Global Scaling Theory

Compendium

A Natural Phenomenon

Scaling means logarithmic scale-invariance. Scaling is a basic quality of fractal structures and processes. The Global Scaling Theory explains why structures and processes of nature are fractal and the cause of logarithmic scale-invariance.

Historical Excursion

Scaling in Physics

In 1967 / 68 Richard P. Feyman and James D. Bjorken discovered the phenomenon of logarithmic scale-invariance (scaling) in high energy physics, concrete in hadron collisions.
Feynman R. P. Very High-Energy Collisions of Hadrons, Phys. Rev. Lett. 23 (1969), 1415
Bjorken J. D. Phys. Rev. D179 (1969) 1547

Simon E. Shnoll found scaling in the distributions of macroskopic fluctuations of nuclear decay rates. Since 1967 his team discovers fractal scaling in the fluctuation distributions of different physical and chemical processes, as well as in the distributions of macroskopic fluctuations of thermic noise processes.
Shnoll S. E., Oscillatory processes in biological and chemical systems, Moscow, Nauka, 1967
Shnoll S. E., Kolombet V. A., Pozharski E. V., Zenchenko T. A., Zvereva I. M., Konradov A. A., Realization of discrete states during fluctuations in macroscopic processes, Physics Uspekhi 41 (10) 1025 - 1035 (1998)

In 1982 – 84, Hartmut Müller discovered scaling further in the distributions of elementary particles, nuclei and atoms dependent on their masses, and in the distributions of asteroids, moons, planets and stars dependent on their orbital properties, sizes and masses.
Müller H. Scaling in the distributions of physical properties of stable systems as global law of evolution. Second Soviet Biophysical Congress, vol. 2, Moskow / Pushchino, 1982 (in Russian)
Müller H., Evolution of matter and the distribution of properties of stable systems, VINITI, 3808-84, 1984 (in Russian)

Scaling in Seismicity

Within the fifties Beno Gutenberg and Charles Richter have shown, that exists a logarithmic invariant (scaling) relationship between the energy (magnitude) and the total number of earthquakes in any given region and time period.
Gutenberg B., Richter C. F., Seismicity of the Earth and Associated Phenomena, 2nd ed. Princeton, N.J.: Princeton University Press, 1954

Scaling in Biology

In 1981, Leonid L. Chislenko published his work on logarithmic scale-invariance in the distribution of biological species, dependent on body size and weight of the organisms. By introducing a logarithmic scale for biologically significant parameters, such as mean body weight and size, Chislenko was able to prove that sections of increased specie representation repeat themselves in equal intervals (ca. 0.5 units of the log based 10 scale).
Chislenko L. L., The structure of the fauna and flora in connection with the sizes of the organisms, Moskow University Press, 1981 (in Russian)

In 1984, Knut Schmidt-Nielsen was able to prove logarithmic scale-invariance in the construction of the organisms and in metabolic processes.
Schmidt-Nielsen K., Scaling. Why is the animal size so important? Cambridge University Press, 1984.

In 1981, Alexey Zhirmunsky and Viktor Kuzmin discovered process-independent logarithmic scale invariance in the development stages in embryo-, morpho- and ontogenesis and in geological history.
Zhirmunsky A. V., Kuzmin V. I., Critical scaling levels in the development of biological systems, Moskow, Nauka, 1982 (in Russian)

Scaling in Neurophysiology

We live in a logarithmic world. All of our senses perceive the logarithm of a signal, not the linear intensity of the signal itself. That is why we measure sound volume in decibels, and consequently in logarithmic units.

Sounds whose frequencies differentiate themselves by double, quadruple or eight-times, we perceive as a, a' or a'', the same sound. This property of our sense of hearing makes it possible for us to differentiate harmony from disharmony. The harmonic sound sequence 1/2 (Octave), 2/3 (Fifth), 3/4 (Fourth), 4/5 (Major Third), and so forth is logarithmic, hyperbolic scale-invariant.

Our sense of touch is also calibrated logarithmically. Assuming that one holds in the left hand 100 grams and in the right hand 200 grams; if one then adds 10 grams to the left hand, then 20 grams must be added to the right hand in order to sense the same weight increase. This fact is known in Sensing Physiology as the Weber-Fechner Law (Ernst Heinrich Weber, 1795 – 1878, Gustav Theodor Fechner, 1801 – 1887): The strength of a sensory impression is proportional to the logarithm of strength of the stimulus.

The Weber-Fechner law also touches on our senses of smell and sight. The retina records only the logarithm, not the number of impinging photons. That is why we can see not only in sunlight but also at night. Whereas, the number of impinging photons varies by billionths, the logarithm varies only by twentieths. ($\ln 1000{,}000{,}000 \approx 20.72$)

Our vision is logarithmically calibrated not only in regards our perception of the intensity of light, but also relative to the lights wave length which we perceive as colors.

Our ability to judge lineal distances is based on the possibility of comparison of sizes and the determination of relative measurement scales. The linear perspective assumes a constant size proportion that is defined by size enlargement or reduction factor. This factor is multiplied several times with itself in the perspective. From this an exponential function is defined which argument is a logarithm.

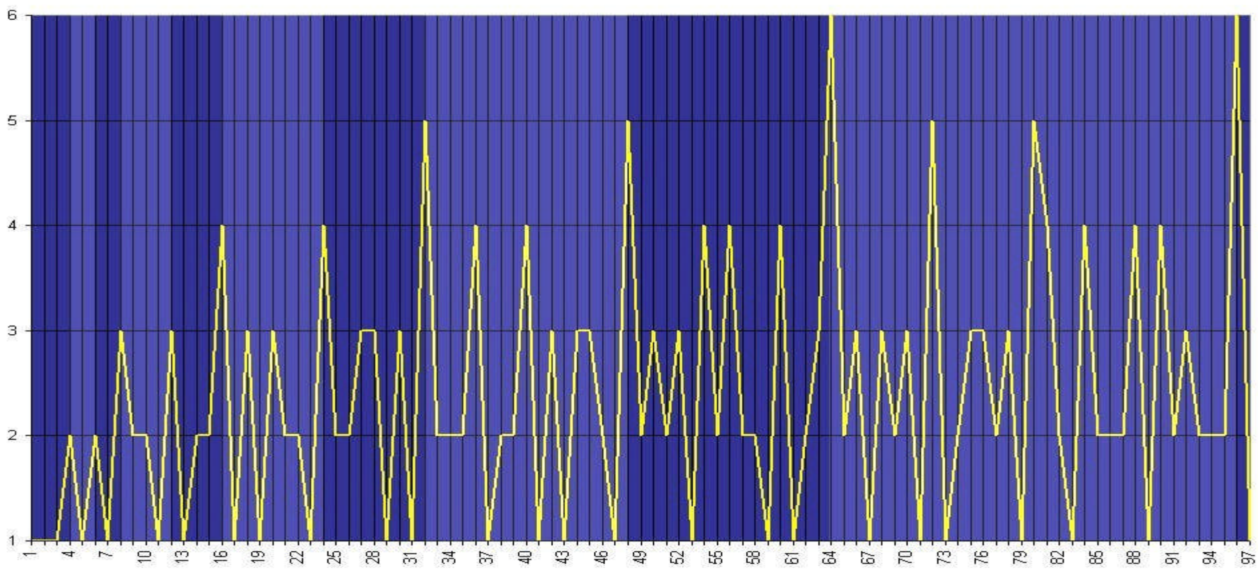
The function of our sense organs is concerned with acoustic or electromagnetic wave processes. The logarithmic scale-invariant perception of the world is a consequence of the logarithmic scale-invariant, construction of the world.

Scaling in Mathematics

All natural numbers 1, 2, 3, 4, 5 ... can be constructed from prime numbers. Prime numbers are natural numbers that are only divisible by the number 1 and themselves without leaving a remainder; accordingly, the numbers 2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31 … are quasi elementary parts of the real number continuum. The distribution of the prime numbers among the natural numbers is irregular to such an extent that formula for this distribution cannot be defined. Of course, prime numbers become found more seldom the further one moves along the number line. Already in 1795, Carl Friedrich Gauß noticed this. He discovered that the set $p_1(n)$ of prime numbers up to the number n could be calculated approximate according to the formula $p_1(n) = n / \ln n$. The larger the value of n, the more precisely is this law fulfilled; and means that the distribution of the set of prime numbers among the natural numbers is scale-invariant.

Non-prime numbers can clearly be represented as products of prime numbers. One could also say that non-prime numbers are prime-number clusters. This means that non-prime numbers are composed from several prime numbers. In this interpretation, one can derive the prime-factor density distribution on the number line.

The next figure demonstrates the logarithmic fractal character of the distribution of the prime-factor density. The diagram shows the number of prime-factors (vertical axis) for natural numbers (horizontal axis).



If one compares the distribution, for example the lighter marked areas, one can recognize a repeat of the example, from right to left, so to speak, with decreasing resolution. The further one moves along the number line from right to left, the more the logarithmic fractal unfolds to reveal the set of prime-factors.

The logarithmic scale-invariance of the distribution of the prime numbers is a fundamental property of the continuum of numbers. Moreover, this is the only non-trivial statement that holds true for all prime numbers.

Logarithmic scale-invariance of the prime-factor density distribution means that one can speak about a standing density-wave in the number continuum. The prime factors, 2 and 3 produce the base-oscillation, and early prime factors produce the spectrum of overtones.

Scaling in Technology

In 1987, Hartmut Müller discovered Scaling as a developmental property of technical systems in relative to their functionally relevant physical properties. Based on a fractal scaling proton resonance model, he developed methods of optimization and prognostication of technical processes.
Müller H., The General Theory of Stability and evolutional trends of technology // Evolutional trends of technology and CAD applications. Volgograd Institute of Technology, 1987 (in Russian)
Müller H., Superstability as evolutional law of technology. // Orders of technology and their applications, Volgograd-Sofia, 1989 (in Russian)

During 1982 – 1989, Hartmut Müller developed the basis of Global Scaling Theory. For his scientific achievements in 2004 he was endowed by the International Interacademic Union in Moscow with their highest honor, the Vernadski-Medal of the First Grade.

From the Model to the Theory

Oscillations are the most energetically efficient kind of movement. For this reason, all matter, not only each atom, but also the planetary system and our galaxy, oscillate and light is an unfolding oscillation and, naturally, the cells and organs of our bodies also oscillate.

Based on their energy efficiency, oscillatory processes determine the organization of matter at all levels – from atoms to galaxies.

In his most meaningful work, "World Harmonic", Johannes Kepler established the bases for harmonic research. Building on the ancient musical 'World Harmony' of the Pythagoreans, Kepler developed a cosmology of harmonics.

Global Scaling research continues this tradition.

The Melody of Creation

Scaling arises very simply – as a consequence of natural oscillation processes. Natural oscillations are oscillations of matter that already exist at very low energy levels. Therefore they lose few energy, and likewise fulfill the conservation law of energy.

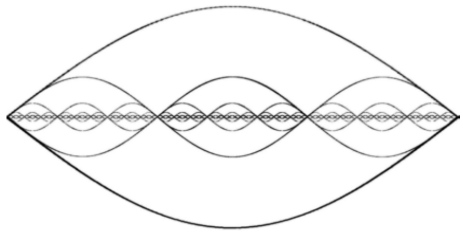
The energy of an oscillation is dependent on its amplitude as well as on its frequency (events per time unit).

Consequently, the following is valid for natural oscillations: The higher the frequency, the less the amplitude. For natural oscillations, the product of frequency and wave length as well as the product of frequency and amplitude are conserved. They limit the speed of propagation of oscillations in mediums, or the speed of deflection.

A standing wave in a homogeneous space arises only if in the direction of the wave penetration the space is finite and if the half wave length is equal to an integer part of the medium size.
As a consequence we can find for any low enough resonant oscillation mode frequency f_0 a higher mode frequency f_1 with an integer relationship n = f_1 / f_0. The frequencies of such resonant oscillation modes generate exponential series:

$$f_{n,k} = f_0 \cdot n^k$$

The next figure shows the situation with n = 3 and k = 0, 1, 2, ... for transversal oscillations:



Therefore, the complete resonant oscillation frequency spectrum can be represented as a set of logarithmic fractal spectra (1) with natural n = 1, 2, 3, ... In this representation the generation of the complete resonant oscillation frequency spectrum can be understood as an arithmetical task, what can be reduced to the fundamental theorem of arithmetic, that every natural number greater than 1 can be written as a unique product of prime numbers.

In our example, the oscillation period of the 1. mode is three times longer that the period of the 2. mode, nine times longer than the period of the 3. mode and 27 times longer that the period of the 4. mode. From this follows the logarithmic, fractal, construction of the (repeating itself in all scales) oscillation representation. In this connection, one speaks of scale-invariance (Scaling). In nature Scaling is distributed widely – from the elementary particles to the galaxies. It is in this connection that one speaks of Global Scaling.

Natural oscillations of matter produce logarithmic, fractal spectrums of the frequencies, wave-lengths, amplitudes and a logarithmic fractal network of oscillating nodes in space.

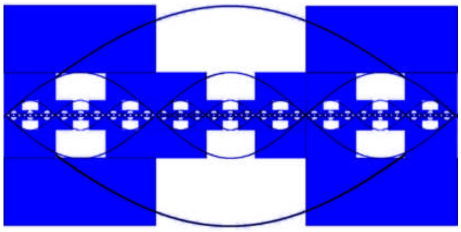
In physical mediums, base-tones, upper- or undertones are produced simultaneously, and in this there arise consonances and dissonances. Not only our hearing can distinguish consonance from dissonance; this capability extends to all matter, and has to do with the energy expenditure necessary to produce an overtone. A musical ‘Fifth’ arises most easily (the least expense of energy per oscillation period), because merely a frequency doubling and trebling is necessary in order to produce an overtone in interval of 3/2 of the base frequency. Somewhat more energy is necessary to produce a musical ‘Fourth’, 4/3, while this additionally requires a quadrupling of the base frequency; and even more energy is necessary for the production of the larger musical ‘third’, 6/5, of the same amplitude, and so forth.

The musical intervals accordingly play an energetic, key-role in the spectrum of the natural-oscillation-modes. In fact, this spectrum is constructed like the spectrum of a melody.

Natural oscillations of matter are probably the most important structure-forming factor in the Universe. For this reason one finds fractal proportions everywhere in nature. The logarithmic, fractal distribution of matter in the universe is a consequence of natural oscillation processes in cosmic, space and time measurement scales. In this connection, one speaks of the “Melody of Creation”.

Logarithmic periodic structural Change

Oscillation-troughs displace matter that then concentrates in the oscillation-nodes. In this way, a logarithmic, fractal distribution of matter density arises in the natural oscillating medium. The next figure, as example, demonstrates this situation.



In the oscillation nodes of the logarithmic fractal oscillation modes the spectral density is maximum. Where the amplitudes of the oscillation modes are maximum, the medium particles have maximum kinetic energy, but near the oscillation nodes the kinetic energy is minimum. The distance between the ranges with maximum particle density (nodes) is the half of the oscillation mode wave length. As consequence, the distribution of the medium particle density will be fractal and exactly the same (isomorphism) as the distribution of the spectral density. The figure shows, that with p = 3 arise Cantor fractals with Hausdorff dimensions, for example, $D = \ln 2 / \ln 3 \cong 0{,}63$.
Georg Cantor. Über unendliche lineare Punktmannigfaltigkeiten. Math. Annalen, 1883
Hausdorff F. Dimension und äußeres Maß. Math. Annalen 79 (1919), pp. 157 – 179

A tendency towards fusion arises during the compression phase, in the transition from a wave-trough to a node, and likewise during the decompression phase, a tendency towards disintegration, in the transition from a node to wave-trough. This change from compression to decompression causes a logarithmic, periodic structural change in the oscillating medium; and areas of compression and decompression arise in a logarithmic, fractal pattern.

A logarithmic-periodic structural change can be observed in all scales of measurement of the universe – from atoms to galaxies.

Determined by global logarithmic-periodic compression and decompression change, essential structural signposts in the universe repeat themselves unobserved, that it is a question of various scales of measurement.

Compressed atomic nuclei with a density in the range of 10^{14} g/cm^3 form larger decompressed atoms whose densities, for example for metals this lies between 0.5 and 20 g/cm^3. Small molecules are, as a rule, more compressed than large molecules. Compressed cell nuclei (and other cell organelles) form relatively decompressed cells. Organisms form (relatively decompressed) populations. Heavenly bodies (moons, planets and stars) form decompressed planetary systems. Compressed star-clusters are, in large measure, detached which again forming relatively compressed galaxy-clusters.

We have the good fortune that galaxy-clusters belong among the compressed structures in the universe. Due to this circumstance, we can be thankful that we know about the existence of other galaxies. If the matter in the universe were not logarithmic, scale-invariant, but linearly distributed, the distances between galaxies would be proportionally; exactly so large as the distance between the stars in our galaxy, and we would have no chance to ever learn anything of the existence of another galaxy. Consequently, Scaling is a global phenomenon, so to speak, the creation plan of the universe.

Continued Fraction as Word Formula

In the works “About Continued Fractions” (1737) and “About the Oscillations of a String” (1748), Leonhard Euler formulated problems whose solutions would keep the field of mathematics busy for 200 years.
Euler L. De oscillationibus fili flexilis quotcunque pondusculis onusti. Opera omnia, II – 10, 35 –49

Euler investigated natural oscillations of an elastic, mass-less string of pearls. In connection with this task, d’Alembert developed his method of integration for a system of linear differential equations. Daniel Bernoulli asserted his known statement that the solution of the problem of the free-oscillating string can be represented as trigonometric sequence, something which started a discussion between Euler, d’Alembert and Bernoulli lasting a decade. Later, Lagrange showed more correctly how one arrives at the solution of the problem of oscillations of a string-of-pearls and the solution of the problem of a homogenous string. The problem-solution was first completely solved by Fourier in 1822.

Almost insurmountable problems arose in the meantime with pearls of various mass and irregular distribution. This task led to functions with gaps (or voids). After a letter from Charles Hermite, May 20, 1893, who additionally added, “Reject in nervous horror the lamentable annoyance of the functions without derivative”; T. Stieltjes investigated functions with discontinuities and found an integration method for these functions which led to continued fractions.
Stieltjes T. Recherches sur les fractions continues, Ann. de Toulouse, VIII-IX, 1894-1895

Meanwhile, Euler already recognized that complex, oscillating systems can contain such solutions (integral) that themselves are not overall differentiateable, and left behind to the future mathematical world an analytical “monster” – that is, the non-analytic functions (this term was chosen by Euler himself). Non-analytic functions provided ample and profuse study up to the 20th century, after the identity crises in mathematics, appeared to be conquered.

The crises began, and lasted until about 1925, when Emil Heinrich Bois Reymond, in 1875, reported for the first time about a Weierstrass constructed continuous, but non-differentiable function. The main players were Cantor, Peano, Lebesgue and Hausdorff; and as a result, a new branch of mathematics was born – Fractal Geometry.

Fractal comes from the Latin 'fractus' and means “broken-up-in-pieces” and “irregular.” Fractals are consequently distinct, fragmentary, tricky mathematical objects. Mathematics in the 19th Century considered these objects as exceptions and from there, tried to derive fractal-objects from regular, continuous and smooth structures.

The theory of fractal groups made possible in-depth investigations in “non-analytic”, manifold, granular or fragmentary forms. It immediately it becomes apparent that fractal structures are by no means so infrequently encountered in the world. More fractal objects are discovered in nature than ever suspected. Moreover, it suddenly seemed as if the entire natural universe were fractal.

Especially, works of Mandelbrot finally advanced the geometry to the position where fractal objects could be mathematically correctly described: fragmented crystal-lattices, Brownian motion of gas molecules, complex, giant polymer-molecules, irregular star-clusters, cirrus-clouds, the Saturn rings, the distribution of moon-craters, turbulences in fluids, bizarre coast-lines, snake-like river-streams, faults in mountain-chains, development branches of the most varied kinds of plants, surface areas of islands and lakes, mineral-formations, geological sediments, the distribution in space of raw-material-occurrences, and, and, and……

A deciding factor in the accurate treatment of fractal objects was the introduction of real and also irrational dimensions, in contrast with the whole-number dimensions of Euclidean Geometry. Let's consider an example: In Euclidean Geometry, a disappearing, small grain-of-sand has dimension 0. A line – dimension 1. But which dimension does sequence of grains-of-sand arranged one after the other? The Euclidean point of view only knows boundary conditions: Either one proceeds on a wide path – until one cannot recognize anymore grains-of-sand and then assigns to this object the dimension 1, or one recognizes the grains-of-sand as objects of dimension 0. and while it is usually known that 0=0=…+0 = 0, the grains-of-sand, are likewise assigned dimension 0. That through this the essential is lost is obvious.

The first step of an in-depth analysis of this situation was undertaken by Cantor in his letter of June 20th, 1877 to Dedekind, the next was followed by Peano in 1890. The mathematicians recognized that an accurate understanding of fractal structures could not be reached when one defines 'dimensions' as a number of coordinates. Therefore, in 1919 Hausdorff defined a new conception of dimension. The fractal (broken) dimension D completed the topological (whole-number) dimension through logarithmic values. The fractal dimension of a grain-of-sand sequence of N grains-of-sand of the relative (In comparison to the total length of the sequence) size 1/k, where D = log(N) / log(k). Assuming a sequence of 100 grains-of-sand is 100 mm in length and the size of a grain-of-sand 1 mm. Then D = log (100) / log (100) = 1. However, if the sequence only consists of 50 grains-of-sand, then D = log (50) / log (100) = 0.849485. The fractal dimension D is, accordingly, a measure for the fragmentary nature of an object. The larger the gaps, the further D is from integer number values.

The application of the Hausdorff-Dimension in geometry now makes it possible to deal with not only completely irregular real mathematical objects, but at the same time provides the formula for the creation of home-made fractal creations. The creation of various Mandelbrot- und Julia-groups using the computer gave rise to a popular mathematical sport. The Mandelbrot-group is still today the object of non-resolved theoretical investigations. However, it is important that these through mathematics that their connections become visible, and are being investigated in the most varied of specialist fields.

Nevertheless, the fractal 'Grain-of-sand' sequence strongly reminds of Euler's 'String-of-Pearls.' Both of these objects are fractal. In 1950, the Leningrad mathematicians, F. R. Gantmacher and M. G. Krein regarded the line-of-deflection of an oscillating string of pearls as a broken line. This initial step even enabled them a fractal view of the problem, without which they were unaware (Mandelbrots Classic "Fractal Objects", appeared in 1975 and was his first works of which 50 were in the field of Linguistics). They first brought the Fractal visibly into the situation, and to completely solve (and also for the most general case) the 200 year old Euler Problem of the oscillating "Sting-of-Pearls" for variable masses and irregular Distribution.

In their work, "Oscillation-matrices, Oscillation-nuclei, and Small Oscillations of Mechanical Systems" (Leningrad, 1950, Berlin, 1960), Gantmacher and Krein show that Stieltjes-Continued-Fractions are solutions of the Euler-Lagrange equations for natural oscillating systems. These continued fractions produce fractal spectrums.

In the same year, the comprehensive work of Oskar Perron appeared "The Theory of Continued-Fractions." The theme was also worked on by N. I. Achieser in his work, "The Classical Moment Problem and Some Associated Questions About the Analysis (Moscow 1961). Terskich generalized the (with regard to the contents) Continued-fraction method on the analyses of Fundamental-oscillating, branching chain-systems (Terskich, V. P., The Continued-fraction Method, Leningrad, 1955). Khintchine resolved the meaning of Continued-fractions in arithmetic and algebra (Khintchine, A. J., Continued fractions. University of Chicago Press, Chicago 1964).

Additional works by Thiele, Markov, Khintchine, Murphy, O'Donohoe, Chovansky, Wall, Bodnar, Kučminskaja, and Skorobogat'ko, etc. helped lead to the final break-through for the continued-fraction method, and in 1981 enabled the development of efficient algorithms for the addition and multiplication of continued-fractions.

Each real number – and also each measurable value – can be clearly represented as a 'normed' continued fraction (all partial denominators are 1). Finite, normed continued fractions converge to rational numbers. Infinite continued fractions converge to irrational numbers. The next figure shows the continued fractions of some prominent irrational numbers:

$$\frac{\sqrt{5}+1}{2} = 1 + \cfrac{1}{1 + \cfrac{1}{1 + \cfrac{1}{1 + \cfrac{1}{1 + \cdots}}}} = 1{,}6180339\ldots$$

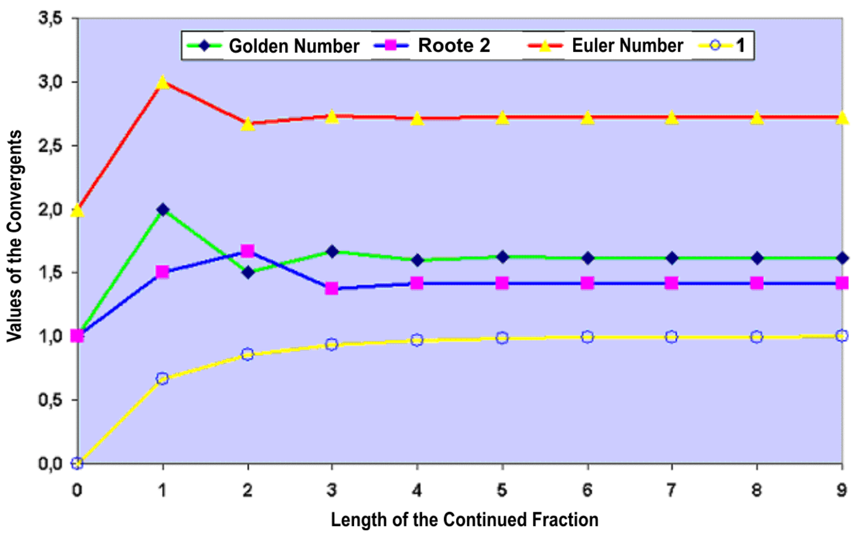
$$e = 2 + \cfrac{1}{1 + \cfrac{1}{2 + \cfrac{2}{3 + \cfrac{3}{4 + \cfrac{4}{5 + \cfrac{5}{6 + \cdots}}}}}} = 2{,}718281828459\ldots$$

$$\sqrt{2} = 1 + \cfrac{1}{2 + \cfrac{1}{2 + \cfrac{1}{2 + \cfrac{1}{2 + \cdots}}}} = 1{,}41421356\ldots$$

$$1 = \cfrac{2}{3 + \cfrac{2}{-3 + \cfrac{2}{3 + \cfrac{2}{-3 + \cdots}}}}$$

The simplest continued fraction generates the 'Golden Number' proportion. All of its elements are 1. Supposedly this is why the 'Golden Mean' is so wide-spread in nature. The sequence {1, 1/2, 2/3, 3/5, 5/8, 8/13, 13/21, 21/34, …} produce the sequence of Fibonacci-numbers. A quite special structure is exhibited by the continued fraction of the Euler-number $e = 2.71828 \ldots$ This continued fraction contains the sequence of all natural numbers and the sequence of all musical intervals. The convergent Continued-fraction for e is composed of the reciprocals of the musical intervals (Prime 1/1, Octave 1/2, Fifth 2/3, Fourth 3/4, Major Third 4/5, Minor Third 5/6, ….). The number 1 – and each other integer number – also can be represented as a continued fraction.

In its continued-fraction representation, every number is an oscillation-attractor. Khinchine could prove that convergent continued-fractions yield the best approximations of the irrational numbers because they themselves converge the most quickly on the eigenvalue of the continued-fraction. The next figure demonstrates both of these facts.



The Spectrum of Vacuum Resonances

The physical vacuum represents the possible energetically-lowest state of matter. This means, however, that in the vacuum only natural oscillations are possible:

The Planck Formula:

$$\Delta E = h \, \Delta f \qquad (1)$$

(h is the Planck Constant) gives the impression that the energy of the natural oscillation of a vacuum-oscillator is frequency-dependent and quantized. Consequently, energy can only be absorbed or emitted in determined portions. That also means that blue light is more energetic that red light.

Based on the continued fraction method we search the natural oscillation frequencies of a chain system of many similar harmonic oscillators in this form:

$$f = f_0 \exp(S) \qquad (2)$$

f is a natural frequency of a chain system of similar harmonic oscillators, f_0 is the natural frequency of one isolated harmonic oscillator, S is a continued fraction with integer elements:

$$S = \frac{n_0}{z} + \cfrac{z}{n_1 + \cfrac{z}{n_2 + \cdots + \cfrac{z}{n_i}}} \qquad (3)$$

The partial numerator z, the free link n_0 and all partial denominators n_1, n_2, ..., n_i are integer numbers. We follow the Terskich definition of a chain system where the interaction between the elements proceeds only in their movement direction.

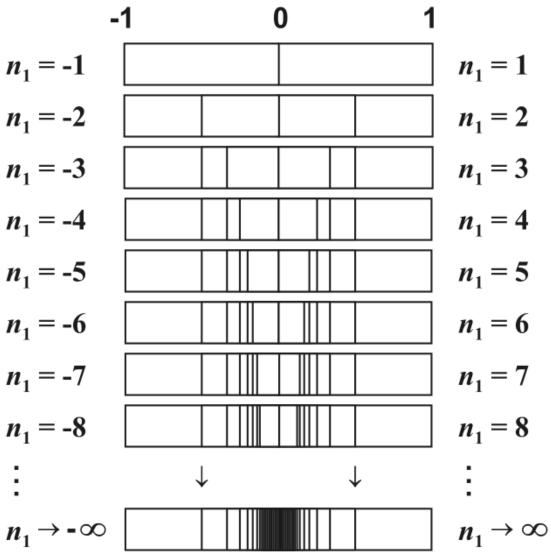
In this connection we understand the concept "spectrum" as a discrete distribution or set of natural oscillation frequencies. Spectra (2) are not only logarithmic-invariant, but also fractal, because the discrete hyperbolic distribution of natural frequencies repeats itself on each spectral level $i = 1, 2, ...$

Every continued fraction (3) with a partial numerator $z \neq 1$ can be changed into a continued fraction with $z = 1$. For this one can use the Euler equivalent transformation and present continued fractions (3) in the canonical form. With the help of the Lagrange transformation every continued fraction with integer partial denominators can be represented as a continued fraction with natural partial denominators, what is allways convergent. We will investigate spectra (2) which are generated by convergent continued fractions (3).

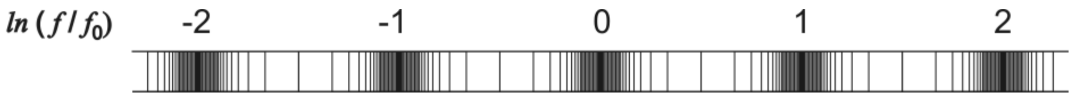
Every infinite continued fraction is irrational, and every irrational number can be represented in precisely one way as an infinite continued fraction. An infinite continued fraction representation for an irrational number is useful because its initial segments provide the best possible rational approximations to the number. These rational numbers are called the convergents of the continued fraction. This last property is quite important, and is not true of the decimal representation. The convergents are rational and therefore they generate a discrete spectrum. Furthermore we investigate continued fractions (3) with a finite quantity of layers which generate discrete spectra. In the logarithmic representation each natural oscillation frequency can be written down as a finite set of integer elements of the continued fraction (3):

$$\ln(f/f_0) = \frac{n_0}{z} + \cfrac{z}{n_1 + \cfrac{z}{n_2 + \ddots + \cfrac{z}{n_k}}} = [z, n_0; n_1, n_2, \dots, n_k] \qquad (4)$$

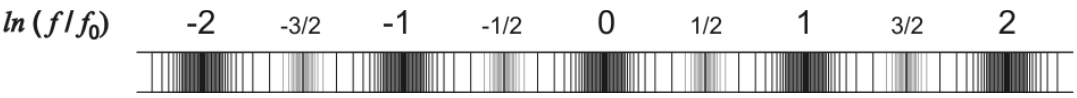
The following figure shows the generation process of such fractal spectrum for $z = 1$ on the first layer $i = k = 1$ for $|n_1| = 1, 2, 3, \dots$ and $n_0 = 0$ (logarithmic representation):



The partial denominators n_1 run through positive and negative integer values. Maximum spectral density ranges automatically arise on the distance of 1 logarithmic units, where $n_0 = 0, 1, 2, \dots$ and $|n_1| \to \infty$. The next figure shows the spectrum on the first layer $i = k = 1$ for $|n_1| = 1, 2, 3, \dots$ and $|n_0| = 0, 1, 2, \dots$ (logarithmic representation):



The more layers $i = 1, 2, 3, \dots$ are calculated, the more spectral details will be visible. In addition to the first spectral layer, the next figure shows the second layer $i = k = 2$ for $|n_2| = 1, 2, 3, \dots$ and $|n_1| = 2$ (logarithmic representation):



On each spectral layer i one can select ranges of relative low spectral density (spectral gaps) and ranges of relative high spectral density (spectral nodes). The highest spectral density corresponds to the nodes on the layer $i = 0$, where $|n_1| \to \infty$. The next (lower) spectral density level corresponds to the nodes on the layer $i = 1$, where $|n_2| \to \infty$, and so on. The largest spectral gaps are between the spectral node ranges on the layer n_0. On the spectral layers $i = 1, 2, 3, \dots$ the gaps are corresponding smaller.

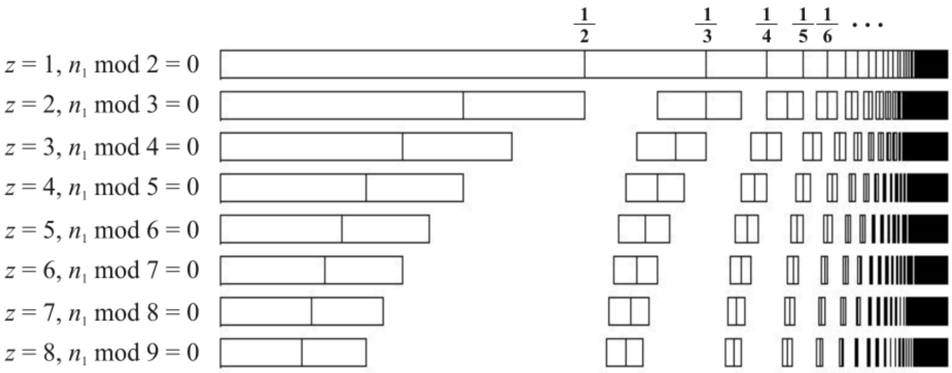
In 1795 Karl Friedrich Gauss discovered logarithmic scaling invariance of the distribution of prime numbers. Gauss proved, that the quantity of prime numbers $p(n)$ until the natural number n follows the law $p(n) \cong n / \ln(n)$. The equality symbol is correct for the limit $n \to \infty$. The logarithmic scaling distribution is the one and only nontrivial property of all prime numbers.

The free link n_0 and all partial denominators $n_1, n_2, n_3, ..., n_k$ are integer numbers and therefore they can be represented as unique products of prime factors. On this base we distinguish spectral classes in dependence on the divisibility of the partial denominators by prime numbers. In addition, we will investigate continued fractions which correspond to the Markov convergence requirement:

$$|n_i| \geq |z_i| + 1 \qquad (5)$$

Continued fractions (3) with $z = 1$ and partial denominators divisible by 2 don't generate empty spectral gaps, because the alternating continued fraction [1, 0; +2, -2, +2, -2, ...] approximates the number 1 and [1, 0; -2, +2, -2, +2, ...] approximates the integer number –1.

Divisible by 3 partial denominators with $z = 2$ build the class of continued fractions (3) what generates the spectrum (4) with the smallest empty spectral gaps. The next figure shows fragments of spectra, which were generated by continued fractions (3) with divisible by 2, 3, 4, ... partial denominators and corresponding partial numerators $z = 1, 2, 3, ...$ on the first layer $i = 1$ for $n_0 = 0$ (logarithmic representation):

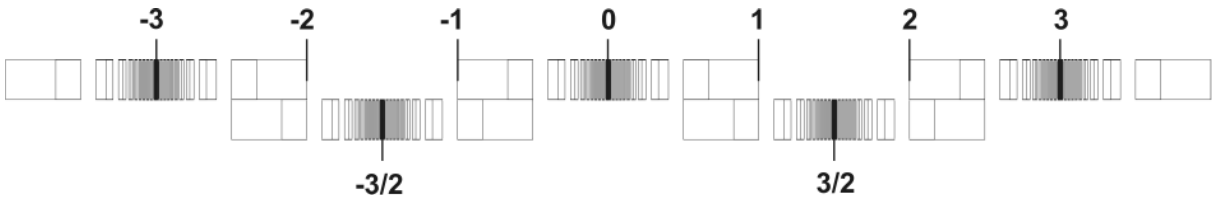


The figure shows the spectral nodes on the first layer $i = 1$ and also the borders of the spectral node ranges, so the spectral gaps are visible clearly. The borders of the spectral empty gaps are determined by the following alternating continued fractions ($z \geq 1$):

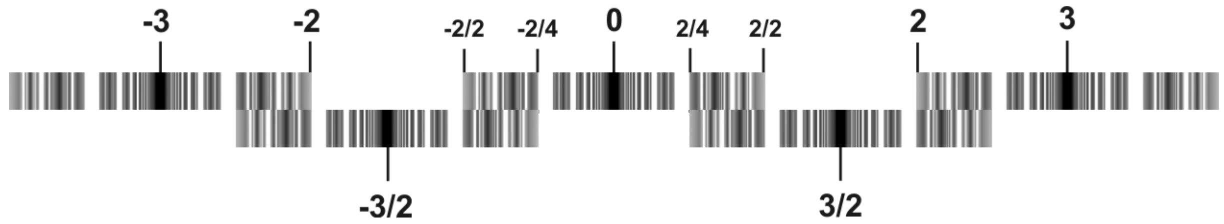
$$-1 = \cfrac{z}{-z-1+\cfrac{z}{z+1+\cfrac{z}{-z-1+\cdots}}} \qquad 1 = \cfrac{z}{z+1+\cfrac{z}{-z-1+\cfrac{z}{z+1+\cdots}}} \qquad (6)$$

More detailled we will investigate the second spectrum, what was generated by the continued fraction (3) with divisible by 3 partial denominators and the corresponding partial numerator $z = 2$. This spectrum is the most interesting one, because with $z = 2$ and $n_i \bmod 3 = 0$ starts the generation process of empty gaps. Possibly, that the spectral ranges of these gaps are connected to fundamental properties of oscillation processes.

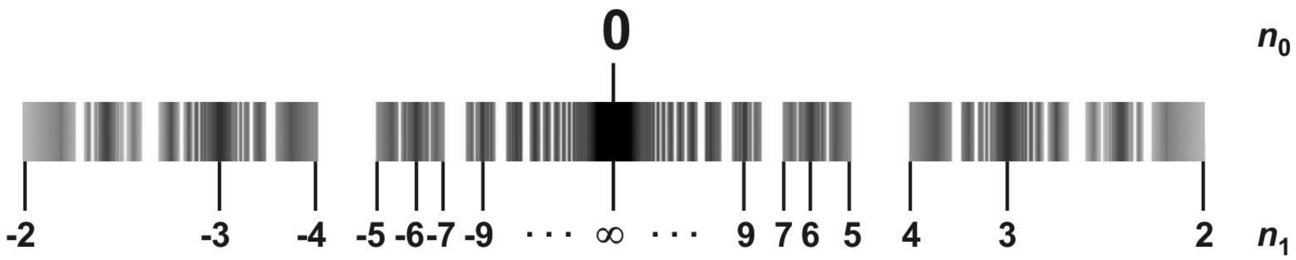
The partial denominators n_1 run through positive and negative integer values. The maximum spectral density areas arise automatically on the distance of 3/2 logarithmic units, where $n_0 = 3j$, (j = 0, 1, 2, ...) and $|n_1| \to \infty$. The following figure shows the spectrum on the first layer $i = k = 1$ for $|n_1| = 3, 6, 9, ...$ and $|n_0| = 0, 3, 6, ...$ (logarithmic representation):



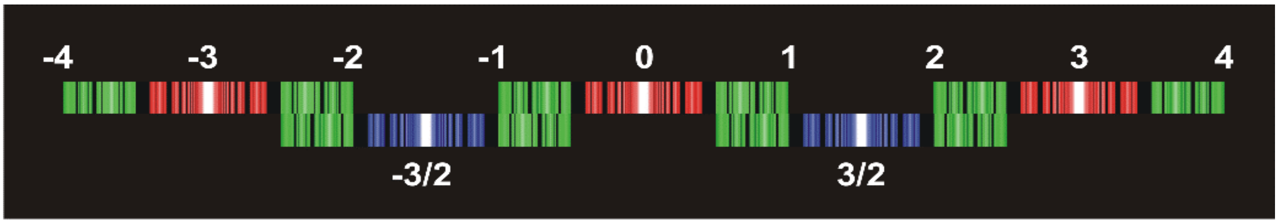
The alternating continued fraction [2, 0; +3, -3, +3, -3, ...] approximates the number 1, but the alternating continued fraction [2, 0; -3, +3, -3, +3, ...] approximates the number –1. In the consequence the spectral ranges between $|n_1| = 3 - 1$ and $|n_1| = 3 + 1$ are double occupied. The more layers $i = 1, 2, 3, ...$ are calculated, the more spectral details are visible:



Divisible by three free links $|n_0| = 3j$, (j = 0, 1, 2, ...) of the continued fraction (3) mark the main spectral nodes, partial denominators divisible by three $|n_{i>0}| = 3j$, (j = 1, 2, ...) mark spectral subnodes. All the other partial denominators $|n_i| \neq 3j$ mark borders of spectral gaps:



The next figure shows the overlapping ranges of the spectrum which are marked in green, but the nuclear ranges of the spectral nodes are marked in red and blue:



Local features of fractal scaling spectra and corresponding properties of oscillation processes

In the spectral node ranges, where the spectral density reachs local maximum, the resonance frequencies are distributed maximum densely, so that near a spectral node almost each frequency is a resonance frequency. The energy efficiency of resonant oscillations is very high. Therefore, if a frequency of an oscillation process is located near a node of the fractal spectrum (6), the process energy efficiency (degree of effectiveness) should be relative high. The highest process energy efficiency corresponds to the nodes on the layer $\lambda = 0$. Near the spectral nodes on the layers $\lambda = 1$, 2, ... the process energy efficiency should be corresponding lower. On the other hand, if a frequency of an oscillation process is located in a gap of the fractal spectrum (6), the process energy efficiency should be relative low. In the centre of a spectral node the spectral compression changes to spectral decompression (or reversed). Therefore the probability of the process trend change increases near a spectral node.

Müller H. Fractal Scaling Models of Resonant Oscillations in Chain Systems of Harmonic Oscillators. Progress in Physics, April 2009, Vol. 2

The Proton Resonance Spectrum

Whether atom, planetary system, or Milky Way - over 99 percent of the volume of normal matter consists of vacuum (particle-free physical fields). Elementary particles, from which matter consists, are vacuum-resonances, and consequently oscillation-nodes, attractors, and singularities of the vacuum. Vacuum-resonance is one of the most important mechanisms, which regulates the harmonic organization of matter at all levels (scales) – from the sub-atomic particles to the galaxies. As this is a matter of harmonic oscillations, one speaks of the "Melody of Creation."

The Proton is, by far, the most stable vacuum-resonance. Its life-span exceeds everything imaginable, exceeding minimum one-hundred-thousand billion billion billion (10^{32}) years. No one knows the actual life-span of a Proton. No scientist could ever witness the decay of a Proton. The unusually high life-span of the Proton is the reason why over 99 percent of matter's mass consists of Nucleons - Protons and Proton Resonances. That is why Proton Resonances determine the course of all processes and the composition of all structures in the universe.

The objective of the Global Scaling Theory is the Spectrum of Proton-resonances. As spectrum of natural-oscillation-processes, it is fractal, that means fragmentary, similarly which is itself and logarithmically scale-invariant. The Global Scaling Theory sees in logarithmic scale-invariance of the Spectrum of Proton-resonances the origin of the Global Scaling phenomenon – the logarithmic scale-invariance in the composition of matter.

Based on (4), the logarithmic spectrum of the Proton-resonances can be described by the following continued fraction:

$$\ln(f/f_P) = \varphi + N_0 + \cfrac{2}{N_1 + \cfrac{2}{N_2 + \cdots + \cfrac{2}{N_k}}} = [N_0+\varphi; N_1, N_2, \ldots] \qquad (9)$$

f_P = 1.425486... x 10^{24} Hz is the natural frequency of the Proton, f is the frequency of a proton-resonance. The spectral phase-shift φ, can only assume the values $\varphi = \{0; 3/2\}$, $\mathbf{N_0}$ and the partial denominators $\mathbf{N_1}$, ... are integer numbers divisible by three (Quantum-numbers). These partial denominators correspond to nodes or subnodes of the Spectrum. All other (integer number) values correspond to Gap-boundaries. The Spectrum of Proton-resonances is the Fundamental-Fractal of the Global Scaling Theory.

Global Scaling Theory is based on the quantum metrology of the Proton. The values of the basic physical constants (Rest-mass of the Proton $\mathbf{m_p}$, and Planck-constant $\boldsymbol{h}$, Speed-of-light in the Vacuum **c**, Boltzmann-constant **k**, and Fundamental Electrical Charge $\boldsymbol{e}$) and the transcendental numbers e = 2.71828... and π = 3.14159 are the uniquely physical standard parameters of the theory.

The Quantum Metrology of the Proton

rest mass	m_p	1.672621... 10^{-27} kg
natural wavelength	$\lambda_p = h / 2\pi\, m_p$	2.103089... 10^{-16} m
natural frequency	$f_p = c / \lambda_p$	1.425486... 10^{24} Hz
natural oscillation period	$\tau_p = 1 / f_p$	7.01515... 10^{-25} s
natural energy	$E_p = m_p\, c^2$	9.38272... 10^{8} eV
natural temperature	$T_p = m_p\, c^2 / k$	1.08881... 10^{13} K
electrical charge	e_p	1.6021764...10^{-19} C

The Fundamental Fractal not only describes the Spectrum of Proton-resonance-frequencies, but also the Proton-resonance-period-spectrum, - Energy-spectrum, - Mass-spectrum, - Velocity-spectrum, Temperature-spectrum, - Pressure-spectrum, Electrical-charge-quantity-spectrum, etc.

The physical properties of the Proton define the calibration units of the Global Scaling Theory, which are used in the Global Scaling analyses of measurement data.

Physical Measurand	Formula	Calibration Unit
mass	m_p	1.67262171 $1.67262145 \cdot 10^{-27}$ kg
velocity	c	$2.99792458 \cdot 10^{8}$ m/s
charge	e	1.602176525 $1.602176399 \cdot 10^{-19}$ C
wave length	$\lambda_p = h / 2\pi\, m_p$	2.1030892566 $2.1030889200 \cdot 10^{-16}$ m
frequency	$f_p = c / \lambda_p$	1.42548636502 $1.42548613694 \cdot 10^{24}$ Hz
time	$\tau_p = 1 / f_p$	7.01515064992 $7.01514952749 \cdot 10^{-25}$ s
energy	$E_p = m_p\, c^2$	1.50327742 $1.50327719 \cdot 10^{-10}$ J
temperature	$T_p = m_p\, c^2 / k$	1.08882027571 $1.08881639695 \cdot 10^{13}$ K
force	$F_p = m_p\, c^2 / \lambda$	7.14794990157 $7.14794764678 \cdot 10^{5}$ N
pressure	$P_p = F_p / \lambda_p^{\,2}$	1.61609255388 $1.61609152693 \cdot 10^{37}$ N/m²
electrical current intensity	$I_p = e\, f_p$	2.2838807907 $2.2838802457 \cdot 10^{5}$ A
electrical voltage	$U_p = E_p / e$	9.3827210591 $9.3827188627 \cdot 10^{8}$ V
electrical resistance	$R_p = U_p / I_p$	4.1082368818 $4.1082349398 \cdot 10^{3}$ Ω
electrical capacity	$C_p = e / U_p$	1.7075823633 $1.7075818293 \cdot 10^{-28}$ F

Global Scaling Methods of Research and Development

Global Scaling Analysis

Global Scaling Analysis begins with the localization of reproduceable measure-values in the correspondingly calibrated Proton-resonance-spectrum. Mathematically, this first stage in Global Scaling analysis consists of the following steps:

1. One divides the measure-value by the corresponding Proton calibration unit.
   Example: GS-Analysis of the wavelength λ = 540 nm:

$$\lambda / \lambda_p = 540 \cdot 10^{-9} \text{ m} / 2{,}103089... \cdot 10^{-16} \text{ m} = 2{,}56765... \cdot 10^{9}$$

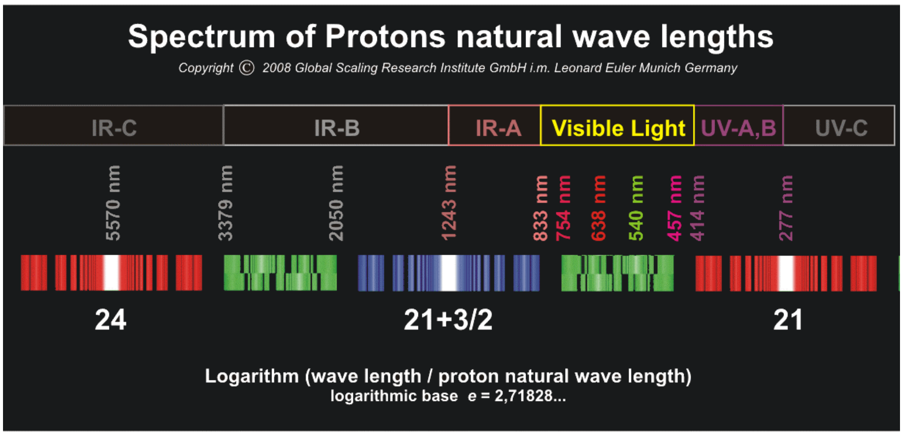
2. The logarithm of the result based on e = 2,71828... is calculated:

$$ln\,(2{,}56765... \cdot 10^{9}) = 21{,}666...$$

3. The logarithm is decomposed into a Global Scaling Continued-fraction:

$$21,666... = 0 + 21 + 2/3 = [21+0; 3]$$

The phase angle φ, and the quantum numbers N_0, N_1, ... provide information about the placement of the measure-values in the Fundamental-fractal. In our example, $\varphi = 0$, $N_0 = 21$ und $N_1 = 3$, which means that the wavelength 540 nm, is located in the vicinity of the Sub-node 3 of the Node-area 21 in the Spectrum of the Proton-resonance-wavelengths. Consequently, it is highly probable that the wavelength 540 nm, is a Proton-sub-resonant wavelength. The following figure illustrates this placement:



Visible light covers the green area (area of higher process complexity and higher influence / sensitivity) between the Proton-resonances [24+3/2] and [21].

The reflection maximum for eukariotic cells at 1250 nm, and the absorption maximum for prokariotic cells at 280 nm are, consequently, with high probability, Proton-resonance wave lengths. It means that these reflections and absorptions, with high probability, are based on Proton resonance processes.

The placement of reproduceable measure-values in the Fundamental Fractal provides explanation about the state of a system or the stage of a process:

If the measure-values relevant to a process lie in a Gap of the Fundamental Fractal, then the process, with high probability, is not in the Proton-resonance-modus and, with high probability, runs through a laminar phase.

If the measure-values relevant to a process lie in the vicinity of a Node (place of high spectral density) in the Fundamental Fractal, then the process is in the Proton-resonance-modus and, with high probability, runs through a turbulent phase.

If the measure-values relevant to a process stay in the vicinity of a Node, then the process, with high probability, is located in a relatively early phase of its development. If the measure-values relevant to a process stabilize on the border of a Node area, for example on the border of a Gap in the Fundamental Fractal, then the process, with high probability, is located in a relatively late phase of its development.

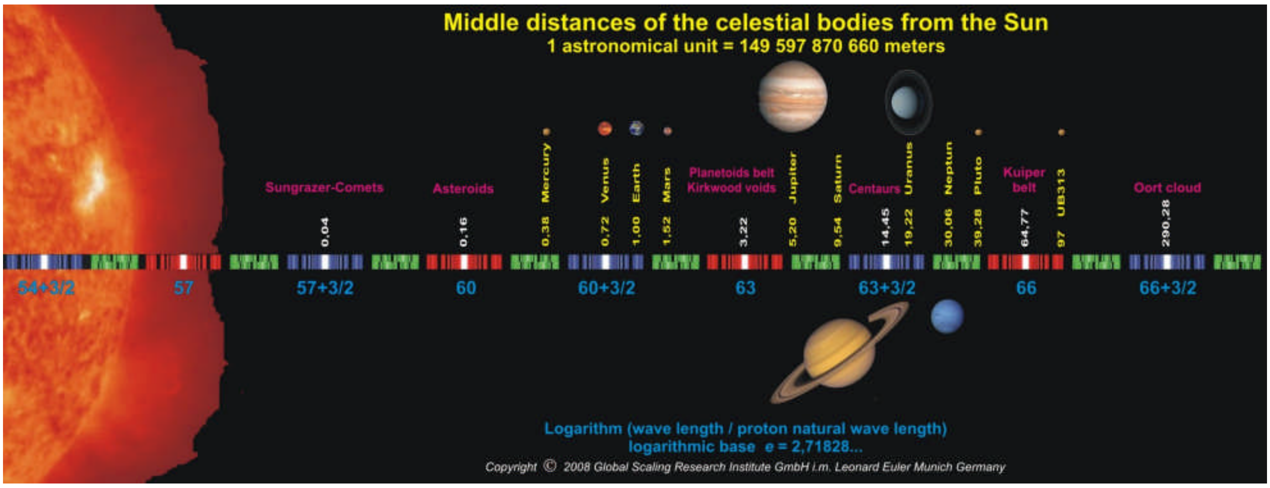
The second step in Global Scaling analysis therefore contains the determination of the state of a system or process in dependence of the placement of the reproduceable measure-values in the Fundamental Fractal (FF). The following Tables describe this connection:

Placement of the Measure-values in the FF	And Expected Process-properties / States
Nodes / Sub-nodes	Turbulent Course of Process High Probability of Fluctuation Early Phase-of-Development High Probability of Tendency Change High Inner Event Density High Resonance / Oscillation Capability High Energetic Efficiency Matter Attractor Event Attractor Minimal Influence / Sensibility
Gaps / Sub-gaps	Laminar Course of Process Minimal Probability of Fluctuation Minimal Probability of Tendency Change Late Phase-of-Development Minimal Inner Event Density Low Resonance / Oscillation Capability High Influence / High Sensitivity
Green Areas	Course of Process Highly Complex Complex inner Event-structure Complex Course of Fluctuation Intensity Laminar Course of Process / Weak Turbulence High Influence / High Sensitivity Mean Phase-of-Development
Gap Borders	Beginning of the compression of event density End of the decompression of the event density Beginning / Breaking-off of an Event Chain Development limit Evolution Attractor High Phase-of-Development

If process relevant, reproduceable measure-values move through the Fundamental Fractal during the course of a process, it is highly-probable that the character of the process will also change. The following Table describes this connection.

Movement of the Measure-Values in the FF	Expected Process-properties / States
Increasing Spectral-density (Compression)	Increasing Probability of Fluctuations Increasing Probability of Turbulence Increasing Probability of Trend Change Increasing Energetic Efficiency Increasing Inner Event Density Increasing Complexity in Process Course Increasing Resonance / Oscillation-Capability High Probability of Fusion
Decreasing Spectral-density (Decompression)	Decreasing Probability of Fluctuations Decreasing Probability of Turbulence Decreasing Probability of Trend Change Decreasing Energetic Efficiency Decreasing Inner Event Density Decreasing Complexity in Process Course Decreasing Resonance / Oscillation-Capability High Probability of Matter Decay

Analysis-Example: Distances of the Planets from the Sun

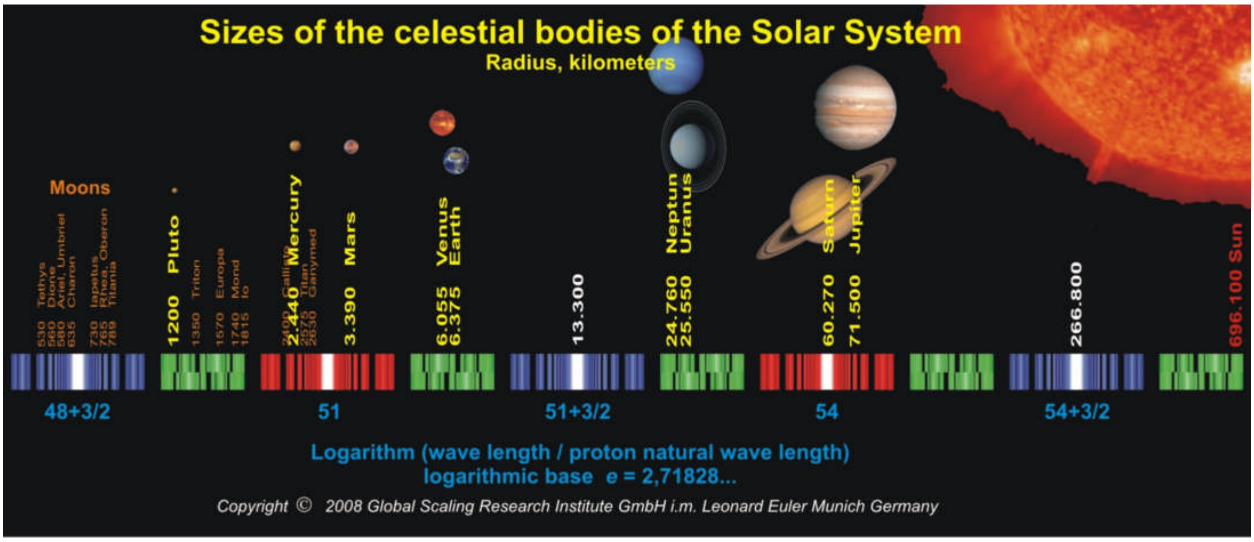


For this GS-Analysis the Proton-standard-measure, $\lambda_p = 2.103089... \ 10^{-16}$ m is used. Venus is the only planet in the solar system whose mean distance from the sun lies, direct vicinity of a Node in the Spectrum of the Proton-resonance wave-length. Therefore a highly-fluctuating orbital-movement of Venus is very probably, something that could explain the extreme and distinct volcanic action (over 1600 volcanoes) on Venus. In addition, the Placement in the vicinity of a Node is typical for a relatively early phase of development. That means, relative its orbit, Venus represents a relatively young phase, the earth an average phase development, and Mars and Mercury relatively late phase developments.

A distribution in the vicinity of a Node is typical for Asteroids and Planets, consequently in areas of high probability of turbulence. This Placement means that planetoid-belts represent a relatively early phase in the evolution of orbits and that their populations fluctuate strongly.

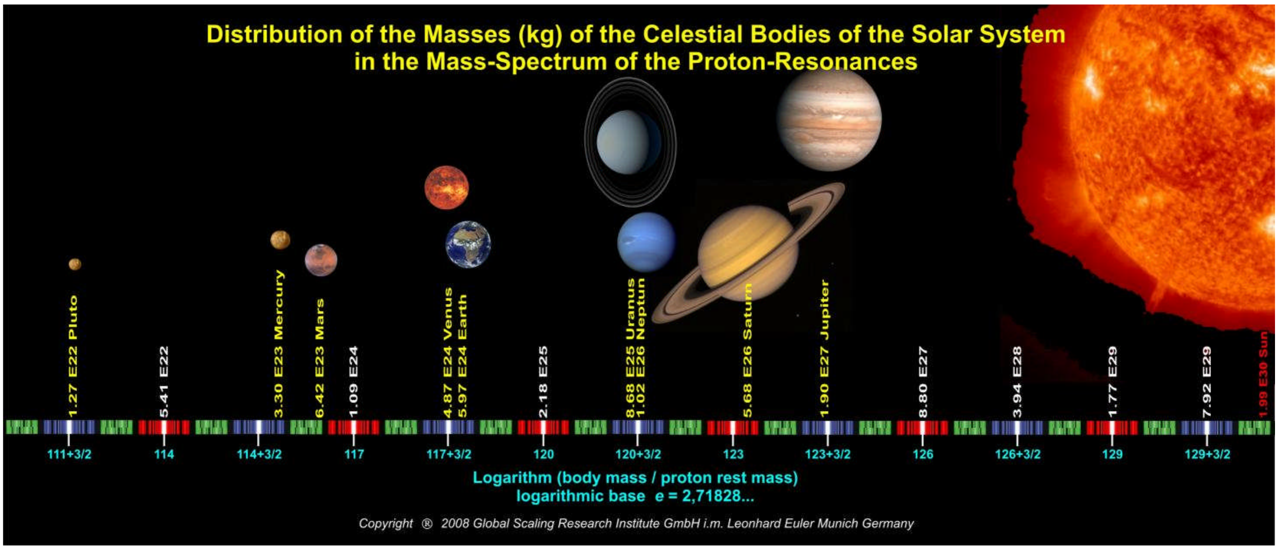
The Node [63] marks the border between the world of established planets and the world of giant gas clouds. To this extent, it is of high probability that Pluto is an older orbit member of the Kuiper-Belt. The dwarf planet, UB313 is located in a younger phase of orbital evolution than Pluto. Jupiter and Saturn are located in a very old phase of orbital evolution. Uranus represents a younger phase of orbital evolution than Neptune.

Analysis-Example: Sizes of the Planets and Moons of the Solar System



For this GS-Analysis the Proton calibration unit λ_p = 2.103089... 10^{-16} m is used. Saturn and Jupiter are located in a relatively young phase in the evolution of their sizes. Saturn is located just a little to the right of Node [54], Jupiter somewhat further to the right, and Saturn and Jupiter, with high probability, therefore become essentially larger. Uranus and Neptune represent an essential later phase of the evolution of the giant gas clouds than Jupiter and Saturn. In the solar system, the Node [51+3/2] separates the world of established planets from the world of the giant gas clouds. Mercury and Mars represent a relatively early phase of size evolution, and Pluto represents, essentially, an older one. This also holds for our moon as well as for the Neptune Moon, Triton, and for the Jupiter Moons, Europa and Io. The sun finds itself, in the evolution of its size, in a relatively late phase. It is highly probable that the sun will become larger, whereby its radius will reach a maximum, [54+3/2; 2] ≈ 725260 km; after which, with high probability, it will not essentially change for a long time.

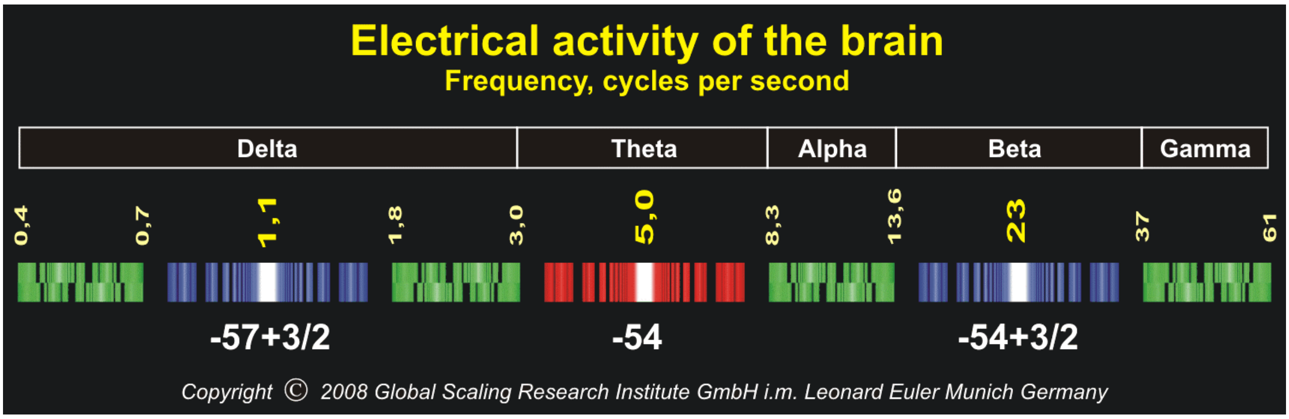
Analysis-Example: Masses of the Planets of the Solar System



For this GS-Analysis the Proton calibration unit m_p = 1,672621... 10^{-27} kg is used.
In comparison with empty cosmic space the celestial bodies (stars, planets, moons, asteroids) are compressed matter, which masses consist of nucleons over 99 per cent. Therefore one can expect, that the distribution of the celestial bodies in the mass-spectrum of proton resonances is not random. The figure above illustrates this fact. The masses of the planets Pluto, Mercury, Venus, Earth, Neptune, Uranus, Jupiter and Saturn are located near the main nodes in the spectrum of proton resonances. Nevertheless one can see some unusual features: Venus and Jupiter are located directly in main spectral nodes, but other celestial bodies are more or less away from the nodes. Particularly, the location of the Sun and Mars is inside the green spectral ranges.

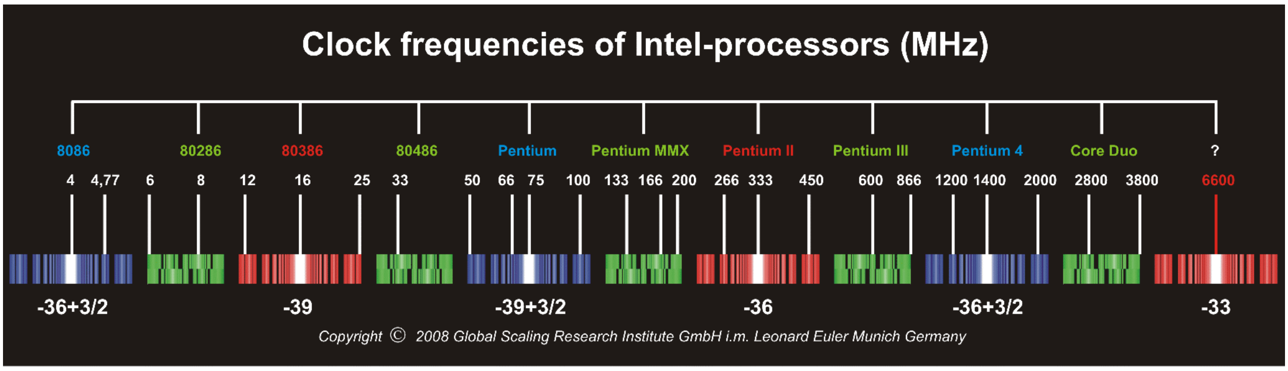
Based on the location of the celestial body mass now we can define the possible dynamics of oscillation processes inside of the celestial body. For example, the oscillation processes inside the planet Venus, with high probability, are turbulent, what shows the extremum seismic activity of the planet. The seismic activity of the Earth and the Mars is much lesser. The Sun runs through a relative quiet stage of the star evolution, its mass is inside the laminar green range of the proton resonance spectrum. In opposite, the oscillation processes inside the gas gigants are quiet trubulent, with high probability, what indirectly shows their radiation and the atmospheric turbulences. Vacant nodes of the proton resonance spectrum, in other planet systems, can be occupied by celestial bodies. In this understanding the Solar System represents only a special case of the possible distribution of celestial bodies in the mass-spectrum of the proton resonances. Based on the proton resonance spectrum one can define and classificate possible mass-distrubutions of celestial bodies in deverse planet systems. Possible, the gas gigant CoRoT-Exo-2b could be a candidate of the node [126], and the planet Gliese 581d could be a candidate of the node [120].

Analysis-Example: Neuro-physiological Rhythms



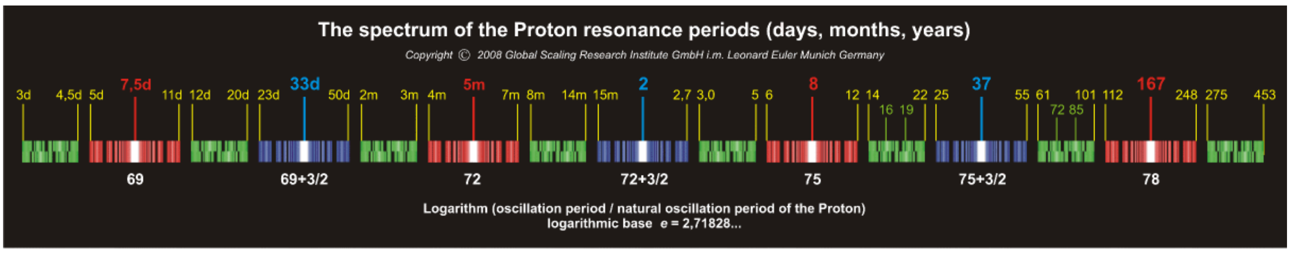
For this Analysis, the Proton calibration unit $f_p = 1.425486...\ 10^{24}$ Hz is used. It is highly probable that the frequency-bands of Delta-, Theta-, Alpha-, Bet- and Gamma-waves in the Electro-electroencephalogram (EEG) are Proton-resonance-frequency bands.

Analysis-Example: Microprocessor Clock Frequencies



For this analysis the Proton calibration unit $f_p = 1.425486...\ 10^{24}$ Hz is used. It is highly probable that the clock frequencies of 16 MHz, 75 MHz, 333 MHz and 1400 MHz are Proton-resonance-frequencies. It is well to recognize that the clock frequencies with which computer processor model changes take place are logarithmically scale-invariant. Basically new concepts in Computer-processor architecture arise in Nodes of the Proton-resonance Spectrum. With high probability, the clock frequencies of microprocessors, obviously, are Proton resonance or subresonance frequencies.

Analysis Example: The Fundamental Time Fractal



For this GS-Analysis, the Proton calibration unit $\tau_p = 7.01515... 10^{-25}$ s is used. The Spectrum of Proton-resonance-periods is the Fundamental Time Fractal of the Global Scaling Theory. Nodes in the Time Fractal mark, with high probability, important points of change in the course of a process, independent of its nature. Proton resonances determine all material processes, because over 99 percent of matter's mass consists of Protons and Proton Resonances - Nucleons.

For example, at the age of 7 days, the fertilized egg nests itself in the uterus; from the 33^{rd} day the brain separates from the spinal cord; at the 5^{th} month the cerebral cortex develops. In the same manner at the 7^{th} and 33^{rd} days after birth and at the ages of 5 months, 2 years, 8 years and 37, essential physiological changes take place in the life of man and animal.

In addition, the Nodes and Sub-nodes in the Fundamental Time Fractal define statistical limits in gerontology; but also the prominent actuarial health and life insurance policy limits, machine appliance service maintenance intervals, as well as maximums in product failures and product-distribution.

Global Scaling Optimization

Global Scaling Optimization begins with Global Scaling Analysis. From the actual placement of real, reproduceable, process relevant, measure values in the Fundamental Fractal, the user formulates recommendations about a better placement, to achieve, with high probability, desired process-qualities in a process.

Global Scaling Prognostication

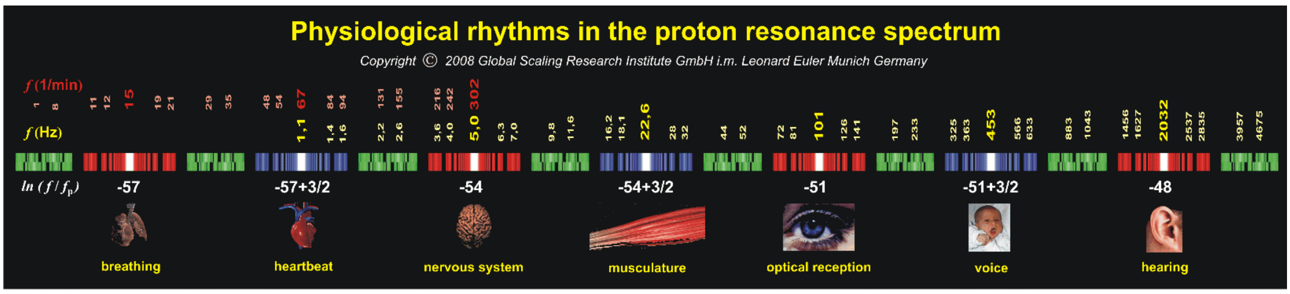
Global Scaling Prognostication begins with Global Scaling Analysis. From the actual placement of real, reproduceable, process relevant measure values in the Fundamental Fractal, the user formulates, relevant statements about the probable course of the process.

Global Scaling Methods of Research and Development are provided in the training courses at the Global Scaling Research Institute in memoriam Leonhard Euler, Munich, Germany, Internet: www.globalscaling.de

Global Scaling Applications

Global Scaling in Medicine

Global Scaling Analysis of physiological oscillation processes, for example, of the human breath frequency or the hearthbeat frequency, the voice frequency spectrum or the electrical activity of the brain, shows how important Proton resonances are in biology:



The graphic shows the placement of important physiological oscillation processes frequencies in the Proton resonance frequency spectrum. With high probability, the frequency spectra of human breath, hearthbeat, brainwork, microarterial blood pumping, optical sensor scan, voice and hearing are identically with the Proton resonance frequency spectrum. Important physiological oscillation processes are presumable based on Proton resonances.

Therefore the Global Scaling Analysis is able to give important criterions for diagnostics of the state of health. In addition Global Scaling Optimization is able to correct the frequency spectrum of physiological and cell biological processes and can obtain therapeutical effects.

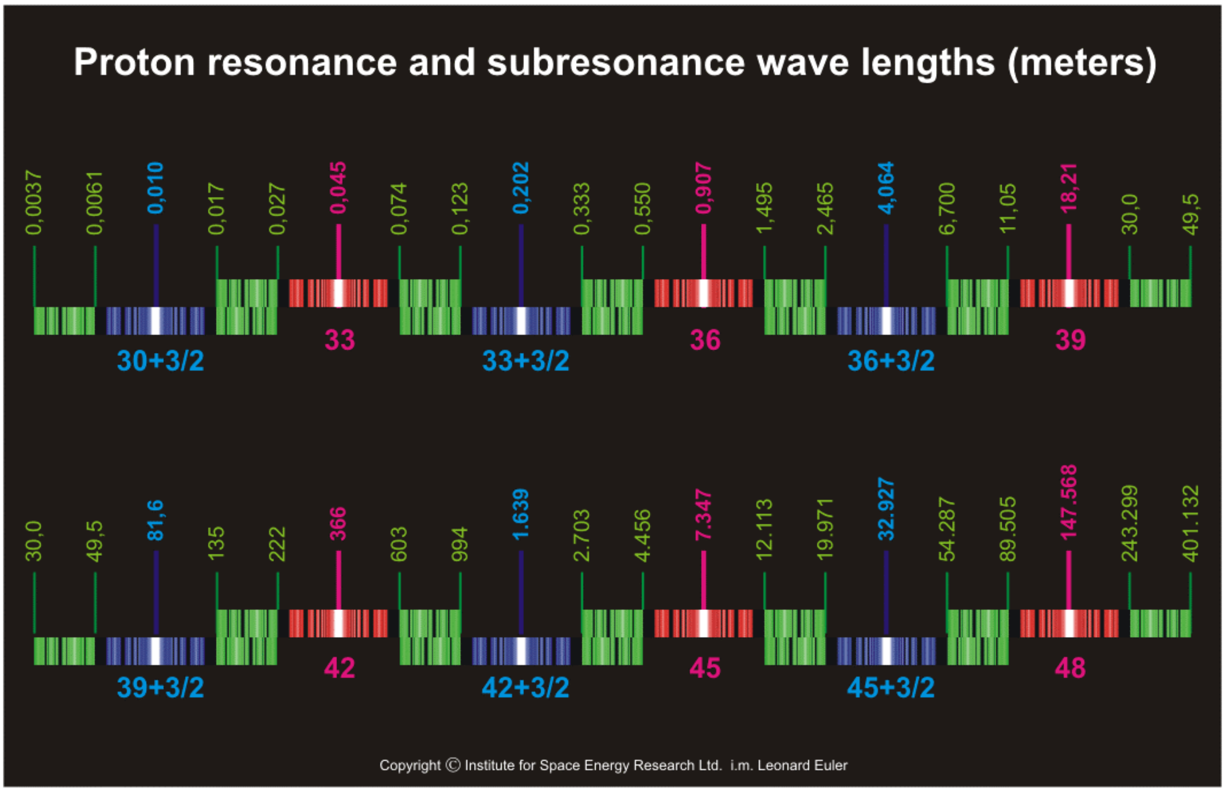
Example: The ProtoLight system

Based on this fact the Global Scaling Research Institute gmbh has developed the *ProtoLight* system. The LEDs of the *ProtoLight* applicators generate monochromatic red / infrared light near the Proton subresonance wavelength 754 nm. This carrier wave is modulated by cell biological relevant Proton resonance frequencies. This means that via a well known Proton resonance carrier wave the *ProtoLight* applicator light brings physiologically relevant Proton resonance frequencies into the cell tissue.

Special cell biological investigations at the Institute of Theoretical and Experimental Biophysics, Pushchino Scientific Centre, Russia, have shown that Proton resonance modulation frequencies regulate the activity of the Succinatdehydrogenase, which oxidates the Amber acid in the mitochondrias. The oxidation process of the Amber acid in the mitochondrias is the most powerful energy source of the cell. For this reason, the *ProtoLight* system uses Proton resonance modulation frequencies for the stimulation of mitochondrial energy production, wound healing and cell regeneration acceleration.

The *ProtoLight* system is used in veterinary medicine successfully. because the light, modulated by Proton resonance, works on the cell biological level. *ProtoLight*® is a registered trademark.

Global Scaling in Architecture



The graphic shows the Proton resonance wavelength spectrum in the range of 3.7 millimeters to 401.132 meters.

Proton resonances determine the oscillation properties of any construction and the characteristics under the influence of periodic loads, because over 99 percent of matter's mass consists of Nucleons (Protons and Neutrons).

Example: Stability of constructions

If the measurements of constructions are in the proximity of Proton resonance wavelengths, this represents a danger for the construction stability, specially under the influence of periodic loads.

For this reason, the Proton resonance wavelength spectrum define a spectrum of limit values of construction measurements in dependence of the construction material and technology.

Example: Space for people

People visit buildings and rooms periodically. Therefore their movement create oscillation processes. The periods of these oscillation processes lie between minutes and days. The people movement velocities are determined by human physiological rhythms. The most important physiological oscillation processes are based on Proton resonances. For this reason, also the periodical components of people movement inside a building or room are based on Proton resonances.

Therefore the Global Scaling Analysis of the sizes of buildings and rooms is able to prognosticate important properties of the movement processes, for example, turbulences. Consequently, Global Scaling can conceive rooms, where people (or animals) feel well, have no stress and find the best conditions for life.