Quark Electrodynamics

by William Gray

Abstract

Presented are two principles by which the Quark, Particle, EM and Gravitational energy domains may be related, one defining sizes and mass-energies and the other defining energy transforms between them. Their derived sizes, mass-energies, magnetons, spins, and binding energies are presented, followed by an Up-Down quark EM phenomenon that provides the basis for particle mass and binding energies, the stable and interactive nuclear states.

As the underlying mechanism for fission and fusion this quark phenomenon offers a Nuclear Energy Alternative that bypasses the safety, waste product and technical difficulties associated with fission and fusion.

I) Fundamental Principles

A) The Entropic Energy Density Progression Principle

If the natural laws are the same in all inertial frames of reference by Einstein's Relativity then:

(1) the speed of light is upper velocity limit of each domain;

(2) a uniform v_o ground state velocity exists for the least massive component of each domain (as for the $v_o = 2.1876915 \times 10^6$ m/s ground state electron velocity in hydrogen);

(3) Sommerfeld's number relates the ground state velocity to the speed of light by $v_o = \alpha c$;

(4) it relates the ground and maximum velocity $\lambda_o = h/mv_o$ de Broglie matter waves in quantum domains by $\lambda_C = \alpha\lambda_o$ (as with hydrogen's $\lambda_o = h/m_e v_o$ and the $\lambda_c = h/m_e c$ Compton wavelength);

(5) Sommerfeld's number squared relates the ground and maximum energy states by $E_o = \alpha^2 E_C$;

(6) thus it relates the domains' component $\lambda_C = \alpha\lambda_o$ sizes and $E_C = E_o/\alpha^2$ energy densities.

B) The Singularity Principle

Singularity Theory shows that when an energy domain's degrees of freedom saturate it transforms into the next domain (i.e. when $\int {}^{1}/_{f(x)}\, dx$ becomes an unbounded singularity as its domain's f(x) functional context saturates its available degrees of freedom at $f(x) \Rightarrow 0$).

II) Sommerfeld's Number

Sommerfeld's $\alpha = e^2/2\varepsilon_o hc = 7.297353564 \times 10^{-3}$ number derives from Maxwell's equations and relates the $v_o = \alpha c = e^2/2\varepsilon_o h = 2.1876915 \times 10^6$ m/s ground state velocity of charged entities in free space to the speed of light. It thus defines each domain's $1/\alpha = c/v_o = 137.03598$ maximum to ground state velocity ratio, $\lambda_C = \alpha\lambda_o$ ground and maximum energy state sizes, and $E_C = E_o/\alpha^2$ maximum $E_C = mc^2$ and minimum $E_o = mv_o^2$ energies.

Einstein demonstrated in his Electrodynamics of Moving Bodies principle of Relativity that the $\gamma = \{1 - (v/c)^2\}^{1/2}$ Lorentz transform factors size and mass in terms of a velocity common denominator by $l = l_o\gamma$ and $m = m_o/\gamma$. It only yields paradoxical $l = 0$ and $m = \infty$ results if applied out of context. The transform only applies to the available velocity remaining in a degree of freedom before it saturates at the speed of light. He relied on a standard $b = \{c^2 - a^2\}^{1/2}$ Pythagorean to isolate this remainder and normalized it to generally apply in all cases.

Substituting $(c/c)^2$ for 1 in the transform shows the $\gamma = \{((c/c)^2) - (v/c)^2\}^{1/2}$ distinction between maximum possible $E_m = mc^2$ and observed $E = mv^2$ energies. Sommerfeld's ground state to velocity of light ratio defines its limits of application within each domain's context. It doesn't define zero size or infinite mass conditions, it descries the effect of varying conditions between a domain's relative ground state and maximum energies.

In the Lorentz transform Sommerfeld's number yields $\gamma_s = (1 - \alpha^2)^{1/2} = 0.999973374$, which is within $1/\gamma_s - 1 = 0.002662675\%$ of saturating a hydrogen electron's orbital degrees of freedom, correlating to a 1-D electron matter wavelength contraction upper limit in the hydrogen domain to $\gamma_s^{1/2}\, \alpha 2\pi a_o = 2.42627844 \times 10^{-12}$ m, within 0.002% of an electron's light speed Compton wavelength, where a_o is Bohr's radius, This is a result of the $r_e = 2 \times 10^{-20}$ m electron and $r_p = 1 \times 10^{-15}$ m proton particle sizes, since $r_e/r_p = 2 \times 10^{-5} = 0.002\%$.

Quantum systems require a physical structural substrate for their standing wave energy states. Thus any mathematical description that doesn't include sizes and mass-energies deviates from physical reality, which offers Yukawa $d = \frac{1}{2}h/2\pi m_\pi c$ and $m_\pi c^2 = \frac{1}{2}hc/d$ Heisenberg Uncertainty particles size and mass solutions, since $\Delta E \bullet \Delta t \geq \frac{1}{2}h/2\pi$, $E = mc^2$ and $x = ct$, according to Einstein's Relativity and Minkowski space principles.

III) Examples:

A) Size

The $\lambda_c = h/m_e c = 2.42631058 \times 10^{-12}$ m Compton wavelength is the electron's speed of light de Broglie wavelength, based on a speed of light maximum velocity in the hydrogen atomic domain with a $v_o = \alpha c = (2E_o/m_e)^{1/2} = 2.1876914 \times 10^6$ m/s ground state velocity. Thus the size ratio between a light speed electron wave and its v_o ground state velocity Bohr radius is $\lambda_c/\alpha 2\pi = a_o = 0.529177249 \times 10^{-10}$ m, the Sommerfeld $1/\alpha = 137.0359804$ ratio times the Compton wavelength adjusted for the degrees of freedom.

B) Mass-energy

Similarly, the $E_o = \frac{1}{2}m_e v_o^2 = 13.605698$ eV ground state kinetic energy compounded by $(1/\alpha)^2$ yields the $\frac{1}{2}m_e = \frac{1}{2}m_e c^2 = 0.2554995$ MeV Compton wavelength kinetic energy. Hydrogen's proton-electron charge and inertial mass-energy equilibrium is thus a de Broglie $\lambda_o = h/m_e v_o = 3.3249185 \times 10^{-10}$ m Bohr circumference wavelength and $a_o = \lambda_o/2\pi = 0.529177 \times 10^{-10}$ m radius with a $PE_o = 2E_o = k_e e^2/a_o = 4.3597485 \times 10^{-18}$ J = 27.2114 eV particle charge potential energy, yielding an $m_e = PE_o/\alpha^2 = 0.510999$ MeV electron mass-energy.

C) EM Waves

Sommerfeld's number also interrelates domains. A hydrogen quantized system is a de Broglie matter wave constrained by particle charge potential energy and inertial mass with a $v_o = \alpha c$ velocity and $\lambda_o = a_o\, 2\pi = 3.32492 \times 10^{-10}$ m Bohr circumference wavelength. Factoring by Sommerfeld's number yields a $\lambda = hc/E = \lambda_o/\alpha = 455.6335 \times 10^{-10}$ m EM wavelength for a $PE_o = 27.211396$ eV energy state.

IV) Energy Density Progression From Electromagnetic to Gravitational Domains

A) Between the Electromagnetic and Atomic Domains

1) an $E_o = 13.6$ eV EM wave has a $\lambda_{em} = hc/E_o = 911.3 \times 10^{-10}$ m wavelength

2) an $E_o = 13.6$ eV orbital electron $\frac{1}{2}$-wavelength is $\lambda_{eo} = h/mv_o = \frac{1}{2}\alpha\,\lambda_{em} = 3.325 \times 10^{-10}$ m

3) an electron's light speed Compton wavelength is $\lambda_c = h/m_ec = \alpha\lambda_{eo} = 2.426311 \times 10^{-12}$ m

4) an electron's $\frac{1}{2}m_ec^2$ Compton wavelength kinetic energy is $E_c = E_o/\alpha^2 = 0.255499$ MeV

Note: The Compton wavelength and energy are simply λ_{eo} and $E_o = k_ee^2/a_o^2$ factored by α and α^2 respectively.

B) Between the EM and Electron (Lepton) Domains

1) the electron's EM field generated mass is $m_e = (2E_o/\alpha^2) = 2\,E_c = 0.51099906$ MeV

2) its interactive radius is $r_{ei} = (\frac{1}{2}\lambda_c\alpha^2)\,2^{1/2}3^{1/2}/\pi = 5.037 \times 10^{-17}$ m $= 0.05037$ fm

3) its observed radius $r_{eo} = (\frac{1}{2}\lambda_c\alpha^2)\,\alpha\,/\,(2^{1/2}\,3^{1/2}\pi^2) = r_{ei}\,\alpha\,/\,6\pi = 1.95 \times 10^{-20}$ m

4) its $\frac{1}{2}$-spin angle = arc cos $(r_{eo}/r_{ei})(2\pi\sqrt{3})$ = arc cos $1/\sqrt{3}$ = arc sin $2/\sqrt{2}\sqrt{3} = 54.74°$

Note: The electron and proton have the same $(\frac{1}{2}\lambda_c\alpha^2)$ energy-size determinant but the electron is a $2^{1/2}3^{1/2}/\pi$ $\frac{1}{2}$-wavelength ground state energy planar and spherical rotation volumetric resultant and arc sin $2/2^{1/2}3^{1/2} =$ 54.74° $\frac{1}{2}$-spin offset. It thus has a $r_{ei} = (\frac{1}{2}\lambda_c\alpha^2)\,2^{1/2}3^{1/2}/\pi = 5.037 \times 10^{-17}$ m interactive radius in the domain of the proton and a measured $r_{eo} = (\frac{1}{2}\lambda_c\alpha^2)\,\alpha/(2^{1/2}3^{1/2}\pi^2) = 1.95 \times 10^{-20}$ m radius.

C) Between the EM and Proton (Baryon) Domains

1) the proton's uud quark generated EM mass-energy is $m_{pem} = (\frac{1}{2}eh/2\pi)2^{1/2}3^{1/2}3c^3 = 1.6727 \times 10^{-27}$ kg, 1.672623×10^{-27} kg if $1-\alpha^2\sqrt{2}\sqrt{3}/\pi$ equilibrium resonance mass defect included

2) its generated centripetal mass-energy force is $m_{pq} = 3^{1/2}\{m_{uq}/\alpha + (m_{dq} - m_{uq})\}\,(1 - \alpha^2) =$ 938.2780 MeV, within 0.006% of measured 938.2723 MeV $= 1.672623 \times 10^{-27}$ kg values

3) its interactive radius is $r_{pi} = (3^{2/3})(\frac{1}{2}\lambda_c\alpha^2)2^{1/2}3^{1/2}\pi = 1.0341$ fm

4) its observed uud quark structure radius is $r_{pq} = (3^{2/3})(\frac{1}{2}\lambda_c\alpha^2)2\pi = 0.8443215$ fm, within 0.3% of the Max Planck Institute's 0.84184 fm measurement

5) its $\frac{1}{2}$-spin angle = arc sin (r_{pq}/r_{pi}) = arc sin $2/(2^{1/2}\,3^{1/2}) = 54.74°$

6) its 2.7928 μ_n magneton deviation is from its $\{(r_{pi}/r_{ei})^3/(m_p/m_e)\}/3^{1/2} = 4.83722\,/\,3^{1/2} =$ 2.7928 proton-electron mass-energy density difference, where the proton's lower density results in 4.837 greater external field strength in its $\frac{1}{2}$-spin vector direction

Note: The proton's $(\frac{1}{2}\lambda_c\alpha^2)$ energy-size determinant has a $2\pi3^{2/3}$ full wavelength volume generated by its quark planar and spherical rotating structure with an observed $r_{pq} = (\frac{1}{2}\lambda_c\alpha^2)\,2\pi\,3^{2/3} = 0.8443215$ fm radius with a $\frac{1}{2}$-wavelength $\frac{1}{2}$-spin offset between the rotating quark structure and generated EM mass-energy field yields an $r_{pi} = (\frac{1}{2}\lambda_c\alpha^2)\,2^{1/2}3^{1/2}\pi3^{2/3} = 1.0341$ fm interactive radius. The $m_{pem} = (\frac{1}{2}eh/2\pi)2^{1/2}3^{1/2}3c^3$ mass-energy is the $(\frac{1}{2}eh/2\pi)$ magneton from the quark charge structure's $2^{1/2}3^{1/2}3c^3$ 3-D planar and spherical rotations at the speed light in equilibrium with it's centripetal $m_{pq} = 3^{1/2}\{m_{uq}/\alpha + (m_{dq} - m_{uq})\}\,(1 - \alpha^2)$ mass-energy.

D) Between the EM and Quark Domains

1) the Up quark mass is $m_{uq} = 2^{1/2}3^{1/2}2\pi\,(E_C = \frac{1}{2}m_ec^2) = 3.9323$ MeV

2) the Down quark mass is $m_{dq} = 3^{1/2}m_{uq} = 3^{1/2}(E_C2^{1/2}3^{1/2}2\pi) = 6.8109$ MeV

3) the Up quark interactive radius of is $r_{qi} = \frac{1}{2}\lambda_C\alpha^2 = 0.0646$ fm

4) the quark's observed radius $r_{qo} = r_{qi}\,\alpha\,3^{1/2} = 0.8165 \times 10^{-18}$ m

Note: The calculated $r_q = ½\lambda_C\alpha^2\cdot 2\pi(3^{1/3})^2 = 0.8443215$ fm radius agrees with the Max Planck Institute findings and was based on the quark's $\frac{1}{2}\lambda_c\alpha^2 = 6.46022 \times 10^{-17}$ m fundamental ground state energy ½-wavelength and radius. An electron at light speed has a Compton $E_C = ½m_ec^2 = 0.25549953$ MeV kinetic energy and $\lambda_C = h/m_ec = 2.42631058 \times 10^{-12}$ m wavelength and relates to Up and Down quarks' mass-energies and size by $m_u = E_C2^{1/2}3^{1/2}2\pi = 3.9323$ MeV and its excited $m_d = 3^{1/2}\,m_u = 6.811$ MeV state and $r_q = ½\lambda_C\alpha^2 = 6.46022 \times 10^{-17}$ m. Its HERA observed size is the 0.8165×10^{-18} m calculated size factored by the α lower proton density and $\sqrt{3}$ statistical centripetal 3-D distribution of its energy that cause the arc cos $\alpha r_{qi}/r_{qo} = 54.74°$ $\frac{1}{2}$-spin effect.

E) Between The EM And Gravitational Domains

Gravity = (Centripetal acceleration x Distance) / (Electromagnetic mass generation), or

$$G = v_e^2 r_{es} / [1.1903459 \times 10^{57} \times (\tfrac{1}{2}eh/2\pi)\cdot\sqrt{2}\cdot\sqrt{3}\cdot 3(\mu_o\varepsilon_o)^{-3/2}] = 6.665 \times 10^{-11}$$

- A 0.12% error derives from the earth's $v_e = 2.97834 \times 10^4$ m/s and $r_{es} = 1.496 \times 10^{11}$ m mean instead of elliptical velocity and radius;
- 1.1903459×10^{57} is the Sun's proton EM mass equivalence;
- $\frac{1}{2}eh/2\pi = 8.448061479 \times 10^{-54}$ is the fundamental magnetic field of a rotating charge;
- $\sqrt{2}$ and $\sqrt{3}$ are the energy resultants of energy in 2-D planar and 3-D spherical distributions;
- $\mu_o\varepsilon_o$ is free space's permeability-permittivity;
- and G is the Gravitational Constant in the $F_g = G\,m_1m_2/r^2$ gravity force relation, which now relates to the $F_e = k_e\,e_1e_2/r^2$ coulomb force, since $k_e = 1/4\pi\varepsilon_o = \mu_oc^2/4\pi$.

Note: By the $\int {}^1/_{f(x)}\,dx$ Singularity principle a reciprocal energy density exists between domains. Thus a reciprocal relation exists between the $\mu_o\varepsilon_o$ permeability-permittivity of free space and a quark's interactive radius in a proton. This manifests as a speed of light distance for a period determined by quark mass, since $c = 1/(\mu_o\varepsilon_o)^{1/2}$, the $F_g = G\,m_1m_2/r^2$ gravitational and $F_c = mv^2/r$ centripetal forces define the earth's orbital period, and the sun and earth masses depend on the quark generated EM mass-energy in protons. A 9.46074×10^{15} m light year's 1.057×10^{-16} m reciprocal factored by $\sqrt{3}$ yields a 0.61 fm, within 6% of a quark's $r_{qi} = 0.0646$ fm interactive radius, and accordingly the observed quark and electron radii and masses. Thus Gravity's constant relates to free space's $\mu_o\varepsilon_o$ by Maxwell's equations and their $F_g = G\,m_1m_2/r^2$ and $F_e = k_e\,e^2/r^2$ forces relate.

V) Nuclear Binding

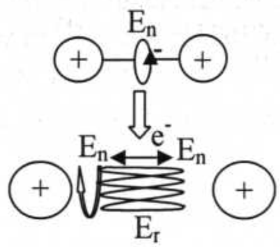
A) Classical

By Bohr's Correspondence principle quantum behavior becomes continuous if the distinction between adjacent quantum states vanishes, when $n \geq 10{,}000$ and $E/n^2 \geq E_o/10^8$ at ionization when $E_o \cong E_o(1 - 10^{-8})$ and the orbital frequency is within 0.015% of the spectral frequency. If electron motion is inward and it has at least an $E_n = m_n - m_p - m_e = 0.78233$ MeV instantaneous neutron state energy, with $E_n/3 = 0.260777$ MeV in each degree of freedom, a $k_ee^2/r^2 = mv^2/r$ coulomb-centripetal interaction occurs and the centripetal radius reduces to $r_n{}^* = a_o(E_o / E_n/3) = 2.761$ fm, which relativistically contracts by $(m_e + E_n)/m_e = 2.531$ to $r_n = 1.0985$ fm.

With $r_{ei} = 0.05$ fm electron and $r_{pi} = 1.0355$ fm proton interactive radii the orbital has an $r_n - r_{pi} - r_{ei} = 0.005$ fm proton-electron gap, 10% of r_{ei}, so the neutron energy state is actually determined by the particle sizes, it results in a $v_n = 2.754 \times 10^8$ m/s $= 0.91$ c electron Lorentz velocity, which results in a arc cos $(r_n{}^* - r_n)/r_n{}^* =$

53° ½-spin by the electron's contraction of space. Since contraction of space constitutes an energy density increase in addition to the electron orbit proton mass center it attenuates the 4.837 μ_n magneton by 2.531 to the 1.9111 μ_n neutron magneton (within 0.12% of 1.9135), negative since it is generated by an electron charge.

A second proton in its vicinity would shift the electron's spherical orbit to a planar orbit that resonates between the protons, with an E_n neutron state energy for each and $(2.531)E_n/3 = 0.660$ MeV 1-D resonance energy between them to yield a $BE_D = 2E_n + 0.66$ MeV = 2.224 MeV deuterium mass defect bond energy, since a resonance's opposite momentums cancel. Because $BE_D - E_n = 1.442$ MeV is the $F_e = k_e e^2/r^2$ coulomb force potential energy for two charges 1 fm apart, the 2.531 contraction yields the observed 0.4 fm nuclear bond.



Thus a classical orbital electron neutron structure yields correct neutron parameters and has a deuteron 0.4 fm gap and 2.224 MeV 1-D bond energy. In triton and helion configurations the mass defect binding energies occur by a simple $BE = 3^{1/d}$ (p x 2.215 MeV)^n = 8.5 MeV for tritium, 7.67 MeV for Helium-3, and 28.3 MeV for Helium-4 geometric relation, where d is 2 for planar triton and 3 for helion structures, p and n are the proton and neutron numbers, and 2.215 MeV is the 1-D bond energy attenuated by 0.4% by geometric interferences.

B) Yukawa

Yukawa theorized that nucleons have messenger particles, predicting the existence of later confirmed pions that travel at close to light speed. If no other nucleon is in the vicinity (1.4 fm) the messenger returns to the nucleon: $p^+ \Leftrightarrow p^+ + \pi^\circ$. He relied on Heisenberg's $\Delta E \cdot \Delta t = h/2\pi$ energy and time Uncertainty because there is no Conservation of Energy violation if it occurs within the Uncertainty period. Thus $\Delta t = 1.4$ fm/c = 0.47×10^{-23} s the energy value is $\Delta E = h/2\pi / \Delta t = 2.23 \times 10^{-11}$ J, which yields a 139.6 MeV 274 m_e pion.

If a second nucleon is in the proton's vicinity the messenger particle annihilates in its neighborhood and the process repeats with the messenger emitting from the second nucleon, in a resonance that gives rise to the quantized nuclear attraction force. Experiments confirm both charged 274 m_e pions and neutral 264 m_e pions in internucleonic forces, and the resulting $p^+ \Leftrightarrow n + \pi^+$ and $n \Leftrightarrow p^+ + \pi^-$ neutron state resonance in bonds.

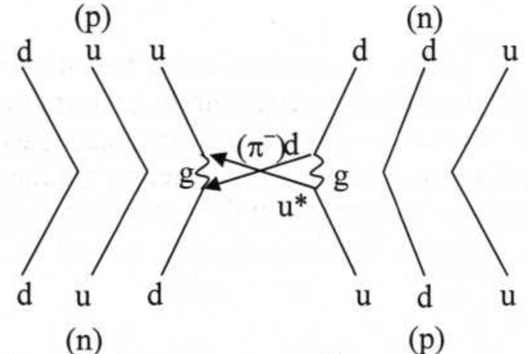
The similarities between the classical and Yukawa concepts are apparent, the first relying on the finite particle sizes and Electromagnetic force to yield the bond energy and gap and the second predicting the pions in terms of the conditions existing in a nuclear bond. Since charged pions decay to muons in about 2.5×10^{-8} s by neutrino emission and muons decay to electrons in about 2.2×10^{-6} s by emission of two neutrinos the pions do in fact constitute instantaneous electron energy states that would occur in a neutron state resonance between two protons. The two analysis techniques show that energy behaves according to and is responsible for its context, but the mechanism of pion decay a requires quark analysis.

C) Quark

Quarks are energy states that exist only in conjunction with other quarks. Since the mass-energy of a down quark is $3^{1/2}$ m_u, the mass-energy of an up quark, it is an excited energy state of an up quark. As such it is stable in configurations where up quarks exceed down quarks, as in the udu quark configuration of a proton, and unstable in configurations where down quarks exceed up quarks, as in the dud neutron configuration.

Pair configurations like du* pions are unstable but udu + dud ⇔ dud + udu deuteron down quark resonances are stable because decay times and energies equate to bond distance, yielding an excited energy state decay resonance between nucleons, like electron resonance bonding in benzene. The Feynman Diagram for pion exchange between a neutron and proton indicates a neutron state decay-fusion resonance.

The $m_d = 6.811$ MeV down quark mass-energy is $3^{1/2}$ times the $m_u = 3.932$ MeV mass energy, and constitutes an $m_d - m_u = 2.88$ MeV excited state, which means the deuteron $BE_D = 2.22$ MeV bond energy yields the neuton state $(E_n/3)2.531 = m_d - m_u - BE_D = 0.66$ MeV resonance energy. Thus a Down quark state exchange agrees with the pion and neutron state exchanges.



D) Weak Force Decay

These nucleon binding models provide information about an important phenomenon. Energy transcends domain boundaries to establish equilibrium between domains, internal and external conditions in equilibrium, which means external circumstances can access internal mass-energy, as shown in fission and fusion reactions.

In stars, gravitational pressure and temperature provide accelerated Electron Capture conditions that cause hydrogen to statistically favor its neutron state boundary condition which fuses into nuclear structures by releasing EM energy that escapes the gravity condition. In U-235, proximity density of the 143 neutron nuclei precipitates release of down quark excited energy states as beta particles, gamma rays and fission products, but U-238 with 146 neutron nuclei and an even number of down quarks only does so under extreme conditions.

Solar fusion and U-235 fission reactions are controlled by a Weak force decay of hydrogen atom orbital electrons into neutrons and decay of neutrons back into electrons. However, Weak force reactions appear to be asymmetrical, which is a major inconsistency for a mechanism that transforms energy between the symmetry based Strong and EM domains.

By symmetry, decay reactions such as $K° \Rightarrow \pi^- + e^+ + \nu_e$ and $K° \Rightarrow \pi^+ + e^- + \nu_e^*$ should occur with equal frequency but more e^+ positrons are produced than e^- electrons. Furthermore, pion and proton interactions should result in equal Kaon + Lambda and Kaon + neutron outcomes, $\pi^- + p^+ \Rightarrow K° + \Lambda°$ and $K° + n$, but the second product pair never results.

These asymmetries occur for good cause however. Reactions only manifest if a degree of freedom is available for the mass-energy to move from its excited region into a depleted one. Positron production is not inhibited because electrons annihilate them so their mass-energy has infinite degrees of freedom available. Thus Weak force charge asymmetry is external circumstance determined.

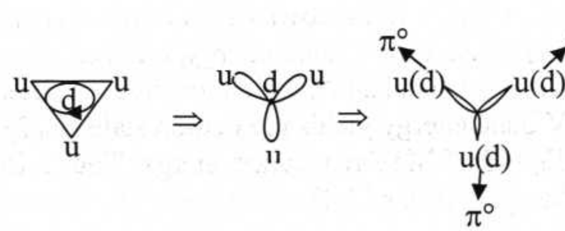
Similarly, decay path asymmetry is internal circumstance controlled. A negative pion is comprised of a u*d anti-up::down quark pair and a proton has a udu quark configuration but a neutral kaon is a ds* down::anti-strange quark configuration. By symmetry, an anti-strange quark production requires a strange quark production which the neutral Lambda uds configuration has while a dud neutron doesn't. Thus u*d + udu ⇒ ds* + uds quark level symmetry occurs by u* - u annihilation into an s* - s pair in Lambda and Kaon forms.

VI) Nuclear Energy Alternative

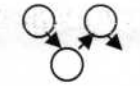
A) Quark Configuration Bonding Symmetry

It's possible to use Weak force to access quarks to transform $E = mc^2$ particle mass-energy into useable EM form in a controlled and sustainable way, bypassing fission or fusion. Weak force causes U-235's 143 neutrons to decay naturally but ignores U-238's 146 neutrons with more down quarks because of internal quark symmetry, except under special conditions such as a high neutron flux that precipitates a neutron fusion into plutonium or a high velocity U-238 rod impacting a U-238 target to precipitate a forced fission reaction.

Quarks energy states don't exist in isolation but are stable in udu proton configurations because the down quark's $m_d - m_u = 2.88$ MeV excited state resonates between up quark triton configuration depletion regions with a speed of light angular momentum that generates the proton's EM mass-energy. The down quark's excited energy state orbital is a relativistically contracted clover leaf that transforms the up quarks into momentary down quarks and Yukawa $\pi°$ messenger particles, since $m_{\pi°} = \{(3/2)^{1/2}m_\mu + (m_d - 2^{1/2}3^{1/2}m_e)\} = \{(3/2)^{1/2}m_\mu + 3^{1/2}2\pi m_e\} = 135.0$ MeV, where the muon mass is $m_\mu = 3m_e/2\alpha + 2^{1/2}m_e = 105.7$ MeV, $m_d = 6.811$ MeV and $m_u = 3.9232$ MeV.



In U-235 and U-238 the nuclear triton structures overlay and bond into stable nuclei by forming 3-D Star of David constructs in which the down quark excited states of the extra neutrons form bonds in the 3rd dimension between the overlayed configurations. Thus as the energy traverses a 2-D planar triton's nucleons it does so by also bonding to nucleons in the overlayed structure and thereby forming triton bonds in all degrees of freedom. Since the quark energies and constructs are uniform so are the nucleons' nuclear structures and bond energies.



B) Quantized Force-Distance

Yukawa showed that nuclear configurations have a quantized force-energy exchange between nucleons within Heisenberg's Uncertainty, only it wasn't an Uncertainty, it was at its limit so it's a finite condition. As Einstein showed in his Minkowski "field-free" space, time flow times the speed of light constitutes a finite x = ct uniform distance between neighboring points in space, so each point is a 4-D $ds^2 = dx_1^2 + dx_2^2 + dx_3^2 - dx_4^2$ space-time Pythagorean construct. When a g_{ik} Riemann condition is superimposed onto the neutral Minkowski construct a $ds^2 = g_{ik}dx_i dx_k \cdots$ Lorentz transformation yields a finite conservative force-distance between points.

It makes no difference whether the energy is from internal down quark excited energy states or external "gravity" between masses acting over distance in Einstein's General Theory of Relativity, which is why a quark size (distance between point energy states) inversely relates by Singularity Theory to the light year distance of a centripetal period of large quark generated nucleon mass systems by a finite quark energy Riemann Lorentz transformation condition of the 4-D points of space between them, finite and conservative but not fixed.

By Relativity, the Minkowski points of space are classical Pythagorean structures inside with quantized finite distances between them under field-free conditions. When a finite quark energy Riemann condition causes a Lorentz transformation the distances are quantized at the fundamental level because their sizes are geometric constructs with finite EM $\lambda = hc/mc^2$ mass-energy wavelengths. Fixed distance constructs sustain quantized wave function quark energy state increases until the distinction between quantum states vanishes and their behavior becomes classical, by Bohr's Correspondence principle, and fixed becomes non-fixed.

At this point the finite effect on the points of space varies with distance as volume increases and energy density decreases. Size and mass-energy density therefore vary inversely until Sommerfeld's $\alpha = (\frac{1}{2}e^2/\varepsilon_o h)/c$ ratio of domains' ground state and speed of light velocities is reached. However, since this is a finite energy density relation between domains' ground states the classical period of large objects over distances must equate by energy density to the smallest point source energy states that determine the fundamental x = ct distance between points, as was shown between the quark and gravitational domains.

C) Heisenberg Uncertainty Resonance Binding

Bonding must be symmetrical and uniform between degrees of freedom in $e^{-ix} = \cos x - i \sin x$ phased timing and $x = ct$ distance when traversing orthogonal dimensions. Otherwise a bond between orthogonal degrees of freedom would leverage a separation between nucleons on the opposite side of their geometric constructs, the π° pion messenger couldn't interact to maintain bonding, and the nucleus wouldn't maintain structural integrity.

 stable  unstable

U-238 with an integral number of down quark pairs maintains symmetrical binding in its geometric structures' degrees of freedom while a U-235 with an odd number of down quarks statistically decays in the proximity of identical nuclear energy structures when they align. However, since U238 with 146 extra neutron down quarks has $146/6 = 24\frac{1}{3}$ six quark 3-D structural pairs it can be made unstable in one degree of freedom if a sudden 1-D down quark density increase occurs, as when a high velocity U-238 rod impacts a U-238 plate.

Stable configurations require resonance of excited and depleted energy regions under uniform structural $\Delta E = m_\pi c^2 = hc/2\pi 2d = hc/\lambda$ matter wavelength conditions, where distance $d = h/2\pi m_\pi c$. It requires symmetry because if the energy cannot move into structurally symmetrical depletion regions with periodicity over finite space-time conditions the energy distributes into chaotically unstable entropic patterns. The energy must be able to uniformly move from excited to depleted regions to maintain structural integrity because it has a fundamental $E = fd = mad$ force-energy relation that equates the excited to depleted region energy differential to space-time and acceleration is a second order space-time derivative that changes as the mass-energy differential changes.

To be stable the forces must obey symmetry over time according to Einstein's Minkowski space $x = ct$ speed of light condition. Since a structure's opposing degrees of freedom are separated by the nucleon sizes a bond on one side can be absent while present on its opposite side because they are separated by the $t = x/c$ time-distance required for the force disparity to traverse the nucleon sizes and manifest as a bond separation. The force's absence however must be phased within the Uncertainty of Yukawa's Heisenberg wavelength bond.

D) Beta Decay

Yukawa's quantized Heisenberg wavelength bond correlates to the classical description of the neutron's electron imparted with a $(m_d - m_u) - BE_D = 2.8787$ MeV - 2.224 MeV $= (\frac{2}{3})^{1/2}\,\pi(\frac{1}{2}m_e c^2) = 0.655$ MeV down quark excited energy state minus deuterium's bond energy, equal to a $(E_n/3)(E_n + m_e)/m_e = 0.66$ MeV neutron 1-D state energy compounded by the electron's relativistic mass-energy increase, and its Compton wavelength factored by $\alpha/2^{1/2}3^{1/2}2\pi$ minus its interactive radius yields the $\lambda_C\alpha/[(2^{1/2}3^{1/2}2\pi)(E_n + m_e)/m_e] - r_{ei} = 0.4$ fm bond.

The 0.66 MeV is the 1-D component that transfers the neutron state to the proton. However a Compton wavelength electron has a $\frac{1}{2}m_e c^2 = 0.2555$ MeV speed of light kinetic energy limit in one dimension so the 0.66 MeV electron's excess energy must take $2^{1/2}$ and $3^{1/2}$ planar and spherical gyration forms as it traverses its 1-D path to the proton (i.e. $(\frac{2}{3})^{1/2}(\frac{1}{2}m_e c^2) = 0.654$ MeV), correlating to the two muon and one electron neutrinos $\frac{1}{2}$-spins and energies in a pion to muon to electron decay, $\pi^- \Rightarrow \mu^- + \nu_\mu^* \Rightarrow e^- + \nu_\mu + \nu_e^*$.

The 139.6 MeV (u*d) negative pion π^-, comprised of a $(\frac{3}{2})^{1/2}\,m_\mu + 3^{1/2}2\pi m_e = 135.0$ MeV neutral pion π° and $2^{1/2}[BE_D + (E_n/3)(E_n + m_e)/m_e]$ energy state components and m_e electron mass-energy, decays to a $m_\mu = (\frac{3}{2})m_e/\alpha + (E_n/3)(E_n + m_e)/m_e = 105.7$ MeV muon, $(E_n/3) = 0.261$ MeV ν_μ^* muon anti-neutrino, m_e Beta particle and 33.128 MeV by Weak force decay in 2.6×10^{-8} s.

E) Strong Versus Weak Decay Transition Times

Strong force interactions are fast high energy decays of unstable high energy density particles, like high pressure tanks in high velocity collision releasing their gas to low density atmospheric pressure with explosive force. Weak force decay is an unraveling of a high energy density construct one degree of freedom at a time based on proximity based statistical interaction with identical constructs in the lower energy density domain.

The $\lambda_C = h/m_ec = 2.42631 \times 10^{-12}$ m and $E_C = \frac{1}{2}m_ec^2 = 0.2555$ MeV Compton wavelength and energy is the upper limit of the hydrogen based atomic domain and relates by the Energy Density Progression Principle to its ground state wavelength and energy, and to the quark, lepton and nucleon high energy density domains, by the $1/\alpha$ and $1/\alpha^2$ Sommerfeld factors. The Compton wavelength's x = ct Einstein and Yukawa speed of light transition time is a $t_C = \lambda_C/c = 0.80933 \times 10^{-20}$ s Strong force interaction time and ,since the natural laws are the same in all reference frames by Relativity, the particle domain's higher energy density decreases its size and relative speed of light accordingly so the transition time remains constant.

Thus the Compton wavelength factored by the $1/\alpha$ Sommerfeld ratio yields the 3.325×10^{-10} m Bohr orbital wavelength and its speed of light transition time factored by the ratio yields the $(\alpha/c)3.325 \times 10^{-10}$ m = 0.80933×10^{-20} s Strong force interaction time. Applying this concept to structural unraveling between domains yields a $t_{\pi^\circ} = t_C3^{1/2}/\pi\alpha^2 = 0.838 \times 10^{-16}$ s neutral pion decay time, which applied to an electron inertial mass yields a corresponding $v_o = \alpha c = 2.1876915 \times 10^6$ m/s velocity and $t_{Wv} = (\pi/\sqrt{3})(2^{1/2}3^{1/2}2\pi)t_{\pi^\circ}/\alpha^2 = t_C3^{1/2}/\pi\alpha^2/\alpha^2 \cdot(\pi/\sqrt{3})(2^{1/2}3^{1/2}2\pi) = 0.44 \times 10^{-10}$ s Weak force decay time, which compounded by the $2^{1/2}\pi/\alpha$ structural density change from decreased velocity yields a $t_{Wv}(2^{1/2}\pi/\alpha) = 2.68 \times 10^{-8}$ s pion to muon decay in hydrogen's domain.

By simply incorporating the $(1/\alpha^2)^2$ two domain Relative energy density change and $(1/\alpha)$ EM to inertial velocity change the Strong and Weak force interaction times are thus exactly correlated, but more significant is the fact that it is a controlled energy release in the form of an electron inertia. A Strong force decay releases its energy too rapidly and in too great a quantity to interact with the electron inertial mass, since only 0.2555 MeV increases it to light speed, so it can't sequence through quantized energy density and relative velocity changes between the domains. This is a Bohr Correspondence principle corollary, too much energy can't quantize.

Quantized energy systems manifest when energy is low relative to component inertial masses. Too much energy to fast can't be conservatively absorbed because it occurs within the Heisenberg Uncertainty of the wave function and changes the structural dimensions the wavelengths depend on to maintain structural equilibrium. Hydrogen's quantum behavior depends on $\frac{1}{2}m_e/\alpha^2 = E_o = 13.6$ eV energies. If energy exceeds this, relativistic effects change $E = mc^2$ inertial mass and the $\lambda = h/m_ev$ momentum based de Broglie wavelength.

Thus Strong force energies can't be released or absorbed in a controlled manner while Weak force decay of a beta particle in pion based bonds results in a controlled energy release in the hydrogen domain's energy and time frame. This is because quark Strong force decays are structural decays into intermediate unstable particles by speed of light quark energy state interactions operating without inertial mass to slow them so the energy can be absorbed as 10^{-20} s quark reconfigurations from the relative perspective of hydrogen's lower energy density inertial mass domain but Weak force decays manifest as slower inertial mass based controlled energy releases.

F) Statistical Behavior

Weak force decays are S = k ln W Boltzmann Principle functions in its $W = e^{S/k}$ probability form based on macrostate entropies, where $N/N_o = e^{-\lambda t}$ is the remaining to starting nuclei ratio and the $\lambda = -(^{dN}/_{dt})/N$ decay constant is proportional to the number present. The concept was originally derived to describe kinetic gases in which molecules occupy all degrees of freedom with equal energy density (molecular pressure), while their instantaneous energies statistically distribute according to Boltzmann's $e^{-Ei/Ea} = e^{-\frac{1}{2}mv^2/kT}$ factor. Planck used the concept to describe $\rho_f = 8\pi hf^3/c^3$ radiated energy density distribution of frequencies and Einstein used it to show that photons were energy quanta that result from electron kinetic energy, instead of it causing their ionization.

In a single molecule gas system the average and instantaneous energies equate but its energy statistically distributes between the degrees of freedom at a temperature based $\frac{1}{2}mv^2$ kinetic energy determined rate so each degree of freedom's instantaneous energy varies by the molecule's presence, with an $e^{-ix} = \cos x - i \sin x$ phase shifted excited and depleted region wave function, like a Star of David configuration resonance bonds between the Heisenberg excited energy state wavelength and the depleted region within its Uncertainty period.

Thus nuclear and kinetic gas domains conservatively equate by wave function energy equilibriums with ground state energies that equate by Sommerfeld's $c / (\frac{1}{2}e^2/\varepsilon_o h) = c/v_o = 1/\alpha$ "electrodynamic" speed of light to ground state velocity ratio, and as Einstein showed, if entropy is a macrostate variable function Boltzmann's $W = e^{S/k}$ principle can be used to calculate microstate probabilities, which means controlling the entropy's variable will provide an optimization method for "tuning" a macrostate system into an energy source.

For the purpose of illustration consider a coin toss system with 5 coins:

Macrostate	Microstate "Complexions"	Number of Microstates	Probability
5H-0T	hhhhh	1	3.125%
4H-1T	hhhht, hhhth, hhthh, hthhh, thhhh	5	15.625%
3H-2T	hhhtt, hhtth, htthh, tthhh, hhtht,	10	31.25%
	hthth, ththh, hthht, thhth, thhht		
2H-3T	same as 3H-2T macrostate, interchanging h and t	10	31.25%
1H-4T	" " 4H-1T " " "	5	15.625%
0H-5T	ttttt	1	3.125%

The probability of a macrostate is proportional to its multiplicity (Complexions), which means that if 5 Heads are considered to be the ordered macrostate then the other 31 disordered microstates have a 96.875% probability of occurring, and if any of these states result in an irreversible system energy loss, from the hhhhh ordered $\Delta S = 0$ reversible $e^{-ix} = \cos x - i \sin x$ equilibrium, then the macrostate system can be "tuned" to release energy like replacing a pressure vessel wall with a piston to remove gas heat by 1-D entropy increase.

Deuterium nuclei, a neutron state in a $\Delta S = 0$ reversible $e^{-ix} = \cos x - i \sin x$ down quark excited state – beta particle equilibrium resonance, exist by providing a "piston" for the nucleons' quark generated $m_{pem} = (\frac{1}{2}eh/2\pi)2^{1/2}3^{1/2}3c^3 = 1.6727 \times 10^{-27}$ kg EM mass-energy, verified by the fact that mass-defect/nucleon increases from 1.1 to 2.7 to 7 MeV for 1-D deuteron, 2-D triton and 3-D helion structures. The 1-D resonance orientation statistically distributes its energy equally between all six degrees of freedom like a single gas molecule system.

However, if their nuclear magnetons are magnetically oriented it would constitute an alignment of their resonance energies into one dimension, like collecting water behind a dam, with an increased proximity density correlating to an energy "height" increase behind the dam. Since the neutron and proton states are excited and depleted down quark energy state resonances, like flipping coins, their energy states would entropically interact to fill available microstate probabilities and a Weak force perspective of their bond energies as a resonating neutron state electrons [Section (V)(A)] would lead to a conclusion that some electrons would statistically accumulate nucleon mass-energies from other electrons, since mass defect increases with degrees of freedom, and cause a forced beta decay.

This description is not strictly correct however because they are not distinct particles in the 10^{-20} s time, < 1 fm size and MeV energy density of their own relative domain, they are energy states with the information of an electron that we measure in our $v_o = \alpha c$ atomic domain. This is indicated by the $\frac{1}{2}$-spin resultant arising from the distinction between their observed and interactive radii [Section (IV)(B)(4)]. The distinction between Strong and Weak force energies is that the quark energy states interact at speed of light velocities absent the impedance of the EM mass-energy their rotational resonance generates. This generated mass-energy confined behind their rotational structure, and the down quark's excited energy state resonance's pion messenger, is like a quantum tunneling of EM mass-energy through a Strong force resonance barrier dam. The tunneling is an external resonance condition that does not become a stable 1-D entropy increase conduit unless a second nucleon is present within its interactive proximity, as indicated by the resulting mass defect.

In a bond the nucleon's EM mass-energy is interacting with an electron energy state's inertial mass so the interactions are slowed to Weak force beta particle domain times which correlate to our atomic domain time frame. However, since the electron energy state resonance is a captured $\Delta S = 0$ stable quantized Strong force derivative resonance the entropic interaction of deuterium nuclei will statistically accumulate energy that is emitted in the 0.26 MeV, 0.66 MeV, 0.782 MeV and 1.44 MeV ranges instead of ionizing, as Einstein showed for atoms in his Production and Transformation of Light, and which Quantum Mechanics theory substantiates.

Aligning the deuterium in 1-D will cause the neutron state resonance energies to align out of phase, as with the phased excited-depleted energy state resonance of the Heisenberg Uncertainty and its wavelength bond energy, adjusted for the $x = ct$ speed of light wavelength communication distance between the nuclei, in order to achieve maximum entropy allowed by the condition. As the number of deuterium and pressure density increases the $x = ct$ proximity wavelength distances will tune to sub-harmonics of the quantized bond wavelength energy and cause statistical accumulation of EM mass-energy, similar to externally "pumping" orbital electron energies in lasers, except that the energy derives from the nucleons' internal mass-energies and is controlled by external macrostate conditions that thus regulate interaction rate, as with proximity density precipitating U-235 fission and Deuterium fusion when their proximity density are suddenly increased under implosion conditions.

G) "Free Energy" Based Interaction

This phenomenon correlates to the individual $\Delta G = \Delta H - T\,\Delta S$ and interactive $\Delta G = -RT \ln$ [products] / [reactants] thermodynamic free energy relations for microstates and their resultant macrostate equilibriums, where ΔG is free energy, ΔH is bond energies with respect to pressure and volume, T is ambient temperature, ΔS is potential entropy change, R is Boltzmann's constant $k = 1.380658 \times 10^{-23}$ J/K° times Avogadro's number $N_A = 6.0221367 \times 10^{23}$ /mole, and [products] / [reactants] is the product to reactant concentration ratio.

"Free energy" is the energy available from the reactant and product component structures. In hydrogen it is the energy of the proton-electron atomic bond, equal to its E_o ground state's Kinetic Energy minus the Potential Energy well it exists in, or $G_o = E_o - PE = 13.6057$ eV $- 27.2114$ eV $= -13.6057$ eV. The H_2 molecular 1-D bond free energy is $G_{HM} = \frac{1}{3}E_o = 4.53$ eV in equilibrium with the 3-D atomic bond energy. Its neutron state boundary condition however is not an equilibrium state because energy must be added to attain the 1-D contraction of the Bohr radius to $a_o\, E_o/(E_n/3) = 2.761$ fm, and $(E_n + m_e)/m_e = 2.531$ relativistically, to 1.091 fm.

The $E_n = 0.78233$ MeV energy limit results from an entropic limit of proton and electron sizes, not the speed of light velocity limit, which is why neutrons are unstable inter-domain transition particles. Hydrogen's quantum states are Heisenberg wavelength energies in $e^{-ix} = \cos x - i \sin x$ wave function equilibriums with their Uncertainty condition, resulting in $\Delta S = 0$ reversible equilibriums. The neutron state is less volume so its position Uncertainty and entropy are decreased (increased probability of location), which can only occur when Heisenberg's Uncertainty portion of the wavelength is reduced by an energy increase. An increased probability of locating something results by decreased probability of occurrence, which is why natural Electron Capture with its proportionately greater instantaneous energy requirement is infrequent.

Borghi in the early 50's and Missfeldt in the late 70's increased the Electron Capture rate by increasing external ambient EM energy, which increased electron average energy and thus frequency of instantaneous energy needed for Capture. Because proton and electron sizes are constant and they limit the E_n energy neutron state boundary condition the Electron Capture rate is solely proportionate to the ambient EM energy condition.

This is the $\int {}^{1}/_{f(x)}\, dx$, as $f(x) \to 0$, Singularity principle that a singularity will transform one domain's construct into the next domain's greater energy density by a $1/\alpha^2$ Sommerfeld ratio (Entropic Energy Density Progression Principle) when the f(x) context of a domain's available degrees of freedom saturate at $f(x) = 0$, when $v = c$ velocity attains the speed of light relative to the domain's energy density, which is why neutrons with $E_n > 3E_C = \frac{3}{2}mc^2$ are unstable states with excess electron energy, stored in their down quark interaction with their EM mass-energy, are transition region interactive energy states.

The $\Delta G = \Delta H - T\,\Delta S$ describes the microstate of an individual structure of a domain, but $\Delta G = -RT \ln [P] / [R]$ describes the microstate equilibrium between the individual reactant and product structures in terms of the average RT ambient energy conditions. Reactants and products have a probability of occurring according to their individual free energies with respect to ambient energy and entropy conditions. Their components form the products or reactants proportionately to their free energies interactions with the macrostate entropy conditions. Since their formation occupies available entropies their [P] / [R] concentration ratio changes their free energy contributions to available entropic degrees of freedom and a $\Delta G = -RT \ln [P] / [R]$ equilibrium results, which is why reaction rates and outcomes shift with temperature, since $S = k \ln W \Rightarrow W = e^{S/k}$ when entropies are macrostate variable functions, so $[P] / [R] = e^{-\Delta G/kt}$.

It makes no difference what energy form is used as long as the entropy conditions relied upon in the free energy relation are affected by that energy form. EM domain forces and energies correlate to 1-D, 2-D and 3-D entropy conditions so EM energy forms render these macrostate entropy variable functions very controllable. In the Strong to EM Weak force decay the reactant component being considered is the generated EM mass-energy confined by the udu proton and dud neutron quark constructs and the product components are the pn nuclei combinations, the electrons and EM energy available to construct their microstate combinations.

The Weak Force decay reaction rate can thus be regulated by EM conditions. However, since EM energy is more useable, and it is more energetically practical to construct a "solar cell" energy converter that responds to 0.66 MeV rather than 1.5 eV solar radiation, controlling proximity density would regulate proximity wavelength energy exchange between nuclei, since by Bohr's Correspondence principle when wavelengths are in the range of a quantized energy system's wavelengths quantized energy exchanges occur.

When proximity wavelengths come within 10,000 the Yukawa Heisenberg bond wavelength, the nucleons' EM mass-energy will statistically distribute and the bonds will emit quantized EM energies less than the 2.224 MeV beta particle nuclear "ionization" energy, as Einstein showed for atoms in Production and Transformation of Light.

Conclusion

This mechanism will therefore provide a controllable $E = mc^2$ mass-energy conversion process without the hazardous waste products of fission or technical difficulties of laboratory fusion.