# The Fundamental Ground State

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## Abstract

A fundamental ground state condition of space is shown to contain the basis for the constructs and behaviors of matter, the logic of mathematics, and the implementation of social institutions like the political constructs of government, economic and business practices, and the laws of society.

## Introduction

From what does order arise?

In 1905 Einstein unified electromagnetic (EM) and mechanical energies with his $E = mc^2$ and $\gamma = (1 - v^2/c^2)^{\frac{1}{2}}$ Lorentz space, time and mass energy transformations and then derailed this step toward unification by showing that black body radiation is energy quanta from atoms' electrons. Quantum Theory widened this gap with Relativity by correctly predicting quantized atomic and nuclear energies.

A step toward unification occurs however by recognizing that Heisenberg's Uncertainty precludes absolute resolution of position and momentum so neither Quantum Theory nor Relativity actually achieve 0 velocity. This is reconciled by the concept of a ground state, a domain's lower limit corresponding to its light speed upper limit. A person standing still doesn't actually have 0 velocity because they are comprised of atoms with orbital electrons in $e^{-ix} = \cos x - i \sin x$ wave function energy states that derive from de Broglie's momentum based $\lambda =$

h/mv waves that give rise to Heisenberg's Uncertainty and Wave Particle Duality. The fundamental atomic structure, hydrogen, has an $E_o$ = -13.605698 eV ground state energy, negative because energy must be added to destabilize it, but actually positive in a $-2E_o$ EM field.

**I) Ground State Correlations**

The velocity and force energy roots of hydrogen's ground state correlate to the speed of light by Sommerfeld's $\alpha = e^2/2\epsilon_o hc$ number, so $v_o = \alpha c = (2E_o/m_e)^{\frac{1}{2}} = 2.18769 \times 10^6$ m/s, and since the laws of physics are the same in all frames of reference (Relativity) the same $\alpha$ ground to light speed coefficient applies in the Strong nuclear, EM atomic, Weak force decay, and Gravity domains as the following correlations show:

**1) Ground State Impedance**

The speed of light is limited and constant because of space's $u_o \epsilon_o$ permeability-permittivity impedance to EM energy, referenced to the Planck Scale as $hc = h/(u_o\epsilon_o)^{\frac{1}{2}} = 1.9864473 \times 10^{-25}$ J·m.

**2) Electron Quantum Optical and Interactive Radii and Mass Energy**

$r_{eo} = hc3^{\frac{1}{2}}pi/\alpha^2 = 2.03 \times 10^{-20}$ m

$r_{ei} = r_{eo}3(2^{\frac{1}{2}}3^{\frac{1}{2}})^2/\alpha = 0.05007$ fm

$m_e = (1-\alpha/pi)(1+2^{\frac{1}{2}}3^{\frac{1}{2}}\alpha^2)[(\frac{1}{2}eh/2pi)3^{2/3}2^{\frac{1}{2}}\alpha/hc] = 9.10936 \times 10^{-31}$ kg

**3) Quark Quantum Optical and Interactive Radii and Mass Energies**

$r_{qo} = hcpi/\alpha^3 = 0.0803 \times 10^{-18}$ m

$r_{qi} = r_{qo}/3^{\frac{1}{2}}\alpha = 0.0635$ fm

$m_{Up} = (\frac{1}{2}m_e c^2)2^{\frac{1}{2}}3^{\frac{1}{2}}2pi = 3.9323$ MeV $= 3^{\frac{1}{2}}$(Fermi Lab's 2.3 MeV), correlating to the $E_C = \frac{1}{2}m_e c^2 = E_o/\alpha^2$ relativistic mass energy increase of a light speed electron and hydrogen's ground state energy

$m_{Down} = 3^{\frac{1}{2}}m_{Up} = 6.8109$ MeV $= 3^{\frac{1}{2}}$(Fermi Lab's 4 MeV)

**4) Proton Quantum Optical and Interactive Radii and Mass Energy**

$r_{po} = r_{qi} 3^{2/3} 2pi = 0.83$ fm

$r_{pi} = hcpi^2 3^{2/3}/2^{\frac{1}{2}}\alpha^4 = 1.017$ fm

$m_p = (\frac{1}{2}eh/2pi)2^{\frac{1}{2}}3^{\frac{1}{2}}3c^3 = 3^{\frac{1}{2}}(m_U/\alpha + m_D - m_U) = 938$ MeV $= 1.67 \times 10^{-27}$kg

**5) Higgs Boson Mass Energy**

$m_H = [m_p - 3^{\frac{1}{2}}(2m_{Up} - m_{Down})]/\alpha = 125.1$ GeV, the proton's generate mass energy accelerated to the speed of light

**6) Hydrogen Mass, Ground State Energy and Wave Length**

$m_h = m_p + m_e - E_o = (\frac{1}{2}eh/2pi)^{\frac{1}{2}}/3^{\frac{1}{2}} - 3^{2/3}2^{\frac{1}{2}}3^{\frac{1}{2}}m_e = 1.67346 \times 10^{-27}$kg = 938.74 MeV

$E_o = (1-\alpha/pi)(1+2^{\frac{1}{2}}3^{\frac{1}{2}}\alpha^2)(\frac{1}{2}eh/2pi)3^{2/3}2^{\frac{1}{2}}\alpha^3/2hc = 2.42543 \times 10^{-35}$kg = 13.60566 eV

$\lambda_o = hc\alpha/2E_o = 3.3249 \times 10^{-10}$m

**7) EM Wave with E Ground State Energy**

$\lambda_{EM} = 2\lambda_o/\alpha = 911.262 \times 10^{-10}$m

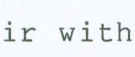
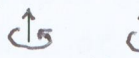
**8) Compton Energy and Wavelength**

$E_C = \frac{1}{2}m_e c^2 = E_o/\alpha^2 = 0.2555$ MeV $\quad \lambda_C = \alpha\lambda_o = hc/2E_C = 2.4263 \times 10^{-12}$m

**9) Gravity:** The $9.64 \times 10^{15}$ m Light Year and $E_g = Gm_s m_e/r_{es} = 5.3105 \times 10^{33}$ J $= 3.31455 \times 10^{52}$eV energy of earth's $Gm_s m_e/r_{es}^2 = m_e v_e^2/r_{es}$ orbit correlates Gravity and the Strong force by space's $h/(u_o\epsilon_o)^{\frac{1}{2}}$ impedance to light and reciprocal energy density symmetry, where one Light Year $= \frac{1}{2}3^{4/3}2^{\frac{1}{2}}pi/r_{pi} = 9.45 \times 10^{15}$m and $1/E_g = 3.02 \times 10^{-53}$eV equates to $(\frac{1}{2}eh/2pi)2pi/3^{\frac{1}{2}} = 3.06 \times 10^{-53}$eV, the EM energy basis of $m_p = (\frac{1}{2}eh/2pi)2^{\frac{1}{2}}3^{\frac{1}{2}}3c^3$ proton mass. These reciprocal $\int 1/f(x)\,dx$ singularity relations exist because the $\alpha = e^2/2\epsilon_o hc$ density coefficient is based on the $hc = h/(u_o\epsilon_o)^{\frac{1}{2}}$ impedance of space and force distance effect of charge energy on space, a unipolar "Gravity" resultant of the EM dipole based energy in the proton and electron $m_p = (\frac{1}{2}eh/2pi)2^{\frac{1}{2}}3^{\frac{1}{2}}3c^3$ and $m_e = (1-\alpha/pi)(1+2^{\frac{1}{2}}3^{\frac{1}{2}}\alpha^2)(\frac{1}{2}eh/2pi)3^{2/3}2^{\frac{1}{2}}\alpha/hc$ magneton based mass energies operating on Einstein's 4-D Minkowski space-time.

## II) Minkowski 4-D Space-Time Point-Pairs

Einstein constructed space-time as  points with $x_1$, $x_2$ and $x_3$ dimensions and an $x_4 = (-1)^{\frac{1}{2}}ct = i\,ct$ time flow distance for energy traveling between points at light speed. The points are 0 change $ds^2 = dx_1^{\,2} + dx_2^{\,2} + dx_3^{\,2} + dx_4^{\,2} = 0$ Pythagorean resultants in field free space that acquire a size change gradient under a $ds^2 = g_{ik}d_{li}d_{lk}\cdots$ "Riemann condition" that describes the unipolar $E = F\cdot d$ field energy influence of Gravity. He wasn't describing the x sizes of space, he was addressing the dx changes to uniform space by field energy and accounted for gradient direction by splitting $dx^2$ into dxdx roots. However this construct also allows a point pair variation that accommodates dipole EM energy operating on the $h/(u_o\epsilon_o)^{\frac{1}{2}}$ impedance of space. Thus by incorporating $dx^2 = dxdx$ he also allowed point acceleration roots that can represent EM field energy polarity as a $dx^2$ unipolar result of dipole point pair space.

A  point pair with  reciprocal $u_o\epsilon_o$ impedance energies is neutral under field free 0 energy conditions, a negative energy ground state construct with ambient opposing light speed momentum energies that cancel. Under an external field energy influence the point pairs align as  or  to store polarized field energy in excited $hc = h/(u_o\epsilon_o)^{\frac{1}{2}} = 2 \times 10^{-25}\,J\cdot m$ energy states that integrate into a continuous field strength that varies with distance with respect to $2 \times 10^{-20}m$ radii electrons because Einstein only addressed dx changes. This defines charge polarity as energy orientation and magnetism as a charge velocity dependent field strength with ix direction polarity that correlates to $e^{-ix} = \cos x - i \sin x$ EM energy wave functions moving in symmetrically uniform free space.

Furthermore, under high energy density field conditions the EM wave's energy resonance would experience wavelength contraction proportionate to the dx energy density gradient, as the $\alpha$ coefficient shows in the $\lambda_o = \frac{1}{2}\alpha\lambda_{EM}$ hydrogen ground state, $\lambda_C = \alpha\lambda_o$ Compton, and $r_{qi} = \frac{1}{2}\lambda_C\alpha^2 = 0.0645$ fm Up quark ground state wavelength correlations, and in proportion to the g-field gradient energy density increase in EM wave refraction.

The measurement uncertainty between the particle and wave function energies statistically integrates over time to an average $e^{-ix}$ value.

This uncertainty is a $\alpha(1 / 2(1/\gamma - 1))^{\frac{1}{2}} = \alpha(1 / 2d\gamma)^{\frac{1}{2}} = 0.99998$ deviation or $0.00002 = 2 \times 10^{-5}$, that's the ratio of the proton's $r_{pi}$ = 1.017 fm interactive radius and electron's $r_{eo} = 2.03 \times 10^{-5}$ m quantum optical radii. It represents a refraction ratio of the particle and wave function energy densities, where $\alpha(1 / 2d\gamma)^{\frac{1}{2}}$ is the quantum optical interferometry deviation of the electron's size to its matter wavelength, and since the wave field energy propagation through the particle's increased field energy density equals the wavelength around its circumference it means that its mass energy is generated by a $B = d\phi_E/dt$ rotating E field, so mass = $f(\frac{1}{2}eh/2pi)$ as $m_p$ and $m_e$ show.

The proton's $m_p = 3^{\frac{1}{2}}(m_U/\alpha + m_D - m_U) = (\frac{1}{2}eh/2pi)2^{\frac{1}{2}}3^{\frac{1}{2}}3c^3 = 938.3$ MeV is generated by the light speed $2^{\frac{1}{2}}3^{\frac{1}{2}}$ angular and spherical momentums of the UUD quark triton's $e^+$ charge. Thus the field wavelength through the mass is the mass energy's radius: $\lambda_r = hc/E = hc/3^{\frac{1}{2}}(2m_U + m_D)pi2^{\frac{1}{2}}3^{\frac{1}{2}}2pi = r_{pi} = 1.01$ fm, where $hc = 2 \times 10^{-25}$ J·m, $3^{\frac{1}{2}}(2m_U + m_D) = 25.4$ MeV = $4.0729 \times 10^{-12}$J is the triton's spherical momentum mass energy, pi is the $\frac{1}{2}$ sphere hemicircle, and $2^{\frac{1}{2}}3^{\frac{1}{2}}$ are the angular and spherical momentums of the 2pi wave energy. Similarly the electron's $\lambda_C = hc/m_e c^2 = 2.4263 \times 10^{-12}$ m light speed wave length, which increases to $\lambda_C\alpha^4 3 = 2.064 \times 10^{-20}$m with two $\alpha^2$ atomic to nuclear to particle 3-D energy density increases, corrected to $r_{eo} = 2.03 \times 10^{-20}$m by $(1 - \alpha 3^2/2^2)$, and $m = (\frac{1}{2}eh/2pi)3^{2/3}2^{\frac{1}{2}}\alpha/hc$, which means the electron's mass is generated by a wave's $e^+$ charge orientation angular momentum with respect to the ground state. The wave is refracted into a radial circumference by the $\alpha^4$ density increase.

Thus all matter components from the $hc = h/(u_o\epsilon_o)^{\frac{1}{2}}$ ground state of space that determines light's velocity, to the electron, quark components and proton, up through the Higgs boson, correlate by the $\alpha = e^2/2\epsilon_o hc$ energy density root that defines Quantum Theory's hydrogen ground state base line and the ground to saturated state limits ratio in Boltzmann $e^{S/k}$ statistical systems. However most significantly, it correlates proton and electron bipolar magneton mass energy generation to Gravity's unipolar behavior and earth orbit energy density as a $\int 1/f(x)\,dx$ singularity.

## IV) Weak Force Transforms

Correlation of the Strong, EM and Gravity forces as an $\alpha^2$ energy density progression from space's hc ground state provides a basis for determining the Strong nuclear and EM atomic domains' Weak force decay transforms. Strong decays obey symmetry, are faster than $10^{-20}$ s, have quantized energies, and involve decays of higher energy state hadrons to lower energy states or alpha particle and gamma ray emissions. Weak decays are asymmetrical, slow, have varying energies, involve Beta particle and neutrino emissions, and result in nucleus spin changes.

This is because Strong decays depend on excited quark states and stay within the Strong force domain while Weak decays depend on excited nuclear bond states and occur between the nuclear and atomic domains. Quarks are quantized energy states so decays from one quark state to another is quantized and conserves charge and spin according to symmetry. Decays are fast because as shown in Quark Relativity Transform (QRT) the proton's mass energy derives from its Up Up Down quark triton structure, actually 3 Up quarks with a $m_D - m_U = 2.88$ MeV gluon orbital energy state binding them. The transit time for 2 quark radii factored by the speed of light is $t_q = 2(\frac{1}{2}\lambda_C\alpha^2)/c = 0.4307 \times 10^{-24}$ s, so quark decays will be of that range.

Weak decays however involve an atomic domain Electon Capture that transmutes a proton into a neutron or decay of a neutron to a proton and atomic domain electron. As shown in QRT §III(C)(1) a neutron results from a captured electron in a relativistic orbital configuration with a resultant ½ spin spatial contraction effect so a neutron state orbital elecron decay from a nuclear bond excited state must result in a nucleus spin change. The neutron state orbital electron is controversial but neutrons decay to protons and electrons, form by Electron Capture, were synthesized from hydrogen by Borghi (1955) and Missfeldt (1979), and the QRT model does account for the observed effects.

Weak decays are slow because they involve the transition of electron inertial mass energy between the light speed Strong force domain and sub-light velocity atomic domain, and thus involve a $t_{Wv}$ light speed to orbital velocity transition coefficient. Its light speed basis rests on

the $t_c = \lambda_c/c = 0.809 \times 10^{-20}$s electron's Compton wavelength factored by the speed of light and $t_{pi^\circ} = 3^{\frac{1}{2}} t_c/pi\alpha^2 = 0.838 \times 10^{-16}$s neutral pion ½-life decay to gamma rays controlled by the $\alpha^2$ density change from a neutron state's 3-D energy to 1-D EM wave.

This energy transition to the atomic orbital domain is characterized as $t_{Wv} = (t_c/\alpha^4)2^{\frac{1}{2}}3^{\frac{1}{2}}2pi = (t_{pi^\circ}pi/3^{\frac{1}{2}}\alpha^2)2^{\frac{1}{2}}3^{\frac{1}{2}}2pi = 0.44 \times 10^{-10}$s. A charged pion's ½-life decay, the neutral pion's interaction energy with a neuton state, is thus $t_{pi^-} = t_{Wv}2^{\frac{1}{2}}3/\alpha = 2.6 \times 10^{-8}$s and decay of this muon state is $t_{\mu^-} = 3^{\frac{1}{2}}t_{pi^-}/2^{\frac{1}{2}}2\alpha = 2.18 \times 10^{-6}$s. The decays are asymmetrical because they don't conserve nuclear spin, they occur between independent symmetry based domains, the energy release depends on the part of the neutron orbital the electron decays from, they depend on charge circumstances, since $K^\circ \rightarrow pi^- + e^+ + \bar{\nu}_e$ decays are more frequent than $K^\circ \rightarrow pi^+ + e^- + \bar{\nu}_e^*$, and they depend on component condition since $pi^- + p^+ \rightarrow K^\circ + \Lambda^\circ$ but never $K^\circ + n$.

These occur because in a Boltzmann $P = e^{S/k}$ system entropies affect outcomes. The atomic domain has $\infty$ $e^-$ electrons and $e^+$ positrons immediately annihilate so they always have an $\infty$ entropic degree of freedom whereas the electron entropic degree of freedom is full so charge asymmetry occurs. Decay path asymmetry depends on component conditions. A $K^\circ$ neutral kaon has an $S^*$ anti-strange quark and a $\Lambda^\circ$ lambda has a S strange quark while a neutron has none so a $\Lambda^\circ$ must produce to maintain quark symmetry with $K^\circ$. Both component internal and external circumstance entropic degrees of freedom affect outcomes but they appear asymmetrical to balance charges and maintain quark symmetry.

**V) Fundamental Systems**

Statistical $e^{S/k}$ systems are predictable at their ground and saturated state conditions, when entropic degrees of freedom are S = 100% and S = 0% available, like earth's orbit or a below ground state Bose Einstein Condensation and at light speed velocity or particle radii interaction distances, when the Heisenberg Uncertainty does not affect outcome and when the Heisenberg Uncertainty is the outcome. This allows the $t_{Wv}$ light speed to ground state coefficient to be evaluated in terms of $t_c = \lambda_c/c = 0.809 \times 10^{-20}$s as $t_{Wv} = (t_c/\alpha^4)2^{\frac{1}{2}}3^{\frac{1}{2}}2pi = 0.44 \times 10^{-10}$s.

A single component system has only a one component degree of freedom available and if only the ground state energy is available no excited states can occur so the component can only distribute its energy equally in the 4 space time degrees of freedom as a quantum continuous and predictable behavior under the influence of a unipolar continuous force like Gravity on mass  or a dipole continuous EM field on a charge  , a net unipolar result because no excited or alternate state. However in a dual charge situation such as an eta particle that changes charge under the influence of a dipolar field and reverses its trajectory curve direction, or if energy exceeds the ground state, excited wave function states can exist.

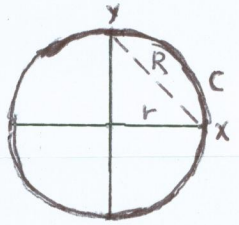
Under the single component ground state condition the force field energy forms an $e^{-ix} = \cos x - i \sin x$ periodic matter wave function that is continuously predictable because $-ix = S/k$ and for a one component system with S = 100% availability, $-ix = 1/k \Rightarrow -ikx = 1$, a periodic x and i 2-D resonance with k magnitude. Setting these equal as $ix = S/k$ or a $S/k - ix = 0$ complex number represents the ground state of quantum statistical and continuous periodic conditions which substitutes into $e^x$ as $e^{S/k - ix} = \cos x - i \sin x = 1$, a non-decay stable equilibrium state designated as $e^{\emptyset = S/k - ix}$ because its average value is 0 but it's a non-zero relative ground state equilibrium between $e^{S/k}$ statistical, $e^{-ix}$ wave function and $e^x$ decay function behaviors.

This ground state nexus of 3 behavior domains constitutes a quantum continuous periodic condition with a $P = e^{S/k}$ probability of becoming 1 of the 3 behaviors depending on the system's S entropic degree of freedom circumstances. In physical reality this is the $hc = h/(u_o \epsilon_o)^{\frac{1}{2}}$ 4-D Minkowski point pair space time impedance that constitutes neutral field free space with $\infty$ entropic degrees of freedom that can become and accommodate $\infty$ matter constructs from the smallest electrons to largest galaxy composites of such constructs, an $e^x$ growth function with the potential of becoming $e^{\emptyset = S/k - ix}$ statistical equilibriums of constructs and their forces because point pair space is an entropic degree of freedom that accommodates bipolar = unipolar conditions, the Fundamental Ground State.

This quantum continuous nexus is the basic construct because its $e^{S/k}$ behavior has S = ∞ entropic degrees of freedom so it's a $P = e^{\infty/k} = e^{\infty/hc}$ 100% probability force on the ∞ hc impedance energy construct of space, an ∞ vacuum on an ∞ energy source, that its EM energy construct force is insufficient to resist. It boils matter under an ∞ vacuum condition because the point pairs are neutral absent external influence and are therefore an ∞ source of $e^{S/k}$ energies with a $P = e^{S/k} = 100\%$ probability of becoming something.

**VI) Fundamental Order**

Matter however doesn't just become anything, it becomes a precise pattern of proton-electron constructs from a hydrogen construct, a saturated neutron state, the elements, and all their larger constructs. The question arises as to what gives energy the information of these constructs? The speed of light correlates space and time flow by its $h/(u_o \epsilon_o)^{\frac{1}{2}}$ energy density impedance that requires energy to polarize its point pairs into excited ↑ ↓ or ↓ ↑ states and provides some inherent energy construct information and a field energy wavelength correlation so it would seem that pi is an information source because of its infinite set of transcendental numbers but it's actually a resultant, not a source.




As an inifinite non-repeating number set pi would seem to represent all known information but with no point of reference to access it because it's a circumferential resultant derived as a diameter to circumference, area, and volume ratio, and wavelength to sine-cosine field strength coefficient, by summing Pythagorean resultants of smaller and smaller xy right angle triangles as the segments approach 0. Since the dx and dy roots vary reciprocally the dR slope varies continuously so pi is actually a $d^2R/dx^2 + d^2R/dy^2 = 0$ slope acceleration factor. Velocity has magnitude and direction and change of either is an acceleration by change of either root with respect to the other. Since dx and dy are reciprocal $dx^2 + dy^2 = dR^2$ is a constant velocity direction change or $\sin^2 x + \cos^2 x = 1$ acceleration.

In physical reality this means energy has two component roots, substance and information, within the contextual boundary condition limits of the domain's total information and total substance, so matter is an $hc = h/(u_o\epsilon_o)^{\frac{1}{2}}$ point pair impedance construct of space within the information limits of its $\infty$ 4-D space-time entropic degrees of freedom, an $s^2 + i^2 = E^2$ Pythagorean energy substance and information resultant. These substance and information roots define the $e^{-ix}$ stable energy form in which the $i^2 + s^2 = E^2$ information and substance Pythagorean is an $e^{-ix}$ $= \cos x - \sin x$ sine-cosine energy resonance space's impedance according to a 2pi wavelength.

Thus pi as a resultant of reciprocal sine-cosine functions is an information change resultant of the orthogonal information and substance components of the stable $e^{-ix} = \cos x - i \sin x$ equilibrium that is the $hc = h/(u_o\epsilon_o)^{\frac{1}{2}}$ energy of matter constructs, an $e^{-ix}$ pendulum resonance of information and hc substance like and EM wave's field energy. Space is conceptually orthogonal to the construct so the informaion resonance is an -ix function where energy must be added to destabilize it because the momentums of the information cancel over time according to symmetry to form a ground state, with $i = -1^{\frac{1}{2}}$ indicating a wave's 90° orthogonal degree of freedom with space and $i^2 = -1$ representing a reciprocal 180° out of phase degree of freedom, is the symmetrical interaction of the wave's energy momentums in the time degree of freedom, an $e^{\emptyset=S/k-ix}$ 0 average energy resonance.

If no internal or external degree of freedom exists to reciprocate with it's a simple $e^x$ constantly accelerating decay function and if an external orthogonal degree of freedom exists for the energy between components it's $e^{S/k}$ statistical. This is shown in the $e^x$ expansion:

Expansion: $e^x = \sum_{n=0}^{\infty} \frac{x^n}{n!} = \frac{x^0}{0!} + \frac{x^1}{1!} + \frac{x^2}{2!} + \frac{x^3}{3!} + \frac{x^4}{4!} + \frac{x^5}{5!} + \ldots$

Degrees of Freedom: 0-D 1-D 2-D 3-D 4-D 5-D

Graphical Representation:


point line area volume velocity acceleration

a simple Calculus progression of integrations, where x can be anything from a measure of the decay, equilibrium and statistical behaviors of energy in matter to the thoughts in a line of reasoning at each level.

It's what occurs as change manifests one degree of freedom at a time in an orthogonal non-interfering way: a point becomes a 45° line ½ way between its horizontal and vertical boundary conditions, a line becomes an area with its apex orthogonal to the line and its roots orthogonal to each other, and so forth, and its $e^{x}$ decay, $e^{-ix}$ equilibrium, and $e^{S/k}$ statistical behavior forms are similarly orthogonal transform, internal, and external behaviors that occur as degree of freedom additions and enable the system energy information to increase in an ordered way since the §$e^{x}$ is an $e^{x}$ function. This progression of mathematical logic and matter constructs match because the same progression of information is occurring in both domains.

**VII) Order in Social Institutions**

What is most notable in this is that mathematics is a creation of mind, "a language of thought whose syntax prevents illogic and error" (Lord Brouncker), "delivering the key to those laws of nature and the universe which are concealed by appearances" (Hannah Arrendt), and since the Law, Political Constructs of Government, Economics, and Business Practices, are the products of men's thoughts it provides as much a basis for the calculus of those institutions as it does for the fundamental order in the constructs of physical reality.

For instance, the Constitution is a limited grant of power by the People to the Legislative, Executive and Judicial branches "to form a more perfect union, establish justice, insure domestic tranquility, provide for the common defense, promote the general welfare, and secure the blessings of liberty...." This balance between the interests of individuals and those of society was patterned after Montesquieu's "Spirit of Law" and Blackstone's "Commentaries on the Laws of England," followed a simple calculus progression from nothing that grew from the subjects of a monarchy to a nation with the greatest individual freedoms, the largest economy (20% of the global economy with only 5% of its population), the most advanced technology, the most powerful military, and the highest overall standard of living, all based on the notion that individuals are important, society is formed for their benefit, and the purpose of government is to preserve this.

This $e^x$ progression, a decay of monarchy started with the Magna Carta's recognition if individual's rights, a degree of freedom from the throne, developed into a government of 3 branches that separated the powers to set policy, enforce it, and safeguard individuals against the misuse of these powers or the possible tyranny of majority opinions. The experiment has worked well until recent years when "the acquisition of unwarranted influence" by special interests has diverted the purposes of government to their ends while a divisive rise of partisanship within government has fractionated and diluted its effectiveness. These e forces of decay challenge the Constitution and what it has provided.

As Montesquieu stated, "Law in general is human reason," and it follows an e progression in the judiciary. A challenge is raised through the lower courts to the Supreme Court which then rules "narrowly" (Ashwander doctrine) on it within the parameters raised. This resolution of a legal point is undefined with respect to boundary conditions because to rule more broadly would constitute "policy setting," a Legislative function and Separation of Powers violation.

This leaves the breath of the point unresolved as to its limits of application so others raise their issues up through the Courts of Appeals until the Supreme Court decides there is an unresolved aspect of sufficient importance to merit review, a calculus of decisions over years that clarify the line between individual safeguards and government authority. One such issue was Sixth Amendment trial by jury safeguards.

In 1970 In re Winship overturned a juvenile's hearing and sentencing by a judge and prosecutor based on the Sixth Amendment presumption of innocence right to proof beyond a reasonable doubt to a jury and the right to have an offense's more serious elements distinguished from less serious ones in sentencing. However in Mullaney v Wilbur (1975) The Court made it the defendant's responsibility to show mitigation of murder to heat of passion manslaughter by requiring proof of the distinction by the defendant, relieving the State of the burden of persuasion on malice because all murder implies malice. In Patterson v New York (1977) the Court set the other boundary by deciding the State could not relieve itself of the burden of persuasion on the other elements of murder, they must clearly define and prove them to a jury beyond a reasonable doubt.

In 1998 a new Sixth Amendment safeguard pertaining to sentencing enhancements was addressed in Almendarez-Torres v US regarding a a 20 year enhancement for an illegal re-entry after a felony conviction and deportation on an initial illegal entry. The Court determined that since the first illegal entry and felony had been proven to a jury Congress could legislate an enhancement penalty based on proven facts, setting policy and not a legislative judgment. In Jones v US (1999) the set the opposing boundary by distinguishing between statutory legislative judgments, judicial policy setting regarding use of aggravating factors in sentencing within statutory ranges, and facts that must be proven beyond a reasonable doubt for enhancement purposes.

In Apprendi v New Jersey (2000) the distinction was expounded upon by determining that any enhancement beyond the statutory maximum requires jury fact finding. Ring v Arizona (2001) required a proven aggravating factor beyond the minimum aggravating factor for Special Circumstances Life imprisonment Without Parole in order to impose a Death Penalty. In Blakely v Washington (2004) the maximum sentence was limited to facts proven to a jury, but US v Booker (2005) allowed evidence of fact that is "overwhelming" and "essentially uncontroverted," while Cunningham v California (2007) extended the right to jury determination on all facts used to enhance a sentence. Facts must be (1) found true by a jury beyond a reasonable doubt, (2) reflected by jury verdict, (3) admitted by a defendant, (4) contained in a guilty plea, or (5) established by prior conviction. The calculus of these determinations was a progression of degrees of individual freedom that limit government, a progression of human reason that correlates to the logic progression of $e^x$ degrees of freedom.

The political constructs of government are bounded by diametrically opposing ideologies - Communism and Fascism. In the mid-19th Century Karl Marx, founder of Communism, asserted that the laws of history are the laws of economics and advocated a "from each according to his abilities; to each according to his needs" economic policy in addition to condemning property ownership, inheritance, religions that abase man, and political structures that facilitate aristocracy. Thirty years later Friedrich Nietzche asserted that "Man is a rope between the animal and the

Superman.... What is great in man is that he is a bridge and not a goal," and advocated an intellectual superiority, physical strength, and mediocrity "order of castes" in place of aristocratic structure.

These ideologies were §1/f(x) dx singularity function root inversions of the elements of aristocracy, advocating beliefs that anyone can rise to the level of a ruler if they have the ability, the "will to power," and conversely that no one is above anyone else and therefore no one should be able to accumulate the means to rule over others, inverse $a^2 + b^2 = c^2$ Pythagorean roots of aristocracy. These lines of reason were passionately embraced and gave rise to a century of global conflict, simple entropic degrees of freedom for those oppressed by conditions.

They failed however because they were only roots, unbalanced and incomplete by themselves, and it was Marx himself who unknowingly stated why, the laws of history are the laws of economics, which Leonard Frank cleverly expressed in terms of government and individual rights:

| Type of Government | Asset Ownership | Social Economy | Individual Rights |
|---|---|---|---|
| Democracy | Private | Capitalism | 11 |
| Democracy | Public | Socialism | 10 |
| Dictatorship | Private | Fascism | 01 |
| Dictatorship | Public | Communism | 00 |

One sided economic structures can't compete with the strength of an economy that allows people to govern themselves, accumulate wealth, and determine the benefit of their labor through consumerism. Communism oppresses and removes incentive, Fascism oppresses, Socialism removes incentive, and Capitalism offers freedom and incentive. It may not be perfect but it raises society because it promotes competition, rewards innovation, and creates wealth, the basis and purpose of any economic system, by promoting both society and individual opportunity.

"A corporation is an artificial thing, invisible, intangible, and existing only in the contemplation of the law," Dartmouth College v Woodward 4 Wheaton 518 (1819), and it derives from the First Amendment right to petition and peaceable assembly clauses, East. RR Presidents Conf. v Noerr Motor Freight 365 US 127, 135-8 (1961) and United Mine Workers v Pennington 381 US 657, 670 (1965). "The best test of truth is the power of the thought to get itself accepted in the competition of the market," Justice Helms, Abrams v US, 250 US 616, 630 (1919), and these principles raised the US to 20% of the global economy.

However an $e^x$ calculus progression is a product of unbalanced forces that become all consuming unless balanced in an $e^{-ix} = \cos x - i\sin x$ equilibrium by limits that introduce stability. In the words of late 19th Century railroad tycoon Cornelius Vanderbilt, "What do I care about the law, hain't I got the power." Government responded to such attitudes with the Sherman Act (1890), Clayton Act (1911), Federal Administrative Agency Act (1933), and Racketeering Influenced Corrupt Organizations Act (1970), to restrain the accumulation of such unwarranted power. No one can dispute the economic and social benefits of such things as railroads or the jobs and economic abundance they have provided. Government merely provided the restraints needed to transform the $e^x$ expansion into an $e^{-ix}$ equilibrium within the Antitrust, Rico, Fair Labor Practices, Environmental, etc., Legislative limits.

There are however more fundamental economic constraints, Adam Smith's Added Value and John Nash's Controlling Market Dynamics, that determine the actual Socio-Economic-Political equilibrium. Labor, energy and technology produce goods for market by adding value to materials. The object of business is profits, literally a force existing only in the minds of men, that are the Cost of Goods and Market Price differential. Nash recognized the significance of $e^{S/k}$ entropic degrees of freedom in this economic objective, a dynamic statistical system affected by available capital k, the measure of society's economic energy, and the S available degrees of freedom for goods such as demand, competition, etc., and the Profit = Price - Cost creation of the social system's wealth.

This actually parallels the $\Delta G^\circ = -RT \ln [\text{Products}]/[\text{Reactants}]$ Free Energy equilibrium in chemical thermodynamics where the Product and Reactant's concentrations are $e^{S/k}$ functions. The Products and Reactants each have their own $\Delta G = dH - TdS$ formation energies, where dH is the bond energy of formation, T is the system average energy, and dS is the change in degrees of freedom for the energy. If energy is released dH is negative and if entropy increases dS is ~~posive~~ positive so -TdS is negative so $\Delta G = dH - TdS$ is negative and the compound readily forms. Thus in a system the concentration ratio of the Products and Reactants depends on the ratio of their $\Delta G$ formation energies, which for RT equal energy condition is a ratio of $e^{S/k}$ functions, or the $\ln \frac{S/k}{s/k}$ natural

log of their S/k exponent entropic energy density concentrations.

In the case of economics the equilibrium is a ratio of the Product Market Potential and Created Value from adding labor, energy and technology, where RT is the system's average energy or currency value. The $\Delta G^{\circ}$ free energy available, which if negative means that the S available degrees of freedom for the market exceeds the available s degrees of freedom for the marketable products, the reaction proceeds - goods produced at a profit are consumed. However as the market saturates the market Price decreases toward the Cost of Goods and Profit approaches zero, so as soon as no wealth is created by the process it stops.

The point is that the economic equilibrium between production and consunption parallels the equilibrium between the Product and Reactant $e^{S/k}$ statistical ~~stastical~~ systems at the molecular level. The economic domain is a creation of mind that parallels the $e^{S/k}$ energy behavior in the physical reality domain. And, just like in a chemical system where reaction conditions and product circumstances determine the reaction direction, product conditions such as technology or market circumstances determine profitability. Specifically, $\Delta G^{\circ} = -RT \ln \frac{S/k}{s/k}$, the ratio of market and product energy densities, where $\alpha^2 = \frac{S/k}{s/k}$, determine the reaction (cash flow) direction, so low S/k market saturation and high s/k product inventories yield profit acceleration.

A NOT LOGIG example of this occurred in the 70's and 80's on the currency, k, when profits were created by fabricated labor cost reduction that in turn cut consumption which required a second fabricated derivative "fix" and ended up devaluing the currency. In 1970 currency held by foreign countries exceeded Federal Gold Reserves so gold redemption was suspended. OPEC raised oil prices and a decade of "Stagflation" followed until "Voodoo Economics" became Reaganomics by implementing a Developing Underdeveloped Nations policy that restored corporate profitability with subsidies and tax incentives to set up production in 3rd World countries with lower labor rates, creating typical 15 to 1 Stock Equity Price increases. This was financed by T-bill sales to foreign markets but T-bill rates increased to over 10% to compensate for the currency's diluted value. A US "Homeless Epidemic" ensued because of factory closures from the labor outsourcing.

This resulted in a major contraction in consumption which was consumption which compensated for by a new policy of business deregulation and cheap and

an asset by deferring it into another form.

This was necessary because no revolutionary technology occured to open new product entropic degrees of freedom to replace those of existing technologies . This distinction between revolutionary and evolutionary technologies occurs by the paradigm shift created by a new degree of freedom in an $e^x$ technology progression, like going from man power to animal power, then water, external combustion steam, internal combustion gas or diesel, nuclear, etc., or the progression from Adding Machines, to vacuum tube computers, to transistor, small, medium, large, VLSI, etc., integration, to global network Social, Search, and App functions. These are tangible products resulting from entropic technology degree of freedom increases for market dynamics to function in that result in jobs, consumers and credit with infrastructure to support the growth.

Evolutionary changes are iterations within existing technology within Law of Diminishing Returns constraints. They require the same magnitude of investment for smaller and smaller returns, an $\propto$ energy density root limitation within the technological degree of freedom as costs shift from product development to market development. Revolutionary developments are technology domain changes made possible by new understanding that resets both the product and markes S and s entropic degrees of freedom, to 100% available because of 100% $\propto^2$ market availability for the new technology. Evolutionary changes work against increasingly saturated market conditions and Revolutionary changes create new markets. The former grows the economy into saturation and the latter restarts saturated (stalled) economies by creating potential wealth domains.

Examples of possible revolutionary changes by addition of one degree of freedom to existing technologies would be: (1) nuclear energy that derives directly from the bond between particles as electrical energy without the ~~techical~~ technical and radioactive waste problems of 60 year old fission technology; (2) computers that rely on $10^{-24}$ S EM energy transfers at the particle level instead of moving electron inertial mass at atomic levels; (3) inertial propulsion that relies on energy's interaction with the hc impedance of space to generate directional gradient acceleration fields; (4) neutrino energy state generation, modulation and detection for light speed interference free communication through the planet without communication satelites.

These would be 1st generation technologies that result from adding single degrees of freedom to existing Energy Generation, Information processing , Transportation, and Communication technologies, completely resetting the available product and market S and s degrees of freedom to 100% available. Since these global economic sectors each represent approximately ~~$12T~~ - ~~$13T~~ markets that would completely restart the economy by replacing the fabricate wealth practices of 30 years with the Created Wealth potential of new technology.

This works because energy has two roots, substance and information that determines its form and function. Since the information root operates on the x exponent of the $e^{x}$, $e^{-ix}$ and $e^{s/k}$ functions the profit gains from the energy's information density increase are exponential, as shown by the profit margins on software development versus hardware development over the past 30 years as revolutionary software information increases to existing hardware technology. They must however be done in harmony, our of phase like an $e^{-ix} = \cos x - i \sin x$ function that brings the substances information content up to meet the demands of incorporating new information.

It is thus evident that the energy density root increase limitation and nexus of $e^{-ix}$, $e^{x}$ and $e^{s/k}$ behaviors are incumbent in man's reasoning, government, business and economic behaviors. This is because the Fundamental Ground State point pair construct of space is both the substance of matter's energy constructs and the available space-time-mass entropic information degrees of freedom of its existance, energy's source and sink, and thus the basis of all $e^{-ix}$ matter constructs and $e^{s/k}$ circumstances of the development of man's reason and his mathematical attempts to characterize the $e^{x}$ calculus of it all.