Introduction to the Higgs Boson Papers

John A. Gowan

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Introduction

Although I had heard about, read about, and wondered about the "Higgs boson" for years, I simply couldn't get a "feel" for this particle, mostly because I was unable to place it within any overall, coherent scheme of physical phenomena (I couldn't answer the question: what is the conservation role of the Higgs boson in nature?). What finally broke the impasse for me was the article by Gordon Kane in Scientific American (and there is much else in this article I don't agree with), which mentioned there could be more than one Higgs boson. (See: "The Mysteries of Mass" by Gordon Kane, Scientific American, July 2005, pp. 41-48.) That idea allowed me almost immediately to "do my thing", which is the construction of General Systems hierarchies, using the "phase transition" energy levels, or force unification symmetry states, as benchmarks for the four sequential steps of a weak force decay "cascade" from the "Multiverse" to "ground state" atomic matter, with one step allotted to each of the four forces as they joined (or separated from) the unification hierarchy.

I had been blocked from this realization through thinking there was only one Higgs boson. The dam burst when I realized there could be more than one Higgs. Suddenly I saw how the various Higgs bosons could serve as a selection mechanism to define, organize, and "gauge" the energy levels or symmetry states of several other processes I had known about for some time, such as the compression of the quarks by the "X" IVBs to produce "proton decay", and the creation of quarks by an even higher energy process involving the splitting of primordial leptons (by "Y" IVBs). It all fell into place once my mind was opened to the possibility of multiple Higgs bosons, one each to "gauge" or scale the stages of the decay sequences of the cascade.

A common interpretation (in the popular literature) of the Higgs boson's role is that it is responsible for the inertial mass (mass measured as resistance to acceleration, as distinct from "rest mass") of elementary particles - see Kane's article, above. This interpretation and distinction I have never understood and still do not agree with. I do agree that the Higgs is responsible for the "rest mass" of a particle ($E = mcc$), in that the Higgs scales, regulates, of "gauges" the creation, destruction, and transformation of elementary particles, determining their mass by setting and quantizing the IVB energy level at which these processes occur. But this is not how most authors seem to interpret the action of the Higgs. Instead, they argue that the Higgs acts like a spacetime field (something like the old "ether") which resists the motion of (accelerating) elementary particles (and only elementary particles, not compound particles such as baryons, whose mass consists mostly of binding energy). The objectionable feature of this idea is that it gives us several different kinds of inertial mass, and therefore compromises (it seems to me) a fundamental principle of Einstein's, the Equivalence Principle between rest mass, inertial mass, and gravitational mass ("weight"). Furthermore, in this interpretation, the Higgs is being thrust into a role which is already filled by the spacetime metric. The inertial mass of a particle (the mass due to a particle's resistance to acceleration) is a consequence of the interference between the particle's gravitational field (which is exactly proportional to its rest mass - Gm) and the spacetime metric. This latter interpretation satisfies Einstein's Equivalence Principle and also explains why the accelerated motion of particles affects their dimensional and mass parameters (because of

feedback between the metric fields of spacetime and gravitation). It also frees the Higgs boson for a more satisfactory role in the conservation economy of Nature as simply the scalar of elementary particle mass during the creation of "singlets" by the weak force. I explain all this in greater detail in the paper: "The Higgs Boson vs the Spacetime Metric".

Charge Invariance

The unified field theory, as developed in various papers on this website (see especially: "Symmetry Principles of the Unified Field Theory"), rests upon 4 fundamental principles of physical law: 1) the Conservation of Energy (1st law of thermodynamics); 2) Entropy (2nd law of thermodynamics); 3) the Conservation of Symmetry (Noether's Theorem); 4) Causality (law of cause and effect). (See: "The Tetrahedron Model" (diagram) (text))

In writing the "Higgs Boson" series of papers referred to in the title (and also the "Global vs Local Gauge Symmetry" papers), I have found it convenient to invoke a corollary, a natural adjunct of the symmetry conservation principle, *charge invariance* (including the invariance of other associated fundamental physical parameters of elementary charge-carrying particles, such as rest mass and spin). The magnitude of charge must remain invariant over time, despite the effects of entropy, the expansion of the Universe, the effects of relative motion, or any other factor which might either inflate or deflate the value of conserved charge. Obviously, symmetry conservation depends upon charge invariance, which is implied in any notion of charge conservation. "*The charges of matter are the symmetry debts of light*"*;* charge conservation and charge invariance in the "particle" forces, the invariance of "velocity c", the "Interval", causality, and inertia in the "spacetime" forces, are the heart and soul of Noether's Theorem regarding symmetry conservation.

While the principle of charge invariance has major consequences for charged particles in relative motion (magnetism for example), it also has major consequences for the creation, destruction, and transformation of "singlet" or unpaired elementary particles over the course of history (the elaborate weak force transformation mechanism, including the massive weak force Higgs boson and IVBs, for example).

The central fact of our Universe is that it is "asymmetric", composed of matter only, not a symmetric mix of matter and antimatter. Nevertheless, the Cosmos apparently was born in a state of massless, chargeless symmetry, originally composed of equal parts matter and antimatter, and subsequently devolved to its current "ground state" of asymmetry (involving mass, charge, gravitation, and time - the asymmetric "gang of four"). Getting from the symmetric "Big Bang" origin of our Universe to its present asymmetric "ground state" is an evolutionary journey that imposes many constraints upon any intuitive mythology or rational hypothesis that attempts to reconstruct it. Among these constraints are the "global vs local gauge symmetry" dualities in the structure of the forces (such as the electro/magnetic force), necessary to accommodate the relative motion of matter vs the (much simpler) absolute motion of light, and the massive Higgs boson and the weak force IVBs, necessary for the creation, transformation, and decay of "singlet" or isolated elementary particles of matter, vs the (much simpler) electromagnetic creation and annihilation of particle-antiparticle pairs.

If the central fact of our Universe is its asymmetric content of matter, then the central force of the Universe must be the weak force, whose role is the creation (and transformation) of "singlet" elementary particles, isolated elementary particles of matter rather than particle-antiparticle pairs (as produced by the electromagnetic force). (See: "The Particle Table".)

Not only does the weak force create isolated particles of matter during the Big Bang (by virtue of its asymmetric reactions with matter vs antimatter), the weak force also creates and transforms isolated particles of matter (and sometimes antimatter) at later times, including today (radioactive decay, astrophysical processes, etc.) The weak force provides a "lawful" pathway of decay ("lawful" in that the

decay pathway, driven by entropy, obeys the conservation laws) from the high energy, high mass particles created during the earliest moments of the "Big Bang", to the low energy, low mass particles of "ground state" atomic matter. The mechanism of particle creation, transformation, and decay involves both the massive Higgs boson and the weak force field vectors, or "Intermediate Vector Bosons" (IVBs) (so-called because in contrast to most massless bosons, IVBs are very massive). The decay cascade is driven by entropy, regulated by the weak force, with a "rebound" driven by symmetry conservation and gravitation. (See: "Nature's Fractal Pathway".)

The Higgs Cascade

The Higgs boson is a quantized scalar particle, reflecting the energy density or energy scale at which the "phase transition" of force unification or force symmetry states occurs, "gauging", "scaling", or regulating the mass of the IVBs which perform elementary particle transformations within those energy boundaries and symmetry states. These are very specific energy levels determined by the "phase transition" boundaries or symmetry states of the four forces - the energy density or temperature at which the four forces merge into (or separate from) one another. These phase transitions are symmetry stages, levels, or steps in a hierarchy of unification regimes beginning with the lowest electromagnetic (E/M) "ground state" (cold atomic matter), and ending with the highest (the "Multiverse"). (See: "The Higgs Boson and the Weak Force IVBs" (table and text)) (table only).

The quantization of the Higgs scalar boson reflects the fact that these phase transitions always take place at the same energy level, and therefore the IVBs gauged and selected by the Higgs always access the same energy level, producing elementary particles of the same charge, mass, and energy, no matter when or where in the Cosmos such weak force transitions happen to occur. The quantized Higgs boson is an obvious concession to charge and mass invariance in the service of energy, symmetry, and charge conservation. The quantized Higgs ensures that the IVB it gauges is in the correct symmetry state, unification regime, or energy level to perform the desired transformation, which will occur as a natural matter of course if the energy level and symmetric energy state is appropriate.

We can think of the Higgs boson as a scalar property of the force unification energy level or symmetry state, a property that converts a representative portion of the symmetry state into a quantized particle - the IVB. The scalar is necessary not only to create the IVB particle form, but to ensure the invariance of the IVB's mass, energy, and consequently its product, regardless of its relative motion, entropy, when or where it operates, or any other factor that could affect the invariance of the elementary particles the IVB produces. The IVB itself is necessary to provide a "lawful" pathway of decay for the "singlet" bound energy forms of one symmetry state to the "singlet" bound energy forms of another state with greater entropy and less bound energy.

The enormous mass of the "W" IVB family - about 80 proton masses - which is apparently much more massive than necessary to effect the transformations it produces (such as the creation of a single electron) - is due to the great energy density of the force unification symmetry state which the IVB represents (the electroweak (EW) force unification symmetric energy state in the case of the "W" IVB "family"). The IVBs work their transformations indirectly, by occupying the original force unification symmetry state in which these transformations first occurred during the exceedingly high temperatures and energy densities of the "Big Bang". Once the IVB is in this original energy density state, the transformations which are the natural consequences of the symmetries native to that state occur as a matter of course. (For example, the lepton and quark "species" of our ground state EM level, exist in a unified "generic" state at the EW energy level - the lepton "genus" and the quark "genus".) This strategy is necessary to ensure that the elementary particles the IVBs create will always be the same, whether they were created during the "Big Bang" or billions of years later, in very different circumstances. Energy and charge conservation obviously demand that the elementary particle created today be exactly the same as that created yesterday, tomorrow, or in the "Big

Bang". This is why the creation of "singlet" elementary particles of matter, particles that are unpaired with antimatter annihilation partners, is fraught with so much difficulty, and requires the extremely elaborate and conservative weak force Higgs and IVB mechanism which reprises the original mode and "Big Bang" environment of particle creation. The mass of the Higgs boson is the universal weak force constant which scales or "gauges" the weak force IVBs, and through the IVBs, the latter-day creation of elementary particles.

Three Energy Levels of Higgs Bosons and Weak Force IVBs

The transformation mechanism of the IVBs is relatively simple. (See: "The "W" IVBs and the Weak Force Mechanism (pdf format)" (html format).) The IVBs are "metric" particles, quantized examples of the energy-dense metric at which a particular symmetry phase transition, or joining of forces, takes place. There are (presumably) three separate and discreet IVB energy levels with a distinct and separate Higgs scalar boson associated with (and definitively distinguishing) each level. The first (lowest) Higgs level is the "W" IVB "family" level, consisting of the W+, W-, and W neutral (or Z neutral) IVBs. This energy level (about 80 proton masses or 80 GEVs for the W+ and W-, and about 91 GEVs for the Z neutral) corresponds to the energy density at which the electric and weak forces join (the photon becomes part of the "W" IVB family). The symmetry of this phase transition consists not only in the merger of the photon and the "W" IVB family, but also in the joining of the three quark family members with each other, and likewise, the joining of the three lepton family members with each other (but quarks remain distinct from leptons). This is a more symmetric state because the lepton species are not distinguished among themselves, nor are the quark species distinguished among themselves, nor are photons distinguished from the "W" IVBs. Consequently, transitions within the six quark species and transitions within the six lepton species take place with complete facility at this energy level. (See: "The Particle Table".) In the (perhaps) more familiar terms of biology, this is a symmetry realized at the generic level rather than the species level.

Because the "W" IVBs are essentially examples of (quantized portions of) the H1 energy density or electroweak force unification symmetry state (which is why they are so massive), they can perform any transformation that normally characterizes this symmetric level of force unification. This level is experimentally verified with regard to the "W" family of IVBs, but the race continues to discover the level 1 (H1) Higgs boson. On this H1 level we find the production of alternative charge carriers (leptons, neutrinos, and mesons), the transformations of hyperons and baryons, and the creation and destruction of isolated or unpaired lepton "singlets". (The creation and destruction of baryon "singlets" is a higher H2 energy level process.) H1 is the familiar energy level of weak-force nuclear transformations, including radioactivity, fission, and element-building in stars and supernovas, accessible only through the "W" IVBs if "singlet", isolated, elementary particles are created, destroyed, or transformed (such as electrons, neutrinos, or changes in quark "flavors").

"Alternative charge carriers" (leptons, neutrinos, and mesons) balance the charges of other particles (notably baryons) in the absence of antimatter charge partners. Importantly, alternative charge carriers avoid annihilation reactions and are therefore crucial for the creation of "singlets" or isolated particles of matter. The electron-proton pair is our most familiar example, but the electron-electron antineutrino pair is equally important - as is the (hypothetical) proton - leptoquark antineutrino pair.

In a similar mode, the next higher step in the force-unification hierarchy is that between the strong force and the electroweak force, the so-called GUT unified force level or Grand Unified Theory. (This second energy level of IVBs and Higgs (H2) remains hypothetical, having not been experimentally verified.) Here the quark families and lepton families are unified, in hybrid particles called "leptoquarks". The IVBs of this "H2" level are designated "X" IVBs (X+, X-, X neutral), and are simply heavier versions of the "W" IVBs. Matter is created at this level (during the Big Bang) through the asymmetric weak force decay of electrically neutral leptoquarks vs antileptoquarks, with the emission of leptoquark antineutrinos. The H2

level hosts the creation and destruction of baryons as "singlets" or unpaired, isolated particles (including "proton decay"). It is here that the creation of matter occurs during the "Big Bang", with the "X" IVBs destroying more (electrically neutral) antileptoquarks than leptoquarks. The leptoquark neutrinos produced in these reactions are "dark matter" candidates. It is possible that this energy level occurs today inside black holes, where "proton decay" may be commonplace. (See: "The Origin of Matter and Information".)

The final IVB level (also hypothetical) is the H3 energy state, designated the TOE (Theory of Everything) or Planck energy level (this is the level of Gamow's primordial substance or "Ylem"). We will name the IVBs of this level the "Y" IVB family, presumably also a triplet of Y+, Y-, and Y neutral "metric" particles. ("Metric" particles are composed of a bound form of compacted, possibly convoluted, energy-dense spacetime metric. Their mass is composed not of quark or leptonic matter, but simply of the energy required to bind and maintain the spacetime metric into their particular form, density, and configuration.) The symmetry "phase transition" of the H3 energy level is the final joining of forces, the joining of gravity with the strong and electroweak forces. This is the level of the creation of leptoquarks, which the "Y" IVBs produce by the splitting of primordial, elementary, leptonic particles into 3 component parts. Like the "X", the "Y" IVB is also a super-heavy version of the "W" IVB. Unlike the "X", the "Y" is special in that it gets some extra help in its role from gravity (although the "X" may also get some help from gravity, as when it produces proton decay in black holes). The "Y" IVBs of the "Ylem" send electrically neutral leptoquarks down to the H2 or leptoquark energy level of the "X" IVBs.

The various Higgs bosons and their associated IVBs must be considered as normal members of the three force unification or symmetric energy states (E/W, GUT, TOE,), no less than the leptons, quarks, leptoquarks, hyperons, baryons, mesons, neutrinos, or alternative charge carriers typically associated with those energy levels. Hence we have the highest TOE force unification level with the Higgs 3 boson, the "Y" IVB family, the primordial leptons ("Ylem"), and their nascent quarks; the intermediate GUT force unification level with the Higgs 2 boson, the "X" IVB family, and the leptoquarks and leptoquark neutrinos; the lowest E/W force unification level with the Higgs 1 boson, the "W" IVB family, and the hyperons, heavy leptons, mesons, leptonic neutrinos, and the alternative charge carriers; still below all these we find the ground state electromagnetic realm of light, space, gravity, time, historic spacetime, atomic matter, and life.

One way to understand the Higgs and its associated IVBs is by analogy with the "ground state" electromagnetic force and its associated photon. "Velocity c", the electromagnetic force constant, is the "gauge" or scalar of the spacetime metric, and the photon is its force carrier. "Velocity c" gauges a symmetric energy state of the spacetime metric in which the photon is non-local, and time and distance (x, t) are banished.

In an analogous fashion, the mass of the Higgs boson is the weak force gauge constant, scaling a "particle metric", and the "W" IVB is its force carrier. The Higgs boson mass "gauges" a symmetric energy state of force unity and particle identity (the electroweak force unified particle "metric" or regime), in which the IVB is "non-local" in the sense that it has no specific identity. Instead, the "W" IVB has many potential quark and lepton identities (the alternative charge carriers it produces - leptons, neutrinos, mesons), while the independent existence of the elementary leptonic and quark species is banished. Only baryons maintain an independent existence in the unified electroweak symmetric energy state. The various baryon species (hyperons) are unified in the generic "leptoquark" only at the next higher GUT or H2 energy level.

Most curiously, we see astrophysical, gravitationally bound states tracking or reprising (approximately) the four stages of the "Higgs Cascade" and force unity states. The planets in stage 1, the electromagnetic ground state; stars in stage 2, the electroweak state of lepton and quark transformations; black holes in stage 3, the GUT state (where proton decay is thought to be commonplace); and finally the Big Crunch in stage 4, where gravity, spacetime, light, and particles are all fused together in the ultimate mixture of matter and

antimatter, positive and negative energy.

Gravity and Mass - "Metric" Particles

All the IVB families work by compression, differing mainly in the intensity of the pressure they can apply, according to their mass and specific Higgs energy density level. The "Y" IVB is seen only during the initial moment of the "Big Bang", or the final moment of the "Big Crunch". Perhaps the most interesting feature of the H3 level is that this is the energy level at which gravity joins the other forces in a final full symmetry. But like the IVBs, gravity also works by metric compression or contraction; the IVBs are compressive metric particles and gravity is a contractile metric force. Clearly, in the joining of gravity with the "Y" IVBs of the H3 energy density level, we have the phenomenon of quantum gravity, a "metric particle" of enormous density. Gravity and the "Y" IVB become indistinguishable, they are one and the same thing. Gravity, the metric, and particles are all joined in the final full symmetry of quantum gravity at the H3 Planck energy density level. It is at this H3 level that: 1) the primordial elementary "leptonic" particles are split into three subunits (the quarks); 2) the metric and particles acquire mass or bound energy; 3) the metric and particles impress their characteristics upon one another. This is why the baryon looks like a miniature 3-dimensional Cosmos, complete with internal "sticky light" composed of a massless boson field traveling at velocity c (the gluons).

This H3 level primordial "Ylem" is an extremely peculiar state of energy, unlike anything we are even remotely familiar with, because the gravitational field, which contains negative energy exactly balancing the positive energy of particle "rest mass", is fully contained within the particle itself, not dispersed throughout a spacetime external to the massive particle. Therefore, the particle contains equal amounts of positive and negative energy within itself, which separates into two components only as H3 decays to H2. During the decay to the H2 symmetry state, the positive component of energy condenses as the particle's rest mass, while the negative component of energy becomes the particle's external gravitational field. The quarks are formed before this separation between particle and gravitational metric takes place, and the particles and quarks are simultaneously imbrued with mass by the enormous compressive forces of the combined "Y" IVBs and the gravitational metric. The unification of gravity with the "Y" IVB is the realization of the union of Quantum Mechanics and General Relativity - "quantum gravity". The decay from the H3 to the H2 energy level (the separation of the gravitational metric field from the leptoquark particle field) may also include the "inflationary" era of expansion envisioned by the theories of Guth and Linde.

All three families of IVBs are simply representative samples of the dense metric of the Cosmos at a particular force unification level or symmetry state of the unfolding, evolving, and cooling (entropy driven) "Big Bang", and each is enabled to perform its particular transformation role by virtue of that fact - it performs whatever transformations are typical of its force unification state or symmetry level - as gauged by the Higgs scalar boson. The role of the Higgs is to ensure the uniformity of the IVBs and their products, identifying and quantifying the proper energy level for each species of IVB, such that all elementary particles produced by the IVBs have the same mass and charge whenever and wherever they may be created in the Cosmos. The role of the IVB is to perform transformations appropriate to its specific energy density level or force unification symmetry level. The role of the Higgs boson is to ensure that the IVB is at the proper energy level, or in the correct symmetry state or unification realm for the transformation/creation task at hand. It is because of these careful, quantized, methodical steps that we find ourselves in a conserved material Universe whose components work together - all its parts are in a seamless harmony of interaction and communication - despite its asymmetric condition, consisting only of matter with no corresponding antimatter component.

Rationale for the Weak Force

Why is all this weak force mechanism and hierarchy necessary? Only because the Universe and the weak

force is producing asymmetric "singlets" of matter, that is, isolated baryons and leptons of matter that have no antimatter partners with which they can annihilate, cancel their charges, and return to the perfect symmetry of the light which created them. In the absence of antimatter annihilation partners, the weak force "machinery" is necessary so that energy and symmetry conservation may be fulfilled in an asymmetric Universe composed only of matter. "*The charges of matter are the symmetry debts of light*", and not until the last charge has been canceled will the Universe cease in its relentless quest for symmetry conservation and the fulfillment of Noether's Theorem.

Electrons (or any elementary particle) created today must be exactly the same as elementary particles created yesterday, tomorrow, or eons ago during the Big Bang. The weak force ensures this necessary uniformity by revisiting, via the Higgs scalar and the "W" IVBs, the energy density or symmetry state in which electrons and certain other elementary particles were first created, or their identities are merged. In this regard, the "W" IVBs are "time machines", reprising the high density metric of the "Big Bang" era in which elementary particles originated.

The highest level of symmetry and force unification involves the entire Cosmos, as it is unified with the "Multiverse". The "Multiverse" is here conceived as the collection of all possible Universes, and our particular life-friendly Universe is but one subset of these possibilities. It is in the initial distinguishing act, the separation of our Universe from the Multiverse, that the arbitrary values of the physical constants of our life-friendly Universe are determined. These values include such physical parameters as c (the electromagnetic constant), G (the gravitational constant), e (the value of electric charge), and h (Planck's energy constant), among others (including the magnitude of the Higgs mass and the weak force asymmetry parameter). There is no explanation for the life-friendly values of these physical constants. They are simply arbitrary, random values of one special (life-friendly) universe among the (?infinitely?) many possibilities available to the creative energies of the "Multiverse". The "Anthropic Principle" determines the life-friendly values of the physical constants of our universe, because obviously we could live in, experience, and wonder about no other.

The only restriction I can imagine upon the creation of Universes by the energy and activity of the "Multiverse" is that, as in our case, a Universe initially requires no net energy or charge for its creation, and must be able to conserve whatever energy subsequently emerges, if, as in our case, the components should separate into positive and negative halves (rest mass energy vs gravitational energy).

We should finally note that the three energy levels of (hypothetical) Higgs bosons and IVB families are mirrored by the three energy levels of (demonstrated) quark and lepton families. Thus there is "precedent" in the other particle families for this structural and mass hierarchy in the "metric" particle families, even though the "precedent" is itself without explanation. Possibly the "precedent" is related to the 3 dimensions of space either as some sort of fractal resonance, or as a direct reflection of metric structure impressed upon particles at the H3 level of force unification. However, we do have an explanation for the three energy levels of the Higgs and IVBs in the "phase transition" symmetry levels of a hierarchy of force unifications, progressing from "ground state" atomic matter upward to the final symmetry of the "Multiverse". Curiously, as noted earlier, these force unification symmetric energy states are also reprised in a parallel hierarchy of gravitationally bound astrophysical states: planets, stars, black holes, and the "Big Crunch".

The Birth of the Cosmos

The only way our Universe can be born as a quantum fluctuation from the Multiverse is if its total energy = zero, and its total charge = zero. These criteria can be met through the negative energy of gravitation, and the balancing charges of matter vs antimatter.

Initially, when our Universe separated from the Multiverse, it was composed of equal parts matter and

antimatter, and the negative energy present as gravitation was equal to the positive energy contained in all the particles. Presumably, our Universe in this primordial symmetry state differed from the "Multiverse" only in the specific "life-friendly" values of its physical constants. This is the perfect symmetric energy state of H3, the conjoining of gravity and the spacetime metric with the "Y" IVB family and the other forces and particles. The decay of the H3 state we attribute to "spontaneous symmetry-breaking", or an entropic instability, perhaps the consequence of a quantum fluctuation. In any case, the "Y" IVBs, aided by gravity, fracture the primordial leptonic elementary particles into 3 parts, the nascent quarks. Particles acquire "metric mass" or "bound energy mass" at this critical transition, when gravity, the metric, the "Y" IVBs, and the leptonic primordial particles (with their nascent quarks) are all fused into a single substance ("Ylem").

Because the particles and the gravitational metric are conjoined when the quarks are formed, particles and the metric share some characteristics. This is why the baryons: 1) appear to be fractured leptons, with partial charges that exactly add up to leptonic charges; 2) appear to be miniature universes, with an internally contained massless field of "sticky light" moving at velocity c - the gluons. In addition, the three families of quarks and leptons may also be a fractal reflection of the 3 spatial dimensions (the physical result of the fusing of the metric with particles during the H3 full-symmetry Planck Era). Finally, the quark "triplet" may be the consequence of the primordial leptons fracturing along the "cleavage planes" of the three spatial dimensions.

Following the fracturing of the primordial leptons and the creation of the quarks - and perhaps because of it - the gravitational metric separates from the particles, in the sense that it becomes external to the particles, rather than wholly contained within them. The gravitational metric field remains centered on particles, however, as the gravitational metric must have a central focus (where the field sums to zero) to balance its own energy accounts. In this separation, all the positive energy remains with the particles, and all the negative energy remains with the gravitational metric, but the two remain exactly balanced in magnitude, despite their physical separation. This separation of field and particles and "spontaneous" decay from H3 to H2 energy levels may correspond to the "inflationary" era of Guth and Linde, as noted earlier.

In the subsequent H2 state (the Leptoquark Era), we find the "X" IVBs mediating the asymmetric decay of electrically neutral antileptoquarks, while their leptoquark partners escape to become hyperons (heavy baryons), as their quarks expand to reveal their conserved and stabilizing color charge (leptoquark antineutrinos produced in these reactions are obvious candidates for "dark matter"). Only electrically neutral particles could undergo such an asymmetric weak force decay, which is the reason why the quarks have to be formed in the beginning if matter is to be produced in the end. The partial charges of quarks can be arranged to produce electrically neutral composite leptoquarks and baryons (such as the familiar neutron), whereas the elementary leptonic spectrum, the electron, muon, and tau, are all electrically charged. Can a heavy neutral lepton exist higher in the profile of the leptonic particle spectrum? Yes - it is precisely the neutral leptoquark, produced by the action of the "Y" IVB. The origin of the asymmetry in these decays is unknown. It is evidently a property of the "X" IVBs (similar asymmetries are known in the "W" IVBs), but I have also seen the opinion that it is a consequence of the 3-family structure of the elementary particles.

During the annihilation reactions between leptoquarks and antileptoquarks, all are destroyed and converted to photons except for one surviving leptoquark per ten billion matter-antimatter particle pairs. Photons are perfectly symmetric energy forms and have no associated gravitational field. Moving at velocity c, photons are "non-local", and as such cannot provide the necessary center for a gravitational field. (See: "'Dark Energy': Does Light Produce a Gravitational Field?") (See: "The Origin of Matter and Information".)

The "Accelerating" Universe

As the Universe evolves, its content of matter is slowly converted to light by various processes, especially in the stars and quasars. Consequently, the total gravitational field of the Cosmos also is slowly diminished,

producing the impression that the Universe is actually expanding at an accelerating rate. If "dark matter" exists, and also is slowly being converted to light in accordance with the universal symmetry conservation laws, this will only add to the total effect. The "repulsive drive" of the so-called "dark energy" of the Cosmos is therefore here interpreted as simply the "rebound" of spacetime as its total gravitational field is diminished by the universal conversion of bound to free energy.

A potential problem with this explanation is this: if gravity is a form of energy, then by energy conservation it should not be possible for gravity (or gravitational "negative energy") to simply vanish. However, we are treating gravity as a form of charge, a symmetry debt acknowledging the non-local distributional symmetry of light's energy, which is obviously broken by the local concentrations of energy in immobile, undistributed, local matter. Symmetry debts and charges can indeed vanish, when they are paid in full. The gravitational charge or symmetry debt is satisfied, paid, or discharged when bound energy (mass/matter) is completely converted to free energy (light). This is the fundamental reason why the negative energy of gravity is so strange and unlike other forms of positive energy: gravitational negative energy is the binding energy of a charge, expressed in metric or inertial terms. (See: "A Spacetime Map of the Universe.")

The Miracle of Mass

When we think about the fact that we find in nature two different paths for the creation of particles, one symmetric and due to the operation of the electromagnetic force (the creation of particle-antiparticle pairs), and one asymmetric through the weak force, we can readily appreciate that these two forces might be joined in the "electroweak unification", and additionally, that the world we live in is apparently of a very special type. For if we can explain the creation of particles by the weak force, then we cannot understand how the electromagnetic force also manages the same feat - excepting for a most remarkable "given" characteristic of spacetime - its ability to create particles from light.

We can understand that the weak force operates in special circumstances, because it only creates "singlets", isolated particles without antiparticle "mates", and so must recreate the original conditions of energy density in which such particles were first made during the "Big Bang". The constraint of universal charge and mass invariance among elementary particles whenever and wherever they may be created is the reason why the massive Higgs boson and IVBs of the weak force are necessary, even to create the lowly electron and its neutrino. We can also appreciate that the mass of the "W" IVBs, which we think of as highly condensed and bound spacetime metric (in fact, as a representative sample of the original symmetric energy state of the electroweak force unification era), may be necessary to create and hold invariant even the tiny mass of the electron. But we also see that electrons are readily created in particle-antiparticle pairs by the electromagnetic force without the help of the massive IVBs. So apparently the IVBs (and the Higgs) are necessary not to create particle mass, but only to ensure the invariance of elementary particle charge and mass, due to the special circumstances of "singlet" creation, in which particles cannot be balanced and referenced against antiparticles. However, both the weak and electromagnetic forces create particles from a common source, the spacetime "vacuum" or metric "zoo" of particle-antiparticle pairs. We must credit this common source of "virtual particles" as the major reason why these two different forces create identical particles. (See: "The 'W' IVB and the Weak Force Mechanism".)

We understand charge as a temporal solution to the problem of symmetry conservation (during the conversion of spatial light (free electromagnetic energy) to historical matter (bound electromagnetic energy)), and mass as a solution to the problem of energy conservation during the same conversion/transformation. Gravitation is likewise the solution to the problem of entropy conservation/conversion, transforming the intrinsic motion of light (the spatial entropy drive of free energy) to the intrinsic motion of time (the historical entropy drive of bound energy). All three processes are obviously linked during the conversion of massless, chargeless, non-local and gravity-free light with intrinsic (entropic) spatial motion "c", to massive, charged, local, gravitating bound energy with intrinsic

(entropic) historical motion "T".

We can understand the creation of charges (and spin) in particle-antiparticle pairs readily enough, because charges are always created in self-cancelling or balancing pairs that sum to zero. But the creation of mass is not so readily comprehended, because there is no "antimass": both particle and antiparticle carry positive quantities of mass. But here the third leg of our "trinity" comes to our rescue, as gravity carries negative energy, for both particle and antiparticle, in exactly the right amount to cancel or balance the positive energy of their "rest" mass. This is one reason (among several) why gravity must always be associated with massive particles, to provide negative energy to balance the positive energy of "rest" mass.

But what is mass and how is it created? It seems that mass, in most cases (including such exotic particles as the IVBs of the weak force), is just a bound form of light or electromagnetic energy mixed with the spacetime metric, usually associated with some form of symmetry-conserving charge and spin. When the "W" IVBs create "singlet" particles they are, through their mass, recreating a primordial condition or symmetric energy state of the spacetime metric (the electroweak force unification era), and when the electromagnetic force creates massive particle-antiparticle pairs, it does so in the current spacetime metric of the ground state electromagnetic force unification era. The spacetime metric is always involved in one way or another or one form or another in the creation of massive particles, and quite obviously no massive particle has ever been created outside the boundary or regulating presence of spacetime.

While we can invoke plausible rationales and roles for the IVBs and the Higgs particle in the case of "singlet" particle creation (the necessity for universal invariance in the charge and energy parameters of elementary particles), in the case of the creation of particle-antiparticle pairs by the electromagnetic force (or its derivative, the strong force), we can only invoke the special properties of spacetime itself. Spacetime has the ability, and indeed the propensity, to convert free forms of electromagnetic energy (light) into bound, massive forms (particles), carrying various charges, spin, time, and gravitation as the several conserved forms of the energy, symmetry, and entropy of light. It is simply one of the "given" ("anthropic") special properties of our universe, that its spacetime metric will assume both free (spatial) and bound (temporal) (wave and particle) forms of electromagnetic energy. Time and gravitation are part of the special entropic properties of our dimensionality (part of its conservation mechanism) which permits the existence and ready creation of massive, quantized, particulate and conserved forms of electromagnetic energy from spatial, free forms of electromagnetic energy. It is this fundamental duality in the expression of its energy forms by our Cosmos which permits our material existence and experience - light and its temporally conserved form, matter.

Of course the ability to form particle-antiparticle pairs is not unique to the electromagnetic ground state energy level, but exists at all energy levels of the force unification hierarchy (because the metric exists in some form at all energy levels). In the ground state, this ability has been reduced to a "virtual" residue or potential, a fleeting reminder of past glories, which nevertheless may be called upon or awakened at any time by a sufficient application and concentration of energy. The creation of particles or bound energy forms by the interaction of light (free electromagnetic energy) with the spacetime metric or "vacuum" remains the single greatest miracle of nature, a "given" or "anthropic" property of our Universe which may remain forever unexplained. (Possibly there is some sort of dimensional or topological entanglement or "knotting" between electromagnetic energy and the spacetime metric - as in the theory of "strings".)

Direct interaction between our electromagnetic ground state and the electroweak force unification energy level occurs in radioactive decay and element-building in stars, through the participation of particle-antiparticle pairs in the nuclear transformations which characterize both processes. Because of our dependence upon solar energy, we have a special connection to the electroweak energy level through daily experience, a familiarity we do not enjoy with processes typical of the higher Higgs energy levels (such as proton decay or the creation of quarks). (The weak force is crucial to element-building in stars because

protons must be converted to neutrons (via the "W" IVB) before strong force fusion can take place.)

The role of virtual particle-antiparticle pairs in the transformation of atomic nuclei via the "W" IVB family level is a fine example of the practical effect of electroweak unification. Our electromagnetic ground state maintains contact with higher force unification energy levels via its retention of the ability to create any particle-antiparticle pair or weak force boson of any Higgs level, given a sufficient input of energy. Thus the importance of the presence of virtual particle-antiparticle pairs in the electromagnetic ground state "vacuum" of spacetime can hardly be overestimated. Without them the Sun itself would be extinguished and element building in stars would cease. Contact between the electromagnetic ground state and higher force unification energy levels would be limited to gravitational interactions, such as in and surrounding black holes.

It must be understood that the Sun is not itself an example of the electroweak force unification era or energy level. However, the "W" IVBs are such examples, and because the Sun (and other stars) provide a superabundant locus for "W" IVB activity (due to element-building and the transformation of nucleons in their cores), stars can at least be seen as connections to, if not gateways between, our electromagnetic ground state and the next higher symmetry realm or energy level of electroweak unity. The same can be said for the radioactive elements and minerals. Interestingly, whereas the lodestone's mysterious "lines of force" provided clues to the electromagnetic unification, radioactive minerals' mysterious "rays" provided clues to the electroweak unification. Indeed, the electromagnetic and electroweak eras are well connected, as the transformation of nucleons involves the crucial participation by particle-antiparticle pairs from our electromagnetic ground state "vacuum", as well as the massive IVBs and Higgs of the electroweak energy level. (See: "The 'W' IVB and the Weak Force Mechanism".)

Our Sun represents a closed symmetry circuit, but only at the electroweak energy level, which means the Sun is limited to the creation and destruction of leptonic matter (although it can also transform quarks and baryons). Hence a neutron star is the (macroscopic) end state of this electroweak conversion or symmetry conservation circuit. To go further, we must climb to the next energy level at which baryons themselves can be created or destroyed, the GUT or leptoquark force unification energy level, represented in our ground state spacetime by black holes and proton decay (in the same sense that the Sun and radioactivity represent contact with the electroweak era). Proton decay is thought to be commonplace inside black holes, converting quarks, baryons, and the internal mass of black holes to gravitationally bound radiation. Outside black holes, in the phenomenon of "Hawking radiation", we once again find that particle-antiparticle virtual pairs of our electromagnetic ground state vacuum are crucially involved in another higher level "gateway" to, or connection between, the several force unification energy levels (or symmetry eras) of the Cosmos. Hence while the Sun radiates at the gateway to the electroweak unification era, the black hole radiates at the threshold to the GUT unification domain, and the Big Bang radiates at the entrance to the TOE and Multiverse unification realm.

Links:

Weak Force, Intermediate Vector Bosons ("IVBs")

Section IV: Introduction to the Weak Force
The "W" Intermediate Vector Boson and the Weak Force Mechanism (pdf file)
The "W" IVB and the Weak Force Mechanism (html file)
Global-Local Gauge Symmetries of the Weak Force
The Weak Force: Identity or Number Charge
The Weak Force "W" Particle as the Bridge Between Symmetric (2-D) and Asymmetric (4-D) Reality
The Strong and Weak Short-Range Particle Forces
Section XVI: Introduction to the Higgs Boson
The "Higgs" Boson and the Spacetime Metric