Quark Relativity Transform

by William Gray

Abstract

By the principle of Relativity and two corollaries, the Entropic Energy Density Progression and Singularity principles, the Strong, Electromagnetic (EM), Weak and Gravity forces are correlated. Derived sizes, mass-energies, magnetons, spins and bond energies for the Up and Down quarks, protons, neutrons and electrons are presented. Also presented are the quark generated pion mass-energies, Weak force decay times, a correlation of quarks and Gravity, and a basis for quantized energy states, distances, and statistical behavior that relies on Einstein's 4-D Minkowski space-time.

Contents

I) Fundamental Principles

A) Relativity: the natural laws and speed of light are constant in all inertial frames of reference.

B) Entropic Energy Density Progression: if the natural laws and speed of light are constant then each reference frame has a ground state velocity v_o and energy $E_o = \frac{1}{2}mv^2$ that relates to the speed of light by Sommerfeld's $\alpha = e^2 / 2\epsilon_o hc = 0.0072973536$ number such that $v_o = \alpha c$ and $E_o = \alpha^2 E_c = \alpha^2 \frac{1}{2}mc^2$, the difference between them are unfilled entropic degrees of freedom, and E_o and E_c are the energy density boundary conditions that relate the Strong, EM, Weak and Gravity domains.

C) Singularity: when an energy domain's degrees of freedom saturate it becomes an E_o ground state component of the next domain with unsaturated degrees of freedom by an $F(x) = \int 1/f(x)\, dx$ function as $f(x) \rightarrow 0$, entropic degree of freedom saturation.

II) Energy Density Progression Transforms

A) Lorentz Transform

In Einstein's 1905 Electrodynamic of Moving Bodies and Energy Content of Inertia papers he defied the speed of light as the boundary at which mass transforms into EM energy domain gamma rays by $E = mc^2$.

His $\gamma = (1 - v^2/c^2)^{\frac{1}{2}}$ Lorentz transformation is a $(c^2/c^2 - v^2/c^2)^{\frac{1}{2}}$ Pythagorean $b = (c^2 - a^2)^{\frac{1}{2}}$ root derivation of inertial energy effects on space, time and mass with respect to inertia's light speed limit, at which $\gamma = 0$ and $s = \gamma \cdot s_o = 0$ space contracts to zero and $m = m_o/\gamma$ mass and $t = t_o/\gamma$ time flow dilation go to infinity. These are relative mathematical observations, while local perspective natural law observations show constant time flow and space with a $KE = \frac{1}{2}mc^2$ mass gain limit.

Mathematical solutions have 0 and ∞ entropic degree of freedom limits but physical reality has natural law limits. A hydrogen orbital electron only ranges from $v_o = \alpha c = 2.1877 \times 10^6$ m/s to c light speed, the velocity degree of freedom limit, and $E_n = E_o/n^2$ quantum behavior saturates when $n > 10{,}000$ and E_n quantum distinctions vanish. (Bohr's Correspondence principle that quantum behavior becomes classical when quantum distinctions vanish, a $\int 1/f(x)\,dx$ singularity as $f(x) = E_o/n^2 \rightarrow 0$.)

However local observer natural law orbital electrons only attain an $E_c = \frac{1}{2}m_ec^2$ kinetic energy, half its $m_ec^2 = 0.511$ MeV rest mass energy, and $\lambda_c = h/m_ec = 2.4263 \times 10^{-12}$m Compton matter wavelength. Thus orbital electrons never attain 0-size and oo-mass for local observers.

This is because the a and b roots of the $a^2 + b^2 = c^2$ Pythagorean only range from $a = v_o$ to c and $b = h/m_ev_o = 3.325 \times 10^{-10}$m ground state wavelength to λ_c Compton wavelength, with an $E_c = \frac{1}{2}m_ec^2$ mass gain and $t_c = \lambda_o/c = 0.80933 \times 10^{-20}$s time flow change, the natural law limits. Relative observer Lorentz limits however exceed this, depending on the ratio of the observer domain's energy density to the electron domain's density and energy addition efficiency.

B) Sommerfeld Transform

The $\alpha = e^2 / 2\epsilon_o hc$ Sommerfeld number represents the $e^2 / 2\epsilon_o h$ ground state potential energy root force of two charges with respect to the light speed kinetic energy velocity limit, $(e^2 / 2\epsilon_o h) / c$, which equates to an $E_o = \frac{1}{2}m_ev_o{}^2 = 13.6057$ eV ground state electron with a $v_o = \alpha c = 2.1877 \times 10^6$ m/s velocity correlated to an $E_c = \frac{1}{2}m_ec^2$ light speed electron domain energy density limit, a correlation coefficient between energy domains.

In the EM free space energy domain an $E_o = 13.6057$ eV EM wave has a $\lambda_{EM} = hc/E_o = 911.3 \times 10^{-11}$m wavelength, exactly $\lambda_{EM} = 2\lambda_o/\alpha$, twice the $1/\alpha$ coefficient since $\lambda_o = h/m_ev_o = 3.325 \times 10^{-10}$m is a 2-D $\frac{1}{2}$-wavelength orbital ground state and λ_{EM} is a 1-D full wavelength EM wave. Similarly, the $\lambda_c = h/m_ec = 2.4263 \times 10^{-12}$m Compton wavelength and $E_c = \frac{1}{2}m_ec^2 = 0.2555$ MeV energy are $\lambda_c = \alpha\lambda_o$ and $E_c = E_o/\alpha^2$ domain energy density changes.

These EM wave and Compton matter wave correlations are the boundary transforms from the orbital electron EM field energy domain to the EM wave and nuclear energy domains, since the $\lambda_c = h/m_ec = 2.4263 \times 10^{-12}$m and $E_c = \frac{1}{2}m_ec^2 = 0.2555$ MeV Compton wavelength and energy are the basis for the quark, proton and electron sizes and mass-energies, the pion and nuclear bond energies and the Weak force ½-life decay times - a physical reality Entropic Energy Density Progression.

At light speed an electron gains the $E_C = \frac{1}{2}m_e c^2$ Compton energy in 1-D. The Up quark is 3-D with $2^{\frac{1}{2}}$ angular and $3^{\frac{1}{2}}$ spherical momentum energy distributions in a 2pi wave structure form so its mass is $m_U = 2^{\frac{1}{2}}3^{\frac{1}{2}}2pi(E_C = \frac{1}{2}m_e c^2) = 3.9329$ MeV, and the Down quark, as an excited Up quark state, is $m_D = 3^{\frac{1}{2}}m_U = 6.8109$ MeV. Their physical sizes also correlate to the λ_c Compton wavelength, with an $r_{qi} = \frac{1}{2}\lambda_c\alpha^2 = 0.0646$ fm (10^{-15}m) interactive radius in the proton's UDU quark triton structural configuration, and the $r_{qo} = 3^{\frac{1}{2}}\alpha r_{qi} = 0.8165 \times 10^{-18}$ m measured quantum optical radius. When quarks interact they have a gluon quantized Strong force interaction distance like the pion's nuclear bond distance so they have actual r_{qo} and interactive r_{qi} radii.

The proton's Up-Down-Up quarks form a triton structure in which the Down quark is an excited Up quark with an $(m_D-m_U) = (3^{\frac{1}{2}}-1)m_U = 2.88$ MeV additional energy component that binds 3 Up quark ground states by rotating between them as a 2.88 MeV gluon orbital binding energy of the 3 Up quark triton structure, so they appear to be a UDU quark configuration.

This quark triton has a $2/3 - 1/3 + 2/3 = e^+$ charge, that by Maxwell's EM Theory, constitutes a $d\phi_E/dt = B$ changing electric field generated magnetic field energy $E_B = (\frac{1}{2}eh/2pi)2^{\frac{1}{2}}3^{\frac{1}{2}}3c^3 = 1.673 \times 10^{-27}$kg = 938.3 MeV proton mass-energy by the triton's $2^{\frac{1}{2}}$ $3^{\frac{1}{2}}$ angular and spherical momentum 3-D $3c^3$ light speed orbital inside the proton, since by Standard Model symmetry energy must evenly distribute in all degrees of freedom. The triton's orbital radius about the E_B field is $r_{pq} = 3^{2/3}r_{qi}2pi = 0.844$ fm, within 0.3% of the Max Planck Institute 0.84184 fm quantum optical radius.

Because the triton has a light speed orbital velocity it contracts the E_B mass-energy field towards it and creates a mass-center offset that gives the proton an interactive $r_{pi} = 3^{2/3}$ $r_{qi}2^{\frac{1}{2}}3^{\frac{1}{2}}2pi = 1.0341$ fm radius and arc sin (r_{pq}/r_{pi}) = arc sin $2^{\frac{1}{2}}$

$/3^{\frac{1}{2}} = 54.74°$ ½-spin angle. Thus the $1/\alpha$ and $1/\alpha^2$ Sommerfeld size and energy coefficients correlate the quarks and proton to the EM field atomic domain.

The Sommerfeld number also yields a $\gamma_S = (1 - \alpha^2)^{\frac{1}{2}} = 0.999973374$ and $1/\gamma_S - 1 = 0.002662675\%$ Lorentz Transform that incorporates the proton and electron sizes, where $(r_{eo} = 2 \times 10^{-20}\text{fm}) / (r_{pi} = 1\text{ fm}) = 2 \times 10^{-5} = 0.002\%$, so it corrects the discrepancy between $\gamma = (1 - v^2/c^2)^{\frac{1}{2}}$ mathematical and $\gamma_S = (1 - \alpha^2)^{\frac{1}{2}}$ physical solutions, where $\alpha^2 = v_o{}^2/c^2 = (e^2 / 2\epsilon_o hc)^2$ is the physical reality density change solution.

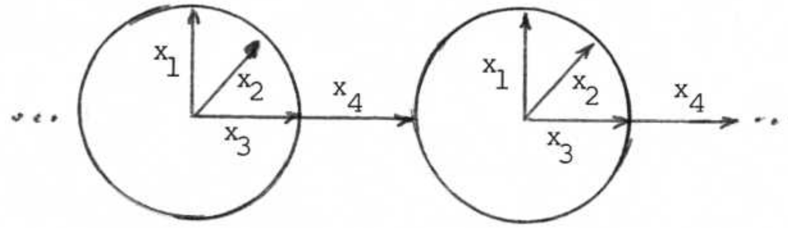
C) Heisenberg Transform

Normally Heisenberg's Uncertainty is regarded as a ½-wave uncertainty resulting from de Broglie's $\lambda = h/mv$ matter wave because a particle is a quantized size and energy and a wave is continuous field energy so a field interaction between the ½-wave nodes yields a ½-wave uncertainty.

However Yukawa used the uncertainty in a different way when he theorized a Strong force messenger particle as the basis for nuclear bonds. He assumed that if it's an uncertainty then Energy Conservation isn't violated if a nucleon emits and re-absorbs it within the ½-wave uncertainty period. If it can't be measured then no conservation violation occurs.

He then set the ½-wave uncertainty to a 1.4 fm nuclear bond distance, so the wave nodes matched the distance, and calculated the messenger's mass-energy from de Broglie's $\lambda = h/mv$ matter wave relation, yielding a 140 MeV pion, which was experimentally confirmed 15 years later. His prediction was accurate because the uncertainty distance matched the nuclear bond distance.

In this application he did what Einstein had done by referencing mechanical and EM motions to the Speed of light, the limit of the variable uncertainty. Both Einstein and Yukawa factored the uncertainties out of their approaches by using what was known about them, the ½-wave node to node energy in Yukawa's case and the speed of light velocity limit in Einstein's. Thus the uncertainty limit became a Heisenberg Transform that yielded the messenger particle's energy in terms of the uncertainty's distance.



D) Minkowski Transform

1) Minkowski Space-time

Einstein's Minkowski's space-time extended the $a^2 + b^2 = c^2$ Pythagorean to 4-D as $ds^2 = dx_1^2 + dx_2^2 + dx_3^2 + dx_4^2 = 0$, with time flow represented as $x_4 = (-1)^{\frac{1}{2}}ct$, a distance correlated to space's 3-D. It's set to 0 because it's "field free" and $E = F \cdot d$ has distance.

He then incorporated a $ds^2 = g_{ik}dx_{1i}dx_{1k} + \cdots$ "Riemann construct" extended to "all combinations 11, 12, $\cdots$ up to 44" coordinate elements to incorporate g_{ik} $E_g = F_g \cdot d$ gravitational field energy "function of coordinate" coefficients to add solution coefficients for gravity's effect on 4-D space-time.

This imposed size onto each "field free" 0-size 4-D point to allow space contraction and time flow dilation according to a gravitational field gradient assigned to each point. This allowed finite solutions for any point that correlated specific acceleration force and time dilation values to continuous $F_g = Gm_1m_2/r^2$ gravity force, a Cause and Effect.

This model however isn't limited to continuous fields, it can also apply to EM wave "energy quanta" that are continuous harmonic field energy states moving through space, proton and electron matter wave field energies, or nucleon pion and quark gluon Strong force messengers.

In the case of quantized forces and distances the speed of light in Einstein's $x_4 = (-1)^{\frac{1}{2}}ct$ time flow dimension represents the time flow distance for energy to move from point to point, and in Yukawa's nuclear bond it's the Heisenberg ½-wave 140 MeV pion messenger energy. The source of the pion comes from within the nucleon, which means the pion matter wave has an equivalent ½-wave energy within the nucleon that correlates by the energy density difference between them.

The $c = 1 / (u_o\epsilon_o)^{\frac{1}{2}}$ speed of light is a permeability-permittivity of free space function and relative $u_r\epsilon_r$ that result from energy fields like a "gravitational lens" effect of large stars or dark matter, but more like muon decay time dilation as it approaches earth in the direction of the space field energy contraction gradient that compounds $u_o\epsilon_o$ to $u_r\epsilon_r$ values. Thus for uniform $u_{o\ o}$ values inside and outside a particle the x_n distances would be uniform and for relative values they would differ by $u_r\epsilon_r/u_o\epsilon_o$ but still be quantized because they are ½-wavelengths.

2) Pion Construct

Yukawa used 1.4 fm and the proton has a 1 fm radius, so the $\frac{1}{2}$-wave pion equals $2^{\frac{1}{2}} r_{pi}$, leading to a conclusion that it's a $2^{\frac{1}{2}}$ angular momentum resultant, and thus a:

$$\underline{\text{3-D m mass to 1-D inertia + gluon trigger + electron component} = m_{pi^-}}$$

$$(3/2)^{\frac{1}{2}}[3(\tfrac{1}{2}m_e c^2)/\alpha + 2^{\frac{1}{2}} m_e] + (m_D - m_U/pi) + 3(m_e + E_n) + 2^{\frac{1}{2}} m_e = 139.7 \text{ MeV}$$

$$(3/2)^{\frac{1}{2}}\ 105.7 \text{ MeV} \quad + \quad 5.56 \text{ MeV} \quad + 4.6 \text{ MeV}$$

$$129.53 \text{ MeV} \quad + \quad 5.56 \text{ MeV} \quad + 4.6 \text{ MeV}$$

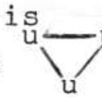
$$\underline{135.1 \text{ MeV} \qquad + 4.6 \text{ MeV} \qquad = 139.7 \text{ MeV}}$$

It contains the m_{u^-}= 105.7 MeV muon and m_{pi°= 135 MeV neutral pion, where $m_{u^-} = 3(\frac{1}{2}m_e c^2)/\alpha + 2^{\frac{1}{2}} m_e$ = 105.7 MeV and $m_{pi^\circ} = (3/2)^{\frac{1}{2}} m_e + (m_D - m_U/pi)$ = 129.5 MeV + 5.6 MeV + 135 MeV.

This pion composite energy construct from the quark triton was determined by the Minkowski and Heisemberg concepts, a $e^{-ix} = \cos x - i \sin x = [\partial^2 u/\partial x^2 + \partial^2 u/\partial y^2 = 0 = \partial^2 v/\partial x^2 + \partial^2 v/\partial y^2]$ 2nd order Cauchy Riemann Laplacian harmonic $\frac{1}{2}$-wave Heisenberg Uncertainty, like Maxwell $\partial^2 E/\partial x^2 = u_o \epsilon_o\ \partial^2 E/\partial t^2$ and $\partial^2 B/\partial x^2 = u_o \epsilon_o\ \partial^2 B/\partial t^2$ wave equations, Schrodinger's wave functions, and Einstein's 4-D space time as $m_p = (\frac{1}{2}eh/2pi) 2^{\frac{1}{2}} 3^{\frac{1}{2}} 3c^3$ = 938.3 MeV, $m_e = (\frac{1}{2}eh/2pi) 2^{\frac{1}{2}} 3^{\frac{1}{2}} 2pi / \alpha r_{eo}$ = 0.511 MeV, and $m_U = \frac{1}{2}m_e c^2 2^{\frac{1}{2}} 3^{\frac{1}{2}} 2pi$ = 3.932 MeV field mass energies.

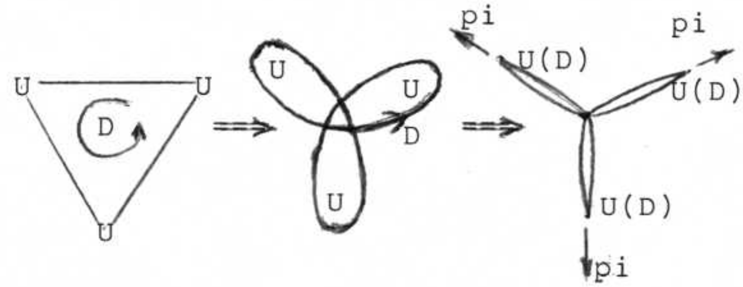
3) Pion Generation (Quark Relativity Discontinuity-Continuity)

The pion generation is a $\int 1/f(x)\, dx$ singularity that occurs as the Down quark's $(3^{\frac{1}{2}} - 1)m_U$ = 2.88 MeV gluon excited energy state component interacts with an Up quark as it travels its $2^{\frac{1}{2}}$ angular momentum orbital around the triton structure. It occurs because the wave function is continuous and analytic over time while the triton structure is a



discontinuous 3 quark construct with the Down quark's excited energy state component rotating between them.

This discontinuity between the quantized triton structure and continuous e^{-ix} Cauchy-Riemann Laplacian harmonic results in a unique orbital that is continuous to the e^{-ix} wave function in its reference frame but discontinuous and compatible with the triton's quantized discontinuous structure because of relativistic contraction the wave undergoes from the triton's perspective.



The Down quark's excited energy state angular momentum forms a clover-leaf orbital that's continuous to the excited energy state's e^{-ix} wave function in its local reference frame, but since it travels between the Up quarks at light speed it exhibits relativistic contraction to the triton's relative reference frame that transforms it to a contracted clover-leaf compatible with the triton's discontinuities.

Without these distinctions between the local and relative effects of Einstein's Lorentz transformation the continuity of the excited energy state's e^{-ix} wave function and the triton's discontinuity could not be accommodated. Thus Relativity makes the quantized discontinuous structure possible by a superposition of local and relative effects in the same structure. The 2.88 MeV gluon excited energy state binding effect makes the Up quark's energy states stable in the triton configuration as it resonates between them, transforming them into excited Down quark states as it does.

4) Pion Cause

This gluon - Up quark interaction causes the pion messenger particle emission as shown in the 135 MeV $m_{pi^0} = (3/2)^{\frac{1}{2}}[3(\frac{1}{2}m_e c^2)/\alpha + 2^{\frac{1}{2}}m_e] + (m_D - m_U/pi)$ pion mass equation. The $(3/2)^{\frac{1}{2}}[3(\frac{1}{2}m_e c^2)/\alpha + 2^{\frac{1}{2}}m_e] = 129.5$ MeV bulk of its energy derives from the triton's orbital around the EM mass it generates but the singularity event that triggers the pion is the $(m_D - m_U/pi) = 5.6$ MeV energy generated when the $m_D - m_U = 2.88$ MeV gluon interacts with the Up quark at a discontinuous clover-leaf tip. Since it occurs at light speed relative to the Up quark it disrupts its $m_U = 2^{\frac{1}{2}}3^{\frac{1}{2}}2pi(\frac{1}{2}m_e c^2)$ orbital wave energy state as a discontinuity to the waves continuity and causes a chain of events.

If this had occured with an uncontracted clover-leaf it would not be stable because it would occur at an angle and cause wave interference with the Up quark's wave state with a ½-wave energy uncertainty because there would always be an unknown reflected gluon energy that could not be recovered by a stable resonance condition. However since it occurs at the right angle of the contracted clover-leaf's intersect with the Up quark, stationary relative to the light speed interaction, it is 100% absorbeb and results in a stable resonance condition by the pion generation that returns in a finite time and restores the gluon's 2.88 MeV by 100%.

The gluon's interaction with the triton's Up quark disrupts the $m_p = (\frac{1}{2}eh/2pi)2^{\frac{1}{2}}3^{\frac{1}{2}}3c^3$ = 938 MeV EM field energy because when the gluon was generated by the Down quark's decay to an Up quark state it carried structural polarity information in its energy that changed the Down quark from a -1/3 e to an Up quark's +2/3 e charge and the Up quark the gluon interacts with from its +2/3 e charge to a -1/3 e Down quark charge. This charge disruption interrupts the triton's $d\phi_E/dt$ proton EM mass-energy field generation and it starts decaying back into the triton to provide the $(3/2)^{\frac{1}{2}}[3(\frac{1}{2}m_e c^2)/\alpha + 2^{\frac{1}{2}} m_e]$ bulk of the pion's energy. When the pion returns its energy the resonance cycle is complete, all energy is restored, as is the gluon resonance between the triton's quarks and its charge is 2/3 - 1/3 + 2/3 = e to resume the $d\phi_E/dt$ generation of the proton's EM mass-energy field.

5) Pion Emission

This is a $1/f(x)\,dx$ singularity, as $f(x) \rightarrow 0$, across a domain boundary as a quantized wave energy, time and distance resonance made possible because relativistic clover-leaf contraction kept the gluon - Up quark interaction quantized and conservative. Because waves are continuous analytic functions the exchange must occur at a node to keep the energy, time and distance quantized, since the $[d^2u/dx^2 + d^2u/dy^2 = 0 = d^2v/dx^2 + d^2v/dy^2]$ 2nd order Cauchy Riemann Laplacian harmonic field energy values are only exactly known at 0, the nodes, so there is no energy state uncertainty, and $\int 1/f(x)\,dx$ singularities only occur as $f(x) \rightarrow 0$.

Thus the wave function energy can pass through a domain boundary and return as a quantized harmonic ½-wave resonance function. The alternative would be a ½-wave uncertainty at every resonance cycle that decays the inter-domain resonance, as with Weak force Beta decays with variable kinetic energies.

The pion energy resonance occurs at a gluon ½-wave node when its 2nd order derivatives are 0 and its light speed interaction velocity with the Up quark is at 0. Thus its distinctly unique quantized energy maintains a resonance with the pion's quantized energy, since it's a ½-wave 2-D orbital to 1-D pion inertia 1/o boundary condition energy density change, so $\frac{1}{2} \cdot 2.88$ MeV / $2^{\frac{1}{2}}\alpha = 139.5$ MeV, as a $\frac{1}{2} \cdot (m_D - m_U/pi) = 2.78$ MeV component in conjunction with the $(3/2)^{\frac{1}{2}}[3(\frac{1}{2}m_e c^2)/\alpha + 2^{\frac{1}{2}} m_e]$ EM field energy decay, which is quantized because the gluon's interaction is so the $d\phi_E/dt$ disruption occurs for only a quantized higher energy harmonic time period, equating the component energies to the pion's $\frac{1}{2}$-wave bond time-distance resonance energy, according to the Minkowski and other Transforms, Maxwell's EM Theory, and Cauchy-Riemann Laplacian harmonic $\frac{1}{2}$-wave singularity function.

6) Quark Gravity Correlation

A specific application of this concept occurs when correlating quarks and gravity, the strongest and weakest forces. The continuity of the Sun's gravitational force results in a 365 day earth orbit, correlating to a 9.46×10^{15}m light year distance. The Sun has a quark generated proton EM mass equivalence of 1.19×10^{57} protons, the basis of all neutron and nuclei masses. At this high number all quantum distinctions vanish (Bohr's Correspondence Principle).

If a $\int 1/f(x)\,dx$ singularity function equivalence exists between the quark Strong force and $F_g = Gm_1m_2/r^2$ gravitational domains then the $F_c = mv^2/r$ centripetal orbit period light year distance should equate to the reciprocal of the quark's Strong force distance in the triton, which it does since $1 / 9.46 \times 10^{15} = 0.1057$ fm, which factors by $3^{\frac{1}{2}}$ to 0.061 fm, within 6% of $r_{qi} = 0.0646$ fm.

This shows a 1/f(x) reciprocal equivalence between the Strong and Gravity energy density domains. The 6% error arises because the mean orbit velocity and radius were used and the Sun is not a ds = 0 size point. The G = (Centripetal Acceleration) / (Equivalent Quark Generated Mass) is $G = (v_e^2/r_e) / [(1.19 \times 10^{57}$ protons$) \times (\frac{1}{2}eh/2pi)2^{\frac{1}{2}}3^{\frac{1}{2}}3c^3$ kg/proton$] = 6.665 \times 10^{-11}$, within 0.12% of the actual $G = 6.6726 \times 10^{-11}$ value. Thus EM energy and quark energy density equate to Gravity.

III) Weak Force Decay

A) Characterization

1) Strong-Weak Decays (see also $\frac{1}{2}$-spin change effect in III-C-1, Nuclear Bonding, Classical)

Strong force decays obey symmetry, are faster than 10^{-20} s, and occur as unstable particle decays to more stable states or EM gamma ray emissions, both of which are still in the Strong force energy density domain. Weak force decays are asymmetrical, orders of magnitude slower, and involve varying kinetic energy Beta particle, or Tau, Pion or Muon higher energy, emissions to the lower energy density atomic domain.

By symmetry, decays like $K^\circ \rightarrow pi^- + e^+ + \nu_e$ and and $K^\circ \rightarrow pi^+ + e^- + \nu_e^*$ should occur equally, exhibiting charge symmetry, but the e^+ positron path is more frequent. Similarly, events like pion and proton interactions should yield equal $pi^- + p \rightarrow K^\circ + \Lambda^\circ$ and $K^\circ + n$ decay products but $K^\circ + n$ products never occur, exhibiting decay path asymmetry. These asymmetries however occur for good cause. Weak force decays are intermediate transitions between symmetric Strong nuclear and EM atomic domains and are affected by conditions of the domain they decay from and circumstances of the domain they decay to.

2) Boltzmann Requirement

This is a Boltzmann statistics requirement. Boltzmann showed that with gases the E_i instantaneous kinetic energies with respect to the E_a average energy per molecule statistically distribute according to his $e^{-E_i/E_a} = e^{-\frac{1}{2}mv^2/kT}$ factor and system characterization coefficients, such that instantaneous energy probabilities are a $P_i = e^{S/k}$ function of the system's entropies, and the entropies are a reciprocal $S = k \ln P_i$ probability function. Normally this is interpreted to mean that if entropies are system functions the probabilities can be controlled, like a piston in one degree of freedom allowing energy extraction from, or addition to, a gas because a system redistributes molecules and energies according to its entropic degrees of freedom.

When Einstein wrote his 1905 Production and Transformation of Light paper he used Boltzmann's e^{-E_i/E_a} factor to show that the additional uv emissions from a heated Black Body came from the electrons in the atoms by Boltzmann's $P_i = e^{S/k}$ probability principle by showing that the uv came from the lower mass electrons because the uv from the higher mass atoms were too low to yield the uv intensities.

There were two important points from this analysis. One was that light has continuous wave field energies and is also "energy quanta," leading to a Nobel Prize and the fundamental basis for Quantum Theory. The other point was how he derived his "energy quanta" conclusion. He used the electron's work function (ionization energy) that he had derived by working with Planck to show that E = hf light frequency energy levels caused electron emission. This was his S entropy function limit responsible for uv emission intensities, so while others had used 0 and ∞ mathematical limits to explain uv from atoms Einstein used the physical reality work function limit to explain uv from electrons.

This was a profound line of reasoning because it demonstrated a Cause and Effect basis of Boltzmann's $P_i = e^{S/k}$ probability principle. Even though they are statistical functions they never the less do equate the probability to the entropy, such as the boundary conditions of a gas system. In a one molecule system $E_i = E_a$ so $e^{-E_i/E_a} = e^{-1}$, a 100% probability, and in a saturated gas system there is no space for E_i energies so again $E_i = E_a$, a 100% probability.

When Einstein limited electron energies to a work function range, instead of 0 to ∞ limits that allowed atoms a uv probability, he derived the correct uv intensity relation and "energy quanta," putting physical limits as Cause and Effect system entropy function limits and the basis for "energy quanta" statistical behavior. It showed that a system's components were systems themselves whose components affected the overall system entropy functions. The Weak force decays are thus affected by the circumstances of the domain's components they decay to.

3) Domain Crossing

Einstein relied on this concept when he related mechanical and EM motion energies to the speed of light velocity limit in his Lorentz transformation, the limit of the velocity entropic degree of freedom. The difference between an object's velocity and the speed of light is a system entropy and probability determinant (space, time and mass in the case of the Lorentz transformation and Relativity) and something completely "revolutionary" in the case of Black Body uv radiation: system components are microstate systems and their entropic degrees of freedom affect overall macrostate system entropies, and thus component energies and probabilities.

This means the circumstances of a system's entropies and the conditions within the system's microstate components, external S and internal s entropies, affect outcomes. This was the basis for recognizing that quantized discontinuities could be correlated to Relativity's continuity at a fundamental Minkowski level and that domains could be correlated by Sommerfeld's $1/\alpha^2$ energy density factor, since 4-D Minkowski space-time point behaviors would be affected by their internal conditions and and external circumstances like energy density entropic degrees of freedom that determine $x_4 = (-1)^{\frac{1}{2}}ct$ time flow of energy motion in terms of distance. Thus quantized systems like atoms could be correlated to continuous classical system circumstances like pressure and temperature in gases, "energy quanta" and wave fields, or energy densities between systems.

This also means they can be related by their S and s entropies' available degrees of freedom like Einstein's v^2/c^2 Lorentz transformation ratio because they must equalize by symmetry, like a system and its components or the atoms' EM force and nuclear Strong force energy domains. Thus each domain's ground and maximum energy states relate by $\alpha^2 = E_o/E_{max}$ ratios, and the ground state energy densities between domains must also relate by the same o^2 ratio because the natural laws are the same for both.

Therefore, transformation probabilities, and thus ½-life decay times between domains, are a function of the components' s and system's entropies. In Weak force decays the decay occur from the s component entropies and to the S system entropy circumstances. Since the s and S source and destination are independent, although statistical probabilities correlate, all such decays appear asymmetric but do correlate to the entropies of the source and destination on a root level, and in some cases both source and destination if they have a common structural pattern such as an $e^x = \sum_{n=0}^{\infty} x^n/n!$ progression or e^{-ix} wave function.

At a boundary between systems if the component domain is saturated, like v^2/c^2 kinetic energy when velocity is at c^2/c^2 light speed, there is 0% E_i instantaneous energy probability because $E_i = E_a$ and all component wave functions are a uniform harmonic so s = 0, but this condition makes them all E ground state energies with S = 100% available system entropic degrees of freedom, creating a (S = 1) - (s = 0) = 100% $\int 1/f(x)\,dx$ singularity transformation as the component achieves f(x) = S = 0 saturation.

It thus transforms to a $1/f(x)\,dx$ ground state component with S = 100% available entropic degrees of freedom. However if the component is not saturated, so s > 0, as in Einstein's uv from atoms' electrons, then its probability of becoming a system ground state depends on the $P_i = e^{(s/S)/k}$ ratio of component to system entropic degree of freedom availabilities as each vary between 0 and 1.

In Boltzmann's model an S=0 condition corresponds to all spaces occupied, all component velocities at light speed, a crystal with all lattice vacancies filled, or a one molecule gas system at ground state with no sources of energy, so $E_i = E_a$, but a one molecule system can absorb energy so it has a potential S = 100%. In the no additional energy ground state the electron's and atom's wave functions are harmonically related, since $E_i = E_a$, and the atom's wave function energy occupies the system's space-time degrees of freedom uniformly as position and time periodic, since excited statistical states require additional energy, so its wave function energy is predictable as occurs with Bose-Einstein Condensates. For saturated states, $E_i = E_a$ so there is a mathematical 100% phase change probability, although physical limits like valence bonding limitations in inert gases limit this.

4) Quantum Continuity

This condition is the Minkowski Transform between quantum statistical and classical quantum continuous periodic distribution of component energies, as with light waves, earth's 365 day orbit, or Bose-Einstein Condensations where identical bosonic atoms' energies are stilled by phased lasers in all 6 degrees of freedom so they're all S=0 ground states and condense into a single S=0 composite. A 5 coin system illustrates:

Macrostate	Microstate "Complexions"	"Complexion" Multiplicity	Macrostate Probability
5h-0t	hhhhh	1	3.125%
4h-1t	hhhht, hhhth,hhthh, hthhh, thhhh	5	15.625%
3h-2t	hhhtt, hhtth, htthh, tthhh, hhtht hthth, ththh, hthht, thhth, thhht	10	31.25%
2h-3t	(same as 3h-2t with h and t exchanged)	10	31.25%
1h-4t	(same as 4h-1t with h and t exchanged)	5	15.625%
0h-5t	ttttt	1	3.125%

Macrostate probability is proportionate to Microstate Complexion Multiplicity. Components have two states and $2^5 = 32$ possible complexions of 100/32 = 3.125% each. In a completely filled system, states can't change so it's a 100% uniformity probability, as with a one coin system that's never shaken, so S=0. These boundary conditions are quantum continuous, and they are Minkowski Transform conditions that are the roots of quantum statistical and continuous energy behaviors. There can be no quantum statistical behavior in a quantum continuous ground state because statistical behavior requires excited energy states. Thus graviton gravitational waves won't emit from ground state orbits.

This ground state $\int 1/f(x)\,dx$ singularity boundary between energy density domains, where the quantum continuous ground state equilibrium components are saturated states with S = 0% entropic degree of freedom availability and the ground state itself is the fundamental component energy of a system with an S = 100% entropic degree of freedom availability. However, if the ground state components are unsaturated so s > 0%, like coins that can internally change their faces, the microstate complexions would no longer have a fixed $1/2^5$ = 100%/32 =3.125% multiplicity probability because they would be systems themselves with their own probabilities of being one state or the other, depending on their s > 0 ratio to 100%. In this case the overall system would have a compounded $P_i = e^{-(s/S)/k}$ probability because the total system entropies now include those of the components, as occurred with the Black Body atoms' electrons in Einstein's Production and Transformation of Light.

B) Decay Modes

1) External Circumstance Driven

Weak force decays behave according to atomic domain circumstances. With an infinite number of electrons and no e^+ positrons, which are annihilated by electrons, positrons have a 100% available entropic degree of freedom. Thus $K^\circ \rightarrow pi^- + e^+ + v_e$ positron production is more likely than $K^\circ \rightarrow pi^+ + e^- + v_e^*$ electron production, but some are produced because Weak force decays are proximity functions.

Normally proximity function is observed as $N = N_O e^{-\lambda t}$ ½-life decay but this is only one side of Boltzmann statistics, where frequency probability is a $P_f = F(e^{-S/k})$ system entropy function. If system entropy decreases the instantaneous energy distribution shifts higher, so when reactants increase the decay rate increases, balanced by an opposing side of proximity that as decay states increase the decay rate decreases. In

Chemical Thermodynamics this is the $G° = -RT \ln [product]/[reactant]$ "free energy" function where reaction rate can be increased by removing products from the system so the system responds by producing more products at a higher rate, like increasing U-235 reactions by removing U-238.

Borghi demonstrated this in Brazil in 1955. He lined a microwave tube with a Beta decay radioisotope after measuring its ½-life decay rate. He then filled the tube with hydrogen and ran it to stimulate orbital electrons with rf energy to increases the Electron Capture rate probability, and thus neutron production that the isotope's decay product absorbed and transmuted back into the isotope, increasing the ½-life decay rate. He was attempting to prove that neutrons were protons that absorbed electrons but his isotope re-transmutation detection method demonstrates External Circumstance Driven Weak force decay mode. Thus e electron production is affected by proximity of other electrons, causing charge asymmetry, but some electrons result from local vacancies.

2) Internal Condition Driven

The $pi^- + p \rightarrow K° + \Lambda^0$ but not $K° + n$ reaction path asymmetry is function of the components' internal quarks. A pi^- pion has has a u*d anti-up - down quark pair and a proton has a udu quark triton while a K° kaon has a ds* down - anti-strange quark pair and a Λ^0 lambda has a uds up - down - strange triton, but a neutron only has a dud quark triton. If a K° kaon's excited state anti-strange quark is produced by a high energy $pi^- + p$ interaction then the Λ^0 lambda's excited state strange quark must also be produced as a Strong force symmetrical pair production, just like Levero- and Dextro- chirality pair production in chemical reactions.

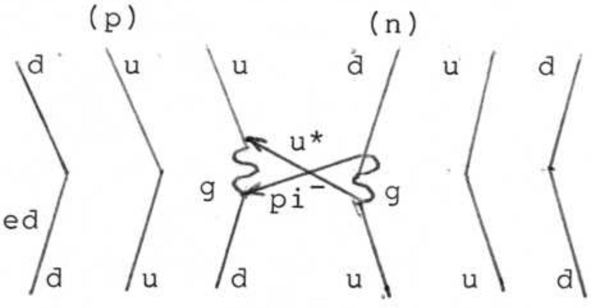
It's not possible to produce a one-sided coin or flip coins without 50/50 outcomes. An s* production without an s production would be a one-sided coin, hence no dud neutrons are produced if a ds* kaon is produced because the uds lambda must also be produced with it. The Weak force reaction path asymmetry thus occurs by a component internal symmetry requirement.

3) Internal Component External Circumstance Driven

a) Tritium - Excess Neutrons

Beta decay however is inevitable if nuclear domain components are unstable, even though there are an infinite number of atomic domain electrons, because the proximity of decay components in the Strong force domain is about 10 times greater than electrons in the EM force atomic domain. Thus Beta decay to the atomic domain is much greater than Electron Capture of orbital electrons to form neutrons.

Most elements have a range of stable isotopes, like H-1 and H-2 hydrogen and He-3 and He-4 helium. However some elements have isotopes outside their stable range, like H-3 tritium or U-235 uranium. This is because of an unbalanced symmetry condition at their quark level that decreases stability an causes ½-life decay.

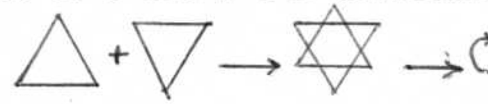


H-3 tritium is unstable because it has 2 neutrons with 2 sets of dud quarks, resulting in 5 excited down quark states to 4 up quarks. The proton's triton was characterized as 3 up quark ground states bound together by a down quark excited energy state component orbiting between them in a contracted clover-leaf orbital that rotates the down quark state between them with a $2^{\frac{1}{2}}$ angular momentum. As it does it generates the pi^- pion shown in the Feynman diagram that forms a stable deuteron by exchanging down quark states between a proton and neutron. The neutron's unstable dud configuration is induced to decay to the proton udu configuration by its extra up quark, forming a stable down quark neutron state resonance.

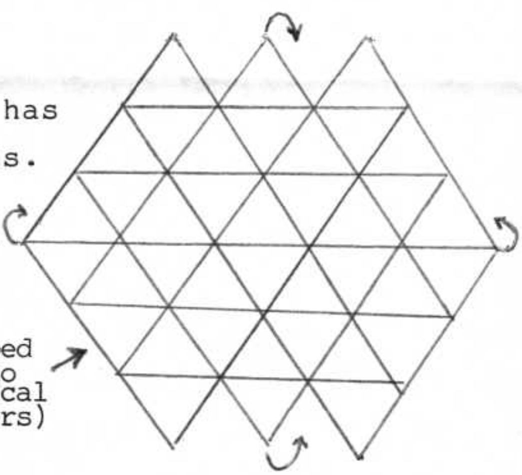
However tritium's 5 down to 4 up quark's can only exchange neutron states half as frequently in a nucleon triton structure that always has 2 neutrons adjacent to each other, existing as dud unstable states twice as long in close proximity. As tritium's proximity density increases the down quark density entropic degree of freedom becomes less available at a geometrically squared rate. This accelerated instability acts as an accelerating force to stabilize the system by increasing decays, as in the $\Delta G° = -RT \ln [product]/[reactant]$ reactant - product concentration ratio equilibrium, shifting when too many of either exists with respect to the other, except down quarks are the reactants. Thus there will always be too many as long as two H-3 tritium nuclei exist. (Note: The He-3 Binding Energy with 1 neutron is 7.673 MeV and the H-3 Binding Energy with 2 neutrons is 7.673 MeV + (E_n = 0.782 MeV) = 8.5 MeV. The additional bond energy arises from the 2nd neutron's Beta electron, which means -8.5 MeV / 2 = -4.25 MeV mass defect negative energy states for each of H-3's two Beta electrons to He-3's -7.673 MeV for its single Beta electron. Thus tritium's electrons are -4.24 - (-7.67) = 3.54 MeV excited states.)

b) U-235 - Too Few Neutrons

U-235 with 143 neutrons is unstable because it has too few neutrons with respect to U-238's 146 neutrons. Bonding between triton structures forms overlayed



tritons with pion messenger bonding between protons and neutrons shared between layers to reduce instability periods. It's very stable when enough neutrons are present like in U-238



to form equal bonding distributions in 3-D spherical layers. Because neutrons transform into protons and vice-versa by down quark state transfers it results in synchronized dynamic shifting of neutron states.

Aside from the Shell Model 2, 8, 20, 28, 50, 82 and 126 "Magic Numbers" that factor into 238 nucleons as 2, 28, 82 and 126, into 92 protons as 2, 8 and 82, and 146 neutrons as 20 and 126, but not evenly into 235 nucleons or 143 neutrons, there is also a specific reason U-238 is stable and U-235 is not. With 146 neutrons and 92 protons there are 2(146) + 92 = 384 down quarks, and with 143 neutrons there are 2(143) + 92 = 378 down quarks.

In triton configurations they are factored by 3, 1 proton and 2 neutron units, and 384/3 =128 while 378/3 = 126. Since 2 = 128 is a simple binary progression value, a simple (2^0 2^1 2^2 2^3 2^4 2^5 2^6 2^7) = (1 2 4 8 16 32 64 128), it very easily results in a synchronized dynamic shifting of neutron states and therefore evenly distributed instability periods. However 126 fits in between 2^6 = 64 and 2^7 = 128 and a 126 counter requires $2^0 2^1 2^2 2^3 2^4$ and 2^5 states as a reset so it's a complex counter that doesn't offer a simple evenly distributed synchronized dynamic shifting pattern so neutron instability periods are not minimized by uniformity. The simpler the harmonic the lower the energy state and the greater the stability.

As with tritium, U-235 proximity density results in more excited, less stable, energy states occupying the energy entropic degree of freedom, thereby increasing decay probability. Thus both Tritium and U-235 decays occur from proximity circumstances and component conditions in which too many or too few neutrons result in excited states and instability.

Beta decays result in a neutron reduction and proton increase, reducing the neutron to proton ratio, by partitioning a neutron into a proton and electron that transitions into the lower energy density atomic domain. An alpha decay however is an emission of a stable 2 proton - 2 neutron helium-4 nucleus with a 1 to 1 p-n ratio so it increases the neutron to proton ratio in the nucleus it decayed from. Thus Beta decays are energy density domain transitions while alpha particles are stable nuclear structures that remains in the Strong force domain.

In summary, Weak force decays are controlled by the circumstances of the domain they decay to, as in charge asymmetry, by the conditions of the components, as in reaction path asymmetry, or both circumstances and conditions, as in tritium and U-235 decays that depend on proximity density of circumstances they decay to and proton to neutron ratio conditions they decay from.

C) Nuclear Bonding

1) Classical

By Bohr's Correspondence Principle quantum behavior becomes classical when quantum distinction vanish, for $n > 10{,}000$ so $E_o/n^2 \longrightarrow 0$, an $1/f(x)\,dx$ singularity as $f(x) = E_o/n^2 \longrightarrow 0$. In this case, if an orbital electron has at least an $E_n = m_n - m_p - m_e = 0.78233$ MeV statistical instantaneous energy and passes near a proton in its nucleus it Electron Captures. This concept was used by Borghi in Brazil in 1955 and Missfeldt in Germany in 1978-9 to excite hydrogen with EM energy, raising the E_a average energy to shift E_i energies higher and produce neutrons.

Classically, with a 1-D $E_n/3$ = 0.260777 MeV energy an electron will undergo a Bohr $k_e e^2/r^2 = mv^2/r$ coulomb - centripetal force interaction at an $r_e = r_o(E_o/E_n/3)$ = 2.761 fm electron local perspective radius, where r_o = 0.529 x 10^{-10}m and E_o = 13.6057 eV are hydrogen ground state values. The r_e = 2.761 fm relativistically contracts by $(E_n + m_e)/m_e$ = 2.531 to a proton independent observer r_n = 1.091 fm neutron radius.

The r_n = 1.091 fm radius isn't circular however, it's a relativistic ellipse with the electron seeing a 2.761 fm local natural law perspective radius from the proton mass center while the proton sees the contracted r_n = 1.091 fm from the electron, resulting in a rotating elliptical proton mass center offset resultant within the neutron's r_n = 1.091 fm interactive radius. With r_{ei} = 0.05 fm and r_{pi} = 1.035 fm interactive electron and proton radii the orbital has a $r_n - r_{pi} - r_{ei}$ = 0.005 fm proton-electron gap, 10% of r_{ei}, so the E = 0.78233 MeV energy state is particle size determined, with a v_n = 2.75 x 10 m/s Lorentz velocity.

The relativistic elliptical orbital mass center offset results in an arc cos $(r_e - r_n)/r_e$ = 53° ½-spin wobble from the electron's Lorentz velocity contraction effect on the proton. Hence, during Weak force Beta decay a spin change occurs to the nucleus because the because the electron emission eliminates its orbital and resultant ½-spin effect.

Additionally, the 2.531 Lorentz contraction constitutes an EM field energy density increase that affects the neutron's magneton. A proton's magneton is not the u_n = ½eh/m 2pi nuclear magneton. It exceeds u_n by 4.83 in its ½-spin vector direction, and 4.83 / 3 = 2.79 in it's vertical measuring field's direction, because its density is 4.83 times less than the electron's, which mitigates attenuation of the ½eh/2pi fundamental magneton by its m mass. The proton's volume is $(r_{pi}/r_{ei})^3$ = 8870 times greater than the electron's but its mass is only m_p/m_e = 1836 so the proton is $(r_{pi}/r_{ei})^3/(m_p/m_e)$ = 4.837 times less dense. The neutron magneton is generated by its orbital electron and attenuated by its proton mass center, mitigated by its lower density, so it would have the same magneton as a proton, but its 2.531 relativistic orbital contraction attenuates the proton's lower density to 4.83/2.53 = $1.9 u_n$, negative because it's generated by the orbital electron charge.

Another proton charge in the vicinity shifts the electron's orbital into a resonance orbital between the additional proton and the neutron's proton, with an E_n neutron state energy for each and $2.53(E_n/3) = 0.66$ MeV 1-D resonance energy between them to yield a $BE_D = 2E_n + 0.66$ MeV = 2.224 MeV deuterium mass defect bond, since opposing momentums cancel. Also, since $BE_D - E_n = 1.44$ MeV is the $F_e = k_e e^2/r^2$ coulomb force energy for for two e charges 1 fm apart it represents the average bond distance, which contracts by 2.53 to the 1 fm/2.53 = 0.4 fm observed bond distance.

The Classical orbital structure yields the correct neutron parameters and deuterium's 0.4 fm and 2.224 MeV bond and also explains the Weak force Beta decay spin loss. In triton and helion configurations the mass defect bond energies are $BE = 3^{1/d}(p \times 2.215)^n$ MeV = 8.5 MeV for tritium, 7.67 MeV for helium-3, and 28.3 MeV for helium-4, a simple geometric relation to deuterium's 1-D 2.224 MeV attenuated by 0.4% to 2.215 MeV by geometric interferences, where d = 2 for 2-D planar triton structures and d = 3 for 3-D helion structures, and p and n are the number of protons and neutrons, p = 1 for tritium and p = 2 for helium-3 and 4 and n = 1 for helium-3 and n = 2 for tritium and helium-4.

While the Classical model exceeds conventional theory it is acceptable according to Bohr's Correspondence Principle that quantum behavior becomes classical when quantum distinctions vanish, it conforms to the Singularity and Entropic Energy Density Progression principles, and it does explain the proton and neutron magnetons, the neutron's size and ½-spin, Beta decay spin loss, the bond energies, and the 0.4 fm bond size.

2) Yukawa

The Yukawa bond was covered in III-3 Heisenberg Transform. He theorized a $p \Leftrightarrow p + pi^-$ 1.4 fm bond uncertainty pion messenger with light speed transit time and $\Delta E = h/2pi\Delta t = 2.24 \times 10^{-11}$ J = 140 MeV = 274 m pion. A second nucleon in the vicinity decays the pion and the process repeats by pion emission from the 2nd nucleon in a quantized nuclear bond energy resonance. Both the Yukawa and Classical bond models yield useful results and pions decay to muons (2.6×10^{-8} s) and muons to electrons (2.2×10^{-6} s) so pions constitute excited electron states, and both models offer a degree of insight.

3)Quark

Quark generated pions and the proton-neutron up-down quark resonance interaction by the pion was covered in II-D Minkowski Transform and III-B-3 Weak Force Decay Modes, Internal Component and External Circumstance Driven sections, deriving the pion mass-energy from the quark generated proton EM mass, so it is EM mass-energy based existing at Strong force energy levels by virtue of the small geometries and $1/\alpha^2$ energy density increase between the atomic and nuclear domains.

Furthermore, the quark generated pion messenger was shown to be a 135 MeV pi° neutral pion until it interacts with the neutron and becomes a 139.6 MeV pi- negative pion by a $2^{\frac{1}{2}}m_e + 3(m_e + E_n) = 4.6$ MeV electron energy addition, with the 4.6 MeV correlating to the bond's two opposing 2.224 MeV momentum mass defect bond energies. Also, the $(m_D - m_U) = 2.88$ MeV that triggers the pion generation equates to the 2.22 MeV and 2.53 $E_n/3 = 0.66$ MeV resonance component, and the pion's 140 MeV mass-energy correlates to the electron's mass by $2m_e/\alpha = 140$ MeV. Thus the quark interpretation constitutes a unification of the Classical and Yukawa nuclear bonds and yields the proton mass, ½-spin, and generation mechanism for its magneton from (½eh/2pi).

D) Strong Versus Weak Force Decay Times

Correlation of Strong and Weak force decays occurs by the α size and α^2 density factors between domains and the geometries involved with the distinction that Weak force decays are slower because they involve particle mass that decays into a slower inertial reference frame by releasing excited state energy while Strong force decays involve EM gamma rays and alpha particles that don't decay energy states or high energy particles that decay to lower energy states within the Strong force domain. However, both Strong and Weak decays relate to the $\lambda_c = 2.4263 \times 10^{-12}$ m Compton wavelength and speed of light.

For instance, the quark's interactive radius is $r_{qi} = \frac{1}{2}\lambda_c\alpha^2 = 0.0646$ fm, and since their triton structure is based on the $(m_D - m_U) = 2.88$ MeV excited down quark's added energy moving between them, as shown in II-D Minkowski Transform, each side of the triton is $2^{\frac{1}{2}}r_{qi} = 0.1292$ fm. Factoring this by the speed of light yields a $t_q = 2r_{qi}/c = 0.4307 \times 10^{-24}$ s transition time for Strong force domain energy.

The quark radius relates to the $t_c = \lambda_c/c = 0.80933 \times 10^{-20}$s Compton wavelength light speed transit time and the 3.325×10^{-10}m Bohr orbital circumference wavelength at the $v_o = 2.1877 \times 10^6$m/s ground state velocity since $v_o = \alpha c$ and $\lambda_c = \alpha\, 3.325 \times 10^{-10}\text{m} = 2.4263 \times 10^{-12}$m, and since $r_{qi} = \frac{1}{2}\lambda_c\alpha^2$ and $t_q = \alpha^2 t_c$, t_c relates both Strong and Weak force decays, since the $\lambda_c = hc/\frac{1}{2}m_e c^2$ Compton wavelength is based on the electron's speed of light energy.

The neutral pion decays into two EM gamma rays with a $t_{pi°} = t_c 3^{\frac{1}{2}}/\alpha^2 pi = 0.838 \times 10^{-16}$s decay time based on the $1/\alpha^2$ energy density change and $3^{\frac{1}{2}}/pi$ structural geometry difference. It is also the common coefficient in the pi^- pion and u^- muon decays since it is the primary energy component of the charged pion, $m_{pi^-} = m_{pi°} + [2^{\frac{1}{2}}m_e + 3(m_e + E_n)] =$ 135 MeV + 4.6 MeV = 139.6 MeV, and it's comprised of the muon's mass $m_{pi°} = (3/2)^{\frac{1}{2}}m_{u^-} + (m_D - m_U/pi) = (3/2)^{\frac{1}{2}}[3(\frac{1}{2}m_e c^2)/\alpha + 2^{\frac{1}{2}}m_e] + (m_D - m_U/pi) = (3/2)^{\frac{1}{2}}$ 105.76 MeV + 5.56 MeV = 135 MeV.

There is also a Weak force common denominator that's the basis of the charged pion and muon decay times. It accounts for the density change effect of going from the light speed Strong force energy domain to the $v_o = 2.1877 \times 10^6$m/s orbital electron ground state and it's based on t_c and the neutral pion's decay time: $t_{Wv} = (t_{pi°}pi/3^{\frac{1}{2}}\alpha^2)2^{\frac{1}{2}}3^{\frac{1}{2}}2pi = (3^{\frac{1}{2}}t_c/\alpha^2 pi)(pi/3^{\frac{1}{2}}\alpha^2)2^{\frac{1}{2}}3^{\frac{1}{2}}2pi = (t_c/\alpha^4)2^{\frac{1}{2}}3^{\frac{1}{2}}2pi = 0.44 \times 10^{-10}$s.

The charged pion undergoes the t_{Wv} transition from the Strong force to inertial atomic domain as it decays to a 3-D lower density domain, $t_{pi^-} = 2^{\frac{1}{2}}t_{Wv}3/\alpha = 2^{\frac{1}{2}}(0.44 \times 10^{-10}\text{s})(411.1) = 2.56 \times 10^{-8}$s. Its ½-life transition time to a muon which decays to an electron in $t_{u^-} = (t_{pi^-})(3^{\frac{1}{2}}/2\alpha 2^{\frac{1}{2}}) = 2.16 \times 10^{-6}$s. These mathematical solutions don't account for particle sizes but do correlate the Strong and Weak forces.

IV) Electron Mass

The electron is symmetrically reciprocal to the proton, but has the same particle ground state stability, $\lambda = h/mv$ wave nature, ½-spin, and $\mu = (\frac{1}{2}eh/m2pi)$ magneton nature, with a negative vector opposite the angular momentum ½-spin vector because of its equal but symmetrically reciprocal charge. It has low mass to the proton's high mass, a high magneton to the proton's low one, and a 4.83 times greater density because of its 4.83 times lower relative volume and 20.7 times smaller interactive radius.

Its interactive and observed radii rely on the same $\frac{1}{2}\lambda_C o^2$ Compton $\frac{1}{2}$-wave coefficient as the quark and proton radii and Weak force decays:

$$r_{ei} = (\tfrac{1}{2}\lambda_C\alpha^2)2^{\frac{1}{2}}3^{\frac{1}{2}}/pi = 0.05037 \text{ fm} \qquad r_{eo} = (\tfrac{1}{2}\lambda_C\alpha^2)\alpha^2(2^{\frac{1}{2}}3^{\frac{1}{2}})^2 = 2.06 \times 10^{-20}\text{m}$$

$$r_{qi} = (\tfrac{1}{2}\lambda_C\alpha^2) = 0.0646 \text{ fm} \qquad r_{qo} = (\tfrac{1}{2}\lambda_C\alpha^2)3^{\frac{1}{2}}\alpha = 0.8165 \times 10^{-18}\text{m}$$

$$r_{pi} = (\tfrac{1}{2}\lambda_C\alpha^2)3^{2/3}2^{\frac{1}{2}}3^{\frac{1}{2}}pi = 1.0341 \text{ fm} \qquad r_{po} = (\tfrac{1}{2}\lambda_C\alpha^2)3^{2/3}2pi = 0.844 \text{ fm}$$

Notice that the interactive / observed radii ratio approaches one as they approach our Classical local observer ground state reference frame.

However while the proton has an EM field mass energy generated by the quark triton's charge in a centripetal force orbital equilibrium with its field mass, $m_p = (\frac{1}{2}eh/2pi)2^{\frac{1}{2}}3^{\frac{1}{2}}3c^3 = 3^{\frac{1}{2}}(m_U/\alpha + m_D - m_U) = 1.673 \times 10^{-27}$ kg, the electron has a fundamental structure and EM field mass generation method because it has no internal quark triton structure in a 3-D orbital to generate and contain its EM field mass-energy.

Instead the $m_e = (\frac{1}{2}eh/2pi)3^{2/3}2^{\frac{1}{2}}3^{\frac{1}{2}}pi/\alpha r_{eo} = 9.13 \times 10^{-31}$kg electron mass is generated directly by a pure EM wave energy with $2^{\frac{1}{2}}$ angular and $3^{\frac{1}{2}}$ spherical momentum rotation of it 2pi wave factored by its $r_{eo} = 2.06 \times 10^{-20}$m radius and $1/\alpha$ size density coefficients, within 0.33% of its $m_e = 9.1094 \times 10^{-31}$kg measured value, since this is a mathematical solution that does not include physical limits and momentum mass cancellation.

It's EM wave based field mass-energy captured by the wave's $2^{\frac{1}{2}}3^{\frac{1}{2}}$ angular and spherical momentums, an EM wave capturing itself by virtue of its opposing $\frac{1}{2}$-wave field energies. However it doesn't just exist by way of reference to the quarks and proton, it actually references to free space's fundamental $u_o\epsilon_o$ permeability-permittivity impedance energy structure, since $c = 1/(u_o\epsilon_o)^{\frac{1}{2}}$, because its $r_{eo} = 2.06 \times 10^{-20}$m wave function size correlates to the $h = 6.626026 \times 10^{-34}$J·s Planck constant minimum unit of energy in space by hc $3^{\frac{1}{2}}pi/\alpha^2 = 2.03 \times 10^{-20}\text{m} = r_{eo}$.

Thus the electron is a fundamental matter ground state structure that references to the $u_o\epsilon_o$ impedance energy of space by the $1/o^2$ energy density factor, and which the quarks and protons reference to. Hence everything from electrons to quarks, protons, and on up rely upon wave based EM field energy as their basis and reference to the basic $u_o\epsilon_o$ impedance energy density of free space.

Appendix

I) Sommerfeld Velocity (Size) and Energy Transforms

$\alpha = e^2/2\epsilon_0 hc = 0.007297353564$ $\alpha^2 = 0.000053246 = 5.3246 \times 10^{-5}$m

$1/\alpha = 137.03598$ $1/\alpha^2 = 18778.85$

$v_o = \alpha c = 2.18769145 \times 10^6$m/s $E_c = E_o/\alpha^2 = \frac{1}{2}m_e c^2 = 0.2555$ MEV

II) Compton Wavelength and Energy

$\lambda_c = \alpha\lambda_o = \alpha\, 3.325 \times 10^{-10}$m $= 2.42637 \times 10^{-12}$m

$E_c = E_o / \alpha^2 = \frac{1}{2}m_e c^2 = 0.25549984$ MeV

III) Quark, Proton and Electron Radii

	Interactive	Quantum Optical
Quark:	$r_{qi} = (\frac{1}{2}\lambda_c\alpha^2) = 0.0646$ fm	$r_{qo} = r_{qi}3^{\frac{1}{2}}\alpha = 0.8165 \times 10^{-18}$m
Proton:	$r_{pi} = (\frac{1}{2}\lambda_c\alpha^2)3^{2/3}2^{\frac{1}{2}}3^{\frac{1}{2}}$pi $= 1.034$ fm	$r_{po} = r_{qi}3^{2/3}2$pi $= 0.844$ fm
Electron:	$r_{ei} = (\frac{1}{2}\lambda_c\alpha^2)2^{\frac{1}{2}}3^{\frac{1}{2}}$/pi $= 0.05037$ fm	$r_{eo} = r_{qi}\alpha^2(2^{\frac{1}{2}}3^{\frac{1}{2}})^2 = hc3^{\frac{1}{2}}pi/\alpha^2$ $= 2.03 \times 10^{-20}$m

IV) Quark, Proton and Electron Mass-Energies

Quark: $m_U = \frac{1}{2}m_e c^2 2^{\frac{1}{2}}3^{\frac{1}{2}}2$pi $= 3.9323$ MeV $m_D = 3^{\frac{1}{2}}m_U = 6.8109$ MeV

Proton: $m_p = (\frac{1}{2}eh/2\text{pi})2^{\frac{1}{2}}3^{\frac{1}{2}}3c^3 = 1.673 \times 10^{-27}$kg $= 3^{\frac{1}{2}}(m_U/\alpha + m_D - m_U)$

Electron: $m_e = (\frac{1}{2}eh/2\text{pi})3^{2/3}2^{\frac{1}{2}}3^{\frac{1}{2}}\text{pi}/r_{eo}\alpha = 9.13 \times 10^{-31}$kg

V) Muon, Neutral Pion and Charged Pion Mass-Energies

Muon: $m_{\mu^-} = 3(\frac{1}{2}m_e c^2)/\alpha + 2^{\frac{1}{2}}m_e = 105.7$ MeV

Pions: $m_{pi^\circ} = 3^{\frac{1}{2}}/2^{\frac{1}{2}}\, m_{\mu^-} + m_D - m_U/\text{pi} = 135.1$ MeV

$m_{pi^-} = m_{pi^\circ} + 2^{\frac{1}{2}}m_e + 3(m_e + E_n)$, where $E_n = m_n - m_p - m_e$ $= 0.78233$ MeV

VI) Weak Force Decays

Strong: $t_q = 2r_{qi}/c = 2(\frac{1}{2}\lambda_c\alpha^2)/c = 0.4307 \times 10^{-24}$s

Compton Wavelength Transit Time: $t_c = \lambda_c/c = 0.80933 \times 10^{-20}$s

Neutral Pion Decay Time: $t_{pi^\circ} = 3^{\frac{1}{2}}t_c/\text{pi}\alpha^2 = 0.838 \times 10^{-16}$s

Weak light speed to orbital velocity coefficient

$t_{Wv} = (t_{pi^\circ}\text{pi}/3^{\frac{1}{2}}\alpha^2)2^{\frac{1}{2}}3^{\frac{1}{2}}2\text{pi} = t_c/\alpha^4 2^{\frac{1}{2}}3^{\frac{1}{2}}2\text{pi} = 0.44 \times 10^{-10}$s

Charged Pion Decay Time: $t_{pi^-} = t_{Wv}2^{\frac{1}{2}}3/\alpha = 2.57 \times 10^{-8}$s

Muon Decay Time: $t_{u^-} = 3^{\frac{1}{2}}t_{pi^-}/2^{\frac{1}{2}}2\alpha = 2.16 \times 10^{-6}$s