**Sound: A Basis for Universal Structure in Ancient and Modern Cosmology**[1]

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Since all sound may be measured and expressed in number, and the relationships of numbers can be precisely translated into intervals that are more musical and less musical, the isomorphic relationship between number and music has been recognized from antiquity. Throughout the early civilizations of India, China, Egypt, Mesopotamia and Greece, it was pervasive that number, geometry, astronomy and music were considered four forms of a single concept of proportions. The study of number in itself was arithmetic, in space it was geometry, in time it was music, and the study of space and time was astronomy.[2] These cultures and traditions all recognized music (sound or vibrational patterns) as a foundation that could provide a cosmological synthesis. In this line of thought, the connection between physical reality and metaphysical principles can be reconstructed and directly experienced in music. These concepts express an intuitive understanding of the cosmos that modern science is now discovering and measuring. String theory, which offers a theoretical framework to explain every fundamental feature of the universe, demonstrates that the vibrational frequencies of particles determine every particular manifestation of the universe.

During the last few centuries science has been increasingly specialized and therefore each discipline has become gradually more isolated. Even though modern scientific minds attained some of the greatest scientific achievements, there is a fundamental dilemma in modern physics. The theoretical physicist, Brian Greene explains that physicists have been aware of the problem that modern physics rests on two foundational frameworks, one, Albert Einstein's general relativity and the other, quantum mechanics. Albert Einstein's general relativity provides "a theoretical framework for understanding the universe on the largest of scales: stars, galaxies, clusters of galaxies and beyond to the immense expanse of the universe itself".[3] Quantum mechanics provides "a theoretical framework for understanding the universe on the smallest scale: molecules, atoms and all the way down to subatomic particles like electrons and quarks."[4] Even though these two revolutionary theories fabricated a new understanding of the universe, the two "foundational pillars" are mutually incompatible. Greene elucidates, "As they are currently formulated, general relativity and quantum mechanics *cannot both be right*".[5] Einstein launched his lonely quest and spent the last thirty years of his life in search of a Unified Field Theory, the one grand underlying principle. He failed, but a few decades later physicists are becoming convinced that string theory may provide the answer. String theory, allegedly a theory of everything (TOE), offers a single powerful framework capable of encompassing all forces and all matter in the metaphor of music; everything at its most microscopic level consists of combinations of vibrating strands, and just as the violin or other musical instruments have resonant frequencies at which they prefer to vibrate, the particle properties are the manifestation of the resonant patterns of vibration.[6] This understanding of the universe directly corresponds to what the ancients imagined, the inaudible music, the link between metaphysics and physics through which the universal laws and their multiple applications could be understood.[7]

Sound is energy and information. Since energy and information are two of the common characteristics of all waves: light waves, sound waves, water waves, seismic waves, X-rays, radio waves, and other waves, they all transport energy and information from one place to another through a medium while the medium itself is not transported. Audible sound is the vibration of molecules, most commonly air particles, which stimulate the eardrum to vibrate. These vibrational patterns are transmitted through the ear and produce vibrations of the basilar membrane. Different parts of the basilar membrane respond to different sound frequencies. The nervous system is then able to identify these vibrations as sound. However, at frequencies below 300 Hz, the frequency of a stimulus tone directly translates into a corresponding set of

neural impulses. For humans, the range of audible sound is, roughly, 20 Hz - 20,000 Hz and some other forms of life have much higher and/or lower limits of hearing. Vibrations exist beyond the range of hearing of all forms of life. Vibrations also exist that are of such low amplitude that no form of life can perceive them. Sometimes vibrations are referred to as "vibration" and sometimes they are referred to as "sound". Sound is generally considered to be vibrations that are audible. Therefore sound is a subset of vibration. However, in written texts, the terms "vibration" and "sound" are sometimes loosely used interchangeably.

Acoustics, the science of sound, became an increasingly interdisciplinary field encompassing the disciplines of physics, engineering, psychology, speech, audiology, music, architecture, physiology, neuroscience, and others.[8] What moderns call acoustics was primacy of reality in the ancient symbolisms that formed virtually all creation metaphors in the early civilizations of Mesopotamia, Egypt, India, Greece, China and numerous religious traditions of Judeo-Christian, Islam and Sufism. They all recognized music (sound or vibrational patterns) as a foundation that could provide a cosmological synthesis. These cultures all believed that numbers correspond to abstract principles, which can be reconstructed and experienced through music. Many parts of the algebraic yantras, systematic views of the number field, from one tradition correspond with algebraic yantras from other traditions.[9] The early civilizations discovered, at different times and in different places, that the musical ratios of the first six integers as derived from the harmonic series defined the octave 1:2, the fifth 2:3, the fourth 3:4, the major third 4:5, and the minor third 5:6, and these civilizations developed a science of pure relations within the theory of numbers, in which the tone-field is isomorphic with the number field.[10]

Throughout history, the Pythagorean concept of "Music of the Spheres" has referred to vibrational systems, or sounds, that are inaudible. The Pythagorean model of the solar system includes two features that mark a permanent break from the previous Greek models: the celestial bodies move in circular paths and, including the Earth, the celestial bodies are not flat but, rather, are spheres. Pythagoras ($6^{th}$ Century B.C.)[11] conceived of the cosmos as a vast lyre, with crystal spheres in the place of strings. The Sun and all the stars moving with rapid motion, produce enormously great sound. The distances between the planets would have the same ratios as those that produce harmonious sounds in a plucked string. To the Pythagoreans, the solar system consisted of ten spheres revolving in circles around a central fire, each sphere producing a sound that depends on its distance from the center; the closer spheres produced lower tones while the farther spheres moved faster and produced higher pitched sounds, all combining into a beautiful harmony, the Music of the Spheres.[12] Pythagoras claimed that the reason we are unaware of this perpetual harmony is that we always hear the sound as a constant background and we have no silence with which to compare it.[13] Plato's *Republic* was the first written reference that illustrated that the movement of the celestial bodies correspond to musical intervals. The $17^{th}$ Century German scientist, Johannes Kepler who explicitly acknowledged Pythagoras and Plato as his conceptual master, revived this idea and took a step further to conceive the Harmony of the Spheres as polyphonic and described their ratios by three dimensional solid figures. With his discovery of elliptical orbits, Kepler associated each planet with two or more number ratios and related these to musical intervals to create an entire harmonic structure. In 1772, the German astronomer Johann Bode continued to try to describe the arrangement of planets in simple mathematical terms. The formula, Bode's law, which describes the relationship between the distances of the planets from the Sun, in fact, is remarkably consistent with the actual distances of the planets.[14]

Pythagoras has been credited in the West as the first to discover the ratios of the musical scale. However, it is generally accepted by most scholars that Pythagoras studied science, mathematics and religious mysteries in Babylonia, Egypt and Persia for over two decades and

traveled widely to assimilate ancient wisdom.[15] Pythagoras may not have been the first to discover the ratios, yet, there is no doubt that he formulated the most fundamental knowledge of musical harmonics and tuning theories, and disseminated them through the writings of his followers and later philosophers in Western civilization. Pythagoras considers *Number* to be a primary principle of the universe. For the Pythagoreans, number is a "living qualitative reality"[16] as real as light or sound. It is clearly different from the contemporary understanding of number, which is merely quantitative and its predominant usage is in the representation or denotation of quantity or amount.

Pythagorean philosophy is based on the concept of dualism as represented in the table of opposites, which Aristotle later reconstructed in his *Metaphysics.* Pythagorean cosmology is exemplified in the figure of the Tetraktys. The Tetraktys consists of the first four integers arranged in a triangle of ten points, which provides a numerical paradigm of Pythagorean principles.

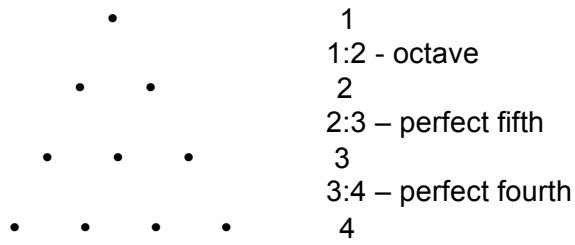


Figure 1. The Tetraktys

The Tetraktys symbolizes the perfection of Number. For the Pythagorean, the number ten was divine; it was the sum of the dimensions of experience (1+2+3+4=10). In the sphere of geometry, one (1) represents the point, two (2) represents the line, three (3) represents the surface and four (4), the tetrahedron, the first solid form. In the realm of music, Tetraktys contains the harmonic ratios of 1:2, the octave; 2:3, the perfect fifth; and 3:4, the perfect fourth.[17] Pythagoras's experimentation with the monochord beautifully demonstrated his metaphysical principles of Limit (peras) and the opposite Unlimit (apeiron) in the realm of sound. The harmonic overtone series occurs when the string is plucked since all strings vibrate at the whole number multiples of the fundamental frequency, where the amplitudes are inversely proportional to the frequencies. First, the string vibrates as a unit, then in two parts, then in three parts, then in four parts and theoretically in an infinite number of partials. Based on the same principle, a vibrating string of any length can be halved to sound an octave higher above the open string pitch, or the length of the vibrating string can be doubled to an octave lower. In the Pythagorean system and, in fact, in all ancient arithmetic-musical speculations, even numbers are female. They define the octave matrix, while odd numbers are male, and they fill that matrix with *tone children*. All tones recur cyclically in octaves: 1: 2: 4: 8: 16: 32: 64: 128 etc. are all recognized as the same tone in tuning theory. Therefore any octave can serve as the model for all possible octaves. Musicologist Ernest G. McClain states thst "The number 2 is 'female' in the sense that it creates the matrix, the octave, in which all other tones are born. By itself, however, it can only create 'cycles of barrenness', in Socrates' metaphor, for multiplication and division by 2 can never *introduce* new tones into our tone-mandala".[18] Hence the divine male number Three (3) will generate the musical ratios of 2:3, the perfect fifth; and 3:4, the perfect fourth. The human male number Five (5) will generate the musical ratios of 4:5, the major third and 5:6, the minor third. This arithmetic-musical construction of deification is pervasive in ancient times. Analogous models can be found in Vedic, Sumerian-Babylonian, and Egyptian-Greek pantheons.[19]

Formation of the Pythagorean scales can be structured as numerical proportions through two simple operations: harmonic mean (2AB/A+B=1 1/3), and the arithmetic mean (A+B/2 =1 ½ ), in the octave of 6:12.

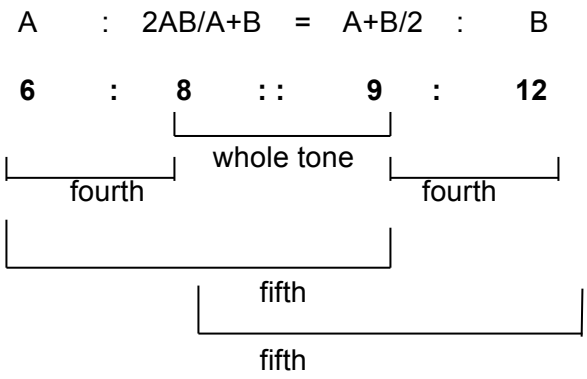


Figure 2. The Harmonic Proportion

In Pythagorean tuning theory these ratios are the only fixed tones and the rest of the intervals are movable. The fixed *invariant* proportions function in reciprocal ways since number functions as both wavelength and frequency or multiples (n) and submultiples (1/n) of string length. These qualities of numbers and proportions are later developed into Plato's political theory: the four model cities, the rationale for justice, and the social classes, all written in musical metaphors.[20]

McClain argued that Pythagorean musical ratios were recognized by both Mesopotamia and Egypt at least two millennia before the Greek civilization and it is not clear how much of the Greek theory of music might also have been Babylonian.[21] Scholars are still in the process of reconstructing the Babylonian tonal system. Egyptians had a special symbol for the perfect fifth, the harmonic ratio of 3:2 associated with the male-female elements through which the cosmos had been created.[22] The idea of the circle of fifths was the most vital concept and appears to be universal in ancient symbolism. The circle of fifths that Pythagoras brought to Greece from his twenty-two years of study in Egypt was the twelve fifths, $(3/2)^{12}$, from which an interval was reached that was very close to 4/3 (but not exactly 4/3) above the starting point, the fundamental one. This series of twelve fifths incidentally provided all of the twelve tones. In *Tableau Comparatif des Intervalles Musicaux,* the Sanskrit scholar and musicologist, Alain Danielou, lists this interval as the 12th Quinte,[23] 531.441/524.288, which has a frequency of 518.986 Hz where the starting point of the series, one, is listed as 512 Hz. The difference between these two frequencies is 23.46 cents, less than an eighth of a tone. This interval is known as the Pythagorean comma. However, the full symbolic circle used in Egypt, China and Babylon was three-hundred-sixty fifths, $(3/2)^{360}$ [24], an almost unimaginably long list of numbers to try to reach an interval that was very close to (but not exactly) a perfect unison or octave with the beginning fundamental one of the cycle. Danielou lists this interval as the 359th Quinte, which gives a frequency of 512.545 Hz/512 Hz, a difference of only 1.834 cents.[25]

Plato's enduring influence on the foundation of Western philosophy, logic, ethics, and mathematics as well as the Pythagorean "Music of the Spheres" were conveyed through ancient Greece, medieval Islamic philosophers, European Renaissance and Baroque Enlightenment to the modern scholars, scientists and musicians of today. Plato, an admirer of Pythagoreanism, believed that all physical phenomena can be explained with music and mathematics, which

encompass 'every possible dimension of thought'. McClain states that Plato's planetary systems described in the *Republic* and *Timaeus* are constructed from musical models and numbers used in the ratio theory of his time.[26] Each of Plato's four model cities derived from a specific tone-arithmetic model with individual algebraic yantras. Justice in the ideal city is described as a city "limited to essentials". For instance, Atlantis was conceived as the worst possible city doomed to destruction in *Republic* because it is "luxurious, feverish and gorged with a bulky mass of things", which lacked a principle of self-limitation. The metaphor of Atlantis constructed in response to the just tuning system, which involves 89 integers ($2^p3^q5^r$) within the octave of 108,000:12,960,000. McClain argues that Plato should not be taken literally but rather from the perspective of music. The fundamental musical problems that Plato allegorized in his treaties arise from the incommensurability of musical thirds, fifths and octaves. For example, as in the comma diesis 81:80, where 81 is factored by $3^4$, and 80 is factored by $(2^4)5$. Both 81 and 80 are versions of the major third above the fundamental, as in, 81:64 and 80:64, which reduces to 5:4. This disturbing incommensurability and the significance of Pythagorean *harmonia*, were applied to construct the Platonian principle of justice, which prioritized the interests of public good, "what is best for the city." McClain writes that "The marriage allegory dramatizes the discrepancy between musical fifths and thirds as a genetic problem between children fathered by 3 and those fathered by 5. The tyrant's allegory dramatizes the discrepancy between fifths and octaves as that between powers of 3 and powers of 2."[27] When Plato states that the tyrant is 729 times as bad as the good man (*Republic* 587e), he is using the metaphor of the musical quality of the tritone (the ratio $3^6 = 729$, a cycle of six perfect fifths above the fundamental), the worst possible dissonance in the musical system known to Plato and, in fact, in all Western tonal systems for two thousand years after him as, "the devil's tone". For Plato, the number 729 quantified the relation between the good man and the tyrant as illustrative of the greatest possible tension within a civilized system.[28]

Alfred Whitehead, influential philosopher and mathematician, emphasized the unbroken and fervent influence of Greek philosophy on European academia. He remarked that the European philosophical tradition is "a series of footnotes to Plato".[29] Is Plato perhaps a series of footnotes to other cultures? In fact, fundamentals of Plato's musical hypothesis can be found to have Eastern roots. The Rg Veda, India's oldest sacred text, was grounded on proto-Pythagorean theories of number and tone, and was concerned with musical hypothesis, which became the focus of Greek tuning theory. *In Meditations through the Rg Veda*, Antonio T. de Nicolas states, "In the beginning was tone, and tone became chant and chant grew into human flesh through the sacrifice... This is the general theme of the Rg Veda".[30] de Nicolas demonstrates how the whole of the Rg veda is not prose or poetry but rather it is chant, close to music in its form; the musical-metric structure of the hymns and the meaning of the hymns are grounded on the model of musical tones.[31] The primary sensorium organized the four intentionality-structures of the Rg Veda from which it derives its meaning, (Non-Existence, *asat*; Existence, *sat;* Images, *rta,* and Sacrifice, yajna; and Embodied Vision, *rta dhih)* are on a model of sound. de Nicolas writes:

> Rgvedic man was enveloped by sound. He was surrounded by sound, excited by sound, made aware of presences by sound, looked for centers of experience in the experience of sound, found the model of complete, absolute instantaneity and communication in sound... The Rg Veda's song-poems were not only oral creations but also chanted creations. While the other sensory media provided discontinuity, sound alone, in spite of its evanescence, gave Rgvedic man the instance of eternal presence and unity he so well used to further develop the world of rta, the well-formed instant.[32]

Rg Vedic hymns portray numbers 'poetically' venerating quanta with classes of gods, and embrace the tonal-arithmetical relations in sexual and musical metaphors. The sexual imagery

of numbers Plato associated in his *Marriage Allegory* was evidently traced to Rgvedic mythology. The cyclic identity of the musical octave is symbolically extended to the cyclic matrix for cosmology. de Nicolas explains how the tone-mythology was created in the Hindu-Greek system: The original unity is 1, the immovable hermaphrodite divinity. His virgin daughter 2, octave-double, was produced from the father 1 without benefit of a mother. 1 and 2 were coupled in divine incest and produced the divine male number 3, from which 'brahman tones' and Plato's 'citizens of the higher property class' were generated, musically defining 2:3 and 3:4. From the demiurge 3, and the female 2, the human male number 5 was born who fathered 'citizens of the second higher property class', which define the musical 4:5, the major third and 5:6, the minor third.[33]

The ancient Indians believed that the cosmos was created with the sound OM. In Vedic thought it is said that there are two kinds of sound, one a vibration of ether (Anahata Nada), the other a vibration of air (Ahata Nada). The Sanskrit scholar and musicologist, Alain Danielou, explains that Ahata Nada is an impermanent vibration of air [medium], an image of the ether vibration. It is audible and always produced by a shock. It is therefore called *ahata* or "struck". We hear this kind of vibration as sound. Conversely, Anahata Nada, a vibration of ether, cannot be perceived in the physical sense, but is considered the principle of all manifestation, the basis of all substance.[34]

Correspondingly, Nāda yoga is an ancient Indian metaphysical and philosophical system. Its principle approach is that the universe and all that exists in the universe consists of sound vibration, nāda. Indian sages and philosophers consider sound to be a vehicle of truth to achieve *moksha*, and they ultimately agree on the premise of *Nada Brahma*, sound is god. The relationship of sound and vibration according to the 10th century Indian philosopher, Ajanaka Kshemaraja, a disciple of Abhinavagupta, one of India's greatest philosophers and musicians: "The *bindu*, wanting to manifest the thought it has of all things, vibrates, and is transformed into a [primordial] sound with the nature of a cry [nāda]. It shouts out the universe, which is not distinct from itself; that is to say, it thinks it – hence the word sabda [word]. Meditation is the supreme word: it sounds, that is, it vibrates, submitting all things to the fragmentation of life; this is why it is nāda [vibration]... Sound [sabda], which is of the nature of nāda, resides in all living beings."[35]

The musicians of India literally lead a life based on the concept of *Nada Brahma*. Music is considered to be a spiritual tradition preserved and passed on in the language of music. In an article "Singing of Pran Nath: The Sound is God" La Monte Young writes that "Nadam Brahmhum. Sound is God. I am that sound that is God. This was the opening phrase of Pandit Pran Nath's own composition in the classical Yaman Kalyan, the first raga that he sang in concert in New York City. How many times Pran Nath has repeated this idea to me since he first came to America in January—not only the abstraction of the Vedic idea that the universe began with vibration, which in itself is very clear, and related to concepts of modern physics, but a reality in his own everyday here-and-now life."[36]

Without knowing their musical origins, it is hard to understand why ancients were concerned with specific numbers and described qualities in particular numbers with no apparent reason. Not only Platonic scholars and Vedic scholars have long been troubled but also Bible scholars complained that the Book of Revelation has "many mythological features which in themselves are neither Jewish nor Christian"[37]: "seven angels with trumpets", "twenty-four elders with harps", "choir of 144,000 male virgins", "hide in the wilderness for 1,260 days", "walls of 144 units" etc. McClain explains, "Five times in Revelation the number 1,260 is alluded to cabalistically; that number measures the greatest distance of the Sun and the minimum distance of Mars in earth

radii in the planetary system Ptolemy developed from Hipparchus' material. That same number – 1,260 = $2^2$ x $3^2$ x 5 x 7 – shows a musical theorist how the sacred number 7 generates along with the 'human' 5 and the 'divine' 3."[38] New Jerusalem's wall of 144 cubits is also from the musical octave 72:144, which is the Hindu-Greek diatonic scale in the smallest integer set 30:60 transposed for monochord. The Hindu-Greek transformation of the Christian scale is as follows:[39]

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|---|---|---|---|---|---|---|---|---|
| Christian | 72 | 80 | 90 | 96 | 108 | 120 | 135 | 144 |
| Hindu | 60 | 54 | 48 | 45 | 40 | 36 | 32 | 30 |
| Ratios | 9:10 | 8:9 | 15:16 | 8:9 | 9:10 | 8:9 | 15:16 | |

Judeo-Christian tradition set forth the word (sound) as the beginning of creation. It is written in the New Testament, John 1:1-5, "In the beginning was the Word, and the Word was with God, and the Word was God." In the above text, if we replace the word "Word" with the word "Sound," we find a correspondence to the Vedic idea that the cosmos was created with the sound OM. Vedic thought states that the sound OM and the word OM are two aspects of the same phenomenon. René Guénon (1886–1951) explains the subtle correspondence between primordial sound and creation with traditional metaphysics in the Vedas and the Judeo-Christian tradition: "the affirmation of the perpetuity of the Vedas is directly connected with the cosmological theory of the primordial nature of sound among sensible qualities (sound being the particular quality of ether, Ākāśa, which is the first element). And this theory is in reality nothing other than that which is expressed in other traditions when 'creation by the Word' is spoken of. The primordial sound is the divine Word, through which, according to the first chapter of the Hebrew Genesis, all things were made. This is why it is said that the *Rishis* or sages of the first ages 'heard' the Vedas. Revelation, being a work of the Word like creation itself, is actually a hearing for those who receive it." [40]

It is a parallel case with the Islamic sacred text, the Quran, which was an aural revelation. The Quran was revealed to Muhammad from 609 to 632 A.D. over a period of twenty-three years. Many acoustical imageries are included in the Quran, and moreover the Quran itself is to be recited with respect for its sound, "in slow, measured rhythmic tones" (1xxiii4). In the Quran, man is described as "sounding clay" (xv.26), and tone as "order" emerging from the ambience of disorder so the soul acquires 'proportion and order'[41] God Himself announces, "Verily all things have We created in proportion and measure" (xxix.62). The author of *Meditation through the Quran*, McClain claims that the Quran could not be more emphatic that "God Himself *measures* and *numbers* all things to ensure *proportion*". The measures 3:4:5:6 embodied in the Ka'ba' were translated into musical ratios and symmetrical lattice arrays.

Sufism, an esoteric sect of Islam, also evolved a concept of inaudible sound. Sufis imagined the movements of the stars and planets, the laws of vibration and rhythm, all perfect and unchanging, show that the cosmic system is working according to the laws of music and harmony. Hazrat Inayat Khan, a Sufi spiritual leader, wrote about vibrations as accounting for the various planes of existence and different aspects of sound. He writes, "The mineral, vegetable, animal and human kingdoms are the gradual changes of vibrations… Man is not only formed of vibrations, but he lives and moves in them... All things being derived from and formed of vibrations have sound hidden within them."[42]

This mode of thought can be found in other ancient cultures and also in different times. Chinese writings claim that in 2697 B.C. the emperor Huangdi sent a scholar, Ling Lun, to the western mountain area to cut bamboo pipes that could emit sounds matching the call of the *fenghuang*, making possible the creation of music properly pitched for harmony between his reign and the

universe.[43] In his book, Genesis of a Music, Harry Partch, the first composer of modern times to compose music using intervals based on whole number frequency ratios and design his own instruments to play his music, elucidates on the origins of harmonic ratios in Chinese music. Parch writes: "Sze Ma-chi'en, historian for ancient China and contemporary of Ptolemy in a culture isolated from the Greek world, ascribes the mathematical formula for the pentatonic scale to *Ling Lun,* minister or court musician under Emperor Huang-Ti, of the twenty-seventh century B.C.[44]

The Chinese philosopher Confucius (551-479 B.C.) writes that music is intimately connected with the essential relations among beings.[45] Another Han Dynasty Confucius philosopher Dong Zhongzu (179–104 B.C.) writes, "the vital spirits of humankind, tuned to the tone of heaven and earth, express all the tremors of heaven and earth, just as several cithers, all tuned on *gong* [tonic], all vibrate when the note gong sounds. The fact of harmony between heaven and earth and humankind does not come from a physical union, from a direct action; it comes from a tuning on the same note producing vibrations in unison… in the universe nothing happens by chance, there is no spontaneity, all is influence and harmony, accord answering accord."[46] Dong Zhongzu's correlative cosmology underlines the mutual responsiveness of Heaven and humanity. He integrates cosmological, meditative and political concerns into a cohesive worldview, which generates the Chinese ethical principles.[47] Similar to the manner in which Plato produced symbolic idioms from musical models to construct political theories and the meaning of justice, Confucius and Dong Zhongzu grounded their political dialogue in correlations between music of the heavenly realm and human conduct.

Dong wrote, "Therefore when the F note is struck in the seven-string or twenty one-string lute, the F notes in other lutes sound naturally in response. This is a case of things being activated according to their sound, but it is invisible. People do not see a physical form associated with what activates them so they say that they sound on their own... In reality, it is not that they do so [sound] spontaneously, but that there is something [Heaven] that causes them to be so.[48] Dong metaphorically relates the phenomenon of sympathetic vibration on a musical instrument to explain the norms of the cosmos in the natural world. He asserts that all phenomena in the universe operate according to constant principles. It closely corresponds to the Pythagorean concept of *musica instrumentalis* (sounds made by singers or instruments), *musica humana* (the internal music of the human body) and *musica mundana* (music of the spheres).

We can think of sound as organized and less organized sound. The contemporary composer La Monte Young points out that through the study of organized sound we learn to recognize vibrational structures and that through the study of sound as a model, we can then conceive of and possibly learn to perceive inaudible vibrational structures such as the vibrational patterns of universal structure. Young writes:

> And while psychoacousticians continue to study and postulate how we actually process and analyze pitch information, the ear seems to have the ability to perceive sound vibration as such and transmit it through the auditory nervous system, including the brain, as information distributed in time. Accepting this premise, we might then think of periodic composite waveforms, and the justly tuned scales, chords and intervals from which they are derived, as classifiable principal vibrational structures that can be experienced in real time primarily through the medium of sound. As such, periodic sound waveforms may be singularly perceptible models of the fundamental principles of vibrational structure. The sensations of ineffable truths that we sometimes experience when we hear progressions of chords and intervals tuned in just intonation may indeed be our underlying, subliminal recognition of the broader, more universal implications of these fundamental principles.[49]

Interestingly, modern physics comes close to approximating the beliefs of inaudible vibrational structure such as *anahata nada* and the Harmony of the Spheres. Brian Greene writes that "From the ancient Pythagorean 'music of the spheres' to the 'harmonies of nature' that have guided inquiry through the ages, we have collectively sought the song of nature in the gentle wanderings of celestial bodies and the riotous fulminations of subatomic particles. With the discovery of superstring theory, musical metaphors take on a startling reality, for the theory suggests that the microscopic landscape is suffused with tiny strings whose vibrational patterns orchestrate the evolution of the cosmos."[50] According to superstring theory, the properties of an elementary particle, its mass and force charges, are determined by the precise resonant pattern of vibration that its internal string executes, just as the different vibrational patterns of a violin string produce different musical pitches.

The history of science reveals a continuing process of narrowing the gulf between hypothetical postulations and practical proofs. Physics and astrophysics today are full of musical vocabularies such as resonance spectra and frequencies evocating celestial music.[51] Scientists discovered that sound exists in space much as ancient philosophers had intuitively speculated. In 2002, using NASA's satellite-borne Chandra X-ray Observatory, astronomers detected ripples in the gas filling the black hole in the Perseus cluster. These ripples are evidence for sound waves that have traveled from hundreds of thousands of light years away. In musical terms, the pitch of the sound generated by the black hole translates into the note of B-flat at a frequency over a million times deeper than the limits of human hearing.[52] In 2006, EIT and GOLF instruments being mounted on the ESA-NASA's SOHO satellite detected and have been analyzing the vibrations radiating from the Sun. Our Sun is a vast ball of gas vibrating at various frequencies, some of which are within the acoustical range and others are within the electromagnetic range.[53]

Modern physicists still do not know exactly why the planetary orbits are arranged as they are. However, some physicists believe that the arrangement of the planetary orbits is the result of resonances between them. The term 'resonance' used by physicists is to describe "a condition prevailing in a system when its vibration increases greatly as a result of a stimulus whose frequency coincides with the natural frequency of the system itself."[54] Sympathetic vibration of strings or gravitational resonances of orbits are both the result of interaction between strings or orbits, which obey the same fundamental laws derived from the same methodology in musical resonance.

Today, scientists have a more sophisticated understanding of the vibrations of the elements. It is known that nothing exists except by the combination of forces and movements. Since every movement generates a vibration and therefore a *sound* that is unique to it, such a sound may not be audible to our rudimentary ears, but it does exist as 'pure sound'. It is extremely significant that it is only through music that we can perceive vibrational structure as vibration and it is remarkable that while philosophers and mystics throughout time intuitively understood the relationship of music to universal structure, it was not until recent times that modern science has actually proven it.



[1] Revised 2009 and 2011

[2] Kenneth Sylvan Guthrie, *The Pythagorean Sourcebook and Library* (Phanes Press, 1987) p. 34
[3] Brian Greene, *The Elegant Universe* (First Vintage Books Edition, 2000) p. 3
[4] Ibid.
[5] Ibid.
[6] Ibid., p.15
[7] Alain Danielou, *Music and the Power of Sound* (Inner Traditions International, 1943) p. 1
[8] Thomas D. Rossing, Richard Moore & Paul Wheeler, *The Science of Sound* (Pearson Education, Inc., 2002) p. 3
[9] In *The Myth of Invariance*, Ernest G. McClain constructed numerous ancient Vedic, Mayan, Egyptian, Babylonian, and Hebrew algebraic yantras.
[10] Antonio T. de Nicolas, *Meditation through the Rg Veda* (Author's Choice Press, 2003) p. 56
[11] Exact dates of Pythagoras's life are unknown. William Keith Chambers Guthrie writes, "The dates of his life cannot be fixed exactly, but assuming the approximate correctness of the statement of Aristoxenus (ap. Porph. *V.P.* 9) that he left Samos to escape the tyranny of Polycrates at the age of forty, we may put his birth round about 570 BC, or a few years earlier. The length of his life was variously estimated in antiquity, but it is agreed that he lived to a fairly ripe old age, and most probably he died at about seventy-five or eighty" *A History of Greek Philosophy, Volume 1: The earlier Presocratics and the Pythagoreans* (Cambridge University Press, 1978) p.173.
[12] John D. Fix, *Astronomy: Journey to the Cosmic Frontier*, 3rd ed. (McGraw-Hill, 2004) p. 42
[13] Ibid.
[14] Marc Lachieze-Rey and Jean-Pierre Luminet, *Celestial Treasury* (Cambridge University Press, 2001) p. 60
[15] Kenneth Sylvan Guthrie, *The Pythagorean Sourcebook and Library* (Phanes Press, 1987) p. 20
[16] Ibid. p. 21
[17] Kenneth Sylvan Guthrie, *The Pythagorean Sourcebook and Library* (Phanes Press, 1987) p. 29
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