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

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PART II

Abstract

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, protect, and maintain 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" (or in any subsequent interconversion between bound and free energy forms). 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.

Introduction: Rationale and Effects of Local Gauge Symmetries

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, causality, 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 whole quantum-unit charges 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, 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:** The invariance of electric charge and "velocity c". Absolute vs relative motion and magnetism; magnetism and the magnetic force associated with the relative motion of electric charge. Magnetic fields 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 electric charge, velocity c, Einstein's "Interval", and causality. 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. The electromagnetic force provides a paradigm of global-local gauge symmetries for the other forces - either by similarity or contrast.

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 "W" IVB and the Weak Force Mechanism".)

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". Virtual particle-antiparticle pairs of elementary particles drawn from the electroweak symmetric energy state constitute the transforming flow of a local gauge symmetry "current".

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", a configuration 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 and the electroweak symmetric energy state).

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 re-calibrate 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 ("asymptotic freedom"). (See: Gross, Politzer, Wilczek: *Science:* 15 October **2004** vol. 306 page 400: "Laurels to Three Who Tamed Equations of Quark Theory.")

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.) (Color charges and their gluons are carried only by quarks - hence this is an internal symmetry which applies only to composite "hadrons": baryons and mesons.)

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 ("Big Bang" or primordial symmetry-breaking), and symmetry conservation via whole quantum-unit 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).

"Gluons" are the field vectors 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 - the "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 due to one-way time and gravitation). 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 inter-convertibility. 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" of 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 the intrinsic motion of 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 spatial 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 living 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).

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

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"Trance, Art, Creativity" An Investigation of the Numinous Element and the Metaphysical Realm. A Book by Prof. John C. Gowan, Sr.
"Operations of Increasing Order" Further Investigations of the Numinous Element and the Metaphysical Realm. A Book by Prof. John C. Gowan, Sr.
"Development of the Psychedelic Individual". A Book by Prof. John C. Gowan, Sr.
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