The Higgs Boson and the Weak Force IVBs (Intermediate Vector Bosons): A General Systems Perspective (part I)

(A 4x3 (or 4x4) fractal pattern: a hypothetical scenario of force unification)

John A. Gowan home page

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"A man's reach should exceed his grasp..." (Browning)

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Abstract

There is a very good reason why the field vectors of the weak force involve the hugely massive Intermediate Vector Bosons (IVBs) and the associated Higgs boson (while the field vectors of the other forces, the photon, gluon, and graviton, are simple massless energy forms): the weak force is the only force that creates and/or transforms "singlet" elementary particles (single particles without antimatter partners). Single particles cannot be directly produced from the vacuum "zoo" of virtual (and symmetric) particle-antiparticle pairs, as in the case of electromagnetic or strong force particle-pair production (in collisions, for example). Hence some other mechanism for reproducing the original and invariant conserved parameters of elementary particles must be employed.

Single elementary particles created today must be the same in all respects as those created eons ago during the "Big Bang", and the massive and elaborate mechanism of the weak force is the only way to accomplish this imperative of energy and symmetry conservation - the invariance of the mass and charge of all elementary particles, wherever and whenever they may be created. It is also for this reason that the whole weak force transformation mechanism is quantized in terms of the invariant Higgs boson and IVB mass.

The large mass of the Higgs and IVBs actually recreates the energy-density of the primordial environment in which the elementary particles whose transformations they now mediate were originally created. A weak force transformation is in effect a "mimi-Big Bang", reproducing the conditions of the "macro-Big Bang", so that the elementary particles produced by each are the same in every respect. This is the only way such a replication could be accomplished after eons of entropic evolution by the Cosmos. The role of the Higgs is to select the appropriate unified force symmetric energy-density state (usually the electroweak force unification energy level) for the transformation at hand; the IVBs associated with that particular symmetric energy state (the "W" family of IVBs in the electroweak case) then perform the transformation. The Higgs provides the mass scalar for the IVBs and elementary particles (the "particle metric"), the IVBs provide the actual transformation mechanism. (See: "The 'W' IVB and the Weak Force Mechanism".)

Within a particular unified-force symmetric energy state (such as the electroweak), transformations

appropriate to that state are but the natural course of events. At the electroweak energy level, all quark "flavors" are equivalent (and hence readily swapped or transformed), and all lepton flavors are likewise equivalent, but the quark and lepton families do not intermingle. At the next higher "G.U.T." energy level, quark and lepton families also merge their separate identities and exchange flavors. In addition to our electromagnetic "ground state", there may be three higher unified force energy-density levels: the electroweak, the "G.U.T." and the "T.O.E.", each with its own Higgs boson ("H1", "H2", "H3") and associated IVB "family" ("W", "X", "Y"). (See: "Table of the Higgs Cascade".)

Introduction

Because it is responsible for the creation and transformation of elementary particles and matter, the weak force is the most important - and the most mysterious - of the four forces of physics. In this paper I model the weak force (with associated Higgs bosons) in its full energy spectrum, which spans three symmetric energy states or force unification domains. We are used to thinking of the weak force only in its lowest energy manifestation of "radioactive" nuclear decay, or element building in stars, reactions mediated by the "W" family of Intermediate Vector Bosons (IVBs) of the electroweak (EW) unified force level. However, the weak force also has two (hypothetical) higher energy manifestations at the "Grand Unified Theory" (GUT) energy level (strong force unification level) and the "Theory of Everything" (TOE) energy level (gravitational unification or Planck scale energy level). These higher energy force-unification domains or symmetric energy states are mediated by the "X" and "Y" IVB weak force families, respectively. We therefore propose a tri-level mass hierarchy in the weak force IVB families ("W", "X", "Y") that parallels the three-family mass hierarchies seen in the quarks, leptons, and neutrinos.

It should be easier to understand and appreciate the functional activity and role of the weak force (and its associated Higgs bosons) when seen in its full-spectrum array than when glimpsed, as usual, only in its partial, low energy, electroweak domain. Whereas at the electroweak energy level the "W" IVB creates single leptons and mesons (and transforms, but does not create, single baryons), the "X" IVB at the GUT energy level creates single baryons (transforming but not creating leptoquarks), and the "Y" IVB at the TOE energy level creates leptoquarks (including the crucially important electrically neutral leptoquarks), transforming but not creating primordial heavy leptons or "Ylem". Without the "X" and "Y" IVBs, we have no source for either single baryons or electrically neutral leptoquarks, so we need them both. The primordial heavy leptons or "Ylem" (Gamow's term) are evidently created by a group effort involving all four forces, with gravity playing a major role.

It should also be noted that not only does the weak force play an essential role in the devolution of our Universe from the Multiverse to its electromagnetic (EM) "ground state" (as driven by entropy and the intrinsic motion of light), but also figures prominently in the reverse process, the evolutionary "rebound" (as driven by symmetry conservation and the negentropic intrinsic motion of gravity) toward our Universe's original symmetric energy state in the Multiverse (progressing through stars, black holes, and the "Big Crunch"). Thus the full range of weak force activity encompasses both the creation and destruction of matter, and the breaking as well as the conservation of symmetry. The weak force model presented below has the 4x3 and 4x4 form of other General Systems models presented on this website (see: "Introduction to General Systems").

A Hierarchy of Force Unification

(See also: "The Mysteries of Mass" by Gordon Kane, Scientific American, July 2005, pp. 41-48)

In our "ground" electromagnetic state, we do not find a Higgs boson or an IVB; they are characteristics of the higher energy levels of force unification (H1, H2, H3) (see: "Table of the Higgs Cascade"). However, we can suggest analogs. The photon is the ground state analog of the

Higgs boson; the spacetime metric is the analog of the Higgs boson's regulatory function. The photons establishes the EM spacetime metric; the Higgs I boson establishes the EW "particle Metric". The two metrics are not strangers and continue to work together seamlessly in the EM ground state because they were once joined as part of the same regulatory metric at the EW energy level. In our ground state, the spacetime metric confers upon the photon a type of entropy-energy, an invariant and specific "intrinsic motion", gauged as "velocity c", which is also a symmetry condition of "non-locality". Similarly, at the H1 energy level, the Higgs 1 scalar boson confers upon the IVBs an invariant and specific mass, gauged at about 81 proton masses (for the "W" IVB), which is also a symmetry condition of electroweak (EW) force unification. Among other conservation roles, the spacetime metric functions as a symmetry gauge for massless free energy and inertial forces; the Higgs boson functions as a symmetry gauge for massive particles and force unification. Like all particles, the quantized Higgs and IVBs are creations of the "energized" spacetime metric as it interacts with the four forces of physics.

In the electroweak unification scheme, the photon is the 4th member of the electroweak family of bosons (force-carriers), the other three being the "W+", "W-", and "Z" neutral. Both photon and the other HiggsHiggs 11 IVBs have access to the same vacuum "sea" of virtual particle-antiparticle pairs. The great difference between them is that:
A) the photon can have virtually any energy, whereas the "W" IVB is quantized to a single specific energy of (approximately) 81 GEV (the energy level of EW force unification); (the Z neutral mass is about 91 GEV).
B) the photon can only create and destroy particle-antiparticle pairs, whereas the "W" IVB can create, destroy, and transform "singlet" (unpaired) elementary particles.

The spacetime metric acts as a regulatory mechanism, not only with respect to the entropy drive and "non-local" symmetric energy state of free energy (all photons travel only at "c"), but also with respect to the mass and charge of elementary particles created by photons in particle-antiparticle pairs (the "particle metric" imposed upon Heisenberg/Dirac virtual particles, bound energy generally, and the creative potential of the vacuum "zoo" or "sea"). No virtual particle or particle pair can be materialized from the vacuum "sea" as a "real" particle unless it meets the universal and invariant standard for the mass and charge of that particle. (The invariant value of Planck's energy constant *h*, the invariant magnitude of the electric charge e, and the invariant value of Newton's universal gravitational constant "G", are (among others) also determined by this regulatory mechanism.) This standard is evidently established during the "Big Bang" and forever afterward maintained by some regulatory aspect of the spacetime metric, a characteristic which is also seen with respect to elementary particle mass through the scalar function of the Higgs, and which also like the Higgs, finds its rationale through symmetry, charge, and energy conservation. This same metric regulatory function extends to the mass of the IVBs and Higgs in the higher energy levels of force unification, as different types of symmetry come into play (the three force-unification symmetric energy levels - H1, H2, H3, with their associated IVB "families": "W", "X", "Y"). The gateway to temporal reality for single, unpaired particles is strictly regulated by the weak force and its quantized conservation mechanisms.

(For a discussion of CERN's Large Hadron Collider see: *Science*, 23 March 2007, page 1657-8.)
(See also: *Science* 9 March 2012 Vol. 335 page 1159: tevatron data hints at Higgs mass of approx. 125 GEV.)

A 4x3 Pattern of Force Unification

The weak force IVBs (Intermediate Vector Bosons), plus their associated "Higgs" (H) bosons, form a 4x3 (or 4x4) "matrix" or pattern that complements the fractal description of the Cosmos at high energies, essentially

describing the weak force creation of matter. The four-part IVB-plus-Higgs pattern occurs in three energy levels or unification regimes (4 "metric" weak force bosons in 3 symmetric energy states), above a fourth level electromagnetic (EM) "ground state". The "ground state" is the decay product of the "Electroweak (EW) Era". (See also: "Nature's Fractal Pathway".) Note in this regard that the quark and lepton "families" also occur in a hierarchy of three energy or mass levels above the ground state photon. The "metric" particles of the weak force (the IVBs and the Higgs boson) seem to be an analogous tri-level energy or mass hierarchy. All decay to the "ground state" of our familiar spacetime metric and the photon, or charge-carrying electrons and protons (in the absence of antimatter).

Perhaps a more familiar analogy from the hierarchy of biological classification will be helpful (species/genus/family/order). At the ground state electromagnetic level we find completely separate and stable elementary particle "species". At the electroweak level we find the several quark species joined together in their own "genus" (hadrons), and likewise the several electron and neutrino species joined together in another genus (the leptons). At this electroweak energy level, transformations may occur within "genera" but not between genera, and single quarks, leptons, and mesons can be created and destroyed, but baryons can only be transformed. At the GUT level we find the hadron and lepton genera joined together in a "family" (the fermions), and the field vectors (except gravity) joined together in another family (the bosons). Now transformations may occur within the "family" level but not between families (creating and destroying single baryons but not yet creating leptoquarks). At the final level of force unity, the TOE level, we find the fermion and boson families (including gravity) joined into an "order" (encompassing all free and bound forms of electromagnetic energy - Gamow's "Ylem"), in which transformations between all types of particles are allowed, creating and destroying leptoquarks (primordial leptonic elementary particles split into three quark components). This is the primordial creation of mass from light or bound electromagnetic energy from free electromagnetic energy. The role of the "Y" IVBs is to split the primordial leptons into tripartite leptoquarks, some of which will be electrically neutral (heavy analogs of neutrons).

IVB "Family" Symmetric Energy Levels

Immediately above the Chemical Era or EM "ground state" of historic spacetime, photons, biology, and cold, atomic matter, is the first IVB "family" level consisting of the W+, W-, and W neutral (or Z neutral), which is associated with the first-level Higgs boson, "H1" (Nuclear Era). This is the energy level of the electroweak (EW) unification, in which all transformations mediated by the "W" IVBs are continuously ongoing (quark-quark and lepton-lepton transformations). This is the level of unification within the lepton and hadron "genera" separately, but not between them. In addition, the photon and the IVBs are indistinguishable at the EW unification level: at an energy density of 90 proton masses, photons and the "Z" IVB are one and the same thing. When this H1 state decays to the EM ground state, light and the IVBs separate (the photon's wave form becomes dominant over its particle form), and the mesons, leptons, and neutrinos (alternative charge carriers) spill out as separate quanta like fruit from a cornucopia. (See: "The Particle Table".) The elementary quark and lepton quanta exist in three families each of four particles, a basic example of a 4x3 and 4x4 resonant, repeating, fractal pattern found throughout the material phenomena of our Cosmos (including, most fundamentally, the 4 dimensions of the spacetime metric). (See: "Table 1: The Fractal Organization of Nature".)

Neither the photon of the electromagnetic force, nor the "EW" level IVBs of the weak force, carry the charge of their respective forces, electric charge and "identity" charge, even though they are the field vectors or force carriers of those forces. In the case of the photon, its electric charge is neutralized by an exactly compensating magnetic field, and the action of the photon field vector is accomplished by a transfer of pure energy or momentum. The photon's electrical neutrality allows it to range freely through spacetime; if the photon itself carried charge, it would be as restricted in its activities as an electron. In the case of the "EW" family of IVBs, their charge neutrality (with respect to the "identity" charge) allows them to mediate the transformation of a variety of different charges - electric, identity, color, and spin - all via virtual particle-

antiparticle pairs which "piggyback" on the massive IVBs. This "lack of agenda" with respect to identity charge allows the EW family IVBs to perform all the various transformations of the lepton and quark families, including those involving heavy leptons, neutrinos, mesons, and baryons (single baryons can be transformed but not created or destroyed at the EW level). (See: "The 'W' IVB and the Weak Force Mechanism" (pdf); also available in html format: The "W" IVB and the Weak Force Mechanism (html).)

The second IVB "family" level (Leptoquark Era) is the unification level of the GUT (Grand Unified Theory), in which the strong force and electroweak force are unified. This second (hypothetical) IVB family consists of the X+, X-, X neutral heavy bosons, associated with a second-level Higgs boson, "H2". Whereas the E/W level IVBs transform one quark to another and one lepton to another (including the creation and destruction of leptons and mesons), the GUT level IVBs can also transform quarks to leptons (including the creation and destruction of single baryons). This is the level of electrically neutral leptoquarks, the union of leptons and quarks. "Proton decay" is a GUT level process, which is why we never see it (the "X" IVB is prohibitively massive). Single hyperons and baryons originate at the "GUT" IVB level, leptons at the "EW" IVB level. Only chemical combinations originate at the "EM" or "ground state" energy level. (See: Howard Georgi: "A Unified Theory of Elementary Particles and Forces," *Scientific American*, Vol. 242, No. 4, April, 1980, page 104+.)

The third "order" of IVBs (also hypothetical) are at the TOE (Theory of Everything) level of unification, in which gravitation is added to complete our 4x3 fractal scenario of force unification (Planck Era energy-level unification). We may designate these third-level IVBs as: Y+, Y-, Y neutral, associated in turn with a third-level Higgs boson, "H3". Particle mass, including primordial leptons and leptoquarks, originate at the H3 energy level. Whereas level two (H2) may be seen today in proton decay (possibly a commonplace in the interiors of black holes), level three (H3) unification exists only at the very beginning or ending of the Cosmos (the "Big Bang" or "Big Crunch") (the conjoining or dissolution of gravity, spacetime, and particles, positive and negative energy). Black holes do not qualify for level 3 because of their partial and extended nature. The Universe does not begin as a black hole, but as an explosion of spacetime and energy, due to its initial matter-antimatter symmetry and consequent annihilation reactions; nor is there any spacetime external to its "horizon".

The entropy-driven (expansion and cooling) decay phase of level 3 to level 2, in which gravity and the spacetime metric separate from the primordial mass-carrying leptoquarks, may be described by the "inflationary" scenarios of Alan Guth and Andre Linde. Although I don't know what to think about this highly mathematical theory, it certainly describes a bizarre spacetime with which we have no familiarity (a supercooled "false vacuum" with "repulsive gravity"), and *if* it belongs anywhere in the "Higgs Cascade" model, it would either have to be here, or possibly at the even earlier stage of the separation between our Universe and the Multiverse. In my view, "inflation", if it exists at all, may simply represent the actual destruction of the spacetime metric by the too-violent explosion of the "Big Bang". Inflation ends (in this scenario) when the initial energy input has expanded and cooled to the point that our familiar spacetime metric can accommodate and regulate it. There are, however, other ways to produce the observational effects which motivate the theory of "inflation" (see: "A Spacetime Map of the Universe").

The "Higgs Cascade" is driven by entropy, which in its primordial form consists of the intrinsic motions of light, gravity, and time, as "gauged" or regulated by c, G, and T. (See: "Spatial vs Temporal Entropy".) The activity of the graviton, the field vector of gravity, is essentially the inverse of the photon, collapsing and heating space rather than the reverse. The intrinsic motion of the photon is the entropy drive of free energy, producing space and the expansion and cooling of space. The active principle of the gravitational "location" charge is time, which has its own intrinsic motion as the entropy drive of bound energy (at right angles to all three spatial dimensions), producing the expansion and aging of history. *A gravitational field is the spatial consequence of the intrinsic motion of time*. (See: "Entropy, Gravity, and Thermodynamics"; see also The Conversion of Space to Time".)

The Role of the "Y" IVBs

The role of the "Y" IVB is to split the primordial massive leptons ("Ylem") into 3 quarks, producing leptoquarks, some of which will be electrically neutral. Neutral leptoquarks survive to the H2 level, where the "X" IVBs proceed with an asymmetric weak force decay, resulting in a residue of matter hyperons and leptoquark antineutrinos. Because the sub-elementary and fractionally charged quarks with their associated gluon field seem to further an agenda of manifestation rather than conservation (the latter function being better served by (much) simpler massive elementary leptons with whole quantum unit charges), the primary rationale for the "Y" IVBs appears to be the production of electrically neutral leptoquarks from their charged congeners.

Exactly how these primordial leptons and leptoquarks are created is of course unknown, but according to the logic of our table, their creation requires the participation of gravity, which is to say, a heavily compressed spacetime metric. Since the IVB families all seem to work by a form of metric compression or density, and the "Y" IVB is the most massive of them all, it seems likely that the "Y" IVB acts, along with gravity, to produce bound energy (particles) from free energy (waves in the metric) through extreme compression of the spacetime metric. Because the metric is apparently quite capable of creating quarks all by itself (as meson pairs in high-energy collisions, for example), it seems the contribution of the "Y" IVBs to the group effort (of all the forces) in the production of mass-bearing leptoquarks is one of organization and transformation. As modeled here, the compressive force of gravity acting upon the spacetime metric at the H3 energy level supplies the primordial electrically charged heavy lepton, which the massive "Y" IVB splits or otherwise organizes into three parts (quarks), perhaps using the resources of the "quark soup" or "Ylem" of the H3 energy level. Note that, as part of the H3 "particle metric", quarks and leptons are already present in the metric (at least potentially/virtually), as gravity and the "Y" IVBs compress it into quantum particle "packages". Subsequently, the "Y" IVBs further transform the charged leptons/leptoquarks into electrically neutral leptoquarks (much as the W+ IVB of level H1 transforms a proton into a neutron), sending them down to the H2 (Leptoquark Era) energy level.

Once formed, these neutral leptoquarks survive long enough to enter the cooler H2 domain. Their necessary electrical neutrality, which is anomalous with respect to the lower energy members of their leptonic family (electron, muon, tau), is probably due to a selection process (only the neutrals survive annihilation reactions to reach the H2 energy level). Electrical neutrality is necessary to break the symmetry of the primordial matter-antimatter particle pairs, which is why the primordial mass-carrier (the leptoquark) must be a composite particle, able to arrange the partial charges of its quarks into an electrically neutral configuration (like a neutron).

(at least potentially/virtually) Electrically neutral leptoquarks flow out of the H3 domain to the H2 energy level (as the universe expands and cools), where they may live long enough to be asymmetrically attacked by the "X" IVBs, rather than undergo the more usual matter-antimatter annihilation reactions (which is why their electrical neutrality is so necessary to this whole process - to allow enough time for weak force asymmetric decays to occur). While all this is of course speculative, it is currently the best I can do to set the stage for baryon genesis via the "X" IVBs of the H2 energy level. The H3 energy level, utilizing an unknown process requiring the cooperative effort of all the forces, acts as a leptoquark "factory", with the "Y" IVBs sending electrically neutral leptoquarks down to the H2 energy level.

The cascade passes from leptoquark genesis (H3) to baryon genesis (H2) to lepton genesis (H1) to atomic/chemical genesis (H0 - ground state). While we do not understand the cascade in detail, something very like it must have happened or we would not be here to wonder about it. The real wonder is that the spacetime metric is prepared to produce and accommodate the conservation needs of such a large variety of particles and charges - leptoquarks, quarks, leptons, mesons, baryons, neutrinos, and their charges and field vectors (including the heavy flavors of quarks and leptons and neutrinos) - and these are just the ones we

know about. Despite this variety, they are no doubt the bare minimum required to produce our universe. All particles, charges, and forces are united by, and originate in, the spacetime/Higgs metric. This metric is a conservation structure which is energized by the electromagnetic and gravitational energy input of the "Creation Event", converting free energy into fully conserved combined forms of free plus bound electromagnetic and gravitational energy.

In the H2 energy level, the "X" IVBs compress the baryon combinations so powerfully that their color charges sum to zero and vanish (in the limit of "asymptotic freedom"). A few of these electrically neutral and colorless leptoquarks will survive long enough without annihilation by their antipartners to undergo (alone) a weak force leptonic decay, exactly like a heavy lepton, via the emission of a leptoquark neutrino (or antineutrino), with the mediation of the "X" IVB (this is also the probable pathway of "proton decay"). Such a single decay isolates its former annihilation partner, which in consequence can only expand its quarks and become a hyperon, at which point it is stabilized by the explicit appearance of the conserved color charge and gluon field. Because of an inherent asymmetry in the weak force with respect to matter-antimatter reactions, greater numbers of electrically neutral matter leptoquarks are isolated from their earstwhile antimatter annihilation partners, and so survive to expand their quarks (in a rapidly expanding Universe), becoming the hyperons (heavy baryons) of the H1 level, where they decay further via the "W" IVBs and their alternative charge carriers (leptons, mesons, neutrinos). These final H1 decays produce ground state protons and electrons, which eventually form atoms. Much later, during the symmetry-conserving "rebound" phase of cosmic evolution, galactic systems with life forms, including us, are created via the negentropic action of gravitation. (See: "The Origin of Matter and Information".)

Each step of the "cascade" exists only because of the activity (perhaps in the past) of the next higher energy level. Just as the chemical realm depends for its existence upon the atomic nucleus, so the biochemistry of life depends upon the H1 energy level operating through weak force transformations in the stars, enabling the nuclear fusions which produce not only heat and light, but create the chemical elements from which living beings are made. Similarly, the stars and their elemental factories depend upon the creation of matter-only baryons at the H2 energy level of asymmetric leptoquark decay. Finally, leptoquarks themselves depend upon the primordial conversion of free to bound forms of electromagnetic energy via the combined action of all 4 physical forces. On the macro-scale, this stage is seen in the "Big Bang" production of spacetime, matter, and energy. Hence we recognize also the effects of our dimensional reality - space, time, and gravity - upon our daily existence as well as our evolutionary history; and we are reminded of the presence of the four forces and charges of physics, embedded in the micro- and macro- structure of the Cosmos, conserving the energy and symmetry of our Universe. Ultimately we must look even further, to the Multiverse, for the source of energy, information, and the physical constants which characterize, activate, and conserve our "life friendly" universe. This is to acknowledge the supreme importance of Natural Law in the ordering of the Cosmos and our experience of it.

Summary

The three IVB species, the "Y", "X", and "W", are all "metric" particles composed of the dense metric of their respective force unification realms, and all function by means of compression. The IVB role (in the case of the "X" and "W" IVB families) is the creation of "singlet" bound energy forms (quarks, mesons, baryons, leptons, neutrinos) peculiar to the IVB's particular force unification level or symmetric energy state, as well as the transformation of "singlets" to the next lower force unification level. Similarly, the "Y" IVBs produce electrically neutral leptoquarks from primordial charged leptons and quarks (Gamow's "Ylem"), which they send down to the H2 energy level, where the "X" IVB family takes over their decay. The IVBs provide a "lawful" conservation pathway for the decay "cascade" of energy in the material system from the "Big Bang" through three force unification regimes of decreasing symmetry and energy (but increasing entropy) to the electromagnetic "ground state" of cold atomic matter. The "Y" IVBs create electrically neutral leptoquarks, helping to create particle mass (with the aid of gravity, electromagnetic energy, and the spacetime/Higgs

metrics); the "X" IVBs asymmetrically transform neutral leptoquarks into heavy baryons (hyperons) and leptoquark antineutrinos, creating matter; the "W" IVBs create alternative charge carriers from the "vacuum", transforming hyperons, neutrons, and heavy leptons into ground state protons and electrons. At the "ground" state EM energy level, photons, gravity and time create large-scale historic spacetime, and protons and electrons create atomic matter, chemical information systems, and eventually life itself.

The "W" IVBs (H1 energy level) combine virtual particle-antiparticle pairs (from the spacetime metric, the Heisenberg-Dirac "vacuum") with "real" particles in a "bear hug" embrace that allows them to exchange charge and energy without offending the conservation laws. The "X" IVBs (H2 energy level) compress the quarks of baryons and leptoquarks until their color charges (which are carried by gluons in all possible color-anticolor combinations) sum to zero color and self-annihilate in the limit of "asymptotic freedom" (see: "The Origin of Matter and Information"). The "Y" IVBs (H3 energy level) compress primordial leptonic and quark particles (provided by super-dense gravitational/spacetime/Higgs metrics) so powerfully that bound energy is converted to massive leptoquarks. Particles acquire mass during the time they are conjoined with all aspects of electromagnetic energy, the Higgs particle metric, and the gravitational metric of spacetime (H3 energy level). The gluon field of "sticky light" arises as a consequence of symmetry conservation, permanently confining quark partial charges into whole quantum charge units that can be balanced, canceled, and/or annihilated by other elementary leptonic charges or alternative charge carriers. Gluons appear to be a form of "split light", or split electromagnetic field vector (photons), consequent upon the splitting of an elementary leptonic particle and its unit electric charge into sub-elementary quarks with fractional charges. (Quarks are necessary subdivisions of the primordial mass carrier, allowing it to achieve electrical neutrality (like a neutron), and so survive long enough to undergo an asymmetric weak force decay, producing the atomic matter of our Cosmos.)

The common mode of action of the three IVB species (metric compression, or the re-creation of the dense metric of a specific force unification symmetric energy state), and the fact that all three have distinctly different but necessary parts to play in the creation of atomic matter - the creation of electrically neutral leptoquarks ("Y" IVBs), the asymmetric creation of single baryons ("X" IVBs), and the creation of single leptons and other alternative charge carriers ("W" IVBs) - lends a strong plausibility to the hypothetical "Higgs Cascade" outlined above. The "W" IVB level is experimentally observed fact. While the "X" and "Y" IVB levels are hypothetical, we obviously have to find a source for baryons and their constituent quarks somewhere. (The same argument holds with respect to the "Multiverse" in the case of our life-friendly "given" physical constants - such as c, G, e, h, etc.) The "Higgs Cascade" at least provides a consistent hypothesis and "reasonable guess" as to these origins. No one expected or predicted the three mass-energy levels of the lepton and quark "families", and we still don't know why they exist (when one level would seem to be sufficient). The (postulated) three mass-energy levels or metric "families" of the Higgs and IVBs may be another example of Nature's penchant for tri-level energy hierarchies or resonant forms, but at least in this case we can suggest plausible/practical reasons for its existence (for example, the three symmetric energy states of progressively more inclusive force unifications, in addition to the respective origins of (and relationships among) leptons, baryons, and quarks).

Finally, we should note that it is the weak force that brings the asymmetric material world into existence, including ourselves. Reality as we experience it is just that form of electromagnetic energy which can be conserved in space and time, whether bound (massive, temporal) or free (massless, spatial). While the origin of energy itself and the "Big Bang" Creation Event will probably forever remain articles of faith for either science or religion, the lesser miracle of matter is contained in the conservation functions of electromagnetic energy and the spacetime/Higgs metrics.

For a commentary on the meaning and role of humanity in the Cosmos, see: "The Human Connection"; also: "Teilhard de Chardin, Prophet of the Information Age"; and books on my father's memorial website: "Trance, Art, and Creativity".

The mass of the Higgs boson is probably not much greater than the mass of the IVBs of its associated family. That, at least, would be our expectation from this model, since the Higgs boson is the scalar gauge of the energy density or force unification symmetric energy state which the IVBs represent and sample. The role of the Higgs boson is to gauge or scale the IVBs to the appropriate force unification energy level at which the desired transformation is simply a normal characteristic of the symmetric energy state (all "species" within a "genus" are equivalent, etc). The quantized IVBs perform the required transformation; the quantized Higgs ensures the proper scale and hence invariance of the product - an invariance, as we have seen, obviously essential for charge, symmetry, and energy conservation.

Postscript I:

Connections Between the "Tetrahedron Model" and "Establishment" Physics

Most of my effort toward unification has been concentrated on the "rebound" phase of the Universe, as we find it today, driven by gravitation, symmetry conservation, and evolution, simultaneously building complex structures (both physical and biological), and returning asymmetric matter to its original symmetric state, light. Conversely, most of the effort of the "establishment" toward unification has been concentrated on the "cascade" phase of the Universe, the stepwise descent from the perfect symmetry of the Multiverse and Planck scale unity, as the forces decoupled from one another in an entropy-driven rush toward our familiar electromagnetic "ground" state. The electromagnetic "ground" state is the common domain from which we both started, but I worked forward in time toward the ultimate symmetry of the "Big Crunch", while the "establishment" worked backward in time toward the ultimate symmetry of the "Big Bang". "My" symmetries are mostly intuitive, involving the long-range forces and the macro-world, and (in general) ignore theirs; "their" symmetries are mostly mathematical, involving the short-range forces and the micro-world, and (in general) ignore "mine". Nevertheless, the two systems are neatly joined by the synthetic power of General Systems, both expressed in a 4x3 and 4x4 matrix format. (See: "A Simple 4x4 Table of Forces and Energy States of Physics".)

The micro-world of the Big Bang, symmetry groups, and the weak force in its full energy spectrum and General Systems format is presented in this and the other "Higgs Cascade" papers. The macro-world is modeled in a General Systems format in such papers as "The Information Pathway", "The Fractal Organization of Nature", and "Nature's Fractal Pathway". The general principles of physical law which underlie all our unification models, whether intuitive, mathematical, macro, or micro, are explored (also in a General Systems format) in the papers "Symmetry Principles of the Unified Field Theory (a "Theory of Everything") - Part I and "A Tetrahedron Model of Light and Conservation Law". The interaction between non-local light and local matter is considered in the "Global vs Local Gauge Symmetry" series of papers, which also suggest connections between my work and "establishment" unification models through the common theme of *charge invariance*. The joining of both micro and macro unification models within a common General Systems model illustrates once again the synthetic power of General Systems, as well as the great value of investigating a common problem from more than one direction and perspective. (See also: "The 'Tetrahedron Model' vs the 'Standard Model' of Physics: A Comparison".)

Postscript II: See:

Higgs Table No. I: Unified Force Eras or Symmetric Energy Levels of the "Big Bang"

Addendum and Recapitulation
(added May, 2012)

In the Beginning

In the primordial crush of the "Big Bang", when all forces are joined in the conversion of light to mass, or free to bound electromagnetic energy, both gravity and the "Y" IVBs apply compressive force to the initial state of energy, producing a primitive, heavy, leptonic elementary particle. As the weak force representative in this 4-force "scrum", the "Y" IVBs provide the all-important identity charge, and split the primordial "Ylem" or leptonic material into 3 subunits, the nascent quarks. In splitting the leptonic material into 3 quarks, the "Y" IVBs are probably aided by electrical self-repulsion between relatively distant parts of this overly massive lepton - an effect which sets a natural upper mass limit to the elementary leptonic spectrum. Most of these leptoquarks will be electrically charged, and immediately annihilate each other. However, some will be electrically neutral (heavy analogs of the neutron), and will live long enough to pass on to the next lower force-unity energy state (the GUT) where they may undergo a typical leptonic decay mediated by the "X" IVB, with the (net) emission of a leptoquark antineutrino, conserving and balancing identity charge. The special character of the "X" IVB decays is their asymmetry, with antileptoquarks decaying slightly faster than leptoquarks. Neutral leptoquarks thus deprived of an annihilation partner can only expand their quarks and become heavy barons (hyperons). Such baryons are stabilized by the appearance of the conserved color charge, which emerges as the quarks expand to typical baryon size; the conserved color charge prevents any further (total) baryon decays at energies less than the "X" IVB can provide. However, partial decays (transformations) of the baryons are possible via the "W" IVB family at the next lower EW (electroweak) force-unity level. The compressive forces of the massive "X" can still cause proton decay on rare occasions. (See: "The Origin of Matter and Information".)

After the Beginning

Above the electroweak critical or condensation temperature, the electric and weak forces are joined in the electroweak symmetric energy state. The energy density of the universe at this time would be greater than that of an atomic nucleus; in the electroweak symmetric energy state all leptons are equivalent and all quarks are equivalent. There is no spacetime as we know it (with freely moving photons) in such a dense medium; photons mediate electric charges, but otherwise they are trapped. Below the condensation energy the photon goes its separate way, gauging and creating spacetime (the "spacetime metric"). The Higgs remains at the electroweak force-unity energy level, gauging matter (the "particle metric"), determining the mass of the weak force bosons (the IVBs), and through the IVBs, determining the mass of the elementary quarks and leptons. The Higgs establishes a "particle metric" just as the photon establishes a "spacetime metric": in both cases the purpose of these domains is the conservation of their respective energy forms, whether massive matter particles or massless light - conservation of symmetry as well as energy.

The weak force charge is "Identity", which is carried in explicit form by neutrinos and in implicit form in the massive leptons as "lepton number" charge (baryons probably carry this same charge in implicit form as "leptoquark number" charge, and in explicit form as leptoquark neutrinos, which may be the mysterious "dark matter"). During the weak force transformation of single elementary particles, the IVBs sample the electroweak symmetric energy state to acquire the elementary particles and charges they need (in "virtual" particle/antiparticle form) to effect the transformation of "real" elementary particles whose conserved parameters (such as mass, spin, and charge), must remain invariant and unchanged since their origin in the "Big Bang". (See: "The 'W' IVB and the Weak Force Mechanism".)

In our modern, cold universe, spacetime and matter remain in partial contact through dimensional forces (inertia and gravity), the latter gauged by Newton's universal gravitational constant "G"; and through the exchange of photons with electrically charged particles (as gauged by velocity "c", the electric charge "e", and the fine structure constant "alpha"). Virtual particles, de Broglie's "matter waves", and other quantum mechanical phenomena also remain as connecting links, and as vestiges of the former unity between spacetime and particles, or between the Higgs and the photon. The former unity of matter and antimatter, and of light and spacetime, is "remembered" through such conserved symmetry debts as gravity's "location" charge and matter's spin and electric charge. Symmetry-breaking by the Higgs is likewise remembered in the

conserved "identity" charges of the neutrinos, and reflected in the distinct masses of the elementary quark and leptonic spectra.

Higgs Conservation Domains

Just as the photon creates a conservation domain for free electromagnetic energy, so the Higgs creates a conservation domain for bound electromagnetic forms. This particle "metric" consists of charges such as electric charge, color charge, "identity" charge ("number" charge), spin, etc., plus the massive bound energy forms necessary to carry them (leptons, neutrinos, quarks, leptoquarks, baryons, mesons, etc.). The charges represent alternative, "abstract" but real (and hence not simply "symbolic") forms of symmetry which can be conserved through time and redeemed for the original symmetry upon demand (just as paper money is an alternative and redeemable form of "hard" currency). The Higgs conservation domains are havens where symmetry, in its various absolute forms in free electromagnetic energy (light), can find temporary conservation in matter, in the form of the various charges of bound electromagnetic energy. There are three levels of these Higgs conservation domains: the first and highest energy level producing leptoquarks, the next producing baryons, and the last producing leptons.

The Higgs boson is the scalar or gauge boson for the unified-force symmetric energy states, of which there are three above the EM (electromagnetic) ground state: the TOE, GUT, and EW. These states are conservation domains in which the symmetries of massless, chargeless, timeless, and non-local light (free electromagnetic energy) can be temporally transferred and conserved in an alternative form, carried by massive, temporal, local particles (bound electromagnetic energy) in the form of various charges, spin, and gravity. These temporal forms of symmetry (the conserved charges of massive particles) can always be redeemed for the real thing: redemption of symmetry debts occurs when bound, massive energy forms (particles) are converted to light, as in matter-antimatter annihilations, particle and proton decay, or the gravitational conversion of bound to free energy in stars and black holes (Hawking's "quantum radiance").

The three Higgs domains form a decay chain or cascade of successively less energetic conservation domains or energy plateaus where the system condenses to a new state of lower energy and lower symmetry, higher order and higher (total system) entropy, finally arriving in the cold "ground state" of atomic matter, a compound electromagnetic domain composed of both light and matter, which we and other biological species currently occupy.

Theory of Everything

The first and highest energy domain is the TOE (Theory of Everything) domain or Planck-era energy level corresponding to the union of all four physical forces (hence including gravity), in which the translation of massless light into the massive form of a leptoquark is accomplished as a 4-force joint effort. This is the most primitive conservation of light's energy in alternative massive form, energy (and symmetry) fully recoverable according to Einstein's E=mcc in matter-antimatter annihilation reactions. "Y" IVBs of the TOE domain assign a neutrino ("Identity" charge), spin, and electric charge to the leptoquark, converting the completely general mass-energy conservation function to the more specific conservation of a species of particle. By means of these identity charges leptoquarks can discover and pair with their appropriate anti-leptoquarks and annihilate each other, returning their energy and charge to the symmetric form of light. It is also by means of these neutrinos or identity charges that they (or any species of elementary particle associated with a specific neutrino) may be created in the first instance, and later identified and exactly reproduced.

Grand Unified Theory

In the second unified force level, the GUT (Grand Unified Theory) energy level, gravity disengages, having balanced the positive energy of the "Big Bang" with its own negative energy; gravity now provides negative

entropy to the mix of forces. Three particle forces remain unified, the electric, strong, and weak. The GUT symmetric energy state is characterized by the "X" IVB family, whose special function is to produce an excess of matter baryons from leptoquarks. Electrically neutral leptoquarks decay asymmetrically, producing a tiny excess of matter leptoquarks over antimatter leptoquarks (perhaps only one extra per ten billion). The excess neutral matter leptoquarks, lacking annihilation partners, live long enough to expand their nascent quarks into the configuration of normal hyperons and baryons, where they are stabilized by the appearance of the conserved color charge. Leptoquark antineutrinos are produced during the asymmetric decay, one per excess leptoquark, balancing the lepton number or identity charge for barons, which all carry a "hidden" leptoquark number charge (AKA "baryon number charge"). These free-roaming leptoquark antineutrinos, which may be quite heavy, are "dark matter" candidates. Conservation charges at this level include gravity, electric charge, spin, neutrinos (Identity charge), and color charge. Quarks and gluons are added to the list of particles (such as leptons) suitable to act as massive carriers of symmetry debts. Quarks and gluons are derived from the tripartite splitting of primordial leptoquarks by the "Y" IVBs. Matter-antimatter annihilations return the material particles to massless symmetry via the system of conserved charges which allows matter particles to recognize their appropriate antimatter annihilation partners. As the leptoquarks demonstrate, in the GUT symmetric energy state, all leptons and quarks are joined, equivalent, and interchangeable.

Electroweak Force Unification

The third and lowest energy of the force-unity states is the EW or electroweak unified-force symmetric energy state. In this state all quark "flavors" are equivalent and all lepton species are equivalent, but quarks (hadrons) and leptons remain distinct within their own generic identities. Mesons (quark-antiquark combinations) and baryons (three quark combinations) are added to the list of allowed massive charge carriers, along with the full leptonic spectrum of alternative charge carriers (neutrinos and massive leptons). The EW state is characterized by the "W" IVB family, which can transform quarks and leptons, mesons and baryons. "W" IVBs can create and destroy leptons and individual quarks and mesons, but while they can transform baryons, they cannot create or destroy them. Only "X" IVBs are powerful enough (massive enough) to create and destroy baryons; similarly, only the "Y" IVBs can create and destroy leptoquarks.

A Cascade of Conservation Domains

The three Higgs domains present us with a cascade of conservation domains and particle "metrics" capable of translating the symmetry of massless light into the charges of massive carrier particles, a linked chain of quantized symmetric energy states or plateaus, each fully capable in its own right of conserving both the energy and symmetry of light until repayment of matter's symmetry debts is demanded by either antimatter or gravity. They serve as transformation stages, stepping down the energy scale from one conservation domain to another, handing off the symmetry and energy debts from higher to lower symmetric energy states until the ground electromagnetic state (cold atomic matter) of our daily experience is reached. In this scheme the Higgs bosons serve to scale or gauge the steps of the symmetric energy states, while the IVBs native to that state perform the work of transformation within the particular domain selected by the Higgs. *The charges of matter are the symmetry debts of light* (Noether's Theorem).

The various force-unity energy states are necessary to the conservation process because they represent defined states of symmetry which can be consistently identified in terms of energy, and therefore quantized, accessed, and exactly reproduced via the mass-energies of the several Higgs bosons. Likewise, the IVBs are a transformation mechanism which can be quantized and also exactly reproduced (the IVBs are physical samples/examples of their native symmetric energy states). The IVBs are able to accomplish their transformations because within the symmetry domain of their native state, all particles belonging to that domain are equivalent, available, and interconvertible. The complex weak force apparatus is necessary because elementary particles created today must be exactly the same in all respects as those created eons ago

during the "Big Bang" - in order to conserve symmetry and energy. Because alone among the forces the weak force creates/transforms *single* elementary particles, the only fail-safe way to produce this result is to return to the original source-energy in which the elementary particles were created - just as Frodo's ring must be returned to the primordial fire in which it was forged. When it comes to conservation, nothing is left to chance in our Universe, which is extremely jealous of its energy content, both with regard to quantity and quality.

References

Gross, Politzer, Wilczek: *Science:* 15 October **2004** vol. 306 page 400: "Laurels to Three Who Tamed Equations of Quark Theory."
Mee, Nicholas: *Higgs Force* The Lutterworth Press 2012

Links:

Unified Field Theory

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
Principles of the Unified Field Theory: A Tetrahedral Model
(Postscript and Commentary on paper above)
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Synopsis of the Unification Theory: The System of Matter
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The "Tetrahedron Model" vs the "Standard Model" of Physics: A Comparison

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