

Music, the Phenomena of the Universe and the Human Being in the Pythagorean tradition

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**Música, os Fenómenos do Universo e o Ser Humano na Tradição Pitagórica
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A palavra “estotérico” vem do Grego *esoterikos*, sendo o comparativo de *eso*, que significa “dentro de”. Parece que esta palavra terá sido usada primeiro na obra de Luciano de Samósata.

Como área académica, o Esoterismo abarca campos de investigação que se centram no estudo de um vasto conjunto de movimento religiosos ou filosofias cujos membros em geral se separam das tradições e grupos estabelecidos. Ao longo dos séculos, autores têm especulado sobre a ligação entre música e cosmologia.

Nesta comunicação propomos examinar o trabalho de pensadores que se debruçaram sobre a relação entre a música e os fenómenos do universo e do ser humano, na tradição pitagórica, desde a Antiguidade clássica até ao Renascimento tardio, onde ocorreu o albar da revolução científica.

Palavras-chave: tradição pitagórica; esoterismo; cosmologia; música.

The word “esoteric” comes from the Greek *esoterikos*, being a comparative form of *eso*, with signifies “within”. This word seems to have been first used in the work of Lucian of Samosata.

As an academic field, Esotericism encompasses the areas of research that focus on the study of a vast array of religious movements or philosophies whose members in general distinguish themselves from established traditions and groups. Throughout the centuries, authors have speculated on the relationship between music and cosmology.

In this communication we propose to examine the works of thinkers who dealt with the relationship between music and the phenomena of the universe and the human being in the pythagorean tradition, from classical Antiquity to the late Renaissance, where the dawn of the scientific revolution occurred.

Keywords: music; pythagorean tradition; esotericism; cosmology

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The word “esoteric” comes from the Greek *esoterikos*, being a comparative form of *eso*, which signifies “within” (ASE, 2015). This word seems to have been first used in the work of Lucian of Samosata (ASE, 2015). Later, it is used to refer to the teachings of Pythagoras to a group of students, coming to designate any teachings meant for a restricted group of learners. As an academic field, Esotericism encompasses the areas of research that focus on the study of a vast array of religious movements or philosophies whose members in general distinguish themselves from established traditions and groups (ASE, 2015).

Throughout the centuries, authors have speculated on the relationship between music and cosmology. In the sixth century BC, Pythagoras seems to have proposed that the universe is ordered and governed by number, and that music was the manifestation of number (Bonds, 2014). Pythagorean thought pervaded western cosmology, bringing inspiration to the ideas of numerous thinkers (Bonds, 2014; Chua, 1999).

In this communication we tried to follow the evolution of the Pythagorean theoretical construct widely known as “the music of the spheres” or “harmony of the spheres” (or *musica universalis*). We proposed ourselves to examine the works of thinkers who dealt with the relationship between music and the phenomena of the universe and the human being in the Pythagorean tradition, from classical Antiquity to the late Renaissance (thus, between the flourishing of Pythagorean philosophy and the beginning of the scientific revolution). The writings of thinkers such as Plato, Gioseffo Zarlino, Robert Fludd, and Johannes Kepler were thus reviewed and analyzed in the light of this philosophy.

In our previous communication, held at the I Lusophone Congress on Religious Studies, Lusofona University, Lisbon 2015, we reviewed the writings that establish the first echoes of Pythagora's views of Cosmology on Western thought. Relying on the earliest and credible academic sources available, we tried to build a coherent image of his theoretical construct. We examined the works of Diogenes Laertius, Porphyrius, Iamblichus, Philolaus, Archytas, unidentified Greek doxographers, Aristotle and also Boethius, in the light of the most recent discoveries in modern physics (Da Rocha & Barbosa, 2015).

It was remarkable to note that we know since the 20th century that stars are formed from clouds of interstellar gas, with their formation and evolution governed by acoustic waves, a product of the competition between the gravitational collapse and of the original interstellar cloud and the pressure of the respective stellar gas (Jeans, 1902). These waves possess a wavelength dependent on the stellar mass. The detection of these acoustic waves and the measure of the stars' vibrational modes has given birth to an important thematic area of

modern astronomy, asteroseismology, precursor of the techniques that nowadays allow the detection of extrasolar planets, orbiting other stars of the Milky Way. Accordingly, in modern Cosmology, the Cosmic Microwave Background (CMB), relic of the hot and dense Universe, from 13.8 billion years ago, contains the fossil signal of these primordial acoustic waves that propagated through all matter and provided the seeds for the structures and objects we observed today, like galaxies, clusters of galaxies and filaments; the study of this pristine cosmic music gave birth to successive generations of space observatories of ESA and NASA like space missions COBE, WMAP and more recently Planck Surveyor (Smoot, 1993; da Rocha & Barbosa, 2015). The study of these waves has contributed to an unprecedented description of the history of our Universe, and our place in it (da Rocha & Barbosa, 2015). We know nowadays that the study of the acoustic waves of the Cosmic Microwave Background shows us an infinite and accelerated expansion of the universe, a dilution of matter. So we now know that the Universe is full of vibration and contains “sound”, and that these vibrations range from a plethora of phenomena: from the acoustic waves imprints of the infant expanding Universe carrying the Big-Bang moments engraved in the Cosmic Microwave Background to planetary aurorae captured by deep space probes like Cassini over Saturn (da Rocha & Barbosa, 2015) to the more recent gravitational waves, the cosmic space-time rumor loudly detected in 2016 by LIGO (Abbott 2016).

A renowned mathematician, philosopher, astronomer and musician, Pythagoras of Samos is said to have lived from ca. 570 to 490 BC (Stanford, 2007). Unfortunately, contemporary researchers only have descriptions of his biography, discoveries and theories left by other authors, such as Plato and Iamblichus (da Rocha & Barbosa, 2015).

Pythagoras ascribed the foundations of the Universe to Mathematics and Physics, namely to the vibration of the cosmic bodies, in the objective part of his Cosmogony. According to his theory, each cosmic body emits a set of vibrations, unperceivable to the human ear yet related to the structure of the Cosmos.

We will now examine how these ideas trickled along the chronology of Western thought after the Pythagorean school ceased to flourish.

Plato (ca. 429–347 BC) is one of the first sages to transmit the Pythagorean construct after the disappearance of the Pythagorean school. Unlike Aristotle, Plato draws large metaphors instead of referring to physical phenomena. Plato refers to the concept of the music of the spheres as the "spindle of Necessity". In *The Republic*, we can read:

"For this light is the belt of heaven, and holds together the circle of the universe, like the undergirders of a trireme. From these ends is extended the spindle of Necessity, on which all

the revolutions turn. (...) Now the whole spindle has the same motion; but, as the whole revolves in one direction, the seven inner circles move slowly in the other, and of these the swiftest is the eighth; next in swiftness are the seventh, sixth, and fifth, which move together; third in swiftness appeared to move according to the law of this reversed motion the fourth; the third appeared fourth and the second fifth. The spindle turns on the knees of Necessity; and on the upper surface of each circle is a siren, who goes round with them, hymning a single tone or note."

In *Timaeus*, we can read:

"The body of heaven is visible, but the soul is invisible, and partakes of reason and harmony, and being made by the best of intellectual and everlasting natures, is the best of things created. "

This tiny fragment may lead us to wonder whether Plato considered the human mind and sensibility (e.g. the nervous system) to reflect the vibrational proportions of the cosmos.

It is remarkable that Aristotle (384–322 BC) seems to be the sage of the Antiquity who better transmits the Pythagorean cosmological theoretical construct, in *On the Pythagoreans*, (as we noted on our previous communication) and in *On the Heavens*. However, faithful as he is in his intellectual efforts to transmit most of the Pythagorean edifice of knowledge, Aristotle actually disagrees with a considerable part of it (Aristotle, 2014). In *On the Heavens*, we can read:

"From all this it is clear that the theory that the movement of the stars produces a harmony, i.e. that the sounds they make are concordant, in spite of the grace and originality with which it has been stated, is nevertheless untrue. Some thinkers suppose that the motion of bodies of that size must produce a noise, since on our earth the motion of bodies far inferior in size and in speed of movement has that effect. (...) But if the moving bodies are so great, and the sound which penetrates to us is proportionate to their size, that sound must needs reach us in an intensity many times that of thunder, and the force of its action must be immense. Indeed the reason why we do not hear, and show in our bodies none of the effects of violent force, is easily given: it is that there is no noise. (...) We may say, then, in this matter that if the heavenly bodies moved in a generally diffused mass of air or fire, as every one supposes, their motion would necessarily cause a noise of tremendous strength and such a noise would necessarily reach and shatter us. Since, therefore, this effect is evidently not produced, it follows that none of them can move with the motion either of animate nature or of constraint."

Although Aristotle mentioned the theory of the harmony of the spheres with great precision, he nevertheless dismissed it. Curiously, Aristotle denied the presence of sound in the movement of celestial bodies, with no proof whatsoever. It is interesting to realize that nowadays the notion that vibration is inherent to the universe is quite established. In fact, it

has been observed that outer space is filled with a partial vacuum. Also to note is the fact that sound is part of the formation of matter such as the birth of stars, as previously stated.

Echoes of Pythagorean thought reached the Republic of Rome two centuries later. In *Scipio's Dream*, Cicero (106–43 BC) surprises us with a poetic quotation of the harmony of the spheres (Cicero, 2011), yet presenting a geocentric model, although the heliocentric model being already foreseen by Greek thinkers:

"When I had recovered from my amazement at these things I asked, 'What is this sound so strong and so sweet that fills my ears?' 'This,' he replied, 'is the melody which, at intervals unequal, yet differing in exact proportions, is made by the impulse and motion of the spheres themselves, which, softening shriller by deeper tones, produce a diversity of regular harmonies. Nor can such vast movements be urged on in silence; and by the order of nature the shriller notes sound from one extreme of the universe, the deeper from the other. Thus yonder supreme celestial sphere with its clustered stars, as it revolves more rapidly, moves with a shrill and quick strain; this lower sphere of the moon sends forth deeper notes; while the earth, the ninth sphere, remaining motionless, always stands fixed in the lowest place, occupying the centre of the universe. But these eight revolutions, of which two, those of Mercury and Venus, are in unison, make seven distinct tones, with measured intervals between, and almost all things are arranged in sevens. (...) But the ears of men are deafened by being filled with this melody; nor is there in you mortals a duller sense than that of hearing.'"

Once more two centuries later, in the Egyptian city of Alexandria, at the time a part of the still existing Roman Empire, Ptolemy (ca. 100–170 AD) tried to combine the Platonic and Aristotelian models of the human soul in his treatise *Harmonics*:

"In the same way, we can relate modulations of *tonos* in *systemata* to changes in souls brought about by crises in the circumstances of life."

After idealizing the harmonic ratios that characterize the soul, Ptolemy went on to speculate on how these same ratios exist in the heavens (Feke, 2009):

"In the first place, then, the truth of our proposition is plainly indicated by the very fact that both the notes [of music] and the courses of the heavenly bodies are determined by intervallic movement alone, upon which there attends none of the changes that alter a thing's being. It is indicated also by the fact that all the circuits of the aetherial things are circular and orderly, and that the cyclic recurrences of the harmonic *systemata* have the same features; for the order and pitch of the notes apparently advances, as it were, along a straight line but their function and their relation to one another, which constitutes their special character, is determined and enclosed within one and the same circuit, since in their nature there is no starting point among them, and their starting point in respect of position is shifted in different ways at different times to the various successive places in the series."

Ptolemy seems to have laid the path for Kepler's endeavours in *Harmonices mundi*, where he elaborated on the third law of planetary motion, many centuries later. Indeed, although Kepler destroyed Ptolemy's hypotheses that the planetary orbits were circular ("...the circuits of aethereal things are circular..."), when he proposed the first planetary law (The Law of Ellipses, that states the movement of planets as elliptical), he nevertheless amplified Ptolemy's idea that "... the courses of the heavenly bodies are determined by intervallic movement alone", when he coined the third planetary law (The Law of Harmonies, that states that the ratio of the squares of the periods of any two planets is equal to the ratio of the cubes of their average distances from the sun).

With the close of Late Antiquity, Pythagorean musical thought survives mostly through the work of the Roman philosopher, statesman and theologist Boethius (ca. 475-526 AD). Boethius set himself the task to write and translate many important Greek texts on arithmetics, music, geometry and astronomy (Castanheira, 2009). Not knowing it, with "*De institutione musica*", Boethius laid the foundation for the musical studies of Medieval Europe. In this treatise, the thread of Pythagorean thought can be found in the recollection of Pythagora's life events, namely the investigation of the proportion of consonances which we referred to in our previous communication (Castanheira, 2009) and many speculations which seem to derive from Pythagorean sources. Boethius proposes three kinds of music, being one of them a cosmic music (being this, most likely, a representation of the music of the spheres) (Castanheira, 2009).

"So, it seems that, for now, it should be said to the one who examines music: how many kinds of music described by scholars we can discover. They are three: the first, cosmic; the second, human; the third, made by certain instruments such as the zither, the *aulos* and others that accompany songs.

Firstly, the cosmic one is perceptible especially by what is seen in the sky itself, or in the combination of elements, or in the passing of seasons, for how is it possible that a machine as fast as the sky can move in a mute and silent course? Even if its sound does not reach our ears, because many times it is thus necessary that it is, it is not possible, however, that such a swift movement of such large bodies doesn't produce any sound, especially because the course of the stars are adjusted in such a large harmony, nothing so perfectly united, nothing so perfectly fitted can be conceived."

In the time span that goes between the early Middle Ages and the Late Renaissance, we would like to focus on Franchino Gafori (1451-1522) and Gioseffo Zarlino (1517-1590). These two scholars produced widely appraised treatises that echo the Pythagorean tradition. Gafori's *Practica musicae*, a treatise written in 1496, shows a remarkable woodcut that appeared as the frontispiece of the treatise (Westbrook, 2001). This work aims to represent celestial harmony (Westbrook, 2001). Time is symbolized by a three-headed dragon, around

which the elements, the planets and constellations, the Muses, and musical notes and modes are arranged, and seen as parts of a mutual order (Westbrook, 2001). At the bottom of the engraving, the four elements, *terra*, *aqua*, *aer* and *ignis* can be seen; and from them arise the eight musical notes of the diapason, coupled with eight modes (Westbrook, 2001).

Gafori links the musical elements with the muses and the planets, each with its presiding deity (Westbrook, 2001). The god commanding the cosmos is Apollo. Holding a lute, or a *lira da braccio*, he sits accompanied by the three Graces; above them beneath a banner reads "The power of the Apollonian mind completely controls these muses (Westbrook, 2001). The universe is seen to be created by musical vibration and given order by the structure of a musical scale (Westbrook, 2001). Such a speculation is rather striking in a treatise devoted to practical music making rather than musical cosmologies (Westbrook, 2001).

A generation later, Gioseffo Zarlino (1517-1590), focused also mostly on practical matters on his *Institutione harmoniche*; however, speculated on Pythagorean heritage via Ptolemy, as can be ascertained in this excerpt:

"Whoever will examine the heavens in detail, as Ptolemy did with such diligence, will find by comparison of the twelve portions of the Zodiac, in which are the twelve heavenly signs, various musical consonances: the fourth, fifth, octave, and others in their turn."

However, Zarlino's effort to examine this subject is one of the last in Western Music Theory. (Godwin in Westbrook, 2001).

Seventy years later two of the referred intellectuals publish their visions. We would like to focus on two eminent scholars who, striving for the same aim, failed however to reach solid conclusions, and, having the possibility to communicate, not only failed to cooperate, but also fell on a bitter dispute: physician Robert Fludd (1574–1637 AD) and mathematician and astronomer Johannes Kepler (1571–1630 AD).

The illustration known as the Divine Monochord appeared in the *Utriusque Cosmi Maioris* of 1617, the *magnum opus* of the British scholar and physician Robert Fludd (Westbrook, 2001). This frequently reproduced engraving presents a musical cosmology in its purest form: a universe represented as the vibrations emanating from a plucked string, with elements, planets and angels given order by musical relationships (Westbrook, 2001).

The monochord's string is a metaphor for the "Great Chain of Being" that links all levels of creation, which Fludd divides in three main realms (Westbrook, 2001). Each of the realms and sub-realms is related through the musical intervals (Westbrook, 2001). The sun is placed at the joining of the two octaves, at the center of the universe (Westbrook, 2001). This diagram represents *musica mundana* and is accompanied by two engravings that represent *musica humana* (the Human Monochord) and *musica instrumentalis* (the Temple of Music). The structure of the universe is likened to an enormous monochord, its proportions governed

by the same relationships that manifest themselves in musical intervals, such as the *diapason* (octave), *diapente* (fifth), and *diatessaron* (fourth) (Bonds, 2014).

The Human Monochord depicts the connection between microcosm and macrocosm (Westbrook, 2001). A link with the divine is present: the Divine Monochord is tuned by God's hand and the Human Monochord is crowned with the Hebrew form of the word "Jehovah" (Westbrook, 2001). As in the cosmic monochord, proportions are represented through musical intervals (Bonds, 2014).

Lastly, the Temple of Music stands for *musica instrumentalis*, a didactic construction including scales and other musical elements (Westbrook, 2001).

If in 1617 Robert Fludd publishes *Utriusque Cosmi Maioris*, in 1619, Johannes Kepler publishes his equally famous work, *Harmonices Mundi* (Westbrook, 2001). Both works can be included in the Magical tradition of thought, which regarded mind as the basic component of the universe, the idea of the world as emanations from a Divine Being; the mathematical harmony of the universe that was revealed to the seer in the form of sacred mathematics; the relationship between the microcosm and the macrocosm; and – of great importance to this study – the idea of the cosmos as a musical structure (Westbrook, 2001). Unfortunately, the two cosmologists engaged in a lengthy and bitter dispute about their work:

"Fludd' s general standpoint is that true understanding of world harmony and thus true astronomy are impossible without a knowledge of the alchemical or Rosicrucian mysteries. Whatever is produced without knowledge of these mysteries is an arbitrary, subjective fiction. According to Kepler, on the other hand, only that which is capable of quantitative, mathematical proof belongs to objective science; the rest is personal." (Wolfgang Pauli in Westbrook, 2001).

In the construction of his thesis, Fludd's musical images owe more to the nature of the analogies he wishes to illustrate than to any emphasis on the accuracy of musical or acoustical structures (Westbrook, 2001). Unfortunately, even the acoustical information used in the presentation of the World Monochord seems to be inaccurate, which must have infuriated Kepler. However, though empirical as his intended proofs were meant to be, Kepler's understanding of the cosmos had a religious background, as can be read in "*Harmonices mundi*":

"Accordingly, since we see that the universal harmonies of all six planets cannot take place by chance, especially in the case of the extreme movements, all of which we see concur in the universal harmonies—except two, which concur in harmonies closest to the universal—and since much less can it happen by chance that all the pitches of the system of the octave (as set up in Book III) by means of harmonic divisions are designated by the extreme planetary movements, but least of all that the very subtle business of the distinction of the celestial consonances into two modes, the major and minor, should be the outcome of chance, without

the special attention of the Artisan: accordingly it follows that the Creator, the source of all wisdom, the everlasting approver of order, the eternal and superexistent geyser of geometry and harmony, it follows, I say, that He, the Artisan of the celestial movements Himself, should have conjoined to the five regular solids the harmonic ratios arising from the regular plane figures, and out of both classes should have formed one most perfect archetype of the heavens (...)"

However, Kepler failed to complete the necessary calculations in order to prove all his speculations, and his successors were to separate permanently scientific knowledge from mystical contemplation:

"The *Harmony of the World* is the continuation of the *Cosmic Mystery*, and the climax of his lifelong obsession. What Kepler attempted here is, simply, to bare the ultimate secret of the universe in an all-embracing synthesis of geometry, music, astrology, astronomy and epistemology. It was the first attempt of this kind since Plato and the last to our day. After Kepler, fragmentation of experience sets in again, science is divorced from religion, religion from art, substance from form, matter from mind." (Arthur Koestler *in* Westbrook, 2001).

However, Kepler himself declared:

"To find a proper proportion in the sensible things is to discover and to recognize and to bring to light the similarity in this proportion in the sensible things with a certain Archetype of a most true Harmony, which is present in the soul."

and finishes "Harmonies of the World" with this statement:

"Purposely I break off the dream and the very vast speculation, merely crying out with the royal Psalmist:

Great is our Lord and great His virtue and of His wisdom there is no number: praise Him, ye heavens, praise Him, ye sun, moon, and planets, use every sense for perceiving, every tongue for declaring your Creator. Praise Him, ye celestial harmonies, praise Him, ye judges of the harmonies uncovered (and you before all, old happy Mastlin, for you used to animate these cares with words of hope): and thou my soul, praise the Lord thy Creator, as long as I shall be: for out of Him and through Him and in Him are all things, καὶ τὰ αἰσθητὰ καὶ τὰ νοερά [both the sensible and the intelligible]; for both whose whereof we are utterly ignorant and those which we know are the least part of them; because there is still more beyond. To Him be praise, honour, and glory, world without end. Amen."

One of Kepler's astounding discoveries was the fact that the ratio between two circles placed inside and outside a triangle, represented the same ratio as that between the orbits of the planets Saturn and Jupiter (Patrick, 2011). He then concluded that the ratios between the remaining planets matched the ratios obtained with the use of five Platonic solids. He then related the ratio between the nearest distance of the elliptical orbit of a planet to that of its farthest, and found that for Mars this ratio is roughly 3:2 (represents the interval of a perfect

5th); for Saturn 5:4 (represents the interval of a major 3rd); for Jupiter 6:5 (represents the interval of a minor 3rd) (Patrick, 2011). It can be suggested that each of the planets produces a musical interval in this way.

Nevertheless, gradually, the study of music began to separate itself from the general concerns of science (Westbrook, 2001). At the same time, empirical evidence was gathering that undermined the basic assumptions of musical cosmology (Westbrook, 2001).

"During this period (...) there took place a twofold expansion of the European imagination. The first aspect was geographical, associated with the names of great navigators from Vasco da Gama to Drake. (...) The second expansion was cosmological, the work of Copernicus, Kepler, and Galileo. Their new cosmologies swept aside the tidy system of nesting spheres, turned by the hand of God, that had served so well since the time of Aristotle." (Godwin in Westbrook, 2001).

What seems to separate the modern from the ancient world is a process of loss of magic. Indeed, to German sociologist Max Weber, modernity is marked by the 'disenchantment of the world [*Entzauberung der Welt*]' (Chua, 1999). In this process, it seems that the Puritans took the Reformation to an extreme, and that it was actually ascetic Protestantism that led to modernity's ascetic rationalism. This means that, according to some authors, the deprivation of the tolerance of certain hypotheses in science was actually introduced by a religious current, which is quite a paradox. In the wake of this phenomenon, Music, too, according to Weber, seems to have lost some of its magic (Chua, 1999).

These echoes of Pythagoras theoretical construct show a number of differences, —but they all posit a direct congruence of cosmic, human, and musical harmony (Bonds, 2014). Until the scientific revolution, the proportional similarities between these realities were seen not only as analogical but also as morphological. The harmony of the Universe was the manifestation of the harmony of musical intervals; it was believed that number revealed such relationships (Bonds, 2014).

By the early fifteenth century, as Joseph Dyer observes, "physical science, not mathematics, was considered best capable of explaining musical phenomena.". In the sixteenth century, the astronomical observations and theories of Nicolaus Copernicus, Kepler, Galileo Galilei, and Tycho Brahe, among others, rendered the theory of isomorphic resonance largely unsustainable (Bonds, 2014).

It is quite paradoxical that Johannes Kepler, one of the scholars who initiated the scientific revolution, in the course of which all ancient magic was eradicated, professed a strong belief in the Universe being ruled by God and tried to prove the music of the spheres, unfortunately failing to defend its disappearance of the set of hypotheses of Physics.

Perhaps a new kind of magic would be needed?

Modern Physics, and in particular with the help of Fourier analysis tools developed by the French Joseph Fourier in the XIXth century, enabled the description and decomposition of many physical (and cosmic) phenomena in a series of waves propagating with a certain sound speed (Fourier 1822). These waves had specific modes that added together corresponded to the behavior of observed phenomena. And from here we took almost a century further to arrive the Fourier analysis of the pristine CMB modes that fill the Universe.

Ironically, the Solar system obeys to the laws of Kepler. These were the building block of gravitational dynamics better known by the predictions of the orbit of Halley comet (a period of 76 years). Based on these laws and Newton's new Gravitational "*Principia*", Edmond Halley predicted the return of the comet by 1758 (Halley). But soon, Kepler's laws were insufficient to account for the rich dynamics of the Solar system. New additions by the likes of Laplace, Herschel, Roche, Poincaré, Kologorov to name but a few, were required to describe the multitude of asteroids, comets, moons of the giant planets and so on. Even the stability of the Solar System became a matter of profound astronomical study: although the Solar System has been observed as stable (if we account historical data gathered by many civilizations) the multiple added weak gravitational effects of the planets on each other can add up to unpredictable dynamics (in scales of tens of millions of years). That is why our Solar system is even considered chaotic.

But the new magic soon arrived in the early XXth century, with Einstein's General Relativity (GR) who described phenomena a result of interactions in the fabric of space-time. And indeed confirmation of the space-time gravitational waves – the true cosmic sound, a gravitational Music of Spheres – came with the discovery of gravitational waves by the LIGO experiment, in February 2016, precisely 100 years after Einstein GR predictions (Abott 2016)!

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