

**A Summary of Sound Therapy
and
Vibrational Healing Concepts
Book I**

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May the sound of light surround us

May the light of sound guide us

May sacred sound come through us

For the Harmony of all

-

Jonathan Goldman
<http://www.healingsounds.com/>

Acknowledgments

The authors of this Summary acknowledge the contributions of Sharry Edwards to sound therapy in general and Human Bioacoustics in particular. Ms. Edwards has researched and publicized sound therapy for approximately twenty years. The co-authors have each participated in courses from Ms. Edwards in the past, as has Daniel Kunkel who provided “History of Sound Therapy” which influenced several sections of these Concepts.

Disclaimer

Neither the co-authors nor Ms. Edwards make any representations, warranties or implications regarding the accuracy or validity of any information contained herein. Sound Therapy is still in the early stages of development, and these concepts are understood to the degree that research studies and limited application can provide. These concepts are provided within the framework of ongoing research to promote professional discussion and advancement of sound therapy towards a science.

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A Summary of Sound Therapy and Vibrational Healing Concepts

Capsule History: over 2,500 years of recorded usage of sound and acoustic principles, since the time of Pythagoras, are described by numerous authors and researchers. Pythagoras is reported to have studied in the mystery schools of Egypt which passed down traditions from much earlier times in Sumeria. Throughout the 19th and 20th centuries, notable scientists and researchers such as Hermann Helmholtz, John Keely, Royal Rife, Albert Abrams, Hulda Clark, Robert Monroe, Robert Sewak and Barbara Hero, to name a few, have contributed their findings and described the common ideas and fundamentals of vibrational healing, *in the public domain*.

Paraphrase of a revealing idea: *If someone takes the work of another as their own, it is called plagiarism. If someone takes the work of many others, it is called research.* This later idea is exemplified in many scientific endeavors, but it is notably evident in some branches of sound therapy. This brief summary is intended to point out the origins of the fundamental concepts of sound therapy or vibrational healing and give credit where credit is deserved.

There are no totally new ideas under the sun, only rediscovery of ancient and/or universal principles. If we allow one person to claim or own the work of others who actually made the discoveries, then we set the stage to have the work withdrawn or destroyed. Hulda Clark displayed great insight and instinct in publishing her work before it could be confiscated by the same forces that destroyed Royal Rife, Albert Abrams and others.

The force of necessity always prompts those “under the gun” to make critical decisions. One could choose to ignore the threats and continue their course, or one could go into hiding, or one could take a defensive position hoping to ward off the threats and attacks. Generally, these ways of dealing with “the gun” have proven both costly and unsuccessful.

One could also go on the offensive, declaring the sources known to exist in the public domain to disarm “the gun”. By revealing the actual sources, technology can be discussed, independent evaluations can be made, and hopefully, technology can progress towards a scientific basis. This is the approach of the authors and others associated with sound therapy.

NOTE: by summarizing the ideas and principles of sound therapy, the authors are by no means suggesting that the reader simply take these ideas, hang out a shingle and begin practicing. In fact, considerable knowledge and experience should be acquired before one becomes a sound therapist or practitioner. Also, care needs to be exercised to maintain discretion in what is offered to clients (there are no cures) and how services are offered.

This summary is not meant to be a complete description of sound therapy. The intended audience is those who already have some knowledge base and are serious about working in sound therapy. Certain computer programs and databases will be briefly referenced, and these intellectual works are proprietary to the individual owners. *The ideas and principles of proprietary programs, as referenced from published public domain sources, are matters of general public knowledge.* The information that is presented herein comes from many different sources, and much of it is described by multiple authors and researchers. However, there has not been a comprehensive summary of this public domain information on frequency domain analysis that has been found in

any venue, not does one exist in private works. Further, this summary describes some research that has been performed independently by the authors that has not been previously published.

We suggest that this is a work in progress, and we welcome your comments and additions to this work. We are convinced that many others are working in various areas of vocal analysis and sound therapy. We have heard that significant research has been undertaken which has not been reported. We invite these researchers to contribute in any way they find appropriate.

References and Recommended reading:

1/ Dr. Scott-Mumby, Keith, 1999; Virtual Medicine: A new dimension in energy healing.

2/ Goldman, Jonathan, 1992. Healing Sounds: The Power of Harmonics.
http://www.healingsounds.com/catalog/healing_sounds.asp

3/ Andrews, Ted, 1992; Sacred Sounds: Transformation through Music & Word.

4/ Garfield-O'Brien, Lauren K. 1997; Bio-Resonance Therapy.

PART A:

A.1 Vibration is a primary force in the Universe and the basis of sound therapy:

- * Principle of Vibration – everything is in vibration or constant motion – Keely's Laws
- * Resonance – every substance on earth and every bone, muscle, organ and microbe in the body has its own resonant frequency.
- * The composite of the resonant frequencies in the body make up a signature vibration.
- * When the body frequencies are in harmony, the body is healthy; when body frequencies are out of harmony, dis-ease results.
- * Finding and balancing frequencies in the body re-establishes the rhythm or flow of energy in the body so that its natural processes can heal the body.
- * Sounds produced by the voice, instruments or electro-mechanical devices can be used to balance frequencies in the body.

These concepts provide the historical and presently accepted basis for sound therapy and vibrational healing. They were adapted from the four references shown above, although many authors describe the same principles.

A.2 History of Sound, ©Georgia Neff, Ph.D.

The arena that is being addressed involves the use of sound as a healing modality. Sound has been used since the most ancient of times in both individual healing and sacred performance. Within the last three decades of the 20th century the resurgence of various forms of sound healing has produced remarkable results. Sound, both as pure tones and as music, has been found to positively affect an astonishing array of physiological and psychological parameters. Among these are the equalization of brain waves, increasing the depth of breathing, slowing heartbeat and pulse, lowering blood pressure, reducing muscle tension, raising body temperature, increasing circulation and endorphin production, boosting immune function, improving memory and learning, decreasing clerical error, increasing endurance and productivity, strengthening digestion and decreasing depression (Campbell, 1997, p. 64) and, many others ailments and conditions.

Music therapist Don Campbell relates the following incident: the famous neurologist Oliver Sacks, testified before a U.S. senate committee on aging, that he had witnessed the effects of music on Rosalie, a patient with Parkinson's Disease. Rosalie was normally inert, with an EEG that indicated a comatose state. However, when Chopin's Opus 49 was mentioned to her, Rosalie, a pianist, would begin to change and as she played the music in her head, her motor activity became normal. If she was able to actually play the piano, she could play fluently for hours. Music therapy programs at universities and clinics around the world have become centers of a healing revolution using sound (Campbell, *ibid.*)

Sound therapies presuppose that the "music" of which we are made has become dissonant and discordant and that our natural ratios or harmonies have been shifted into disharmonies, i.e. ratios that do not support biochemical and/or structural integrity. Illness is seen as a result of this disharmony or lack of integrity. On this premise almost all kinds of sound therapies will agree.

The belief that sound can heal and is profoundly implicated in health has ancient roots. Pythagoras of Samos (600, BC) considered the father of western science, was deeply imbued with the belief that sound, and sound ratios, are the primary forces that hold physical reality together. The seven day week, and the seven note musical scale were direct results of his belief that the seven visible planets were in ratioed orbits that created specific harmonics. Those harmonics were believed to create a "music of the spheres". And his mathematization of astronomy through music was to lay the foundations of western science and result ultimately in the work of Kepler and Newton. Most importantly he believed that sound, audible and inaudible, had distinct effects on the health and emotional well being of humans. He prescribed particular music to calm and to balance biochemistry. In the early 17th century, Johannes Kepler would use Pythagoras' idea of geometrical ratios and the music of the spheres to develop his laws of planetary motions and finally accomplish the mathematical task of putting the planets in elliptical orbits around the sun.

Though scholars have commonly credited Pythagoras, as the first researcher into the origin of musical intervals, the decoding of the cuneiform tablets of ancient Mesopotamia (southern Iraq) has revealed that the Sumerians simultaneously developed cuneiform writing and a base-60 number system that allowed them to create "an extensive tonal/arithmetical model for the cosmos..." thousands of years before Pythagoras (McCain, 1994) The typical Eurocentric assumption had been that the

rationalistic Greeks refined nascent/primitive mathematical concepts that existed before, and made them more useful. But the decoded tablets yield a far different view, one in which the Sumerians created a far reaching allegory in which the physical world is known by divine mathematical analogy. In this allegory the gods gave divinity not only to natural forces, but to a "supernatural" intuitive understanding of mathematical patterns and psychological patterns (McCain, *ibid.*)

It has long been understood that Pythagoras' alleged experiments in musical intervals were seriously flawed. What is just coming to be understood is that a much more exact model of harmonic theory had predated Pythagoras by millennia. The author of *Musical Theory and Ancient Cosmology* (Ernest G. McCain) argues that from these Sumerian roots (and before), theology "is a mathematical allegory with a deeply musical logic." Using Sumerian base-60 numerics, the Babylonians (circa 1800 BC) developed a "formula for the square root of two accurate to five decimal places...or the formula for generating all Pythagorean triples...a thousand years before Pythagoras explicated the first one." (*ibid.*)

In McCain's exposition of the harmonic and arithmetic talent of the Sumerians and Babylonians, these adepts were themselves dependent on being "grounded in a common *aural (emphasis mine)* biological heritage, some of which we share with other animals, and are by no means dependent, as Aristotle noted, on precise numerical definition." (From a correspondence between McCain and musicologist William Thompson). Philosopher of science Karl Popper once remarked that our senses were theories about what it is important to attend to in the universe. McCain's researches put us in way of understanding that we emerge into our biological forms equipped to process the universe in terms of this "mathematical allegory with a deeply musical logic." What may seem a unique gift in some individuals may well be the underlying common *logos* of matter and being. "The scales on which music is based are not an arbitrary creation of man; they are formed on very definite patterns that are intrinsic to all nature" (*ibid.*)

McCain's article deals with the correspondence between music (as a pattern of intervals) and nature, including the psychology of humans. Particularly pertinent is the correspondence of the periodic chart (Mendeleev, Newlands, Doeberinger) to the musical octave and musical chords. In fact, the understanding of the overall arrangement of the chart came directly as an illumination of the elements being naturally musically arranged. Chemist John Newlands endured years of collegial ridicule when he expressed this repeating pattern as a "law of octaves." Mendeleev later extended this understanding of interval to the chemical properties of the elements and concluded that these "were the periodic functions of their atomic weights" (*ibid.*). McCain's article can be found at:

<http://www.new-universe.com/pythagoras/mcclain.html>

A modern astrophysicist, Trinh Xuan Thuan, has written that " *if the cosmos is vast it is by no means silent. Nature delights in continuously sending us her notes of music*". To understand this "music", in modern terms, is to understand that nature communicates to us in the language of wave patterns: sound waves, light waves, electromagnetic waves, etc. All these waves are on a continuum from lower frequencies to higher frequencies. The degree of frequency is how fast, or

often, something vibrates in one second. As chemist Donald Hatch Andrews put it in his book, "The Symphony of Life":

“The music of the universe is a cosmic symphony that embraces all the waves of sound audible and inaudible, all the waves of light visible and invisible, all the waves of gravity, felt and unfelt, and all the waves of atoms explicit and implicit. *Every scientific conclusion must be consistent with the harmonic (wave aspect) model of the atom* (author’s emphasis). Thus it begins to look more and more as if our universe is constructed not of matter but of music.” (in Harris, 2000).

Everything on the planet, living or not, is radiating frequencies. We know that this broadcasting of frequency is a primal form of communication. Before the specialization of eyes or ears, before olfactory organs, organisms locate and identify with frequency. We live in a sea of frequencies and we are composed, in essence, of frequencies. The structure of matter is a dynamic relationship of frequencies, which is to say, of *relative motion*. Astronomers speculate on the structure of a distant star based on the various band-widths of frequencies it is emitting and the *relationship* of those various frequency bandwidths. We are an arrangement of frequency constellations. Nuclear physics has been telling us this story for quite a while. To understand how one substance, or a group of substances, affects other substances is to understand the primacy of frequency constellations.

Also see <http://www.new-universe.com/pythagoras/mcclain.html> for additional history.

Some additional thoughts by Bill Meyer:

Sound therapy / vibrational healing as referenced in this summary can be described as a mix of harmonics theory, musical therapy and biofeedback. Sound therapy is directly related to harmonics and music by the use of combinations of sounds (frequencies), but it definitely is not music by any current standard.

***Some day, in the Future,
People will be
Cured by Sounds.
It will be very practical.***

...Master Phillippe of Lyon, 1898

Vibrational healing and sounds do not diagnose medical conditions, nor do they cure or heal diseases of the body. Sound therapy can be described as a noninvasive, energy-based alternative health approach to wellness.

Many types of vibrational healing in addition to sound therapy are being practiced around the world, including audiology (the Tomatis method), chanting, music, and vocal toning with many modalities in between. Even modalities that do not directly use sounds should also be included in the general category of vibrational healing, such as polarity therapy.

A.3 History of Sound, ©Robert Sewak, 1984.

This history is included in the BIO-RESONANCE THERAPY manual, Lauren Garfield-O'Brien, R.N., originally published 1997. [4/](#)

The use of music for healing may have originated more than 30,000 years ago. At that time illness was a great mystery, thought to be caused by an evil spirit that had to be expelled from the body and mind of the afflicted. Each member of the group or family, who was able to perform tasks within the group were extremely valuable. The onset of illness created a hardship for the other members, perhaps even to the point of jeopardizing the survival of the group itself. It was imperative, therefore, that the afflicted individual be returned to health as quickly as possible.

The earliest form of music healing was a wordless wailing, vocal chant that was mono-tonal and rhythmic, the rhythm being based on length of breath and heart pulse. Later, gourd rattles and drums were added for the spiritual powers attributed to them. The process must have been successful, for eventually, healing specialists began to emerge and became highly valued for their knowledge and skill. These individuals were called upon to lead healings and other rituals. Before long, all-important occurrences in tribal life were solemnized with sacred rites in which music and dancing played a central role, under the direction of the specialist.

The development of the long tradition of Shamanism evolved and is still practiced today in some parts of the world. The prevailing musical characteristics of shamanistic healing songs are the irregularity of accent and unexpected interruptions of a steady rhythm. The singing is mostly mono-tonal and is sung without emotion. The rhythm attracts the attention of the patient and may be hypnotic in effect, for one of the purposes of the healing song is to quiet the patient emotionally.

The use of sound in healing is an ancient practice, which has been utilized since before the beginning of recorded history, with remarkable results. Sound healing was regarded as an effective and acceptable healing modality until the advent of modern medicine 150 years ago. When we entered the Industrial Revolution, our society underwent a major change, and the medical community underwent a major shift. With the discovery of the chemicals and technology that made surgery possible, voice, sound and music healing was progressively forced into the background and urged into disregard.

The process of healing with sound works because of its ability to calm the mind, by suspending much of the normal day to day conscious activity. During a relaxed state, one is able to access the deep realms of consciousness, which allows the subconscious part of the mind to activate and re-energize (harmonize) disruptive conditions. Conversely disruptive, disharmonious sound can disorganize thought processes and create a tense, disharmonic state in the body.

It should be noted that the understanding of vibrational healing (and all) concepts tends to improve with time. We speculate that some of the conclusions formed from the concepts described herein might be in excess of what the stated researchers actually knew or intended. We have today a broad scope of information, which when taken together, forms a more complete picture of the relationships and interactions of harmonics, music and bio-frequencies than was likely known 50, 100 or more years ago. WLM

A.4 Bioinformatics, Sound Informatics and Computer Skills

Bioinformatics as applied to sound therapy is a scientific discipline that uses vocal recordings as a basis to understand the energy patterns related to human biology. In a more strict sense, bioinformatics is a subset of the larger field of *computational biology*, which applies quantitative analytical techniques in modeling biological systems. *Sound informatics* may be a better phrase to indicate the more limited scope of bioinformatics that is commonly applied in sound therapy.

As a suggestion, the reader is encouraged to perform a Yahoo search on “Bioinformatics”. The number of references to web pages is huge, but it illustrates the amount of interest in this subject, which you may not have on the tip of your tongue.

One of our goals in this and following documents is to summarize a range of concepts and techniques we believe are needed to understand and apply the basic computational tools that are available today. We will introduce the idea of databases for bio-frequencies and other types of data, computational approaches to acoustical problems, data mining, data visualization, and tips for working with data analysis to meet individual sound therapy needs.

The main goal of sound informatics *is not* developing the most elegant or sophisticated analyses; **the goal is *finding out how living things work*** as represented by frequencies in the human voice. All of this technology presents a logical foundation to selectively determine the “points” that reflect underlying energetic health issues and to look for patterns in dynamic sets of data.

The application of sound informatics contains potential pitfalls for those who look for patterns and make predictions without a complete understanding of where acoustics data comes from and what it means. By providing analytical tools, databases, user interfaces, and techniques, sound informatics makes it possible to do exciting things such as determining bio-energetic issues and balancing frequencies that are potentially significant to a client. "**Potentially significant**" is perhaps the most important phrase, because these tools also provide an opportunity to over-interpret data and assign meaning where it may not exist.

Computer science and sound informatics are only tools to analyze vocal frequencies. These tools need to be fully understood to prevent the potentially significant from becoming the potentially harmful. Experience and the availability of technical forums for continued discussion and learning are vital to the success of sound therapists. No single person can be expected to be the “all-knowing guru” for the wide range of knowledge needed in sound therapy and research; many good minds are needed to share their findings and to work together for the benefit of all.

Basic computer skills that are required for sound informatics include being able to

- * work with the Windows or another operating system,
- * work with standard word processing and spreadsheet applications (e.g., Word, Excel),
- * manipulate files and different computer media, and
- * work with audio interfaces.

These basic computer skills can not be properly learned at the same time as a sound therapy system. Reasonable computer skills need to be learned before sound therapy.

A.5 Misinformation and Public Domain

There have been claims of *trade secret* for various principles and information contained herein. It is the authors' contention that:

- (1) the status of public domain information precludes any claim as a trade secret for all such published information;
- (2) once material is publicly disclosed (published), it loses any status it ever had as trade secret;
- (3) one person cannot claim information discovered by others as private Intellectual Property by coining different terms for the ideas or placing a copyright notice on the work of others.

Also please remember that copyrights on published work DO NOT confer ownership of the ideas that are contained in the work to the author – only valid patents confer such rights. Copyrights on published works are deemed appropriate to protect the investment by authors to create the work.

All information presented herein was acquired directly from the public domain and published sources or from the authors' own research.

This information WAS NOT obtained by any illegal or improper means, nor was it taken from disclosures in any legal discovery process.

Further, the concepts and information in this Summary ARE NOT covered by any existing or pending patent.

Sources of the information are noted, but most concepts have been described by multiple authors.

Further, it is a contention herein that the use of confidentiality agreements can not be applied to public domain information in an attempt to restrict the discussion of public issues. Various issues have been adjudicated over a number of years, and these issues “*have been resolved to the satisfaction of the parties involved*”, as documented elsewhere.

NOTE: The above contentions in themselves are neither legal advice nor an invitation to “out” anyone’s real trade secrets, but are stated here only for the record. Please consult a legal professional if you have any doubt about your right to reveal or use information.

This document contains copyrighted material the use of which has not always been specifically authorized by the copyright owner. We believe the statements and ideas contained herein constitute a 'fair use' of any such copyrighted material as provided for in section 107 of the US Copyright Law. For more information go to <http://www.law.cornell.edu/uscode/17/107.shtml>

These Concepts papers are also being published on the Yahoo Group TRUTHsound, which exists as a forum where those who are interested in any aspect of vibrational healing / sound therapy can share technical ideas, information, and comment on the work of others. If you're interested, you can subscribe by sending an email to:

TRUTHsound-subscribe@yahoogroups.com

One of the purposes of TRUTHsound is to promote discussion of the public domain concepts of sound therapy. We want others to know that we are truly talking about public issues, and that the discussion of these issues should benefit individual understanding as well as sound therapy. It is hoped that others will contribute some of their thoughts and ideas to extend these Concepts.

When William Meyer began his training in sound therapy in May of 2001, no reference manual existed for the course. Initially, a notebook was pieced together with bits of key information for private use. It was not known at that time that the vast majority of the information was publicly available, even though it was asserted to be both confidential and proprietary. Some of this information forms the basis for these Concepts papers.

This public domain information has been the subject of considerable legal maneuvering through the seven-year period ending with the July 21st, 2003 settlement of a lawsuit in Athens County, Ohio. The court docket for this long and complex case may be viewed at the following website: <http://www.athenscountycpcourt.org/> - click on the gold "Press Here" button then click on the "Docket Sheet" link and enter 97CI000264 in the box. Towards the bottom of this lengthy court record, look for the **07/21/03** entry "**JOURNAL ENTRY OF SETTLEMENT . . .**"

A considerable amount of the technical documents that were obtained from the public domain and filed with the court in May 2002 have been sealed. The plaintiff's lawyer used an obscure part of the Ohio law which allowed the plaintiff to "allege" that this public domain information contained trade secrets, without having to substantiate any allegation. The local Judge who heard the case sealed the copies of documents containing widely available concepts without allowing arguments concerning what was in the public domain.

Allegations about the "confidential/trade secret" status of widely available public domain concepts are still being made by the plaintiff in the above court case. As one lawyer has recently stated "***There should be no dispute with the general rule of law that once material is publicly disclosed, it loses its status as trade secret?***", and it was also stated that "***to assert that [plaintiff] has trade secret protections for information that has been previously disclosed publicly is frivolous.***"

These Concepts papers carefully and repeatedly document the sources for the information that has been used in these publications. This documentation of source data clearly demonstrates that the information utilized came from sources that are readily available in the public domain.

It should be noted that certain textbooks have been filed in the U.S. Copyright Office. It must be stated that a copyright registration does not create confidentiality or trade secret entitlements to the information contained in the copyrighted publication.

The transcribed text of the Athens County court case 97CI000264 is available on the Internet, at the following website: <http://www.biowaves.com/Sharry-Edwards/Sharry-Edwards.cfm> - click on the link "[The Final Settlement](#)" about half way down in the initial page.

NOTE: The above contentions in themselves are not legal advice, and the authors are not lawyers. These statements are made here only for the record. Please consult a legal professional if you have any doubt about your right to reveal or use information.

Part B: Frequencies and Sound Therapy

B. Frequencies and Sound Therapy sections:

1. Alfred Partheil's formula relating atomic weight and frequency
2. Use of a reference octave – Beta brain waves
3. Biochemical compounds – the Merck Index
4. Muscles and organs – kinesiology and various authors
5. Pathogens and toxins – H.Clark and Internet databanks
6. Genomes – C. Boehm and the Genome-Frequency Method
7. CAFL – Consolidated and Annotated frequency lists
8. Special frequencies – Royal Rife and Schumann resonance

References for Frequencies and Sound Therapy

4/ Garfield-O'Brien, Lauren K, R.N., 1997. Bio-Resonance Therapy.

5/ Oschman, James L., 2000. Energy Medicine: The Scientific Basis. Churchill Living stone, an imprint of Harcourt Publishers Limited.

6/ van Spronsen, J.W., 1969. The Periodic System of Chemical Elements - A History of the First Hundred Years

7/ Becker, Robert O., M.D., 1990. Cross Currents : The Promise of Electromedicine, The Perils of Electropollution

8/ Clark, Hulda, Ph.D., N.D., 1995. The Cure for All Diseases

9/ Silver, Nina, Ph.D., 2001. The Handbook of Rife Frequency Healing

10/ Kunkel, Daniel, 2001. The Sound – Quantum Connection; paper presented at the 2001 U.S. Psychotronics Association annual conference.

11/ The Merck Index, 12th Edition, 1996.

12/ <http://www.lunarsight.com/biblio.htm> Bibliography of Brainwave Frequencies: this is an extensive reference list with internet links from A to Z. on vibrational therapies.

Additional Information and Citations

Significant background information for frequencies is presented in James Oschman's book on Energy Medicine, 5/, chapter 3 on *the circuitry of the body* and chapter 4 on *the living matrix: five views*. These chapters are recommended reading, and it should be noted that this book contains an extensive list of references with each chapter.

The following is quoted from 5/ Oschman, page 87:

Definition and hypotheses

'Healing energy', whether produced by a medical device or projected from the human body, is energy of a particular frequency or set of frequencies that stimulates the repair of one or more tissues.

Oschman, James L., 1997. What is healing energy? Journal of Bodywork and Movement Therapies 1(5): pp.297-309

See also:

Boehm, C., 1999. A Look at the Frequencies of Rife-related Plasma Emission Devices.

Lakhovsky, Georges, 1939. The Secret of Life. Heinemann Medical, London
Also: <http://educate-yourself.org/be/lakhovskyindex.shtml> and US patent # 1,962,565.

Rife, Royal R. <http://www.rife.org>

Sisken B.F. and Walker J., 1995. Therapeutic aspects of electromagnetic fields for soft-tissue healing. In Electromagnetic fields: biological interactions and mechanisms. Advances in Chemistry Series 250, pp. 277-285.

Szent-Gyorgyi, 1941. Towards a new biochemistry? Science 93: pp.609-611 (also published in 1941 as: the study of energy levels in biochemistry.)

Kepler, Johannes, 1571-1630. The Laws of Planetary Motion
<http://csep10.phys.utk.edu/astr161/lect/history/kepler.html>

Part B: Frequencies and Sound Therapy

The fact that **each body is a unique energy system** is now accepted by the most conservative and orthodox members of science and conventional medicine. Some common applications that measure the emission and absorption of different wavelengths of light (frequencies) of this personal energy system include Electrocardiograms (EKG's), Magnetic Resonance Imaging (MRI's), sonograms and other spectroscopic methods used for medical diagnosis.

However, even though the presence of the body's energy system is accepted, the implications of manipulating this energy system through vibrational therapies such as sound and light have a long way to go in being accepted by the orthodox sciences. It should be noted that one medical application of frequency therapy is being used to treat various bone problems and fractures using pulsed EMF: <http://users.med.auth.gr/~karanik/english/articles/emf2.html>

The results of numerous research studies by biomedical scientists using spectroscopic methods have validated what bodywork and movement therapists have long known:

"The human body emits vibratory information that precisely specifies the activities taking place within." *5/ Oschman, page 140*

This vibratory information is measured as frequency, the number of cycles per second that the substance vibrates. The technical name for frequency measurement is Hertz. Every substance on earth and every bone, muscle, organ, vitamin, mineral, enzyme and microbe has its own resonant frequency. Otherwise, the spectroscopic diagnostic methods mentioned above would not work.

"Every human molecule has a particular corresponding musical frequency; and masses of particles behave and maneuver among themselves as if they were musical notes on the chromatic scale." ~ Joel Sternheimer, from his article, "The Music of the Elementary Particles"

The frequencies of substances have been determined by many different methods, **some which are open to question**, by many different people. One commercially available database of frequencies is the Nutritional Sounds DataBase™ from Carl Parker. This collection of frequencies and cross-referenced data was **developed from hundreds of sources** over an extensive period of time and is regularly maintained. The sources of this information are identified. Parker's website is <http://www.nutritionalsounds.com/>

The Nutritional Sounds DataBase™ was originally created as a companion to a voice analysis software program, and it is still used in Biosonic software. However, it is now also an excellent stand-alone program that can be used with or without the frequency associations. Another database, the BioWaves Nutritional Assistant, also contains frequency associations and nutritional cross-references that are available at the touch of a button. The search feature allows you to find all associations to specific items not already cross-referenced for you.

Access to a database containing the frequencies and/or molecular weights of biochemical and nutritional substances is a key component and reference for voice frequency analysis. This function has been incorporated into commercial computer programs, as described in a later section. We make no claims for the usefulness or applicability of the following types of frequencies.

It is not possible to include an exhaustive list of all individuals who have made and are making significant contributions of frequencies related to sound therapy in a summary of this type. What we are trying to indicate is that a considerable amount of work has been performed by a large number of individuals, many working alone or in small teams, over a long period of time.

ROYAL RIFE should be considered one of the fathers of vibrational (frequency) healing. By the mid 1930's, Rife had found and documented frequencies which would devitalize many of the illnesses of his day, using a plasma tube device in conjunction with his Universal Microscope. He had considerable success with cancer clients, which unfortunately put him in harms way with the entrenched medical establishment. There is considerable difference in the delivery of sounds between using a plasma tube device (frequency therapy) and using speakers or headphones (sound therapy). See additional Rife history at <http://www.dfe.net/RifeHist.html>

CYMATICS therapy was developed by Dr. Peter Guy Manners, a British medical doctor, in the 1960s. The therapy grew out of early research into electromagnetic energy and the concept that every living thing – person, animal, plant or organism – is surrounded by an energy field that resonates at its own particular frequency. Professor Gaveau of the Sorbonne in Paris, Dr. Brunner from Germany, Dr. Harold Burr from Yale University and Swiss scientist Dr. Hans Jenny were all involved in this research. Dr. Manners developed sets of five harmonically related tones to treat (resonate) parts of the body using a special device, the Cymatic Instrument..

HEMI-SYNC: The Monroe Institute was founded by Robert A. Monroe, and it is internationally known for work with audio sound patterns that can have dramatic effects on states of consciousness. Monroe observed that certain sounds create a Frequency Following Response in the activity of the brain in his early researches circa 1950. Hemi-Sync works by sending different sounds (tones) to each ear using stereo headphones. The two hemispheres of the brain then act in unison to “hear” a third tone, the difference between the two tones supplied through headphones.

TOMATIS METHOD: some 40-50 years ago, French physician Dr. Alfred Tomatis made some significant discoveries which are the basis of a therapy used by audiologists throughout the world. Dr. Tomatis discovered that when your ears cannot hear certain frequencies, your voice does not contain them either. Dr. Tomatis postulated that if we modify the hearing, the voice changes immediately, and he developed a device to train people to hear and listen better.

B.1 FREQUENCY AND ATOMIC WEIGHTS : Alfred Partheil (1861-1909)

One problem that arises in studying the vibrations of substances is that the reference measurements are in terms of atomic or molecular weight, not as frequency. Dr. Partheil, professor of pharmacy at Konigsberg, studied the relationship between music and the periodic table of elements. From [6/ page 201](#), on The Periodic system and music: "Dr. Partheil made a most remarkable and interesting discovery, i.e. that of a connection between the harmonic relationships of the spectral lines of the elements and the wave numbers of the tones of the musical scale." Partheil discovered that the spectral lines were in proportion to the atomic weights which established that **atomic weight and frequency of tones were equivalent**

From page 203: "The atomic weights of the first and the last elements, hydrogen and uranium respectively, when multiplied by 16

$$1.008 * 16 = 16.128$$

$$238.5 * 16 = 3816$$

are indeed almost equal to the vibration numbers of the sub-contra C = 16 and the B 4 = 3840, respectively. These numbers apply to pure tuning. In this the B is the harmonic 15th. The divergence of the vibration numbers from the atomic weights multiplied by 16 are less than the differences between them and the corresponding vibration numbers in the equal temperament. In the twelve-tone system (A=440, C2=16.5) the vibration number of C2 = 16.165 and of B4 = 3906.168."

Simply stated,

$$\text{Frequency} = \text{atomic weight} * 16$$

B.2 Use of a reference octave – Beta brain waves

"Brain waves are rhythmic fluctuations of electro-chemical potential between parts of the brain, mediated by neurons, chemicals, and hormones. The electro-chemical range of the brain is between .05 to 32 hertz. The typical human ear is described as not capable of hearing frequency below 14 hertz. Giving frequency below 14 hertz is not recommended due to problems with accurate reproduction"; [4/ page 20](#).

Table of brain wave octaves : [4/ page 20](#) and M. Gonzalez Sterling

<u>Frequency range</u>	<u>brain waves</u>	<u>affects on the body</u>
0 – 2 Hz	Omega	bio-magnetic
2 – 4 Hz	Delta	bio-electric
4 – 8 Hz	Theta	chemistry and nutrition
8 – 16 Hz	Alpha	emotions
16 – 32 Hz	Beta	muscles, organs and structure
32 – 64 Hz	Gamma	environmental sounds

Note that the Beta brain waves have been defined from 14 or 16 up to 30 or 31 Hz. The regular octave definitions are used above, in which each successive octave is a factor of 2 greater than

the preceding octave, corresponding to musical octaves. This table of brain waves has been researched and published by many people in the neuro -sciences throughout the 20th century.

In studying frequencies for vibrational healing, **the octave from 16 to 32 hertz, belonging to the Beta brain waves, is generally used as a reference octave**. It is stated in various references that frequencies up to 100 hertz are best suited for entraining the brain to desired energy patterns, and this range of 0-100 is called Extremely Low Frequencies or ELF; [7/ page 237](#).

It should be noted that some Neuro-acoustic researchers classify Beta brain waves to be in the range of 14 to 100 Hz. Since this range covers several octaves, it isn't convenient for reference purposes, but it is worth noting.

There is a formula commonly used in physics and music to represent a frequency by a higher or lower octave. That way we can take the sound of the planets as Kepler did, just by taking the time they take to circle around the sun converting it into seconds and then reducing that through an octave shift to any desired audible octave. This idea was expressed by David Bilary in 1978, but it has been expressed for hundreds of years by many authors.

OCTAVE SHIFT: to reduce any vibration (frequency) to another octave, just **multiply by 2 to go up an octave -or- divide by 2 to reach a lower octave**.

This octave shift process has also been described in patents dating back to at least 1984, but as a simple formula it is not patentable. See Joel Sternheimer's international patent on "Method for the Musical Modeling of Elemental Particles and Applications", Aug. 1984; patent [WO8403165](http://12.espacenet.com/espacenet/viewer?PN=WO8403165&CY=ep&LG=en&DB=EPD) <http://12.espacenet.com/espacenet/viewer?PN=WO8403165&CY=ep&LG=en&DB=EPD>

The frequency of an element or a compound of known molecular weight can therefore be reduced to the Beta brain wave octave (16 to 32) by successively dividing by two until the desired range is reached. It should also be noted that 16 is a power of 2 (or 2⁴), which means that Alfred Partheil's formula can be simplified for ease of use as follows:

frequency is equivalent (actually directly related) **to molecular weight**

Einstein expressed this same idea that mass and energy are interchangeable in his famous equation, $E = mc^2$ or by substitution where $e=hf$, $mc^2 = hf$, showing how **f**requency and **m**ass are related was originated by Louis de Broglie; c and h are constants. It is interesting to note that the de Broglie and Partheil equations are related by the musical fifth when constants are applied and reduced in octaves [10/ Kunkel](#); there will be more on this in section D.

The following Internet link is an informative website on Octaves in Light and Sound -- <http://www.cosmicharmony.com/Ha/HAmain.htm>

B.3 Biochemical compounds – the Merck Index and Alfred Partheil

The Merck Index is an encyclopedia of chemicals, drugs and biologicals which is published by the Merck Research Laboratories. This 2600 page encyclopedia is used by scientists, biochemists, pharmacists and sound therapists. The Merck Index began in 1889 and is in its second century of publication. This standard reference is also available in a computer CD form.

Using the relationship between molecular weight documented by Alfred Partheil above, any substance in the Merck Index can be converted to a frequency in the Beta octave for terms of reference using the octave shift process. This procedure is commonly used to create searchable databases for use in sound therapy.

There are a few substances in the Merck Index that are listed in terms of Daltons. These values are approximate weights, and are subject to variation. “The terms molecular weight and Dalton are used interchangeably. For example, a 20,000 Da protein has a molecular weight of 20,000. A Dalton is a unit equal to 1.0000 on the atomic mass scale; this unit is very nearly equal to that of a hydrogen atom.” <http://fig.cox.miami.edu/~ddiresta/bil256/sds.htm>

The following table shows Partheil’s research findings. Notice that he is using the values for the elements as they were known in his time. <http://www.biowaves.com/Research/Partheil.cfm>

<i>Element</i>	Atomic	Atomic	Pitch	Vibration	Musical
	Weight	Weight*16		Number	Note
Li	7.03	112.48	# A - 1	112.5	A
B	11	176	# F 0	177.7	F
C	12	192	G 0	192	F#
O	16	256	C 1	256	C
Na	23.05	368.8	b G 1	368.64	F#
S	32.06	512.96	C 2	512	C
Ca	40.1	641.6	E 2	640	E
V	51.2	819.2	b A 2	819.2	G#
As	75	1200	# D 3	1200	D
Br	79.96	1279.36	E 3	1280	E
Sb	120.2	1923.2	B 3	1920	B
Hg	200	3200	# G 4	3200	G

The Twelfth Edition of the Merck Index contains 10,330 monographs on chemicals, drugs and biological compounds. Each monograph defines the chemical composition, the molecular weight and relative composition of elements, physical data, literature references, alternate names, use, and therapeutic categories if applicable. This wealth of information defines most of the chemical compounds that are of interest in sound therapy, and a sample of information is shown below:

Sodium Chloride. “Salt; common salt. NaCl; mol wt 58.44 Cl 60.66%, Na 39.34%.”

Various information on physical characteristics and literature references is included.

USE: “Natural salt is the source of chlorine and of sodium and practically all of their compounds ...”

THERAP CAT: “Electrolyte replenisher; emetic; topical anti-inflammatory.”

THERAP CAT (VET): “Essential nutrient factor. May be given orally as emetic, etc.”

[An emetic is a substance used to induce vomiting.]

Note: the information above is a small extract of what the Merck Index contains.

Using Octave Shifting (reduction), you can obtain a reference octave or Beta brain wave value of sodium chloride of 29.22 (58.44 / 2).

It should be noted that the Merck Index does not necessarily contain all the information that will be useful in sound therapy applications. For example, sodium chloride is a cell salt which is an essential nutrient and electrolyte in the body. It is one of twelve such cell salts that the body requires for normal growth and maintenance. A good reference for cell salts is *The Biochemic Handbook*, now published by Formur, Inc. This small paperback book is in its 37th printing since 1970.

The Merck Index is lacking in information about enzymes. There is a cross reference titled the Therapeutic Category and Biological Activity Index, THERAP. CATS, towards the back of the volume. It contains references to about twelve enzymes, while the body uses and produces tens of thousands of enzymes. One enzyme listed in the Merck Index is Amylase.

Amylase. “Enzymes catalyzing the hydrolysis .. of polysaccharides such as glycogen, starch, or their degradation products.” [*Sorry; you’ll just have to look up some terms.*] Several forms of Amylase are listed which each have different molecular weights: β -Amylase (sweet potato), mol wt ~152,000 *but what is the relation of this form of amylase to or the use in the human body?*

A good source of general information on enzymes is the book by Lita Lee, PhD and Lisa Turner, *The Enzyme Cure: How plant enzymes can help you relieve 36 health problems*, 1998. There are a number of sources on the Internet for enzyme information, and there is very accurate enzyme information available in certain molecular biology databanks. However, this is an area in which some professional knowledge should be used. Discussion on enzymes is invited in public forum.

See also <http://us.expasy.org/>

B.4 Muscles and organs – kinesiology and various authors

A list of muscle frequencies can be found on the Yahoo Biosonic group site. This list is in the *Files* section. It was determined through the use of kinesiology, and it first appeared in the published volume on Clinical Kinesiology by Dr. Alan Beardall developed in the 1950 's.

The list of muscles appeared on the Biosonic YahooGroup site in mid 2000, and it is in terms of the actual frequencies determined from kinesiology research by Dr. Beardall. These Frequencies range from about 50 hertz for the areas at the top of the head, all the way to 975 Hz for at the feet area. These frequencies can easily be converted to a frequency in the Beta octave for terms of reference using the octave shift process, repeatedly dividing by two.

<http://groups.yahoo.com/group/biosonic/files/MUSCLE%20FREQUENCIES.doc>

Organ frequencies: Barbara Hero

Barbara Hero has published a number of frequencies of the organs of the body. These were available from her older website, <http://members.aol.com/Lambda3/Chakras.html>

NOTES AND FREQUENCIES OF THE ORGANS OF THE BODY	
ORGAN	FREQUENCY/NOTE
BLOOD	321.9 (E)
ADRENALS	492.8 (B)
KIDNEY	319.88 (Eb)
LIVER	317.83 (Eb)
BLADDER	352 (F)
INTESTINES	281. (C#)
LUNGS	220 (A)
COLON	176 (F)
GALL BLADDER	164.3 (E)
PANCREAS	117.3 (C#)
STOMACH	110 (A)
BRAIN	315.8 (Eb)
FAT CELLS	295.8 (C#)
MUSCLES	324 (E)
BONE	418,3 (Ab)

NOTE: Barbara Hero now has her own website: www.lambdoma.com

Also see Bruce Stenulson's Normalizing and Stimulating Frequencies list at <http://stenulson.net/althealth/stimfreq.htm>

B.5 Pathogens – H.Clark, Ph.D.,N.D.

Dr. Hulda Clark has vigorously studied the work of Royal Raymond Rife, who successfully eliminated cancer and other diseases using an electronic device he invented that emitted specific frequencies. Rife also measured the frequency range for a host of pathogens including bacteria and viruses. The theory proposed is that a pathogen will be killed when exposed to its own frequency. Dr. Clark's work and website are under attack from the FDA, who would like to limit public access to this valuable information.

Hulda Clark has researched and published frequencies for many pathogens. These frequencies were originally contained in her book **The Cure for All Diseases**. These frequencies have been accessed from Dr. Clark's Internet site www.drclark.net .

These frequencies are given in kilohertz (1000's of hertz), which must be kept in mind when converting to a frequency in the Beta octave.

Please note: "It is important to keep in mind that while at any point in time pathogens may be killed by a frequency, **this is not a permanent solution**. In other words, the blood and body are constantly inviting or reproducing pathogens so zapping is only one part of Hulda Clark's ongoing protocol to help the immune system overcome pathogens and allow the body to rebuild health." <http://www.sharinghealth.com/researchers/clark.html>

Toxins – Internet and Commercial Databases

The Merck Index contains many toxic substances, as does the Nutritional Sounds and Sound Assistant databases. Some useful Internet sites to access toxin information are:

<http://toxnet.nlm.nih.gov/> databases on toxicology and hazardous chemicals

<http://www.cdpr.ca.gov/> California Department of Pesticide Regulation

<http://www.cdpr.ca.gov/docs/label/labelque.htm#regprods> Pesticide database

<http://www.epa.gov/superfund/resources/chemicals.htm> Chemicals Found at Superfund Sites

<http://www.hclrss.demon.co.uk/index.html> ISO names and formulas of chemical pesticides

<http://www.cdc.gov/niosh/npg/npgd0000.html> NIOSH Guide to Chemical Hazards

Some skepticism should be applied to any and all sources of frequencies to be used in sound therapy. Some questions that need to be asked are whether or not any detailed testing has ever been conducted and whether there is any documentation or anecdotal evidence to support use of any particular frequency in sound therapy.

B.6 Genomes – C. Boehm and the Genome-Frequency Method

The initial calculation procedure for converting genome information into frequencies was created by Charlene Boehm. The process has been submitted, and it is under patent pending status. Charlene Boehm's information was originally published with a database of frequencies on the Internet, but it has since been withdrawn to accommodate new research and updating. It is believed that the genome information from Boehm's original database was included in at least one proprietary voice analysis computer program without her knowledge or permission, which is contrary to stipulations in her original copyrighted paper.

The use of genome frequencies has not been documented by publicly reported research known to the present time (September 2003), and the use of existing genome frequencies would therefore seem to be questionable. The genome frequencies were not intended to be used with typical audio equipment (speakers), but with frequency plasma devices.

The scientific community in conjunction with NIH maintains a databank of genome information which is directly available to the public, although it does not contain frequencies directly. The Internet site is: <http://www.ncbi.nlm.nih.gov/Sitemap/index.html#Databases>

B.7 CAFL – Consolidated and Annotated frequency lists

The Consolidated Annotated Frequency List was Compiled by turf@electroherbalism.com. The recent version from the site was dated 6/01/2003. This list is taken from many sources and it is included here for reference purpose. It does indicate the amount of interest and effort that has been invested in determining frequencies.

<http://www.electroherbalism.com/Bioelectronics/FrequenciesandAnecdotes/>

The page above contains several links including the CAFL. Be sure to read the Introduction to Frequencies and Anecdotes section. It must be stated that the CAFL is a mixed bag of anecdotal frequencies by both serious researchers and hackers – use these frequencies with caution.

B.8 Special Frequencies

Rife frequencies – Royal Rife was a unique individual who experimented with using electromagnetic fields at certain frequencies to treat various illnesses. The frequency set of 20 HZ, 727 HZ, 787 HZ, 800 HZ, 880 HZ, 5000 HZ, and 10000 HZ were used for general treatment across the board, and other frequencies were then added to treat specific conditions.

While Rife's frequencies were generated using electromagnetic means - some of the "mental state" entries for Rife may work using a sound medium, since brain wave entrainment can be done with any periodic phenomena, whether it be light [strobe lights], sound [ocean waves, binaural beats, etc.], EM fields [from appliances], vibration [like massaging devices], or even motion [rocking a baby to sleep]. These mental state frequencies are not actually part of Rife's work.

The Handbook of Rife Frequency Healing by Dr. Nina Silver: “This meticulously researched book examining the discoveries and inventions of Royal Raymond Rife provides new and ample

documentation to lend credence to his theories. In addition, Dr. Silver's supporting information on a variety of wellness issues is fascinating. ”, Phyllis A. Balch, CNC and author of Prescription for Herbal Healing and Prescription for Nutritional Healing. The first copyright form for Silver’s book says it was completed in 1998, and it was distributed with a frequency device.

Schumann resonance - A simple definition – EM (electromagnetic) field generated by the earth's atmosphere when it's struck by energy from the sun - it can entrain brainwaves much as EM fields from appliances can, in theory. Here's some additional information.

A resonant cavity is formed between the ionosphere and the earth. Energy from the snap, crackle and pop of lightning all over the earth or other sources may excite this natural resonator to ring at about 8 Hz. <http://www.altair.org/natradio.htm>

The Schumann Resonances are actually observed by experiment to occur at several frequencies between 6 and 50 cycles per second, specifically 7.8, 14, 20, 26, 33, 39 and 45 Hertz, with a daily variation of about +/- 0.5 Hertz. <http://www.innerx.net/personal/tsmith/Schumann.html>

7.83 is the strongest Schumann resonance, <http://www.danwinter.com/schumann/schumann.html>

Additional information on *Schumann’s Resonances and Human Biology* by Richard Miller and Iona Miller can be found at the Nexus website, <http://www.nexusmagazine.com/Schumann.html>

It must be stated in the strongest terms that except for genomes which have been withdrawn, the frequency sets described above are public domain. Many of these public domain frequencies are contained in proprietary software, but this information is not “owned by” or “trade secret to” any individual.

There are differences (discrepancies) between the various software systems, and some significant errors are known to exist in at least one software database.

We have reported the original sources thought to have been most influential in the creation of frequencies that are reported in the public domain. We make no comment about others who claim ownership of similar frequencies, particularly those who offer no evidence of research efforts actually “doing the work”. In addition, there are many people not mentioned above that have contributed to the databanks of frequencies.

Sharry Edwards, founder of Sound Health, has widely proclaimed that she has special hearing and speech abilities which are the basis for some proprietary frequencies that are unavailable to the general public. One has to sign a most restrictive agreement before being accorded access to any of Edwards’ proprietary and/or trade secret frequencies.

PART C: HARMONICS

C. Harmonics Sections

1. Introduction
2. Principle of Octaves and octave harmonics
3. The Lambdoma matrix – Barbara Hero
4. Overtones and Undertones within an octave
5. Resultant tones

It is highly suggested that some familiarity with basic acoustic principles and the physics of sound is needed before reading the following sections on harmonics and musical scales. The following Internet sites may be accessed for these basic principles:

Dale Pond's **Basic Acoustic Principles** <http://www.svpvriil.com/basicac.html>

BioWaves' **Physics of Sound and Light** <http://www.BioWaves.com/Physics/SoundPhysics.cfm>

References for Harmonics Concepts

13/ Goldman, Jonathan, 1992. *HEALING SOUNDS : The Power of Harmonics* (paperback).
See in particular chap. 2, Science of Harmonics and chap. 7, Harmonics and Healing..

14/ Hero, Barbara, 1994. *A Brief History of the Lambdoma*; now a chapter of the book “The Lambdoma, Resonant, Harmonic Scale; pp. 133 – 146.

15/ Hero, Barbara, 1992. *Lambdoma Unveiled*. see also www.lambdoma.com

16/ Pond, Dale, 1990. *Universal Laws Never Before Revealed: Keely's Secrets*

17/ Pond, Dale, 1990. *It Really is a Musical Universe*. <http://www.svpvriil.com/>

18/ Helmholtz, Herman 1954 republication of 1885 edition. *On the Sensations of Tone*

19/ Tomes, Ray, Nov-94. *Harmonics Theory Overview*; Reference: RT103.
<http://homepages.kcbbs.gen.nz/rtomes/rt103.htm>

20/ Lambdoma.xls file – full 32 x 32 matrix as ratios.

Additional Information and Citations

Pitch is the relative frequency of vibration, and

Vibration is the rhythmical motion within a body

Svpvril is the Yahoo Groups Sympathetic Vibratory Physics Discussion Forum

Svpvril is moderated by Dale Pond - See <http://groups.yahoo.com/> to register

Dale Pond also runs a website <http://www.svpvril.com/>

SVP = Sympathetic Vibratory Physics is the general field exploring the fundamental physics and phenomena of sound and vibration as these work in and through all known material and energetic matrices which includes Mind, Matter, Spirituality and their intimate linkages.

vril = Vibration Research Institute and Laboratories

Dale Pond's site and the discussion group are excellent sources of information. Svpvril on Yahoo contains a large number of messages on a wide range of interests, which can be somewhat time consuming to find information on just the topics of interest; but it is well worth the time.

Hightower, Thomas, index for various articles <http://home22.inet.tele.dk/hightower/>

? The Creation of Musical Scales <http://home22.inet.tele.dk/hightower/scales.htm>

? The Power of Harmonics: <http://home3.inet.tele.dk/hitower/harmonics.html>

Harmonics, as represented by the Lambdoma matrix, has been a subject of interest and speculation since Pythagoras over 2500 years ago. Many scientists have contributed to the store of knowledge:

Albert von Thimus, *The Pythagorean Table*; Die Harmonikale Symbolik des Alteriums, Vol. II, Koln, 1868 - 76.

Hans Hayser (1891-1964), *Akroasis, The Theory of World Harmonics*; translated edition 1964, Plowshare Press, Boston, Mass.

Ernest G. McClain, *The Pythagorean Plato, Prelude to the Song Itself*; Nicolas-Hays, Inc., York Beach, Maine, 1978.

Ernest G. McClain, 1974. *Musical Theory and Ancient Cosmology*, first published in The World and I, February 1994 (pp.371-391). <http://www.new-universe.com/pythagoras/mcclain.html>

PART C: HARMONICS

The following quotes provide some impetus for the interest in harmonics for sound therapy:

"The human organism is not only constructed according to harmonic principles, but also functions within them." - Gunther Hildebrandt, German physiologist

"It has been found that the rhythmic of the human organism function utterly harmonically -- that is, the frequencies of pulse, breathing, blood circulation, etc., as well as their combined activities." - Rudolf Haase, German musicologist

C.1 Harmonics Introduction

Harmonics in music and sound therapy have several meanings and applications. The following definitions from the 1957 college edition of Webster's Dictionary are a starting point for useful concepts in music and sound physics.

Harmony – **1.** a combination of parts into a proportionate or orderly whole;
6. in music, a) the pleasing combination of two or more tones in a chord. b) structure in terms of the arrangement, progression, modulation, etc. of chords: distinguished from *melody, rhythm*.

Harmonic – **2.** in mathematics, designating or of a series of numbers whose reciprocals are in arithmetical progression. **3. in music** c) designating a tone whose rate of vibration is a precise multiple of a given fundamental or base tone; 2, 3, 4, etc.

A Mathematical Example: For a base, fundamental, or first harmonic tone of 30 Hz, the second harmonic is 60 Hz, the third harmonic is 90, then 120, 150, 180, etc.

Pythagoras formulated the law of musical pitches in terms of numerical proportions (ratios of small numbers); see section C.3. From this he based his underlying principle of "harmonia" (harmonious joining). This discovery led him to the idea of Harmony of the Spheres, based on the seven planets known at his time (see <http://home22.inet.tele.dk/hightower/spheres.htm>). Johannes Kepler(1571 - 1630) refined Pythagoras' Harmony of the Spheres notion .

From Jonathan Goldman's chapter on Science of Harmonics: *"In ancient Greece, the God Apollo was god of both music and medicine. There were healing temples which focused upon music as the main force for harmonizing the body and spirit."* 13/ p.29 This is an early example of vibrational healing, and it was probably based on even earlier Egyptian knowledge and practice.

It is my opinion that understanding and using of harmonics is a key element in assisting the body to balance abnormal energies, and, perhaps, to aid the body in its own healing. This opinion is shared by others such as Barbara Hero, as expressed privately. Bill Meyer, wlmeyer@scican.net

From the Ray Tomes web site: <http://homepages.kcbbs.gen.nz/rtomes/rt103.htm> , 19/

This site explores the development of a pattern of harmonics in non-linear systems with resonance. The pattern is shown to explain many phenomena in a number of different scientific fields including cosmology, physics, geology and even economics. The mathematical nature of the harmonics is considered in detail, and it is not for the faint of mathematical heart.

The following basic ideas from Ray Tomes' site should be of interest from a harmonic viewpoint. The text below is basically taken verbatim from the site, but it is an extract of the information.

Preconditions:

- * **In any system which has non-linear relationships, harmonics will develop**, and for many systems there will be power in all or most harmonics;
- * **If the system also has some form of resonance**, then individual harmonics may be selected by parts of the system, and in turn generate further harmonics, and so on.

Once the above two conditions are satisfied, it is not very important what the nature of the system or the functions are, because the result is almost totally independent of them.

Consider an initial frequency 1 in such a system. It will generate harmonics of frequencies 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, etc. Now consider each of these frequencies in turn. They will each create harmonics (multiples) of themselves which will be frequencies of ...

1 -->	1	2	3	4	5	6	7	8	9	10	11	12	...	16
2 -->		2		4		6		8		10		12	...	16
3 -->			3			6		9				12	...	
4 -->				4				8				12	...	16
5 -->					5					10			...	
6 -->						6						12	...	
7 -->							7						...	
8 -->								8					...	16
9,10,11,12 .. --->									9	10	11	12	...	16
etc														

Now notice that some numbers occur much more often than others:

Number	1	2	3	4	5	6	7	8	9	10	11	12	...	16
Occurs	1	2	2	3	2	4	2	4	3	4	2	6	...	5

From simple harmonics only, you can see that 12 and 16 are important numbers by simply being the most numerous.

It will be observed later that series of 12 and 16 will be significant in the concepts of music and harmonics pertinent to sound therapy. Also notice that 6 and 8 are lower octaves of 12 and 16, respectively. If you continue the series above, 24, 30, 36, 40, 48, and 60 also appear significant.

C.2 Principle of Octaves and octave harmonics

“Octaves appear in many places: time, the musical vibrations of sound, and in the electro - magnetic spectrum (infrared, visible light, ultraviolet light, and beyond). In music, the doubling of sound frequencies represents an octave. The frequency of the highest note in an octave is exactly two times the frequency of the lowest note in the octave. Within an octave we progress through the seven “natural” musical notes C, D, E, F, G, A, B and arrive at C again - one octave higher.” <http://www.cosmicharmony.com/Ha/HAMain.htm>

The term “octave” was coined by Pythagoras of Samos (c.582 - c.507 B.C.) who derived the word from the Latin term for the number 8. It represents the musical interval of eight tones that are required to obtain the next pitch that sounds harmonically similar to the original note.

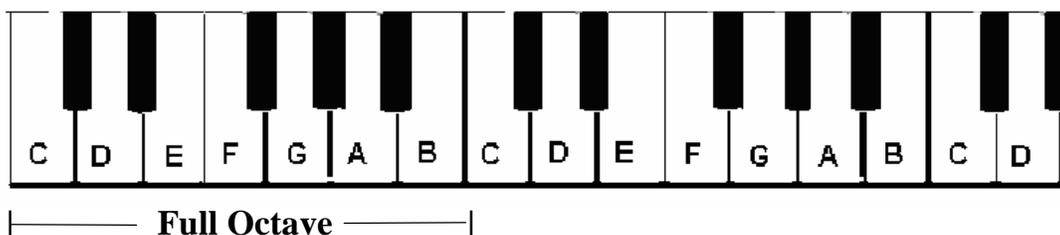
“There is a striking similarity between the musical octaves and the octaves of the electromagnetic spectrum that we see as visible light. Just as in music with its seven natural notes, we commonly say that there are 7 distinct colors in the spectrum of the rainbow.”

<http://www.cosmicharmony.com/Ha/HAMain.htm>

The 7 Notes of the Octaves of Light and Music (as hues of light and not of pigment 16/ p. 92)

Red	Orange	Yellow	Green	Blue	Indigo	Violet
C	D	E	F	G	A	B

It is interesting to notice the prevalence of the numbers 7 and 12 in both music and time. There are seven whole notes in the octave and 12 half steps in the octave. We see the correspondence of these same numbers in our time divisions - 12 hours each of day and night, 7 days in a week, 12 months in the year. The piano keyboard illustrates the 12 half steps in an octave:



In 1864, a man named John A. Newlands grouped the known chemical elements in the order of their atomic weights. He then divided these into groups of seven elements each. He demonstrated that when the atoms were put into order with their weights increasing, there was a pattern of repetition that was identical to the musical octave, the same found on the piano keyboard.

http://www.dovesong.com/positive_music/musical_scales.asp

From www.BioWaves.com: “**The Law of Octaves** states that in a frequency sense, we can often use an octave of a frequency to the same effect as the frequency itself. An octave is a doubling or halving of a frequency. Doubling would involve going up to the next higher octave, while halving involves coming down an octave.”

Notice in the example in section C.1 for a base tone of 30 Hz, that harmonics at 2, 4, 8 times the base etc. are exact octaves of the fundamental or base tone. Successive powers of two (i.e. doubling) produce successive octave harmonics of a base tone.

From Dale Pond in *Svppril #4244*: "The Harmonic Scale is formed by a series of natural harmonics. It should be noted that our conventional music scale is a melodic modification of a naturally occurring harmonic scale or series of naturally occurring tones."

"The universe consists solely of waves of motion." relates Walter Russell in chapter 31 of *A New Concept of the Universe*. Another way of saying this is: "There exists nothing other than vibration."

It is a well known and accepted fact that any vibration as in a sound tone will give rise to its octave harmonics. These are the harmonics generally acknowledged by science as multiples of 2, which multiplication derives super-harmonics, and divisions by 2 derive subharmonics. These types of harmonic products or results of 2 are called octave harmonics; Dale Pond [17/](#).

What is not so generally acknowledged but nevertheless just as true is a tone will give rise to harmonics not divisible by 2 but divisible by other numbers such as 3, 5, 7, etc. These other harmonics are developed from and within the octave harmonic series first mentioned by the octave harmonics interacting arithmetically within and among themselves and with the fundamental. These spontaneously and naturally occurring tones will add and subtract from each other in a perfectly orderly manner giving rise to summation and difference tones sometimes referred to as secondary, tertiary or higher harmonics. When these summation tones are very powerful they are referred to as beat tones or beat frequencies and are considered enharmonic. These arithmetically derived harmonics are characterized in Keely's Law of Cycles; Dale Pond [17/](#).

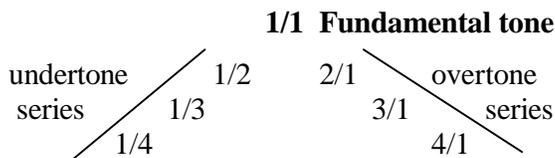
"Coherent aggregates harmonically united constitute centers of vibration bearing relation to the fundamental pitch not multiples of the harmonic pitch, and the production of secondary unions between themselves generate pitches that are discords, either in their unisons, or overtones with the original pitch;" John Keely, 1894 [16/ p.116](#)

Harmonic Rel.Intensity Frequency : **The Power of Beat Harmonics, [16/ p. 186](#)**

1st	29	257	
2nd	7	514	
3rd	20	771	
4th	1	1028	
5th	2	1284	
6th	6	1542	
7th	6	1928	
8th	8	2056	
9th	16	2312	
10th	9	2568	
11th	30	2827	} these harmonics are stronger than the 1 st note, and are composed almost entirely of beats of lower frequencies, referred to as the "beat harmonics."
12th	35	3084	

C.3 The Lambdoma matrix – Barbara Hero

The Greek mathematician Pythagoras of Samos, circa sixth century BC, studied at least 20 years in Egypt. He is credited with the idea of the Pythagorean Table or the Lambdoma matrix, which relates harmonic series as a table of overtones (multiplication) and undertones (division). These series are ratios of whole numbers, as shown in the following illustration: [14/ and in Hero's site http://www.lambdoma.com](http://www.lambdoma.com)



Simple Lambdoma matrix, named after the Greek letter lambda, ?

In the 1920s the German scientist Hans Kayser developed a comprehensive theory of harmonics based on the Lambdoma matrix. Kayser determined that harmonious structure in nature and the principles of harmonics were basically the same. He believed that by understanding the relation between mathematics and music, one could create an understanding between tone and numbers.

According to Hans Kayser's theory, **the whole number ratios of musical harmonics (as in the Lambdoma) corresponds to an underlying framework existing in chemistry (and hence biochemistry), physics, spectroanalysis and other physical sciences** He also stated that the fundamental structure of matter, embodied in the periodic table of elements, resembles the overtone structure in music. (also see the overtone description below)

In the 1970's, Barbara Hero made charts of numerical frequencies based on the sequence of ratios that represent the overtone and undertone series in the Lambdoma matrix. She has written and lectured extensively on the wisdom encoded within that ancient matrix of whole number ratios. Ms. Hero also mentions the use of octave shifting to find the equivalent tone of any number:

Octave expansion is the doubling and redoubling of a number;
Octave reduction is the halving and rehalving of a number. [15/](#)

The full Lambdoma matrix is calculated by first numbering the columns and rows in ascending sequence from 1. The ratios are simply the column number divided by the row number as shown below in the matrix below.

	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>
1 :	1/1	2/1	3/1	4/1	5/1	6/1	7/1	8/1
2 :	1/2	1/1	3/2	2/1	5/2	3/1	7/2	4/1
3 :	1/3	2/3	1/1	4/3	5/3	2/1	7/3	8/3
4 :	1/4	1/2	3/4	1/1	5/4	3/2	7/4	2/1
5 :	1/5	2/5	3/5	4/5	1/1	6/5	7/5	8/5
6 :	1/6	1/3	1/2	2/3	5/6	1/1	7/6	4/3
7 :	1/7	2/7	3/7	4/7	5/7	6/7	1/1	8/7
8 :	1/8	1/4	3/8	1/2	5/8	3/4	7/8	1/1

These ratios can also be expressed as decimal fractions: [see 20/](#) for the full Lambdoma matrix

	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>
1 :	1.000	2.000	3.000	4.000	5.000	6.000	7.000	8.000
2 :	0.500	1.000	1.500	2.000	2.500	3.000	3.500	4.000
3 :	0.333	0.667	1.000	1.333	1.667	2.000	2.333	2.667
4 :	0.250	0.500	0.750	1.000	1.250	1.500	1.750	2.000
5 :	0.200	0.400	0.600	0.800	1.000	1.200	1.400	1.600
6 :	0.167	0.333	0.500	0.667	0.833	1.000	1.167	1.333
7 :	0.143	0.286	0.429	0.571	0.714	0.857	1.000	1.143
8 :	0.125	0.250	0.375	0.500	0.625	0.750	0.875	1.000

How fractions denote pitches

The ratios and fractions shown in the two Lambdoma matrices above can be used to represent pitches, which are actually ratios between any desired pitch and the base pitch (fundamental). For example, if C is the base pitch (i.e., the key of C), then it is the ratio of 1/1, the top left element of the Lambdoma. The C in the octave above the base would be 2/1.

A potentially confusing factor is that the ratios (fractions) denoting octaves are equivalent. In other words, 1/1 is the same pitch as 2/1 which is also the same pitch as 4/1, etc. Thus, in an uncharacteristic way, $1/1 = 2/1 = 4/1$, which is another way of justifying the use of octave shift.

The Lambdoma matrix can therefore be used to represent any base frequency, as illustrated briefly in the next section. Using the idea of a reference octave, the calculated frequencies that are above and below the reference can be shifted to the common octave.

Barbara Hero's paper, *SOME EFFECTS OF WHOLE NUMBER RATIO INTERVALS IN MUSIC* contains an excellent summary of information on the Lambdoma matrix (Cantor array). She begins this paper with the statement “*The most powerful effects of music* (sounds in general) *may be realized by following some of the perhaps little known laws of harmonics.*”

Hero's paper on whole number ratios contains a glossary of important terms related to harmonics. The definition for Interval has relevance to the following section on resultant tones:

INTERVAL: “is the ratio of two tones with regard to their pitch, vibration numbers

C. 4. Overtones and Undertones within an octave

**Overtones lie above the fundamental 1/1 diagonal, ratios > 1;
Undertones lie below the 1/1 diagonal, ratios < 1.**

Note that there are multiple occurrences of some values in the matrix (e.g. 1.0 and its next octaves 2.0, 4.0 and 8.0). Note also that through octave expansion (shifting), there are additional duplications in the undertones below the diagonal (0.50, 0.25 etc).

Looking at the ratios in the first matrix above, if you start at the first occurrence of 3/2, the next occurrence is over three (3) columns to the right and down two (2) rows. This relationship is the same in both the overtone and undertone areas of the matrix.

If it is desired to create the **overtone series** based on fourths for a specified tone (sound), then the four fractions outlined above from matrix column:row **4:4 to 7:4** can be multiplied by the specified tone. For the tone of 22.00, this overtone series would be 22.0, 27.5, 33.0, and 38.5. Multiplying by the next factor of 2.0 brings you to the octave above the specified tone or 44.

If it is desired to keep the values within the Beta brainwave octave of 16 to 32, those values above 32 can be shifted down or reduced by halving the values. Bringing the series above into this Beta or reference octave gives the series of 22.0, 27.5, 16.5 and 19.25.

Beta Brainwave Reference Octave, 16 to 32-- Beta brainwaves are of particular interest to many researchers in the fields from bioenergetics and neuro-acoustics to sound therapy. Beta brainwaves are stated as being those of the normal waking state, and this range is thought to have the greatest effect to entrain the brain. The lower limit of 16 cycles per second (Hertz) is a typical lower limit of hearing for humans, although some people can hear down to 14 cycles per second.

Relating beta brainwaves to the Lambdoma matrix, the **overtone or harmonic series** starting at 16/16 would be of particular interest.

16/16	17/16	18/16	19/16	20/16	...	31/16
-------	-------	-------	-------	-------	-----	-------

The factors corresponding to the above ratios are:

1	1.0625	1.125	1.1875	1.25	...	1.9375
---	--------	-------	--------	------	-----	--------

Calculating a harmonic series of overtones is a simple process of multiplying a specified tone or frequency by the set of factors illustrated above. For a frequency of 22.00, the overtone series is:

22.000	23.375	24.750	26.125	27.500		42.625
---------------	--------	--------	--------	--------	--	--------

If it is desired to keep the values within the Beta brainwave octave of 16 to 32, those values above 32 can be shifted down or reduced by halving the values, i.e. octave reduction.

Edwards explains the 16th based Lambdoma series as a ***harmonic scale based on the Pythagorean string theory***: reference the Yahoo SvpvriI message #4618 posted by Sharry Edwards.

For instance, if your base number is 280, you would divide that number by 2 until you could no longer get a whole number [*between 1 and 2*]. In this case, you could divide it by two until you got 1.09375 (the fundamental or harmonic increment). **Starting with the first hearing multiple of this number in the (beta brainwave) range – in this case 17.50, add the fundamental back to it, successively:** 17.50, 18.59375, 19.6875, 20.78125, 21.875, etc.

	Base 22.00	[beta range for base frequency of the Lambdoma example above]
**		
1 st	23.375	1 ST and 8 TH values of this scale are related as ~ base - complement
2 nd	24.75	
3 rd	26.125	[the harmonic increment for 22.00 is 1.375]
4 th	27.50	
5 th	28.875	
6 th	30.25	
7 th	31.625	
8 th	33.00	[this value is the perfect fifth of the base value, here 22.00] **
.		[The dominant Perfect Fifth = Base note * 1.5 (or * 3/2)]
15 th	42.625	
16 th	44.00	at the 16th addition, you will have doubled the original number.

“The most compelling information concerning the number 16 as a frequency harmonic may change medicine and the way we treat disease.” Sharry Edwards, *Decloaking Pathogens with Sound Waves, Nexus Magazine*.

The Lambdoma matrix is undoubtedly the genesis of the preceding “harmonic scale based on the Pythagorean string theory”. Using the Lambdoma factors for the beta brainwave octave is the more direct method of calculating a 16-based harmonic series.

The authors suggest that Frequency Harmonics contain the keys to effective sound therapy. While you might not see the significance at first, **note that the body is a Carbon (at.wt=12) and Oxygen (at. wt=16) engine**. The body also depends on **Nitrogen (at.wt=14)** as a primary element.

Note further that Beta octave tone of **Hydrogen**, corresponds to the 16 frequency harmonic to the nearest whole number; $1.00794 * 16 = 16.127$. Hydrogen is the most prevalent element in our sun (~75%) and in the universe (~92%).

C.5 Resultant or Combination Tones Getting Something out of Nothing

When two pure tones (sine waves) are sounded together, they combine and produce at least two new additional resultant tones. This is a very interesting effect where combining frequencies creates new frequencies out of thin air and, in fact, is how frequencies are normally created to make radio waves for sending signals into thin air. Specifically, by combining a 20 and 22 Hz tone, will appear to yield a 2 Hz, 20 Hz, 22 Hz, and at least one more tone.

“A Combination Tone is a third sound, which may be heard or measured, when two tones of different pitch are simultaneously sounded, and which are not heard when either of these two tones is sounded alone.”^{16/ p.144}

There are two main physical processes in action when combining two tones: **interference and mixing**. Interference is the algebraic addition of two tones whereas mixing is similar to multiplication. Each of these processes will, when performed with sound waves in air, create two additional tones.

Interference

Interference is more simple, so we'll start here. With interference, you are simply adding two waves together. At times these two waves will combine constructively, creating a larger single wave, and at other times, these two waves will oppose each other, canceling each other out.

If one hears two similar amplitude waves with a nearly identical pitch or frequency they will slowly shift from constructively combining with each other to destructively canceling each other out. My favorite example of this is a twin prop airplane where everyone hears a WOW WOW WOW sound as the noise from the two engines constructively and destructively combines. How often the Wow sound occurs represents the difference of the two frequencies.

Some scholars suggest that a “summation” tone can also be attained through interference mixing, although they agree that the tone is barely audible, and the effect is minimal. Daniel Kunkel believes that this effect, if it is detected, is more likely from some sort of mixing of the electrical, or auditory signals, as will be described next.

Consider two sounds **f_1 and f_2** , with f_2 being higher frequency,

will produce a **average tone at $(f_1 + f_2) / 2$**

and a **difference tone at $(f_2 - f_1)$** .

Of note, if you're working with non-sinusoidal waveform, or waveforms with a strong second harmonic, you can also detect a *cubic difference tone* from the first overtone of the lower frequency interfering with the second frequency which can be calculated as $(2f_1 - f_2)$.

As an example, consider two sounds with frequencies of 400 Hz and 500 Hz respectively: The frequency of the sum tone would be $400+500=900$ Hz and the simple difference tone would be $500-400=100$ Hz. The frequency of the cubic difference tone would be $2 \times 400 - 500 = 300$ Hz.

Mathematically, the frequency of the summation tone can be attained by adding the frequencies of the two initial tones; the frequency of the difference tone is the difference of the two.

Because the sum tone is usually not as audible as the difference tone (some scholars even agree that sum tones do not exist), its effect is often described as minimal in comparison to difference tone.

The early beginnings of musical acoustics with combinatorial tones can be traced to Italian violinist Tartini (1692 -1770), from whom they were called Tartini's tones. These tones were described by German organist G.A. Sorge in his 1745 book.

Mixing and Binaural Beats

If the two frequencies combine through a mixing process, an entirely different phenomenon occurs with surprisingly similar results. When mixing or multiplying two frequencies together, the resultant will contain two new frequencies. This can be most easily represented by the following mathematical identity for multiplying two sine waveforms.

$$\sin(a) * \sin(b) = \frac{1}{2} \cos(a - b) - \frac{1}{2} \cos(a + b)$$

As you can see, the $a - b$ creates a tone at the difference frequency, while the $a + b$ term results in a frequency at the sum of both frequencies. In radio tuners, this process is called heterodyning, and is a function performed in almost all radios.

Our brains, when hearing two different frequencies in each ear, will combine them in such a way so that we will "hear" the sum and difference tone.

For example, two sounds **f_1 and f_2** , with f_2 being higher frequency, will produce a **summation tone at $(f_1 + f_2)$** and a **difference tone at $(f_2 - f_1)$** .

As an example, consider two sounds with frequencies of 400 Hz and 500 Hz respectively: The frequency of the sum tone would be $400+500=900$ Hz and the simple difference tone would be $500-400=100$ Hz.

Robert Monroe, founder of the Monroe Institute patented the Hemi-sync™ process of playing two different frequencies in each ear to create very low frequency signal that would "entrain" the brainwaves. His work and research continues to attract many people wanting mind expanding experiences.

While these effects occur at all frequencies, it is most noticeable to the human ear at low frequencies, i.e. when the two frequencies are only slightly different.

When sounding two notes a fifth apart, a third tone is heard an octave below the lower of the two, or the difference of the cycles per second of the two tones. In general, the combination of any two notes will produce resultant tones.

For the harmonic scale example with

the fifth = 26.25	3/2 base	}	17.50 : 8.75 = 2 : 1
base tone = 17.50	2/2 base		

Difference= 8.75	1/2 base		
Summation = 43.75	5/2 base		average = 21.875

It should be noted that the “third tone” of 8.75 would not in itself be audible. Harmonics (octaves) of this tone would be audible.

Note that the Resultant tones from a base tone and its fifth form a harmonic series:

Average : base tone = 21.875 : 17.50 = 1.25 : 1
Summation : base tone = 43.75 : 17.50 = 2.5 : 1
Summation : **Difference** = 43.75 : 8.75 = 5 : 1

Another interesting feature of resultant tones involving perfect fifths was noticed when working with the two frequencies **16.85 and 28.09**

Resultant Difference = 28.09 - 16.85 = 11.24 -or- 22.48 beta;

Resultant Sum (avg.) = (28.09 + 16.85) / 2 = 22.47

The fifth of 22.47 (22.47 * 1.5 = 33.70) is 16.85

Therefore, if you wanted to find the two tones that would produce the same resultant difference and summation tone, **the perfect fifth would be one of the tones**, and the second tone **f2** can be calculated as follows:

$$(f2 + fifth) / 2 = resultant$$

-or- $(f2 + 16.85) / 2 = 22.47$

$$f2 = 2 * 22.47 - 16.85 = 44.94 - 16.85 = 28.09 \text{ [as above]}$$

Note: the perfect fifth, 16.85 above, must be less than the desired resultant tone, 22.47; use octave reduction dividing by 2 If it's necessary to reduce the fifth.

The equation for calculating the second frequency, **f2**, can be expressed as

$$f2 = 2 * resultant - fifth$$

which is the same form of calculation as the cubic difference tone shown on the previous page.

Note further that the harmonic series example for 22.00 in section C.4 provides this calculation: Base = **resultant**, 4th increment = **f2**, and 8th increment = **fifth** -or- $f2 = 2 * 22.0 - 16.5 = 27.5$

FIBONACCI NUMBER SERIES

This series is named after Leonardo of Pisa, also known as Fibonacci, who lived around 1100AD. Each number of the series is the sum of the two previous sequential numbers. The Fibonacci series created from unity is as follows: 0, 1, 1, 2, 3, 5, 8, 13, 21, etc. Musically, this series represents

1:1	Unison
2:1	Octave
3:2	Perfect fifth
5:3	Major sixth
8:5	Minor sixth
13:8	Major sixth
21:13	Minor sixth

Note that all of the ratios which follow the above sequence in the Fibonacci series continue to oscillate from a Major to a Minor Sixth. These oscillations approach what is termed a Perfect or Harmonic Sixth.

The series based on the ratios of sequential numbers in the Fibonacci series is as follows:

1/1, 2/1, 3/2, 5/3, 8/5, 13/8, 21/13, etc. converges to the “golden mean” value of 1.618 or PHI
also 1/2, 2/3, 3/5, 5/8, etc. converges to the inverse of the “golden mean” or 0.618

When the two tones are of equal amplitude, these resulting overtones also combine to produce further resulting tones, also called heterodynes in sacred geometry. This process of space filling of 'resultant tones' follows the famous Fibonacci Series. All ascending summation tones follow the line of the PHI spiral.

Since the descending reduction tones are not universally apparent, because of their intermittent appearance, they are mostly sensed as undertones and beat-tone brain pulsations.

There are two series, (1) the Natural Harmonic Rise and (2) the Non-Harmonic Summation Rise. Each is distinctly different in its function.

While the universal rise of natural tones proceed from Octave to fifth to fourth (2nd Oct.) to major third and on to smaller and smaller increments until they disappear from hearing range; the resulting summation rise, levels off at PHI or the minor sixth of 1.618 as they ascend beyond hearing. As all matter disintegrates it follows this overtone dissolution.

The non-harmonic partials produced by resultant tone combinations, being space filling and dependent on amplitude and density, level off to more and more discreet increments of harmonic congruency (PHI). Don Conreaux, <http://www.holistic-resonance.com/ToneTheory.html>

PART D – MUSICAL SCALES AND RELATIONSHIPS

D. Musical Scale Sections:

- D.1 Pythagoras and the Monochord
- D.2 Musical scales and Intervals
- D.3 Circle of Fifths – the Musical Wheel
- D.4 Tuning the Scale – Diatonic and Equal Tempered Scales
- D.5 Triads and PODS
- D.6 Note Correlates
- D.7 Binaural Beats
- D.8 Mathematics of Music

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mathematical faint of heart.

PART D – MUSICAL SCALES AND RELATIONSHIPS

The following quote is repeated: "*Every human molecule has a particular corresponding musical frequency; and masses of particles behave and maneuver among themselves as if they were musical notes on the chromatic scale.*" ~ Joel Sternheimer, from his article, "The Music of the Elementary Particles".

D.1 PYTHAGORAS AND THE MONOCHORD

One of the foremost Greek thinkers and acknowledged father of geometry was the sixth-century BC philosopher Pythagoras. He is generally recognized as the first person to correlate the relationship between musical intervals, and his teachings continue to influence us to the present day. Our understanding of mathematics and ratios is based upon Pythagoras's observation of music.

Pythagoras' discoveries form the basis for the science of sound, technically known as acoustics. In our recorded history, music has been an art long before its nature began to be examined in a scientific manner by Pythagoras. He is credited with the discovery that for two strings fastened at the ends and with the same tension, if one string has twice the length of the other, the shorter will produce a tone one octave above the other.

"The key to this discovery was a simple instrument called the monochord that was composed of a single string stretched over a piece of wood. Using the monochord, Pythagoras was able to discover that the man-made division of this string created ratios. By examining the intervals created by this division, Pythagoras found that whole number ratios could be observed. These whole number ratios, such as 2:1, 3:2, 4:3, were archetypes of form, demonstrating harmony and balance that could be observed throughout the world."

"If, for example, a string is divided into two even portions, the note that is created is an octave of the open string. The two even portions vibrate at a ratio of two to one (2:1). Then when the string is divided into three equal portions, the string vibrates at a ratio of three to one (3:1). When the string is divided into four equal portions, this creates a ratio of four to one (4:1). Looking back at the ratios created from the harmonic series, it is noted that the man-made division of strings exactly follows these ratios of the harmonic series." (J.Goldman, 13/ pp.29-30)

The concept of pitch was understood at the time of Pythagoras, but its association with the frequency of vibrations from the instrument probably was not understood until the time of Galileo Galilei (1564-1642). Galileo is probably better known as the founder of modern physics, with his *Discourses Concerning Two New Sciences* in 1638.

In his *Discourses*, Galileo describes the phenomenon of sympathetic vibrations (also known as resonance) in which the vibrations of one object will eventually produce the same vibrations in a nearby object. This phenomenon can be observed between two or more pendulum clocks that are near each other. Galileo made several other observations that will be presented in later sections.

D.2 MUSICAL SCALES AND INTERVALS

The Octave was introduced in the preceding section C.2. The Octave divides the realm of sound with the factor 2, and it can be subdivided in three basic ways: see [22/](#)

1) By a **geometric progression**, with any number of **equal** intervals, e.g.. 12 as in the Equal Temperament, and other numbers (such as 16).

A geometric progression is a sequence in which each term (after the first) is determined by multiplying the preceding term by a constant. This constant is called the common ratio of the arithmetic progression. The octave sequence is also a geometric progression; so is the golden proportion.

2) By **proportions with low number ratios**, e.g.. Just Intonation with its triads of major thirds, or by other harmonic relationships.

3) By **generating Fifths**, e.g. Pythagorean Tuning of an instrument up and down by fifths to create a complete musical scale that sounded good (see circle of fifths).

The reason there are so many different ways to divide the octave and display such a diversity of scales, can be found in the fact that there are no formula there can fit the octave perfectly - unless some notes or keys sound disharmonious.

Musical Intervals are the ratios or space between musical notes.

When music is played, the sounds or vibrations that are created affect each individual in the vicinity both mentally and physically. The effects on each person will depend on the harmony or disharmony of the musical vibrations. Each musical scale will create different vibrations, and the melody in each scale will affect people differently.

The Pythagorean tuning is the oldest tuning system that is used in European music. The ancient Greeks recognized three primary harmonious tones or concords: fourth, fifth and octave. The corresponding ratios of string length using Pythagorean string theory are:

$$\frac{3}{4}, \frac{2}{3} \text{ and } \frac{1}{2}$$

If a vibrating string produces a note of C at its full length, it will sound an F with three quarters of its length, G with two thirds and C an octave higher with half of its length. Because the intervals with these ratios do not cause beat frequencies, they are called pure intervals. Pythagorean scales are built upon pure fourths and fifths.

The ratios above are related to simple string lengths, but modern acoustics and sound therapy use the ratios of frequency. To convert lengths into frequency ratios, use mathematical inversion so $\frac{3}{4}$ becomes $\frac{4}{3}$. Thus, in relation to the fundamental tone, the frequency ratios of the fourth, fifth and octave would be:

$$\frac{4}{3}, \frac{3}{2} \text{ and } 2$$

It should also be noted that the fourth and fifth taken together form a full octave.

D.3 CIRCLE OF FIFTHS – The Musical Wheel – *D.Kunkel, Biowaves*

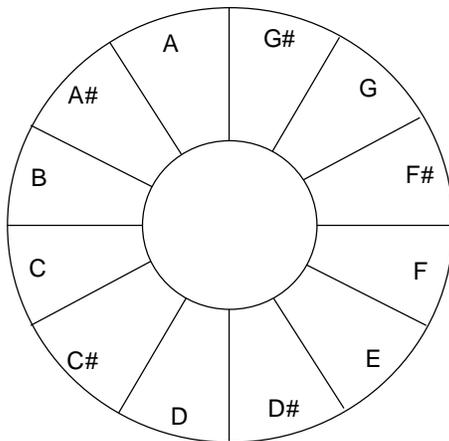
One of the common harmonics or intervals in music is the fifth. It is the lowest ratio harmonic you hear, and is mathematically calculated by multiplying a frequency the ratio $\frac{3}{2}$ or 1.5. For example, in the note of C, the perfect fifth would be the G. You can continue to go up the scale by fifths, following the pattern:

$$C > G > D > A > E > B > F\# > C\# > G\# > D\# > A\# > F > C.$$

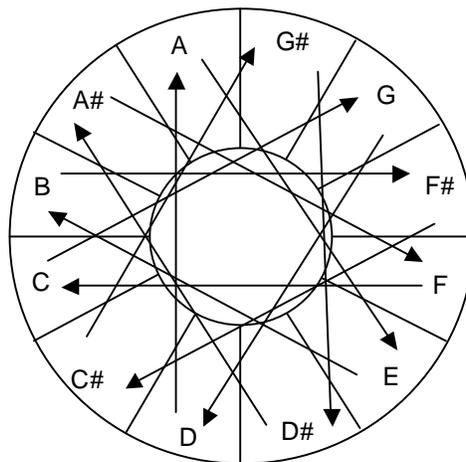
Pythagoras first used the idea of tuning an instrument up and down by fifths, and, in fact, the slight error that occurs when you tune using this method is called the Pythagorean comma. If we set the value of C with the number one, the frequency ratios of this scale are as follows:

C	C#	D	D#	E	F	F#	G	G#	A	A#	B
1	$\frac{2187}{2048}$	$\frac{9}{8}$	$\frac{19683}{16384}$	$\frac{81}{64}$	$\frac{4}{3}$	$\frac{729}{512}$	$\frac{3}{2}$	$\frac{6561}{4096}$	$\frac{27}{16}$	$\frac{59049}{32768}$	$\frac{243}{128}$

Johann David Heinichen published the Circle of Fifths in his book, *Der Generalbass* in 1728. By placing each note in a slice of the wheel, you can see that the relationship of a fifth is one past the note opposite. The wheel also clearly shows the repeating pattern of the notes, automatically wrapping to the next octave, making no distinction as to the octave.



Musical fifths are indicated by the arrows:



D.4 Tuning the Scale – Determining Note Frequencies – *D.Kunkel, Biowaves*

Defining the frequencies of the notes has been hotly debated, and it has changed repeatedly throughout time. The current standard with A = 440 Hz has only been the standard since 1939 when it was adopted at the Second International Standard Pitch Conference in London. There are two other standard definitions in use today, the International pitch of A = 435 Hz, and the Concert Pitch of A = 442 Hz,. The pitch for the note of A has varied from 395 in Italy during the 1720's to 442 Hz, the current Concert Pitch.

Even with agreement on the pitch for the note of A, we still need to calculate the frequencies of all of the other notes. Pythagoras of Samos (c.582 - c.507 B.C.) is attributed with being the first to discover the “**music of the spheres,**” and the ratiometric nature of musical notes, specifically the octave, the fourth and the fifth, and that these relationships correlated to the orbits of the planets.

Johannes Kepler (1571 – 1630), an early astronomer discovered that the planets do not travel in a perfect circle as Pythagoras had thought, but rather travel in an elliptical orbit. Kepler expanded the music of the spheres concept, realizing that the planet's orbits contained all of the basic ratios of the musical scale. Kepler wrote that he wished "...to erect the magnificent edifice of the harmonic system of the musical scale . . . as God, the Creator Himself, has expressed it in harmonizing the heavenly motions." in his book *Harmonice Munde* (1619).

The Just Diatonic Scale Ratios:

The Just Scale, or Scale of Ptolemy, c 130 A.D. is based on the ratios of the major triad, or tonic chord. In the note of C, this chord would be a C, E, and G. The chord is built from applying the ratios that make up the major triad, a major 3rd (5/4), minor 3rd (6/5), 4th (4/3), and perfect 5th (6/4) to a starting point (A = 440 Hz) to determine the tuning for the whole scale.

C	D	E	F	G	A	B
1	$\frac{9}{8}$	$\frac{5}{4}$	$\frac{4}{3}$	$\frac{3}{2}$	$\frac{5}{3}$	$\frac{15}{8}$

Of particular interest, notice that combining a major 3rd and minor 3rd together is equivalent to a perfect 5th.

$$\frac{5}{4} ? \frac{6}{5} ? \frac{6}{4} \text{ or } \frac{3}{2} \quad (\text{A perfect 5}^{\text{th}})$$

The Equal Tempered Scale

The easiest way to break it up is to divide the octave into 12 equal ratio pieces. This technique defines a fixed ratio (approximately 1.059) whereby you can multiply each note's frequency by the ratio to determine the next note. This calculation results in a smooth transition between notes, and, at the completion of the 12th multiplication, you have exactly doubled the starting value. This technique defines the equal tempered scale calculation.

The following table shows the ratios for the equal temperament scale, starting with the note of C being equal to 256. In reality, you can start from any note at any frequency. Of special note, notice that the ratio for the note 6 notes away, or half way is $\sqrt{2}$ times the fundamental.

Musical Relationship	Formula	Factor	Freq.	Biowaves Terms	Astrology
Fundamental or Bass Note	$2^{\frac{0}{12}} = 1$	1	256	Fundamental	
Minor 2 nd	$2^{\frac{1}{12}} = \sqrt[12]{2}$	1.059463	271		
Second	$2^{\frac{2}{12}}$	1.122462	287		
Minor 3 rd	$2^{\frac{3}{12}}$	1.189207	304	Magnetic	Square
Major 3 rd	$2^{\frac{4}{12}}$	1.259921	323		Triad
Major 4 th	$2^{\frac{5}{12}}$	1.33484	342	Electric	Quincux
Augmented 4 th	$2^{\frac{6}{12}} = \sqrt{2}$	1.414214	362	Inverse	Opposed
Major 5 th	$2^{\frac{7}{12}}$	1.498307	384	Electric	Quincux
Augmented 5 th	$2^{\frac{8}{12}}$	1.587401	406		Triad
Major 6 th	$2^{\frac{9}{12}}$	1.681793	431	Magnetic	Square
Augmented 6 th	$2^{\frac{10}{12}}$	1.781797	456		
Major 7 th	$2^{\frac{11}{12}}$	1.887749	483		
Octave	$2^{\frac{12}{12}} = 2$	2	512	Octave	

Compared to the other tuning systems, Equal Temperament is fairly young, but it is by no means less important. J. S. Bach's *Well-Tempered Clavier* (1722) was one of the first compositions to demonstrate the power of Equal Temperament and flexibility of modulation. Just Temperament calculated as above will produce a pleasing harmony because all the intervals are pure.

Alexander John Ellis (1814 – 1890) developed another similar concept, **the cent**. In Alexander’s scheme the octave would be broken down into 1200 cents, making each equal tempered half tone equal to exactly 100 cents.

$$1 \text{ Cent} = \sqrt[1200]{2} \quad 1 \text{ Half Tone} = 100 \text{ Cents} = \sqrt[12]{2} = 1.059463$$

Notice that if you take a frequency, and multiply it by 1.059463, you get the frequency for the next note. If you repeat this step 11 more times for each note in an octave, you will find that you have exactly doubled the original starting frequency.

In the preceding section C.4, it was suggested that a harmonic series based on 12ths could be constructed in addition to the series based on 16ths. The following information shows the series based on 12ths, which has a harmonic increment of 0.083333; this has been called the Mitosis Scale by Edwards in Svpvrl message #4685. The Equal Tempered tones are shown for comparison.

	“12ths”		Equal Tempered
	Base 22.00 [<i>base frequency of the example in C.4</i>]		
1 st	23.833 [1 ST and 6 TH values are ~ base – complement]		23.308
2 nd	25.667		24.694
3 rd	27.50 [the harmonic increment for 22.00 is 1.8333]		26.163
4 th	29.333		27.718
5 th	31.167		29.366
6 th	33.00 [this is the perfect fifth of the base value]		31.113
11 th	42.167		
12 th	44.00 <i>at the 12th addition, you will have doubled the base frequency</i>		

D.5 TRIADS and PODS

The basic chord of music is called the *triad or chord of three tones*. It provides the underpinnings of the seven-note scale, the scale of the octave. A triad can be demonstrated by playing a simple C major chord containing three notes: C, E, and G.

The triad that Johann Doebereinger found in the relationships of atomic structures was based on a principal that he found to be similar to the principal of a musical triad. In 1829, Doebereinger demonstrated that particular elements could be arranged in groups of three, according to their weights. In each group of three, the elements had similar properties and the weight of the middle atom in the group was close to the average of the other two. These were said to be chemical equivalents to the musical "triad," the most basic chord in music.

Musically, **the major triad consists of the Fundamental tone, a major Third and a Fifth**. Therefore the ratios are:

$$\begin{array}{ccc} \mathbf{C} & : & \mathbf{E} & : & \mathbf{G} \\ \mathbf{1} & : & \mathbf{5/4} & : & \mathbf{3/2} \end{array}$$

Other major triads:

$$\begin{array}{ccc} \mathbf{C} & \mathbf{F} & \mathbf{A} \\ \mathbf{C} & \mathbf{E_b} & \mathbf{A_b} \end{array}$$

From an acoustics or sound therapy viewpoint, triads could also represent the three tones of the fundamental, fourth and fifth. Note that the fourth is the inversion of the fifth, and that the fourth and fifth taken together form a full octave. This would follow the triad logic of Doebereinger that was referred to above.

The musical triad also corresponds to the three primary colors of the color spectrum that can be seen when light is passed through a prism. These colors are red, yellow, and blue: the only three colors that cannot be created by combining other colors. Yes, there is a color octave also. The same patterns that are the basis of sound and music are also the basis of all nature.

See: Octaves in Light and Sound <http://www.cosmicharmony.com/Ha/HAmain.htm>

A POD is a subset of the 12-note wheel, and is defined in the descriptive terms of the preceding table in the equal tempered scale section. In SVP #5484, Edwards defines "*A POD is a set of 6 notes. In combination the body uses these notes to create structure, maintain structure, process biochemistry and protect the body from outside influences.*"

The following description comes from Ms. Edwards' posting # 5536 to the Svpvrl discussion group on Yahoo.

We would start with the note I heard and we called it a BASE note. Sometimes the note that would help them was just the opposite of that note; 180 degrees away if you were to look at the notes as positions on a clock. This mathematically was also the complement of the BASE if you were to translate the note into a color. So now we have a BASE and another note that is 180 degrees away. We needed something to call it, so we called it a RECIPROCAL - or opposite.

Sometimes, the Base nor the RECIPROCAL would work so we would "tweak" around on the note. We found that the BASE was pretty set and usually would not allow for much "tweaking" but the RECIPROCAL was very open to being tweaked.

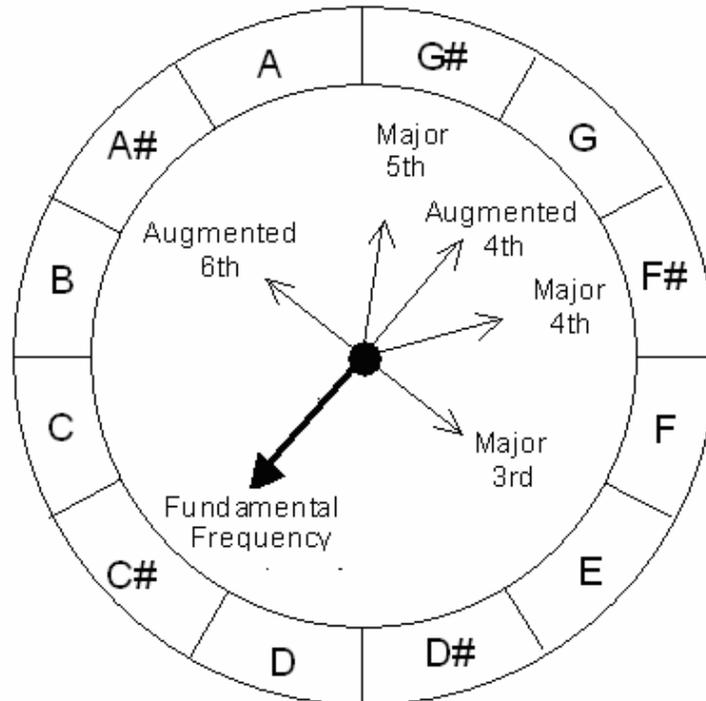
When you tweak backwards on a RECIPROCAL, sometimes you can tweak so much that you get another note. The same with tweaking forward on a RECIPROCAL. These notes we found were helpful to maintain the processing, emotional or biochemical, for the body.

Sometimes, the body liked two notes together. When you use the BASE and RECIPROCAL together, the body creates two additional notes. One that is the difference of the BASE and RECIPROCAL and one that is the average of the BASE and RECIPROCAL. We called these notes CONVERGED notes and found them helpful in dealing with outside influences on the body.

Each position definitely represents something specific to the body. The BASE is used for physical, self issues. The RECIPROCAL that is direct to the BASE is used for physical maintenance. The -1 and +1 RECIPROCALs is used for processing of emotional or biochemical issues that are self generated. The CONVERGED notes most often help with issues that are from outside the body, like toxins. The placement comes from looking at the notes in a circle configuration.

The original musical terms for the POD are shown on the following diagram:

(courtesy of Dan Kunkel, Biowaves)



D.6 NOTE CORRELATES

The first known work correlating the 12 notes of the chromatic scale to physical and emotional issues was performed by **Robert Sewak, Ph.D in Vocal Technology**. He published his findings as “Voice, Sound and Music, a New Technology” in 1984. Note correlates are useful in a general way to help understand potential energetic issues showing as anomalies in voice analysis.

Wayne Perry evidently accessed Sewak’s information and created a **Correlative Healing Chart for Sound Therapy** which was copyrighted in 1993. Mr. Perry is noted for conducting healing sessions, classes, and workshops on Toning through his own company, Musikarma Productions. Mr. Perry is also the founder and director of the Sound Therapy Center of Los Angeles, and he has been in private practice as a sound therapist and vibrational healer since 1992.

Mr. Perry’s correlate chart was included with one of his audio cassettes in the mid 1990s. Perry also had a radio show in southern California in the early 1990s and interviewed Sharry Edwards on one of his shows. Mr. Perry’s chart is publicly available through various bookstores and at <http://www.wayneperry.com/collect.htm> near the bottom of the page.

Ms. Edwards studied Sewak’s note correlate information and created her own **Sound Health Note Correlate Chart** which was copyrighted in 1996. The physical and emotional aspects of the 1996 chart basically duplicates Perry’s chart which was based on Sewak’s original work reported in 1984. The Sound Health chart has additional correlates to various biochemicals and muscles. Both charts include color correlates for all 12 notes, although there are some slight color differences between the two charts.

A sampling of Note Correlate information from Mr. Perry’s chart is shown below:

Note	C red	D orange
Physical Correlates	Gross circulation Large muscles Heart muscle Hormones ..	Digestion Liver Pancreas Gall bladder ..
Emotional Correlates	Self power issues Listlessness Ability to self - direct ..	Self approval issues Complainer Sexuality issues Low self esteem ..
Astrological Correlates	Aries	Gemini
Energy center Chakra	1st Chakra Base/Root	2nd Chakra Sacral/Spleen

D.7 BINAURAL BEATS

In 1839, German experimenter H.W. Dove determined that the brain produced its own unique tone, or 'third beat', when two separate tones of slightly differing frequency were applied separately / simultaneously to each ear. This third signal, perceived only in the brain, is actually the difference between the two frequencies being presented to the ears. Dove speculated that binaural beats were an evolutionary adaptation of the brain to localize sound accurately.

For example, a tone of 530 Hz in the left ear, and a tone of 540 Hz in the right ear will combine in the brain to form the difference of 10 Hz - which corresponds to an alpha brainwave state. The tones produced by the two frequencies are heard by the listener as pulsating, rhythmic signals.

In nature, these phase differences would be used to determine location of a sound source. But in an artificial environment of headphones, binaural beats can induce a frequency following response (FFR). Using the two frequencies 100 and 104 Hz produces a binaural beat in the brain of 4 Hz, which can be used to entrain the brain.

Since the range of human hearing is between 20 to 20,000 Hz, many frequencies that could be beneficial to the brain are too low for the ears to hear (the lower frequencies ranging from 1-20 Hz). For this reason, binaural beat technology can play an essential role in helping the brain produce lower frequency effects in sound therapy

Research into binaural beats was performed by Dr. Gerald Oster at the Mount Sinai Hospital in the early 1970's. Dr. Oster had been investigating the effects of sound waves on the brain. Dr. Oster also published an article in Scientific American in **1973** on ***Auditory Beats in the Brain***, which explains in detail the beat phenomena and the 'phase difference' involved using two separate frequencies. He stated that beats are produced when the two tones were within 18%.

Robert Monroe also researched binaural beats in the 1960's and 70s; he created an extensive Hemi-Sync technology which is still in use today. Mr. Monroe was awarded a United States Patent number 5,213,562 for his ***Method of Inducing Mental, Emotional and Physical States of Consciousness, Including Specific Mental Activity, in Human Beings***.

The patent describes that binaural beat phenomenon in general works as follows. *"When an individual receives signals of two different frequencies, one signal to each ear, the individual's brain detects a phase difference or differences between these signals. When these signals are naturally occurring, the detected phased difference provides directional information to the higher centers of the brain. However, if these signals are provided through speakers or stereo earphones, the phase difference is detected as an anomaly. The resulting imposition of a consistent phase difference between the incoming signals causes the binaural beat in an amplitude modulated standing wave, within each superior olivary nucleus (sound processing center) of the brain. It is not possible to generate a binaural beat through an electronically mixed signal; rather, the action of both ears is required for detection of this beat."*

See also <http://davidicke.www.50megs.com/icke/magazine/vol10/research/5213562.html> , and U.S. patent 2,304,095 which relates a method of inducing sleep by generation of an audible sound.

D.8 MATHEMATICS OF MUSIC

Many people in sound therapy would probably prefer to have mathematics buried in a computer program, never to see the light of day; after all they're interested in sounds not mathematics. If this is your preference as well, then you may want to skip this section. However, if you want to understand a bit more about the current art of sound therapy and physiological acoustics, then please read on even if you think you're somewhat math phobic.

Previous sections of both this part of the Summary on Music and the last part on Harmonics have used ratios and the equivalent decimal fractions. The Lambdoma Matrix started as simple ratios 2500 years ago, and musical scales are still explained in terms of ratios. Pitches are given as a ratio between the base or fundamental pitch and the named pitch.

It doesn't matter what part of the musical scale (note) that you start with, a particular relation such as the fifth (3/2) is calculated in the same manner. The same relationship holds for frequencies, whether it represents sounds or colors. If it is desired to combine two intervals starting from a given note, for example a step of an octave (ratio of 2:1) followed by another fifth (3:2), then the ratios must be compounded as:

$$\frac{2}{1} \times \frac{3}{2} = \frac{3}{1}$$

Considering an octave of the Equal Tempered Scale, one can view the calculation of the 12 notes in mathematical terms. **Octaves are an exponential function with 2 as base; $y = 2^x$** , and the results are shown in the Formula and Factor columns of the table in section D.4. By this formula, the twelfth part of an octave is calculated as 2 to the 1/12th power or 1.05946, and when this step is repeated twelve times, it brings the tone to the next octave above the base tone.

Thus, to **measure intervals in a proper sense, we need to use the logarithm of the ratio**, not the characteristic ratio itself. This is the logic behind the formula for the 12 notes of the Equal Tempered Scale, and the reason for the following:

- * **Inverse** (opposing) note = 2 to the 6/12th or 1/2 power or square root of 2 \approx **1.4142**;
- * **Converged**, quarter note = 2 to the 1/4th power or fourth root of 2 = square root of the square root of 2 \approx **1.1892**;
- * **The 2nd converged** note = 2 to the 3/4th power or the **inverse of the quarter note**.

A **Tutorial for logarithms** is available at the following website, in case you want a review:
<http://www.phon.ucl.ac.uk/cgi-bin/wtutor?tutorial=t-log.htm>

Using the logic for powers of 12ths above, note that **the fifth is 1.4983** (versus 1.50 or 3/2) and the **fourth is 1.3348** (versus 1.333 or 4/3), which would be very small differences (considering a fudge factor of 0.03) when dealing with frequencies in the Beta brain wave octave.

Additional information regarding Octaves as an exponential function can be found at website:
<http://home22.inet.tele.dk/hightower/exponential.htm>

The Arithmetic and Harmonic Means (averages)

Considering a set of n frequency points (f_1, f_2, \dots, f_n)

The Arithmetic Mean = (sum of frequencies) / (number of frequencies)

$$\text{Mean} = \sum_{i=1}^n f_i / n, \text{ where } i = 1 \dots n$$

For 2 frequencies, mean = $(f_1 + f_2) / 2$

Where the reciprocal of a frequency, $rf = 1 / f$,

The Harmonic mean, Hm = (sum of reciprocals) / (number of frequencies)

$$1 / \text{Hm} = \sum_{i=1}^n rf_i / n, \text{ where } i = 1 \dots n$$

-or-

$$\text{Hm} = 1 / \left[\sum_{i=1}^n rf_i / n \right]$$

For 2 frequencies, Hm = $2 * f_1 * f_2 / (f_1 + f_2)$

Consider the two Beta frequencies 32:16 which express the octave 2:1;

The Arithmetic Mean = 24.00, and

The Harmonic mean = 21.33

For the mathematics of the octave, it is interesting to note that

the *fifth* is the **arithmetic mean** of an octave ($16 * 3/2 = 24$), and

the *fourth* is the **harmonic mean** of an octave ($16 * 4/3 = 21.33$).

The *fourth* and *fifth* combined form an octave: $3/2 * 4/3 = 2/1$.

There are other measures of the mean which could potentially be significant to sound therapy, but the calculations above with the rest of musical scales and relationships is undoubtedly more than you wanted to know.