Section IV: Introduction to The Weak Force

(See also: "Introduction to the Higgs Boson Papers")

(revised Dec., 2012)

John A. Gowan

home page

Papers:

The "W" Intermediate Vector Boson and the Weak Force Mechanism (pdf file)
The "W" IVB and the Weak Force Mechanism (html file)
The "Higgs" Boson and the Weak Force IVBs: Part I
Identity Charge and the Weak Force

Table of Contents:

Abstract
Introduction
Virtual Particles
"Metric" Particles
Particles and the Spacetime Metric
Neutrinos
Alternative Weak Force Reaction Pathways
Links and References

Abstract

The weak force is responsible for the creation of matter during the "Big Bang", apparently via the asymmetric decay of electrically neutral leptoquark-antileptoquark particle pairs; responsible also for the creation, transformation, and destruction of *single* elementary particles - particles that do not exist in matter-antimatter pairs (as seen in radioactivity, fission, single particle decays and transformations). Elementary particles created today must be interchangeable with those created during the "Big Bang" (or anywhere else) with respect to all conserved parameters - mass, spin, charge, etc. Creating absolutely invariant *single* elementary particles any time or place is the conservation challenge presented to and surmounted by the weak force, requiring the elaborate mechanism of the Higgs boson and the Intermediate Vector Bosons (IVBs). The great mass of the IVBs recreates the original energy density and unified-force symmetric energy state in which the elementary particle classes (leptons and quarks) were first created, while the Higgs boson "gauges" (scales and selects) the appropriate IVBs and unified-force symmetric energy state (there are several). It is the quantization of the Higgs boson and the IVBs (plus virtual particles drawn from the global "vacuum sea") that ensures the invariance of the weak force transformation mechanism. The weak force charge is "identity" charge (AKA "number" charge), and is carried *implicitly* by all massive leptons (including leptoquarks and their derivative baryons) and *explicitly* by neutrinos.

Introduction: The "W" particle and the "IVBs"

Although this is a somewhat technical paper (but without mathematics), there should be much of interest in the mechanism of the "W" particle for the general reader, since in the action of the IVBs, we glimpse the fearful asymmetry of creation.

The first version of this paper was written in April 1983, submitted to two physics journals in 1985 (rejected by both), and submitted to the Archives of Physics on 9 Aug. 2000 (with several subsequent updates). Unlike my other papers which are mainly of theoretical or philosophical interest, this paper is also potentially of significant practical utility, since it treats the reaction pathways of nuclear transformations.

The "W" is one of several "Intermediate Vector Bosons" ("IVBs") of the weak force (see: "The Particle Table"). Bosons are the "field vectors" or force carriers of the four forces. Bosons are particles or "force quanta" produced by charges; there is associated with every charge a boson responsible for the transmission of the actual force associated with the charge. In the quantum mechanical interpretation of modern physics, every force is transmitted by an actual quantized particle. This notion supplants the classical Newtonian idea of "action at a distance" (which even Newton didn't like). The bosons of the electromagnetic force are "photons"; "gravitons" are the bosons of the gravitational force; "gluons" and mesons are the bosons of the (two-level) strong force; and the very strange "IVBs" (W+. W-, Z neutral, and the hypothetical X) are the bosons of the weak force. These weak force bosons are called "Intermediate" because unlike other bosons, they have a large mass, whereas all other bosons are massless. The "W" and "Z" IVBs are about 80-90 times (respectively) more massive than the proton; the hypothetical "X", presumably responsible for proton decay and the creation of matter itself, is thought to be much more massive.

The huge mass of the IVBs immediately tells us they are very strange particles indeed, because they cannot be made out of the usual nuclear material - quarks and gluons. What then is the "stuff" they are composed of? This is not "atomic matter" in the sense we are familiar with, and these are not particles in the sense we are familiar with, either. The IVBs are particles of interaction only - they are metric catalysts, mediators, or "brokers" which allow and facilitate transformations and decays within and between the "families" of elementary particles, the quarks and leptons, which are respectively the constituents of the nucleus and the electron shell of atomic matter. The "W" IVB is a type of "virtual" particle which exists only during the reaction it catalyzes and is otherwise not seen. Like all virtual particles, the "W" IVB is always potentially present but is actually materialized only within the Heisenberg spacetime limit for virtual reality, or if there is enough energy in the IVB's immediate vicinity to momentarily bring it into existence.

Virtual Particles and the Vacuum "Sea"

"Virtual" particles are the creation/discovery of quantum mechanics, P. A. M. Dirac, and Werner Heisenberg. The "vacuum" of spacetime is actually full of photons left over from the "Big Bang" - resulting in the 2.7K "cosmic background radiation". Traveling at velocity "c", photons are "non-local", which means they are effectively everywhere simultaneously. Due to the Heisenberg "Uncertainty Principle", the energy associated with these photons (or with any given point in space), will vary due to "quantum fluctuations" - depending on the time scale one chooses to associate with a specific photon or spacetime location. The shorter the time scale, the more energy one is allowed to associate with a particular photon or spacetime point and its "quantum energy fluctuation". Pick a small enough time interval and you can associate almost any amount of energy with a specific point or photon, energy sufficient to materialize almost any particle you choose (usually a particle-antiparticle pair due to symmetry conservation). This brief time interval is the "Heisenberg Interval" of "virtual" reality. The energy to produce these virtual particles must be borrowed from the "vacuum" surrounding their point of manifestation, and this energy must be paid back to the vacuum before its loss is "noticed" by the "police" - the conservation laws - particularly the conservation of energy. ("Cinderella" is one example of a folk tale involving virtual reality with its time limit. Indeed, almost every aspect of modern physics has an intuitively realized cultural counterpart, whether in art, mythology, religion, or the occult and mystical traditions.)

As we go back in time toward the "Big Bang", the cosmic background radiation (the effective temperature of spacetime) gets hotter and virtual particles become easier to materialize, because there is more energy nearer at hand available to be borrowed - the energy "economy" becomes richer, so borrowing is easier. Eventually the "vacuum" becomes so energy dense and hot that the virtual particles don't have to borrow energy at all, they can exist as "real" particles in their own right because the environment is so "energy rich" it can support or materialize them all the time. It then becomes a question of which and how many particles the environment can materialize.

In our imagination we can see a whole new reality emerging from the energized "vacuum", materializing out of the virtual particle "sea", like ghosts raised from the dead: the lightest particles surface first, always in particle-antiparticle pairs, and as the temperature continues to rise, heavier particles materialize, including particles whose names we do not know because they have not yet been discovered. We know that among this carnival of particles there are at least 6 types of quarks and 6 types of leptons, and that they can transform into one another, not only within "genera" (quark-quark and lepton-lepton) but also (at much higher temperatures) between "genera" (quark-lepton) as well. How do they do it?

If our imaginary spacetime "vacuum" is hot enough (or equivalently, early or young enough relative to the "moment of creation"), we will see the IVB catalysts as well as the particles they help to interact. Transformations will become easier and more common until a temperature and energy density is reached at which the IVBs are materialized. At this point a "phase transition" takes place because the metric itself becomes the IVB - spacetime becomes dense and energetic enough to act as a cosmic-sized IVB and particles transform freely into one another (within certain classes, depending upon temperature). At high energy density particles are so close together they can swap charges and energies without "concern" for the conservation laws, simply due to their extreme closeness and the high temperature and energy density of this very compressed metric. (The lowest energy phase transition occurs at the energy density/temperature of the *electroweak force unification era* - a symmetric energy state of the early universe reproduced by the large mass of the "W" family of IVBs.) In the electroweak symmetric energy state the separate leptonic "species" (electrons, electron neutrinos, and their heavier kin) are collected into their common "generic" identity ("leptons"), and likewise the quark species gather into their generic identity ("hadrons"). Within each "genus", transformations of "species" identity take place naturally, simply as a matter of course between congeneric members. This is the general principle underlying the IVB transformation mechanism. (See: "The 'W' IVB and the Weak Force Mechanism".)

As the temperature continues to rise, spacetime goes through several more "phase transitions" which are symmetry states of successive unifications of the four forces. The "W" IVB mass "family" is gauged or scaled (by the appropriate Higgs boson) to the lowest or first in this hierarchy of force unification symmetry regimes, the electroweak unification energy level. (See: "The "Higgs" Boson and the Weak Force IVBs: Part I.)

Now in our imagination let us reverse the process and allow the "Big Bang" to proceed normally, expanding and cooling spacetime. Spacetime quickly cools below the point where it can act like a cosmic-sized IVB, and particles can only transform if they get caught in local "knots", eddies, or fluctuations of sufficient metric energetic density. As spacetime continues to expand and cool, all the virtual particle-antiparticle pairs rapidly disappear back beneath the "surface" of the virtual sea, the heaviest ones first and the lightest ones lingering the longest. The IVBs are among the first to go, and as the spacetime metric cools and expands, transformations among or between elementary particles become less frequent because these very heavy metric particles or quantized "knots" of spacetime (the IVBs) are very expensive and hence very difficult to materialize, depending entirely on the temperature and energy density of the local spacetime metric. As spacetime passes through the phase transitions between three successive levels of force unification, a great deal of heat is released reflecting the loss of symmetry (analogously to the "heat of condensation" released by rain or freezing water). This energy contributes to the heat and the formation of particle-antiparticle pairs during the "Big Bang". (The original positive energy of the "Big Bang" may be due to a similar loss of symmetry or "degrees of freedom" as our asymmetric universe of electromagnetic energy (with its special "life-friendly" physical constants) separated from the all-symmetric Multiverse.)

"Real" (temporal) particles are left floating on the "surface" of the spacetime sea as it cools, while the virtual particles "sink beneath the waves". They are all still there in unlimited potential, but are seen only if enough energy can be brought to bear locally to materialize them, to raise them to the surface of the "sea" and give them again a brief "life".

In the Universe today, with the cosmic background radiation (the basal temperature of spacetime) at about 2.7K, the virtual particle sea is rarely seen because the spacetime metric is cold and energy sparse - a necessary condition, however, for our life form. But just occasionally, for very brief instants, due to quantum fluctuations of vacuum energy focused around and by the presence of a real particle, the particles of the "virtual sea" can be raised again to perform their former duties, like the ghostly crew of a briefly surfacing phantom ship. The weak force IVBs are especially difficult to materialize because they are so heavy, hence weak force transformations are rare and for this reason the force is said to be "weak".

"Metric" Particles

I have called the weak force IVBs "metric particles", because I conceive of them as simply quantized "knots" of very dense spacetime metric, whose "mass" is a consequence of the very great energy required to compress (and perhaps convolute) the spacetime metric to such a density and/or configuration. The IVBs simply recreate the very dense metric of the early moments of the Big Bang when all elementary particles were so close together that they could freely swap and exchange charges and energies amongst themselves without danger of violating any charge or energy conservation law - because being so close together (or actually "touching"), exchanges can happen very quickly.

The "W" IVB family specifically recreates the energy-dense metric of the electroweak force-unification era, the moment during the "Big Bang" when the electric and weak forces were united. During this time, quark-quark transformations and lepton-lepton transformations were simply part of the natural course of events - a state of greater symmetry than we know today - a state of "generic" unity/identity rather than specific distinctions - (the mythical analog is a bygone "golden age" or "state of grace" (such as the "Garden of Eden").

Today the role of these metric catalysts, the IVBs, is to bring together within their dense metric a "real" particle ripe for a transformation (typically carrying excess bound energy), and an appropriate particle-antiparticle pair from the virtual "sea", such that the charges of the virtual particle pair can be made available to the real particle, and the energy of the real particle can be made available to the virtual pair, facilitating and effecting the transformation of both.

The most significant feature of the massive IVBs is that they recreate the original conditions of the energy-dense primordial metric in which particles were first created and transformed during the early micro-moments of the "Big Bang". This recapitulation (which is scaled or "gauged" by the Higgs boson) ensures that the original and invariant values of charge, mass, energy, etc. are handed on to the next generation of (single) elementary particles, which must be created exactly the same today as those created during the "Big Bang". The IVB mass not only provides a "conservation containment" where charge and energy transfers can safely take place, it simultaneously ensures that the appropriate alternative charge carriers are present (leptons, neutrinos, mesons). (See: "Identity Charge and the Weak Force".)

There is a crucial difference between the electromagnetic or strong force creation of particles via symmetric particle-antiparticle pair formation, and the weak force creation or transformation of asymmetric "singlet" particles of matter to other elementary forms. ("Singlets" are matter particles without antimatter "mates".) In the case of particle-antiparticle pair creation, there can be no question of the suitability of either partner for a subsequent annihilation reaction which will conserve their original symmetry. Both particles are referenced against each other and gauged or scaled by universal electromagnetic and metric constants such as c, e, and h. However, in the case of the weak force creation or transformation of a "singlet" elementary particle of matter to another form, alternative charge carriers must be used to balance charges, since using actual antiparticles for this purpose can only produce annihilations.

But how can the weak force guarantee that the alternative charge carriers - which may be a meson, a neutrino, or a massive lepton - will have the correct charge in kind and magnitude to conserve symmetry at some future date in some future reaction, or with an unknown partner which is not even its antiparticle? Furthermore, quark charges are both partial and hidden (because they are "confined"), and number charges of the massive leptons and baryons are also hidden (because they are "implicit") - they have no long-range projection (such as the magnetic field of electric charge) to indicate to a potential reaction partner their relative energy state. Nevertheless, conservation of energy, charge, and symmetry require that elementary particles created at any time or place be exactly the same in all respects as those created eons ago in the "Big Bang".

These problems of equilibration are all solved by a return to the original conditions in which these particles and transformations first appeared, much as we return and refer to the Bureau of Standards when we need to re-calibrate our measuring instruments. The necessity for the charge and mass invariance of elementary particles in the service of symmetry and energy conservation therefore offers a plausible explanation for the otherwise enigmatic large masses of the weak force IVBs. Weak force "singlets" can only be referenced against their original creation energy, as scaled by another universal constant of nature, the mass of the Higgs boson. The Higgs and IVB mass serves to recreate the original environmental conditions - metric and energetic, particle and charge - in which the reactions they now mediate first took place, ensuring charge and mass invariance and hence symmetry and energy conservation regardless of the type of alternative elementary charge carrier that may be required, or when and where new elementary particles are created. (See: The Higgs Boson and the Weak Force IVBs.)

No "real" particle is transformed without some compensating transformation in the virtual particle sea. The IVBs act somewhat like a human shaman, spirit-medium, or priest, who connects real people to the spirit world, and in the process transforms both. It is the role of the IVBs to join or bridge the real and virtual worlds of reality, raising virtual particles up to reality and sending real particles down to the virtual "sea". The virtual sea remains connected to temporal reality through a constant exchange between real and virtual particles, a constant potential which becomes actualized in the nuclear transformations and element-building of stars. On Earth it is usually seen only in radioactive decays, nuclear power stations, or in the reactions of cosmic rays and our particle accelerators, or (sadly) in nuclear weapons. Humans are learning to participate, perhaps at their great peril, in exchanges with the Electroweak Era and the "virtual particle sea".

Because the weak force IVBs extract virtual particles and alternative charge carriers from the universal vacuum "sea" of spacetime, and these virtual particle charges, masses, and energies are gauged by global electromagnetic and metric constants, this common source constitutes another part of the mechanism which assures that elementary particles created today will be the same in all respects as those created yesterday or tomorrow, whether created as "singlets" by the weak force, or as particle-antiparticle pairs by the electromagnetic force.

As to why the Z is heavier than the W, I suggest it is because the W has only to accommodate the quarks and massive leptons (since only they bear electric charges), but the Z has to account for the neutrinos in addition. Since Z-neutral elastic scattering can occur with all quarks and leptons, the set of particles "under the Z's wing", as it were, is larger than the W's, requiring more energy to conjure from the vacuum. There are simply more possibilities for neutral interactions than for charged interactions, and therefore the primordial unified-force symmetric energy state recreated by the Z is larger and more inclusive than that created by the W. Furthermore, since the role of the massive IVBs is expressly to ensure the exact replication of single elementary particles, we may suspect that the neutrino which emerges from a seemingly humble Z-neutral scattering event is not the same "individual" that entered the interaction, even though both are of the same "flavor".

In the operation of the "W" family of IVBs, we see a hint of the process of creation, although not yet creation itself - because although "W" IVBs are examples of a low-energy particle-producing interaction between the spacetime metric and energy, they can produce only alternative charge carriers (leptons, neutrinos, and mesons) and baryon transformations. "W" IVBs cannot create or destroy baryons themselves; some yet-more-energetic analog of this process, perhaps involving leptoquarks and the superheavy "X" IVB, must hold the key to the mechanism of the primordial and asymmetric creation of matter, baryons, and quarks in the "Big Bang". (See: "The Origin of Matter and Information".) (See: "Table of the Higgs Cascade".)

The "identity" charge of the weak force functions in (at least) three crucial ways to conserve symmetry within the context of the material realm of atomic matter. In the first instance, it allows elementary particles to identify their appropriate annihilation partners in a timely fashion (in the case of both "real" and "virtual" particles); in the second instance, and perhaps more fundamentally, the "identity" charge is necessary to allow the exact replication of elementary particles, such that (for example), one electron is precisely identical to every other electron ever created. Without the identity charge, there would be no "benchmark" against which to measure one electron against another, especially in those cases (typical of the weak force) in which single electrons are created rather than particle-antiparticle pairs. Finally, the identity charges of neutrinos, which are the "bare" identity charges of their massive leptonic counterparts, provide an alternative identity charge carrier which accomplishes charge conservation even when single massive leptons (rather than particle-antiparticle pairs) are created. Without this charge-conservation service via the alternative pathway of the neutrino, our asymmetric "matter-only" universe could not have broken the perfect symmetry of light and its particle-antiparticle form during the "Big Bang", since without neutrinos, charge conservation could only have been accomplished via antimatter partners (such as electron-positron pairs), resulting in perpetual annihilations reactions. (See: "The Origin of Matter and Information".)

Particles and the Spacetime Metric

I believe that during the "Big Bang", the interaction of (very high-energy) light with the metric structure of spacetime and the four forces of physics created massive particles: free electromagnetic energy was converted into bound electromagnetic energy, although the details of this primordial interaction remain unknown. This interaction includes gravity during the initial moments of creation. This sketchy scenario nevertheless suggests that the structure of spacetime may well be the source for the structure of particles, and one might reflect the other in some transformed parallelism. For example, the three energy "families" of quarks and leptons may reflect the 3 dimensions of space. We have no better explanation for the existence of these 3 energy families. The interaction between particles and the geometry of spacetime is currently being investigated by "string" theory (see Brian Greene's book "The Elegant Universe"). The IVBs are not "strings", but they may be analogs of "strings".

In the 4x4 matrix representation of the unified field theory (see table), we have 2 pairs of forces: the long-range or spacetime forces (electromagnetism and gravitation), and the short-range or particle forces (strong and weak). It may be these force pairs are in some sense transformed analogs of each other. For example, we have in the spacetime force pair the electromagnetic force representing a symmetric free energy input, while asymmetric gravitation transforms 3-dimensional space into linear time, maintains contact between matter and the spacetime metric, and gravity's product (time) represents an alternative entropy carrier, conserving energy and causality and allowing the transformation of energy to work. In the analogous case of the particle force pair, the strong force represents a symmetric bound energy input, while the asymmetric weak force transforms 3-dimensional quarks into point-like leptons (as in the "beta decay" of a neutron to a proton, electron, and electron antineutrino), maintains contact with the virtual particle sea, and the weak force product (leptons) represents an alternative charge carrier, conserving symmetry and charge and allowing the transformation of energy to information. (See: "The Strong and Weak Short-Range Particle Forces".)

This parallelism becomes evident only upon the effective arrangement of the 4x4 matrix of particles, charges, and forces - which like the Periodic Table of the Elements, carries an intrinsic level of information when properly configured and interpreted.

The Weak Force Mechanism

See: The "W" IVB and the Weak Force Mechanism

Leptons and the "Identity" Charge

See: Identity Charge and the Weak Force

Elementary Particles and Neutrinos

Recent observations suggest that the neutrino series itself may spontaneously "decay", oscillate, or transform into one another, much as their massive leptonic counterparts do (but in the latter case, with the necessary mediation of the massive "W" IVB family). (There may also be a 4th undiscovered neutrino which carries the identity charge of the primordial leptoquark, but this cannot be observed until we observe either leptoquark or proton (baryon) creation or decay). The lesson to be learned from the tau cascade decay-reaction is straightforward: elementary massive leptonic particles cannot be created or destroyed unless their identity charges are conserved by neutrinos. In fact, it is the presence of a neutrino which identifies a truly elementary particle. This is strict charge conservation operating again, telling us that an important symmetry of light, "anonymity", has been broken, and by Noether's Theorem requires conservation. The same system does not operate for the quarks (there are no quark neutrinos), evidently because quarks are not elementary particles, rather they are sub-elementary particles. I presume the identity system in this case operates only at the elementary (leptonic) level of particles, which in the case of quarks and baryons corresponds to the primordial leptoquark. This leptoquark neutrino, however, can only be seen, as mentioned above, if we observe a leptoquark creation or decay, or what is equivalent, a proton (baryon) creation or decay. (I presume that a single species of leptoquark neutrino suffices to represent the identity charge of all the many varieties of baryons - since all must return to the same single leptoquark configuration to decay.)

The simple view of neutrino function presented above is correct so far as leptonic decays are concerned. However, this picture has recently become more complicated by the discovery of neutrino "mass states" and the oscillation of neutrino "flavors" in flight after the decay. Here symmetry conservation is apparently observed at the generic level of flavor, rather than the specific level - see the discussion below. (In a similar fashion, the presumed leptoquark neutrino is thought to code for the generic identity of all baryons, rather than any particular baryon "species".)

Neutrino Mass and Oscillations

See: *Scientific American,* May 2010 pages 38-45: "Through Neutrino Eyes" by Gelmini, Kusenko, and Weiler for an authoritative discussion of neutrino oscillation and mass.

According to Gelmini et al., neutrino mass is the basis upon which one neutrino is distinguished from another. Neutrinos oscillate not only between their 3 leptonic "flavors", but between 3 "mass states", and it is the relative proportion of these mass states that determines flavor. Because any neutrino flavor can exhibit any mass state, neutrinos evidently code for flavor identity at both the generic level of all lepton flavors, and at the specific level of a single leptonic flavor. This solves the "mystery of the missing solar neutrinos". (See: A. McDonald, J. Klein, and D. Wark: "Solving the Solar Neutrino Problem". *Scientific American,* April, 2003.) (See also: *Science*: Vol. 313, 21 July 2006, page 291, regarding neutrino oscillations). The situation is complex in that while an electron neutrino can only react with an electron (or positron), it may nevertheless change into a muon or tau neutrino during flight, and while in this new configuration, react only with a muon or tau (or their antiparticles). Hence while a specific neutrino flavor does code for and react with a single leptonic flavor, you can't be sure which neutrino flavor you are going to end up with, no matter what flavor you began with. However, because all neutrino flavors play the same game, in sum they balance out each other's charges.

The fluid mix of neutrino identities (in flight) reflects the fluid state of identity in the electroweak symmetric energy state generally, in which all leptonic identities are merged at their generic level, and likewise all quark identities are merged at their generic level. In the electroweak symmetric energy state (or during the electroweak era of the "Big Bang"), transformations of one leptonic flavor into another, or one quark flavor into another, were simply the normal course of events. This is the generic level of symmetry which the "W" family of IVBs recreates (and is how the "W" effects identity transformations), not the specific level of "broken" symmetry (individual identity) we experience today. Specific leptonic and quark identities "freeze out" or "crystalize" only in the cold ground state of our present electromagnetic era. In flight, the neutrino seems to at least partially return to this fluid state of electroweak generic identity. Oscillations or superpositions of identity also occur between other closely related (massive) particles as well, including the quarks of the "K-neutral long" and "K-neutral short" mesons, and even the proton/neutron "nucleons".

The leptonic mass series (electron, muon, tau) serves as an alternative charge carrier for two charges, the electric charge of the electromagnetic force, and the "identity" charge of the weak force. Electric charge is quite independent of mass, and serves only as a long-range "locator" charge, identifying the spacetime location of an electrically charged particle, in this way serving matter's eternal search for antimatter and a return to the symmetric energy state of light (via an annihilation reaction). It is the task of the weak force "identity" charge (AKA lepton "number" charge) to distinguish between the several massive leptons so that they may in fact identify and annihilate with their appropriate anti-partners, once the electric charge has performed its locating and motivating functions.

The leptonic series is distinguished only by mass and identity charge, and it is interesting to note that the several identity charges (as carried in explicit form by neutrinos) are also distinguished one from another by mass - in this case by the disparate proportionate allocation of the superimposed deBroglie mass waves of the three neutrino "flavors" (see the Gelmini article cited above). The weak force focus upon mass, whether in the Higgs boson and its associated IVBs, the leptonic spectrum, or the neutrinos, suggests that the force which creates the massive, material, and particulate universe uses mass (bound electromagnetic energy) in all cases as a hedge against the attenuating effects of entropy, whether spatial or temporal, in our rapidly expanding universe. Charges and massive particles are simply immune from entropic enervation by the expansion of the cosmos, hence both can and do serve as invariant conservation parameters in the economy of Natural Law.

The "W" IVB "family" recreates an invariant, primordial state of force-unification symmetry (the Electroweak Era) by virtue of its huge and quantized mass. In this state the three members of the leptonic elementary particle spectrum are all equivalent (a "generic" level of identity rather than a "specific" level of identity), and transformations of one leptonic species into another are accomplished as a matter of course. Now it is most curious to note that the observed oscillations of the neutrinos apparently preserve a "memory" of this same primordial "generic" symmetry state, and in this reflection we catch a glimpse of why both the IVBs and the neutrinos must share a massive parameter. The neutrino cannot interact unless the "memory" of the "generic" electroweak symmetric energy state it carries within itself can be recreated, matched, or decoded by the IVB field - a "lock and key" mechanism. There is something special about the mass state of a neutrino which allows it to interact with (and only with) the mass state of an IVB. Hence we arrive at the curious phenomenon of a particle which carries its charge (partly) in the form of mass, and yet can travel through light years of lead without interacting.

It has been suggested that the three-family structure of the particle spectrum (including the quarks) is necessary to produce the weak force asymmetry which allows the primordial creation of matter during the "Big Bang". (For example, the "three family" structure allows many more opportunities for the creation of electrically neutral leptoquarks during the "Big Bang". Electrically neutral leptoquarks (heavy analogs of the neutron) are deemed necessary to break the primordial symmetry of light and its particle-antiparticle pairs, leading to the creation of our asymmetric "matter-only" universe.) If this is true, the "harmonic" 3-part family structure of the elementary particles may have an ultimate explanation beyond simple "anthropic" necessity. Because "cosmological" neutrinos can carry, without interaction, significant amounts of energy (due to the phenomenon of relativistic mass?), they may have been instrumental in the dispersal of energy during the initial expansion of the Big Bang, preventing the collapse of the entire system into a cosmic-scale black hole.

The hypothetical leptoquark neutrino is a candidate for "dark matter". This neutrino could be quite massive (and therefore relatively slow moving?), and if it is sufficiently different from the other leptonic neutrinos, it may not participate in their "harmonic" spectrum and oscillations. It is "sterile" to the extent that it can only be seen during proton decay or proton creation - via the "X" IVB. The search for a "sterile" (non-interactive) 4th neutrino species is currently ongoing in both Europe and the US, as an internet search on the term will confirm. (See: Adrian Cho: "The Sterile Neutrino: Fertile Concept or Dead End?" *Science* Vol. 334 21 Oct., 2011 page 304-6.)

Hiding the Neutrino's Identity Charge

The charge conservation reason for hiding identity charge is simple. Since identity charge is a "handed" charge, as we know from the explicit example of the neutrino, massive leptons (such as the electron) cannot conserve this charge in its explicit form, since any massive particle can be either left- or right-handed in its spin orientation. "Hiding" the handed identity charge as an implicit lepton number charge renders this conservation dilemma moot, since in this hidden condition the charge exhibits no handed preference. Only during a weak force transformation involving the IVBs must the lepton "awaken" to its true identity and left-handed spin orientation.

We can think of neutrinos as traveling (existing) from one IVB "event" to another - almost as an airplane travels only between airports. Typically, the neutrino is "born" or initiated in an IVB event (for example, during the decay of a muon to an electron, in which both a muon neutrino and an electron antineutrino are produced (in all reactions below, antiparticles are underlined; the electroweak transformation matrix of the "W" IVB is represented by square brackets; virtual particle-antiparticle pairs of mesons and leptons are enclosed in parentheses)):

Muon Decay:
u-[($\underline{e}$+ x e-)]W- ---> νu + $\underline{\nu e}$ + e-

In such an initiating decay, neutrinos pick up their symmetry debt of "identity" and perform their function as alternative charge carriers (and conservers) of the muon's and electron's identity charges (which are "hidden" in the massive leptons). Subsequently, the neutrinos carry their charges through spacetime at nearly the speed of light until they engage in another IVB interaction in which their services as alternative charge carriers are required, or they are annihilated/neutralized by corresponding anti-charges. Neutrino oscillations during flight mean that weak force charge conservation may by observed at the generic level of lepton number rather than the specific level of lepton identity: what began as an electron neutrino may end up as a muon neutrino (and vice versa), etc. Once within the transformation matrix of the "W" IVB, however, oscillations cease and weak force charge is conserved at the specific level of lepton identity: electron neutrinos only react with electrons, etc. Below I give abbreviated examples of baryon transformations occurring in the Sun and in the neutrino detector (antiparticles are underlined):

Solar fusion: proton ---> neutron
uud+[(d$\underline{u}$- x $\underline{d}$u+)(e- x $\underline{e}$+)]W+ ---> udd + νe + e+

Neutrino detector: neutron ---> proton
νe + udd[($\underline{d}$u+ x d$\underline{u}$-)($\underline{e}$+ x e-)]W- ---> udu+ + e-

In the detector reaction, the incoming electron neutrino cancels identity charges with the positron of the leptonic particle-antiparticle pair, releasing the electron of the pair to the product. The positron's positive electric charge cancels the negative electric charge of the pion in the adjacent meson-anti-meson pair; the pion subsequently self-destructs. Meanwhile, the positive pion's anti- d quark annihilates one of the neutron's d quarks, replacing it with an u quark, and donates its electric charge to the product proton. All charges, leptonic and electric, are balanced from one side of the equation to the other.

For a more detailed explanation of these reactions and symbols see either "The Particle Table" or "The 'W' IVB and the Weak Force IVBs".

See also: Sverker Johansson's website for an authoritative discussion of neutrinos and the "Soar Neutrino Problem":
http://www.talkorigins.org/faqs/faq-solar.html
"The Solar FAQ"

Electron and Neutrino Pair Production

(added Nov. 28, 2011)

In the case of electron-positron pair production, we need only supply enough energy to satisfy the rest mass of the pair according to Einstein's famous equation: E = mcc. However, in the creation of a matter-antimatter neutrino pair, with a very much smaller rest mass energy, we must supply enough energy to create a Z (neutral) IVB (about 91 MEV) - the equivalent of approximately 91 proton masses. Why this enormous difference between particles joined in the electroweak unification? In the case of the electron-positron pair, the weak force identity charges are hidden and balancing, so only the electromagnetic force boson (photon) need be involved to create the electric charges. However, in the case of the neutrino-antineutrino pair, there is no electric charge present and the neutrinos represent "bare" weak force identity charges, which can only be produced by a weak force boson, in this case the Z (neutral) IVB. Similarly, in the case of the production of an electron and electron antineutrino during the decay (for example) of a neutron (beta decay), a "bare" single antineutrino is produced (balancing the hidden "lepton number" or weak force "identity" charge of the electron). This bare, single neutrino (an explicit weak force identity charge) can only be created by a weak force IVB, in this case the W-.

The ability to "hide" neutrinos or weak force "identity" charges is what determines the members of the massive leptonic spectrum or series - the electron, muon, and tau, and in all probability, the leptoquark. The leptoquark is the heaviest member of the series and progenitor of the proton, neutron, and hyperons, providing the missing link between leptons and quarks.

The ability to hide the weak identity charge in leptonic alternative charge carriers is absolutely necessary for weak-force symmetry-breaking via the production of single matter baryons from electrically neutral leptoquark-antileptoquark pairs during the "Big Bang" - since by this means charge conservation is satisfied despite breaking the symmetry of matter/antimatter pairs. (See: "The Formation of Matter and the Origin of Information".)

Another view of the problem of identity charge conservation by massive neutrinos is that this immediately explains why neutrinos are so light and why (consequently) they move so fast - nothing except light itself moves as fast as neutrinos. Hence, the handedness of neutrinos cannot be reversed simply by overtaking them in flight, and the conservation of handedness is accomplished by super-fast neutrinos despite the fact that they have a tiny mass.

Hence the high energy regime of the IVBs and the weak force identity charges follows the usual and logical pattern that higher energy processes nearer in time (and space) to the Big Bang lay the foundation and pave the way for the lower energy phenomena which follow - all the way down the scale to the electron shell chemistry of life.

The interior of stars, where the transmutation of particles and the building of the heavy nuclei of "metallic" elements is on-going, is the current locus of weak force activity. Metaphorically, we can think of the stars as bits torn off the Big Bang and scattered throughout space and time, bits reconstituted by the negative energy and entropy of gravity, the ancient era of the electroweak unification at least partially recapitulated and still blazing in the cold sky of our biological Cosmos.

Alternative Weak Force Reaction Pathways (section below added April 2014)

The leptonic spectrum of elementary particles is clearly some sort of resonant series. In this case it appears to be a resonant series of the combined electromagnetic and weak forces. The leptonic series identifies the mass-energy at which the electromagnetic/photon and weak force/neutrino frequencies are in "sympathetic" vibration - the leptonic particle series delineates the nodes of sympathetic vibration or resonance between these two forces at the electroweak energy level. The electromagnetic force can probably produce particles of any rest-mass energy, but it is only at the nodes of the resonance series where these two forces are in sympathetic vibration that massive particles can be paired with neutrino "identity" charges. This joining of forces is necessary to produce particles that can be conserved in the sense that they can be exactly reproduced at any time and place, matching up precisely with others of their kind, including annihilation reactions with their antiparticles.

While the electromagnetic and weak forces are "in resonance" at the electroweak "force-unity" energy level, the massive leptons of the electromagnetic force (such as the electron) and its neutrino, or "identity charge" of the weak force, are joined together at a "generic identity" level, in which they freely exchange identities without restriction. It is during this period of exchange, and because of it, that the massive lepton acquires its "hidden" identity charge, or is in some way prepared to acquire and carry one. Such is also the case for the entire "leptonic spectrum" - the electron, muon, tau, and presumably the leptoquark also. Of (infinitely?) many possible rest-mass energies that can be produced by the electromagnetic force, just these four are compatible with the weak force to the degree that instead of a massive electromagnetic particle-antiparticle pair being produced (such as an electron-positron pair), in the electroweak "resonance" a mixed pair is produced instead - the electron-neutrino pair (actually a positron neutrino, balancing the electron identity charge). In the decay of a neutron to a proton, it is just this electron-positron neutrino pair which we find accompanying the proton as products of the decay - the electron and proton balancing each others' electric charges. The "resonance nodes" are just the rest mass energies of the leptonic spectrum, and they delineate the frequencies at which the massive electromagnetic leptons and the weak force neutrinos can form these mixed lepton-neutrino pairs in place of the usual particle-antiparticle pairs of the pure electromagnetic force - conferring "hidden" charges upon those few suitable members of the "leptonic spectrum". The neutrino match assures conservation is possible because the particles and their antiparticles can be perfectly reproduced and annihilated at any future time. It is this conservation possibility which allows these particles to eventually materialize.

The electroweak union is remarkable for its "leptonic spectrum", which at the highest energy level involves the leptoquark and the strong force in a "grand unified" energy level. In this, the too-massive leptoquark divides under its own self-repulsion to more stable, lower energy configurations of three quarks, held together by the gluon field of the strong force, the latter arising naturally among the quark subunits, holding them together in whole quantum units of charge (including the zero charge of a neutron-like configuration). Electrically neutral leptoquarks are subject to asymmetric weak force decays (because of their long lives), producing the matter-only atomic constituents of our cosmos. "Lepton number" or "hidden" identity charges of the massive leptons and baryons are balanced by the explicit identity charges of neutrinos, one for each type of lepton and anti-lepton (including the presumed leptoquark neutrinos). Electrical charges of the baryons are the same as those of the leptons because baryons are derived from the leptonic spectrum via the leptoquark, and the leptons are therefore able to act as alternative charge carriers for the baryon's electric charges (or for other leptons or mesons).

If all this seems too complex, it is nevertheless the bare minimum needed to break the electromagnetic symmetry of the primordial universe, ending with a completely conserved system of energy, particles, charges, and symmetry debts, fully capable of replicating itself and returning to its original state of symmetry - with or without gravity (because of the possibility of proton decay).

The positively charged meson involved in the "beta decay" of a neutron is fully absorbed by the product proton, including its charge. No neutrinos are associated with mesons, which as quark-antiquark combinations, are not elementary particles. Presumably the only direct interaction between quarks and weak force neutrinos is at the much higher energy level of the "leptoquark" neutrinos and the "X" IVBs.

I think this new proposal for the mechanism of beta decay is much better than my old one. The new mechanism features a true electroweak mechanism, an actual marriage of the electric and weak forces, while the old is purely an electromagnetic model, involving only the usual particle-antiparticle pairs. The old "beta decay" model also has two problems: 1) Where does the product neutrino come from? and 2) What happens to the negatively charged meson that cancels electric charges with the positron? Neither problem arises in the new mechanism, and no new problems are introduced. (Problem 2) persists in charged meson decay, but at least the (more intractable) origin of the neutrino is solved. We assume, as before, that the quark-antiquark composition of the meson results in self-annihilation between the (non-conserved) quark flavors, once the electric charge is transferred to/conserved by other carriers.

1) "Beta Decay" of neutron to proton: (antiparticles underlined, neutrinos in italics)
Old: udd [($\underline{\text{d}}$u+ x d$\underline{\text{u}}$-)($\underline{\text{e}}$+ x e-)]W- ----> udu+ + $\underline{v\text{e}}$ + e-

New: udd [($\underline{\text{d}}$u+)($\underline{v\text{e}}$ x e-)]W- ----> udu+ + $\underline{v\text{e}}$ + e-

2) Decay of muon to electron:
Old: u-[$\underline{\text{e}}$+ x e-]W- ----> *v*u + $\underline{v\text{e}}$ + e-

New: u-[(u+ x *v*u)(e- x $\underline{v\text{e}}$)]W- ----> *v*u + e- + $\underline{v\text{e}}$

3) Decay of charged meson to muon:
Old: $\underline{\text{u}}$d-[$\underline{\text{u}}$+ x u-]W- ----> $\underline{v\text{u}}$ + u-

New: $\underline{\text{u}}$d-[$\underline{v\text{u}}$ + u-]W- ----> $\underline{v\text{u}}$ + u-

In all the decays above, what had been essentially electromagnetic decays mediated by typical particle-antiparticle pairs drawn from the Heisenberg-Dirac spacetime "vacuum", are replaced by electroweak lepton pairs (neutrino - massive lepton pairs) drawn directly from the high-energy, "generic" electroweak unified-force energetic symmetry state represented by the "W" IVBs. These are typically simpler, direct, less problematic pathways. The electroweak pathways furthermore illustrate the massive leptons' acquisition of "hidden" identity charges via exchanges with neutrinos.

The question now is whether or not I should throw out all the earlier reaction equations of the weak force IVB mechanism - the ones utilizing strictly electromagnetic particle-antiparticle pairs? Unfortunately, to do so would simply be replacing one speculation by another, for the actual mechanism "inside" the weak force IVBs will probably forever remain something of a "black box", due to constraints upon our detailed knowledge imposed by the rules of quantum mechanics. But both pathway representations have utility, and I propose to retain both.

The "electromagnetic" pathway illustrates the parameters of charge conservation that any reaction pathway must observe, and demonstrates that these parameters can be filled by virtual particle-antiparticle pairs readily available from the "vacuum". The "electroweak" pathway may give a (relatively) more accurate picture of reality and the marriage between the electromagnetic and weak forces (as represented by the huge mass-energy of the IVBs). This marriage also gives us some understanding of how the massive leptons acquire the "hidden" identity charges from their associated neutrinos (via continuous identity exchange in the "generic" union created by the mass-energy of the IVBs). It also helps us understand why the leptonic mass spectrum is so limited - it represents the "harmonic" convergence of the electromagnetic and weak forces at just those few energetic frequencies where electromagnetic massive particles and weak force neutrinos can be paired, and "hidden" charges can be acquired by the massive leptons, charges which are the exact equivalent of the "explicit" identity charges carried by neutrinos.

Links:

Information

Section VI: Introduction to Information
The Information Pathway (text)
Chardin: Prophet of the Information Age
The Formation of Matter and the Origin of Information
Causality vs Information
Nature's Fractal Pathway

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

The "Higgs" Boson and the Weak Force IVBs: Part I
The "Higgs" Boson and the Weak Force IVBs: Parts II, III, IV
"Dark Matter" and the Weak Force
Section XVIII: The Strong Force: Two Expressions
The Particle Table

home page

References:

Brewer, J. W. and M. K. Smith, eds. *Emmy Noether: A Tribute to her Life and Work*. 1981. M. Dekker, New York.
Sean Carroll: *The Particle at the End of the Universe*, Dutton, 2012
Pierre Teilhard de Chardin: *The Phenomenon of Man*. 1959. Harper and Row, New York.
Cho, Adrian: "The Sterile Neutrino: Fertile Concept or Dead End?" *Science* Vol. 334 21 Oct., 2011 page 304-6.
Frank Close: *Lucifer's Legacy*. 2000. Oxford Univ Press.
Frank Close, 2010. *Neutrino* Oxford University Press.
Close, Frank. *The Infinity Puzzle*. 2011. Basic Books.
G. Gelmini, A. Kusenko, and T. Weiler,*Scientific American* May 2010 pages 38-45: "Through Neutrino Eyes".
John Curtis Gowan, "Trance, Art, Creativity". 1975. Privately printed.
Gross, Politzer, Wilczek: *Science:* 15 October **2004** vol. 306 page 400: "Laurels to Three Who Tamed Equations of Quark Theory."
Leon Lederman with Dick Teresi: *The God Particle*. 2006. Mariner Books.
Leon Lederman and Christopher Hill: *Symmetry*. 2008. Promethus Books.
J. E. Lovelock. *Gaia*. *A New Look at Life on Earth*. 1979. Oxford University Press.
Mee, Nicholas: *Higgs Force* The Lutterworth Press 2012
Robert Oerter: *The Theory of Almost Everything*. 2006. Penguin (Plume).
Pais, Abraham *Inward Bound: of Matter and Forces in the Physical World*. 1986. Oxford University Press, NY
Robert Resnick: *Introduction to Special Relativity*. 1968. John Wiley and Sons, Inc.
James S. Trefil: *The Moment of Creation* 1983. Collier, Macmillan.
Frank Wilczek: *The Lightness of Being*. 2008. Basic Books.