Hidden Worlds in Music

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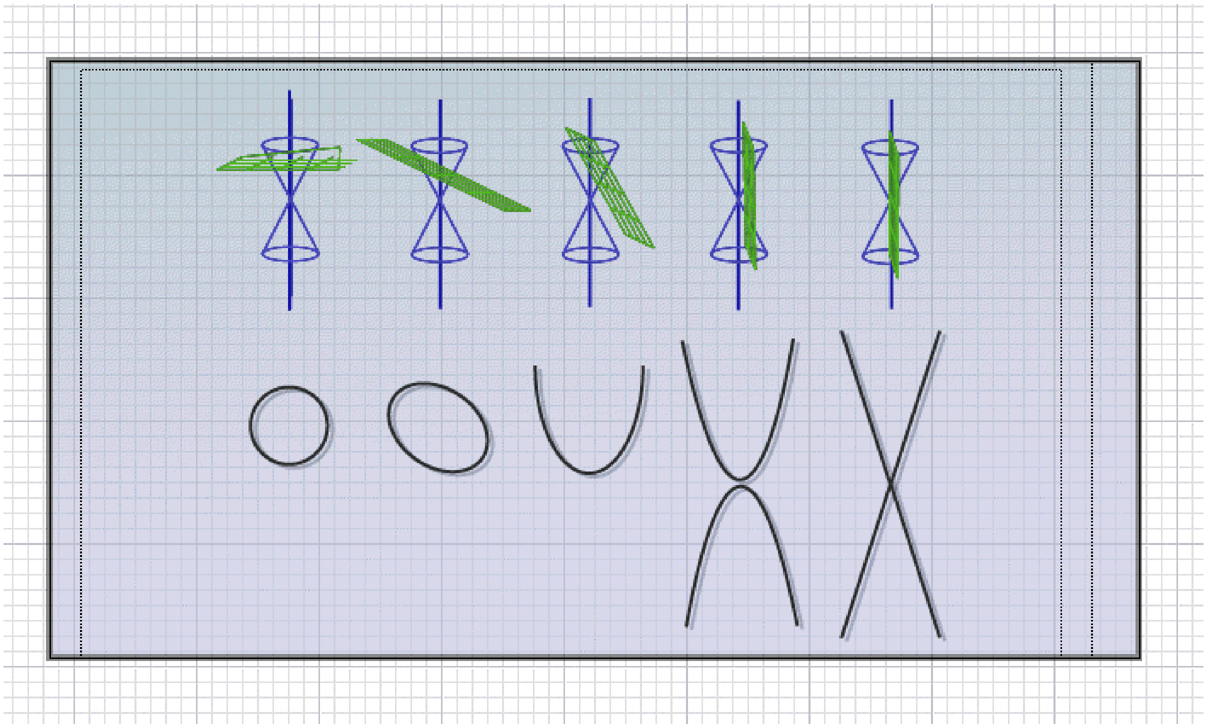
Part I – Pitch Equals Rhythm

The History of Humanity is replete with innovation. As one recognition took place, another would often come along soon after, painting a former innovation within a larger perspective. This synthesis of properties into a larger unifying framework allowed further work to continue in a subject.

Among many, the Greeks have handed us one such innovation in the form of a treatise written by Apollonius of Perga, (300-200BC). It was a mathematical treatise which united a series of shapes in geometry. Though it is held that the idea may have been known but undocumented in Babylonian and Indian mathematics prior- the first female mathematician then in documented history- Hypatia of Alexandria (~370 - 415), In her popularized treatise "on the conic sections of Apollonius" would then go on to synthesize Apollonius' ideas and consolidate the into the form to which we have inherited them today.

In their treatises, Apollonius and Hypatia go on to describe for us the relationship between several 2 dimensional shapes: the parabola; hyperbola; triangle; oval and circle. What was remarkable about their viewpoint was not that they chose these common day objects, but that they chose to view them on a higher level for us. Not as 2 dimensional objects strung out on a line, but united rather in the higher 3 dimensions.



(figure 1.0)

Apollonius outlined how the triangle, circle oval, parabola and hyperbola were all indeed slices from a single 3 dimensional shape: that of two cones held end to end, like the arrangement found with an hour glass. Thus, even to this day, the study of these objects is known as the study of conic sections. This principle gave a unifying view of the field, allowing further study to take place.

A similar unification process occurred throughout the 19th century, slowly combining the magnetic/electric fields among various frequencies, dissimilar as radio waves, x – rays, visible light, to which the various gifts of: am/fm radio, cell phones, x-ray machines, microwave popcorn, weather radar, warm buffet food, and visible light, we owe thanks for.

Such disparate phenomena in our daily lives align themselves to show that indeed it is only a single happening. The above properties can all be ascribed to electromagnetic waves in one form or another.

As a musician, I believe it might be similarly advantageous to unify a view of music in this way. To see it as Apollonius did, held together by an underlying thread. For this reason, I ask the reader to consider if music itself is similarly composed of a single thing? Strewn across disparate phenomena but unified in the same manner.

I believe it is possible to see that the elements of music, what we acknowledge as **pitch, rhythm, harmony, timbre and form** as projections of a higher principle, unified under a single entity, which can be called for lack of a better word – the property of 'oscillation' – which perhaps finds a parallel in the propagation of electromagnetic waves and the electromagnetic spectrum (as longitudinal air waves in this case versus electromagnetism's transverse).

When we view a piece of sheet music, we see that the up/down direction indicates specific pitches (A to G). Perpendicularly then, a left right direction indicates a rhythm for the performer with respect to time (whole notes, quarter notes, eighth notes et cetera). The two can be likened to an x and y axis (x being the rhythm - the horizontal element of music - and y being pitch, the vertical element). But I believe from further a view, the two will begin to combine into each other.

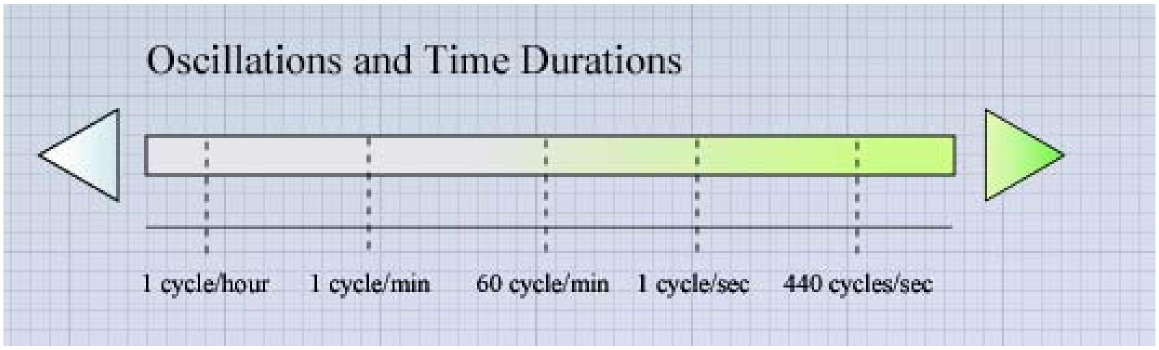
To demonstrate this, let us take a hypothetical entity –"Abigail" lets call her, and let us ask her clap in applause today. As Abigail claps vehemently in applause, she creates beats. If her rhythm is good, those beats would be regular, like: clap clap clap clap clap etc. To convert sound into numbers, we could measure the number of claps over a period of time, perhaps with a beat of a metronome or stop watch to figure out her rate of clapping.

If Abigail is very excited, her claps will increase in speed. We then start our experiment by asking Abigail to clap a bit faster for us. We would then begin to hear: clapclapclapclapclapclap…. Most humans can only get about 5 claps a second, but guessing that Abigail is more talented, suppose that Abigail is an excellent clapper. She happens to be extra excited that day, and through sheer will, she manages to clap at 20 times per second. This is a significant barrier for us, because it sits at the lowest range of our human hearing. In the processing of sounds, our brain will begin to resolve the clapping not as beats, but as pitch for any frequency faster than 20 beats per second (20 hz). As Abigail is clapping, in the room we suddenly begin to hear a very low pitched sound in our ears. The conversion from beats to pitch has occurred along a smooth gradient.

As Abigail claps faster and faster, the low pitch rises for us. Abigail continues to clap, we ask her to continue increasing the speed of her clapping until she reaches 262 times per second, and we ask her to stay there.

Abigail is basically on fire at this point trying to keep up, clapping middle "C" for us. The specification for middle C is any air that moves back and forth at 262 times a second. It could be anything in fact. If she is a consistent clapper, we could probably tune a Steinway to it. The air could be between two rods on a tuning fork, between your ear drums, forced through a pipe on a trumpet, the grinding wheels of the subway, a vibrating frying pan, your computer speakers, or even Abigail clapping. They are all perceived as middle "C'. This is precisely what we hear in fact when a fly makes its way around a room on a summer's day. It beats its wings back and forth quickly enough so that we interpret beats as a pitch. Hence we can see that rhythm & pitch lie on a single gradient.

Determined by frequency, rhythm & pitch, these phenomena are manifestations of a single type of oscillation.



(figure 1.1)

Maybe Abigail is part human, part fly? (we never specified after all). If Abigail were sufficiently agile enough, she could if she wanted to clap the pitches to the Magic Flute for us like the Berlin Philharmonic. If this is what she wanted to. This is in fact what a speaker does for us. A speaker is an amazing thing for this reason? It simply moves air back and forth, much like a piece of paper or Abigail's hand (or wing) would. It is possible for a speaker to sound like anything for this reason, allowing us to listen to music wherever and whenever providing the speaker technology is present. It simply needs to move back and forth in the prescribed manner (and fast enough) to do so.

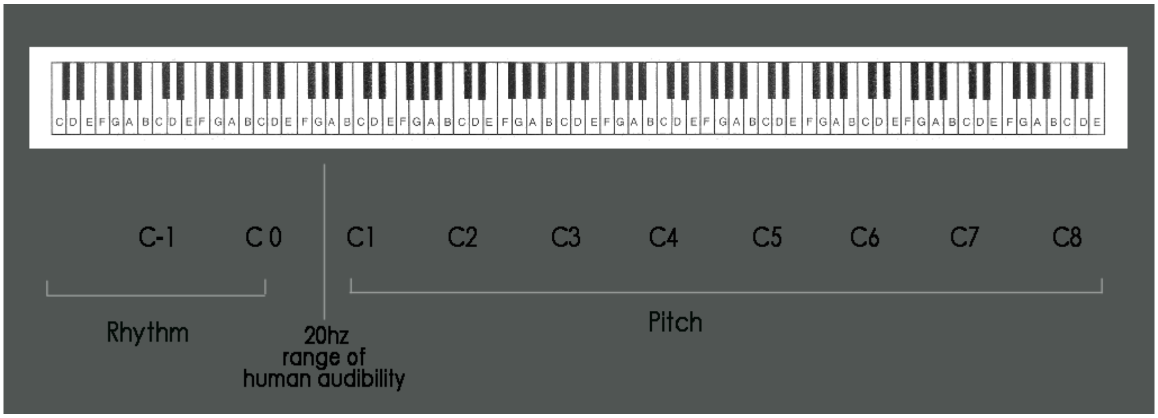
Depending on our own hearing,, when Abigail claps faster than 20,000 times per second, we start to top out of our range of audibility. But up until then, we would relate everything she was clapping as pitch.

We ask her to slow down, from 20 beats per second to about 20 beats per minute now.

She would now transition her clapping from the realm of pitch to that of rhythm (I hope you agree they are the same thing now). Simply instead of finding this oscillation on the piano, we would find it on our metronome.

When we slow her down like that, as we continue to whistle the Magic Flute in our heads, we would start to notice something different about Abigail's clapping. Suppose that she is clapping half notes in the 4/4 bar.

Abigail has now gone from clapping middle C, to clapping above the range of human hearing and now she has decreased her clapping to the familiar half notes of the bar in this case. But remember that it was possible for her to do so in one smooth continuous fashion, simply by speeding up her claps or slowing them down.



As half notes, she is clapping an octave above the meter. If an animal with low enough hearing were able to hear at that range, what they would perceive would be Abigail sounding claps an octave above the measure of the bar. This is because Abigail, would be clapping twice the frequency of at which we hear the bars oscillation, just as any pitched sound occurring twice as fast would be an octave in melodic terms.

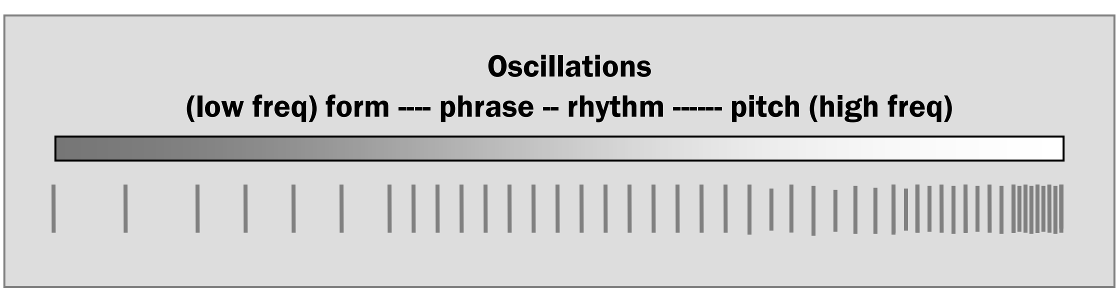
We ask her to go half the frequency and Abigail is finally clapping on the bar. Because pitch and rhythm are the same, the tempo at which Abigail claps can be considered to be a note. The tempo of a piece is for this reason another form of 'tonic' signature of the piece by which the whole piece is divided.

If Abigail slows down even more, we start to see that Abigail is only clapping once at the beginning and end of a phrase, then only once every phrase, once for each section; the A section, we hear her clap once, then the B comes, we hear her clap again, she peters out, and then the recap comes, and we hear her clap once more. Good Job Abigail. She is now clapping the oscillation property known as form.

If this were Wagner, Abigail could theoretically clap once a music drama. Or once a year at Beyreuth, or decade.. you name it. Abigail would be able to clap it!

From this, we can see that music lies on a gradient. Although it manifests itself in different properties, the gradient is actually a smooth one.

To plot it out:



(figure 1.2)

It is very much analogous to the unification which occurs along the EM spectrum.

What is even more amazing - is that we are able to take in all of these oscillations across many different frequencies simultaneously. This is another fundamental property of waves, and thus of music which we will explore in the next section.

Pitch = Rhythm

The two as well as Meter, Phrase and Form can be unified along a single spectrum of freqeuency.

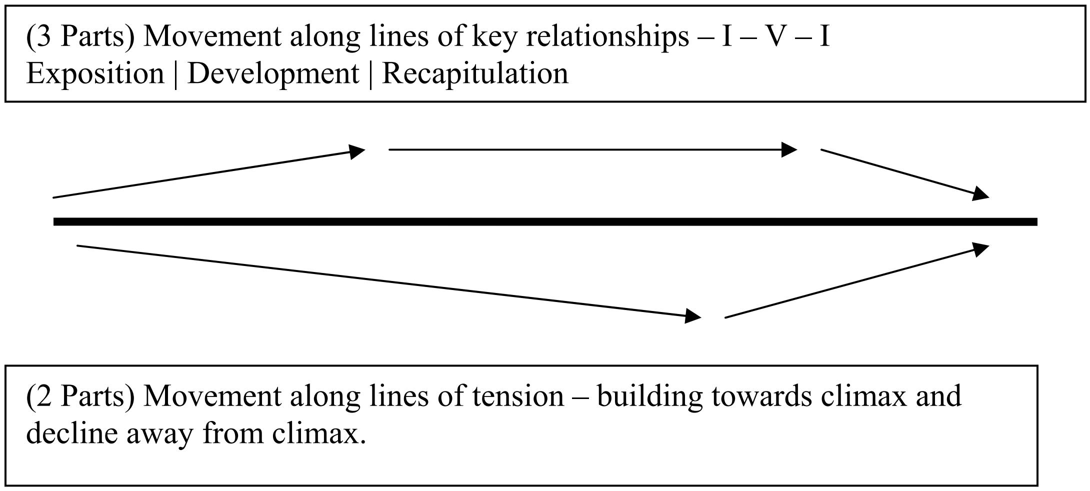
PART II - multiple pitches

It can equally rewarding to look at 2 pitches. For instance, if we take/ask Abigail to clap at middle "C" (262 oscillations per sec) and now her kid sister Clarissa to clap at "G" above middle C (391/sec) what we get is a perfect fifth. As they change their speed, they will pass through our band of audibility (as pitch). As they slow down further pitch changes to rhythm, as we spoke about previously. What is peculiar here is that a fifth sufficiently slowed down will become at some point (show notes three quarter notes over two dotted quarter), three quarter notes over two dotted quarters, and all their intermediate values such as eight-note triplets over 2 regular eighth notes, and so forth and so on…

Thus we can conclude that a pitched fifth in the rhythm 'band' of the spectrum is 3 over 2 as triplets over eighths. In the meter 'band', which is just below, it occurs as the duality between ¾ and 6/8 namely (show a Spanish hemiola). In it's largest incarnation – within the form 'band' – it occurs as the duality between 2 and 3 in the sonata form.

The duality between 2 and 3 in the sonata form is well documented. It can be viewed as three parts because of the characteristic exposition, development and recap sections.

(show diagram of Sonata timeline divided by 2 and divided by 3)



(figure 2.0)

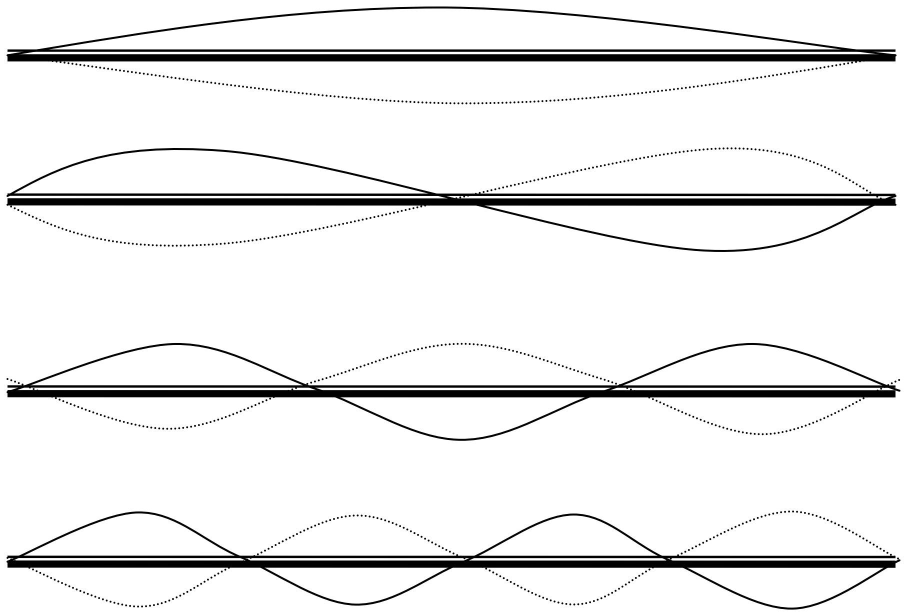
The Sonata is divisible by 2 parts also however, if not more elemental to its conception. It is characterized by motion to the climax & motion away from it. If the final cadence is considered a peak (a summit/hill), there are only two main motions to go from there: up or down. There is climbing up to the hill and climbing down again. There may be stalling here or there but over a prolonged term, it eventually resolves as upward or downward.

In a sense this is the 'most' important view of the sonata because it is a direct mirror to the ascension & decline of the tension in the piece.

This is equally true for moves, ballet, computer games, our finances, etc. as it is for musical forms.

Generally for these forms, and specifically for the formalized structure of the sonata, the longevity of this form has endured specifically because it acts as a 'launching pad' for development in the piece. (the poles of tonic & dominant are maximized in this form.)

Another view of the organic form of the sonata can be seen in the property of a vibrating/oscillating string. When a string of fixed length vibrates, depending on how it is struck the string vibrates in 1s, 2s, 3s, and so on….



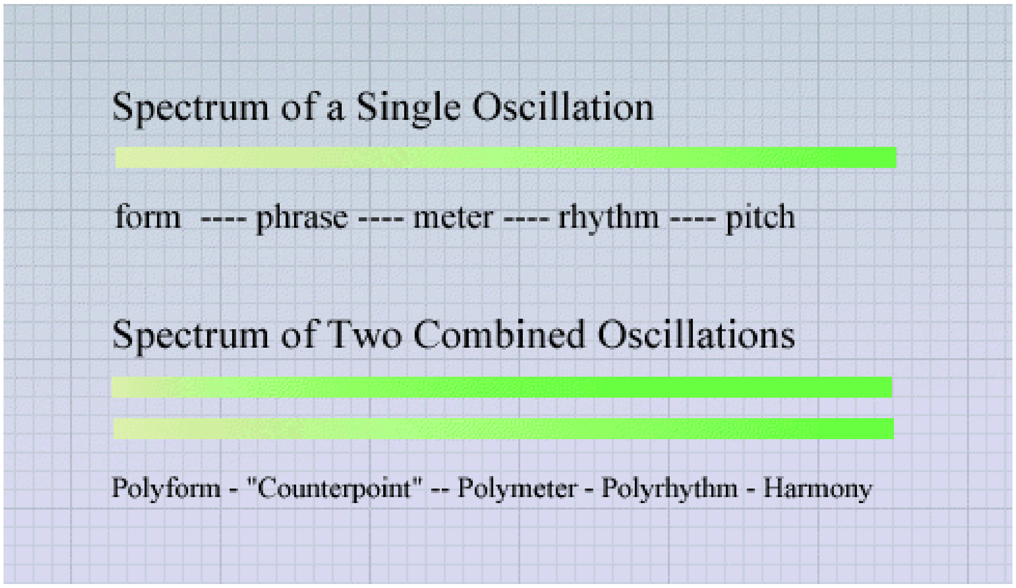
1st harmonic, 2nd harmonic, 3rd harmonic, (continued) etc.

(figure 2.1)

The separation, fragmentation and duality of the piece into 2s and 3s is the natural outcome of ‘excited overtones’. 2 'against 3 is of course one possible outcome out of many. There are similar dualities between 5 against 2, 5 against 3, 3 against 4 and so on.

The interval of a perfect 4th between any two notes is in fact predicated on the pairing of 4 against 3. Similarly a major 3rd is composed by the duality of 5 against 3.

Thus we can see that harmony, polyrhythm, polymeter (& also phrases of different periods which coincide – call it ‘counterpoint’) and ‘superimposition of groupings in form – can we call it ‘polyform’?’ are exactly the same things merely occurring at different frequencies.

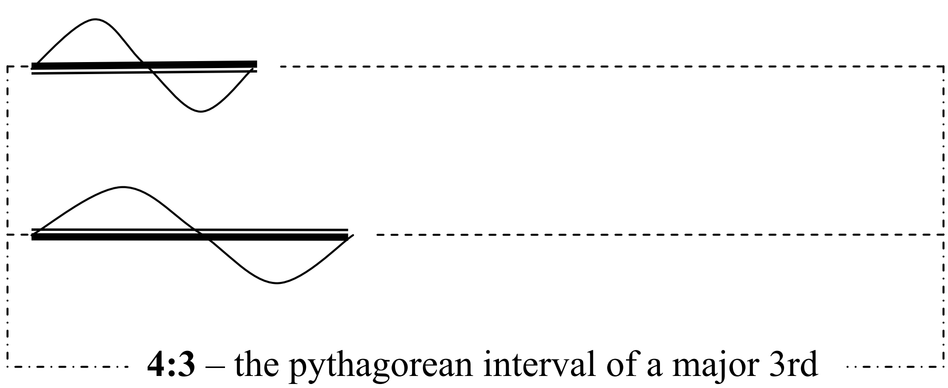


(figure 2.2)

Part III – To the Right is Timbre

On the right edge of this chart lies one more possible ‘bandwidth’ which we have yet discussed , which is timbre the yet undiscussed element of music.

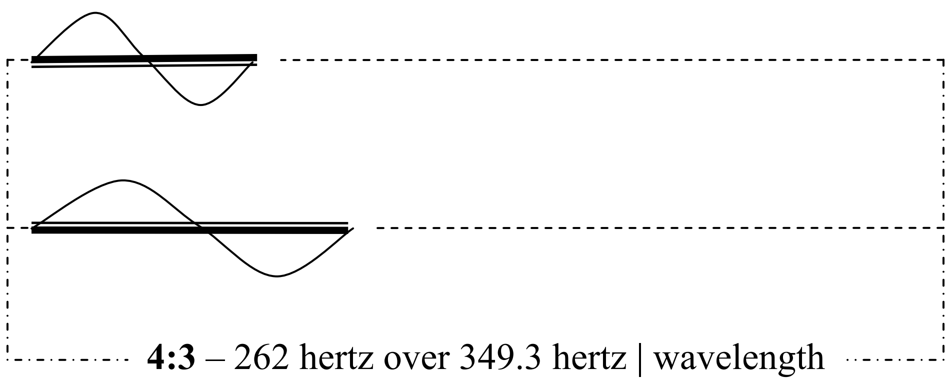
To investigate this property, let’s look more closely at the major 3rd interval.



(figure 3.0)

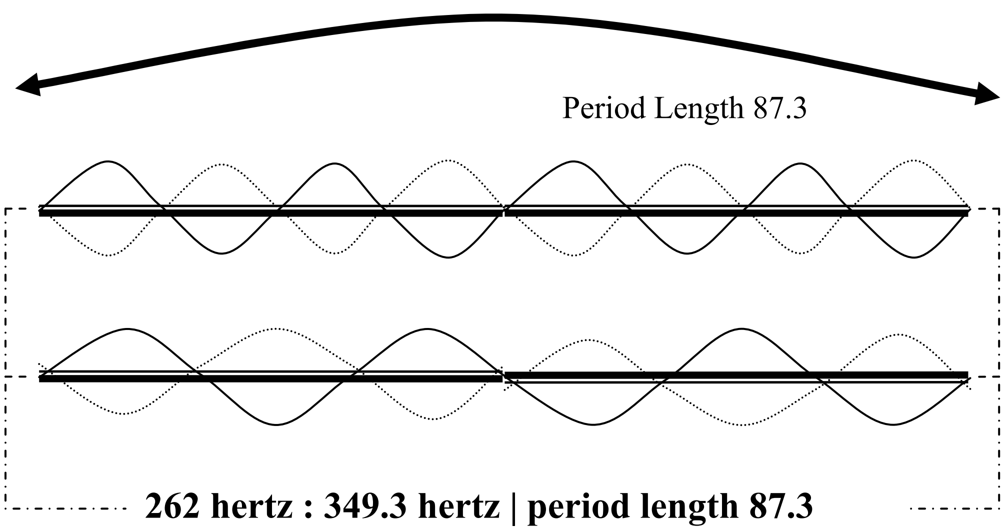
It could be any interval, but for argument's sake I chose this one. Notice how no frequency has been specified, it could be any as well, but arguments sake let's choose middle "c" and the "e" above middle "c".

Thus our chart now reads:



(figure 3.1)

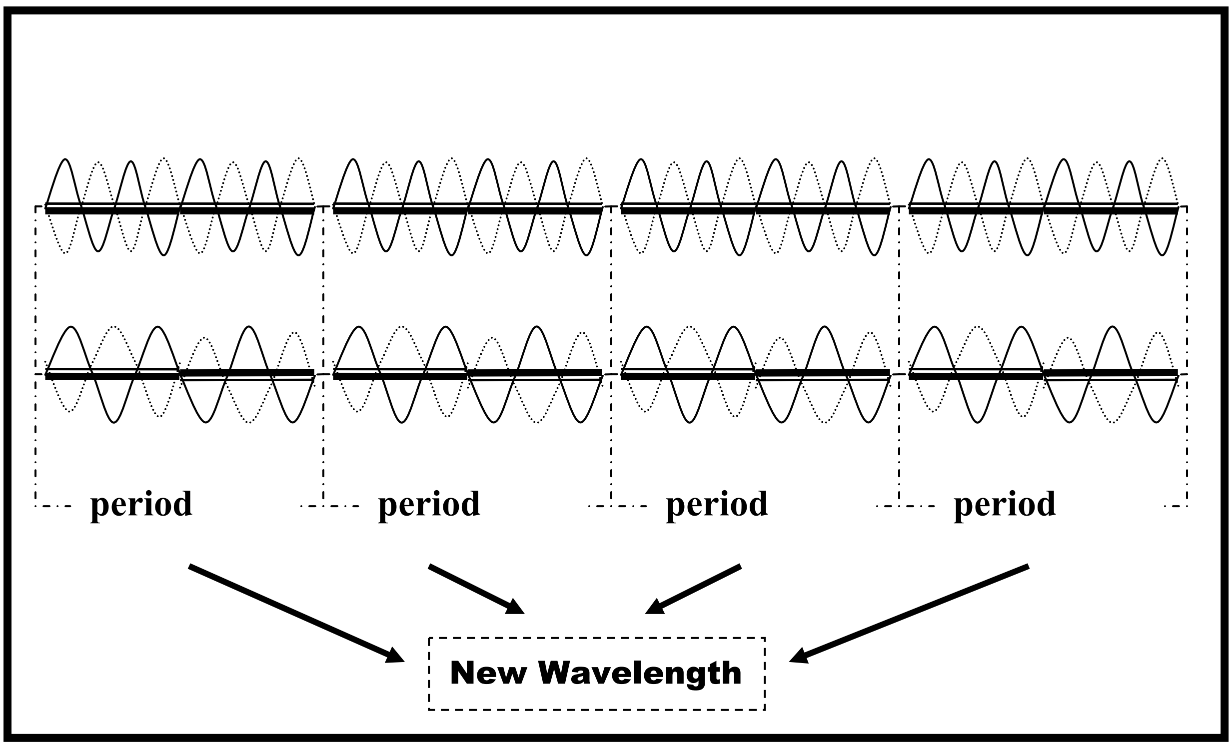
Visually we can see that no points meet up, within the frequency – that is – except for the start point. If we were to line up multiple frequencies in a row we would see a new pattern emerging.



(figure 3.2)

That after 4 iterations of the high frequency and three with the lower, the waves meet up again. This in my opinion is the key to music: coincidence. It doesn't even have to occur as audible waves, it could be anything, in any kind of available waves, for ex. Pond waves or waves made in grass, gamma rays or people at a baseball game etc… Their meeting is precisely regular as well. For this reason, can we say that the coincidence of the two wavelengths have a wavelength of its own???

It does! The wavelength in this case is 756 hz (translate to wavelength), which we can see repeats itself every 756 hz (translate to length).

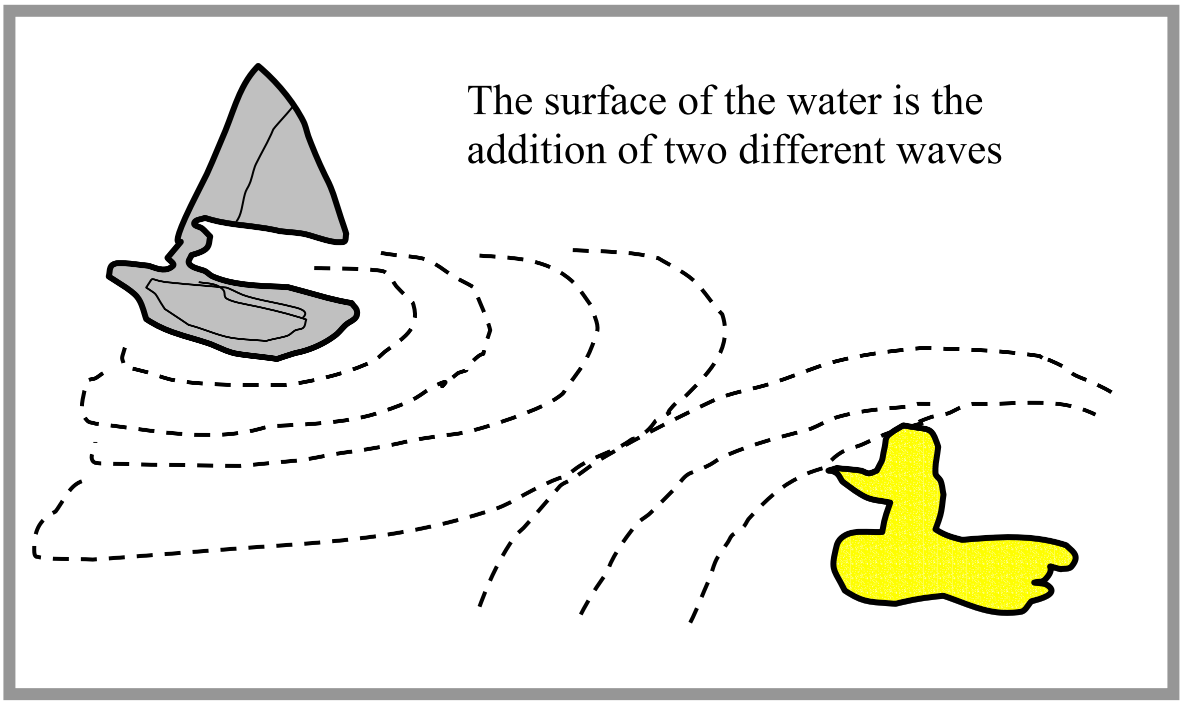


(figure 3.3)

So there is a periodic 'oscillation' to the oscillations…. When the two pitches meet up again.

The mathematician Joseph Fourier (1768 – 1830), who had made significant breakthroughs in the theory of waves had discovered in 1789 that sine waves could be added and subtracted to produce any complex waveform, and furthermore that the process was reversible, that any complex waveform can be broken down into a series of sine waves.

Though remarkable, this should be appear 'natural' to our instincts. We see this in life when, for instance, the wake of one boat (or a duck) crosses that of another.

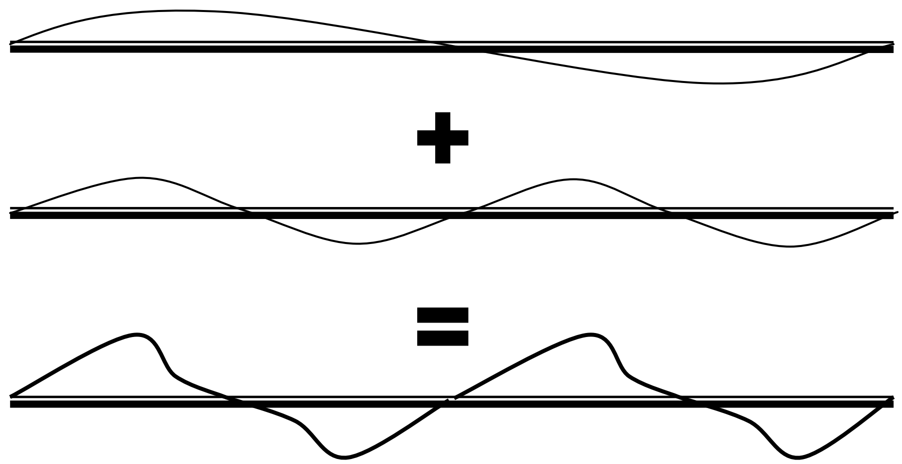


(figure 3.4)

We come to and expand this analogy further on. For the time being, it is only important to recognize that sine waves can add together to form complex waves forms.

When we add two sine waves together (or any waveform) the energy of the waves are merely added to one another – much like setting your bills against your earnings at the end of the month. If the two waveforms oscillate in the same direction at a certain region, they add on to each other. If one is positive and the other is negative, they cancel each other out.

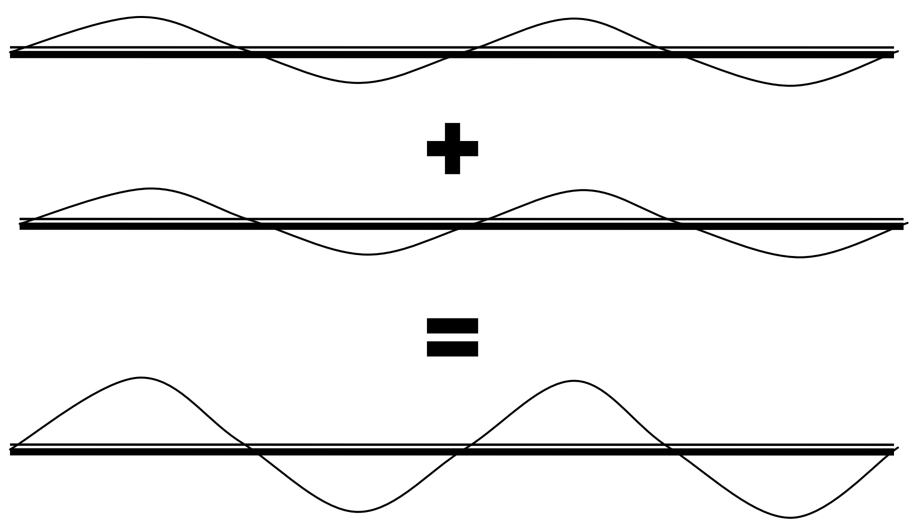
For example, in the case of a pitch adding with another an octave higher, the result would look like this:



(figure 3.5)

Again notice how no wavelength is specified, this is a result that is universal, as long as the waves are in this proportion to one another. (its 'universality' is just like how 3 + 3 ducks, or fire trucks will ultimately yield the same number result. The units don't matter.)

If one sine wave were added to the exact same wave, the result would look like this.

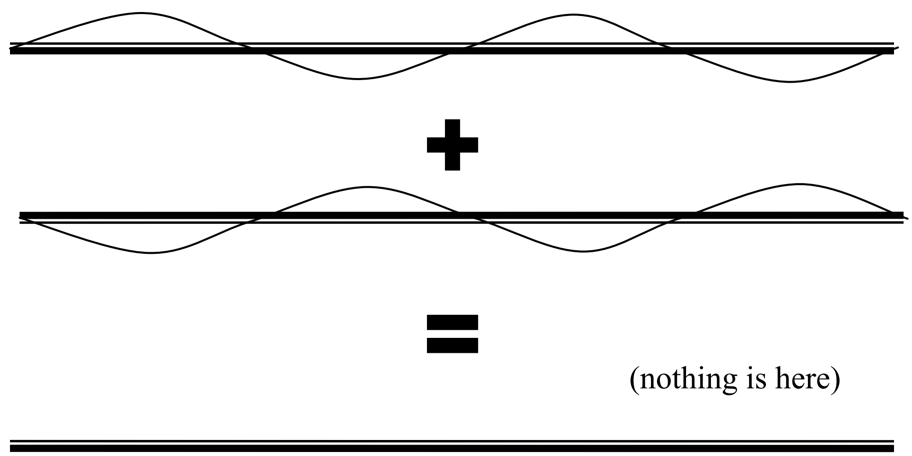


(figure 3.6)

the amplitude increases.

If instead we take these two sine waves and shift one a half turn (phase) away, the result is this:

(show diagram of 1 in phase, and 1 out of phase sine wave and product of zero (full cancellation))



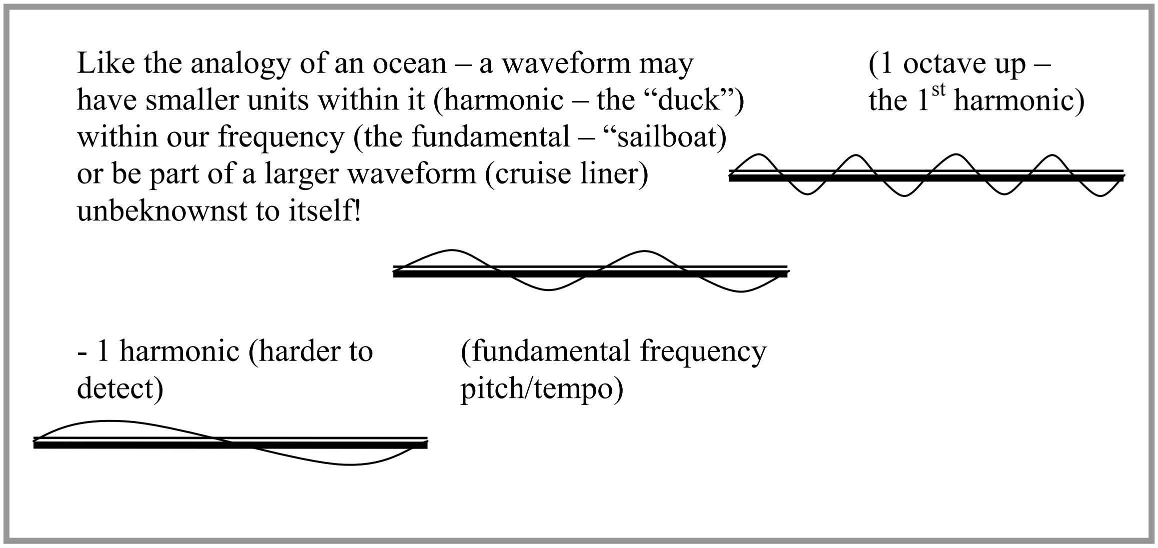
(figure 3.7)

The two waves cancel each other out.
We have said previously that two frequencies will meet up after a given amount of time, and in turn, the time between their meeting can be assigned a frequency of its own. For anyone who has sat through traffic during raining season, a great example can be seen in the windshield washer blades, going out, in and out of phase again, where the tie in between is the meet up frequency. Much like fractions or short and tall people walking beside each other, we are forced to find the lowest common denominator (the meetup frequency) between any two numbers.

Now if any 2 frequencies can have a lowest common denominator, should/can we not consider the inverse to be true as well, that any larger pitch can be composed of smaller units????

It turns out that this is the case, and because waves can come in any size, very large and or very small (basically infinite in scale), we can say it is a property that is true of all waves that we encounter because no units have been specified. They are equally relevant to waves in nanometers as they are to waves in kilometers. A wave regardless of scale can always be broken up into smaller components, or be considered as part of a larger waveform if we wish.

This then forms the basis of overtones / harmonics / partials in music.



(figure 3.8)

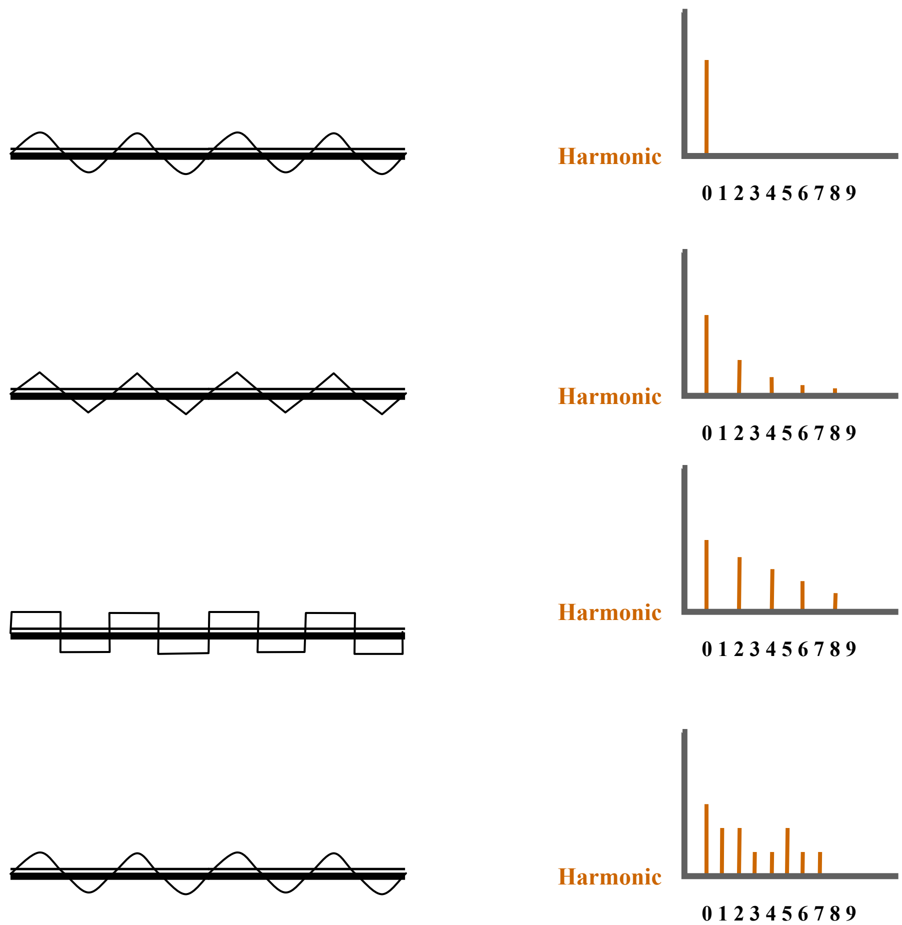
For instance, when we experience changes within our own lives, those circumstances may show larger waveforms at work to which our lives run as simple harmonic to. For instance, trends of say baby booming populations or this year's fashion to which we partake in without our determination but simply as a function of our participation in society.

In Music, when we hear a cello string or trumpet for example, we are not just hearing the length of the string or pipe but also the excited harmonic overtones produced by those instruments as well. This note may be a harmonic of the tonic, the major 3rd (harmonic 4) or perfect 5th (harmonic 2) of a chord in turn, which is nested within the oscillation of the sinusoidal 4/4 meter (strong-weak-middle-weak), within the repeating 8 bar phrase, within the 100 bar oscillation of an ABA form etc.

It is this mixing of distinct pitches which accounts for harmonics in waves. The distribution of harmonics and their intensity serve to control the timbral quality in music. This mixing (fourier wave addition) controls the pitch of a certain note by adding other notes in various quantities to it.

For example the note C may sound smooth and warm if it only contains the harmonic G and F spice it, but may sound harsh if the F# spice is tossed in.

Here are some characteristic/commonly found waveforms & their harmonic distribution.



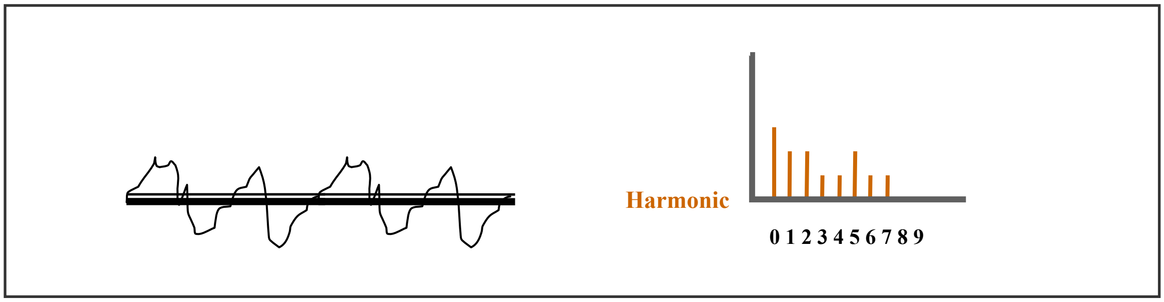
(figure 3.9)

For example, the distribution of harmonic in a clarinet is based solely on odd harmonics. The bore of the clarinet can be seen to mute even harmonics produced by the instrument, thus giving it its characteristic sound.

Both the square and the triangle wave are composed of only odd numbered harmonics, the difference is between the two is due to the intensity of the harmonics. The technical reason for this is because the intensity of harmonics in a square wave occur at an inverse ratio to the harmonic **1/n** whereas the harmonics of the triangle wave will dissipate proportional to the inverse square of the harmonic $\mathbf{1/n^2}$. Thus if the fundamental tone was say, A, and the fundamental frequency is F, then the square wave would have harmonics at frequency 3f, 5f, 7f, etc. at amplitude 1/3, 1/5, 1/7 and so on. The triangle wave would have he same frequencies, but the amplitudes would be 1/9, 1/25, 1/49 etc.

This brings out an important pattern for us, that the harmonics are sloped downward, and always decrease for us at a rapid rate. If they didn't, what would happen?

What for example would a note such as this sound like?

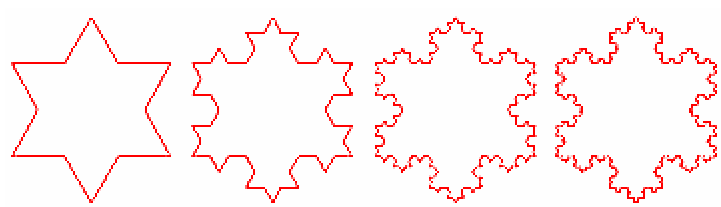


(figure 3.10)

It turns out that such a note would begin to sound like two distinct pitches if a peak of one of the harmonics is sufficiently high (loud) enough. This intuitively makes sense to us. For example if we had a bunch of tuning forks lined up, and I played a pitch on my cello, a few of the forks would be vibrating. The fundamental tone, say at 100%, and the next few perhaps at 35% and 15%. If I plucked two forks in particular, say the 100% and 15% ones, I would begin to hear 2 notes instead of the harmonically 'rich' one.

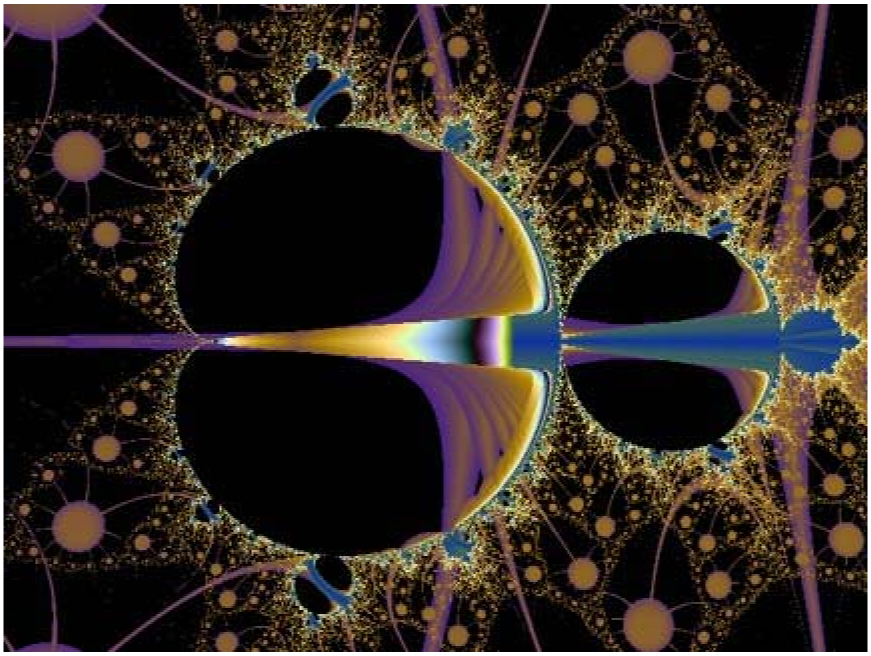
This means, as we have been developing it, that all pitches lie on a gradient between the single pitch and multiple pitches in music.

Much like the partial dimensionality of fractal that mathematicians have found, where structures can contain partial/incomplete dimensions. For instance, the diagram below contains 1.261859 dimensions, known as a Koch Snowflake.



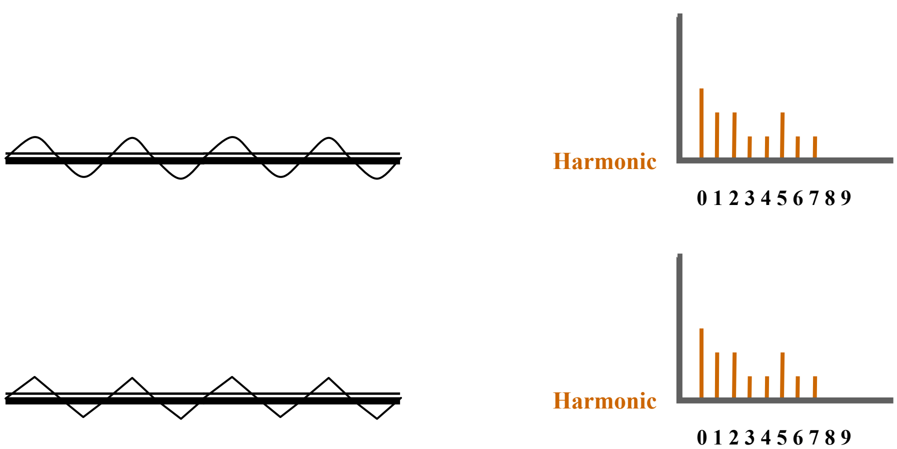
A more elaborate set fractal, again with consisting of a partial dimension (for more information please visit (http://pro.wanadoo.fr/quatuor/english/fractal_00.htm)

A more elaborate construction demonstrating self similarity and partial dimensionality



(for more information – please visit -
http://thefractalfarm.homestead.com/Freedownloads.html)

All music that is not dominated by sine waves (about all music, with the exception of very low grade synthesizer music), then essentially lies on a timbral 'gradient', where a single sine wave is represented on one end of the spectrum.



(figure 3.12)
and equal amplitude along all frequencies (ie. 'white noise') on the other side.

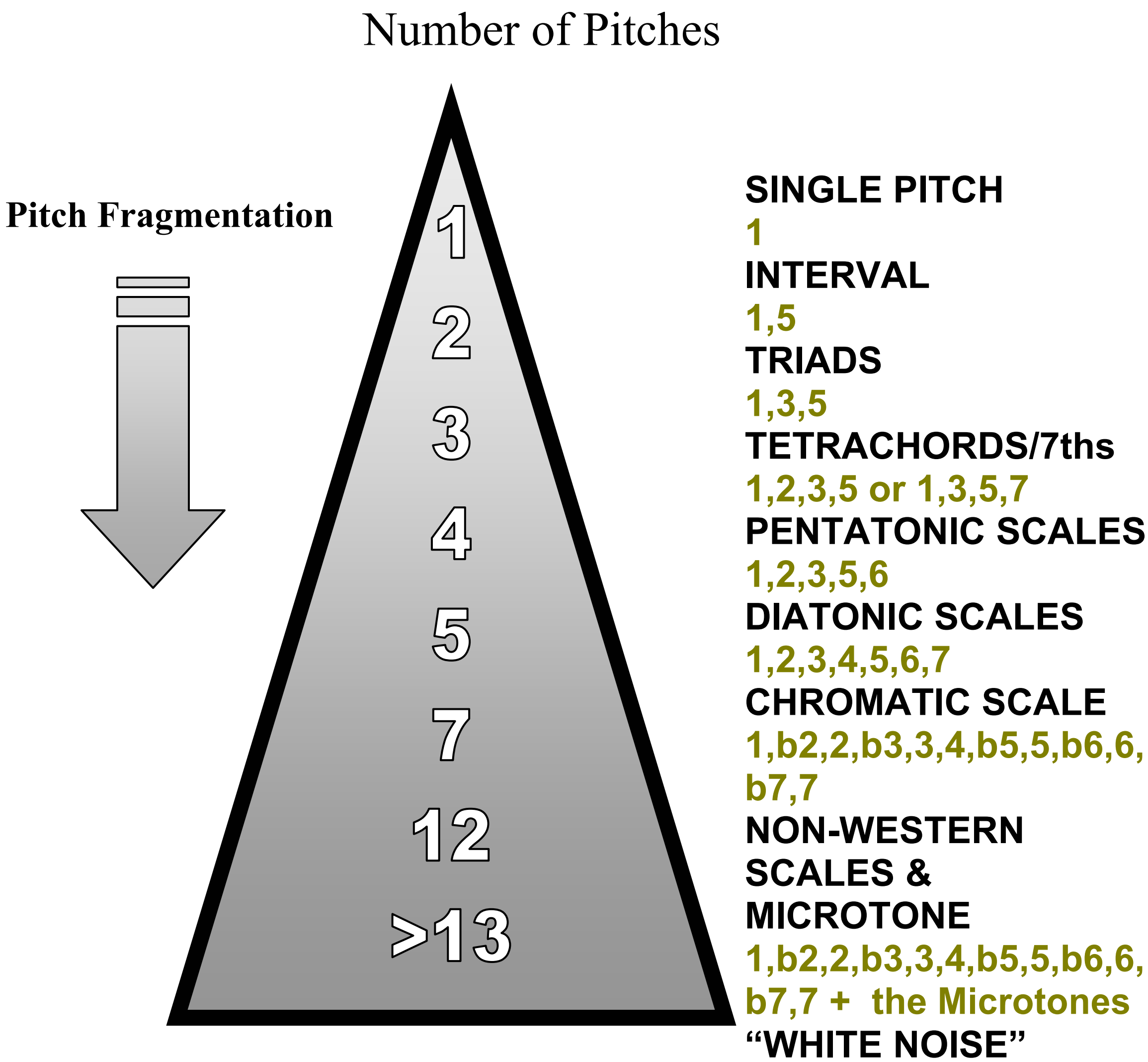
(show diagram with all frequencies across spectrum at same amplitude)

(figure 3.13)

Between the two extremes then can be found notes, intervals, triads, tetrachords, pentatonic scales, hexatonic scales, diatonic, chromatic, larger-than-twelve tone mircro-tonic non-western music scales and so on until we reach the stage of ‘white-noise’.

This gradient seems more hierarchical than the others though. Whereas the other two spectrums have frequency as the main spine along which form, pitch, polyrhythm etc are aligned, the timbral spectrum aligns from single to multitude, 1 frequency to a dispersion of many. It seems to be more hierarchical in this manner for this reason.

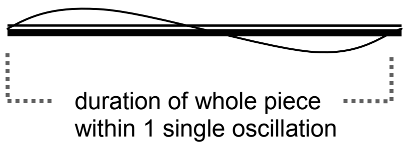
(show diagram of pyramid, with pitch on the top, then subsequent fragmentations into intervals, triads, pentatonic/hexatonic, diatonic, chromatic, non-western in pyramid form, poss. w/ accented 1,5 and main partials)

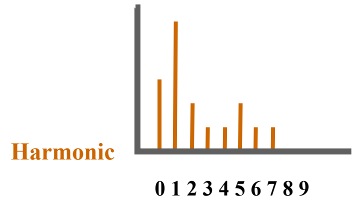


(figure 3.14)

That is is a matter of density or fragmentation, whether it is a 'pure' tone , or whether it has been fragmented into a scale. That these pitches are all related.

It is also interesting to note that a piece of music itself will have timbre envelope as well. That is, if we take any piece of music and speed it up to such a degree – the meter/measure/bar of the piece will form the fundamental 'pitch' by which overtones and undertones will expose themselves. Say that we have a piece that is in 4/4 time and within the piece there is a predominance of half notes – in such a case, the harmonic spectrum of the piece will then contain a high peak at the 1st harmonic, (the octave).



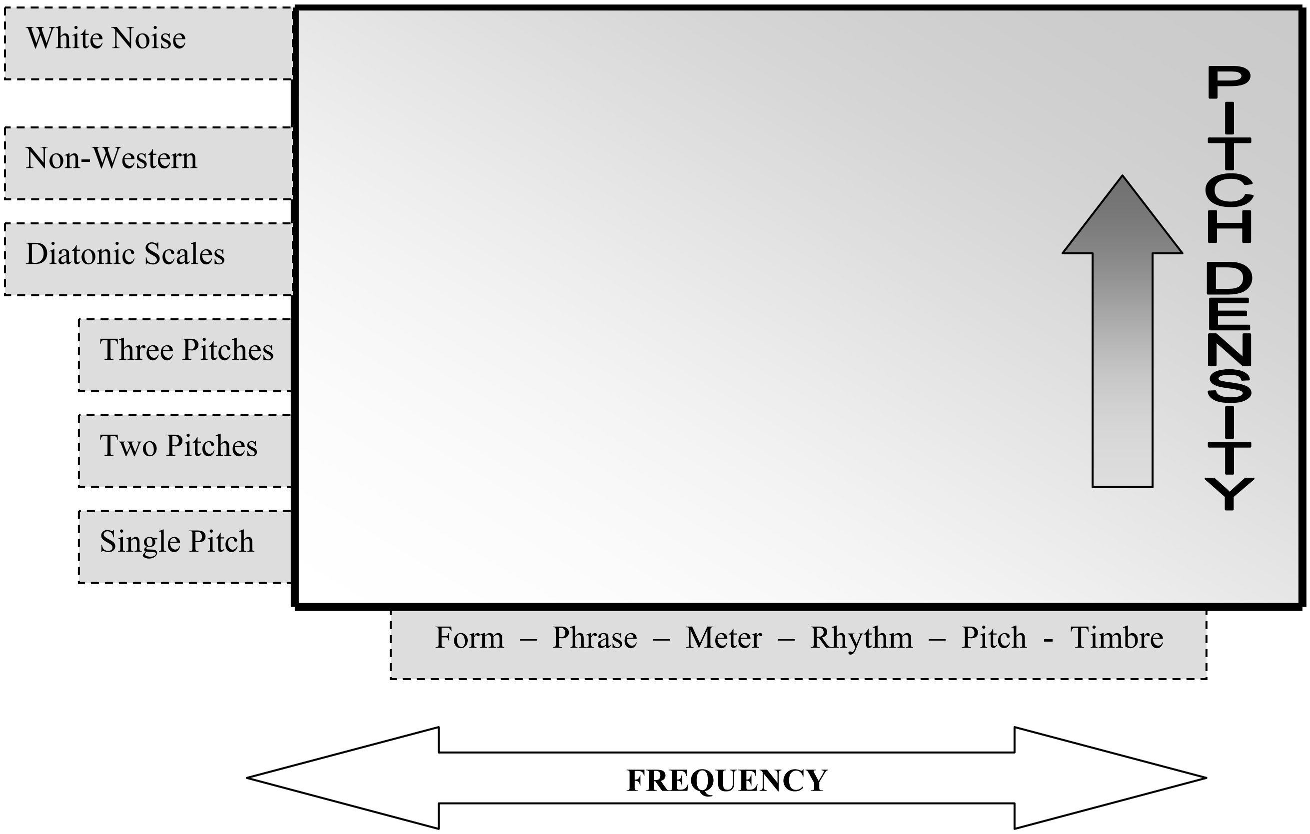


Thus each piece can contain a timbre in the sense that its distribution of higher harmonics (most commonly half, quarter, triplets in this case). Alternatively, The most correct division should be made at the fundamental of a piece – which is it's total duration. The harmonic of the bar then would be the / (number of bars – 1)th harmonic.

In such a method of analysis, it would be entirely possible for the microscale harmonic spectrum of an instrument, say the clarinet (having solely odd harmonics), to have a mirror representation by the distribution of the harmonics of the piece itself. Such large scale unity would appeal to and be characteristic of a composer such as Beethoven who sought to unify small and large scale structures at such a level.

One possible way to view the 3 gradients that we have discussed so far might be:

(show Cartesian x,y with frequency as x, and density/fragmentation of pitch along y)



(figure 3.15)

whereby three pitches and diatonic scales would just be a higher density/fragmentation of the 'two pitches' gradient already discussed, though I believe I haven't look into the ramification of more than 2 pitches in too much detail.

This mapping of frequency and density does seem to hold well for most musics it seems, and across frequency 'bands'.

For example, a large historical trend in the rhythm 'band' occurs where classical music becomes more fragmented in the romantic period, with increasingly more complex rhythms such as Chopin or Debussy's polyrhythms and apexes with masters of polyrhythm such as Stravinsky, Bartok and then reduces again to minimalism. This can viewed as a move on the left hand side up the density scale in the rhythmic band to a point of high fragmentation (upper left hand corner) and then back down again over time (this occurs harmonically across the other 'bands' as well – for instance dissonant pitch groups and complex forms).

There are many ways to interpret this trend, but certainly this is one way of mapping it that may be useful to musicians.

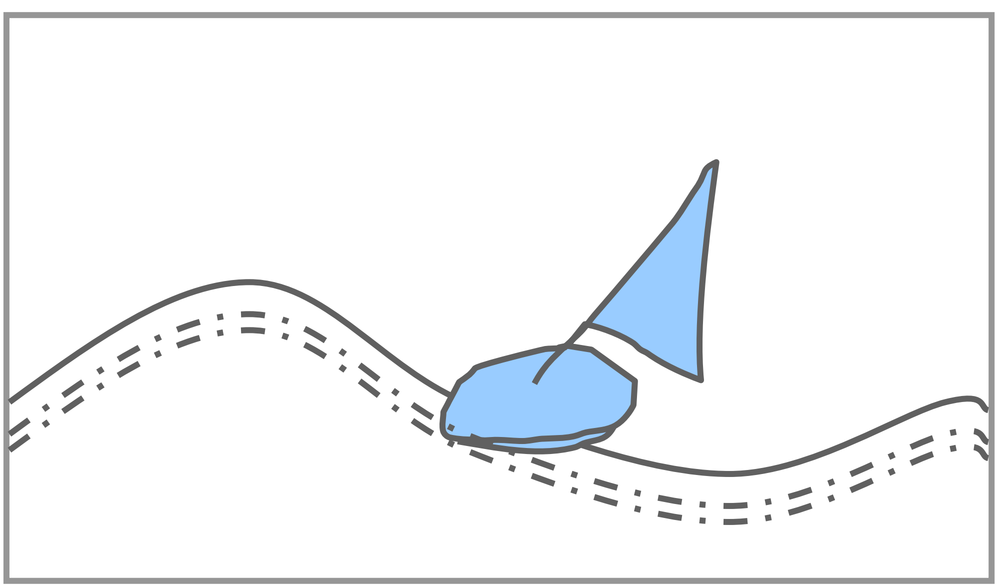
As you read this sentence, your body is becoming part of the medium by which a whole league of particles and waves pass. Just alone within the electromagnetic spectrum – radio waves, x-rays, microwaves are able to pass through you. This does not even include the more eccentric of nature's army: gravity waves, neutrinos or any of the other the universes constituents.

If we view music solely as the process of waves, another finding which avails itself is the idea or process of broadcasting across many wavelengths simultaneously. This is due to their additive properties.

It is much analogous to observing the oceans. If we sit on a rowboat in the middle of a calm and still ocean and a cruise ship passes by at a rollicking speed, in it's wake we are exposed to 'its waves'.   If a motor boat then passes nearby, and then a medium sized yacht, all these wakes will eventually add up to create the surface of the water as it is.

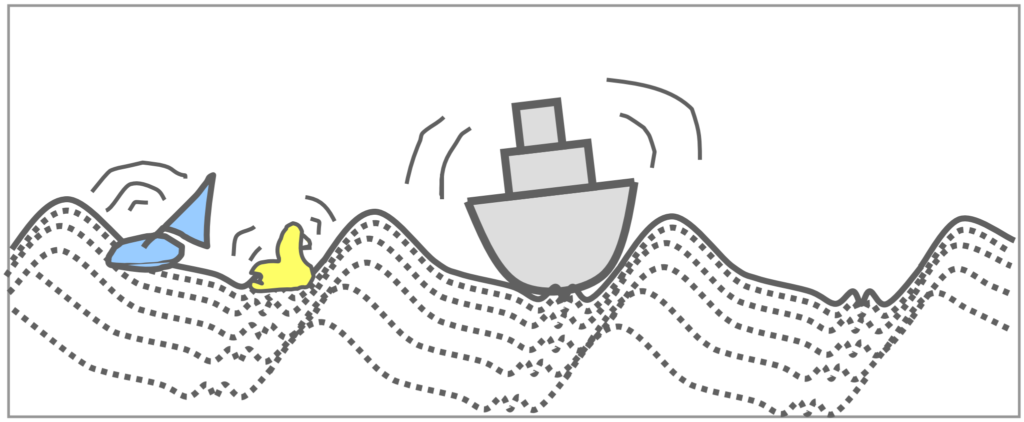
Similarly, if a double bass plays, and then on the other side of the room a viola & piccolo play, our hearing is no less diminished by it. We merely receive all these sounds at the same time. The surface of the water for boats, or air for musicians is the same. They simply add all that is happening around us to create 'the surface'. That is the property of these mediums.

To explore this analogy further, say that as the cruise boat passed, the wave might look like this:



(figure 3.16)

as the motorboat and yacht pass us, the surface will begin to look like this. It is fourier visiting us again.



(figure 3.17)

The benefit of this is that a piece of music (especially good music) can and does 'broadcast along many different wavelengths/frequencies simultaneously.   We can tune into these different 'frequencies' of the piece simply by changing the scale at which we hear it.

A good piece like the chaconne by bach, will have something of artistic value at each wavelength for the listener: (the ocean liner) ABA form, (the yacht) 32 variations, (the house boat) the chord progression, the figuration of bars and even the figuration within each beat bears witness to this.

This too – being only in the analytical mathematical/structural realm, as there is the spiritual & psychological realm including the hymns which Bach most likely quoted for those who look deeply enough; and for those who do not, the piece can still be understood simply by the ear of anyone able to listen. This piece communicates on all levels. This is a great piece.

This piece communicates on all levels to everyone, from every perspective that you view it. Sculpted from all angles and scales. The message is broadcast on all wavelengths for this reason, no matter what scale we view. And beyond merely scale, it speaks in all the human realms of spiritualism, intellectually, emotionally, and perhaps even physically.

It's a great piece of communication and art for this reason and many more.

Part IV - Speculation

Continuing in this vein, vibrato too can be seen as a form of oscillation. It can be considered as the oscillation, or modulation of the frequency which is produced.

When – for example – a string or pipe are excited naturally, its tendency is to oscillate in all forms & degrees of motion available to it. I wonder if vibrato (the oscillation of frequency) is an outcropping of this.

Most certainly vibrato on a another level, has its organic origins in the physiology of the original instrument, the voice.

Despite the previous truism, it might be possible still to view part vibrato as extra energy being diverted to other oscillations, we already take this view in regard to higher harmonics. Distortion, especially on guitars, is the natural outcropping of intensity and sounds pleasant to the ears, this gives some credence to vibrato as well, as it maybe the outcropping of extra energy, and is certainly descriptive of intensity.

Additionally, because one thing is true, does not necessarily discount another thing from being true as well,

Most certainly however (and despite this truism) it seems incontestable that vibrato's manifestations in the lower frequency band would occur as rubato, accelerando/deccelerando, and large tempo changes allowing this form of oscillation to stretch across several bands.

As the intensity of excitation (of anything) increases, more ad more of the higher harmonics & degrees of movement will present themselves. This does seem to hold true for vibrato, if it is a degree of motion, as it is generally an indicator of intensity. We want the soloist or melody line to vibrato after all don't we, and not the chorus.

We see looking back, that a case can be made for viewing rhythm, form & pitch as a single entity and identical processes. This is the crux of my argument, that there are really no differences between the three as we normally tend to view them.   That merely by our biology we 'must' view them as separate, when they are held together in actuality by a single strand.

If we view music as consisting of waves, then it can be said that oscillation is the prime characteristic/phenomena. Oscillation constitutes the soul of music.

If oscillation is the soul however, then coincidence/coalescence is certainly the flesh and skeleton.   That the process of coalescence/coincidence between waves gives the quality of aligning, 'meeting' or unifying. For anyone who has ever heard, there is an unmistakable 'meeting' that occurs when tuning pitches (especially at the octave).

We are able to detect this coincidence with our ears in all 'bands' where it is able to occur; with pitch, rhythm, meter and form. That the coincidences are best expressed as the Pythagorean ratios of 4:3, 3:2, 2:1 etc, despite modern advantages to equal temperament, where ratios appear as 256/587 etc.. (that most string players will, who are able to fine tune pitch, will tune to a pythagorean third gives evidence of this).

That the other component of music – timbre - in this view, can be considered to occupy grey areas between a single and multiple pitches, and that the further fragmentation of a single tone will produce triads and scales. (this is why triads and scales have tonality, that they are scattered from one initial pitch).

That music because of it's composition from waves, is able to communicate across all the wavelengths that it encompasses. Specifically that each frequency or 'band' can be a carrier of communication, which is a mechanism, along with counterpoint and words etc, by which music becomes multidimensional.

I hope there is a benefit to viewing music in this way.

Of greater conjecture would be the view that vibrato maybe viewed as another form of oscillation, and degree of movement.

Finally, that this view is only one view, that there are many ways to view music. In our discussion the idea of compliment by words, or history were not discussed, and yet they comprise large realms that also factor and influence into our hearing of things.

The thing that makes music beautiful, is because it is a cosmos. Anything can be said, and there are an infinite possibilities.| One might be a wonderful sightreader,
One might have a wonderful ear. | When they get together, they will be able to coexist, despite having neither the others skills, or a weak version of it.| Any version of the arts will have this quality of the infinite No matter at what level.

Recently I had the opportunity to play with a young and very distinguished pianist from Korea. Although it was mainly informal, it is a testament to the breath and enormity of our field that, she – a skilled reader, who spoke little English and lacking in ear training and improvisation, and me – a horrible sight reader with no Korean, but able to hear pitches and improvise, were able to coexist – that our playing blended seemingly without difficulty, and interact despite our musical skills being utterly different. That the deaf and the blind can lead each other somehow is something worth admiring it seems. It proves the strength and power of our endeavour.

Part V – Conclusion

It is uncertain whether any of this is indeed true, or whether it is just speculation; however in interviewing many musicians and bouncing these ideas off them, it became clear how very few musicians were able to speak and present their ideas about waves and particularly the Pythagorean musical intervals, which seem to form the basic reasoning for all musical happening that is created. The fact that a string divided perfectly in half creates our musical octave, or thirds creates an octave and a fifth seems a fundamental demonstration of the organic attachment, the root – of music to the world. Such a fundamental and physical property of our education has gone missing, that it seems astonishing to find so many who dedicate their lives to music, are seemingly unaware of these things.

When we say "music is mathematics" – I believe we have no idea what branch or why we say this anymore, which is a shame. Across the nation, music students are learning what a 2nd inversion V chord looks like with very little idea of its use or application.

In this essay, I have tried to show connections between parts which we normally view as separate and non-interacting parts. I came by these ideas by reading about physics and then going to music classes.

It seems to me the first principles we must teach our students are based on the harmonic ratios of dividing a string or column of air, these are the demonstrations of music which connect it to the natural and real world --- and not what the note "C" is. Or what forte means… Those have been arbitrary decisions inherited from the rich cannon of musical tradition, but which derive little from the nature of it. That music would still have a Loudness, with out calling it by the name Forte seems important to point out, for when we are moved by the experience, it is the natural Loudness which speaks and not the label we have attached to it.

If we are teach our kids to produce new forms and directions in music, we must show them where the arbitrary decisions have been made within this cannon.
Why are there only 12 notes in music and who made that decision? Why do two notes sound good together? These seem like questions a student of music should be able to answer before being able to identify "C". I would posit that the classical institution of music has been built from generations of passed on knowledge, which through orthodoxy and fundamentalism, strays widely from the fundamental organic basis (and beauty) of music. That we need a new form of musical theory based from first principles seems necessary. The notion that music education and theory have strayed far from it's initial source is explored in the next essay.