

Noel Putnik

DE HARMONIA MUNDI: THE EARLY GREEK NOTIONS OF HARMONY AND SYMMETRY

Abstract. The notions of harmony and symmetry played a pivotal role in early Greek mathematics as well as in philosophy, science, religion and art. Since all these areas of intellect were not sharply divided and separated in ancient Greece as they are today, their meanings and connotations tended to overlap and intersect. The essay offers a brief historical-philological examination of the terms *harmonía* and *symmetría* in ancient Greek thought, with a comparative look at some cognate terms such as *métron*, *lógos* and *analogía*. By examining these terms from the vantage point of etymology, semantics and intellectual history, it is possible to acquire a more comprehensive understanding of their multilayered meanings in different fields, from mathematics to art. The analysis focuses more closely on the concept of harmony in the Pythagoreans and Plato, who applied this term in their doctrines of the harmony of the spheres.

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The Institute of Ethnography SASA, Belgrade, Serbia

noelputnik@gmail.com

ORCID: 0000-0002-9233-2605

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1. Introduction: the harmony of the world

This essay borrows a part of its title from a philosophical treatise written in early 16th century: Francesco Giorgi Veneto (1466–1540), a Venetian Franciscan friar, renowned theologian and proponent of Christian Kabbalah, published a lengthy work in 1525 titled *De harmonia mundi totius* [The harmony of the whole world]. In addition to being attracted to Jewish Kabbalist tradition, which he attempted to appropriate and Christianize, Giorgi was strongly influenced by Renaissance Neoplatonism, and through it by the ancient philosophers Plato and Pythagoras [30, p. 33–42]. In his treatise, Giorgi developed a concept of harmony that God bestowed upon the world at the moment of creation. This harmony is based on number and measure, that is, on the numerical and mathematical laws of proportion. According to the Venetian friar, the Universe was built and structured by the divine Architect as a temple of perfect proportions, in accordance with the immutable principles of cosmic geometry and arithmetic. It was created as a primordial unity from which all things proceed by four ways: arithmetic, geometric, harmonic and musical [29, p. 112–119][26, p. 126–140]. In consonance with the Neoplatonic idea of cosmic correspondences, such a structure of the Universe enabled man-the-microcosm to harmonize with the macrocosm [22, p. 151–187], which is one of the main topics of *De harmonia mundi*.

Francesco Giorgi was far from being the only philosopher with such views. The Platonic–Pythagorean notion of the harmony of the world flourished especially in the Renaissance and the early modern period: one finds it in the works of many other authors such as Marsilio Ficino, Cornelius Agrippa, Athanasius Kircher,

Robert Fludd etc., and it continues to influence modern science, art and culture in a variety of ways.

One of the most important early modern proponents of this notion was Johannes Kepler (1571–1630), the famous German mathematician and astronomer who discovered the laws of planetary motion and was one of the key figures in the Scientific Revolution. In 1619 Kepler published a book with almost the same title as that of Francesco Giorgi – *Harmonices mundi libri V* [Five books on the harmony of the world] – in which he analyzed various forms of cosmic harmony, above all the harmony of the planetary motions, and linked them to the concept of *musica universalis*, musical consonance. He based his idea of musical consonance on the geometrical ratios and angular velocities of the planets, but also on the well-established ancient and medieval notion of *musica universalis* that goes back to Pythagoras' and Plato's harmony of spheres¹. This notion was conveyed to the Middle Ages and, later, to the early modern period through Boethius and his educational system of *quadrivium*, as well as through Pseudo-Dionysius the Areopagite and his doctrine of the angelic hierarchies [28, p. 59–60].² Thus, it had deep philosophical as well as religious roots [2, p. 88–113].

Kepler developed his theory of the universal harmony from his examination of regular polygons and the five Platonic solids, which he believed formed the geometric basis of the universe: in another, much earlier work, the *Mysterium Cosmographicum* [Cosmographic mystery, 1596], Kepler argued that the planetary orbits were determined by the Platonic solids inscribed and circumscribed by spherical orbs [7, p. 60–66]. In conjunction with his analysis of planetary motions, especially relationships between orbital velocity and orbital distance from the Sun, this conviction led him to postulate the idea of musical harmony that resulted from the tones made by the six known planets (Figure 1).

Coming back to the religious roots of Kepler's theory of the cosmic harmony, founded on his theological convictions about the connection between the physical and the spiritual, it is important to add that this theory was not based only on observation and analysis, but also on certain irrational factors. Namely, in several instances Kepler claimed that his discoveries had come to him as a result of epiphany, some sort of divine revelation: one of such epiphanies came to him on the 19th of July 1595, just prior to writing the *Mysterium Cosmographicum*. As I will show below, this motif of divine revelation concerning the structure of the cosmos appeared regularly in other, much older doctrines of *musica universalis*.

2. In search of the deepest layers of meaning

In order to better understand this ancient link between mathematics, music and philosophy, it is important to gain a deeper insight into the etymological origins

¹In a 1597 letter to Galileo, Kepler referred to Plato and Pythagoras as “our true masters” [4, p. 41].

²Some sources suggest that Kepler even tried to compose the music of the spheres, even though he believed it was inaudible to the ordinary human beings [7, p. 47]. A number of modern composers have been influenced by Kepler's concept of *musica universalis* (Rued Langgaard, Paul Hindemith, Philip A. Sparke and others).

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omnia (infinita in potentia) permeantes adu : id quod aliter à me non potuit exprimi, quam per continuam seriem Notarum intermedia. CAP. VI

Acquiſignatura diuini in communi Syſtemate Clauium, & formatio Reſta Octaue, per comprehensionem certi intervalli concinunt, eſt rudimentum quoddam diſtinctionis Tonorum ſeu Modorum: ſunt ergo Modi Muſici inter Planetas diſperſi. Scio equidem, ad formationem & definitionem diſtinctarum Modorum requiri plura, que cantus humani, quippe intervalli, ſunt propria: itaque voce quodammodo ſum uſus.

Liberum autem erit Harmoniſte, ſententiam deprimere ſum: quem quique planeta Modum exprimat propiis, extremis ſic ipſi ſignatis. Ego Saturno darem ex officio ſeptimum vel Octauum, quia ſi radicem eius clauem ponas G, perihelium motus ſcendit ad G: Jovi Primum vel ſecundum, quia aphelium eius motus ad G accommodato, perihelium ad ſcendit: Marti Quintum vel Sextum: non eò tantum, quia ſcendit Diapente aſſequitur, quod intervalum commune eſt omnibus modis: ſed id eò poſſibilem, quia redactus cum ceteris ad commune ſyſtema, perihelio motus aſſequitur, aphelio ad ſcendit: que radix eſt Toni ſeu Modi Quinti vel Sexti: Telluri darem Tertium vel Quartum: quia intra ſemitonium eius motus uenitur: & uerò Mercurio Primum illorum Tonorum intervalum eſt ſemitonium, Mercurio uerò ob amplitudinem intervalli, promiſſiue omnes Modi vel Tonos conuenient: Venere ob anguſtiam intervalli, planè nullus: ſi ob commune ſyſtema, etiam Tertius & Quartus: quia ipſa reſpectu ceterorum obtinet.

CAPVT VII.
Harmonias univerſales omnium
 ſex Planetarum, ueluti communia Contrapuncta, quadriformia dari.

Nunc opus, Vranie, ſonitu maiore: dum per ſcalam Harmonicam coeleſtium motuum, ad altiora conſcendat, quò ge-

FIGURE 1. Planetary musical scales from Kepler's *Harmonices mundi* (1596) [32].

and the earliest meanings of the Greek lexemes ἀρμονία [*harmonía*] and συμμετρία [*symmetría*], which preserve the basic mental images related to these lexemes.³ Various meanings attributed to harmony and symmetry played important roles in several areas of Greek spirit: in mathematics and science, in philosophy, religion and mysticism, as well as in arts, especially music, architecture and visual arts. This is particularly emphasized by the fact that these areas were not sharply divided and compartmentalized in ancient Greek thought as they are in our time; instead, they overlapped, intersected and cross-fertilized, allowing various terms and concepts to shift between areas, which is precisely why at the present time we operate with so many different usages of the terms in question. All these usages come down to several basic meanings or, as I call them, mental images that informed the traditional concepts of harmony and symmetry.

Thus, the vantage point of my analysis is primarily that of etymology, semantics and intellectual history. By tracing the historical development of the concepts of harmony and symmetry as attested in the surviving ancient Greek and Roman literature, it is possible to uncover the oldest layers of their meanings that have become integral parts of their usage in vastly diverse fields and disciplines. The

³ On numerous applications of the terms harmony and symmetry in mathematics and music, see [8].

analysis reveals that the basic, original meanings of the terms in question were not abstract, as they would become in the later phases of development, but rather surprisingly concrete and linked to everyday life. However, as already said, the mental images related to these concrete meanings were gradually transferred to the abstract meanings, too.

3. Building a raft: the original meaning of harmony

The earliest attested meaning of the lexeme *harmonía* in Greek literature comes from the *Odyssey* (8th–7th century BC): it is found in the episode in which Odysseus builds a raft to continue his long journey to Ithaca. He spent seven years as a captive of the nymph Calypso on the mythical island of Ogygia. The enamored nymph did not want to let him go, promising him immortality in exchange for love. Only after the intervention of the gods she allowed him to leave and continue his journey. Moreover, she was forced to provide him with clothes, food and water for the journey, as well as to help him build a raft. This is how Homer (Od. V 244–248) describes the process of building the raft:

εἵκοσι δ' ἔκβαλε πάντα, πελέκκησεν δ' ἄρα χαλκῶ,
 ζέσσε δ' ἐπισταμένως καὶ ἐπὶ στάθμην ἴθυνεν.
 τόφρα δ' ἔνεικε τέρετρα Καλυψῶ, δῖα θεάων:
 τέτρηνεν δ' ἄρα πάντα καὶ ἤρμωσεν ἀλλήλοισιν, [hérmosen alléloisin]
 γόμφοισιν δ' ἄρα τήν γε καὶ ἀρμονίησιν ἄρασεν. [harmoníesin árasen]⁴ [33]

Twenty trees in all did he fell, and trimmed them with the axe; then he cunningly smoothed them all and made them straight to the line. Meanwhile Calypso, the beautiful goddess, brought him augers; and he bored all the pieces and *fitted them to one another*, and with *pegs and mortises* did he *hammer it together*.⁵

These verses tell how Odysseus processes, stacks and joins wooden logs with the tools he received from Calypso. For the present discussion, the most important part of the description is the way he fits the logs to one another by using wooden pegs: he unites them into a *harmonious whole*, which will be able to sail the sea (until the angry Poseidon wrecks the raft). Here Homer uses the nouns γόμφος (peg, tenon, nail) and ἀρμονίη (*harmoníē*, the Ionic Greek equivalent of ἀρμονία), which Murray translates as “mortise”, while other English translators (e.g. [12]) render it as “rivets”, “bonds” or “joints”. Whatever the translators’ word choice, the earliest attested meaning of *harmonía* in Greek is “bond”, “joint”, “means of joining”, “connection”, something that connects and binds things in a harmonious way [17, p. 244]) (Image 2).

Two other important words that Homer uses in this passage are the verbs ἤρμωσεν [*hérmosen*], a past tense of ἀρμόζω [*harmódzo*], and ἄρασεν [*árasen*], a past tense of ἀραρίσκω [*ararísko*], both with the meaning “to bind”, “to join”, “to fit together” [17, p. 234, 243]. They are both etymologically and semantically akin to “*harmonía*”. Their reconstructed Proto-Indo-European root is **h₂er-* [9, p. 128,

⁴ The relevant words in the standard Perseus online Greek edition are marked in bold and their pronunciation is given in square brackets. It is a digital version of the text given in Homer 1919.

⁵ This is a digital version of A. T. Murray’s translation [11].

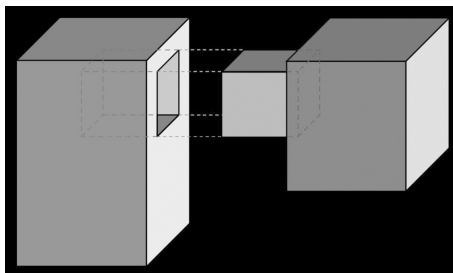


FIGURE 2. A mortise and tenon joint – the original meaning of *harmonía* [35].

145] [5, p. 123, 134–135], with the general meaning “to bind”, “to fit together”⁶. We thus come to the earliest, Proto-Indo-European meaning of the word “harmony”, whose root is also **h₂er-*: it pertained to *the act of binding or fitting together* and this mental image was the core of all later meanings of the word. It can also be noticed in some words with the same root in Greek and other languages, such as ἄρθρον [*áarthron*], “joint”, “wrist” (hence arthritis), or the Latin *artus* / *articulus*, “joint”, “knot”, “knuckle”, and *artare*, “to press close together”, etc.

4. A shift to cosmological and ontological meanings

It appears that the term *harmonía* started to acquire more abstract meanings during the 6th century BC with the activities of the first philosophers of nature and protoscientists in ancient Ionia. It is in the extant fragments of thinkers such as Thales, Anaximander and Anaximenes of Miletus that we first find rationally articulated ideas about cosmology and a universe governed by the immutable cosmic order and its laws [3, p. 53–100]. During this period, the notion of cosmic order was linked to and expressed through the terms ἄρμονία, μέτρον [*métron*] and λόγος [*lógos*]. One of the earliest testimonies of the term *harmonía* with the abstract meaning of cosmic order comes from Heraclitus of Ephesus (6th–5th century BC), whose fragment 54 reads as follows:

ἄρμονίη ἀφανῆς φανερῆς κρείττων. [*Harmoníe afanés fanerés kreítton*]

An unapparent *connection* (or: harmony) is stronger (or: better) than one which is obvious [25, p. 39–40].

Although in his translation of Heraclitus T. M. Robinson sticks to the earliest, literal meaning of *harmonía* (or *harmoníe* in the Ionic rendering) as “connection”, it is often directly rendered as “harmony” [3, p. 169], which implies that by Heraclitus’s time, or in his own usage, the term had acquired an abstract meaning referring to the invisible cosmic order. In the context of the Heraclitan philosophy of constant flux and change and his concept of the conflict and unity of opposites,

⁶ It is important to note that Butler renders the words ἄρμονίησιν ἄρασεν [*harmoníesin árasen*] more precisely than Murray: instead of “he hammered it together”, which is a visually striking image, Butler translates this place as “he fitted the timbers together”, conveying the original meaning of the root **h₂er-*.

harmony appears as a force that reconciles and unifies the opposites. The conflict of opposites, which is the *primum movens* of Heraclitus's world, is brought into balance by that "unapparent" or hidden harmony which, in Robinson's words, can be interpreted

as the greater power and/or acceptability of the Pythagorean "harmony of the spheres" (God-made, and unheard) than that of man-made *harmoníe*, or the greater power and/or acceptability of the deep, unifying structure of the real (God-made, and unseen) than that of man-made structures [25, p. 118–119].

As Robinson implies, it is quite possible that Heraclitus adopted such a concept of harmony from Pythagoras, although he did not have many nice words for the legendary philosopher (see, for instance, frag. 40, [25, p. 30–31] [3, p. 165]).

There is another term in Heraclitus that resembles that of harmony – the word μέτρον [*métron*] with the abstract meaning of "proper measure": The sun (god) will not overstep (his) measures (μέτρα). Otherwise (the) avenging Furies, ministers of Justice, will find him out (frag. 94, [25, p. 96–97]).

In other words, every single element and aspect of the universe is harmonized and synchronized with the others, perfectly fitted into the whole, even though everything is in constant flow and subject to change, or – in Heraclitus's view – in war with one another (Frag. 80, [25, p. 48–49]). Interestingly enough, this idea of harmony as a union, balance and consonance of opposites also appears in early Greek mythology: it was personalized as the Theban queen Harmonia, the wife of Cadmus, the founder of the mythical Thebes. Harmonia was the daughter of the gods Ares and Aphrodite [27, p. 446]. In other words, she had a divine origin and was united to a man – a theme later interpreted as implying the harmony of the macrocosm and the microcosm. More importantly, Harmony was the child of gods who symbolized the exact opposites: Ares was the god of war, Aphrodite the goddess of love. Their daughter reconciled the opposites and thus ensured the unity of the world.

5. Pythagoras and the harmony of the spheres

The concept of cosmic harmony is, above all, associated with the name of Pythagoras (c. 570–c. 495 BC), the philosopher-mystic from the island of Samos. From the earliest times, his name was conjoined with the doctrine of the universe as a harmonious system of numbers and their relationships. According to many ancient sources (referred to in [16, p. 273–274]), Pythagoras and his followers regarded number as the essence of all things and believed that mathematical relations permeate the cosmos and express its timeless, eternal principles. The Greek tradition maintains that Pythagoras was the first philosopher who realized that the planets move according to certain mathematical laws and that in their motion they create the harmonious tones of a cosmic music (*musica universalis*) inaudible to ordinary people. That early concept would later become known as the harmony of

the spheres [21, p. 277–278].⁷ The Pythagorean idea of the “harmony in the universe” (ἁρμονία ἐν κόσμῳ) implied that the cosmic music created by the motions of the celestial objects was a system (σύστημα) of three consonant tones – a quarter, a fifth and an octave [15, p. 207] (Image 3).

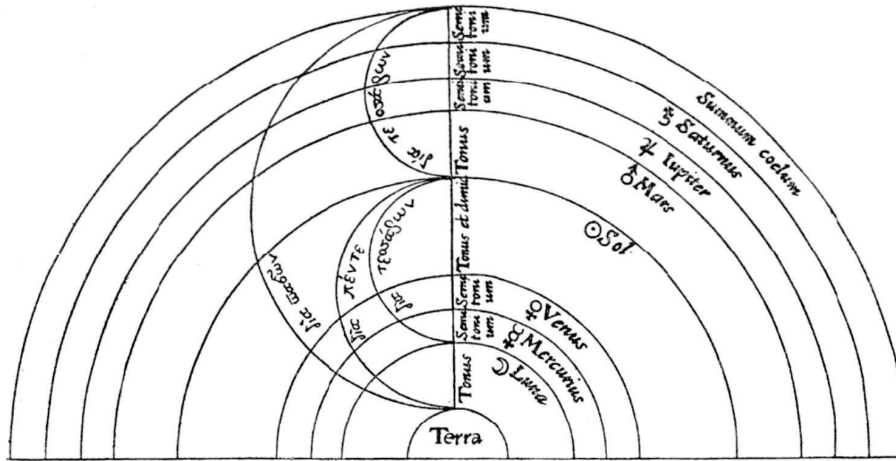


FIGURE 3. The intervals and harmonies of the Pythagorean spheres [36].

According to legend, Pythagoras discovered a mathematical relation between numbers and music once while passing blacksmiths at work. He heard the different tones produced by the hammer hitting the anvil and realized that these differences were directly related to the different sizes of the hammers [24, p. 27–28]. This is how he concluded that music was mathematical in nature. Pythagoras or his followers were also credited with discovering that a taut string, when pressed exactly halfway, produced a tone an octave higher; if it is pressed in the ratio 3:2, it gives a fifth, and in the ratio 4:3 a fourth – the so-called *συμφωνίαι* [*symphoniai*], the basic musical intervals. Allegedly, Pythagoras and his students experimented with sound on a monochord: by varying the length of the string standing under constant tension, they discovered that halving the length gave an octave, while shortening it to two-thirds corresponded to a fifth, and to three-quarters a quart [8, p. 38–39].

Of course, the problem historians of philosophy have with Pythagoras is that he left no written record behind. It is very likely that, like Socrates, he simply did not write anything. This also seems to be indicated by the formula the Pythagoreans used to settle all disputes among themselves – *αὐτὸς ἔφα* [*autós éfa*], “he personally said” [3, p. 335]. We find fragmentary information about Pythagoras – more about

⁷ As Rackham puts it, “occasionally Pythagoras draws on the theory of music, and designates the distance between the Earth and the Moon as a whole tone, that between the Moon and Mercury as a semitone, (...) the seven tones thus producing the so-called diapason, i.e. a universal harmony”.

his teachings than about his personality – in Plato, Aristotle and other writers, but the oldest surviving biographies date back to the 3rd century CE, eight centuries after Pythagoras' time. These biographies of Pythagoras came from the doxographer Diogenes Laertius [16, p. 267–280], the Neoplatonist Porphyry of Tyre (3rd–4th century CE) and by Iamblichus, a Neoplatonist from the same era [13, p. 5].

Notwithstanding these temporal differences, all the ancient sources clearly indicate that, among the Pythagoreans, mathematics and music were at least as much in the domain of mysticism as in the domain of rational thought, if not more so [1, p. 315]. The Pythagoreans gave mystical meaning to mathematical relationships. According to these sources, Pythagoras himself did not come to his discoveries through rational thinking but through some kind of mystical insight, and his figure was more prophetic than philosophical [16, p. 268–271].⁸

6. Measure, symmetry, harmony

Before I proceed with the discussion on the development of the concept of harmony in ancient Greece, once again I return to Heraclitus and his notion of measure, since it is an idea very similar to the idea of harmony and should also be examined in terms of etymology and semantics. The lexeme μέτρον [*métron*] shows a similar pattern of semantic development like *harmonía*, from the most concrete to highly abstract meanings.

The basic meaning of the word *métron*, deeply rooted in everyday life, was “measure” as an object (e.g. a scoop), in other words “that by which anything is measured” [17, p. 1123]. Its root has been reconstructed as **meh*₁- [5, p. 939–940] [9, p. 220–221], “measure”, and can be found in many Greek compounds such as σύμμετρος [*sýmmetros*], “with the same measure, measured, appropriate, symmetrical”, συμμετρία [*symmetría*], “symmetry, harmony”, περίμετρον [*perímetron*], “circumference”, etc. It is also found in other Indo-European languages, e.g. the Latin *mensura*, “measure / measuring”, and *metiri*, “to measure”, or the Serbian “mera” and “meriti”, with the same meanings retrospectively.

In its oldest attested, non-abstract meanings, *métron* signifies objects for measuring or a measure of some quantity, as found in Homer:

δῶκεν μέθυ χίλια μέτρα (Il. VII 471) [*dóken méthy hília métra*]
[Euneus] gave wine [to be brought them, even] a thousand **measures**;
ὑδατος εἴκοσι μέτρα χεῦε (Od. IX 209) [*hýdatos eíkosi métra heúe*]
He would fill [one cup and] pour it into twenty **measures** of water.

A similar meaning, but pertaining to any measured or measurable space (= dimensions), can be found in the *Odyssey* (IV 389) – μέτρα κελεύθου [*métra keleúthu*], “the measure of [thy] path” – or in Hesiod (*Works and Days*, 648) – μέτρα θαλάσσης [*métra thalásēs*], “the measures (= dimensions) of the sea”. In Aratus, a didactic poet from the 4th–3rd century BC, one also finds this word in the sense of temporal

⁸There is a striking parallel with Kepler in this regard: he also claimed that some important discoveries, such as his third law of planetary motion, came to him through an epiphany, i.e. a mystical insight [19, p. 80]; see more on this below.

span: μέτρα νυκτός [*métra nyktós*], “the measures (= duration) of night” (*Phenomena*, 731).

However, just as the lexeme *harmonía* gradually developed abstract meanings, the same was the case with *métron*: in addition to signifying measuring objects, measurements and quantities, it acquired qualitative overtones too, mostly in the ethical, aesthetic and epistemological spheres. Thus, the meaning of “right measure”, temperance, moderation and balance can be found already in Hesiod (*Works and Days*, 694): μέτρα φυλάσσεισθαι [*métra fýlasesthai*], “[take care] to keep things moderate”.⁹ Another telling example comes from Theognis of Megara, a lyric poet from the 6th century BC. Speaking of wine and how to drink it properly, he says πίνειν ὑπέρ μέτρον [*pinein hypér métron*], “[Wine makes light the mind of wise and foolish alike when they] drink beyond **their measure**”. It is important to note that, in this semantic shift, the lexeme *métron* no longer signified something measured by man but something measured for man (either by gods and destiny or by social norms and laws) and assigned to him as his share.¹⁰

With the Athenian sophists of the 5th century and their philosophical relativism, *métron* acquired a new layer of abstract meanings, not only ethical but also epistemological and aesthetic. Determining the measure again passed into the hands of man, this time not in terms of quantity but quality: the sophists believed that human perception and attitudes were those “scoops” by which everything in life is measured, including good and evil, beauty and ugliness [14, p. 23–26]. This meaning of *métron* was famously inaugurated by Protagoras of Abdera (5th century BC) in the following way:

Πάντων χρημάτων μέτρον ἄνθρωπος: τῶν μὲν ὄντων ὡς ἔστιν, τῶν δὲ οὐκ ὄντων ὡς οὐκ ἔστιν. [*Pánton hremáton métron ánthropos: tón mén ónton hos éstin, tón dé uk ónton hos uk éstin.*]¹¹
 Man is the measure of all things: of the things that are, that they are, of the things that are not, that they are not [6, p. 57].

This broadened field of meanings attributed to *métron* and linked to the idea of balance, moderation and harmony led to the formation of the compound noun συμμετρία [*symmetría*] from the preposition σύν (“with”) and the noun μέτρον, literally “[the quality of being] with measure”, commensurability. The term acquired the general meaning of harmony or due proportion as one of the characteristics of beauty and goodness [17, p. 1679], as e.g. in Democritus (frag. 191): βίου συμμετρίῃ [*bíu symmetríē*], “by harmony of life”. Thus, it comes as no surprise that the compound *symmetría*, understood in the sense of harmonious and beautiful proportion and balance [10, p. 9–10], found its way to Greek philosophy, as we shall see in more detail below, and to mathematics, where it primarily referred to an object that is invariant under some transformations such as translation and rotation. The

⁹ Note the Greek proverb Μέτρον ἄριστον [*métron áriston*], “Moderation is best”, which Diogenes Laertius attributed to the poet and sage Cleobulus [16, p. 31].

¹⁰ The Greek word for destiny εἰμαρμένη [*heimarméne*] literally means “that which one receives as one’s share”, implying the idea of measuring [17, p. 1093].

¹¹ The statement was preserved in Plato’s *Theaetetus*, 152a.

fact that an object was considered “symmetric” if it could be divided into two or more identical pieces that are arranged in an organized fashion [18, p. 14] implied precisely its inner or immanent harmony.¹²

7. Plato’s harmony of spheres

One of the most prominent immediate successors of Pythagoras was Philolaus from Croton (5th–4th century BC). It seems that in his lost writings Philolaus, who is often credited as the first proponent of heliocentrism, advocated the idea of two principles on which the world rests – the limiting and limitless – and of harmony as the force that unites them and enables the existence of the world. He linked man’s epistemological potential to the idea of number as the basis of the world: one can understand only what one can measure [3, p. 326–335]. It is also believed that Philolaus introduced the idea of cosmic harmony into his mathematical analysis of the octave. The tradition holds it was Philolaus who influenced Plato the most concerning the Pythagorean elements in his *Timaeus*. In fact, Dionysius Laertius conveys rumors that Plato bought Philolaus’s books and wrote the work based on them, thus committing some sort of plagiarism [16, p. 291].¹³

Plato (c. 427–348 BC) is the most important source of our knowledge of the Pythagorean teachings. Many of his philosophical concepts are of Pythagorean origin, including his understanding of harmony and symmetry, as well as of geometry and mathematics in general. This also applies to some other crucial Pythagorean tenets, not directly relevant for this discussion, such as anthropological dualism, the immortality of the soul and metempsychosis (reincarnation), which are discussed in a number of Plato’s writings.

We owe Plato the oldest surviving description and interpretation of the harmony of the spheres, coming from Book X of the *Republic* (614–621). As part of his discussion on the immortality of the soul, Socrates tells the story of a Pamphylian soldier called Er, who fell on the battlefield. His comrades find him ten days later and, thinking he is dead, take him with the corpses of other soldiers with the intention of cremating him. However, Er is not dead: he wakes up on the pyre and tells what he experienced on the other side. His soul left his body and, together with many others, stood before the Judges of the dead. In his vision, Er also traveled across the universe and, among other things, observed the immense cosmic machinery: the spindle of Necessity (*Ananke*) whose rotation moved the eight concentric celestial circles and thus created the cosmic music. In Plato’s words:

¹² A synonym for *symmetría* was *ἀναλογία* [*analogía*], a compound of the noun *λόγος* [*lógos*], as can be found e.g. in Plato’s *Timaeus* 32c. Given the sheer complexity of the word *lógos*, its analysis would surpass the scope of my essay. Suffice it to mention that Marcus Terentius Varro and Cicero rendered *analogía* in Latin as *proportio* – a compound derived from the noun *pars*, “part”, again connected with the idea of measuring and sharing.

¹³ Some scholars, including Barnet [3, p. 328–334], downplay Philolaus’s role in conveying and articulating the Pythagorean teachings, but it is of less importance for the present discussion, since it is beyond doubt that Plato inherited a number of Pythagorean concepts either from Philolaus or from some other Pythagoreans.

And from the extremities was stretched the spindle of Necessity, through which all the orbits turned. (...) And the spindle turned on the knees of Necessity, and up above on each of the rims of the circles a Siren stood, borne around in its revolution and uttering one sound, one note, and from all the eight there was the concord of a single harmony (616c–617b).¹⁴

What one finds in Plato's description, then, is a mythologized version of the idea of *harmonia mundi*, which is a symphony of sounds sung by the Sirens standing on the rims of the circles (not spheres in Plato's interpretation).¹⁵ He believed that the idea of harmony should be recognized in the mathematical principles of numerical relationships, and not in imperfect musical practice. The beauty of music is only a reflection of an order that is essentially formal and mathematical in nature.

As shown at the beginning of this essay, the notion of *musica universalis* became a highly influential philosophical concept in Antiquity and later. As an example, I quote a passage from Cicero's influential work *Dream of Scipio* (*Somnium Scipionis*), which is actually the sixth book of his *Republic* (*De re publica*). It describes a dream vision of Scipio Aemilianus, the Roman general who destroyed Carthage in 146 BC. Cicero deliberately modelled his tale on the myth of Er. In his dream, Scipio has an out-of-body experience and travels across the universe made up of nine celestial spheres. Suddenly he hears an overwhelming but pleasant sound and asks his guide (the spirit of his grandfather) about it:

“What”, I asked, “what is this sound that fills my ears, so loud and sweet?” “This”, he replied, “is that sound which, divided in intervals, unequal, indeed, yet still exactly measured in their fixed proportion (*pro rata parte ratione*), is produced by the impetus and movement of the spheres themselves, and blending sharp tones with grave, therewith makes changing symphonies (*concentus*) in unvarying harmony (*De re publica* VI, 10) [38], [31, p. 1–36].

It is important to note that neither Er nor Scipio experienced their journey through the universe in the normal state of consciousness: Er was badly wounded in battle and in a coma, while Scipio was asleep. This motif fits perfectly into the above-mentioned pattern: Pythagoras allegedly reached his conclusions about the universe through some kind of mystical insight, and the same was the case with Kepler and his epiphanies. It can be interpreted as a symbolic link between the rational and the irrational, between the domains of mathematics and science on the one hand and religious experience and artistic imagination on the other.

Back to Plato, we find more on harmony and symmetry in his *Timaeus*, probably the most influential of all his writings in the West due to the fact that it was

¹⁴It is interesting to note that Aristotle, who did not accept the notion of a music of the spheres, reported the Pythagorean explanation that we do not hear it because we have been accustomed to it from birth (*De caelo* 290 b 12 ff). As mentioned above, something similar was later claimed by Kepler.

¹⁵On Plato's custom to express his ideas through the so-called philosophical myth see [23, p. 79–81].

Plato's only work preserved in Latin translations throughout the Middle Ages. In his account of the creation of the universe and the world-soul (*Timaeus* 29e–36d), Plato describes the world-soul in terms of musical relations and harmony. Central to Plato's cosmogony is the figure of the Demiurge, a divine entity who did not actually create the world *ex nihilo* but fashioned and shaped the already existing, chaotic matter, “all that was visible (...) in a state of discordant and disorderly motion” (*Timaeus*, 30a) – that is, in a state of disharmony. In the context of Plato's highly complex mathematical cosmogony and cosmology (on which see [15, p. 207–238]), it is of crucial importance to note the term Plato uses to qualify the Demiurge: he is described as ὁ συνιστάς [*ho synistás*], literally “the one who puts together”, from the verb συνίστημι [*synístemi*], “to put together”, “to unite” [17, p. 1718]. In other words, this verb is synonymous with the above-analyzed verbs *harmódzo* and *ararísko*, “to bind”, “to fit together”. The conclusion is that Plato preserves the Homeric meaning and mental image of *harmonía* as the core of his highly abstract term *synistás*: the Demiurge is he who *fits together in a harmonious way* the disorganized and disparate pieces of primordial matter and thus turns the chaos into the cosmos, much like Odysseus who fitted together separate logs into a raft as a functional whole. It is precisely the newly formed harmonious whole that turns Plato's universe into a sentient living being.

Just as the body of the universe and its world-soul are harmonious, so should be the human body and soul (*Timaeus*, 88b–e). In his articulation of this idea Plato significantly employed the term *symmetría*, “a due measure”, in the sense discussed above. The body and soul should be in a harmonious relation, developed “symmetrically” – that is, in congruity and balance:

all that is good is beautiful, and what is beautiful is not *ill-proportioned* (ἄμετρον). Hence we must take it that if a living thing is to be in good condition, it will be *well-proportioned* (σύμμετρον) (87c [20, p. 1286]).

In this passage one comes across the adjective σύμμετρον [*sýmmetron*], “well-proportioned”, “with measure”, and its opposite ἄμετρον [*ámmetron*], “ill-proportioned”, “without measure”, which clearly implies the original meaning of *métron* in the core of these concepts. However, one also finds here a highly abstract sense of *métron*: Plato masterfully connects three different domains of intellect: the harmonious living being is “good” (the ethical level), “beautiful” (the aesthetic level) and created as a reflection of the macrocosmic harmony and symmetry (the ontological level). Moreover, man's inner harmony and symmetry pertain to the domain of medicine and psychology as well, for it is through these concepts that Plato defines physical and mental health (ὑγίεια):

For with respect to health and disease, virtue and vice, there is no *symmetry* or *lack of symmetry* (συμμετρία καὶ ἀμμετρία) greater than that which exists between the soul itself and the body itself (87d; [20, p. 1286]).

In this way, Plato laid the foundations for the doctrine of the harmony of the microcosm and the macrocosm, which the Neopythagoreans and Neoplatonists would

later carry into the Middle Ages and the Renaissance: just as “the body of the cosmos was harmonized by proportion ($\delta\iota'$ ἀναλογίας) and brought into existence” (*Timaeus*, 32c), so were the individual bodies as a reflection of the macrocosm. The bodies of living beings were made that way by the Demiurge, and artists should strive to emulate him in their own creative work (Image 4).



FIGURE 4. A hydria from Attica, c. 500 BC (British Museum, London). The symmetrical is both beautiful and good.

8. Conclusions

In this essay I offered a brief historical-philological examination of the terms *harmonía* and *symmetría* in ancient Greek thought, with a comparative look at the cognate term *métron*. All these terms and concepts based on them played a pivotal role in Greek thought, from mathematics and early science to philosophy, religion and art. Since these fields of intellect and spirit were not as sharply divided as they are today, the analyzed terms overlapped and intersected across the fields, always carrying something of their primary meaning, the lowest common denominator in the semantic sense. Basing my approach on etymology, semantics and intellectual history, I demonstrated that the primary or oldest attested meanings of the analyzed terms, as well as the mental images related to them, have origins in the sphere of non-abstract, everyday life, and that these meanings informed all the later concepts of harmony and symmetry.

My analysis also focused on the concepts of harmony in the Pythagoreans and Plato, who applied this term in developing their ideas about *musica universalis*. Over time, these ideas shaped a powerful philosophical tradition, which was transmitted through Late Antiquity and the Middle Ages until the early modern era and even our time. It is important to emphasize the irrational aspect of the notion of cosmic harmony: in all considered cases, the knowledge about it was given to individuals in states of altered consciousness. Pythagoras received it as part of his

semi-divine powers. The Pamphylian soldier in Plato's account received it after he was wounded and his soul temporarily left the body. In Cicero's account, the Roman general had this revelation while asleep. Finally, Kepler was led to some of his discoveries about the nature of the universe through his epiphanies. This common motive points to the liminal character of that kind of knowledge: it is both rational and irrational, mathematical and mystical, with music as the most subtle bridge between these apparent extremes.

In this context, I return to Kepler and his alleged attempt to convey the harmony of the spheres with plain musical instruments. As the music sounded bad, Kepler defended himself against mockery by claiming, just like Pythagoras many centuries before him, that human ears were incapable of hearing the heavenly harmony. If only he had been reborn a few centuries later and seen the launch of space probes to the planets of the solar system, he would have realized that his theory was not entirely wrong: NASA's Cassini spacecraft, launched in 1997, flew past Jupiter in 2000 and detected waves in the thin gas of charged particles that surround the planet [40]. The waves are in low radio frequencies, which have been converted to sound waves to make the patterns audible. The result is a symphony of wondrous, otherworldly noises that most resemble electronic ambient music. A similar phenomenon has been detected in the electrically charged surroundings of the Sun, Saturn and other planets. It may not be harmony, but it is definitely some kind of cosmic music.

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