem iam diu merito exstinctam... cum expresse contraria sit rationi humanae atque sacris adversa literis", an audacity portending conflict (2). The decree issued in 1616 by the Holy Congregation of the Index condemned as "falsam illam Pythagoricorum, divinaeque Scripturae omnino adversantem de mobilitate terrae et immobilitate Solis", the idea sustained by Copernicus and Father Foscarini (3).

The defenders of the Copernican system also spoke openly of the "opinione Pitagorica della mobilità della Terra", as Galileo stated at the beginning of the Dialogo sopra i massimi sistemi and repeated on several other occasions (4). And Pierre Gassendi, in his Life of Copernicus, commented: "He knew that the Pythagoreans had removed the Earth from the center and had placed there, as in a most noble position the Sun, a most noble body" (5).

The Copernican revolution took place in what may be termed a somewhat Pythagorean vein: in many other writings similar formulas were to be found, so much so that they acquired the weight and importance of commonplaces. Were these purely rhetorical? Did they have a philological basis or was their value merely symbolic? To supply answers to these queries one must turn to the origins, that is to say, back to the writings of Cicero, Plutarch and Lysis on the ancient Pythagoreans, which Copernicus inserted in strategic points of his work (6).

We can exclude that these quotations were merely ornamental, or simply the affectation of an erudite. Accepted without objection by 16th- and 17th-century astronomers and controversialists, they helped to supply the charisma of antiquity to the heliocentric doctrine when brought under fire by its adversaries. It was only at the beginning of the 19th century that a more refined philology once again began questioning the connection between the Copernican system and its alleged Pythagorean predecessors. Philolaus' system was reconstructed in detail, testimony concerning Iceta, Ecfantus of Syracuse and Heraclides Ponticus were carefully examined, and the poverty of these ancient intuitions was revealed. Philologists such as Boeckh, Martin and Apelt concluded that the fragments of the Pythagoreans could not stand up to the achievement of Copernicus (7) who, it was rightly said, was fundamentally not so naive as to attribute to the followers of Pythagoras the technical aspects of heliocentric astronomy. In reality, he had cited their intuitions only as concerned the Earth's motion of rotation and revolution; as he was careful to point out: "I undertook the task of gathering together the books of all the philosophers I could find, with the purpose of discovering if any of them had hypothesized that the movements of the spheres of the world were different... And I thus found first of all in Cicero that Niceto had speculated that the Earth moved. Then I also found in Plutarch that others were of the same opinion..." (8).

The Greek quotation that follows, taken from the Placita of the pseudo-Plutarch, briefly states that according to Philolaus the Earth rotates around the central fire, while in the opinions of Heraclides and Ecfantus it rotates around its axis (9). By implication, Copernicus appears to suggest that the Pythagorean school had combined the two motions. One thus obtains an orbit around the central fire, described every twenty-four hours, by the Earth - Counter-Earth body, which always presents the same face at the center because at the same time it describes a complete revolution around its axis. Thus were saved to great advantage the apparent motions of the entire celestial sphere by putting in motion "the content and not the container, the located and non the locator", as Copernicus argued in Book 1, ch. V, where he makes other references to the ancient Pythagoreans (10).

The philologists of the last century noted that Philolaus' system presented only this advantage over the Ptolemaic system. The lack of parallax of planetary motions had previously been adopted by Aristotle as proof against

the Earth's motion. As for the rest, Philolaus' system created more problems than it solved, and it was anything but heliocentric. This analysis destroyed Copernicus' reputation as a "Pythagorean", which he had not desired - it was concluded - but which had been created by those who came after him; it was spurious, or simply an "errore storico" as it was authoritatively described by Giovanni Schiaparelli in 1873, according to whom Copernicus' only true predecessor was Aristarchus of Samos (11).

A strictly philological criterion cannot but arrive at these conclusions. But must we really conclude that Copernicus' cautious references to the Pythagoreans were casual, that the vagueness of their content escaped him, his followers and those who opposed him? On the other hand, a reputation that has lasted for two hundred years cannot be totally without foundation or insignificant, nor can it be explained away simply as a mistake. Recent critical literature has restored a certain credit to Copernicus' so-called "Pythagoreanism" within the frame of the dilemma in question: was Copernicus a progressive or a conservative, modern or archaic? Let us circumscribe the question.

If Copernicus turned to the cosmological speculations of the "Italic school" - to use Aristotle's well-known definition of it - he did so first and foremost because he shared with Italian humanists the idea of very ancient knowledge being the depository of the original divine revelation, which had to be rescued and reinterpreted. In one of his manuscript notes we read: "our knowledge is a reminiscence of the ancients (antiquorum reminisci)" (12). This maxim, smacking of Platonism when referring to astronomy, helps us to understand the constant attention given to the sententiae of the Pythagoreans which accompanied the development of Copernicus' ideas from the Commentariolus to the De revolutionibus. In fact, the doxography included in the letter to Paul III - a late text - represents no more than the conclusive seal on Copernicus' meditation. On going back to his formative years in Poland and Italy, scholars have found the vestiges of his early interest in the Pythagoreans. The passage from Cicero concerning Iketas figures in a note in the margin written by the young Copernicus sometime around the year 1500 in his copy of Pliny's Naturalis historia. As regards the passage of the pseudo-Plutarch on Philolaus and the other Pythagoreans, it appears that he first read them in Giorgio Valla's Latin translation (1501) and later consulted the original Greek text (13).

The importance of these indications is confirmed by the chronological evidence to be found within the Commentariolus and the De revolutionibus. In one passage of the Commentariolus (written between 1507 and 1513), after formulating the postulates of the system, Copernicus anticipated those who were to accuse him of affirming, "randomly" with the Pythagoreans, the Earth's mobility ("ne quis temere mobilitatem telluris asseverasse cum Pythagorici nos arbitretur"), referring his malevolent reader to the geometric treatment of the circles (14). Later, certain fragments of the manuscript of the De revolutionibus (written between 1516 and 1522) contained, as a confirmation of the argumentation on the Earth's motion, a paraphrase of the original passages by Cicero and Plutarch, which only in 1540 were cited in their entirety in the dedication to Paul III. Thus the masterly persuasive texture of this text, so full of Pythagorean echoes, not only imitates the rhetorical and erudite cadences of a widespread literary genre (15), but also faithfully summarizes the phylogenesis of the work.

If the technical necessity of saving the phenomena does not appear to be a satisfactory justification for the adoption of those ancient precursors, other reasons must be taken into consideration. As was noted some time ago, the fascination exerted by Pythagoreanism on Copernicus and his followers is more general. It includes the predominance of mathematics, the principle of the harmony of the celestial spheres, which was disrupted by the extreme complexity of geocentric astronomy; the need for greater elegance and simplicity; the bond of initiation ans secrecy, which was borrowed from the ancient Italic school to hide the "absurda opinio" of terrestrial motion (16) from laymen. These are collateral motives woven into the letter to the Pope and, beyond their literal interpretation, they must be integrated into the main argument concerning the Earth's motion.

In a passage of the manuscript of the second book, which was excluded from the published edition, Copernicus affirmed that the postulate of the Earth's motion was the cornerstone on which he had constructed the entire science of the stars (17). Only in this - as B. Bilinski recently stated - consists the essential message of the Pythagoreans. Heliocentrism, according to this scholar, comes from other sources: the pseudo-hermetic cult of the Sun, the sun worship that was so widespread in the Renaissance. But the dichotomy between terrestrial motion and heliocentrism is not convincing. How can we introduce a clear-cut distinction between two ideas so closely connected? How

can we say that the Polish astronomer had effectively "begun to consider the mobility of the Earth" only after he had found the fragments in question? If, as has been seen, the internal chronological evidence appears to confirm this interpretation, there is also a certain amount of polemic artifice for the simple reason that Copernicus may have been oriented towards research on the Pythagoreans by frequent testimonials and polemic allusions that are to be found in Aristotle, as in a passage from the De Caelo: "In the opinion of most people, the Earth is at the center. The contrary is held by those of the Italic school, known as the Pythagoreans. They say that in the center is the fire, that the Earth is a star that by rotating around the central part originates day and night. Then, against this, they say that there is a second Earth, which they call the Counter-Earth: and they state this not by searching for the reasons for the phenomenon, but by exaggerating the meaning of the phenomena and trying to make them agree with some of their preconceptions" (De Caelo, B 13-293 to 18) (18).

All specialists were familiar with Aristotle's and Ptolemy's argumentations for and against the thesis of the Earth's motion sustained by the Italic school. To ponder too subtly on the sources appears to be somewhat idle, and the same can be said for wondering whether or not Copernicus was really a Pythagorean, or just "Pythagoric" (19). It can surely be stated, however, that inclusions in the De revolutionibus of repeated references to the Pythagoreans alluding to astronomical arguments notoriously rejected by the dominant cosmology were not dependent upon specific mathematical or astronomical reasons, nor upon personal acts of faith; but rather upon the cultural context of Italian humanism, the mental outlook and the conflict in progress among upholders of the various philosophical traditions of the ancients. The difficult battle against the principle of Aristotle's authority could be fought only in the name of another principle of authority. The unsaid was a most effective rhetorical weapon. Copernicus' intention was exactly this: to tacitly counter the testimony concerning the Pythagoreans with Aristotle's confutation of them. His relatively simple polemical technique consisted just in his rehabilitation of the opinions rejected by Aristotle and Ptolemy in the first book of the De revolutionibus, which acts as a critical counterpoint to the Almagestus and the De caelo. It can be said that to counter the overriding authority of Aristotle and Ptolemy by proposing the obscure names of Iketas, Heraclides, Ecfantus and Philolaus was similar to putting David in the field to face Goliath. The hopes of victory were placed first and foremost in the hands

of reason and the calculations of mathematical astronomy. But in the background there was the support of the great Pythagorean revival that had taken place in 15th-century Italian philosophical circles. Recent studies have documented the renewed prestige enjoyed by Pythagoras - Plato's master - in the context of the hermetic and neo-Platonic current (20). His archaic ipse dixit was capable of challenging successfully that of his rival Aristotle. His name figures as the third in the golden chain of the prisci theologi drawn by Marsilio Ficino and accepted by his followers, among whom Copernicus, Bruno, Kepler and many other natural philosophers up to Newton.

One most important aspect of the Pythagorean revival was the decrypting of the Symbola and the Aurea Carmina, to which the Florentine Platonists had dedicated themselves. These texts, attributed to Pythagoras but in reality apocryphal, were considered examples of the strategy of silence, the use of enigmas and parables to conceal the truth from the uninitiated, in line with the customs of the Italic school of those times. The humanistic philosophers attached great importance to this esoteric and initiatory aspect of Pythagoras teachings, both in theological and moral questions as well as in mathematics.

Copernicus intentionally revived the initiation and strategy of silence as a part of his own strategy in publishing the work. From the very beginning, in the letter to Pope Paul III, he stresses the need to keep philosophical opinions "remotas a iudicio vulgi", the accusation of absurdity which certainly would have struck the "acroama" of terrestrial motion, and continued: "I hesitated at length on whether to publish my commentaries demonstrating such motion, or if it would not be wiser to follow the example of the Pythagoreans and some others, whose custom it was to hand down the mysteries of philosophy only to relatives and friends, not in writing, but orally only, as we can see in the letter sent by Lysis to Hipparchus" (21).

In the manuscript of the first book of the De revolutionibus was found the Latin transcription of this ancient Greek text - Lysis's letter to Hipparchus - which recommended the Pythagorean practice of silence (22). Copernicus eliminated this from the published work and left only a trace of it in the passage of the letter to the Pope just mentioned. The letter attributed to Lysis has a strictly religious, moral and philosophical sense, Copernicus, however, extends its meaning to cover astronomy as well, by bringing Philolaus and Aristarchus into the question:

"Since we are dealing with things we can understand only by applying acute ingenuity and diligence over a long period of time, they had therefore remained hidden to most philosophers, and few were those at that time who knew the laws governing astral movements, as Plato states. But if they were understood by Philolaus or other Pythagoreans, it is in any case probable that they were not handed down to their descendants. In fact, it was the custom of the Pythagoreans not to record their observations in writing and not to reveal to all the secrets of philosophy, but only to inform their friends and those close to them and put them in their hands"(ibid).

The astronomical doctrine of the Italic School was thus secret, entrusted to the oral, "acroamatic" tradition: the key to Copernicus' controversial "Pythagoreanism" is to be found in these words, which had remained unpublished up to 1873 (and were thus unknown to Schiaparelli). They mean simply that the residual fragments of Philolaus and the other Pythagorean authors are, like the Symbola and the Aurea Carmina, the coffer of a secret doctrine, so to speak. They do not contain a precise exposition of the world system kept secret from the non-initiated, but only an incomplete and enigmatic version of it. For this reason they simply mention the Earth's motion, while concealing all the technical details of the heliocentric doctrine. Copernicus' insistence on the figure of Philolaus is to be interpreted in this sense: he alludes more to the keeping of the secret than to the system in itself, which is so difficult to decipher. We must not in fact forget that according to the doxographic tradition, Philolaus had been the first to reveal, at least in part, the secret teachings of the school; and that Plato was informed thanks to the acquisition of his books in Italy (23).

There is thus in Copernicus an evident process of self-identification with Philolaus. This reached its apex when the publication of De revolutionibus, postponed for many years, was finally decided on. Contrary to what we read in Osiander's "hypothetical" prologue, the epistemology of the author was solidly realistic: Copernicus was convinced that there was a single, real world system, known to the Pythagorean "mathematicians" of the past, who were the depositories of an original revelation. The task he had assumed was that of reconstructing - through experiment, observation and mathematics - the exact structure of this system, which had remained hidden to the uninitiated for twenty centuries. Within certain limits, the ancient oath of silence remained in force. The well-known clause "Mathemata mathematicis scribuntur" (24) may

be translated as: "Mathematical truths are reserved to those capable of understanding mathematical symbols". This may appear to be somewhat tautological, but it no longer appears as such if we keep in mind, going beyond the more obvious sense of the term, its meaning in the Pythagorean schools: "mathematician" was a hierarchical title reserved to members of the supreme élite among the initiated (25).

Aristotle and his followers were in no sense of the term "mathematicians". The critical exposition of Philolaus' doctrine in the De caelo is therefore, in the eyes of Copernicus, flawed by the gross distortion of a layman who never passed the threshold of secrecy and who was deceived by the esoteric version of the astronomical teaching of the Italic school.

Kepler's writings confirm this viewpoint. Interest in the Pythagorean doctrines, as Koyré notes, guided almost obsessively his research, from the aprioristic model of the Mysterium cosmographicum of his youth to the music of the spheres of the Harmonice mundi. Throughout the work of the Bohemian astronomer we find an abundance of motifs tending towards the hermetic and Pythagorean, gathered from ancient sources or from the Italian Platonists. What is important here is to recall that Kepler traced the cosmological doctrine of the five, perfect regular solids, which was re-elaborated throughout the Greek and Renaissance tradition, back to Pythagoras. In the Mysterium Cosmographicum (1597) he proclaims that his model of the heliocentric system, built upon the regular polyhedra, "was proposed more than two thousand years ago by Pythagoras, but now for the first time is being made known to mankind" (26). The five "perfect" geometric figures are the archetypes with which the divine mind created the cosmos. Arranged in concentric succession, they mark the order of planetary orbits.

It is known that the model of the Mysterium Cosmographicum, or more precisely, the Pythagorean-like obsession at its origin, was not foreign to the birth of elliptic astronomy, thanks to the influence it had on the formulation of the three planetary laws. Twenty years later, in the Harmonice mundi, Kepler retraced and concluded the context of the discovery, insisting on the Pythagorean genealogy behind it. While debating with Pietro Ramo, he exclaimed: "What if the Pythagoreans taught the same doctrine that I teach, and concealed it in the veil of words? fact, the Copernican world system is present in Aristotle himself, and confuted by him under different names... We

therefore argue that their opinion, read *sub aenigmate* by Aristotle, was confuted by him as if the words had real meaning" (27).

In other words, the Stagirite did not understand the secret symbolism of the heliocentric doctrine, which was hidden under the five regular solids inserted into the orbits around the Sun. He erroneously identified the regular solids with the four elements and the quintessence. Kepler thus corrects him: the cube does not designate the Earth but the motion of Saturn; the octahedron not the air but Mercury's orbit; the tetrahedron not fire but Mars; the icosahedron not water but Venus. Finally, the dodecahedron circumscribes the world. "In this way", Kepler concludes, "in the Pythagorean mysteries the five figures were distributed not among the elements, as Aristotle believed, but among the planets" (28).

As a consequence of this error - the error of a layman to whom the Pythagorean mysteries were locked away under seven seals - the Earth was placed at the center, and the real world system remained buried for twenty centuries beneath the enormous weight of the principle of authority.

As can be seen, Kepler's comment explains Copernicus' intentions. The two great mathematical astronomers were convinced that in the book of nature they were rereading the palimpsest previously written by the ancients: "antiquorum reminisci". At the end of the astronomical revolution, Newton remembered the Pythagorean argument and adapted it to his own celestial mechanics with a wealth of references in the so-called classical scholia, which were drafted for the second edition of the Principia mathematica. In those pages, Newton stated that in the fragments of the Pythagoreans, hidden behind symbolic phrases and figures, knowledge of the inverse-square law was already present (29). Thus the circle closed. The decisive discovery of modern mathematical astronomy was reread, by the protagonist himself, in the enigmatic formulas of the "mathematicians" of the ancient Italic school.

NOTES AND REFERENCES

1. For the Narratio prima and the Copernican texts, unless otherwise indicated the reader is referred to N. Copernico, Opere, Italian trans. edited by F. Barone, Torino 1979; "Prima esposizione...", pp. 784-85, where Rhäticus describes the six heliocentric spheres and dedicates a paragraph to the mystic numerology of the Pythagoreans; shortly afterwards he states that Copernicus followed "Plato and the Pythagoreans" in his system. For the later passages cited from the De Revolutionibus, lib. I, the Italian translation by C. Vivanti in the edition with parallel text in Latin, edited by A. Koyré, Torino 1975, was consulted.

2. E. Garin, "Alle origini della polemica anticopernicana", in Colloquia Copernicana, Ossolineum 1937, p. 38, which reproduces a manuscript opuscule of 1544, conserved in the Bibl. Naz. of Florence (Conventi Soppressi, J. I. 25), written by the Dominican friar and astronomer Giovanni Maria Tolosani (1470-1549); reproduced in E. Garin, Rinascite e rivoluzioni, Bari-Roma 1975, pp. 283-95; cit. on p. 291, and passim the considerations in defence of Aristotle and Thomas Aquinas against the Pythagoreans.

3 Cit. in G. De Santillana, Processo a Galileo, Italian trans., Milano 1960, p. 264. The decree explicitly mentions the Lettera del Padre Maestro Antonio Foscarini Carmelitano, sopra l'opinione de' Pittagorici e del Copernico della mobilità della terra e stabilità del sole, et il nuovo Pittagorico sistema del Mondo. In Napoli, per Lazzaro Scoriggio, 1615.

4. G. Galilei, Dialogo sopra i due massimi sistemi del mondo..., "Al discreto lettore", in Edizione Nazionale, VII, 29; from other references to the Pythagoreans on pp. 34, 35, 215, 354, 355 and 369 it can be deduced that Galileo, although rejecting the "misteri" and the "sciocchezze" of the occultism of a certain Pythagorism, attributed with no hesitation the first intuition of the Earth's motion around the Sun to the Italic school.

5 "Cum nosset vero Pythagoreos ablegasse Terram a centro, et in eo, ut loco nobilissimo, constituisse Solem corporum nobilissimum...". After citing the same Greek authors mentioned by Copernicus and upholders of the Earth's motion around the Sun, he added: "praeclarius fecisse Philolaum dum Terram a centro amovens tribuit ipsi non modo motum diurnum circa proprium axem, sed circumductum etiam annuum circa Solem"; P. Gassendi, "Nicolai Copernici Vita", in Opera omnia, Lyon, 1658, 6 vols.; V, 501 a-b.

6. Letter to Paul III, pp. 169, 174; Lib. I, ch. V, 191, ch. XII, 221, 222.

7. A. Boeckh, Philolaos des Pythagoreers Lehren, Berlin 1819; T. H. Martin, L'hypothèse astronomique de Philolaüs, Roma 1872; E. F. Apelt, Untersuchungen über die Philosophie und Physik der Alten, Leipzig, 1848, Cf., G. V. Schiaparelli, Scritti sulla storia dell'astronomia antica, Bologna 1925-1927, (some essays were written in around 1873) vols. 3; I, 229 ff.

8. Letter to Paul III, p. 173.

9. Ibid., p. 174.

10. Ibid., p. 191; cf. Note 22.

11. G. V. Schiaparelli, I precursori di Copernico nell'antichità (1873), in op. cit., I, 361, 377 ff; cf. J. L. E Dreyer, History of the planetary system, from Thales to Kepler, Cambridge 1906; T. Heath, Aristarchus of Samos, the ancient Copernicus, Oxford 1913.

12. Cit. in B. Bilinsky, Il pitagorismo di Niccolò Copernico, Ossolineum, 1977, p. 46; this well-documented and thought-provoking study is recommended for the many details it provides. Cf. A. L. Birkenmajer, Stromata Copernicana, Krakow 1924, p. 301.

13. Bilinski; Il pitagorismo..., p. 56.

14. In the Commentariolus, Italian trans. cit., p. 111, Copernicus states, on referring to the agreement between calculation of the circles and observational data, "Let no one suppose that I have gratuitously asserted, with the Pythagoreans, the motion of the Earth; strong proof will be found in my exposition of the circles."

15. Besides Bilinski, cit., see R. Westman, "Proof, Poetics and Patronage - Copernicus's preface to De revolutionibus", in Reappraisals of the Scientific Revolution, by various authors, edited by D. C. Lindberg and R. S. Westman, Cambridge 1990, pp. 167-205.

16. See in this sense S. K. Heninger Jr., "Pythagorean cosmology and the triumph of heliocentrism", in Le soleil à a Renaissance, Science et mythes, Colloque international, avril 1963, Bruxelles-Paris 1965, pp. 35-53.

17. Bilinski, cit., p. 69.

18. Diels/Kranz, 58, B 37, Italian trans. by A. Maddalena in I presocratici, various authors, Roma-Bari 1983; I, 582.

19. It is a question that has been discussed from different viewpoints by B. Bilinski, in reply to T. W. Africa, "Copernicus' relation to Aristarchus and Pythagoras", Isis, 52, 1961, pp. 404 ff., E. Rosen, "Was Copernicus a Pythagorean?", ibid., 53, pp. 508 ff.

20. Besides the well-known studies on Marsilio Ficino by O. Kristeller and the essay by C. Vasoli, "Copernico e la cultura italiana del suo tempo", in I miti e gli astri, Napoli 1977, pp. 313-50, see the documentation brought by J. H. Swogger, Antonio degli Agli's Explanatio Symbolorum Pythagorae. An edition and a study of its place in the circle of Marsilio Ficino, Phil. Dr. Thesis, University of London 1975, a typewritten copy of which I was able to consult.

21. Letter to Paul III, cit., pp. 168-69.

22. N. Copernicus, De revolutionibus orbium caelestium, Lib. I, ch. IX, cf., Facsimile ms, Warsaw-London 1973, cc. 11 v.-12 r.v. See the notes added to the respective translations by F. Barone, p. 219, and C. Vivanti, p. 113.

23. Diogene Laerzio, VIII, 84-85, in Diels-Kranz, cit., 44 A 1.

24. Letter to Paul III, p. 177.

25. Giamblico, La vita pitagorica, XVIII, Italian trans. with parallel text and comments by M. Giangiulio, Milano 1991, p. 217.

26. J. Kepler, Mysterium Cosmographicum, editio altera, in Gesam. Werke, hgbn. von F. Hammer, Munchen 1963, vols. 17; VIII, 16, 23, 27, 28.

27. Harmonice Mundi, hgbn, von M. Kaspar, ed. cit., VI, 17. On the question see especially A, Koyré, La rivoluzione astronomica, Italian trans., Milano 1966, pp. 97 ff.; an up-to-date anthology of criticism is offered by the volume La musica nella rivoluzione scientifica, edited by P. Gozza, Bologna 1989.

28. Harmonice Mundi, p. 18.

29. I refer the reader to my paper: "Newton: gli scolii classici", in Giornale critico della filosofia italiana, V series, LX (LXII, 1981), pp. 7.53 [= "Newton: the classical scholia", in History of science, XXII (1984), pp. 1-59] for this aspect.