

Vibrational Basics

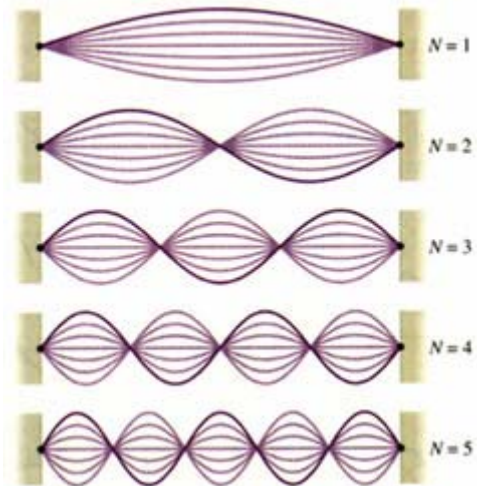
A note is a single tone, pitch or frequency.

A doubling of the frequency of any note produces a higher note with the same pitch, as in middle C and high C on a piano. This is known as an **Octave**.



Vibrational Patterns in Water

1st thru 5th harmonics of a vibrating string



Octaves go on forever above and below our musical scale, they are simply halving's or doublings of frequency. One drum beat per second is what middle C sounds like 8 Octaves down. By some strange coincidence, there are 50 octaves from a beat of one per second (the lowest range of the human heartbeat) to the frequency of visible light. A beat or Rhythm is a couple octaves below what we hear as music and light and color are a few dozen octaves above music.

A **chord** is any two notes or pitches played simultaneously.

All chords produce certain sounds which are unique because whenever two notes are played together, a third note or beat is also heard. this third note is not inherent in either

note but only as a synergetic consequence of their unity, constructed in the brain. Two notes played together produce a third, three notes played together produce three other notes from the various combinations of two notes, four notes produces six new tones, five produces eleven, and so on. The notes may not always sound like musical pitches because their frequencies may be below 16 cycles per second, the minimum frequency that sounds like a note to our ears.

The secondary notes (children, or 2nd level 'iteration' (repeating sequence) of the first notes) interact with one another and create tertiary notes (grandchildren or 3rd level iterations) and so on, to infinity, so that the combinations become rather astounding.

The Harmonic Series

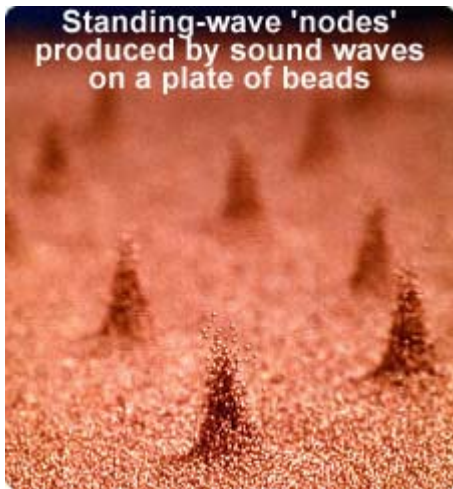
The notes within any note are the iteration of the **harmonic series**, wherein if we could hear 'down' into it, any note contains all other notes by way of this harmonic subdivision. But each new generation has less volume than the previous and fades into the background after so many. Even so, a part of you can sense the presence of nearly subliminal notes. It is even possible that the brain picks up on the pattern and carries the iterations out farther than hearing actually allows.

Pluck a string and you get a complex wave composed of all the harmonics of the root note. The different standing waves corresponding to different fractions are called harmonics.

The first five harmonics on a vibrating string are shown on the right.

The same Harmonic (father, children, grandchildren) subdivision that happens in musical notes and chords happens in any situation where vibrational events are intersecting, including atomic vibration. The wave interactions and phase cancellations that happen in a musical chord are the very same ones that govern

- ways which molecules will bond or repel,
- which waves on the ocean will pass through others, and
- what gravitational orbits the planets fall into - among other things.



Standing Waves - sound and form

When a vibration or wave reflects off of something, such as another wave, it can interfere with its own reflection. The interference is alternately constructive or destructive as the two waves move past each other. This creates a **standing wave** . *Only waves with certain frequencies can create standing waves*. This is because the distance from one node to the next must always be some fraction of the total length (one half, one third, etc.).

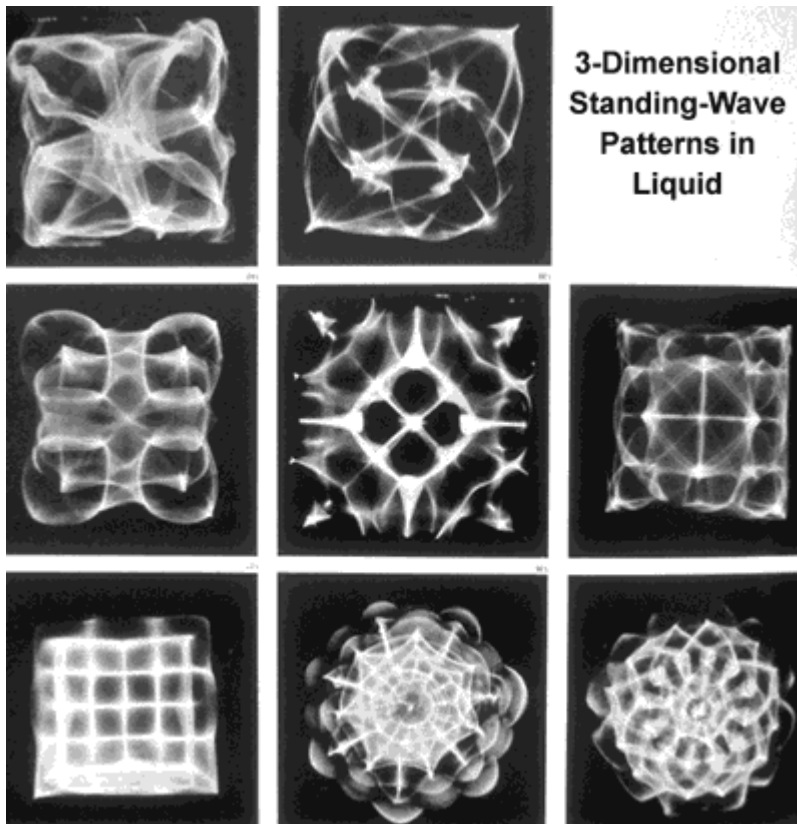
all objects have a frequency or set of frequencies with which they naturally resonate when struck, plucked, strummed or somehow disturbed. Each of the natural frequencies at which an object vibrates is associated with a standing wave pattern. When an object is forced into resonance vibrations at one of its natural frequencies, it vibrates in a manner such that a standing wave is formed within the object. So the natural frequencies of an object are merely the harmonic frequencies at which standing wave patterns are established within the object.

These standing wave patterns represent the lowest energy vibrational modes of the object or complex system. While there are countless way by which an object can vibrate (each associated with a specific frequency), objects favor only a few specific modes or patterns of vibrating.

The favored modes (patterns) of vibration are those which result in the highest amplitude vibrations with the least input of energy.

Test this: Step into your bathroom and close the door. If it's a bathroom with lots of tile it should be quite resonant.

Hum a melody or a variety of different notes you will notice one note seems to "Echo" considerably longer and sound louder than the others. This note is the resonant pitch of your bathroom. The room *wants* to vibrate along with that note - and the note travels thru the surfaces with less loss of energy and therefore echoes louder. This can be used for psycho-acoustical effects by testing and then playing a song in the *Root-Note* of a room, so that the room itself acts as an amplifier for the vibrational structure of the song.



Music and Geometry: Standing Waves form Platonic Solids

"In 3D standing waves, a structure, with all characteristics of a platonic solid, is formed for each standing wave mode. Within an atom, which is the building block of matter, the platonic solid is not formed by salt or known particles, but by electromagnetic waves in vacuum.

Both the students of Buckminster Fuller and his protege Dr. Hans Jenny devised clever experiments that showed how the Platonic Solids would form within a vibrating / pulsating 3D sphere.

In the experiment conducted by Fuller's students, a spherical balloon was dipped in dye and pulsed with pure sine wave sound frequencies. A small number of evenly-distanced nodes would form across the surface of the sphere, as well as thin lines that connected them to each other.

If you have four evenly spaced nodes, you will see a tetrahedron.

Six evenly spaced nodes form an octahedron.

Eight evenly spaced nodes form a cube.

Twelve evenly spaced nodes form the icosahedron

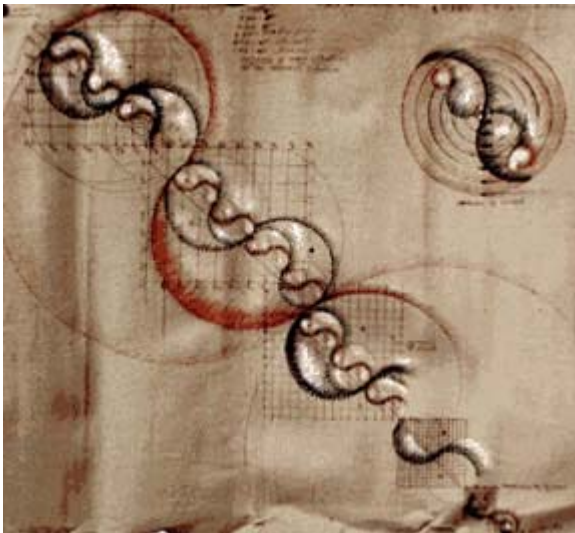
and twenty evenly spaced nodes form the dodecahedron.

The straight lines that we see on these geometric objects simply represent the stresses that are created by the closest distance between two points for each of the nodes as they distribute themselves across the entire surface of the sphere."

the Musical Scale

The **musical scale** is not an accident. It is a natural consequence of pure mathematics and nature. It's more proper to say it was discovered - not invented. This is one reason why music can be seen as the true universal language. Music is vibrational physics and math that is sensed almost as a language by the ear/brain combination. Many musicians tend to overlook or forget this fact.

The scale we use divides the octave based on the harmonic series into 12 notes, the 12th being the same note an octave higher than the first. Many other harmonic subdivisions of the octave are possible yielding scales of 42, 60 even 360 notes (ancient Chinese scale) per octave. Music has existed in *written* form as far back as the ancient Sumerians. It is an interesting 'coincidence' that the old frequency for middle C seems to have been about 256, which is a doubling of 128, which is 64 doubled, which is 32 and so on, neatly landing back at the number



Spheres of Sound:

Illustrated sequence of wave vibrations on the harmonic diagonal

(from <http://www.lambdoma.com/>)

The tone C is the whole, a ratio of 1:1, therefore C encloses the total space.

The tone G*, a ratio of 2:3 or 12 in inverse, falls next in the sequence, so becomes 2 of C. Subsequent tones of F, 3:4; A, 3:8; E, 5:6; B, 9:16; D, 8:9, all become 2 of the previous tone and form comma-like wave motions when drawn, so that an extended line does not twist when it meets the diagonal. It is thus easy to see an expansion or contraction.

An expansion goes away from the diagonal, while a contraction moves toward a diagonal. By reducing the scale, the whole takes on the familiar form of the PROGRESSION BY SQUARES, and is likened to a falling body.

* **Note:** For the drawings the ratios are in wavelengths. Some of the wavelengths are in inverse relationship to the frequencies of the notes. Therefore 2:3 in frequencies in music is an F, while 2:3 is a G in wavelength.

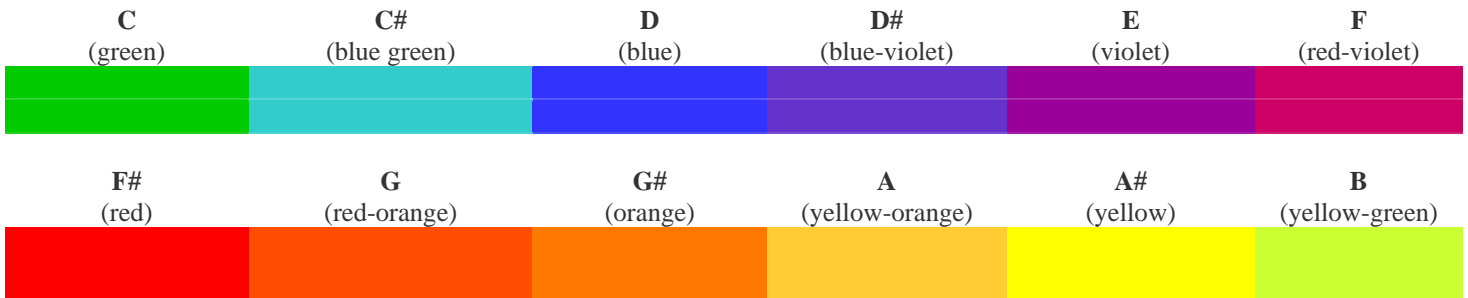
41 Octaves above Sound - notes have color

We hear about ten octaves of sound and see about one octave of light with our eyes. Because going up an octave is doubling, each octave has a bandwidth (range of frequencies) that is as large as the sum of all bandwidths of the preceding octaves (similar to each time a population doubles). This means that visible light, 41 octaves up from the middle of our hearing range, is an octave with a bandwidth many times greater than that of all 10 octaves of the hearing range. So the human eye has a very wide range even though it sees in only one octave.

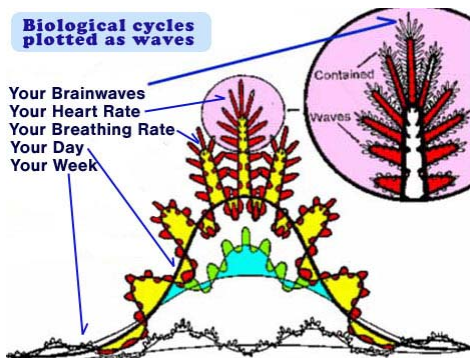
Exact Color / Musical Note Correspondence Chart

note: in this example C=256.
Modern ISO C=261.63Hz

There are many ancient and modern interpretations of the correspondences between color and musical notes. This one is completely accurate and non-arbitrary because it is generated by frequency doubling the notes 41 times until we find them in the hertzian band of visible light.

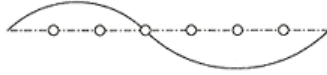


This knowledge may inexplicably have been in the hands of the ancients. In the ancient middle east Aries was given the color red, and in china this sign was given the note F. Same with leo, yellow for the middle east and A# for the chinese, and so on for the other signs/colors. - *Rephrased and quoted from "The Oldest Magic: A guide to the prehistory, ancient history, nature of and early influence of Music"*

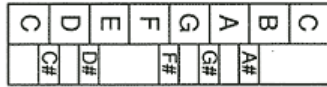


Even the biological cycles of a human life can be plotted as frequencies of embedded wave forms

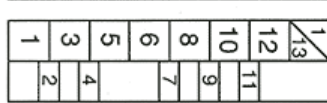
Are the Dimensions Harmonically Arranged According to the Laws of Musical Proportion?



Chromatic Scale
13 Notes

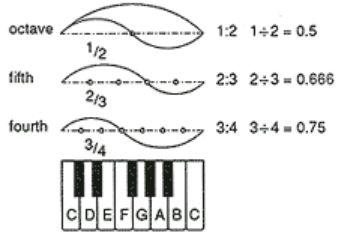


Octave
8 Notes



Pentatonic Scale
5 Notes

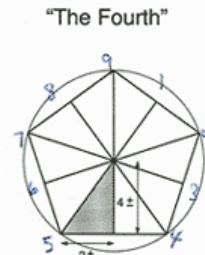
Dimensions



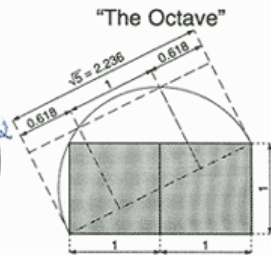
The Ratios of Musical Proportion



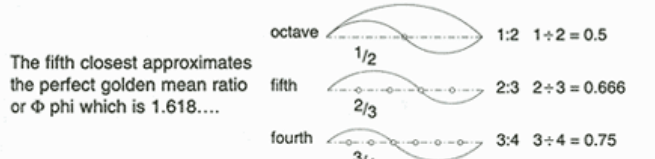
2:3 - corresponds to the sides of the pentagram's triangle, which approximates the ratio 2:3.
 $2 \div 3 = 0.666$



3:4 - corresponds to the sides of the pentagram's triangle.
 $3 \div 4 = 0.75$



1:2 - corresponds to a rectangle composed of two squares with a diagonal of 2.236, which is $\sqrt{5}$.

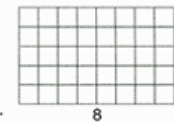


The fifth closest approximates the perfect golden mean ratio or Φ phi which is 1.618....

The black & white keys represent the ratios of musical proportion.

There are 8 white and 5 black keys.
 $8 : 5 = 1.6$ — $5 : 8 = 0.625$

The black keys are in groups of 2 and 3. The series 2 : 3 : 5 : 8 is part of the Fibonacci series. All these ratios come close to Φ , which is 1.618.



5 8:5 8 ÷ 5 = 1.6

Just as some of these dimensions and proportions are approximate (+ or -) values, it should be remembered that there is no "perfect" tuning for the piano. Variance is part of nature. If everything were numerically and geometrically exact, reality would be crystalized in time.

Most of this page is rephrased and quoted from "The Oldest Magic: A guide to the prehistory, ancient history, nature of and early influence of Music" except where noted.