Global and Local Gauge Symmetries: Part V

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John A. Gowan
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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 (leptons, neutrinos, mesons) 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 symmetry currents (the IVBs

and their associated virtual cloud of alternative charge carriers) 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".)

Note that the electroweak symmetric energy state which the IVBs create has two components - the (global) electric and the (local) weak force component, like the electromagnetic and the spacetime field discussed above. So we can view the electoweak symmetry state as the source state of the local gauge symmetry current, consisting of the alternative charge carriers manifested from the vacuum by the massive IVBs, preserving baryon and lepton number and all other charges (including spin), regardless of the various manifestations of those particle spectra or "families": protons, neutrons, hyperons, and the leptonic series.

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 fractured photon or field vector of a lepton's fractured electric charge.

> We have again a dual entity - the leptoquark - as before (at lower energy) we had the electromagnetic, spacetime, and electroweak fields. In those cases we found magnetism, time, and the weak force IVBs as compensating local gauge symmetry currents ensuring the invariance of electric charge, velocity c, and elementary particles. In the leptoquark case we find the gluon field ensuring whole quantum units of (global) leptonic charge, which sum to the elementary unit of electric charge, despite the composite nature of baryons. We deduce that the leptoquark is in fact an internally fractured heavy lepton, giving rise to the composite class of baryons, thanks to the local gauge symmetry field of the gluons which maintains its various charges in whole quantum units.
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> The other leptons of the (lower energy) leptonic spectrum serve as alternative charge carriers for the mass-carrying barons, thereby avoiding the annihilation reactions certain to occur if antiparticles are used to balance the baryon's charge. Hence internally we have a local gauge symmetry current in the form of a gluon field, maintaining whole quantum unit charges, despite the composite structure of the baryons. In this case, we must regard the leptonic field with the leptoquark as the source global field and the gluon field as the derived local field.
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> Within baryons we have the local gauge symmetry field of the gluons, maintaining whole quantum charge units. It does not matter (to the gluon field) if all "u" quarks are interchanged with all "d" quarks - the gluon strong force remains unaffected by such a (global) transformation, since the binding principle is color exchange, not "flavor" exchange. Similarly, we have another strong force local gauge symmetry current operating between baryons at the organizational level of the compound atomic nucleus, Yukawa's meson exchange field. It does not matter (to the meson field) if all protons and all neutrons are interchanged - the meson field is unaffected by such a (global) transformation, since the meson exchange field consists of "u" and "d" quarks in either case.
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> The Yukawa meson exchange field is curious in that it is maintaining a bound energy state or

"resonance" of lowered total energy between protons and neutrons, in which the exchange of a shared virtual meson field allows each baryon to morph into the other. The shared field allows the baryons to shed some bound energy - the release of this free energy becomes the binding principle (energy debt) keeping them within the nuclear boundary, and lowers the neutron's total rest energy level below the threshold required for "beta" decay. Hence the Yukawa local exchange field is not serving an invariant conservation parameter such as charge, but only a "least bound energy state". The nuclear bond can therefore be physically overcome by raw energy inputs sufficient to replace the lost binding energy (as via a collision). This is not the case for quarks bound within a baron, as the conserved color charge is being served, and must somehow be neutralized (as "in the limit" of "asymptotic freedom" leading to "proton decay", or by the anticolor charge of an antibaryon).

Neutrinos serve as alternative charge carriers of "identity" charge (AKA "number" or "flavor" charge) for the leptonic field, including the leptoquark. Neutrinos are necessary because matter is not paired with antimatter, hence the "hidden" identity charge of the massive leptons must be balanced by an alternative charge carrier with an "explicit" identity charge - the neutrino.

The leptonic charge of elementary particles, the whole quantum unit of charge, we may regard as 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 both spacetime and light.

The strong force color charges and gluons 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 - the invariant metric parameters of Special Relativity), connect global with 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 creates negative energy and entropy but nevertheless observes 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, causality, 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 (in each case there is a neutral condition in which the field effectively or actually vanishes):

Gravitational Transformations

1) "Charge" = 0: free fall, orbit, center of field; (field neutralized by co-mover or self-annihilation; field "actually" vanishes only when bound energy (mass) is completely converted to free energy (light).
2) Gravitational "Lorentz Invariance": co-variance of space and time in a gravitational field (clocks run slow and meter sticks shrink, protecting velocity c, the "Interval", and causality, within the gravitationally "warped" metric. (Global-local transformation)
3) 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).
4) Gravitational deceleration of cosmic spatial expansion; (global-local transformation - expansion of space converted to the expansion of history).
5) 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. Mass and gravitational field vanishes - since light produces no gravitational field.)
6) Creation of planets, stars, galaxies, and megastructure of universe.
7) Negative energy of gravitation allows creation of Cosmos from zero net energy during "Big Bang". This is the primordial rationale for gravitation. (Global-local transformation from global Multiverse to local electromagnetic Universe.)

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 electric charge plus a magnetic field, but a co-mover with the charge sees only the invariant electric charge). (Relative motion of electric charge transformed to magnetic field, leaving electric charge invariant - a consequence of the "Lorentz Invariance" of the dimensions, as is the Doppler effect.)
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 the electric/magnetic charges of atoms. (Global-local transformation: symmetry -> charge -> information -> life).

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" - "nucleons" stabilized; proton stable).
2) Transformations among "number" charges: electron, muon, tau, leptoquark (?); elementary particle creation, destruction, and transformation (quarks, leptons, and neutrinos); "cascade" decays in lepton and quark "families"; 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 Transformations

1) Charge = 0: "white" color charge, only allowed quark combinations = mesons and baryons (ground state atomic matter); (field neutralized). Creation of compound particles (baryons, mesons).
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 of the periodic table.
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 (electromagnetic) form or transformation 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 2-D or 3-D global or absolute, invariant, non-local, spatially symmetric energy states of light, the metric, and the (virtual) charges into 4-D local, relative, variable, temporal, asymmetric energy states of atomic matter, also containing invariant (real) charges. Matter is characterized by inertia, "rest mass", and by motion at less than velocity c; also by magnetism, gravity, time, IVBs and alternative mass and charge carriers, and by quark partial charges confined to "white" whole quantum unit color charges. Matter is a charge-conserved quiescent "maintenance" state; gravity pays the entropy-"interest" on matter's symmetry debt, creating time via the annihilation of metrically equivalent space, decelerating the Cosmic spatial expansion to fund the Cosmic historical expansion. Gravity transforms light's spatial entropy drive (the intrinsic motion of light) to matter's historical entropy drive (the intrinsic motion of time).
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 (bound energy) 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 or metric energy and entropy, transforming space to time (everywhere) 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; the Higgs is also a "metric" particle, which is a quantized alternative form of a unified force symmetric energy state (such as the electroweak force unity state), allowing the creation and transformation of invariant single elementary particles.
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). Fractional charges allow the creation of electrically neutral mass-carriers (heavy analogs of neutrons), necessary to break the primordial symmetry of matter-antimatter particle pairs during the "Big Bang".

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" (= "devil") 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, temporal, asymmetric transformation of an absolute, global, symmetric energy state (the "Multiverse"). The "Big Bang" is the positive energy release consequent upon such a transformation and loss of symmetry, balanced by the negative "binding energy" (gravity) 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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