Global and Local Gauge Symmetries: Parts IV and V

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Global vs Local Gauge Symmetries: Material Effects of Local Gauge Symmetries

Abstract

"Local gauge symmetry currents" are forces that maintain the local invariance of universal constants and other conserved parameters (such as causality and the "Interval") despite the hostile environment of a variable gravitational (or inertial) metric, relative rather than absolute motion, entropy, partial charges, etc. These compensatory forces are due to the activity of the field vectors of the four forces, which not only act (in the long term) to return these asymmetric material systems to their original symmetric state (light), but also act (in the short term) to protect and maintain the invariant values of their symmetry debts while awaiting a final repayment via antimatter annihilation, proton decay, the "quantum radiance" of black holes, or a universal "Big Crunch".

Preface

"Global vs local gauge symmetry" may sound like a forbidding technical concept, but it addresses a simple and powerful idea: in order to conserve energy, symmetry, charge, and causality, etc., certain constants of the "global" symmetric universe of light, space, and absolute

motion must be maintained in the "local" asymmetric universe of matter, time, and relative motion. It is because we live in a universe compounded of both free and bound electromagnetic energy (light and matter), in which matter is an asymmetric form of (and derived from) light, that we need a concept such as global vs local gauge symmetry to address the conservation issues arising from this fundamental dichotomy in our energy forms and their interactions. The "global" parameters are universal constants such as the electromagnetic constant "c", and the gravitational constant "G", Planck's energy constant "h", etc. Similarly, the several charges of matter represent symmetry debts of light whose full values must also be protected. Included in the list of conserved invariants are such metric parameters as Einstein's "Interval" and the principle of causality, the latter addressed by Special Relativity and "Lorentz Invariance", the co-varying dimensions of space and time.

Parameters such as charge and velocity "c" are "global" in the sense that if we could change their value everywhere simultaneously, we wouldn't know the difference. However, variations in the value of these constants on the local scale, from one point to another (or from one day to another, or from one moving reference frame to another) would constitute a conservation disaster - from the point of view of energy, symmetry, or charge conservation. Therefore, in the material realm of relative (rather than absolute) motion, where the energy of an atom or a system varies with the relative motion of its reference frame, "local gauge symmetry currents" arise to protect the invariant value of charge, velocity c, and other global constants derived from the universe of light and space. Magnetic forces and the time/space dilations of Einstein's Special and General Relativity ("Lorentz Invariance") are premier examples, protecting electric charge, velocity c, causality and the "Interval", in moving (and gravitational) reference frames. (The Doppler effect (in light) is a related, consequential phenomenon.) Other examples include permanent quark confinement via the "gluon" field in the strong force (protecting whole quantum units of charge) and the great masses of the Intermediate Vector Boson (IVBs) in the weak force (protecting the invariance of all conserved parameters of elementary particles (mass, charge, etc.).

Introduction: Charge Invariance

The principle of *charge invariance* is a common feature of both the "Tetrahedron Model" and the "Standard Model" of physics. *The charges of matter are the symmetry debts of light* (Noether's Theorem); if these debts are to be paid in full upon demand, charge invariance must hold in every system at all times. Consequently, charge magnitude and value must not be diluted or otherwise affected by inflation, entropy, relative motion, the expansion of the Universe, quark partial charges, particle transformations, distortions of the spacetime metric (gravitation), etc.

Charge invariance in the temporal realm of relative motion and atomic matter (vs the spatial realm of absolute motion and light) is the rationale for "local gauge symmetry". Charge invariance must be maintained in both the global (absolute) and local (relative) realm, by the field vectors of the forces which accomplish transitions between these realms. Charge invariance is a corollary of charge and symmetry conservation, and ultimately, of energy conservation.

In the spacetime or "metric" forces (electromagnetism, gravitation, inertial forces), analogs of charge invariance take the form of the metric invariance of Einstein's "Interval", velocity c, and the invariance of the principle of causality ("Lorentz Invariance" - accomplished by the covariance of space and time in both Special and General Relativity). Two global or universal gauges are involved: 1) the universal electromagnetic constant "c", regulating the absolute

global spatial metric, the intrinsic (entropic and "nonlocal") motion of light, and the invariance of causality and the "Interval"; 2) the universal gravitational constant "G", regulating the relative local spacetime metric (because gravity creates matter's time dimension). "G" introduces the explicit presence of time, which modifies, "warps", or produces a certain bias or inertial acceleration to the otherwise symmetric spatial metric, creating spacetime, the compound historical metric and domain of free and bound electromagnetic energy. The local expression of "Big G" is "little g", which we experience as "surface gravity" (or forces of acceleration), and which varies from place to place within a given field (with altitude or with local concentrations of mass), and as the total field varies (for example) from planet to planet. Despite such variations in the spacetime metric, energy conservation is accomplished, the "Interval" and velocity "c" remain invariant, and causality is upheld, thanks to the local covariance of the dimensional parameters of space and time.

In the particle forces, the charge neutrality of cold, ground state atomic matter is a commonplace (if unappreciated) expression of local gauge symmetry. Charges are universal invariants, but they must also be translated into local invariants on an individual basis, for example, individual electrons must remain charge invariant in a temporal, 4-D world of relative motion. Charge neutrality is achieved in matter despite the relative motion of electrons in their atomic orbits (or elsewhere, thanks to magnetic forces), the partial charges of quarks (thanks to the gluon field), or that protons and electrons are not each other's antiparticles (thanks to the IVBs). Bosons (field vectors) of all the forces (gravitons, photons, IVBs, gluons) are their own antiparticles (either individually or as a group), an attribute necessary to their interactions with antimatter and virtual particles, as well as to their function as the force carriers or "currents" which translate invariant global gauge symmetries or charges ("location", electric charge, number, color), into equally invariant local gauge symmetries or charges - and vice versa.

Phenomena of Local Gauge Symmetries

Whether or not we understand the full mathematical form of global vs local gauge symmetries (typically expressed through "group theory"), we can nevertheless appreciate some of the everyday consequences of the translation of global gauge symmetries into local gauge symmetries: our material world would be unrecognizable without them.

Electromagnetism

1a) Electromagnetic Force: magnetic rather than electric forces. Magnetic forces allow the existence of electron shells and the formation of atomic matter, with a variety of bond strengths rather than just one global electric bond strength (without magnetic forces, matter would exist only as an ionized plasma - chemistry of any kind would be impossible). Magnetism is the consequence of the relative motion of an electric charge or field. Variable magnetic fields complete the local gauge symmetry of electric fields in relative motion. Magnetic fields protect the invariant magnitude of electric charges in relative motion - the variable relative motion of an electric charge is expressed as a variable magnetic field rather than as variation in the value of electric charge. Similarly, the Doppler effect does not change the velocity of light, but instead changes light's frequency. The electrical neutrality of cold, ground state, crystalline atomic matter is a manifestation of the local gauge symmetry of electromagnetism, demonstrating the invariance of electric charges in relative motion (electron shells; moving electrons vs stationary protons). Both magnetic forces and the Doppler effect are part of the suite of relativistic effects associated with the covariance of space and time due to relative motion ("Lorentz Invariance" of special and General Relativity), protecting the invariance of velocity c, the "Interval", and causality, as well as the value of electric charge.

Electroweak Force

1b) Electroweak Force: mass rather than light - hν = mcc; bound energy rather than free energy. "Spontaneous symmetry-breaking" produces mass from the interaction of the spacetime metric with the energy of light (as gauged by the "Higgs" boson). The return conservation loop is through matter-antimatter annihilation reactions. In the conversion of light to mass we begin to see the real effect of the electroweak unification. (See: "The Higgs Boson vs the Spacetime Metric".)

The photon is its own antiparticle and is the field vector or boson of both the electric and magnetic fields. The duality in every force often includes the matter-antimatter duality, which is also the expression of duality on the cosmic level, touching the "multiverse". At cosmic scale, the multiverse is a global gauge expression, and our derived material Universe is a local gauge expression, conserving and processing energy and information in its own unique way.

We might characterize the generalized rationale for the global-local divergence at the multiverse level as the creation of "something rather than nothing" - which also pertains to the energy fluctuations in the quantum mechanical "vacuum". In "inflationary" theories, quantum energy fluctuations in the vacuum are the origin of our Universe, completing its fractal description. In these ideas we see the physical "vacuum" and analogous notions of the metaphysical "void" as expressions of a global gauge symmetry, or the multiverse, conceived in terms of pure creative potential. There may be many possible ("local") universes, all equally capable of energy conservation in their own way, no one to be preferred over another.

The electromagnetic force, electromagnetism, light, is the primary energy form of our Universe, and is associated with many fundamental dualities: electric and magnetic forces, the creation of spacetime, the creation (and annihilation) of matter-antimatter particle pairs, and free vs bound energy forms (light vs matter). The electromagnetic constant "c", the "velocity of light", is the master global gauge energy constant, implicitly or explicitly involved in all four forces. All charges, forces, and masses are derived from light and eventually return to light via matter-antimatter annihilations, fusion or fission, particle and proton decay, or various astrophysical processes (stars, quasars, supernovas, etc.) including Hawking's "quantum radiance" of black holes. (See: "Symmetry Principles of the Unified Field Theory".)

Weak Force

2) Weak Force: asymmetry vs symmetry - charge conservation vs symmetry conservation. *The charges of matter are the symmetry debts of light*. The creation and transformation of matter: the decay and transformations of neutral leptoquarks (to mass carrying baryons and charge carrying leptons) proceeds via the weak force "IVBs" (Intermediate Vector Bosons), the "X" and the "W+", "W-", "Z", including the virtual particle-antiparticle pairs of the Heisenberg vacuum of spacetime, and from various fields of alternative charge carriers: the leptons, neutrinos, and mesons. The role of the IVBs is the creation of unified force-symmetry states (such as the electroweak force-unity state) in which elementary particles with invariant mass and charge may be created and/or transformed, protecting charge, symmetry, and energy conservation. Within these force-unity symmetry states, the IVBs make available vacuum charges and alternative charge carriers to various real particles, allowing transformations, decays, and the creation and destruction of elementary particles. The weak force establishes charge conservation (via massive charge-carrying particles) as an alternative (temporal, historical) form of symmetry conservation; otherwise we would have only a Universe of light and matter-antimatter (virtual particle) annihilations. (See: "The Origin of Matter and

Information".)

The role of the weak force is the creation and transformation of elementary particle "identity", including the creation, destruction, and swapping (exchange) of elementary charges and associated mass-energy quanta. Just as charge invariance is a critical issue for charge and symmetry conservation, so also must be the mechanism of elementary charge carrier creation/transformation (creation/transformations of quarks and leptons). The role of the weak force and the massive IVBs is to ensure that charge invariance, charge conservation, and energy conservation are all scrupulously observed in any creation/transformation of elementary particle charge, mass, and identity. To this end, the massive IVBs provide a "conservation containment" or "safe house" in which charge and energy can be transferred between "real" and virtual particles in very close proximity (perhaps essentially "touching" each other), such that no conservation laws are threatened or actually broken by risky long-range transfers. These interactions can also be understood as reprising the original "Big Bang" symmetry state of the electroweak force unification realm in which all such transformations are but the normal course of affairs. That is, the "safe house" is the symmetry state of electroweak force unity. (See: "The Higgs Boson and the Weak Force IVBs".)

The weak force IVBs are "metric" particles, catalytic particles composed entirely of a densely compressed and (perhaps) convoluted metric, probably similar to the densely energetic and compressed primordial metric of the early "Big Bang". The great mass of the IVBs consists of the binding energy required to compress and maintain a volume of spacetime metric into the IVB configuration and density. (See: "The Weak Force IVBs as a Bridge Between 2-D and 4-D Reality".)

The most significant feature of the massive IVBs is that they recreate the original conditions of the energy-dense primordial metric in which particles were created and transformed during the early micro-moments of the "Big Bang" (the "W" IVB family recreates the electroweak era; the "X" IVB family recreates the GUT era). This recapitulation ensures that the original and invariant values of charge, mass, and energy are handed on to the next generation in the charge-transfer chain. The IVB mass not only provides a "conservation containment" or "safe house" where charge and energy transfers can take place, it simultaneously ensures that the appropriate alternative charge carriers (leptons, neutrinos, mesons) are present. (See: "The 'W' IVB and the Weak force Mechanism".)

There is a crucial difference between the electromagnetic or strong force creation of particles via symmetric particle-antiparticle formation, and the weak force creation or transformation of asymmetric "singlet" particles to other elementary forms. ("Singlets" are matter particles without antimatter "mates".) In the case of particle-antiparticle pair creation, there can be no question of the suitability of either partner for a subsequent annihilation reaction which will conserve their original symmetry. Both particles are referenced against each other and gauged or scaled by universal electromagnetic and metric constants such as c, e, and h. However, in the case of the weak force creation or transformation of a "singlet" elementary particle to another form, alternative charge carriers must be used to balance charges, since using actual antiparticles for this purpose can only produce annihilations. But can the weak force guarantee that the alternative charge carriers - which may be a meson, a neutrino, or a massive lepton - will have the correct charge in kind and magnitude to conserve symmetry at some future date in some future reaction, or with an unknown partner which is not its antiparticle? Furthermore, quark charges are both partial and hidden (because they are "confined"), and number charges of the massive leptons and baryons are also hidden (because they are *implicit*) - they have no long-range projection (such as the magnetic field of electric charge) to indicate to a potential reaction

partner the relative condition of their energy state. Conservation of energy, charge, and symmetry require that elementary particles created today, tomorrow, or yesterday be exactly the same in all respects as those created eons ago in the "Big Bang". (See: "Introduction to the Weak Force".)

These problems are all solved by a return to the original conditions in which these particles and transformations were created, much as we return and refer to the Bureau of Standards when we need to recalibrate our measuring instruments. The necessity for charge invariance in the service of symmetry conservation therefore offers a plausible explanation for the otherwise enigmatic large mass of the weak force IVBs. Weak force "singlets" can only be referenced against their original creation energy, as scaled by the universal Higgs boson. The IVB mass serves to recreate the original environmental conditions - metric and energetic, particle and charge - in which the reactions they now mediate took place, ensuring charge invariance and hence symmetry conservation regardless of the type of alternative charge carrier that may be required. (See: The Higgs Boson and the Weak Force IVBs.)

In function, the mass of the IVBs constitute the weak force analog of the magnetic field of the electromagnetic force. IVBs mediate the "local gauge current", while the particle-antiparticle pairs of the spacetime vacuum "zoo" comprise the "global gauge symmetry" in terms of charge magnitudes, which must be the same universally. The IVBs form a bridge between the global virtual "zoo" and local "real" (temporal) particles, distributing the charges of the "zoo" so the real particles can undergo transformations and decays. The "current" is the flow (in both directions) between the global "zoo" and the local particles as mediated by the IVBs; the real charges themselves constitute the local (temporal) gauge symmetry. The local symmetry is manifest as the balancing of charges, achieved despite the differing ages, histories, species, and relative motions of the particles. The return conservation loop (matter to light) is accomplished through various routes, including particle-antiparticle annihilation, particle and proton decay, and astrophysical processes in stars, etc. (the gravitational conversion of bound to free energy). (See: " The Weak Force IVBs as a Bridge Between 2-D and 4-D Reality".)

The charge specifically associated with the weak force is "identity" (also known as "number" charge), carried in explicit form by neutrinos and in "hidden" or suppressed form by leptons and the (hypothetical) leptoquark. The hidden form of the identity charge requires the mass of the IVBs as a local compensatory response; the mass of the IVBs is the weak force analog of the magnetic field of electric charge, equilibrating the hidden charges of the massive leptons and the explicit charges of the (nearly) massless neutrinos - so that charge balancing and/or annihilation can occur. (See: "Identity Charge and the Weak Force".)

Phenomena associated with weak force particle transformations include particle creation during the Big Bang, radioactivity, fission, particle and proton decay, contributions to element building and the nucleosynthetic pathway in stars, supernovas, etc. (See: "The Particle Table".)

Strong Force

3) Strong Force: Partial charges (the local gauge symmetry) rather than whole quantum unit charges (the global gauge symmetry); (quarks, gluons, color charges, and baryons vs leptons; composite vs elementary particles; electrically neutral composite particles vs electrically charged elementary particles). Partial charges include a variety of charge species carried by the quarks (electric, flavor, color, spin) - allowing the creation of electrically neutral leptoquarks and baryons (such as neutrons). Electrical neutrality permits the creation of matter via the asymmetric decay of neutral leptoquarks (which otherwise would be instantly annihilated by

their electrically charged antimatter partners). Partial quark charges are permanently confined to whole quantum unit charge combinations (baryons and mesons) by the gluon field, composed of color-anticolor pairs in eight different combinations, all moving at velocity c (gluons have been compared to "sticky" light because they attract each other).

The global condition (whole quantum unit charges which are universally the same - as in the elementary leptons) will not permit the creation of matter because electrically neutral mass carriers cannot be formed (electrically charged massive particles are immediately annihilated by their oppositely charged antimatter partners - fulfilling the global symmetry-keeping function of electric charge and the photons (field vectors) of the electromagnetic force, as required by "Noether's Theorem"). However, partial charges carried by the quarks can form electrically neutral combinations (such as the familiar neutron). The criterion of electrical neutrality is why the primordial mass carrier (the baryon) must be a composite particle. Electrically neutral leptoquarks have time to undergo individual leptonic (weak force) decays, independently of their electrically neutral antimatter partners, producing in the asymmetric decay process an excess of matter over antimatter (see: "The Origin of Matter and Information").

In "proton decay", the "X" IVB of the weak force (GUT energy level) compresses the gluon field to its original leptoquark configuration, squeezing the color-anticolor charges of the gluon field until they physically sum to zero and self-annihilate ("asymptotic freedom"), allowing again a leptonic decay and restoring the original global symmetry of leptonic unit charge and massless light. The leptonic whole unit charge (electric charge and "number" or "identity" charge) is the global gauge symmetry (of Noether's Theorem and charge conservation), the partial charges of the quarks are the derived local gauge symmetry (summing to unit charge), the gluon field is the local gauge symmetry "current" or force, the field vector of color charge, permanently confining the partial charges of the quarks to whole quantum unit values. Electric charge is universally interchangeable, and identity charge is interchangeable within a species (all electrons are identical, etc.); these are global symmetries. All quarks are interchangeable with respect to color charge (global symmetry); quark partial charges sum to unit leptonic charges and "white" color despite their differing "flavors" (u, d) and fractionally charged states (local symmetry). Proton decay closes the charge symmetry and energy conservation loop (leptoquark - baryon - leptoquark; light - mass - light; symmetry - charge - symmetry).

Phenomena associated with the strong force include: sunshine and the stars - nuclear fusion - and the elements of the periodic table (meson exchange field - see below). The nucleosynthetic pathway - element building in the stars - is the first (gravitational) step toward the return of matter to its original form, light. The process goes to completion in Hawking's "quantum radiance" of black holes. "Quantum radiance" completes the symmetry circuit beginning with light, devolving to matter through the conserved charges of the electric and nuclear forces, and finally back to light again through fusion and ultimately "quantum radiance". (Another strong force conservation circuit goes to completion through the alternative route of proton decay (gluon exchange field - see above) - proton decay may be commonplace in the interior of black holes.) (See: "The Half-Life of Proton Decay and the 'Heat Death' of the Universe".)

The Strong Force - Two Expressions

The strong force has two structural levels of expression, quite different, one within the individual baryon (mediated by a gluon exchange field), and one between individual baryons (mediated by a meson exchange field). While the internal baryon level of the strong force consists of an interaction among three quarks carrying 3 "color" charges ("red, green, blue") exchanging a color-carrying gluon field, the strong force at the compound nuclear level consists

of an interaction between two or more baryons carrying 2 quark "flavor" charges ("up, down"), exchanging a flavor-carrying meson field. The gluon field is composed of virtual color-anticolor charges, and the meson field is composed of virtual flavor-antiflavor charges, so the analogy is complete, except that the gluon field is massless while the meson field is massive. The massless gluon field nevertheless produces a short-range field because unlike photons, the gluons attract each other (gluons have been compared to "sticky light").

Two particle charges unique to the quarks, "flavor" and "color", each produce a version of the strong force, expressed at different structural levels of the nuclear material. The color version of the strong force is expressed within the baryon, producing absolute quark confinement, while the flavor version of the strong force is expressed between baryons in a compound atomic nucleus, producing a very powerful (but not absolute) binding of baryons within the nuclear boundary.

The role of the color charge is to protect charge invariance, charge conservation, and symmetry conservation by maintaining the integrity of whole quantum charge units, hence explaining the absolute character of the confinement of quark partial charges. The role of the flavor charge is also symmetry-keeping, but with respect to energy states rather than charge, which is a more variable function (since energy can be conserved in many forms.) The flavor charge role is to reduce the amount of bound energy (mass) contained in the baryon ground state as far as possible, while not violating the absolute parameters of charge conservation (electric charge, color charge, baryon number charge, spin).

It is the fact that we have two ground state flavor charges (up-down), that allows us to have two ground state baryons (neutron and proton), which can share their (obligate) virtual meson fields and so bond together by reducing their total bound energy content. Because neutrons spontaneously decay into protons (half-life of about 15 minutes), and protons, given a sufficient energy boost, will revert to neutrons, we see that these two particles are in a real sense simply differently charged versions of one another. This close "family" relationship (as demonstrated by these weak force transformations) is the basic reason why these particles can form a combined "resonance" or "superposition" - the "nucleon" (as demonstrated by strong force meson field bonding).

It is remarkable what a variety of compound atomic nuclei can be produced by the exchange of a simple meson particle-antiparticle pair between proton and neutron (92 natural elements plus hundreds of isotopes). Another remarkable fact is that it requires the input of gravitational energy (as in the stars) to force these nucleons into such close proximity that they will actually bond. They will not bond spontaneously (unlike the gluons), but require some additional external coercion. Hence the nucleosynthetic pathway conversion of bound to free energy is actually the role of gravitational symmetry conservation, not actually an "agenda" of the flavor charge, although we can see it as a role of their combination (flavor charge plus gravitational force). As we have seen, the gravitational force is produced by the time dimension or entropy drive of matter. Therefore, the stellar conversion of bound to free energy is ultimately a consequence of the temporal entropy drive of matter, eroding and vitiating the energy content of atoms via gravity. Entropy increase and symmetry conservation work hand in hand.

The color charge of the strong force clearly has an "agenda" of quark confinement in the service of symmetry and charge conservation, through the protection of whole quantum charge units. Flavor charges, however, apparently exist only to quantize and regulate, scale, or gauge the mass of quark and leptonic elementary particles. Flavor charges are associated with and identify the specific masses of quark and leptonic elementary particles. This mundane or "maintenance"

scaling or gauge function is nevertheless vitally necessary to allow the invariant quantification of elementary particle mass and the faithful replication of same.

The miracle of the (nuclear level) strong force is of course the 92 elements of the periodic table (and their many isotopes). These exist only because the proton and neutron can coexist as a "doublet", a paired bound state of nuclear matter which achieves in its combined form (the "nucleon") a state of lower bound energy than either partner could alone. The origin of this miracle goes back to the paired quark families and the ground state "up, down" flavor pairs. Why do quarks come in paired families, anyway? The pairing phenomenon is also seen in the lepton families, and in the pairing of quark families with lepton families, of meson and gluon charge-anticharge pairs, of matter and antimatter, and even of space and time. The ultimate source of all this pairing is probably electrical, originating with the dipoles of both electric and magnetic fields in the primordial source of cosmic energy, light. When light interacts with the metric of spacetime to produce particles (during the Big Bang), the electromagnetic dipole of light, the tripole of space, and the quadrupole of spacetime are carried into the structural fabric of particles. (See: "Nature's Fractal Pathway".)

The "nucleon" is a combined state of both the proton and neutron, a resonance or superposition of these particles. Because in the combined state the baryons can share their load of "parasitic" virtual mesons, a significant reduction of their total bound energy is possible. This reduced energy is the "binding energy" of the atomic nucleus released in nuclear fusion (this energy would have to be replaced before the neutrons and protons could become independent, free particles again). The quark composition of the proton is "uud+", while that of the neutron is "udd". The exchange of a (virtual) meson particle-antiparticle pair, u$\underline{d}$+ and $\underline{u}$d- (antiparticles underlined), changes a proton into a neutron and vice versa. If two protons and two neutrons combine, they can position themselves at the corners of a tetrahedron in which all partners are equidistant. In the tetrahedral configuration meson exchange is especially efficient, as each proton has two equidistant neutrons to play the round-robin exchange game with, and vice versa. This 4-baryon tetrahedron is the alpha particle or helium nucleus, an especially tightly bound and favored nuclear configuration (the "brick" of the nucleosynthetic pathway), and it is easy to see why. The exchange of mesons between neutron and proton is exactly the "sharing of differences" that epitomizes the third stage of the General Systems model. It leads directly to the 4x3 tetrahedral bonding of the alpha particle (4 nucleons each of 3 quarks), and thence to the carbon atom - 3 alpha particles each of 4 nucleons; and so on up the nucleosynthetic pathway in alpha particle increments. (See: "The Fractal Organization of Nature".)

The "nucleon" can also be seen as a state of higher symmetry than either the proton or neutron alone - the analog of a force unification symmetry state, but expressed at the (much lower energy) particle level. This symmetry state was originally given the name of "isospin" symmetry or "isotropic spin" symmetry, and was conceived as a global symmetry state for which meson exchange formed the local symmetry "current" or field vector, and the proton and neutron were the local particle/charge derivatives.

"Isotropic spin" symmetry or "isospin" symmetry leaves the strong force unaltered when protons and neutrons are interchanged. The name derives from assigning a completely imaginary state of "spin" to the nucleon ("up" for the proton and "down" for the neutron). This theoretical spin state is isotropic (invariant) insofar as the strong force is concerned, whether it is in the up or down "phase". Isospin symmetry was understood as a natural consequence of strong force meson exchange between the nucleons. When the quark model was developed by Gell-Mann and Zweig, the "up" and "down" designations were retained for the ground state quark flavors. The superseded isospin model was then applied to the actual (rather than virtual) weak force

transformations of neutrons to protons ("beta decay"). Like the strong force, the weak force is also a short-range force with massive field vectors, the IVBs. Also like the strong force, virtual meson exchange occurs in weak force baryon transformations, but is mediated by the much more massive IVBs. (See: "The 'W' IVB and the Weak force Mechanism".) (See: Robert Oerter: *The Theory of Almost Everything*. Penguin (Plume) 2006.) (See: James Trefil: *The Moment of Creation*. Macmillian (Collier) 1983.)

Local gauge symmetry is epitomized in the neutral, quiescent nature of the cold, crystalline, ground state of atomic matter, the state we normally occupy that is so life-friendly. Because it is our normal, habitual state, we become thoroughly accustomed to it and forget how remarkable it really is. The heavy elements of which we are composed are very strange particles indeed: the nuclear material is composed of baryons containing 3 "colored" quarks confined by a massless gluon field exchanged at velocity c. Baryons in turn consist of two kinds, protons and neutrons, bound (in compound atomic nuclei) by a virtual meson field exchanged between baryons, which reduces them both to a common denominator of least bound energy - the androgynous "nucleon". This fantastically complex nucleus is in turn surrounded by a cloud of electrons bound to the nucleus (and each other) by a massless field of exchanged photons. These electric and magnetic fields will allow the creation of molecules and a further hierarchy of chemical structure, information, and complexity.

Nor is this all: these particles and fields are surrounded by (and engender) clouds of virtual particles which contribute to the interactions and total bound energy. Elementary particles carry various conserved charges such as electric, color, identity, and spin, including partially conserved charges such as the local quark "flavor" charges. There are neutrinos associated with each elementary particle (neutrinos function as alternative charge carriers for "identity" or "number" charge); and while all charges are balanced by alternative charge carriers rather than antiparticles, antimatter is abundantly present in the gluon and meson fields, and in the clouds of virtual particles. The photon is its own antiparticle. The whole atomic complex is set within the regulatory metric and entropic fields of spacetime and gravitation, and subject to the exotic transformation fields of the weak force IVBs which can create or destroy elementary particles, and elevate portions of the material system above the ground state of electromagnetic symmetry to a higher level of force unification (electroweak force unification or even the GUT symmetry level).

The incredible complexity of matter beggars our understanding, and yet in its ground state it is perfectly well behaved and predictable (in its gross characteristics), a benevolent condition necessary to our evolution and survival. The meson field of the strong force succeeds in reducing the energy level of most heavy atomic nuclei to a quiescent ground state. Radioactive decay is not a common phenomenon in our ordinary elements - one has to look rather hard to find it, as the Curies discovered. The local activity of the meson field provides us with a non-radioactive spectrum of stable heavy elements capable of producing and sustaining life - which itself is a whole new level and hierarchy of biological information and complexity, built upon the electron shell and delicate bonding chemistry of carbon atoms. At the top of this biological order, humans are building an entirely new information domain of abstract and symbolic thought patterns, imagination, languages, culture, and mechanical and technological systems. (See: "The Fractal Organization of Nature".)

Gravity

4) Gravitational Force: Intrinsic motion in time rather than space (mass vs light); negative vs positive energy and entropy; temporal vs spatial entropy; history vs space; many asymmetric

local metrics vs one symmetric global metric (g vs c).

Gravitational phenomena: the earth, the solar system, the galaxy, planets, stars, astronomical phenomena of all kinds - supernovas, quasars, black holes, the "Big Bang" and the "Big Crunch". Time and historical spacetime - cosmic spatial deceleration. Relative motion rather than absolute motion; energy conservation within an historic, local (spacetime) metric rather than within a purely spatial, global metric.

Gravity: time; many different local spacetime metrics (gauged by "g") rather than only one (the single global spatial metric gauged by c). Many different clock rates, local accelerations ("little g"), many different planets and star sizes, galaxies, etc. The local metrics of gravity (g) are all variations of the global metric (c), with energy debited from the expansion of space, causing in consequence the gravitational deceleration of the cosmic spatial expansion. This energy is (eventually) returned by the gravitational conversion of bound to free energy in stars and finally by Hawking's "quantum radiance" of black holes. The metric of light is primary and global, the metric of gravity is secondary, derived, and local. The conservation loop is from the gravitational deceleration of cosmic spatial expansion, through stars, and back to the spatial expansion of the Universe via the gravitational conversion of bound to free energy (seen today as the recently discovered "acceleration" of the cosmic expansion).

When g = c, at the "event horizon" of a black hole, we find matter in the same inertial state as light: matter moves at velocity c, time stands still, meter sticks shrink to nothing, etc., and the temporal entropy drive of matter completely replaces the spatial entropy drive of light. Inside the event horizon, proton decay completely converts matter to light; outside the event horizon, "quantum radiance" distributes this radiation to space, eventually converting the entire mass of the black hole to light.

The global symmetry expression is light, which has intrinsic motion in space (gauged by "velocity c"), actually creating and expanding space by its own intrinsic motion. Light is the only energy form which creates its own conservation domain out of its own nature (the "intrinsic" motion of light, the entropy drive of free energy). The local symmetry is gravity, gauged by "velocity G", which regulates the conversion of space and the intrinsic motion of light (the expansive entropy drive of space and free energy) to history and the intrinsic motion of time (the expansive, one-way entropy drive of bound energy's time dimension). Time is the active principle of gravity's "location" charge. Gravity creates time via the annihilation of space. *A gravitational field is the spatial consequence of the intrinsic motion of time*. Gravity is the inversion of the entropy/symmetry drive causing light's intrinsic motion (see: "Gravity Diagram No. 2".)

Gravity connects back to the global symmetry of light in three ways:

> 1) Decelerating the light-driven expansion of the Cosmos - paying the entropy-interest on the symmetry debt of matter by creating the intrinsic motion of matter's time dimension from energy supplied by the intrinsic motion of light's spatial dimension. Symmetry conservation = charge conservation *in the time dimension*.
> 2) The nucleosynthetic pathway and the "quantum radiance" of black holes. Return of bound energy to free energy, paying all symmetry and entropy debts of matter and bound energy.
> 3) The negative gravitational energy of mass exactly balances the positive rest mass energy of matter - allowing the creation of matter from zero net energy - as a quantum mechanical fluctuation of the vacuum (in the "Big Bang" - as per the

"inflationary" theory of Alan Guth, Linde, and others).

Light produces a single universal metric symmetry; gravity produces many local metric asymmetries of various magnitudes and intensities. Nevertheless, all gravitational (spacetime) metrics conserve energy and protect the invariance of velocity c, Einstein's "Interval", and causality, regardless of the magnitude of the local "warpage" - due to the covariance of space and time, and the perfectly spherical overall or net symmetry of any gravitational field. The covariant current of space and time (the gravitational force field), is the "local gauge symmetry current" which vanishes when we move with the flow - as also seen in the case of magnetic fields, and in the "asymptotic freedom" of the strong force gluon field - all "local gauge symmetry currents" maintaining the local invariance of globally conserved charge and metric parameters.

The energy to produce matter's time dimension comes from the gravitational deceleration of the spatial expansion of the Universe, so it is ultimately the expansive energy (entropy drive) of light and space which funds the expansive energy (entropy drive) of matter's time dimension and historical spacetime. The energy circuit between the parental (global) metric gauge symmetry (c) and the derived local metric gauge expression (g) is completed by the gravitational conversion of bound to free energy, as in stars. The radiance of our Sun is the expression of a completed symmetry circuit. Spatial vs historical expansion is also linked (through entropy) as the implicit vs explicit expression of time. (See: "Currents of Symmetry and Entropy" and "The Conversion of Space to Time".)

The weakness of gravity is due to the tangential connection (the "present moment") between matter and its historical conservation domain (historic spacetime). This tangential connection is due to the fact that it is matter's time dimension, and not matter itself, that has intrinsic, entropic historical motion (the metric equivalent of light's intrinsic, entropic spatial motion, both gauged by "velocity c"). Matter has no (net) intrinsic motion in either space or time, although its associated gravitational field (Gm) consumes space to produce time. Matter's gravitational field represents matter's primordial, intrinsic entropy drive, producing matter's moving time dimension via the annihilation of a metrically equivalent quantity of space. The separation between matter and its historical conservation domain is the root cause of human anxiety regarding our fleeting experience of life, but is necessary to protect both the energy and charge of atoms from the vitiating action of temporal entropy (aging). In consequence, atoms retain the full value of their energy content and charge magnitude until their energy and symmetry debts are paid in full, for the age of the Universe, if necessary. "Diamonds are forever".

The negative energy of gravitation exactly balances the positive energy bound in mass (a realization attributed to Pascual Jordan). Because this same negative gravitational energy decelerates the positive, expansive energy of the Cosmos, we begin to understand how it is that the expansive and contractile energies of the Universe are so nearly balanced (the geometry of the Universe is "flat"). In the "Big Bang", positive energy and negative gravitational energy were in exact balance, so the Universe "cost" nothing to produce, essentially as a gigantic quantum mechanical fluctuation of energy in the "void". Since that time, a lot of matter has been converted into light, and no new matter has been created. Since light produces no gravitational field but matter does, this conversion (by stars, quasars, supernovas, particle fission and fusion, etc.) has the effect of reducing the total mass of the Cosmos and its associated gravitational field. (The conversion of bound to free energy presumably also occurs in "dark matter", in observance of the usual conservation laws.) This mass and gravitational loss produces the impression that the expansion of the Universe is "accelerating", whereas in fact it is simply decelerating less rapidly. (See: " A Spacetime Map of the Universe" and "A

Description of Gravity".)

Global vs Local Gauge Symmetry: Part V
Origin of the Local Gauge Symmetry Currents

We observe that the local gauge symmetry currents (the field vectors of the forces, or components thereof), are in the case of both the spacetime metric (time) and the electromagnetic force (magnetism), devolved from an implicit expression embedded in the original global symmetry state. Magnetism, for example, occurs in its primordial state as the magnetic half of an electromagnetic wave, or light. Likewise, time occurs in an implicit and suppressed state ("frequency") in the global metric of space, again as gauged by the global energy and metric constant c (frequency x wavelength = c). This naturally leads us to suspect the same relationship should hold for the two particle forces (strong and weak forces) - we should find the precursors of their local, material gauge currents in the primordial and symmetric global metric of light and space.

In the case of the (low energy) weak force, the local gauge current is expressed through the massive "Intermediate Vector Bosons", the "IVBs" (W+, W-, Z), which function to reduce the bound energy of particles to their "ground" state, through weak force decays, or vanish mass completely through proton decay (via the "X" IVB). These spontaneous weak force decays (radioactivity, fission, "beta decay") constitute a type of "particle entropy drive", in that the energy of the material particle system and hence its capacity to perform work is reduced (as in a nuclear power station). Charge conservation and charge invariance are also rigorously observed during these transformations, with alternative charge carriers derived from the virtual vacuum "sea". The IVBs are themselves "metric" particles, condensations or compressions of the spacetime metric, the global gauge symmetry expression from which they are devolved. The mass of a "metric particle" derives from the energy required to bind the spacetime metric into the particular density and configuration of the particle in question. ("Metric" particles would have been abundantly formed in the dense metric of the very early Universe; in this sense they are "fossil relicts" of that time.) Hence we can trace the weak force local gauge currents (the IVBs) back to their origin in the energy dense, primordial spacetime metric and the virtual vacuum particle-antiparticle reservoir - as we surmised above. (See: The "W" IVB and the Weak Force Mechanism".)

Finally, the strong force local gauge current is manifest in the gluon field of "color" charges (summing to zero or "white" color), which confines the partial charges of quarks to permanent whole quantum units in baryons (such as protons and neutrons). The gluons are massless, composed of color-anticolor charges, and travel at velocity c. Gluons have been compared to "sticky" light, and are most probably a form of light, created by dividing a whole quantum unit of electric charge into three parts (shared among the quarks). Since the photon is the force carrier of electric charge, it seems reasonable to suppose that the gluons are derived from "fractured" photons, in the same sense (and by the same mechanism and action) that quarks are derived from electrically charged "fractured" leptons. The fractured lepton in this case is the "leptoquark", the common source or "ancestor particle" of the quarks and leptons. We find as conjectured above, the strong force gluons, like the local gauge symmetry currents of the other forces, can be traced to an origin in light.

The leptonic charge of elementary particles, the whole quantum unit of charge, is the global symmetry gauge from which the local symmetry gauge of the quark's partial charges is derived (and to which it must eventually return, as in "proton decay"). The whole quantum unit of charge is primordially expressed through particle-antiparticle pairs of elementary virtual

particles produced by the quantum fluctuations of energy in the "vacuum" of the spacetime metric, where they are immediately annihilated by the action of their opposite electric charges, for which the photon is the field vector - conserving the primordial symmetry of spacetime and light.

The strong force color charges form a local gauge symmetry current at the bottom of a gauge hierarchy, permanently confining quarks to whole quantum unit charge values. Quark partial charges are apparently derived from "split" whole or global leptonic unit charges, which are themselves derived from the global symmetry of the photon and the spacetime metric (as expressed through matter-antimatter virtual vacuum particle pairs). Gravity is the local entropy force associated with massive systems; gravity produces time, the entropy drive of bound energy, derived as a local gauge current from the intrinsic motion of light, the entropy drive of free energy and the global gauge of electromagnetic energy.

Throughout, the principle of charge invariance, and its analogs in the spacetime forces ("Lorentz Invariance", the "Interval", velocity c, and causality - invariant metric effects of Special Relativity), connect global and local gauge symmetries via the field vectors of the four forces. The field vectors translate the symmetric global realm of timeless light, absolute motion, and invariant (virtual) charges to the asymmetric local realm of temporal matter, relative motion, but nevertheless similarly invariant (real) charges. The local symmetry currents (field vectors) protect charge invariance in the translation, and establish charge balance and charge neutrality in atomic matter. Gravity achieves energy conservation in a (spherically symmetric) temporal, historical metric of its own creation, ruling over an imperfect world of asymmetric bound energy, relative motion, and flexible spacetime. The whole process is regulated and driven by energy, entropy, and symmetry conservation, facilitating and ensuring the (eventual) return of bound to free energy as required by Noether's Theorem. (See: "The Tetrahedron Model".)

The Universe vs the Antiuniverse

The photon and the graviton are their own antiparticles; the IVBs as a group are their own antiparticles, and also use particle-antiparticle pairs of alternative charge carriers (derived from the virtual spacetime vacuum "zoo") to accomplish the creation, destruction, and transformation of elementary particles; the gluons are composed of color-anticolor charges in all combinations. The Universe-antiuniverse duality (which we glimpse as the matter-antimatter duality) is the most fundamental of all physical dualities, and is the source of many lesser examples.

It is such contact with the antiuniverse that allows the charges and field vectors of matter to return the world of matter to the symmetry of light, despite the absence (in most cases) of actual particles of antimatter. The influence of the antiuniverse is still with us, and explicitly so in the form of the antineutrino: there is one antineutrino extant in the Universe for every lepton, and probably one for every baryon as well - the leptoquark antineutrino - balancing "number" or "identity" charge in baryons as well as leptons.

The photon, space and time, electric charge, color charge, the magnetic field, spin, the graviton, gravity, mass, energy, entropy, the gluons - unchanged, all would function equally well in the antiuniverse. Charge and spin are reversed in the antiuniverse, but this is a matter of convention. Only the weak force asymmetry (resulting in the production of matter during the "Big Bang") fundamentally distinguishes the Universe from the Antiuniverse.

A diagrammatic representation of the global-local gauge symmetry structure of natural law and

the physical forces can be seen in: "The Tetrahedron Model".

Transformations

Local gauge symmetries involve transformations performed by the field vectors (or components thereof) of the forces. Below I list a number of transformations in the forces, some of which are local gauge symmetry transformations involving the field vectors:

Gravitational Transformations

1) Charge = 0: free fall, orbit, center of field; (field neutralized by co-mover or self-annihilation).
2) Gravitational transformation of space to time and history, spatial entropy drive of light transformed to temporal entropy drive of matter, intrinsic motion of light transformed to intrinsic motion of time; (global-local transformation).
3) Gravitational deceleration of cosmic expansion; (global-local transformation - expansion of space converted to the expansion of history).
4) Gravitational conversion of bound to free energy (as in the sun and stars, etc., and by "Hawking radiation" of black holes); (local-global transformation; all symmetry and entropy debts of matter paid in full). (Field vanishes - since light produces no gravitational field.)
5) Creation of planets, stars, galaxies, and megastructure of universe. Negative energy of gravitation allows creation of Cosmos from zero net energy during "Big Bang".

Electrical Transformations

1) Charge = 0: atomic matter ground state (electron vs proton); alternative charge carriers (leptons, mesons); electric vs magnetic field of light (the photon is the electrically neutral field vector of electric charge); (field neutralized by opposite electrical charges (electrical dipole)).
2) Special Relativity: relative vs absolute motions, reference frames, magnetic field vs electric field; (global-local transformation; the motion of an electric charge relative to an observer is seen as the invariant charge plus a magnetic field, but a co-mover with the charge sees only the invariant electric charge).
3) Particle-antiparticle and/or matter-antimatter annihilations; (field vanishes; electric field becomes electromagnetic field - light; all symmetry debts of matter or antimatter paid in full) (local-global transformation).
4) Biology: transformation of electrical charge to the electron orbits and shells of atoms, molecules, chemical systems, information, and living organisms. Creation of life from atoms.

Weak Force Transformations

1) Charge = 0: hidden vs explicit number charges; lepton vs neutrino (ground state atomic matter); possible baryon vs leptoquark neutrino; (field neutralized by opposite number charges; also, weak force decays cease in "ground state").
2) Transformations among "number" charges: electron, muon, tau, leptoquark (?); elementary particle creation, destruction, and transformation (quarks, leptons, and neutrinos); hidden charges transformed to explicit charges - leptons transformed to neutrinos (and vice versa); particle decay, radioactivity, fission; (Global-local

transformation; global virtual particle-antiparticle pairs and explicit neutrino charges transformed to local real matter particles and implicit ("hidden") charges).
3) Leptoquarks transformed to baryons (?); quarks transformed to leptons (and vice versa) (?); ("X" IVBs); (field transformed - asymmetric creation of matter during the "Big Bang").
4) "Big Bang" symmetry-breaking: free energy transformed to matter, matter-antimatter asymmetry, symmetry conservation transformed to charge conservation, global symmetry of light transformed to local asymmetry of matter (but matter remains charge invariant, charge balanced, charge neutral, or charge-symmetric). Creation of matter; transformation of light to particles.
5) Proton decay: (field vanishes, all symmetry debts paid - requires strong force cooperation to vanish conserved color charge); (local-global transformation).

Strong Force Trnsformations

1) Charge = 0: "white" color charge, only allowed quark combinations = mesons and baryons (ground state atomic matter); (field neutralized). Creation of compound particles (baryons).
2) Color charge exchanges among quarks (via gluon field); (field transformed).
3) Partial charges transformed into whole quantum unit charges (quark confinement); (local-global transformation).
4) Element building in the nucleosynthetic pathway - nuclear fusion - protons and neutrons bond through meson exchange, creating "nucleons" (sun and stars, supernovas); (local-local transformation). Creation of the 92 elements.
5) Proton decay: "asymptotic freedom"; (field vanishes, all symmetry debts paid - requires weak force cooperation to supply "X" IVB and leptoquark neutrinos) (local-global transformation).

We note in the above table an ontological progression of symmetry transformations:

1) The Universe begins with the perfect, global symmetry of light and space (derived from the "Multiverse" - the ultimate reservoir and source of "global symmetry"). (Our Universe is a local form of the global "Multiverse".)
2) "Symmetry-breaking" during the "Big Bang" creates an alternate (transformed) local system of conserved symmetry and energy forms, consisting of mass (transformed free energy), charge (transformed symmetry), time (transformed space), and gravity (transformed entropy drive) - which retains some characteristics of the original global symmetry (especially in the electromagnetic force and light). (Entropy driven devolution from the "ideal" global state).
3) A quiescent, stabilized, charge-balanced and neutralized "ground" state of local symmetry evolves - cold, ground-state atomic matter, due to the activity of the field vectors of the forces (photons, gravitons, IVBs, gluons). Quantum mechanics provides a "bottom" or foundation for the material system (through the quantization of energy, charge, spin, etc.). Field vectors translate the global or absolute, invariant symmetry states of light, the metric, and the (virtual) charges into local, variable, and relative symmetry states of atomic matter, also with invariant (real) charges (characterized by motion at less than velocity c: magnetism, gravity, time, IVBs and alternative mass and charge carriers, quark partial charges confined to "white" whole quantum unit color charges). (Charge-conserved quiescent "maintenance" state; gravity pays the interest on matter's symmetry debt, creating time via the annihilation of space, decelerating the Cosmic spatial expansion to fund the Cosmic

historical expansion: the gravitational transformation of light's spatial entropy drive to matter's historical entropy drive.)
4) A violent (apocalyptic?) restoration of the perfect global symmetry of light through the further action of the field vectors: matter-antimatter annihilations (electromagnetic force), fusion, fission, particle and proton decay (strong and weak forces), and the gravitational conversion of matter to light in stars, supernovas, quasars, and finally Hawking's "quantum radiance" of black holes (including the possible gravitational collapse of the Cosmos in a final "Big Crunch"). (Driven by symmetry conservation - Noether's Theorem.) (See: "The Higgs Boson and the Weak Force IVBs".)

The Role of Alternative Forces and Charge Carriers

The role of alternative forces and charge carriers is thoroughgoing and essential (although not by itself sufficient) to breaking the initial symmetric energy state of the Universe, which begins with light, the spacetime metric, and particle-antiparticle pairs. Symmetry and charge conservation, including charge invariance, plus the necessity of pairing alternative charge carriers with charge partners that are not their antiparticles, requires the large mass of the IVBs. IVBs reprise the primordial metric of the "Big Bang", in which all such particles were originally created. (The "W" IVBs recreate the force-unity state of the "electroweak era" - IVB transformations are "mini" Big Bangs. The massive IVBs and the alternative charge carriers of the virtual particle vacuum "zoo" comprise the "local gauge symmetry currents" of the weak force.) Some of the more significant alternative forms, forces, carriers, and dynamics include:

1) Antimatter is an alternative form of matter and necessary for its creation (in the "Big Bang");
2) Entropy is an alternative form of energy which allows the transformation of light to "work", manifesting in its primordial form as the intrinsic motion of light ("velocity c"), creating, expanding, and cooling space, the dimensional, entropic conservation domain of free energy;
3) Virtual particle-antiparticle pairs are alternative forms of light and the source of "real" (temporal) particles;
4) Mass is an alternative form of free energy, whose conservation allows the transformation of light to particles;
5) Gravity is an alternative (negative) form of spatial entropy, transforming space to time and vice versa (in stars). Gravity is a negative form of energy, allowing the creation of matter in the "Big Bang" from a quantum fluctuation of the vacuum containing zero net energy;
6) Time is an alternative form of spatial entropy drive, allowing the relative (non-absolute) motion of matter, and creating, expanding, and aging history, the dimensional conservation domain of bound energy's causal information field; *gravity is the spatial consequence of the intrinsic motion of time*.
7) Charge conservation is an alternative form of symmetry conservation which allows the transformation of light to conserved charges, "information", and vice versa (when charges annihilate);
8) Leptoquarks are an alternative form of elementary particle which allow the transformation of elementary leptons into sub-elementary quarks (via the "X" IVB, an alternative form of the "W" IVB);
9) IVBs are alternative forms of the spacetime metric which allow the transformation of virtual particles into real particles (and vice versa), and the transformation/creation of elementary particles as unpaired matter "singlets"; the

mass of the IVBs is gauged by the Higgs boson;
10) Leptons (including neutrinos) are alternative charge carriers which, in the absence of antiparticles, allow transformations of whole quantum units of charge among elementary particles (electric and identity charge);
11) Mesons are alternative charge carriers which allow transformations of partial quantum units of charge among sub-elementary quarks (electric, flavor, color, spin);
12) Gluons are an alternative form of light ("sticky light"), and color charges are an alternative form of electrical charge, which allows the transformation of whole quantum charge units into fractional quantum charge units (quark partial charges);

The crucial role of embedded alternative forces has long been recognized in philosophical systems of thought. In religious terms and symbolism, the "devil" is necessary so that God may manifest; the role of "evil" in the world is to activate the "good" (= "God"). Similarly, the "soul" is an alternative form of personal identity, the "ideal" is an alternative form of the "real", words and symbols are alternative forms of objects and ideas; language is an alternative form of thought; imagination, art, science, and technology are alternative forms of nature and reality, etc. - all having creative potentials and functions. In every respect, our material Universe is a wholly conserved, relative, local, asymmetric transformation of an absolute, global, symmetric energy state (the "Multiverse"). The "Big Bang" is the energy release consequent upon such a transformation and loss of symmetry, the "binding energy" of matter and our material Cosmos. Nevertheless, the return of the Universe to its original condition of energetic symmetry is an inevitable consequence of its embedded conservation laws. (See also: "A General Systems Analysis of the Creative Process in Nature".)

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