Section IV: Introduction to The Weak Force

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

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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

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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), and for the subsequent creation, transformation, and destruction of single elementary particles - particles that do not exist in matter-antimatter pairs (seen as radioactivity, particle decay/transformation, fission). Elementary particles created today must be interchangeable with those created during the "Big Bang" 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 symmetry state in which the elementary particle classes (leptons and quarks; leptoquarks; primordial "Ylem") were originally created, while the Higgs boson "gauges" (scales and selects) the IVBs and unified force symmetry state (there are several) appropriate to the transformation class. 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" or "flavor" charge), and is carried *implicitly* by all massive leptons (including leptoquarks) 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 technical 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 produced by 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". 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, and 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. 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 chosen point in space), will vary due to "quantum fluctuations" - depending on the time scale one chooses to associate with a specific photon or spacetime point. 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 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 and 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 the more complex question of which and how many particles the environment can materialize, not just for how long.

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 (and fewer) particles materialize, 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 types (quark-quark and lepton-lepton) but also (at much higher temperatures) between types (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 all particles transform freely into one another. At this 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 energy density of this very compressed metric. (The lowest energy phase transition occurrs at the energy density 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 into their generic identity ("hadrons"). Within each "genus", transformations of "species" identity take place naturally, simply as a matter of course betweem 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 is gauged or scaled (by the 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 slowly 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 rarer and rarer because these very heavy metric particles or quantized "knots" of spacetime 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 freezing water). This energy materializes as the heat and particle-antiparticle pairs characteristic of the "Big Bang".

"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 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 (the cultural 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 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 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 today, tomorrow, or yesterday 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 recalibrate our instruments. The necessity for charge and mass invariance in the service of symmetry and energy conservation therefore offers a plausible explanation for the otherwise enigmatic large mass 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, or in the reactions of cosmic rays and our particle accelerators, or (sadly) in nuclear weapons. Humans are learning to participate, perhaps at their peril, in exchanges with the "virtual sea".

Because the weak force IVBs extract virtual particles and alternative charge carriers from the universal vacuum "sea", 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.

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 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 creation of matter, baryons, and quarks in the "Big Bang". (See: "The Origin of Matter and Information".) (See: "Table of the Higgs Cascade".)

Particles and the Spacetime Metric

I believe the primordial interaction of (very high-energy) light with the metric structure of spacetime - an interaction between energy and spacetime mediated, regulated, or structured by the weak force - creates particles, although the details of this interaction remain unknown. This interaction may include 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 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

The primary role of the weak force is to break the primordial symmetry of light, space, and particle-antiparticle pairs, and thereby allow the creation of matter and the material Universe we know. Exactly how the initial symmetry-breaking was accomplished is unknown, but one hypothesis is that it involved an asymmetric weak force decay, mediated by supermassive "X" IVBs, of electrically neutral leptoquark-antileptoquark particle pairs. (See: "The Origin of Matter and Information")

Associated with this primary symmetry-breaking role is a secondary weak force role, the mediation of identity transformations (via the "W" IVBs) among "singlet" elementary particles (particles of matter lacking antimatter "mates"), the leptons, neutrinos, and quarks. This is the more familiar role of the weak force in nuclear fission and fusion reactions, such as occur in radioactive decays, element-building in stars, and fission and fusion bombs. The primary symmetry-breaking role of the weak force involves the creation and destruction of baryons (via leptoquarks and the "X" IVB?); the secondary role involves the creation and destruction of leptons (via the "W" IVB), but only the transformation of baryons - the latter process requiring the leptons (and mesons) as alternative charge carriers.

Central to this latter-day and secondary process of elementary particle "singlet" creation, destruction, and identity charge transformation, is the role of the leptons and mesons, which function as alternative charge carriers for both the quarks and leptons, a role which allows charges to be balanced, neutralized, and canceled without resorting to antiparticles (which would simply produce annihilation reactions). The familiar decay of a neutron to an electron-proton charge pair is paradigmatic of this process: electric charge is balanced, but not by an antiparticle, allowing the atoms so formed to "live" rather than annihilate. Neutrinos are similarly involved as the alternative, explicit carriers of "identity" charge (also recognized as "number" or "flavor" charge). Mesons (quark-antiquark pairs) also function as alternative charge carriers of quark partial charges (flavor, color, spin, and electric charges), facilitating quark transformations and especially baryon decays. (See: "The 'W' IVB as a Bridge Between 2-D and 4-D Reality".)

Mesons are the only alternative charge carriers that are able to carry quark partial charges, and for this reason mesons play an important role in the transformations of baryons and quark flavors in both the weak force and the strong force (in the latter case, as the "Yukawa" meson field binding nucleons in compound atomic nuclei.) (See: "The Strong Force: Two Expressions".)

Leptons and the "Identity" Charge

The mediators of weak force identity charges are the IVBs (Intermediate Vector Bosons), the bosons, field vectors, or force carriers of the weak force "Identity" charge. Identity charge is, like all charges of matter, *a symmetry debt of light*. In the case of the weak force identity charge, the broken symmetry is the "anonymity" of photons, the quanta of light. All photons are alike, one cannot be distinguished from another, and this is a symmetry of identity (amounting to a lack of individual identity), which I call light's "anonymity" symmetry. In contrast, elementary particles can be distinguished from light, and the several species of quarks and leptons can be distinguished from one another, hence breaking light's "symmetry of anonymity" and requiring/acquiring an "identity" charge. One practical function of this charge is to facilitate the annihilation reactions of particle-antiparticle pairs by helping them properly identify one another and hence link up and annihilate with the correct anti-partner. Electric charge by itself is insufficient help in such identifications - witness the familiar electron-proton pair - hence another charge is necessary to further specify the partner's identity. Spin-handedness (left-right, or "parity") is another factor in this series of identity-defining parameters, distinguishing neutrinos from antineutrinos.

Identity charge is carried in explicit form by neutrinos, and in implicit or "hidden" form by the massive leptons, including the hypothetical leptoquark, the "common ancestor" of the leptons and quarks. This arrangement is familiar to us (by analogy) as the relationship commonly presumed to exist between the human body and soul. Theoretically, the soul is the explicit (and conserved) "massless" form of personal identity, which is "hidden" in the massive body during life and released in explicit ("spiritual") form at death.

In the massive leptons (electron, muon, tau), identity charge is carried in implicit form by each particle but must simultaneously be balanced by an explicit antineutrino of the corresponding type. In this regard, balancing identity charge is like balancing electric charge, except there are three kinds, one for each lepton species or "flavor", as well as "implicit" vs "explicit" charges (which are equivalent). For example, only three massive elementary leptons are known: the electron (e-), the muon (*u*-), and the tau (*t*-) (each has a corresponding antiparticle of opposite electric charge). The familiar electron is the lightest, the muon is about 200 times heavier, and the tau is about 3500 times the electron mass. Because symmetry conservation will always drive toward the release of as much free energy as possible from any system of bound energy, the leptonic series will spontaneously decay in a "cascade" from tau through muon to electron. It is instructive to note that each decay results in the release of the "hidden" or implicit identity charge (neutrino) of the massive lepton as it "dies", and also results in the creation of a new identity charge - a balancing antineutrino - when the new massive lepton is "born". Thus:

$$t- \text{ ---> } u- + \underline{vu} + vt$$

$$u- \text{ ---> } \mathrm{e}- + \underline{v\mathrm{e}} + vu$$

(where antiparticles are underscored and the symbol (*v*) represents a neutrino). (See also: "The Particle Table".)

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 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 can exhibit any mass state, neutrinos can 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.

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 occur between other closely related particles as well, including the quarks of the "K0 long" and "K0 short" mesons, and even the proton-neutron "nucleons".

It is interesting to note the unexpected but crucial role of mass in both the IVBs (field vector) and the neutrino (alternative charge carrier) of the weak force. This mass is the basis of similarity allowing their interaction, and it is of course the weak force that brings mass-matter into existence. The three oscillating mass states associated with a neutrino flavor bring to mind the three oscillating (but massless) color charges which are likewise necessary to differentiate the quarks of a baryon. Just as any quark can have any color, so any neutrino can have any mass state. We cannot push this analogy too far, however; we are trying to use it to understand why neutrinos are distinguished by mass rather than by some massless attribute (such as color).

The mass of a neutrino provides a basis of similarity allowing interaction with other massive particles, beginning with the massive IVBs. Because neutrinos lack electric charge, there must be some other (non-gravitational) principle which allows interactions with other massive particles. A charge carrier must not only be able to accept and bear a symmetry debt, it must also be able to pay and discharge the debt through a final interaction.

The role of deBroglie mass waves is fundamental to the phenomenon of neutrino oscillation. The oscillating neutrino spectrum is a consequence of the 3-member family structure of the elementary leptonic mass series - electron, muon, tau. If the leptonic spectrum had only a single member, then we would have only a single neutrino and no oscillations. Since this hypothetical single neutrino would still have to interact occasionally - to receive and discharge its symmetry debt - we may assume it would still have to be massive to provide a functional basis for interaction with the IVBs.

The IVBs recreate an invariant, primordial state of force unification symmetry (the electroweak era) by virtue of their 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 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 electroweak symmetric energy state it carries within itself can be recreated, matched, or decoded by the IVB field - a "lock and key" mechanism. Hence we arrive at the curious phenomenon of a particle which carries its charge 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". If this is true, the "harmonic" 3-part family structure of the elementary particles may have its ultimate explanation as "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 possibly relatively slow moving?), and because 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.

Hiding the Neutrino's Identity Charge

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. 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 anticharges. 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, 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:

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

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

In the detector reaction, there is no way to balance the lepton number of the reaction unless we assume that the incoming (solar) electron neutrino is conserved as the hidden (but real) number charge (identity charge) of the product electron. It is as if the electron is transformed from virtual to real by the act of consumming a real electron neutrino and "hiding" it internally.

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"

Mechanism of the "W" IVB

A question arises concerning the mechanism of the weak force identity decays or transformations. In the standard model these are mediated by the IVBs (Intermediate Vector Bosons), very heavy particles (about 80 proton masses). My own presumption is that the IVBs are a type of "metric particle", primarily composed of a very dense knot of the spacetime metric (which the hypothetical "Higgs" boson presumably "gauges" or scales). This dense knot of the spacetime metric is probably an example of the "primeval metric", which was dense and heavy with energy when the Universe was very young, small, compact, and energy-dense. In any case, the function of such a dense metric "knot" would be to bring particles and virtual particle pairs into intimate proximity, such that charges could be exchanged at very close range through some sort of "fail safe" mechanism, allowing a transformation of identity (through interaction with the virtual particle "sea") and a release of free energy. The W is then a sort of "kissing box", where real particles can shed their excess bound energy, and virtual particle pairs can get intimate with the real particles and with each other by virtue of the box's dense metric, which forces them together. The large mass of the "W" IVB is interpreted as a measure of the extreme proximity between particles required by the transfer mechanism (the greater the proximity, the higher the energy required to force the reactants together, and hence the greater the necessary mass of the IVB).

The large mass of the "W" IVB is also interpreted as a re-creation of the dense spacetime metric of the primordial electroweak force unification era during the initial moments of the "Big Bang". The electroweak force unification era is a symmetric energy domain in which transformations within (but not between) the quark and lepton families are characteristic of the state. (The several leptonic "species" identities are subsumed into a common "generic" level, and likewise the quarks.)

Looking at a simple example, we diagram the decay of a muon (*u*) to an electron (e-) (as above, antiparticles are underlined and the symbol (*v*) represents a neutrino):

W-[*u*- (<u>e</u>+ x e-)] ---> *vu* + <u>*v*e</u> + e-

(Where the square brackets indicate the "interior" of (or the mediation domain of) the "W" IVB)

We see how natural a transformation this is when diagrammed via the catalytic action of the W- and a virtual electron-positron pair. The negative muon (*u*-) and positron (<u>e</u>+) simply cancel each other's opposite electric charges, which frees both their neutrinos (*vu* and <u>*v*</u>e), and forces the electron (e-) to become " real", as it no longer has an antiparticle annihilation partner. All the W has done is catalyze the reaction by bringing the muon (*u*-) and the virtual particle-antiparticle pair (<u>e</u>+ x e-) into intimate contact, where the charge cancellations and energy transfers can take place safely. Hence the "kissing box" of the IVBs is really a "conservation containment", which ensures that charge and energy transfers take place in a secure environment - a perfectly natural role in the well regulated and orderly conservation domain of spacetime. Perhaps a more satisfactory theoretical interpretation is that the "W" IVB recapitulates the original electroweak force unification symmetry state or energy level of the "Big Bang", in which all such transformations and creations take place simply as the normal course of events (the electroweak symmetry state of generic rather than specific lepton and quark identity). (See: "The Higgs Boson and the Weak Force IVBs".)

The role of the W, and of the IVBs generally, is to manifest the virtual particle "sea" by forming a secure bridge between real particles and the virtual "sea", such that the charges of the "sea" are made available to assist the identity transformations and energy releases of "real" particles. In this regard, the IVBs perform a role very similar to that of the human spiritual medium, shaman, or priest, connecting individual humans to the generalized and "virtual" spiritual realm.

The standard model offers no explanation for the mechanism of the W, which remains a "black box" in that theory, spitting out leptons, neutrinos, and quarks of all species without explanation as to the source of these particles. The mechanism I propose (which simply affords a view of what is happening inside the standard model "W") provides a natural source for these reaction products: the virtual particle "sea".

All weak force interactions, including those involving quarks, can be diagrammed as charge transfers involving virtual particle-antiparticle pairs (including mesons in the case of quark transformations). (See: "The 'W' IVB and the Weak force Mechanism"). This is not surprising, since adding a particle-antiparticle pair to any reaction is like adding zero to an equation - no net charge is added, yet the opportunity for transformation is nevertheless provided - the typical role of the catalyst. Since all these reactions must obey charge conservation in any case, a particle-antiparticle pair (of zero net charge) can be inserted anywhere in the reaction. Below I diagram the complex "beta decay" of a neutron into a proton (again, the interior of the W is indicated by the square brackets and antiparticles are underlined):

$$W\text{-}[ddu\ (\underline{d}u{+}\ x\ d\underline{u}{-})(\underline{e}{+}\ x\ e{-})] \text{ ---> } duu{+} + \underline{\nu e} + e{-}$$

The decay of a neutron (ddu) into a proton (duu+) is a complicated process involving two particle-antiparticle pairs (shown in parentheses) reacting with the neutron and each other, either sequentially or simultaneously. The $\underline{d}$u+ meson (a positive "pion") reacts with the neutron, the meson's anti $\underline{d}$ quark annihilating with one of the neutron's d quarks, which is replaced by the meson's u quark. This transformation of quark flavors from d to u changes the neutron into a proton. The d$\underline{u}$- meson (a negative "pion") and the $\underline{e}$+ positron cancel each other's electric charges, freeing the positron's hidden neutrino ($\underline{\nu e}$) and forcing the electron (e-) to become "real" through lack of an annihilation partner. The d$\underline{u}$- meson, composed of a quark and antiquark whose partial flavors are not conserved, simply self-annihilates once its electric charge is cancelled. Energy liberated by the reaction is expressed through the mass and momentum of the products. This complex reaction pathway, plus the small amount of energy available to drive it, is why the half life of this decay is so long, about 15.4 minutes, effectively an eternity on the typical time scale of other weak transformations - which are themselves very slow, when compared to electromagnetic and strong force decays.

Mesons "come into their own" as the preferred alternative charge carriers by which baryons can transform their internal quark flavors and other quark partial charges in both the weak and the strong forces. In the strong force, mesons are the field vector of the "Yukawa" binding mechanism which holds together the "nucleons" (protons and neutrons) of compound atomic nuclei. (See: "The Strong Force: Two Expressions".)

Are these mechanisms real or only fanciful? There is a rule in quantum mechanics that if a reaction is not forbidden (as by some conservation law), then it is mandatory. As I can't think of any reason why adding a virtual particle-antiparticle pair as a catalyst to this reaction should be forbidden, I must presume these are the real pathways of these reactions - the true story of what happens inside the "W". At the very least, these particle-antiparticle reactions help us understand how these decays can proceed along a pathway which conserves charge at every step, and removes some of the mystery from the "W" and the standard model "black box" of the weak force transformation mechanism. (For a more complete discussion of the weak force mechanism see: "The 'W' IVB and the Weak Force Mechanism" - available in pdf format or html format. For a further discussion of the weak force in its full energy spectrum, see: "The Higgs Boson and the Weak Force IVBs (parts 2, 3, 4)".)

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