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. In the early civilizations of India, China, Egypt, Mesopotamia and Greece, numerology, music, mathematics, cosmology and mythology were converged to construct a musical and arithmetical model of the cosmos. It was pervasive that number, geometry, astronomy and music were considered four forms of a single concept of proportions. These cultures and traditions virtually all conceived the concept of inaudible sound vibrations, such as the Pythagorean concept of *Music of the Spheres* and the Vedic concept of *Anahata Nada,* as a basis of universal structure, and recognized music (sound or vibrational patterns) as the numerical structure that was capable of synthesizing a correspondence between the imperceptible abstract principles and the perceptible world. In this line of thought, the universal principles can be understood through music, and the connection between metaphysical principles and physical reality can be reconstructed in music. Consequently in the early civilizations, the musical ratios became developed into 'a science of pure relations,'[2] which provided a foundation for the social justice and class systems on the basis of musical criteria.

Interestingly, modern physics has come close to approximating the beliefs of inaudible vibrational structure, just as the ancient cultures imagined it, to be the principle of universal structure. String theory, which offers a unified theoretical framework to explain fundamental features of the universe, demonstrates that "the vibrational frequencies of particles determine every particular manifestation of the universe,"[3] which is analogous to the harmonic oscillatory pattern of the string on a violin or other musical instrument. 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 between the understanding of the universe at its microscopic and its astronomical levels. 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".[4] 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."[5] Even though these two revolutionary theories fabricated a new understanding of the universe, the two "foundational pillars" are "mutually incompatible"[6]. Greene elucidates, "As they are currently formulated, general relativity and quantum mechanics *cannot both be right*".[7] 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 that could describe nature's principle forces both on its microstructure and macrostructure. He failed, but a few decades later some 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"[8] in the metaphor of music; it explains that 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 properties of an elementary particle are the manifestation of the resonant patterns of vibration that its internal string executes.[9] 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.[10]

Sound is energy and information. Energy and information are two of the common characteristics of all waves such as light waves, sound waves, water waves, seismic waves, X-rays, radio waves, etc. Sound waves transport energy and information from one place to another through a medium, while the medium itself is not transported.[11] 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 sounds of different frequencies. The nervous system is then able to identify these vibrations as sound. Significantly, in the lower-frequency range, the auditory nerve fiber carries information on periodicity and possibly on the vibration pattern itself.[12] 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, has been developed into an increasingly interdisciplinary field encompassing the disciplines of physics, engineering, psychology, speech, audiology, music, architecture, physiology, neuroscience, and others.[13] However, what we call acoustics today 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. It is known that the ancient cultures discovered and vigorously used the musical Intervals in the third or fourth millennium B.C. or presumably even before. They found the corresponding ratios between the tones, the properties of vibrations, and the physical lengths of strings or pipes. The early civilizations recognized, 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 established a ratio theory where the tonal relation fundamentally corresponds with the number field.[14] Antonio T. de Nicolas, philosopher and Vedic scholar, inferred that the epistemology of human consciousness is grounded on sound and states that "From these first six integers, functioning as multiples and submultiples of any reference unit (1) of length or frequency, a numerological cosmology was developed throughout the Near and Far East."[15]

Throughout history, the Pythagorean concept of "Music of the Spheres" has referred to vibrational systems, or sounds, that are inaudible. Pythagoras (6th Century B.C.) 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, produced 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.[16] 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.[17]

Pythagoras has been credited in the West as the first to discover the musical intervals and tuning theory. However, it is generally accepted by most scholars that Pythagoras was heavily influenced by Orphism, an esoteric religion of ancient Greece, and traveled widely to assimilate ancient wisdom to study science, mathematics and religious mysteries in Babylonia, Egypt and Persia.[18] Pythagoras may not have been the first to discover the musical 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. It is clearly different from the contemporary understanding of number, which is merely quantitative or denotative. For the Pythagoreans, number is a "living qualitative reality"[19] as real as light or sound. Number is seen as a divine principle and is believed to be "the principle, the source and the root of all things."[20]

Pythagorean cosmology is exemplified in the figure of the Tetraktys, which provides a numerical paradigm of Pythagorean principles.[21] The Tetraktys consists of the first four integers arranged in a triangle of ten points.

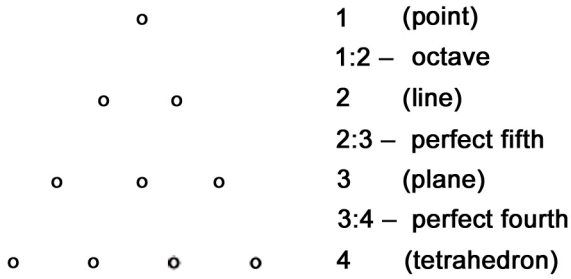

Figure 1. The Tetraktys

The Tetraktys symbolizes the "perfection of Number" and expresses "a differentiated image of Unity".[22] For the Pythagoreans, number one was the Unity, a principle underlying number,[23] the same as the fundamental (1/1), which is the underlying principle of the entire harmonic series. Number ten was divine as demonstrated in the Tetraktys, which includes the four smallest consecutive integers; it was considered to be the sum of the dimensions of all 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 represents the harmonic ratios of 1:2, the octave; 2:3, the perfect fifth; and 3:4, the perfect fourth.[24]

Pythagorean philosophy is based on the concept of dualism as represented in the Table of Opposites, which Aristotle later reconstructed in his *Metaphysics:*

Limit	Unlimited
Odd	Even
One	Plurality
Right	Left
Male	Female
At Rest	Moving
Straight	Crooked

Light	Darkness
Good	Bad
Square	Oblong

Figure 2. The Pythagorean Table of Opposites[25]

The Pythagorean cosmology of *kosmos*, literally world-order, is directly connected with the concepts of Limit and the opposite Unlimited. The central focus of the Pythagorean paradigm was placed on the principle of *Harmonia,* the logos of relation.[26] One represents the principle of Unity, the principle underlying number from which all things arise; Two represents the first possibility of logos, the relation of one to another from which the Dyad arises, the duality of subject and object; Three represents Relation or Harmonia where the extreme two are balanced in process, the Triad, which realizes 'the logos of relation in actuality'. [27] Pythagoras's experimentation with the monochord provided inevitable meanings to his metaphysical principles of Limit and Unlimited) in the realm of sound. Harmonic nodal points that exist on a string clearly manifest the integral numerical proportions that arise from the continuum of tonal flux. When the string is plucked, there will be many modes of vibration, and the harmonic overtone series occurs 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 ($f_1 = v/2L$)[28] then in two parts ($2f_1 = v/L$), then in three parts ($3f_1 = 3v/2L$), then in four parts ($4f_1 = 2v/L$) and theoretically in an infinite number of partials ($f_n = nf_1$, n = 1, 2 ,3 …). Based on the same principle, when the length of the vibrating string is divided in half, it sounds an octave higher above the open string pitch, or the length of the vibrating string can be doubled to an octave lower. In tuning theory 1: 2: 4: 8: 16: 32: 64: 128 etc. are all recognized as the same tone in the matrix of octaves, the arithmetic double. Since tones recur in all octave cycles, intervallic relationships schematized in any octave can be a functional model for all other octaves.[29]

The 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.

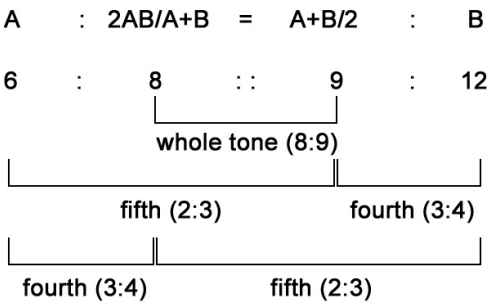

Figure 3. The Harmonic Proportion

In Pythagorean tuning theory the fixed *invariant* proportions function in reciprocal ways.[30] The number 9 is the arithmetic mean and the number 8 is the harmonic mean within the matrix of the octave 6:12. The arithmetic mean (A+B/2) divides the octave into a perfect fifth, the ratio of 2:3 (=6:9) and a perfect fourth, ratio 3:4 (=9:12). The harmonic mean (2AB/A+B) divides the octave in a reverse order, perfect fourth (3:4 = 6:8) and perfect fifth (2:3 = 8:12), which formulates

reciprocity and creates inverse symmetry, dominantly used in art, architecture and music in ancient Greece.[31]

Musicologist Ernest G. McClain claims that Pythagoras brought the musical proportion of 6:8:: 9:12 from Babylon[32] and Pythagorean musical ratios were recognized by both Mesopotamia and Egypt at least two millennia before the Greek civilization.[33] The idea of the circle of fifths was the most vital concept and appears to be universal in ancient symbolism. 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.[34] 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,[35] 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, $(3/2)^{360}$ [36], 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.[37]

Pythagoras did not leave any first-hand writings of his teachings or doctrines, which were esoteric and of an oral nature.[38] Plato's *Republic* was the first written reference that illustrated that the movement of the celestial bodies corresponds to musical intervals. Plato (427-347 B.C.) took the same view as Pythagoras. Plato's enduring influence on the foundation of Western philosophy, logic, ethics, and mathematics as well as the Pythagorean "Music of the Spheres" was conveyed from ancient Greece, medieval Islamic philosophers, European Renaissance and Baroque Enlightenment to the modern scholars, scientists and musicians. Plato believed that all physical phenomena can be explained with music and mathematics, which encompass 'every possible dimension of thought'. Plato insisted on the superior role of music in the education of the whole man, and his political framework has been constructed with the musical allegories. 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."[39] Plato quantified the "beastly nature" of the tyrant in the *Republic* as the tyrant's suffering is exactly 729 times that of a philosopher, using the metaphor of the musical quality of the tritone (the ratio 3^6 = 729) to illustrate the tension in the society. The ratio 729/512, three whole tones (8:9) above 512, is a 'Pythagorean approximation' of the square root of 2 (obviously inconsistent with the true square root of 2) creating a discrepancy between G# and Ab, respectively three whole tones above and below D. This interval is known as Pythagorean comma, 524288:531441, where six consecutive whole tones (8^6 and 9^6) exceed the octave 2:1, which was conceived as a flaw and evil in the Plato's marriage allegory.[40] The smallest integers for six whole tones (8^6=Ab and 9^6= G#) are

524288:531441, which reduce to (512^2x2) and 729^2. Siegmund Levarie comments that in this allegory Plato illuminated the worst possible dissonance in the musical system known to Plato and which in fact, affected all Western tonal systems for the next two thousand years, called "the devil's tone".[41] Plato's planetary systems described in the *Republic* and *Timaeus* are constructed from the musical models and the ratio theory of his time. Each of Plato's four model cities - Callipolis, Ancient Athens, Atlantis, and Magnesia - is derived from a specific tone-arithmetic of the first ten integers. Since *Self-limitation* is an important value in Platonic political theory, *Justice* in the ideal city is described as a city 'limited to essentials'.[42] For instance, Atlantis was conceived as the worst possible city doomed to destruction in the *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 was constructed with tonal implications of the central island (30:60) and three outer rings that are the successive octave doubles generated by powers of 60 (3,600; 216,000 and 12,960,000), which involves 89 integers ($2^p3^q5^r$) within the octave of 6,480,000:12,960,000 correlating with 121 tones.[43]

In the Pythagorean system and, virtually, in all ancient arithmetic-musical speculations, it is believed that even numbers symbolize female, and odd numbers symbolize male. Even numbers define the octave matrix 2:1, the basic field of a musical scale, and odd numbers fill that octave matrix with *tone children*. McClain states, "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."[44] As it is mentioned above, any arithmetic doubles, for example, 3: 6: 12: 24: 48 are all recognized as the same tone transposed in different octaves. Numbers I and 2 are often not even considered to be numbers but rather to be divine. Hence number 3 is acknowledged as the first number. In Plato's musicalized number theory, the divine male number Three (3) generates, "citizens of the highest property class" defining the musical ratios of 2:3, the perfect fifth; and 3:4, the perfect fourth. The human male number Five (5) generates, "citizens of the second highest property class" defining the musical ratios of 4:5, the major third and 5:6, the minor third. The number Seven (7) generates, "citizens of the third highest property class" defining the musical ratios of 6:7, the septimal minor third; and 7:8, the septimal major second.[45] 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.[46]

Remarkably, fundamentals of Plato's musical hypothesis and theory can be traced to earlier Eastern sources. The Rg Veda, India's oldest sacred text, was grounded on proto-Pythagorean theories of number and tone, which may be the roots of Pythagorean tuning theory. Rg Vedic hymns epitomize deities with tonal-arithmetical relations in sexual and musical metaphors. Plato's sexual imagery of numbers and musical hypothesis in his *Marriage Allegory* evidently had long been known to Rgvedic poets. *In Meditations through the Rg Veda*, Antonio T. de Nicolas illustrates that the cyclic identity of the musical octave is symbolically extended to the cyclic matrix for Vedic 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, the 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, and thus musically defined 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.[47]

More importantly, the entire context and structure of the Rg Veda are grounded on harmonics

and the mathematical measures through which the harmonics of the hymns can be identified. The Rg Veda demands that we take sound and musical criteria in order to understand its structure and the true meaning it embodies.[48] 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."[49] It is a critical condition to understand that the Rg Veda is not prose or poetry but rather 'chant, close to music', which demonstrates that the meaning and structure of the hymns are on the model of musical tones.[50] Sound is intrinsically reciprocal and manifests itself on an integrated dimension of spatiality and temporality, as de Nicolas describes, "The space is the musical scale, and it is neither here nor there prior to song; space and song are simultaneous. Time, again, is not prior to the singer; and the singer is no other than the song; the singers body shares its dimensions with the structure of the song."[51]

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; surrounded and 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 ability to be bodily at home with any god, any human personality, any perspective.[52]

From the Vedic period to the present time in India, it is emphasized with an absolute significance that only the sonic dimension or the utterance of mantra has the efficacy to transmit the sacred power. An ancient Hindu text, *Parama-Samhita* prohibits the written form of mantras: "It is by mantra that He is released. By secret utterance these are mantras, and therefore these are not to be published."[53] Since the Rg Veda is firmly grounded on oral-aural perceptions, it is necessary to interiorize all perception from the perspective of sound and on the model of sound to approach the meaning of the hymns. It is solely *Sound* that provides the key to understand our "interiority", as de Nicolas elicits: "it is only through sound that interiors as interiors are manifested. Sound is the greatest clue we have to interiority, our own and that of others. It is only sound which makes true interiority communicative."[54] In Greek philosophy, numerical proportion and logos are used synonymously. In the same vein with Vedic thought, *logos* can be thought of as the relation of one to another, communication between the realm of thought and the realm of spoken language unfolding in the medium of sound.

The ancient Indians believed that the cosmos was created with the sound OM. Based on the *Sangita-makaranda*, written by Narada around 1100 CE, it is said that there are two kinds of sound: one a vibration of ether, 'the Gods delight' (Anahata Nada), the other a vibration of air (Ahata Nada), and the Yogis project their mind, by an effort of the mind, into this vibration of ether (Anahata Nada) to attain Liberation.[55] 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.[56]

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 philosophers considered sound to be the most effective vehicle of truth to

achieve *moksha*, and they ultimately agreed on the premise of *Nada Brahma*, sound is god. The 10th century Indian philosopher, Ajanaka Kshemaraja, a disciple of Abhinavagupta, one of India's greatest philosophers and musicians, set forth the relationship of sound and vibration: "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."[57]

In ancient India, it is believed that all aspects of the world originated from the same principle, sound. Music was considered to venerate the equivalence between the perceptible world and the abstract transcendent world. Since each divine aspect is connected with some particular form, sound and vital energy, and which may appear on the particular proportions of tones, deities are given an important place in all Sanskrit treatises on music.[58] In the Sanskrit nomenclature, there are two terms that denote sound: one is *sabda*, a masculine word connoting meaning (*artha*), the other is *nada*, the feminine energy that signifies the voiced sound of vowels. Many schools of thoughts and traditions in India such as Yoga, Sangita, Sakta-Tantra, Saivism and Vaisnava, *Nada Brahma* is the term indicated for sacred sound. Guy L. Beck notes that the term *Nada Brahman* received "a broader and deeper exegetical treatment in the succeeding Sanskrit literature than any of the other terms and becomes the classical Hindu notion of sacred sound par excellence."[59] Music is considered to be a spiritual tradition preserved and passed on in the language of music. The musicians of India lead a life based literally on the concept of *Nada Brahma*. In an article "Singing of Pran Nath: The Sound is God" La Monte Young writes, "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."[60]

The arithmetic-musical construction of deification is pervasive in ancient times and analogous models can be found in Vedic, Babylonian, Greek and Egyptian pantheons.[61] Correspondingly, certain numbers or proportions are recurrently presented in the ancient texts from various cultures. Number 432 and its ten-ness is an example that was given a significant place in much of the ancient numerical symbolism. In Hindu cosmology, the invariant five-tone set, Brhaspati yantra (C G D A E), and seven-tone set, Parajapati yantra (F C G D A E B), are identified as symmetrical expansions of the basic materials defined by 60. The prevailing numbers in Hindu cosmology are derived from the symmetrical scale order of the seven tones in the 432:864 octave-double.[62]

Ratios	432	486	512	576	648	729	768	864
Rising	D	E	F	G	A	B	C	D
Falling	D	C	B	A	G	F	E	D
Components 3^n	3^3	3^5	3^0	3^2	3^4	3^6	3^1	3^3

The first Yuga (ages of the world) of the Hindu cosmic cycle and the total of all four yugas correspond with the number 432, which has been multiplied by 1000 and 10000 respectively.[63]

Kali Yuga	=	1	=	432,000
Dvapara Yuga	=	2	=	864,000

Treta Yuga	=	3	=	1,296,000
Krta Yuga	=	4	=	1,728,000
Maha Yuga, total	=	10	=	4,320,000

McClain identifies the number 432,000 which appeared in various Ancient writings:

> For Berossos, the last priest of Marduk (c. 300 B.C.), 432,000 was the Babylonian "Great Year"; for the author of the *Grimnismal,* 432,000 was the number of fallen warriors whom the Valkyries carried to Valhalla and who ride forth to do battle for Odin on the last day of its existence. In the Rg Veda, whose 10,800 stanzas average forty syllables per stanza, 432,000 is the total number of syllables. In the Babylonian sexagesimal notation, 432,000 is merely another form of the female matrix number 2, written as 2;0;0;0 in Neugebauer's modernized form and meaning 2 x 60^3. For Ptolemy, 432,000 was least common denominator for his monochord fractions.[64]

Without knowing their musical origins, it is hard to understand why the ancients were concerned with specific numbers and described qualities in particular numbers with no apparent reason. Not only Platonic scholars and Vedic scholars have been troubled interpreting the numerological implications of certain numbers that appear repeatedly in the ancient texts, but also Bible scholars complained that the Book of Revelation has "many mythological features which in themselves are neither Jewish nor Christian"[65]: "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."[66] 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 the monochord. The Hindu-Greek transformation of the Christian scale is as follows:[67]

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. 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.[68]

It is a parallel case with the Islamic sacred text, the Quran, which was an aural revelation. It is said that 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'.[69] This concept directly corresponds with the Vedic concept of *Sat* (existence) and *Asat* (non-existence), and the Pythagorean concept of Limit (peras) and Unlimited (apeiron). In the Quran, God Himself announces, "Verily all things have We created in proportion and measure" (xxix.62). In *Meditation through the Quran*, McClain affirms 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 comprehensively translated into musical ratios and symmetrical lattice arrays in Islamic culture.

In contrast to the general worship of exoteric Islam, which confines music only to chanting of the Quran, in Sufism, an esoteric sect of Islam, music has been the most integral part of the religious practice, *sama (listening)*, which is considered an exclusive path to a higher spiritual state that is otherwise very difficult to attain.[70] An old Sufi story tells that when God created the body, the soul did not want to go inside. The soul did not understand the reason it had to take the body and come to earth. The soul could see this was going to be a trap; the soul was going to be in this cumbersome body and it would be a life of hardship from there on. God used music to lure the soul into the body. Since the soul itself is music, it entered the body to experience the music of life.[71] This Sufi message recognizes that sound is caused by the vibration of air molecules and by having a body it is possible to experience these vibrations. The vibrational structure of sound can be experienced through the body and the reason for the soul coming to earth is to study music in order that the soul can learn and understand more about universal structure. Music has been considered as a perceptible model for the experience of vibrational structure in Sufism, which also evolved a concept of inaudible sound. Sufis imagined that 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."[72]

The corresponding mode of thought can be found in other ancient cultures and also in different times. Not only the ancient Greeks and Indians recognized the connection between universal principles and physical laws, the ancient Chinese established a profoundly similar worldview, "Being the expression of natural harmonies, music is a translation of the moral forces that are also a part of the universe; it arises from it but regulates it in turn."[73] The ancient Chinese believed that the two principles, Yin and Yang are the basis of all existence, which corresponds to the Sanskrit *linga* and *yoni; purusha* and *prakriti*.[74] The Chinese classic, Tao-te Ching, written by Lao Tzu around the 6th century B.C., illustrates a very similar number genesis with the musical implication to the Greek and Vedic texts, "One has produced Two, Two has produced Three, Three has produced all the numbers."[75] Three refers to the musical fifth, *lü* in Chinese, which produces all the tones in the Chinese musical system with the sequences of octaves and cycles of fifths. Certainly, many of the ancient cultures created their musical cosmology and tonal imagery involving powers of 2 intersecting with powers of 3 such as Greek "Chi X", Plato's "World–Soul" and the Hindu "Drum of Shiva".[76] The origin of the twelve-pitch pipes, *lü*, the Chinese version of the spiral of fifths, is attributed to the reign of the Emperor Huang-Ti (Yellow Emperor reigned 2674-2575 B.C.) *Lü Shih Ch'un Ch'iu* (*Mr. Lü's Spring and Autumn Annals*), compiled around 240 B.C., claims that the Emperor Huang-Ti ordered his chief director of music,

Ling Lun, to make pitch pipes that make possible the creation of music properly pitched for harmony between his reign and the universe. Ling Lun went to a valley in the west and found the bamboo appropriate to make pipes that could emit sounds matching the call of the *fenghuang*, the singing of legendary male and female birds.[77] In his book, *Genesis of a Music*, Harry Partch, one of the first Western composers of modern times to compose music using intervals based on whole number frequency ratios and design his own instruments to play his music, also elucidates on the origins of harmonic ratios in Chinese music:

> 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[78]

The Chinese philosopher Confucius (551-479 B.C.) wrote that music is intimately connected with the essential relations among beings. 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."[79] 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.[80] 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."[81] 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).

The Pythagorean "Music of the Spheres" has influenced a long line of thinkers from Neopythagoreans in the ancient world to the modern scholars, scientists and musicians of today. The 17th Century German scientist Johannes Kepler, who explicitly acknowledged Pythagoras and Plato as his conceptual masters, 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 whole number ratios and related the structure of the solar system to musical intervals to create a harmonic structure. The German astronomer Johann Bode (1747-1826) later tried to describe the arrangement of planets in simple mathematical terms. The formula published in 1772, Bode's law, which predicts the relationship between the distances of the planets from the Sun, in fact, is astonishingly consistent with the actual distances of the known planets at that time, Mercury through Saturn, and yet discovered a dwarf planet Uranus and the asteroid Ceres-1.[82] With the subsequent discovery of Neptune and Pluto, which were found not to satisfy the

formula, Bode's Law had been discredited as a law by the later astronomers. However, some physicists today believe that the cause of the planets in the solar system distributed in such a way is the result of "resonances" between orbits, which "obeys the same fundamental laws as musical resonance."[83] 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."[84] Sympathetic vibration of strings and gravitational resonances of orbits are both the result of interaction between objects following the same fundamental law in musical resonance.[85]

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. In a written communication La Monte Young stated, "it is extremely significant that it is only through sound and especially music that we can perceive vibrational structure as vibration." 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.[86]

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.[87] 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.[88] In 2006, EIT and GOLF instruments 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.[89]

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 from the quantum level to astronomical scale, which may not be audible through our auditory mechanism, the whole universe exists as 'pure sound'. From antiquity, man's quest to understand our relationship to the universe has a significant connection to music (sound). 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 substantiated it.

[1] Revised 2009, 2011 and 2013
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[3] Brian Greene, *The Elegant Universe* (New York: First Vintage Books Edition, 2000), p. 3.
[4] Ibid.
[5] Ibid.
[6] Ibid.
[7] Ibid.
[8] Ibid., p. 15
[9] Ibid.
[10] Alain Danielou, *Music and the Power of Sound* (Rochester, VT: Inner Traditions International, 1943), p. 1.
[11] Thomas D. Rossing, Richard Moore and Paul Wheeler, *The Science of Sound* (San Francisco: Addison Wesley, 2002), p. 3.
[12] Ibid., p. 169
[13] Ibid., p. 3
[14] de Nicolas, *Meditation through the Rg Veda,* p. 56
[15] Ibid.
[16] John D. Fix, *Astronomy: Journey to the Cosmic Frontier*, 3rd ed. (New York: McGraw-Hill, 2004), p. 42.
[17] Ibid.
[18] David Fideler, ed., Kenneth Sylvan Guthrie, trans., *The Pythagorean Sourcebook and Library* (Michigan: Phanes Press, 1987), p. 20.
[19] Ibid., p. 21
[20] Theon of Smyrna, *Mathematics Useful for Understanding Plato* (12) quoted in David Fideler, ed., Kenneth Sylvan Guthrie, trans., *The Pythagorean Sourcebook and Library* (Michigan: Phanes Press, 1987), p. 21.
[21] Fideler, *The Pythagorean Sourcebook and Library*, p. 28
[22] Ibid., p. 29
[23] Ibid., p. 22
[24] Ibid., p. 29
[25] Ibid., p. 23
[26] Ibid., p. 43
[27] Ibid., p. 22
[28] $\lambda = 2L$: $f_1 = v/2L$ (λ = wavelength, v = *speed of sound, L = length of the string)*
[29] Ernest G. McClain, *The Myth of Invariance: The Origin of the Gods, Mathematics and Music from the Rg Veda to Plato* (York Beach, ME: Nicolas-Hays, Inc. 1976), p. 19.
[30] McClain, *The Myth of Invariance*, p. 27
[31] Ibid.
[32] Ibid., p. 25
[33] Ernest G. McClain, "Musical Theory and Ancient Cosmology", *The World and I* (February 1994): p. 371-391
[34] Edith Borroff, "Ancient Acoustical Theory and a Pre-Pythagorean Comma", *College Music Symposium*, Vol. 18, No. 2 (Fall, 1978), pp. 20-23.
[35] Alain Danielou, *Tableau Comparatif des Intervalles Musicaux* (Paris: Institut Francais d'Indologie, 1958), p. 128.
[36] Borroff, "Ancient Acoustical Theory and a Pre-Pythagorean Comma," p. 20-23
[37] Danielou, *Tableau Comparatif des Intervalles Musicaux*, p.2
[38] Fideler, *The Pythagorean Sourcebook and Library*, p. 19
[39] McClain, *The Myth of Invariance*, p. 5
[40] Ernest G. McClain, *The Pythagorean Plato,* (York Beach, ME: Nicolas-Hays, Inc. 1978), p. 33-37.
[41] Siegmund Levarie, "Introduction" in Ernest G. McClain, *The Myth of Invariance*. p. xii
[42] McClain, *The Myth of Invariance*, p. 161
[43] McClain, *The Pythagorean Plato,* p. 84
[44] McClain, *The Myth of Invariance*, p. 19
[45] McClain, *The Pythagorean Plato,* p. 14
[46] *Ibid.*
[47] de Nicolas, *Meditation through the Rg Veda,* p. 63
[48] Ibid., p. 11
[49] Ibid., p. 49
[50] Ibid., p. 558

[51] Ibid., p. 133
[52] Ibid., p. 130
[53] Guy L. Beck, *Sonic Theology: Hinduism and Sacred Sound* (Columbia, SC: University of South Carolina Press, 1993), p. 1.
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[56] Ibid.
[57] Ajanaka Kshemaraja quoted in Alain Danielou, *Music and the Power of Sound*, p. 3
[58] Alain Danielou*, The Myths and Gods of India: The Classic Work on Hindu Polytheism (*Rochester, VT: Inner Traditions International, 1964), p. 4.
[59] Beck, *Sonic Theology: Hinduism and Sacred Sound,* p. 8-9
[60] La Monte Young, "Singing of Pran Nath: The Sound is God", *The Village Voice*, (April 30, 1970)
[61] Ernest G. McClain offered numerous arithmetic-musical constructions of deification from various cultures in *The Myth of Invariance*
[62] Ibid.
[63] Ibid., p. 73
[64] Ibid., p. 75
[65] Mathew Black, ed., *Peake's Commentary on the Bible* (London: Thomas Nelson and Sons, Ltd., 1962), p. 1051 quoted in McClain, *The Myth of Invariance*, p. 107
[66] Ernest G. McClain, *Meditation through the Quran* (York Beach, ME: Nicolas Hays Inc., 1981) p. 108
[67] McClain, *The Myth of Invariance*, p. 109
[68] René Guénon, "Quelques Aspects du Symbolism du Poisson," *Etudes Traditionnelles* no.104 (February 1936), p.68 quoted in Alain Danielou, *Music and the Power of Sound*, p. 3
[69] McClain, *Meditation through the Quran*, p. 29
[70] The philosopher brothers Al-Gahazali: Abu Hamid (1058-1111) and Majd al-Din (d. 1126) quoted in Joscelyn Godwin, *Harmonies of Heaven and Earth*, (Rochester, VT: Inner Traditions international Rochester, 1987), p. 58.
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[72] Ibid., p. 13
[73] Danielou, *Music and the Power of Sound,* p. 31
[74] Ibid.
[75] Ibid., p. 35
[76] McClain, *The Myth of Invariance*, p. 5
[77] Chou Wen-Chung, "Chinese Historiography and Music: Some Observations," *The Musical Quarterly* Vol.62, No. 2 (April 1976): pp. 224-225.
[78] Harry Partch, *Genesis of a Music*, 2nd ed. (New York: Da Capo Press, 1974), 362
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[85] Ibid.
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