The Music of Physics

Presented to the Acoustical Society of America, Music City Chapter

Monday, June 9, 2014

Slide: Title

I'd like to start this talk with a question that I want you all to apply to everything I discuss: If sound is vibration, and vibration causes heat, which releases infra-red light, and if at the same time, through the exchange of energy, the fields of gravitation, acoustics and electromagnetism intersect, and if in all three fields, musical ratios are present... does this mean anything? If so, what does it mean?

Music is a liquid form of culture, shaping itself to it's container. Like water, it gets recycled and reused. It can be frozen, forgotten, and rediscovered years later like an ice core, holding the secrets of the past in it's rapidly melting embrace. It's a raging flood, plowing through entire generations and rearranging the intellectual landscape. It has the healing power of a sauna and the destructive force of a hurricane; it can be polluted and poisoned, and it can be a shelter during hard times.

I've been a musician since I could first sing, playing instruments since I was 5. I studied music at Hampshire College and Berklee School of Music. Since then, I've done nothing but play and teach music professionally. I've shared the stage with a some amazing artists, both famous and obscure. I've made records, played with orchestras, and toured in different countries, even recently writing a book on music called "The Magic Music Method." Sometimes my life feels like that scene in the movie "Being John Malkovitch" when they get off the elevator and they're on the Malkovitch floor and everyone is saying "Malkovitch Malkovitch Malkovitch!" Only in my life, it's "Music, music music!"

Slide: Overtone Series

If physics is how we describe nature using the language of math, music is the sound of that language. Sometimes, when people make claims about music and physics, it comes in a new-age context of mystery and wonder, involving non-disprovable elements where magic and time travel are right around the corner of whatever scientists haven't quite figured out yet. Then the corner moves, and the magic moves with it.

We need disprovability to build a more rational, intelligent, efficient and well structured world. This is one of the core messages of the new Cosmos series. Speaking of Cosmos, I met Neil Degrasse Tyson last year at a gig. I was hired to play music at a dinner at Vanderbilt's Dyer Observatory, where he gave a speech. He was impressive with his charm, intellect, and philosophy, and his amazing vest with stars on it. Based on meeting him in person, it strikes me as odd that he was recently quoted taking a very anti-philosophical tone. He said, and I quote, "What are you doing? Why are you concerning yourself with the meaning of meaning? If you are distracted by your questions so that you can't move forward, you are not being a productive contributor to our understanding of the natural world. And so the scientist knows when the question "What is the sound of one hand clapping?" is a pointless delay in our progress."

It's as if he is saying "Thanks, philosophy, but your job is done here." I'll give him the benefit of the doubt and assume that there is a larger context to his statements. At least, I hope there is. The fact remains that when taken at face value, Tyson's comments reflect a real problem. Without philosophy, science has no guidance. And just what kind of

philosophy is he recommending we drop? If he's talking about modern academic philosophy, I can see why he might not think it always directly applies to the hard sciences. At the same time, we can't know what kinds of problems the future will hold and we need all the tools at our disposal to solve them. For that reason philosophy is important, but I wouldn't stop at academic philosophy. I find it interesting that in the Cosmos series, the more ancient philosophy, embodied in the Hermetic axiom "As Above, So Below," is either passed over completely or taken literally to only reflect a kindergarden level, straw man interpretation of it's symbolism, instantly discarded as superstition.

This reminds me of the allegory of the three blind men and the elephant. Each one thought they were touching something different, and of course, none of them realized that they were all touching a single thing: They were all touching the elephant. The elephant in this room is not immediately obvious, but hopefully by the end of my talk it will be clear. In order to talk about the music of physics, I need to talk about the philosophical foundation for both music and physics.

The elephant in the room is the subject of Harmony, with a capital "H". This is a very, very old discipline, one that at different times and in different societies has held together both the arts and the sciences. It's what Buckminster Fuller meant with his definition of Synergy. He said, "Synergy is the only word in our language that means behavior of whole systems unpredicted by the separately observed behaviors of any of the system's separate parts or any subassembly of the system's parts. There is nothing in the chemistry of a toenail that predicts the existence of a human being."

I like Fuller's definition. Synergy, or Harmony, is the study of whole systems in which the whole is somehow greater than the sum of it's parts. The philosophical foundation for this can be found in the seven-fold framework of The Seven Liberal Arts and Sciences. These seven early interdisciplinary studies, which lay at the foundation of the Renaissance and Enlightenment, are broken into two groups: the "Trivium" and the "Quadrivium."

Slide: Trivium

The Trivium is Grammar, Logic and Rhetoric, and must be studied in that order. Grammar is the collection of verified facts and evidence, and the

structure of the language used to describe those facts. With Grammar, we learn how to listen, how to study, how to inspect. Grammar is more than just subject/object agreement. It's the basis of the empirical method.

The next step in the Trivium is logic: the removal of contradiction. Logic is the math behind thought, it is the algebra of language. Once contradiction is removed, the third step in the Trivium is rhetoric, or the art of communication, persuasion, writing, speaking. I'm using rhetoric right now. You're using grammar to take in my rhetoric, and you are exposing it to your own sense of logic, either agreeing or disagreeing with what I have to say. Rhetoric is the way that the findings of grammar and logic are shared with the larger community. Neil De Grasse Tyson is a master of rhetoric.

Slide: Number

If the Trivium is the foundation for research, analysis, evidence gathering, and publication the Quadrivium is what is being studied in the first place: the patterns of nature. The first step of the Quadrivium is known as "number". In this stage, the idea of "number" or "ratio" is larger than what we currently think of today. Number is a measure of proportion.

This older idea of "number" is philosophical, and includes not just counting but the personality of each number. To the Pythagoreans and to Plato, as well as the builders of the great temples, monuments, and cathedrals the world over, numbers have identity. They interact with each other like characters in a great drama, creating ratios in their interactions that allow their personalities and meanings to intermingle.

Slide: Geometry

The second stage of the Quadrivium is geometry. Geometry can be defined as "number in space". When proportions, ratios, and numbers appear visually, they create patterns. The simplest patterns which follow whole number ratios have the most powerful psychological effect. Symbolism always uses a certain amount of geometry because of this, and it can be seen in religious and spiritual symbols, art, corporate logos, national symbols, family crests, tombstones, ancient monuments, and even the layouts of entire cities.

Slide: Music

The third step of the Quadrivium is music. Music is "number in time." As any musician who understands theory knows, music is the sound of

math. As math is the language of physics, all music is the music of physics. The ratios and proportions of tuning systems have always been related, one way or another, to the concept of number presented here. With their common origin in the overtone series, the whole number ratios of the older tuning systems of Pythagoras and Ptolemy directly mirror the whole number ratios of the approximate geometry of nature. While the modern equal tempered tuning system has departed from pure number ratios, the rules of musical harmony are still based on the underlying structure of the overtone series, which is based on whole number ratios.

Slide: Astronomy

The fourth step of the Quadrivium is astronomy: "number in space and time." Astronomy was required in older times for civil engineering, for the planning of empires, navigation, and planting and harvesting crops. It was a critical aspect of national security, economics, and war. Astronomical observations were passed down from one generation to the next, and encoded in stone monuments that were built like giant clocks to track the movements of the sky.

In order to have a "Music of Physics," it's necessary to focus on the aspects of physics that can be translated into a musical language. The best place to start looking, based on the Quadrivium, is astronomy. Let's take a look at the music of the spheres, and see what it's all about.

Slide: Megalithic Monuments

In ancient times, when the great megalithic monuments such as Stonehenge, the Pyramids, and the Temple of the Sun were built, it was not possible to measure beyond 97-99% accuracy. The numbers were based on very close approximations. Looking at these close approximations reveals the underlying harmonic patterns which correlate musical ratios to the celestial patterns these monuments were symbolically marking. This is similar to using the Golden Mean to reveal the geometry of the human form, while acknowledging that no individual person's body demonstrates the Golden Mean proportion with 100% accuracy. We are going to look at three areas that all share the same ratios: The Overtone Series, the whole number ratios of Just Intonation, and the Orbital Resonances in the Solar System.

CHANGE Slides: Overtone Series

In the overtone series, if a string is vibrating at a fundamental frequency, for example the note G, there will be a series of notes that sound all at once. These notes are so quiet, you can only hear them if you manipulate the string by touching it in different places to silence the louder, lower notes and allow the higher, quieter "overtones" to emerge. The overtones go up in a very specific order: Fundamental, **SLIDE:**Octave, **SLIDE:** Fifth, **SLIDE:** another Octave, and then finally **SLIDE:** Major Third.

Octaves, Fourths and Fifths are the most similar in different cultures, no matter how differently tuning systems have evolved. Once you go higher, into Thirds and beyond, there is more variety in the tuning of individual notes. This creates a greater and greater series of culturally different approximations. Rather than a perfect conformity to the overtone series, each different tuning system has it's own opinion on how to tune various intervals. This often confuses people into thinking that it's all culturally constructed, which is false. The overtone series is not culturally constructed, but what we choose to do with it is.

In equal temperament, even Fifths are no longer exactly the same as what the overtone series offers. The overtone series, then, is the perfect ideal form of musical harmony which various tuning systems approximate but never completely reach. Consonant intervals, or pleasing intervals, are octaves, fifths, and major and minor thirds. It's no accident that the loudest, clearest overtones in the overtone series are octaves, fifths and major thirds. When put together, these notes create a major chord.

Slide: Major Chord

There are two categories of consonances: **Slide:** Perfect consonances, and **Slide:** Imperfect Consonances. The ratios listed here are from Just Intonation and Pythagorean Tuning. Both are relevant here, and whenever you see a musical ratio listed in this presentation, it will either be Pythagorean or Just.

Because the frequencies have been modified in equal temperament, the music you are familiar with would sound a little out of tune to someone who only knew Just Intonation. You might be tempted to think "Now that we use equal temperament, all that whole number ratio stuff must not matter anymore," but actually it does matter because of the way the major scale is

structured. The chord progressions and musical harmonies we use today all have very specific personalities and functions, like individual members of a family. There's a mom, a dad, a sister, a brother, a dog. All of the personalities of the chords of a key are based on the overtone series, and in order to explain exactly how this works, I'd need a lot more time. Maybe that will be the focus of another entire presentation. Those familiar with music theory should know what I mean when I say that the overtone series itself defines tonal gravity, consonance, and dissonance, whether or not you realize it. It is not subjective, or socially constructed. This is the reason why certain chords create expectations of resolving into other chords. This is why we have tension and resolution, and when we don't get the resolution that is expected, we feel it on a deep level. This is the machine code of the operating system of western music, at the structural level. The user interface of whatever tuning system you choose, of course, is as subjective as whether someone prefers Windows, Linux or Mac.

In our Solar System, a similar phenomenon is taking place but it's not happening with acoustics, it's happening with gravitational attraction and repulsion. Yet somehow, the same approximate ratios can be found. This

observation amazed our ancestors, who called it "The Music of the

Spheres."

Slide: Measurements.

Every celestial body has a different orbit, whether it is a moon, planet, or

something else. Some celestial bodies are locked into patterns called

"orbital resonances," when two orbiting bodies exert periodic gravitational

influence on each other. This happens when the orbital periods are related

to each other by a ratio of two small integers. Orbital resonance can either

lock into a stable pattern that lasts for millions of years, or actually cause

bodies to be ejected from their orbits.

When I first heard that many of the orbital resonances trace out musical

intervals, I didn't believe it. I took this chart of measurements from Jean

Martineau's book on the music of the solar system, and checked that the

data were correct, by comparing them to figures posted online by NASA. I

even got a calculator out and did some fifth grade algebra. It turns out that

these ratios are correct, to between 97 and 99.9% accuracy.

Slide: L Points.

There are many categories of orbital resonances, but only two that we will cover here. First, mean-motion orbital resonance is when the orbital periods of two or more celestial bodies create a ratio, such as 2:1 or 3:2. This is explained by the laws of planetary motion, Bode's Law and the equations that govern Lagrangian Points, which would be best left for a physicist to explain in detail.

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<u>Slide: Pluto and Neptune, with data, and musical 5th</u>

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The orbits of Pluto and Neptune create a 2:3 ratio, which is a musical Perfect Fifth. When you do the math, it comes out to 99.199% accuracy. There are some other factors which bring this up to 100% when taken into account, which include the existence of points in space that are defined by the gravity of the different bodies in resonance with each other. **<u>Slide: Lagrange and Cymatics</u>** These points create nodes, which are similar to the nodes that appear in cymatics experiments. It's interesting to think of the Solar System as a large resonant structure composed of standing waves.

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<u>Slide: Pluto and Neptune with Overtone</u>

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Back to Pluto and Neptune: recall that the 2:3 ratio is also second overtone in the overtone series.

Slide: Jupiter Moons

The moons of Jupiter create Octaves. Ganymede, Europa and Io create 1:2 and 2:4 ratios. Again, the exact orbital periods have a margin of error that is made up for when the harmonic nodes created by their mutual gravitation are taken into account.

Slide: Mean-Motion Orbital Resonances

This is a list of the main mean-motion orbital resonances in our Solar System. They are Unisons, Octaves, Fourths and Fifths. There are no dissonances, such as Minor Seconds, Tri-Tones, or Augmented Sixths.

3 Slides: Venus/Earth Near Resonance

When two bodies are almost perfectly in resonance, but off by even a very small amount, they are in a Near Orbital Resonance. They do not exert a periodic gravitational pull that is large enough to lock them in mean-motion resonance, but they may appear to be in resonance. In fact, they may have been in mean-motion resonance in the past, and they may be headed toward mean-motion resonance in the future. A perfect example of this is the Venus/Earth resonance that approximates the Golden Mean ratio.

The "mean-motion" orbital resonances have periods of stability that last into time frames of hundreds of millions of years. The approximate ones are either thought to be moving towards mean-motion resonance or moving out of mean-motion resonance. It is likely that it takes just as long for celestial bodies to fall into these stable patterns, predicted by the laws of planetary motion. There are more near orbital resonances in our Solar System than mean-motion resonances. The near resonances fall into three categories: Musical Intervals, Rhythmic Ratios, and Philosophical Ratios.

Slide: Nix and Kerberos Near Resonance of 4:5

The musical intervals represented by near orbital resonance are all imperfect consonant intervals. For example, the moons of Pluto, Nix and Kerberos, create a Major Third.

Slide: Mars Venus Near Resonance of 1:3

All the common ratios used in rhythm exist in near orbital resonances. Mars and Venus play triplets with each other. There are roughly three orbits of Venus for each orbit of Mars. **Slide:** He's clearly outnumbered here!

3 Slides: Great Pyramid and Earth/Moon/Sun

The philosophical significance of the Earth/Moon/Sun relationship is demonstrated with the concept of squaring the circle, through the use of the ratio 22/7 which approximates Pi. This approximation is the foundation for the geometry of the Great Pyramid, which encodes both the Golden Mean and Pi in it's architecture. By doing so, it demonstrates the connection between the human form and the measurements of the diameters and circumferences of the Earth and Moon. These numbers have very high significance to Pythagorean Tuning as A was tuned to 432, and harmonically tied to the approximate diameter of the Sun and Moon, as we'll soon see. But we are led to believe that the people who build this monument thought the world was flat.

The perfect mean motion orbital resonances of the planets stop at the 2:3 ratio, the interval of the fifth, or the second overtone, if you still think Pluto is a planet. If you have finally accepted the loss of Pluto, then the only perfect resonances of planets are octaves. Beyond this, only moons create perfect resonances. It's interesting that the moons in our Solar System, which have much smaller orbits, are the main source of higher resonance. This reminds me of the fact that the most common musical intervals across

all tuning systems are octaves, fourths and fifths. Human culture is quite

literally imitating the patterns of nature by doing this, because the only

perfect resonances happen to be the most common intervals that have

been changed the least from the overtone series.

Many of these orbital resonances were only discovered and measured in

the last few centuries, and create what may seem to be a problem. If the

observations of orbital resonance are meaningful to music theory, how

could there be any meaning in resonances that were impossible to detect

thousands of years ago, when the basic intervals of music had already

been created? After all, most of these moons were invisible to Ptolemy

when he was creating Just Intonation, and he didn't even realize that the

Earth went around the Sun. Pythagoras, the father of western music theory,

didn't have NASA telescopes.

I don't know the answer to this, but I'd guess that there are laws of

nature at work here which govern some of these observations. It might be

wise to look at how the overtone series can be applied to gravitation and

electromagnetism. Since laws of nature are consistent, maybe the patterns

that evolve on both large and small scales are harmonically related by a mutually shared, deeper unseen cause.

Slide: Notes and Colors

If you take musical vibrations, and double the frequencies until the numbers land in the visible light spectrum, it is possible to visualize the higher octaves of sound vibrations as colors. Light and sound are different phenomena, of course, but that doesn't stop us from correlating them for artistic purposes. In fact, the great composer Scriabin invented a "light organ" for this very purpose. This is how art imitates nature.

Here are a few quick observations of strange synchronicity. Taken alone, they could be random, but seen as a group, they may require more explanation than I can provide, and I'd love to hear the opinions of scientists on this.

Slide: 1:1 Unison

The radius of Saturn's orbit is approximately the same as the circumference of Mars's orbit. The circumference of Saturn's orbit is approximately the same as the mean diameter of Neptune's orbit.

Slide: 2:1 Octave

Venus's mean orbit is roughly twice that of Mercury's. Mercury's approximate day is twice as long as it's own year.

Slide: 2:3 Fifth

Saturn takes approximately the same number of years to orbit the Sun (29.46) as the Moon takes, in days (29.5), to complete a Lunar Phase Cycle (to 99.864% accuracy). The Lunar Phase Cycle is longer than the 27.3 day long orbit of the Moon; it is the amount of time (29.5 days) that it takes for the Moon to fully move through all 4 phases.

This means that the Lunar Phase Cycle happens a total of approximately 365 times (99.923% accuracy) in one Saturn Year (Saturn has a 10,759.2 day year measured in Earth days, and 10,759.2 / 29.5 = 364.718). If Lunar Phase Cycles were thought of as a "Lunar Day," Saturn's year would be approximately 365 "Lunar Days" in length, to a level of accuracy that is within 1/100th of the percentage difference between our 365 day year and the true 365.25 day year (it is 99.932% accurate to say a year is 365 days long).

Slide: Earth Venus 3:4 Fourth

Earth passes by, or "kisses," the planet Venus 4 times for every 3 times

it passes by, or kisses, Mars.

Slide: 354:399 or 8:9 Whole Step

The Lunar Year is 354 Earth days. The synod of Jupiter, or the "kiss" of

Jupiter, is 399 Earth days. This creates a resonance which reduces down

to the ratio of 8:9, and that ratio is the Pythagorean whole-step.

Slide: 354:378, or 15:16 Half Step

The Lunar Year is 354 days. The synod of Saturn, or the "kiss" of Saturn,

is 378 Earth days. This creates a resonance which reduces down to the

ratio of 15:16, and that ratio is one half-step.

This brings up another interesting point. The patterns of music theory

don't stop at orbital resonance. They reflect nature on many other levels,

mostly related to how we measure time.

Slide: Musical 7's

There are 7 notes in every Major and Minor scale, and there are 7 white

keys on the piano. There are 7 classical modes, and there is evidence that

they may even go all the way back to Sumeria. There are 7 days in a week, 7 classical planets which correspond to those days, and which correspond to the 7 liberal arts and sciences. There are many other 7's, too many to mention here.

Slide: Musical 12's

There are 12 notes to choose from, 12 hours on a clock, just as there are 12 months in the year and 12 Zodiac signs. There are 12 tribes of Israel, 12 apostles, and of course 12 cylon models in Battlestar Galactica.

Slide: Musical 24

There are 24 Major and Minor keys, which correspond to the 24 hours in a day; half of the keys are Major, or light, like the 12 hours of day time. Half of the keys are Minor, or dark, like the 12 hours of night time.

Slide: Musical 60

There are 60 seconds in a minute, and the middle of the range for the average resting heart rate is 60 beats per minute, or one beat per second. The most common musical tempos fall in this range. The limit of mental processing power for most people is about 60 bits of information per second, and the electrical grid is operating at an alternating current of 60

cycles per second. 60 is a number that ties together the way time is

counted with the heartbeat and brains of the people doing the counting.

60° is also present in an equilateral triangle, an ancient symbol of light,

knowledge, perfection and divine harmony.

<u>Slide: Musical 72</u>

There are 72 basic hand positions when the 24 Major and Minor chords

are played, each in Root Position, First Inversion and Second Inversion.

The Earth's precession moves 1° every 72 years, which is why it takes

2,160 years (72 years * 30) to move through one zodiacal sign (each sign

covers 30°, as 360/12 = 30).

There are 72 basic scales in South Indian (Carnatic) music, each of

which corresponds to a 20 minute long period of time. Every 24 hours, all

72 of these scales have had their ideal time to be played.

The interior angle of a pentagon is 72º, and the pentagon is based on the Golden Mean which appears in human body as well as the near resonance of Earth and Venus.

Slide: Musical 432

A432 is the frequency assigned to A by Pythagoras. It is one of the most interesting older tunings for A; instruments can be tuned to A432 whether or not they are equal tempered. A lot of controversy surrounds the idea of returning to the old Pythagorean tuning of 432 Hz for the note A. It definitely gets a lot of hippies, myself included, very excited for different reasons.

Remember, approximations are valid expressions of underlying harmonic structures, which in the case of orbital resonances may be moving into or out of perfect resonance. Jupiter takes roughly 4,320 days to orbit the sun (99.723% accuracy). Mars is close to 4,320 miles in diameter (97.5% accuracy). 432 is almost but not quite the square root of the speed of light, to 99.666% accuracy. People who take this literally often think they've discovered magic. Really, they have discovered philosophically relevant approximations. Without that kind of thinking, we wouldn't have

physics, because no one would have come up with the first hypothesis worth testing. It's not about choosing creativity over intellect, or vice versa.

So go ahead and tune to 440, and use equal temperament, but also understand that the original source of this information is based on a set of ratios that are centered around 432. Let's cut 432 in half, dropping down an octave.

Slide: Musical 216

A216 is exactly one octave below A432. The Moon is approximately 2,160 miles in diameter. The Earth's meridian circumference is approximately 21,600 nautical miles (99.820% accuracy) Each astrological age (we are currently in the age of Pisces) is 2,160 years long. 12 of those cycles create a Great Year, which lasts for 25,920 years. Now let's drop an octave lower.

Slide: Musical 108

108 is the number of the Moon. The Moon's radius is 1,080 miles. The distance between the Earth and Sun (92,955,807.3 miles) is approximately 108 times the diameter of the Sun (864,337.2 miles) to 99.579% accuracy.

The diameter of the Sun is approximately 108 times the diameter of the Earth (7,918 miles) to 98.925% accuracy. The average distance between the Earth and Moon (238,900 miles) is 108 times the diameter of the Moon to 97.591% accuracy.

Further strange connections appear in the following measurements:

Saturn's polar diameter is approximately 108,000 km (99.336% accuracy). Saturn's orbital period is approximately 10,800 days (99.619% accuracy).Venus's distance from the Sun is approximately 108 million km (99.815% accuracy). Earth's orbital velocity is approximately 108,000 km/hour orbital velocity (99.352% accuracy)

There are commonly 108 beads in Buddhist prayer beads. There are 108 steps in Tai Chi, and there are 108 Sun salutations in Yoga. 108 is considered a sacred number to Buddhism, Hinduism, Jainism, and Islam.

Now let's take a look at the octave above A432.

Slide: Musical 864

It takes the Earth 86,400 seconds to spin once on it's axis, creating the familiar 24 hour day. The Sun is approximately 864,000 miles across. The diameter of Jupiter is approximately 86,400 miles across (99.446% accuracy).

864 divided in half is 432, the original pitch that Pythagoras, the father of music theory and geometry, assigned to the note A. Thus, the note A, the approximate diameter of the Sun, and the rotation speed of the planet Earth are all harmonically related through the number 864.

Slide: Clock of Fifths

The standard 24 hour day, broken into 2 periods of light and dark and lasting for an average of 12 hours each, is how we currently measure time. It also happens to match the basic light and dark harmonies of music theory, with Sharps representing light and Flats representing dark.

Slide: Clock With Star

Since the circle of fifths is like a clock, it's interesting to see what happens when you put in all 60 seconds. The earliest example I know of

was given to my teacher Yusef Lateef by John Coltrane. Another teacher of

mine, Regi Wooten, decoded it for me.

An interesting thing happens when you connect all 5 instances of the

same note, for example, "C", on this diagram: The symbol of the

Pythagorean School, which is the 5 pointed star, containing the golden

mean, the geometry of the human body and the pattern traced in the sky

every 8 years by Venus, appears. Right there on the most common

diagram in all of music theory!

Let's take a step back now and look at the bigger picture. Both literally

and figuratively, music is a reflection of the Solar System and the collective

unconscious of the culture that creates it. It is not a perfect reflection, but

rather it is an approximation, and in this way it reveals hidden

correspondences and harmonies between seemingly separate fields.

The resonance patterns of the overtone series also happen to be

frozen into the musical geometry of ancient stone temples and monuments.

These structures were built by scientists and astronomers to follow the

movements of the heavenly bodies. They traced the ratios and proportions

of both music and physics in stone clocks whose gears were turned by the rotation of the Earth itself, and whose hands pointed to clock faces written in the constellations. These celestial patterns were remembered with myths and allegories, thus backing them up in the cloud of the collective memory of humanity long after the people who built the temples, their writings, and their organizations had turned to dust. This mythological hard drive, used to store data inside of coded allegory, was taken literally at times and has a lot of bad blocks and data corruption, and we have inherited the ruins. It is up to us to decode them and put the pieces back together, and recover what we can. Rather than discarding this, we should be investigating it.

The path of intuitively guided empirical study is something that artists, musicians, writers, and scientists share. It's what created the Renaissance. Some of us are more into proving and disproving things than others, but the foundation is the same: a strong desire to understand what the world is made of, and to participate in the remaking of that world into something more interesting, more efficient, more creative, more beautiful. Musicians who play with sounds to come up with recipes and combinations of notes, chords and scales, as well as the infinite varieties of non-pitched sounds,

non-tempered sounds, altered tuning systems and computer based

manipulations of musical texture and language, are very similar to

scientists who conduct experiments, who spend time in a laboratory or out

in the field collecting evidence and data to support or challenge their

theories. The creative process is alive and well in both fields.

So I ask again: If sound is vibration, and vibration causes heat, which

releases infra-red light, and if at the same time, through the exchange of

energy, the fields of gravitation, acoustics and electromagnetism intersect,

and if in all three fields, musical ratios are present... does this mean

anything? If so, what does it mean? I would argue that it means that we are

a part of a whole system which is greater than the sum of it's parts. What

we are calling "reality" is a harmonic system, a resonant structure within

which many different kinds of overtone series' intermingle on large and

small time scales to produce cycles within cycles that we call

consciousness and reality, and I would argue that it is disprovable and thus

not subject to superstition. We need philosophy to really understand this.

Philosophy is what we use to inoculate ourselves against shattered, narrow

thinking. Philosophy is what allows the blind men touching the elephant to actually see the whole elephant.

If you were to take a chainsaw and cut this elephant into separate pieces, it would no longer be a whole greater than the sum of it's parts. The study of Harmony puts the pieces back together, allowing quantitative measurements to sit right next to qualitative, philosophical ideas. This is exactly the kind of effect that music has on human consciousness. Allowing these parts of a whole to come back together is what gave us the Renaissance and the Enlightenment. Separating the parts of this elephant has given us the Scientific and Industrial Revolutions, and putting them back together again, without falling into superstition or logical fallacy, should be a critical part of how we will navigate the future, assuming we survive this infancy of our modern world.

Thank you.