Global and Local Gauge Symmetry in the "Tetrahedron Model": Part I

John A. Gowan
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PART I

Abstract

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6) The field vectors of the forces act as "local gauge symmetry currents" which maintain charge invariance despite relative motions or other variations in local conditions - serving charge and symmetry conservation, and in the case of gravity, serving energy, symmetry, entropy, and causality conservation (because gravity creates time).
7) Gravity (as gauged by the universal gravitational constant "big G") transforms the global spatial metric of absolute motion and light, as gauged by the universal electromagnetic constant "c", into a local spacetime metric accommodating relative motion and matter, as well as light. (The local gravitational metric is characterized by "little g".) (Gravity creates time by the

annihilation and conversion of space.)
8) Gravity pays the entropy-"interest" on matter's symmetry debt, creating time by the annihilation of metrically equivalent space, decelerating cosmic expansion in consequence. Conversely, the gravitational conversion of bound to free energy (as in the stars and via Hawking's "quantum radiance" of black holes), pays the energy-"principle" on all symmetry and entropy debts, restoring (and hence to all appearances "accelerating") the original cosmic expansion. The radiance of our Sun and the stars represents a completed "circuit" of symmetry conservation. (See: "Currents of Entropy and Symmetry)".

Preface

"Local vs global gauge symmetry" is a technical subject which, in its full formal application, is far beyond this author's level of mathematical ability. Nevertheless, we very much need to understand some important physical concepts addressed by this topic, so I will define below my own usage of this term and concept, which may be at some variance (hopefully small) with the way these ideas are presented in the textbooks.

As I understand and use these terms and concepts in the papers on this website, "global gauge symmetry" refers to a symmetry which is universally expressed, and which is not affected by changes in the absolute magnitude of its significant variable - provided these changes are universally applied. The usual example given is the voltage of a closed electrical system. Examples I use are the value of "velocity c" (the entropy and symmetry gauge of light), and the magnitude of various charges - electric, color, and flavor. If the magnitudes of "velocity c" or electric charge were different from what they are, we wouldn't experience the difference, provided the difference was universal. Even moderate changes in the value of the universal gravitational constant ("big G") could not be detected in free fall or orbit (if external observations are excluded). It is only when the values are locally different from one place to another that we become aware of such changes - as an electrical shock or current, or as the "tidal" stress of uneven gravitational attraction.

In the "local" case the value of "little g" varies from place to place and planet to planet (or equivalently, in accelerated motions of various magnitude, as per Einstein's "Equivalence Principle"). Because "G" determines, regulates, or "gauges" the spacetime metric, variations in the local metric ("g") pose a problem for globally invariant parameters dependent upon the metric such as "velocity c", the "Interval", and causality. Nevertheless, due to a "local gauge symmetry current" involving the covariance of space and time in Einstein's Special and General Relativity (clocks run slow and meter sticks shrink in the direction of motion or in a gravitational field), the invariance of velocity c, the "Interval", and causality are upheld under all circumstances of local variation in "little g" and the spacetime metric ("Lorentz Invariance" in Special and General Relativity).

The issue (of global vs local gauge symmetry) becomes of crucial importance only because we live in a compound universe composed of free and bound forms of electromagnetic energy (light and matter), which interact with one another in global (universal) vs local terms, an interaction which usually requires some sort of flexibility in its contact parameters. The universal or "global" terms are charge and such constants of the light universe as velocity c, while the "local" terms are matter, time, and relative and variable motion rather than absolute and invariant motion. Because charges are the symmetry debts of light, and therefore charge conservation = symmetry conservation, the invariance of charge must be strictly protected, in "local" variable conditions as well as in "global" invariant environments. A moving electrical charge is the classic example of a globally invariant energy form in a relative and variable environment - how can the invariant magnitude of its symmetry debt (electric charge) be protected if its energy content and charge magnitude varies with its relative motion? This protection is afforded by the action of the charge's magnetic field, which varies in strength in direct proportion to the relative motion of the charge. The electric charge remains invariant because its associated magnetic field exactly compensates any effects of relative motion.

A magnetic field is our prototypical example of a "local gauge symmetry current" employed to protect the magnitude of a globally invariant charge or symmetry debt. Note that the magnetic field is an embedded feature of the electric field itself ("electromagnetism"). All "local gauge symmetry currents" (field vectors) are of this type, containing embedded secondary features of their primary fields, specifically addressing the problem of the interaction of globally invariant parameters with locally variable conditions - that is, they form a flexible connection between the invariant, global parameters of the light universe and the relative, variable, and local conditions of the matter universe - free electromagnetic energy vs bound electromagnetic energy (the spacetime dyad mentioned above is the gravitational analog). A little thought suggest that it could not be otherwise - only energy with this innate characteristic could produce our compound universe of light and matter. Sunshine - the common light of day - is another example, in this case produced by accelerated electric charges in the Sun. Electric charge remains invariant while the excess energy of acceleration is released as light and/or other forms of electromagnetic radiation. Here, electric charge and its field vector, the photon, work together as an embedded pair, maintaining charge invariance in a relative rather than an absolute environment. "Cherenkov radiation", synchrotron radiation, radar, medical x-rays, radio and TV, microwaves, are all related phenomena, produced by accelerated (or decelerated) electric charges.

It is worth noting here that it is only through such connections that these two intimately related domains of energy can interact at all, for reasons of energy conservation. For example, neutrinos are restricted to interactions mediated by gravity or the weak force IVBs - since they lack electric charge and hence also lack magnetic fields. "Dark matter" may be a form of energy which has only gravitational connections to matter. Gravity is the "connection of last resort" between light and matter - the ultimate glue holding the universe together and maintaining its energetic and dimensional unity.

Co-varying spacetime is a dimensional example of a "local gauge symmetry current" which mediates between the 2- and 3-D spatial ("global") realm of light and the 4-D historical ("local") domain of matter. Gravity produces matter's time dimension directly from space, creating a combined historical metric which allows the basic dimensional interaction of free and bound energy, equilibrating not only the compound metric of light and matter (historical spacetime), but the primordial entropy drives of free and bound forms of electromagnetic energy (the intrinsic motions of light and time). Time is the critical dimensional parameter which allows energy conservation in the realm of matter and relative motion, including matter's causal linkages as well as matter's historical entropy drive. The multiple energy-conserving functions of the time dimension are why all forms of bound energy (and only bound energy forms) must have a gravitational field. Massless light is non-local, atemporal, and acausal, producing no gravitational field; massive matter is local, temporal, and causal, and produces a gravitational field. (See: "Entropy, Gravity, and Thermodynamics".)

Gravity, which because of its dimensional activity and metric function is the most fundamental and general of the "local gauge forces", does not conform exactly to the electrical pattern, because unlike electric charge, the gravitational charge is monopolar rather than dipolar, and moreover, gravity represents both a symmetry and an entropy debt of light. It is this double conservation role of gravity that makes it such a confounding force, for although its entropy conservation role is immediately and universally expressed in the conversion of space to time (for any bound energy form, large or small), its symmetry conservation role is only apparent at high field strengths, when bound energy is returned to free energy (in our Sun for example). Electric charge has only a symmetry conservation role, which can be neutralized, if not completely satisfied, by any opposite charge carrier (not necessarily an antiparticle) - due to the dipolar character of electric charge. The symmetry debt of gravity, however, can only be fully satisfied by the complete conversion of matter to radiation - as in stars and Hawking's "quantum radiance" of black holes - due to the monopolar character of gravitational charge (because gravity produces one-way time). The two (gravitational) processes are essentially the inverse of each other, causing a lot of confusion regarding the actual rationale for gravitation, which on the one hand converts space to time (at all field strengths), and on the other converts matter to light (only at high field strengths) - conserving both the entropy drive of light (immediately) and the non-local symmetric energy state of light (eventually). Time is the functional analog of the magnetic field (in the terms of local gauge symmetry), and whereas the flexible magnetic field protects the invariance of electric charge, in material systems flexible time protects the invariance of velocity c, the "Interval", and causality ("Lorentz invariance").

As we shall see below, similar considerations apply to the field vectors of the short range or "particle" forces: the strong force whose gluon field produces quark confinement and whole quantum units of charge, and the weak force in which the massive Higgs boson and the IVBs produce invariant, single elementary particles. The "payoff" for "local gauge symmetry" is the quiescent state of ordinary, cold, atomic matter, in which charge conservation is observed, velocity c remains invariant, energy conservation and causality are strictly obeyed, and matter interacts seamlessly with light despite the absence of antimatter, and despite the huge differences between the "local" asymmetric, variable, and relative domain of bound electromagnetic energy (matter), and the "global" symmetric, invariant, and absolute realm of free electromagnetic energy (light).

The charges of matter are the symmetry debts of light. The requirement of charge invariance in the service of charge and symmetry conservation is the key to understanding the local action of the field vectors of the four forces of physics ("local gauge symmetry currents").

Charge Invariance

The common factor or pivotal connection between my use of the notion of symmetry in the "Tetrahedron Model" and the mathematical formalism of the "Standard Model" is the idea of *charge invariance*. This notion is the rock to which both our systems are anchored: charge invariance is crucial to symmetry and charge conservation. Charges are invariant with respect to relative motion, entropy, age, or gravitational metric, protecting their symmetry conservation function. The charges (among other parameters) of elementary particles are quantized expressly to maintain their invariance and thus their conservation function. The case of electric charge and magnetism is paradigmatic: the magnetic field is the relativistic expression of the motion of an electric charge with respect to a stationary observer.

The magnetic field is an alternative form of electrical energy which encodes and energetically accounts for the relative motion of electric charge, but which does not change the magnitude of electric charge. The existence of the magnetic field allows the relative (rather than absolute) motion of electric charge, conserving charge invariance, and therefore accomplishes the translation between the global, invariant gauge symmetry of electric charge and the local electromagnetic gauge symmetry of individual charge carriers in relative motion. The local gauge symmetry is expressed through (for example) the electrical neutrality of (ground state) atomic matter, despite the large relative velocities of electrons in atomic orbits around the massive and essentially stationary protons.

Because of the compensating action of magnetic fields, and the special quantum-mechanical rules that apply to electrons in atomic orbits, local leptonic charges in relative motion have the same magnitude as the proton charge, and as the global, universal value of electric charge everywhere - a fact we ordinarily take for granted. We have the magnetic field (and laws of quantum mechanics) to thank for the local phenomenon of electrically neutral, charge-balanced, quiescent atomic matter and chemistry (including biochemistry and life), and for the relative ease with which free electromagnetic energy (light) interacts with matter (bound electromagnetic energy).

The smooth translation from global electrical gauge symmetry to local electromagnetic gauge symmetry depends upon the fact that light is an electromagnetic wave and that the photon is the field vector of electric charge. Thus the magnetic field is part of the electrical phenomenon and the electrical field vector from the beginning (maintaining the electrical neutrality of light), always ready to act in defense of the invariant value of electric charge, charge conservation, and hence symmetry and energy conservation. The magnetic field acts as the "local gauge symmetry current", maintaining the invariant magnitude of massive electric charges in relative motion. Here we see that a portion of the electromagnetic field vector is "split out" to serve as the local gauge symmetry compensatory current, a notion which we can also apply to the binding principle of the gluon field of the strong force, apparently also a subdivision of the original electromagnetic field vector (gluons have been aptly called "sticky light" - because they attract each other). Gluons are the strong force analog of a magnetic field, maintaining whole quantum unit charges despite a local environment of fractionally charged quarks.

We furthermore take note of the fact that the photon is its own antiparticle, an internal or self-symmetry which is also found in the field vectors of all the other forces, either individually (as in the graviton), or as a group (in the IVBs of the weak force, and in the gluon field of the strong force). This is an important factor enabling the field vectors of the forces to translate a global symmetry into a local one - especially evident in the action of the gluon field of the strong force, where "anticolor" is used to attract and cancel "color", so the transformation to a new color can occur. (Gluons are composed of color-anticolor charges in all combinations. In the case of the weak force IVBs, it is virtual particle-antiparticle pairs which become alternative charge carriers, facilitating particle decays and transformations (leptons, neutrinos, mesons). See: "Global and Local Gauge Symmetries in the Weak Force"; see also: "The "W" IVB and the Weak Force Mechanism".)

Noether's Theorem

The concept of symmetry in physics is founded upon a great theorem formulated by Emmy Noether (in 1918), which states that in a multicomponent field, such as the electromagnetic field of light, or the metric field of spacetime, where one finds a symmetry one will find an associated conservation law, and vice versa. Hence the conceptual and unifying power of symmetry in physics derives from its intimate association with conservation laws. The mathematical field which addresses this association is known as "Group Theory".

Noether's Theorem states (in essence) that the symmetry of light must be conserved, no less than its raw energy. We have two outstanding examples of Noether's Theorem enforced in everyday experience: 1) charge conservation; 2) the inertial forces of the spatial metric. My own formulation of Noether's theorem is: "*the charges of matter are the symmetry debts of light*". Charge conservation (including spin) = symmetry conservation (symmetry as transferred from light and virtual particle-antiparticle pairs to a conserved form in massive elementary particles composed only of matter). Charges must retain their invariant, absolute values regardless of entropy, relative motion, gravitational metrics, alternative charge carriers, or the expansion (or contraction) of the universe. Otherwise, charges will not be able to cancel, balance, or annihilate each other upon demand, and charge conservation, symmetry conservation, and energy conservation will all fail: the Universe would default upon its symmetry debt.

The field vectors of the charges (the local symmetry "currents") all operate in some way to maintain the invariant, absolute value of charge, despite the variable, relative environment of matter. For electric charge, this compensating factor in the field vector is the magnetic field of the photon; for the "location" charge of gravity it is the time component of spacetime; for the "identity" charge of the weak force it is the mass of the IVBs (necessary to produce invariant, single, elementary particles); and for the strong force color charge it is the gluon field with its peculiar force law, which gets stronger with distance, producing the permanent confinement of the partial charges of quarks to particles (baryons and mesons) which display only whole quantum unit charge values ("white" color).

The usual electrical neutrality of the (low temperature) atomic realm, established through balancing charges, is an expression of the local gauge symmetry of individual carriers of electric and magnetic forces, despite the fact that the atomic realm is constantly in a state of relative motion (electron orbits, gluon exchange between quarks, thermal agitation, quantum excitations, gross relative motions, etc.) - and consists of alternative charge carriers which are not the antiparticles of their charge-balancing partners (the electron-proton pair is the obvious example).

Time - like magnetism - is a "local gauge symmetry current", in both Special and General Relativity. Causality, velocity c, Einstein's "Interval", and energy and symmetry conservation, are all invariant principles requiring the protection of the flexible time dimension (and therfore the gravitational force) when massive particles and relative motions are involved. Electric charge, velocity c, and symmetry conservation are invariant principles requiring protection in the case of magnetism and the electromagnetic force. Time is necessary to conserve matter's energy accounts because of matter's relative (rather than absolute) motion, and time is also necessary to conserve matter's causality and "Interval" for the same reason. Time is furthermore the critical dimension for charge conservation (charges, in the absence of immediate matter-antimatter annihilations, may be "stored" indefinitely in the temporal dimension until the debt is retired by charge annihilation). Finally, time is the primordial entropy drive of bound energy, creating and expanding history, the conservation domain of matter's causal information "matrix".

Gravity pays the "entropy-interest" on the symmetry debt of matter by creating time via the annihilation of metrically equivalent space, decelerating light's cosmic spatial expansion to fund matter's cosmic historical expansion. Gravity pays the "energy-principle" on matter's symmetry debt through the conversion of bound to free energy in the nucleosynthetic pathway of stars (partially), and via Hawking's "quantum radiance" of black holes (completely).

In the case of the weak force, the invariance of elementary particles over time and space is the global symmetry which must be observed. The spacetime metric (the "vacuum") maintains this symmetry for the creation of particle-antiparticle pairs; but because the weak force only creates, destroys, or transforms single elementary particles (not particle-antiparticle pairs), the huge mass of the IVBs is necessary to recreate the primordial metric and energetic conditions of the "Big Bang" in which these particles were first created.

Each of the four forces of physics is associated with a specific charge. ("Charge" can be regarded as a type of energetic asymmetry (representing a broken symmetry of light in its temporally conserved form) from which the associated force acquires its characteristic activity.) My method of unification (in the "Tetrahedron Model") is simply to show how these charges correspond to broken symmetries of light (broken originally when light is converted into matter or bound energy during the Big Bang). This simple method leads to a qualitative understanding of how the forces are unified (they all originate as "symmetry debts" of light), and why they behave as they do (to restore the symmetric energy state of light - as per Noether's Theorem). It is not a quantitative, mathematical understanding, but because it is firmly based upon the physical principles of natural law - energy conservation, symmetry conservation, entropy, and causality - I expect it could be reformulated mathematically into a fully consistent and formal statement of the Unified Field Theory. (See: "The Tetrahedron Model".)

The original understanding gained through the development of the "Tetrahedron Model" is now considerably enlarged by the addition of the principle of *charge invariance* as developed in the "global vs local gauge symmetry" theories of the "Standard Model". This marriage between the "alternative" "Tetrahedron Model" and "establishment" physics is a union which is possible only because both models are based squarely upon the same conservation laws. (See: "The 'Tetrahedron Model' vs the 'Standard Model' of Physics: A Comparison".)

Summary: Rationale and Effects of Local Gauge Symmetries

The charges of matter are the symmetry debts of light (Noether's Theorem). These debts must be paid in full to satisfy energy, symmetry, and charge conservation (as through matter-antimatter charge annihilation or its equivalent). The function of local gauge symmetry, as effected by the field vectors of the four forces, is to ensure charge invariance (serving charge and symmetry conservation) and the invariance of the "Interval" and velocity c ("Lorentz Invariance" serving causality and energy conservation), during and after the transformation of light (free electromagnetic energy) to matter (bound electromagnetic energy), as in the "Big Bang". Conservation must be observed in the "local" realm of matter no less than in the "global" realm of light - and in their compound domain of historical spacetime.

The conversion of the absolute, "global", "non-local" realm of light and space, gauged by the electromagnetic constant "c" and driven by the intrinsic motion of light (the spatial entropic drive of free energy), to the relative, local realm of matter and history, gauged by the gravitational constant G and driven by the intrinsic motion of time (the historical entropic drive of bound energy), requires the compensating mediation of local gauge symmetry "currents" (derived from the field vectors of the forces), for reasons of energy, symmetry, and charge conservation, including charge invariance.

We find a distinct role for each of the four forces, ensuring the invariance of elementary particles plus the invariance of charge magnitudes and charge wholeness in the realm of matter. Through the creation of matter's time dimension and spacetime, gravity provides an historic domain for the long-term conservation of matter's charges through time, including an entropy drive for bound energy and a means of accommodating matter's variable energy accounts. The co-variance of time and space (the "Lorentz Invariance" of Special and General Relativity) also ensures the invariance of velocity c, the "Interval", and causality in the gravitationally compounded metric of spacetime.

1) **Electromagnetic force:** absolute vs relative motion and magnetism; magnetism and the magnetic force associated with the relative motion of electric charge. Invariance of electric charge despite the *relative motion* of massive charge-carrying particles - serving charge and symmetry conservation. Example: magnetic forces ensure the electrical neutrality of ground-state atomic matter despite the orbital motions of the electrons vs the (relatively) stationary protons.

All electrical charges are the same in magnitude (charge invariance), a global symmetry within the electromagnetic force required by charge conservation and "Noether's Theorem". In atomic matter, charge invariance requires the existence of magnetic forces (the "local symmetry current"), to achieve electrical neutrality, while simultaneously balancing the energy accounts of electric charges in relative motion - such that energy is conserved but without changing the invariant value of the electric charge. The photon is the field vector, whose magnetic component constitutes the compensating factor of the "local gauge symmetry current". The electrical neutrality of cold, "ground state" atomic matter is the evidence of the local symmetry state, achieved despite the relative (rather than absolute) motion of electrical charges (orbital electrons) - thanks to the compensatory action of magnetic force fields. Another ubiquitous example is the radiation produced by an accelerated electric charge - the charge remains invariant while the excess energy of acceleration is shed as radiation (sunshine, radio, TV, synchrotron radiation, etc.). The electromagnetic force provides a paradigm of global-local gauge symmetries for the other forces - either by similarity or contrast. Magnetic fields and the Doppler effect are epiphenomena of, or related to, the "Lorentz Invariance" of space and time (Special Relativity), in which the co-varying and flexible dimensions form a "local symmetry current" simultaneously protecting the invariance of charge, velocity c, Einstein's "Interval", and causality.

2) **Weak Force:** Transformations of (single) elementary particle "identity", including the creation, destruction, and "swapping" of single elementary particles and 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 and transformation (creation and/or transformations of single quarks and leptons). The role of the weak force and the massive Higgs boson and IVBs (Intermediate Vector Bosons) is to ensure that charge invariance, charge conservation, and energy conservation are all scrupulously observed in any creation or transformation of (single) elementary particle charge, mass, and identity. To this end, the massive IVBs (as gauged by the Higgs mass scalar) reprise the original energy

density of the electroweak unified force symmetric energy state in which these particles and charges were originally created and/or transformed (during the "Big Bang"). (See: "The Role of the "W" IVB in Weak Force Transformations".)

Global symmetry: the invariant charge and mass of elementary particle-antiparticle pairs created during the "Big Bang" in an era of force unification, as scaled or "gauged" by the universal energy constants of light and the spacetime metric: c, e, h, G, etc. Local symmetry: the charge and mass of single elementary particles created here and now. Local gauge symmetry current: the mass of the Higgs boson and weak force IVBs recreate the energy level of the original electroweak unified force symmetry state in which these particles were first created and/or transformed during the "Big Bang".

The weak force IVBs are "metric" particles, catalytic particles composed entirely of a densely compressed and (perhaps) convoluted metric, 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 in the particular configuration and density that recapitulates the electroweak era of the "Big Bang", which we recognize as a weak force IVB.

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 first created and/or transformed during the early micro-moments of the "Big Bang". This recapitulation ensures that the original and invariant values of charge, mass, and energy are handed on to the next generation of particles, even though they are "singlets" rather than particle-antiparticle pairs. The IVB mass not only provides a "conservation containment" where charge and energy transfers can take place, it simultaneously ensures that the appropriate alternative charge carriers are present (in the form of virtual particle-antiparticle pairs derived from the Heisenberg-Dirac "vacuum zoo" of spacetime).

There is a crucial difference between the electromagnetic or strong force creation of particle-pairs 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 the spacetime metric (the "vacuum") and by universal electromagnetic constants such as c, e, and h (resident and available everywhere in the global spacetime metric). 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 how 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 even 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 yesterday, today, or tomorrow, be exactly the same in all respects as those created eons ago in the "Big Bang", and can seamlessly swap places with them if necessary. The absolute and interchangeable identity of all elementary particles (of a given species) is a universal symmetry which must be respected by all charges and forces everywhere and at all times.

These conservation problems are all solved by a return to the original environmental 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 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 a specific 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 first took place (the primordial electroweak unified force energy level or symmetric energy state), 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.)

3) **Strong force:** partial quark charges and gluons. Invariance of whole, elementary quantum charge units despite the *partial charges* of the quarks - serving charge and symmetry conservation. Strong force color charges permanently confine quark partial charges to whole quantum unit charge values (baryons and mesons), so they may be canceled, neutralized, balanced, or annihilated by other elementary, whole quantum unit charges - such as those carried by the alternative charge carriers, the leptons and mesons.

Leptonic whole charge units represent the global charge condition; quark partial charge units represent the local condition. The gluon field is the local gauge symmetry current which restores the local condition to global invariance. The gluon field has the unusual property that it grows stronger with distance, hence permanently confining quarks and their partial charges to whole quantum charge units.

Global Symmetry: whole quantum unit charges.
Local Symmetry: partial charges of the quarks and their gluon field vectors; permanent quark confinement and neutral ("white") color charge despite the partial charges carried by the quarks. ("White" color also sums any other quark partial charges to whole quantum unit values.)

The charges of matter are the symmetry debts of light and must remain whole to be payable on demand. But quarks must carry partial charges so they can assume electrically neutral combinations (such as the neutron) to allow symmetry-breaking (of electrically neutral leptoquark-antileptoquark particle pairs) during the "Big Bang". Hence the strong force is a compromise between the demands of manifestation (symmetry-breaking), and symmetry conservation via whole charge conservation (charges are symmetry debts). This compromise also allows non-leptonic composite particles (baryons and mesons) to exist provided their partial components (the quarks) can never become individually free. Baryons and mesons (the only allowed "white" quark combinations) must always express whole quantum unit charge values to the external world (in essence, as "seen" by the long-range forces) for purposes of charge balance (in atomic matter) and/or symmetry conservation (as via charge-anticharge annihilation). (Quarks only - "hadrons": baryons and mesons.)

"Gluons" are the field vector of color charge, and the analog of the photon field vector of the electromagnetic force. Gluons are massless and move at velocity c; they are composed of color-anticolor charges in all possible combinations, and hence the field in total sums to zero or "white" color. Gluons have been compared to "sticky" light (because in "white" combinations gluons attract each other). Just as quarks may be the remains of fractured primordial leptons and hence carry fractional electric charges, gluons may be fractured photons - "split" field vectors of fractured electric charge. Various processes such as fusion, the nucleosynthetic pathway in stars, Hawking's "quantum radiance" of black holes, and finally proton decay with color charge self-annihilation ("asymptotic freedom" - summing the gluon field to zero color by compression), and the cancellation of leptoquark identity charge via the leptoquark antineutrino ("proton decay"), returns the bound energy of the quarks and hadrons to light and whole quantum unit charge symmetry. (See: "Proton Decay and the 'Heat Death' of the Cosmos".)

(See: "The Strong Force - Two Expressions

4) **Gravitation:** Gravity is wholly a "local gauge symmetry current" (gauged by the universal gravitational constant "G"), composed of the flow of space and time, which modifies the global, absolute metric of space and light (gauged by the universal electromagnetic constant "c"). Gravity establishes a new, compound

metric containing a temporal parameter to accommodate the entropy, causality, and energy conservation requirements of bound electromagnetic energy (mass-matter). This new compound metric containing both temporal and spatial conservation/entropy parameters (historic spacetime) is produced by gravity through the annihilation of space and the extraction of a metrically equivalent temporal residue. The intrinsic motion of time serves as bound energy's entropy drive and marches on to create history (historic spacetime), the conservation domain of matter's causal information web, network, or "matrix".

Electromagnetic metric - gauged by the universal electromagnetic constant "c" (global electromagnetic gauge) = spatial absolute metric - a perfectly symmetric metric.
Gravitational metric - gauged by the universal gravitational constant "G" (global gravitational gauge) = historical, relative local metric (spacetime - an asymmetric metric). The gravitational metric is derived from and imposed upon the spatial metric (asymmetric time "warps" the symmetric spatial metric).
"Little g" = local gravitational gauge; local gravity bends light but maintains the invariance of "velocity c", due to the covariance of space and time, and despite variations in the strength of the local gravitational metric.
Flow of space and time = "local gauge symmetry current", which controls the local rate of flow of time (clock rate), maintaining the invariance of the "Interval", causality, and velocity "c" in the local, variable, historical (gravitational) metric.

"Little g" on the Sun (and stars generally) begins to return some mass-matter to the symmetry of light and light's absolute, spatial metric. When "g" = "c" (in black holes), then the local gravitational metric is equivalent in strength and effect to the global electromagnetic metric: matter travels with "intrinsic motion" of "velocity c"; time stands still and meter sticks shrink to nothing (at the "event horizon"); proton decay (inside the event horizon) and Hawking's "quantum radiance" (outside the event horizon) return matter to light, and likewise return the gravitational, historic metric to the electromagnetic, spatial metric. These actions restore light's symmetry, paying all the symmetry and entropy debts of matter and bound electromagnetic energy. (See: "Entropy, Gravitation, and Thermodynamics".)

The invariance of the "Interval" is due to the flexible nature of time and space, and their interconvertibility. Flexible metric scales and the invariance of the "Interval" are both necessary to rescue energy conservation and causality from the fluid metric and dimensionality of General Relativity, and from the relative motion of matter at less than "velocity c". Because of the invariance of the "Interval", energy conservation and causality is observed in all local metrics (on Jupiter, the Earth, the Moon, the Sun, etc.), despite the fact that time runs at a different rate on each, because length scales are also affected in a compensatory manner ("Lorentz Invariance" in General Relativity). (See: "A Description of Gravitation".)

Gravity acts to conserve the "non-local" symmetric energy state of light, and light's primordial entropy drive (light's intrinsic motion), by converting space and the embedded entropy drive of free energy (the expansive properties of space and light), to matter's primordial entropy drive (the intrinsic motion of time and the expansive properties of history). (See: "The Double Conservation Role of Gravitation".) Time, the entropy drive of bound energy and history, is also necessary to matter's causal relations and energy conservation accounts (because the energy content of matter varies with its relative velocity).

Gravity introduces local time (and hence local causality) with the gravitational "location" charge, converting globally symmetric space to locally asymmetric time. This is a conversion from a global absolute metric and entropy drive, to a local relative metric and entropy drive. The expansion of causal history replaces the expansion of acausal space; aging replaces cooling; the intrinsic motion of time (the local entropy drive of bound energy) replaces the intrinsic motion of light (the global entropy drive of free energy). Gravity is the conversion force for the primordial entropy drives of global space vs local history, in either direction. (See: "The Conversion of Space to Time".)

Because the gravitational charge specifies a particular place (holds space constant), it must introduce movement in another dimension to satisfy entropy demands: matter's moving time dimension. Because matter does not expand or move in space (matter has no (net) intrinsic spatial motion), matter's time dimension must move instead - entropy increase is mandatory in some dimension, for all energy forms in our universe of free and bound electromagnetic energy.

Time is the "local symmetry current" which adjusts the causal linkage and the energy accounts of matter in relative (rather than absolute) motion from place to place in space. Energy conservation is accomplished in systems of bound energy despite the relative (rather than absolute) motion of matter, and despite the variable metric of gravitational spacetime. This is the conservation role of the local gauge metrical symmetry imposed by the gravitational force, whose field vector is time, spacetime, or the "graviton". (See: "The Time Train".)

The function of the spatial metric in any situation is energy conservation, which requires a symmetry parameter (inertial force) and an entropy parameter (the intrinsic motion of light as gauged by "velocity c"). This metric conservation function is globally gauged by c, and locally modified by G, which introduces the asymmetric time parameter, necessary for matter's entropy drive, causal linkage, and energy conservation. Time also indicates inertially (dimensionally/gravitationally) the spacetime coordinates of the distributional asymmetry of mass, including magnitude and density. *A gravitational field is the spatial consequence of the intrinsic motion of time*. Time and gravity induce each other endlessly. (See: "A Description of Gravitation"; and "Entropy, Gravitation, and Thermodynamics".)

The Material Cosmos is no Accident

If there is one conclusion we should draw from the global-local force structure of our Cosmos, it is that the appearance of matter in this Universe is no accident. The material Cosmos is a system of energy that was destined to manifest in its current life-friendly form from its beginning. It is not only the weak force asymmetry (creating matter) that is built into the laws of Nature, but the duality of the global-local structures of all the other forces as well (as is especially evident in their field vectors). The magnetic field of the electromagnetic force, the gluon field of the strong force, the embedded temporal metric of light ("frequency"), gravitation, and spacetime - all these anticipate the creation or existence of matter, and are in addition to the weak force asymmetry parameter, the massive Higgs boson and the IVBs, and the alternative charge carriers of the leptonic field. And this is still to say nothing of the "life-friendly" values of the physical constants.

All these parameters are fixed at the level of the Multiverse, and once they are engaged as a self-consistent and self-referent set, capable of internal energy conservation, and requiring no net energy or charge to produce, the birth of our manifest Universe is assured. It is my assumption that our Universe is but one of perhaps infinitely many created in a similar fashion, each with its own unique set of physical parameters, all capable of conserving energy and requiring no net energy to produce. Any notion of "Divinity" thus resides in the creative energies of the truly global Multiverse, of which our Universe is but one local example and subset. We simply have *no idea at all* what creative possibilities are available to the Multiverse in this regard - the multifaceted exploration of itself through the creation of myriad universes.

For a summary of my own formulation of the force symmetries see:

Symmetry Principles of the Unified Field Theory (a "Theory of Everything") - Part I
Symmetry Principles of the Unified Field Theory (a "Theory of Everything") - Part 2
Symmetry Principles of the Unified Field Theory (a "Theory of Everything") - Part 3 (summary).

See also: Postscript to this paper

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The "Higgs" Boson and the Weak Force IVBs: Parts II, III, IV
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