THE SYMMETRY GROUPS OF LIGHT

(Revised April, 2013)

JOHN A. GOWAN

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Abstract

In the mathematical terms of Evariste Galois' "Group Theory", the "Tetrahedron Model" is a description of the *symmetry group of light*, including its destruction by asymmetric weak force decays (producing our matter-only Cosmos), and its on-going restoration in obedience to Noether's Theorem of symmetry conservation (as in the conversion of bound to free energy in stars). (See diagram: "The Sun "Tetrahedron".)

The usual symmetry group identified with light is that of local phase transformations, and it is designated as either SO(2) or U(1). However, I am suggesting here that light contains a very much larger (and more interesting) symmetry group associated with its transformation into particle-antiparticle pairs (and back again into light). I don't know what the formal designation of this group might be.

For an expert's explanation of the formal aspects of symmetry and group theory see: Keith Devlin *The Language of Mathematics* Chap. 5 "The Mathematics of Beauty", 1998 W. H. Freeman & Co. (Holt Paperbacks); see also: Ian Stewart *Why Beauty is Truth* Chapt. 13 "The Five Dimensional Man", Basic Books 2007. See also: *Symmetry* by Roy McWeeny, 2002, Dover Pub. Inc. (highly mathematical).

A "symmetry group" consists (for one example) of a collection of figures that can be transformed into one another without changing the original. The symmetry group of an equilateral triangle consists of all the triangles that can be created from an original by means of rotation, translation, reflection, etc. - provided the transformed articles are indistinguishable from the original. How do we apply this notion to the case of light? In what sense is there a symmetry group associated with transformations of light (free electromagnetic radiation)?

Beyond the simple phase transformations of the electromagnetic field, the examples of interest here are the particle-antiparticle pairs of the Dirac/Heisenberg "vacuum" of spacetime. These particle-antiparticle pairs are constantly produced from borrowed energy and instantaneously annihilate each other in an endless cycle of creation and destruction alternating between light and virtual particles, a cycle which has been ongoing throughout spacetime since its beginning in the "Big Bang". Since these are "virtual" rather than "real" particles, we do not notice them even though they are everywhere around us. We especially notice the asymmetric forces and particles which surround (and comprise) us: gravity, time, atomic matter, charge. We only notice light because it interacts with asymmetric (charged) matter - including us.

These virtual particle-antiparticle pairs consist of all known (and unknown) species of elementary particles; their creation and annihilation cycles form (along with the aforementioned phase

transformations) the primordial symmetry group of light or free electromagnetic energy. During the "Big Bang", the symmetry of light and its virtual particle-pairs was broken by asymmetric high-energy weak force decays which resulted in the creation of our matter-only universe. Our Cosmos consists of one-half of light's original symmetry group, the matter half. The antimatter half was annihilated along with most of the original matter. Hence the universe around us (including ourselves) is 1/2 of light's original symmetry group revealed in its low-energy, matter-only form: put it together with its vanished antimatter counterpart and you will get back the original light. What we are seeing in the physical objects around us (plants, animals, planets, stars) is the long-term evolutionary consequence of the energy and information contained in the original light and its particle-antiparticle symmetry group, exposed to our view only because its original symmetry was broken (in half), unleashing powerful and inexorable forces which forever seek to restore (conserve) the original whole symmetry. Evolution is ultimately driven by matter's eternal search for antimatter - seen most directly and commonly in the electron-proton pairing - the primordial, powerful, and eternal attraction between positive and negative electric charges. (See: "Light and Matter: A Synopsis of the Unified Field Theory".)

The periodic table of the elements is a basic (and astounding) example of the potential for information contained in (one half of) light's symmetry group. In some sense the elements of the periodic table *are* a symmetry group of light - since they do transform into one another (in stars, via the "W" IVBs and the alternative charge carriers), and when mixed with their anti-particles they return to light. But atoms and elements are themselves already compounded objects. At a deeper level we discover this information content is fractal - beyond the U, D (up, down) quarks of the proton and neutron lies another (heavier) level of C, S (charm, strange) quarks, and beyond them, a still heavier tier of T, B (top, bottom) quarks (see Fig. 3). The three quark "families" are likewise accompanied by three successively heavier levels of leptonic "families": the electron, muon, tau and their respective neutrinos (see Fig. 1). (Leptons, neutrinos, and mesons serve as alternative charge carriers for the quarks and for each other - replacing the original antimatter charge carriers.) The symmetry group of light turns out to be complex indeed (see Fig. 4), a complexity revealed only when its symmetric form is cut in half - like exposing the seeds, cells, nuclei, and DNA of a cantaloupe when we cut in half its smooth and simple spherical surface. (See: "The Particle Table".) (See also: "A List of the Possible Quark Combinations of the Baryons and Their Charges"; See also: "Flavor Combinations of Baryons Containing U,D or C,S Quarks"; See also: "Flavor Combinations of Baryons Containing C,S or T,B Quarks"; See also: "Flavor Combinations of Baryons Containing U,D or T,B Quarks".)

The quark and lepton series (including the neutrinos) are obvious examples of light's symmetry groups, and they will be emphasized here. They can be transformed into other members of their kind (via the "W" IVBs and the alternative charge carriers), and when combined with their antiparticles, restore the light from which they were originally created. But this is not all. *Single* particle transformations within these symmetry groups are (must be) precisely controlled by the weak force IVB (Intermediate Vector Boson) mechanism, such that every electron or other elementary particle created today is exactly the same as those created in the "Big Bang". Going back to the equilateral triangle analogy, the triangle can rotate only through 60 degree "quantum" steps; these fixed points correspond to the fixed mass, spin, and charge of the various elementary particles. The mass hierarchy of the leptons and quarks perhaps corresponds to rotations or scale changes in our triangle analogy. The creation of *single* particles (rather than particle-antiparticle pairs) is especially difficult, and is the sole purview of the weak force and the reason for its elaborate and massive mechanism. The

symmetry group remains constant throughout time, thanks to the weak force transformation mechanism. (The triangle has a "rotation" in time as well as space.) (See: The "W" IVB and the Weak Force Mechanism"; see also: "The Strong and Weak 'Particle' Forces": Part 2.)

And there is more. At the high energy levels of the early "Big Bang", the particle "species" lose their individual identities and combine in ever more inclusive categories - analogously to the biological classification hierarchy of species, genus, family, and order. These particle classes come together as the forces unite (at earlier times and at successively higher temperatures and energy levels): first the electric and weak forces combine, the "electroweak" unification bringing together all the lepton species and (separately) all the quark species into a lepton "genus" and a hadron "genus". At the electroweak unification energy level all leptons can freely transform one into another, and likewise all quarks can freely transform among themselves - having given up their individual identities for a more inclusive "generic" identity. Hence this is a higher energy and symmetry state of force unification, another category of light's symmetry groups (the "electroweak" symmetry group - a simpler group than the ground state, having fewer distinct members: leptons vs hadrons). Indeed, these force-unity states are also fractal, like the three quark and lepton energy levels noted above. There are three of these force-unity states as well, the second being the GUT (Grand Unified Theory) unification level of the combined electroweak and strong force, unifying all the leptons with all the quarks (the "family" group of "fermions" (including leptoquarks) - a further simplification of light's symmetry group: fermions vs bosons). Third and finally, the TOE (Theory of Everything) unification comprising all four forces, including gravity, unites the bosons (field vectors) and fermions (particles) in a single grand electromagnetic energy "order". (See: "The Higgs Boson and the Weak Force IVBs".) In this final state of ultra-high energy and symmetry (seen only at the beginning of the Cosmos in the "Creation Event"), free electromagnetic energy (light) is transformed into bound electromagnetic energy (massive particles), and vice versa, setting the stage for weak force symmetry-breaking and the emergence of the matter-only universe of light's energy and information content (see Fig. 1). The Cosmos we now occupy, consists of light's symmetry group revealed in its low-energy, conserved, asymmetric, bound and temporal form as massive atomic matter, charge, gravity, time, and information. (See: "Symmetry Principles of the Unified Field Theory".)

All the conservation laws and forces of the Cosmos work continuously to maintain, conserve, and/or restore its original symmetric energy state (light), even as the information content of matter evolves (in the biological realm) toward a fractal iteration of its Creator. (See: "Teilhard de Chardin: Prophet of the Information Age".)

Returning the material system to symmetry in the absence of antimatter is the central problem of the Universe, requiring the creation (by gravity) of a new (alternative) entropy-carrying dimension: time. The historical maintenance of charge invariance in a world of relative rather than absolute motion, composed of both light and matter, space and time, is a challenge met by the field vectors of the four forces, which are themselves compounded of matter and anti-matter (or are their own anti-particles) expressly for this purpose. (See: "Global vs Local Gauge Symmetry in the Tetrahedron Model".)

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Cosmic Transformation: Multiverse --> Universe (creation of our Universe as a conserved electromagnetic subset of the Multiverse). Gravitational negative temporal energy balances electromagnetic positive spatial energy; charge balances anti-charge (matter vs anti-matter). The universe is created from a condition of zero net energy and zero net charge: therefore and thereafter the total system must be conserved (must continue to sum to zero net energy and charge).

Before Symmetry-Breaking: "Theory of Everything" ("TOE" - all forces unified).
Planck Era "Order" level: fermions combined with bosons - all electromagnetic (EM) and gravitational energy forms unified.

Group 1 - leptons) Primordial electromagnetic group: *charged* elementary leptons x anti-leptons (see Fig. 1). Electron, muon, tau, leptoquark, plus a neutrino for each (and antiparticles). Only elementary leptonic particles are distinguished by neutrino "identity" charges. Electric charge, "identity" (AKA lepton "number" or "flavor" charge), spin, and left-right handedness (parity) are also present as conserved parameters.

Group 2 - hadrons) Quarks are produced from "leptoquarks" (primordial, very heavy leptons), where they originate as triplets (the leptoquark splits into three subunits) (see Fig. 2). In the primordial "quark soup" they recombine in quark-antiquark pairs (mesons) or again as electrically charged triplets (baryons). Electrically neutral baryon combinations (produced by the "Y" IVBs) persist into the next lower (GUT) energy level.

Energy Transformations: Free (massless) EM energy (waveform) --> particle-antiparticle form of bound (massive) EM energy. Symmetry parameters are transformed to and conserved as charges. *The charges of matter are the symmetry debts of light*. All four physics forces (including gravity) are involved in the conversion of massless light to primordial massive leptonic particles, including leptoquarks.

Elementary particle transformations: Primordial leptoquarks are converted from electrically charged to electrically neutral by "Y" IVBs (see Fig. 1). This transformation is considerably facilitated by the merger of all fermion identities at the TOE energy level. These electrically neutral leptoquarks persist into the symmetry-breaking realm of the "X" IVBs (see GUT Era below). Leptoquarks are the heavy terminus of the leptonic spectrum of elementary particles, split in thirds (the nascent quarks) due to the self-repulsion of its own electric charge in the overly-massive corpus of the particle - setting a natural upper limit to the leptonic mass spectrum.

Higgs(y), "Y" family of IVBs. The Higgs(y) gauges the energy level of the TOE and the "Y" IVBs. The Higgs is to the mass relations of the "particle zoo" what "c" is to the metric relations of spacetime. (See: "Table of the Higgs Cascade".)

During Symmetry-Breaking: "Grand Unified Theory" (GUT - strong and EW forces unified).
Leptoquark Era "Family" level: all fermions combined with one another (= leptons combined with hadrons); bosons separate.

Group 3 - mixed) Leptoquarks - electrically neutral only: particle-antiparticle pairs - 18 possible pairs (18 different ways to create a neutral 3-quark baryon from our given 6 quark flavors); leptoquark

neutrinos and anti-neutrinos are part of this mixed group. This group is important because it permits the asymmetric weak force decays which produce our matter-only universe. (currently no diagram)

Elementary particle transformations: matter-only hyperons created from the asymmetric weak force decay of electrically neutral leptoquarks (mediated by "X" IVBs, with the emission of leptoquark anti-neutrinos). Leptoquarks may be transformed at the GUT level but are first created at the TOE level. (Leptoquark anti-neutrinos are obvious candidates for "dark matter" WIMPS.)

Alternative charge carriers: leptons, neutrinos (carrying electric and "identity" charges); mesons (carrying partial quark charges). Alternative charge carriers act in place of antiparticles, permitting decays rather than causing annihilations. Alternative charge carriers play a crucial facilitating role in breaking the primordial symmetry of light and its particle-antiparticle pairs, and afterward, in balancing charges between matter-only dissimilar charge partners (as in the familiar electron-proton pair).

Higgs(x), "X" family of IVBs. "X" IVBs mediate the asymmetric decay of electrically neutral leptoquarks to hyperons (heavy baryons); "X" IVBs also mediate "proton decay". Higgs(x) gauges the energy level of the GUT and the "X" IVBs. (See: "The Origin of Matter and Information".)

After Symmetry-Breaking, "Electroweak" (EW - electric and weak forces unified):
Matter-only Hyperon Era "Genus" level: all leptons combined with themselves, all hadrons combined with themselves, but leptons and hadrons remain separate from each other (see Fig. 4).

Elementary particle transformations: heavy hyperons decay to less massive and ground state baryons, leptons, and leptonic neutrinos (via the "W" IVB); likewise, the "W" IVB mediates the decay of heavy leptons. Creation, destruction, and transformation of *single* elementary particles (quarks and leptons); transformations (only) of baryons. Baryons may be created or destroyed only at higher energy ("GUT" level).

Higgs(w), "W" family of IVBs. The Higgs "W" gauges the EW energy level and the "W" family of IVBs. (See: "The 'W' IVB and the Weak Force Mechanism"; see also: "The Higgs Boson and the Weak Force IVBs".)

"Rebound" to Symmetry: EM ("Electromagnetic") "Ground State" of "Ordinary" Matter; (EM - all forces separate).
Atomic, Chemical, Information, and Biological Era; Periodic Table elements; "Species" level: electrons, protons, neutrons. Chemical (electron shell) transformations only; all nuclear transformations belong to EW level (above). Rebound phase begins (restoring (conserving) the original symmetric energy state of the universe and light); gravitational creation of planets, stars, galaxies and cosmic megastructure.

Chemical/molecular transformations; electron shell transformations; information transformations; creation of life and the biological realm. Higher-order "emergent" information processing and creation, fractal iterations of fundamental forces, including evolution and creative drives. (See: "The Information Pathway".)

All forces act to return matter to light: fission, fusion, radioactive particle and proton decay, matter x antimatter annihilations, the nucleosynthetic pathway of stars, quasar conversion of gravitational potential energy, "Hawking radiation" of black holes. Note the similarity between the black hole and the initial TOE state, in that gravity is equivalent in strength to, or united with, the other forces (see Fig. 9). Gravity simplifies and completes the mixed partial symmetry groups of matter either through proton decay within a black hole's event horizon, or through the extraction of antimatter from spacetime outside the event horizon, producing Hawking's "quantum radiance", the ultimate fulfillment of Noether's symmetry conservation theorem. (See: "A Tetrahedron Model of the Unified Field Theory".)

The appended diagrams suggest solutions to certain of light's symmetry groups in the format of the "Tetrahedron Model". These diagrams are also intended to illustrate the deep connections between the "Standard Model" of physics and the "Tetrahedron Model" as presented in these web pages.

Many thanks to my dear wife Esther for preparing these diagrams!!

Fig. 1 "The Symmetry Groups of Light: The Leptonic Spectrum". Theory of Everything (TOE) Energy Level - all forces unified.

The leptons are the only truly elementary particles. Leptons are the original symmetry group - all else derives from them (through asymmetric weak force decays of electrically neutral "leptoquarks", the postulated heaviest member of the leptonic spectrum or series). There are two kinds of "normal" or low-energy leptons, a massive series: electron, muon, and tau; and a (nearly) massless "companion" series of neutrinos, one associated with each massive lepton: *ve*, *vu*, *vt*. The neutrinos are the explicit form of leptonic "identity charges", and are a distinguishing feature of the truly elementary particles. Only leptons have associated neutrinos; the sub-elementary quarks have none. The massive leptons also carry identity charges, but in "hidden" form. Leptonic identity charge is strictly conserved (like electric charge), and must remain balanced between left- and right-handed charge vs anti-charge. All matter neutrinos are left-handed, all anti-matter neutrinos are right-handed. Because the hidden charges of the massive leptons also figure in this conservation accounting, and because our universe consists only of matter, the weak force mediation of transformations involving neutrinos is exclusively "left-handed". The weakforce is therefore said to "violate parity"; however, parity would be restored if the universe could contain both matter and antimatter. Number charge is hidden in the massive leptons because they cannot travel at velocity c, and therefore cannot conserve the handed charge.

Leptonic transformations are mediated by the weak force "W" family of "Intermediate Vector Bosons" (IVBs), and always include the emission of neutrino identity charges to balance the hidden identity charges of the massive leptons, should the latter either enter or leave equations or "real" (as opposed to "virtual") spacetime.

"Identity" charge (AKA lepton "number" charge) is the most basic of the several charges of matter which code for the symmetry debts of light. It is the analog in physics of the human soul in metaphysics. It has recently been discovered (see Scientific American April 2013) that neutrinos naturally transform or oscillate into one another as they travel (hence announcing they are in fact a

natural symmetry group); however, they nevertheless react only with their appropriate massive leptonic partner and anti-charge. Neutrino "oscillation" solved the long-standing problem of the "missing neutrinos" emanating from our Sun.

A 3rd type of lepton is hypothetical, the very high-energy "leptoquark", which caps the high-energy mass spectrum of the leptonic series, and provides a necessary link between the leptons and quarks. Leptoquarks exist only at the highest energy of the very early micro-moments of the "Big Bang". The speculation is that this fourth member of the leptonic mass series is simply too massive to be stable, and so splits into 3 subunits (quarks) under the self-repulsion of its own electric charge. Splitting an elementary particle should be forbidden, and so the symmetry/charge conservation laws "in protest" give rise to the strong force, color charge, and gluon field of the quarks, which function to "confine" their fractional charges to whole quantum unit combinations (the baryons and mesons).

As a genuine member of the elementary leptonic mass spectrum, the leptoquark also has a neutrino coding for its identity (*v*Lq). This neutrino is a natural "dark matter" candidate, as it may be very heavy. One anti-leptoquark neutrino should exist for every baryon in the universe, balancing its leptonic number charge. In the universe today, the leptonic symmetry group does not exist with all its antimatter members. Therefore, the full leptonic symmetry group should be regarded as "virtual", theoretical, or as existing only when the early universe still contained its full antimatter complement.

Fig. 1 "The Symmetry Groups of Light: The Leptonic Spectrum

Fig. 2 "The Symmetry Groups of Light: leptoquarks". Grand Unified Theory (GUT) Energy Level - strong and electroweak forces unified.

Perhaps the simplest way to think about the origin of quarks, gluons, and the strong force "color" charge is to imagine they derive from the splitting of a primordial, massive, elementary leptonic particle - a "leptoquark". Such a particle would form the upper limit of the elementary leptonic mass series - in fact it would be so massive that it would be unstable to the self-repulsion of its own electric charge. Splitting its mass and charge into three parts (the quarks) then represents a "survival strategy" to achieve a permanently stable internal home pagemass configuration and charge distribution.

The price to pay for subdividing an elementary lepton is the fractional charges of the quarks, which threaten to violate symmetry and charge conservation if they cannot be cancelled, annihilated, or otherwise neutralized by the whole quantum unit charges of the other members of the elementary particle spectrum. The strong force solves this conservation problem by confining the quarks permanently to whole quantum unit charge configurations (baryons and mesons), by virtue of its peculiar force law, which grows stronger with distance. However, this anomalous strong-force law makes perfect sense in the context of symmetry conservation among fractionally charged subatomic units, for symmetry conservation (charge conservation) is increasingly threatened as these fractional charges separate and attempt to escape as individuals, whereas the conservation threat is reduced as they crowd together at a common center. This behavior produces the phenomenon of "asymptotic freedom" (see: Gross, Politzer, Wilczek: *Science:* 15 October **2004** vol. 306 page 400: "Laurels to Three Who Tamed Equations of Quark Theory"), in which at the limit of mutual proximity, the strong force vanishes completely. Again this makes sense in that the strong force is transmitted by a gluon

field comprised of color-anticolor charges in all combinations, which simply sum to zero when it is physically added up. This vanishing of the (conserved) color charge sets the stage for both "proton decay" (perhaps in the interior of black holes) and the asymmetric leptonic decay of electrically neutral leptoquarks as mediated by the highly compressive forces of the "X" IVBs during the early micro-moments of the "Big Bang" - home pagethe primordial symmetry-breaking reactions that produced our "matter-only" universe.

The pathway to symmetry-breaking (of the original light and its primordial particle-antiparticle pairs) is through the asymmetric weak force decay of electrically neutral and colorless leptoquarks (imagine colorless neutrons), leptoquarks rendered colorless by the immense compressive forces of the "X" IVBs and/or the ultra-high energy density of the early "Big Bang". Electrical neutrality is a necessary prerequisite for these primordial leptoquark particles, if they are to live long enough to undergo a weak force decay (otherwise they annihilate with their antimatter charge partners immediately), which brings us back to the necessity of quark fractional charges for the primordial symmetry-breaking mechanism. This pathway will be broader the more ways there are to create electrically neutral configurations within baryons, which perhaps helps to explain the utility of the three energy levels of quarks, since 6 neutron-like leptoquarks or baryons can be formed within each of the home pagethree "families" of quarks.

The strong force consists of the "round-robin" exchange (at velocity c) of virtual gluons between quarks. Because gluons consist of color-anticolor charge pairs in every combination (except green-antigreen, which is doubly neutral), the quarks are constantly alternating between a red, green, or blue color charge, without regard to their different "flavors" or masses, just as electric charge is insensitive to the different masses of its carrier particles. The great difference between the exchange of virtual photons vs gluons is that gluons attract each other, whereas photons do not. Hence the massless gluons have been compared to "sticky light". It is the attraction of one gluon for another that results in the peculiar strong force confinement mechanism. The gluons and color charges form a natural symmetry group independently of the masses ("flavors") of their carrier quarks, with the baryons and mesons representing a "white" or stable configuration of allowed whole quantum unit charge states, while the leptoquark (as mediated and compressed by the massive "X" IVB) represents a summation and return of the individual quarks and gluons to their original leptonic state, lacking any color charge at all.

Fig. 2 "The Symmetry Groups of Light: leptoquarks"

Fig.3 "The Symmetry Groups of Light: Strong Force "Flavor" Charges.

Like the leptons, the hadrons (particles composed of quarks) are another obvious example of one of light's fundamental symmetry groups. Hadrons occur as "baryons" containing three quarks (like the familiar proton or neutron), including a number of unfamiliar and short-lived "hyperons" consisting of one or more heavy quark flavors. A second form of hadron is the meson, composed of quark-antiquark pairs - the only other type of hadron known to exist (mesons also may contain heavy quark

flavors). Quarks do not exist individually, but only as baryons or mesons. Given sufficient energy, and with the mediation and facilitation of alternative charge carriers (leptons, neutrinos, mesons), most baryons can transform into other baryons, most mesons can transform into other mesons, and most quarks can transform into other quarks. (See: "The 'W' IVBs and the Weak Force Mechanism". However, mesons cannot transform into baryons and vice versa, hence mesons and barons must be considered two distinct subgroups within the hadrons. Within the leptons, we also find two distinct subgroups, the massive, electrically charged leptons vs the chargeless and (nearly) massless neutrinos. All these groups, however, find ways to at least interact with each other with the assistance of the "W" family of weak force IVBs and the services of alternative charge carriers.

The several flavor charges of the massive leptons are associated with and conserved by corresponding neutrinos; neutrinos are simply the "explicit" or free form of leptonic "identity" charges (AKA lepton "number" or "flavor" charges). Leptons are elementary particles, and nature is extremely "picky" regarding the conserved parameters of elementary particles. No massive lepton (such as the electron) can appear, disappear, or be otherwise transformed in any reaction without conserving its identity charge via the emission of a neutrino or antineutrino, or the transfer of its identity charge to another exactly identical particle, or the complete annihilation and cancellation of the particle and all its charges with a corresponding antiparticle.

Unlike the leptons, the individual quarks have no associated neutrino, and they can appear, disappear, and be transformed without the necessity to conserve their flavor charges. How are we to understand this (apparently) fundamental difference between the leptons and quarks? The solution to this puzzle is actually simple enough, when one remembers that quarks are not elementary particles, but sub-elementary particles, and baryons are not elementary either, but are composed of quarks. Both are derived from the leptoquark, which *is* an elementary particle (the massive end-point of the elementary leptonic series), and the leptoquark *is* associated with a leptoquark neutrino, which codes for the identity not only of the original leptoquark, but for any hyperons and baryons subsequently derived from it (in a "cascade" decay, for example). Now recall also the "hidden" number charges carried by the ordinary members of the massive leptonic series, and you will realize that we are confronted with the same phenomenon in the quark flavor charges - they also carry "hidden" number charges, subdivisions of the also-hidden baryon number charge which itself is derived from the hidden leptoquark number charge of its primordial massive ancestor.

Lepton number charge = leptoquark number charge = baryon number charge, and they all have "explicit" free forms as neutrino "identity" charges, and "hidden" forms carried by the massive members of the series. Since baryons always transform into other baryons, its hidden number charge is just passed along from one baryon host to the next. No *single* baryon has ever been seen to simply appear or disappear in any reaction (instead, always as a particle-antiparticle pair); despite extensive and continuing searches, no one has ever seen "proton decay" or the explicit form of baryon number charge - the leptoquark neutrino. Recall also that the reason why number charge is and must be hidden in the massive leptons is that leptonic identity charge is "handed": all neutrinos are left-handed, while all anti-neutrinos are right handed. Handedness is just the way matter identity charges are distinguished from antimatter identity charges. The problem is that this type of charge can only be strictly conserved in massless particles traveling at velocity "c" - so nature simply finesses the conservation problem by "hiding" the handedness identity charge when it occurs in massive particles which cannot travel at light speed. It's like a "virtual charge", not so different from "virtual particles",

which are also quite real but hidden from our view.

In principle, "baryon number charge" can be seen in its explicit neutrino form (as a leptoquark neutrino *v*Lq) only during proton creation or decay, but neither process has ever been observed. The leptoquark antineutrino is an obvious "dark matter" candidate (WIMP), as it may be quite heavy, and one should exist for every baryon in the universe (therefore leptoquark anti-neutrinos should be several times as heavy as a proton, if current estimates of total dark matter energy are correct). Proton decay cannot happen unless the conserved color charge also self-annihilates (presumably via the "X" IVB, or due to the extreme pressure inside a black hole). Hence proton decay either requires the spacetime coincidence of two extremely rare events, or in the case of the black hole, cannot be seen at all.

Fig.3 http//:www.johnagowan.org/tetrahadrons.pdf.

Fig. 4: "The Symmetry Groups of Light: Sub-atomic Particles of the 'Standard Model'".

Fig. 4 shows all the particles of the "Standard Model" as they are known today. All vertices of the diagram will transform into one another with the aid of the weak force "W" family of IVBs and the "alternative charge carriers" (leptons, neutrinos, mesons, virtual particle-antiparticle pairs). These transformations are detailed in various papers on my website such as: "The 'W' IVBs and the Weak Force Mechanism"; "The Higgs Boson and the Weak Force IVBs"; "The Weak Force Identity Charge"; "The Strong Force: Two Expressions"; and "The Particle Table", among others. Suffice it here to say that the weak force rationale is the creation of *single* elementary particles (leptons, neutrinos, quarks) that are in all respects the same as any others of their kind ever created - or that ever will be created. To this end (an obvious desideratum of the conservation laws) the great mass of the IVBs (as gauged by the Higgs boson) recreates the original conditions of energy density in which these particles were first created: the "electroweak symmetric energy state" during the "Big Bang Creation Event".

The electroweak symmetric energy state (the energy density at which the electric and weak forces are joined) consists of a "generic" level of particle identity in which all "species" of leptons are united and can freely transform into one another, and likewise all quarks merge their separate "flavor" identities and may freely transform into one another. Baryon transformations (including hyperons) are therefore possible at the electroweak energy level, but not baron creation or destruction. Baryon creation/destruction is presumed to occur at the next higher energy level of force unification, the GUT level of Fig. 2 and the "X" IVB family (in which leptons and quarks merge their "generic" identities in a combined "fermion family" of the leptoquark era, during which matter is created - probably via the asymmetric weak force decay of electrically neutral leptoquarks.

Recall that this symmetry group is fundamentally asymmetric in that it consists only of matter particles. This fundamental asymmetry is reflected in the universal weak force "parity" violation in which the weak force participates only in left-handed interactions - because it has only matter to interact with (the antimatter all having been destroyed in the "Big Bang"). As indicated in the diagram, we have only one-half of the original symmetry group, with the antiparticles not shown. Antimatter is still abundantly present in our universe, however, but mostly in a virtual state, where it

is essential for all kinds of transformations among particles.

Even the center of our sun is only hot enough to produce transformations involving the U, D quarks of the "A" or lowest-energy vertex in the diagram. Transformations involving the heavy quark flavors occur only in the early universe or in the ultra-high temperatures of our largest accelerators.

Figure 4 is an attempt to represent diagrammatically the connection between leptons and quarks. The leptonic set or "group" is represented by the large triangle, one elementary lepton at each apex (electron, muon, tau), the quark set by the small interior triangles (representing baryons from each quark family), while the leptoquark is shown at a fourth apex (making the figure a tetrahedron). The essence of the relationship is that the quarks are a resonant subset of the leptons. When the original leptoquark is subdivided into three quarks (due to its huge mass), all other nodes in the leptonic set (the elementary particles) respond with similar (but lower energy) subdivisions, producing the three quark families (u,d; c,s; t,b). Within any resonant set, what affects one will, by the principle of sympathetic harmonics, affect all other members of the set. This is why it is so important to recognize the leptoquark as a true member of the leptonic set (with its own neutrino), albeit the highest energy, most massive, most primordial, and most ephemeral member (which vanishes during the "Big Bang"). Sauce for the leptoquark is sauce for all the other leptonic elementary particles, leaving us with three families of quarks in parallel with three elementary leptons.

Fig. 4: "The Symmetry Groups of Light: Sub-atomic Particles of the 'Standard Model'"
http://www.johnagowan.org/tetrapart.pdf

Fig. 6: "The Symmetry Groups of Light: A Universe of Light".

Figure 6 is an idealization of a universe composed only of light, useful for comparison with Fig. 7, the latter showing our universe as it actually is - filled with the asymmetric matter-only residue of the "Big Bang". In Fig. 6 we see conservation laws as they apply to light; however, it is these same laws that produce the asymmetric matter-only universe of our immediate experience as a response to breaking the symmetry of light and its matter-antimatter pairs during the "Creation Event" (or "Big Bang"). *The charges of matter are the symmetry debts of light* (Noether's Theorem). In Fig. 6 we begin to see where those charges come from and what broken symmetries they represent, code for, and conserve. (See: "Symmetry Principles of the Unified Field Theory".)

The three major parameters of light's free spatial form that will require conservation when light (free electromagnetic energy) is converted to matter (bound electromagnetic energy) are: 1) total raw energy; 2) entropy; 3) symmetry. Light's raw energy is conserved as the mass and momentum of particles; light's entropy, which manifests as intrinsic spatial motion (gauged by "velocity c"), creates, expands, and cools the spatial dimensions of the universe, and will be transferred and conserved as time's intrinsic motion (by the action of gravity), creating, aging, and decaying the historical universe. Light's symmetry, which takes two principle forms (virtual charge-anticharge particle pairs, and the inertially symmetric and timeless spatial metric), is transformed to and conserved as the various real charges of matter and the gravitationally warped metric of spacetime. Light's inertial spatial metric is a composite of entropy and symmetry conservation, in which the temporal/gravitational component is completely suppressed at velocity c, as are actual (rather than virtual) massive particles and the

charges they carry. The entire diagram is gauged by the electromagnetic constant "c". Dirac/Heisenberg virtual particle-antiparticle pairs, which are hidden or latent in light and the spacetime "vacuum", represent the original, dormant information content of the Cosmos, waiting to be awakened by the "Big Bang" and the asymmetric decays of the weak force. (See: "Entropy, Gravity, and Thermodynamics".)

In the universe of pure light, energy is only in the form of freely moving massless photons; entropy is only in the form of expanding and cooling space; light's symmetry is expressed through spatial timeless metric symmetry and the equal representation of matter and antimatter in virtual pairs of oppositely electrically charged particles, which annihilate each other as soon as they are formed, restoring (conserving) the perfect symmetry of the light-energy which formed them. This is the fundamental symmetry conservation role of electric charge - preventing the spontaneous conversion of free electromagnetic energy (light) to bound electromagnetic energy (massive particles). Hence in the light universe, there are no massive particles, no gravity, no charges, and no time. The metric is entirely non-local and acausal. All this will change when the symmetry of light and its virtual particle-antiparticle pairs is broken by the asymmetric action of the weak force, producing an excess of matter hyperons from the decays of electrically neutral leptoquarks (via the "X" IVBs). (See: "The Origin of Matter and Information".) (See: Fig. 2, Fig 3.)

Fig. 6: "The Symmetry Groups of Light: A Universe. of Light"

Fig. 7: "The Symmetry Groups of Light: A Universe of Matter"

Fig. 7 shows the universe as we find it today, an asymmetric collection of matter-only particles, atoms, and elements. Unlike Fig. 6, the weak force in Fig. 7 has broken the primordial symmetry of light and its particle-antiparticle pairs - probably via the asymmetric decay of electrically neutral leptoquarks via the "X" IVBs. The Dirac/Heisenberg virtual particle-antiparticles pairs of light and the spacetime "vacuum" constitute the inherent, latent information content of the universe, waiting for the weak force to release it into the explicit form of particles, atoms, and eventually, the elements of the periodic table.

Once light's primordial symmetric energy state is broken, multiple conservation responses are entrained. Light (free electromagnetic energy) is the most symmetric form of energy known, and therefore the most "primitive". Light is two-dimensional, massless, timeless, non-local, carries no charges of any kind, and produces no gravitational field (when in free flight). All forms of energy (possibly excepting gravitation) begin as light and in the end return to light.

Light's raw energy is conserved as the mass and momentum of particles, in accordance with Einstein's famous formula: E = mcc. Light's entropy, which is expressed through light's intrinsic motion "c" (creating, expanding, and cooling space), is transferred to and conserved as time's intrinsic motion (creating, aging, and decaying history). In other words, the spatial entropy drive of free electromagnetic energy is converted to, and conserved as, the historical entropy drive of bound electromagnetic energy. Since matter cannot move with intrinsic (entropic) motion "c", matter's time

dimension must move with a metrically equivalent entropic motion "T". (See: "Spatial vs Temporal Entropy".) The conversion of light's entropic drive to matter's entropic drive is accomplished by gravity, which collapses and annihilates space, extracting a metrically equivalent temporal residue. (See: "The Conversion of Space to Time".)

Light's symmetries are principally conserved in two forms: by charge conservation in atomic matter, and by the inertial forces of the metric, including gravitation; and such effects as "Lorentz Invariance" involving the covariance of space and time, functioning to conserve the invariance of the "Interval" and causality. Gravity conserves both light's entropic drive (by converting space to time), and light's symmetric energy state (by converting bound to free electromagnetic energy, as in the sun, stars, quasars, etc.). This gravitational conversion goes to completion via Hawking's "quantum radiance" of black holes. (See: "A Description of Gravity"; See also: "The Double Conservation Role of Gravity.)

The asymmetric weak force converts light's symmetric particle-antiparticle pairs to matter-only particles during the "Big Bang" - thereby releasing the sleeping "virtual" information content of the universe to the real-time charges of atomic matter. (See: "The Higgs Boson and the Weak Force IVBs".) This particle-antiparticle expression of light's symmetry is converted to atomic charges and conserved through the strict principle of charge conservation. *The charges of matter are the symmetry debts of light* (Noether's Theorem - See: Noether`s Theorem and Einstein's "Interval".) Noether's theorem provides us with a single conceptual mantel under which we can unify all four forces of physics - they all originate as symmetry debts of light. (See: "Symmetry Principles of the Unified Field Theory".)

Electric charge originally functions to annihilate particle-antiparticle pairs, thereby preventing the spontaneous conversion of light to massive particles, and hence protecting light's non-local symmetric energy state. The strong force functions to maintain whole quantum units of charge, so they may be neutralized, cancelled, or annihilated by other elementary whole-charge units. The weak force creates *single* elementary particles that are the same as any other of their kind ever created - or that ever will be created, and provides them with an "identity" charge to ensure the possibility of their timely annihilation by a corresponding antiparticle. The gravitational force conserves both light's intrinsic motion (entropy conservation) and light's metric symmetry and non-local symmetric energy distribution (symmetry conservation), via the conversion of space to time and bound to free energy - as in our Sun. (See: "A Rationale for Gravity".)

The challenge posed to our universe is this: can matter find a pathway to return to its original symmetric energy state (light) in the absence of antimatter? The answer is yes, given the extra dimension of time and the all-conserving force of gravitation. (See: "A Tetrahedron Model of the Unified Field Theory".)

Fig. 7: "The Symmetry Groups of Light: A Universe of Matter"

Fig. 9: "The Symmetry Groups of Light: The Black Hole".

(See: Section II: Introduction to Gravitation; See also: Why Gravity? A Rationale for Gravitation.)

Figure 9 (our last) is a departure from the series of tetrahedrons that in one way or another lead up to it. The black hole is a culmination of nature's conservation laws, in particular the gravitational law, as gravity completely overwhelms and replaces the other forces of physics and the electromagnetic domain of spatial reality.

The black hole is the most bizarre and mysterious of all astrophysical objects - indeed of all objects in nature. We were completely mystified regarding its role, purpose, or conservation goal until Stephen Hawking discovered the process of "quantum radiance": black holes actually have a temperature and (slowly) radiate away their rest mass. Eventually the entire rest mass of any black hole will be converted to radiant energy (light) by "Hawking radiation". In other words, the black hole is the finale of the gravitational quest for symmetry conservation, which begins, as we have seen in Fig. 8, with the stars. Unlike the conversion of mass to light by the usual thermonuclear pathway of stars, "Hawking radiation" is a true quantum interaction involving a kind of "tunneling" from the surface of the event horizon, due to an interaction between the virtual particle-antiparticle pairs of the "vacuum" of spacetime and the extreme gravitational "tidal" forces near the "event horizon".

I have drawn Fig. 9 as a circle/sphere rather than a tetrahedron, because there is only one force present in the black hole - gravity has replaced all other forces, including the electromagnetic metric of spacetime. What we have is a gravitational metric instead, the event horizon consisting of a pure time surface. The event horizon is where the gravitational acceleration is equal to velocity "c" - preventing the escape even of light from the black hole. At g = c, time stands still (one second lasts forever, the time dimension becomes monolithic, replacing space) and meter sticks shrink to nothing (again, space replaced by time), apparently the same condition that obtains at velocity c, but in the latter case we think of time as actually vanishing, as being replaced completely by space. So in a backhanded way, gravity and the temporal metric restore matter to its original symmetric state of intrinsic motion c - "the extremes meet" at the event horizon of the black hole, where the spatial entropy drive of light and the temporal entropy drive of matter become equal. Here we see the temporal metric of gravitation producing an alternative type of symmetric energy state; in effect, the temporal metric is saying: "I can play this metric game, too, and here's what it looks like when I do it my way." The (extreme) gravitational metric causes space (and everything in it) to move at "c", the electromagnetic metric causes only light to move at "c". The gravitational metric is a temporal metric, and we note here that both gravitational space and the time dimension are moving dimensions. In fact, as we have seen (Fig. 8), *a gravitational field is the spatial consequence of the intrinsic motion of time*.

I like to think of the black hole as the end-point of the takeover of the spatial metric of electromagnetism by the temporal metric of gravity. Just as we can think of an ordinary rock as the energy of light transformed to an asymmetric state (matter) and brought to rest - so too we can think of the black hole as the entropy drive of light (light's intrinsic motion) transformed to an asymmetric state (time) and brought to rest. The black hole is a temporal entropy "rock". In the black hole we see time in an actual physical form; it is black because time has completely displaced space and we cannot see into a time surface - it is a perfect "black body" absorbing all the radiation that falls upon it.

It seems likely that "proton decay" is commonplace inside black holes, especially at the central "singularity", where sufficient pressure, symmetrically applied, is available to cause the self-annihilation of the color charge of baryons - the precondition necessary for "proton decay". Hence the black hole may well be filled only with trapped light - removing the problem of the "infinite density" of the singularity.

With matter restored to "velocity c" by the temporal metric outside the hole, and matter restored to light by "proton decay" inside the hole, and "quantum radiance" converting the rest mass of the hole to light, we can begin to understand why nature is so fond of black holes. It is also true that black holes, in the form of quasars, are far more efficient than the thermonuclear fusion pocesses of stars in the conversion of the rest mass of in-falling matter to light. We should also note in closing that the temporal entropy drive of the black hole, being one-way in time, is less symmetric than the "all-way" spatial entropy drive of light. Hence the gravitational conversion of mass to light extends gravity's symmetry-conservation role even to the entropy drive of matter, in complete obedience to Noether's Theorem. (See: "Information in the Holographic Universe" by Jacob D. Bekenstein: *Scientific American* August, 2003 PP. 58-65.)

If the black hole is indeed filled with trapped light, then gravitation and the temporal metric have achieved a common symmetry-conservation goal - the conversion of mass to light - within their own domain. Sharing this information or these trapped photons with the outside world of the electromagnetic metric and arena of space may have limited (if any) value from a conservation point of view - at least from the perspective of the temporal metric. The one-way entropy issue may only be relevant to an observer outside the event horizon. This may help explain the extreme slowness of the radiation release in the Hawking process. Assuming this scenario is correct, we find that the conservation goal of one-way gravity and one-way time are the same - the conversion of mass to light, or bound electromagnetic energy to free electromagnetic energy. So all forces, in the end, lead to the same result. This all makes sense if indeed, as postulated in these webpages, time and gravity engender each other. (See: Section II: Introduction to Gravitation; See also: Why Gravity? A Rationale for Gravitation.)

Fig. 9: "The Symmetry Groups of Light: The Black Hole"

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