The "W" Intermediate Vector Boson and the Weak Force Mechanism

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John A. Gowan
http://www.people.cornell.edu/pages/jag8/index.html

(Readers unfamiliar with the particles in the reactions below should consult “The Particle Table”. This paper is more technically oriented than most on my website, and may be of little interest to the general reader, in which case see the "guide" paper (below), linked from the Homepage. (See also: “The Weak Force Identity Charge”.) (I furthermore recommend the reader consult the "preface" or "guide" to this paper, which may be found on the Homepage at "About the Papers: An Introduction" - Section IV.)

Introduction

The "W" Intermediate Vector Boson (IVB) is the "black box", as well as the "workhorse", of the weak force. The W mediates transformations of "identity" charge (also known as "number" or "flavor" charge) among the quarks and leptons, including their creation and destruction as singlets, that is, when they are not paired with antimatter partners. The W is very massive - about 80 times heavier than a proton. Because the large mass-energy of the W must be borrowed within the Heisenberg time limit for virtual particles, decays mediated by the W are both very short range and very slow - particles have to wait a long time for such a large amount of energy to become available as a quantum fluctuation within the temporal bounds of the Heisenberg "virtual interval".

The decays of the weak force are slow only in relation to other nuclear processes. Typically, the lifetimes of particles undergoing weak reactions is around 10(-10) seconds (one 10 billionth of a second, or a tenth of a nanosecond), but this may nevertheless be ten billion times (or more) longer than typical strong force nuclear reactions. Because the W mediates so many different kinds of reactions, involving the decays of baryons, mesons, and leptons, with the production of so many different products, including photons, neutrinos, leptons, quarks, mesons, and baryons, one has to wonder what sort of transformation mechanism is operating inside the "black box" that is the W.

In this paper I propose a very simple mechanism to explain the manifold transformations and products of the "W" IVB. I begin by making an assumption about the nature of the W itself, a speculation concerning the origin of its great mass. This mass cannot be derived from quarks, the source of mass in ordinary particles. I suggest that the W and the other weak force "Intermediate Vector Bosons" (IVBs) (the Z and the hypothetical X) are "metric" particles, composed simply of a very dense spacetime metric, similar to the very early, energy dense Universe of the first moments of the Big Bang. The huge mass of the IVBs is due to the binding energy needed to compress, perhaps convolute, and maintain the metric of spacetime in these particular forms.

An IVB "metric particle", mediator, or catalyst functions by engulfing a particle ripe for transformation (referred to below as the "parent" particle), and combining it with one or more suitable particle-antiparticle pairs, these latter drawn from the infinitely varied resources of the virtual particle "sea", the quantum fluctuations of the vacuum. (The vacuum will be polarized by the presence of the "parent" particle, facilitating the production of suitable particle-antiparticle pairs.) The W works its transformations simply by virtue of its dense (and perhaps convoluted) metric. The dense metric brings particles so close together they can react with each other quickly and in ways which are impossible when they are separated by ordinary distances. In particular, particles can exchange charge, spin, momentum, and energy without violating the conservation laws, due to their intimate proximity (perhaps essentially "touching") within the embrace of the IVB's dense metric. The massive IVBs provide a "conservation containment" or "safe house" in which charge and energy can be transferred at very close range between "real" and virtual particles. The W acts simply as a metric catalyst while the virtual quantum "sea" provides the diversity of reactants.

The basic role of the IVBs is therefore to form a bridge between real particles and the virtual particle "sea" of the vacuum; the IVBs thus make available all the electric, number, color, and flavor charges (and spin) of the virtual particle "sea", so that "real" (temporal) particles can use them to accomplish transformations and decays, and to materialize and dematerialize as necessary. It is the ability of the IVBs to contact and materialize the virtual particle "sea" that is their distinguishing characteristic and that requires their unique structure. Because the real and virtual particles of today were once all part of the same primordial high energy "sea", it appears that the IVBs are simply reconnecting the manifest and unmanifest parts of the original "sea" by reconstituting the dense metric in which both were born.

Even the surprisingly large mass of the top quark (about 170 GEV) is not a problem for the transformation mechanism proposed here. The "W" IVB does not create the "parent" particle in any reaction. The parent particle is always provided by the environment; only the mass of the reactive particle-antiparticle pair must be provided by the IVB. In the decay of the top quark, the mediating virtual pair is a bottom-antibottom meson; since the bottom quark mass is only about 4 GEV, this meson is readily produced by the "W".

Just as charge invariance is a critical issue for charge and symmetry conservation, so also must be the mechanism of elementary charge carrier transformation (transformations of quarks and leptons). The role of the weak force and the massive IVBs is to ensure that charge invariance, charge conservation, and energy conservation are all scrupulously observed in any transformation of elementary particle charge, mass, and identity.

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 created and transformed during the early micro-moments of the "Big Bang". This recapitulation ensures that the original and invariant values of charge, mass, and energy are handed on to the next generation in the charge-transfer chain. The IVB mass not only provides a "conservation containment" where charge and energy transfers can take place, it simultaneously ensures that the appropriate alternative charge carriers are present.

There is a crucial difference between the electromagnetic creation of particles via particle-antiparticle formation, and the weak force transformation of existing particles to other elementary forms. In the case of electromagnetic pair creation, there can be no question of the suitability of either partner for a subsequent annihilation reaction, conserving symmetry. However, in the weak force transformation of an existing elementary particle to another form, alternative charge carriers must be used to balance charges, since using actual antiparticles for this purpose would only produce annihilation reactions. But how is the weak force to guarantee that the alternative charge carrier - which may be a meson, a neutrino, or a massive lepton - will have the correct charge in kind and magnitude to balance and conserve symmetry in some future reaction 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*). Neither color nor number charge has a long-range projection (such as the magnetic field of electric charge) to indicate to a potential reaction partner its relative energy state. Finally, unlike electric or color charge, neutrinos are linked with particles of a specific mass (the leptonic elementary spectrum), possibly raising an energy conservation problem. Energy conservation combined with symmetry conservation, hidden charges, and alternative charge carriers, all pose a unique challenge to the weak force transformation mechanism.

All such problems are solved by a return to the original conditions in which these particles and transformations were created, much as we return and refer to the Bureau of Standards when we need to recalibrate our instruments. The necessity for charge invariance in the service of symmetry conservation therefore offers a plausible explanation for the otherwise enigmatic large mass of the weak force IVBs. The IVB mass serves to recreate the original environmental conditions - metric and energetic, particle and charge - in which the reactions they now mediate took place, ensuring charge invariance and symmetry conservation regardless of the type of alternative charge carrier or transformation involved. There is no practical difference between the "original metric" and the "safe house" explanations for the IVB mass; one cannot be disentangled from the other, and both may be necessary to the process. (See: “Global-Local Gauge Symmetries of the Weak Force” on the Homepage.)

Below I list all the major examples of the slow or "weak" reactions as recorded in the "Stable Particle Table" of the 65th CRC Handbook of Chemistry and Physics. A typical way of writing a weak reaction might be as follows, illustrating the weak decay of a negative pion (ud^-), producing a muon (μ^-) and an antimuon neutrino ($\underline{\nu\mu}$) (antiparticles underlined):

$$\underline{u}d^-(W^-)\ \text{--->}\ \underline{\nu\mu} + \mu^-$$

I could write this reaction as:

$$\underline{u}d^-(\ )W^-\ \text{--->}\ \underline{\nu\mu} + \mu^-$$

suggesting there are virtual reactants in the empty parenthesis which actually make the reaction happen. For example:

$$\underline{u}d^-\ (\underline{\mu}^+ \text{ x } \mu^-)W^-\ \text{--->}\ \underline{\nu\mu} + \mu^-$$

Here I show the W joining a muon-antimuon particle pair ($\underline{\mu}^{+}$ x μ^{-}) drawn from the virtual vacuum "sea" with the negative pion ($\underline{u}d^{-}$) to produce the actual reaction and its products. In this example the electric charges of the antimuon and pion cancel each other, releasing the antimuon's neutrino. The original electric charge of the pion is conserved in the reaction's product by the muon; the pion's u and d quarks undergo a matter-antimatter annihilation, possible because their electric charge, momentum, and rest energy can be transferred to the product particles by their close proximity within the metric scaffold of the W (individual quark flavors are not strictly conserved).

All the reactions and their products listed below (essentially all the common weak force decays) can be produced by placing a suitably chosen particle-antiparticle pair (sometimes two) in the brackets between the reacting particle and the W. Since adding a particle-antiparticle pair (or two) to a reaction is like adding zero to a mathematics equation, it is no surprise that it works in every case. Still, I do not think this result is trivial. At least it gives us a plausible, specific mechanism and reaction pathway rather than the "black box" as the "W" appears to us now. In addition, notice that in the baryon decays a particular meson is always necessary to both annihilate and supply a specific quark flavor in the baryon being transformed. The antiparticle of this reacting meson always appears among the product particles, suggesting that the proposed mechanism is in fact the actual pathway. From this observation we deduce the two-stage "beta" decay of the neutron, which helps explain the enormous lifetime of this particle. While this observation always applies to baryons, it only sometimes applies to the decay pathways of the mesons themselves, as in mesons we are dealing with particle-antiparticle pairs which can eventually annihilate each other regardless of differences in their quark's flavors.

In reading the reactions below, notice that typically the first member of the particle-antiparticle pair reacts with the "parent" particle outside the brackets, while the second member of the pair usually goes straight to the product unaffected. A few reactions have three or four components and apparently two steps, but none are particularly complicated. The energy released in the transformation of the "parent" particle to a lower mass product (E = mcc) is used to manifest virtual particles, and appears in the reaction products as rest mass, momentum, and/or free energy.

In quantum mechanics, unless a process is expressly forbidden by some physical law, it is presumed to occur. Hence, unless the participation of virtual particle-antiparticle pairs in particle decays is for some reason forbidden, the reactions as written below, at least for the most part, should occur in nature. The only question would be what percentage of the total decay spectrum these pathways might occupy, in cases (if any) where they are in competition with other routes.

Lepton Decays

I presume in these reactions that quarks annihilate only with antiquarks, and leptons annihilate only with antileptons. Thus, in the case of tau decay producing a negative pion, (as in reaction 2c below), the tau's and positive pion's electric charges cancel, allowing the quarks of the positive pion to self-annihilate, simultaneously releasing the tau neutrino. The considerable mass difference between the "parent" tau and the product pion supplies the energy to materialize the remaining negative pion of the virtual pair.

(μ = muon, t = tau, v = neutrino, y = photon)
(antiparticles underlined; lifetimes in seconds; mass in MeV)
(all reaction percentages, products, lifetimes, and masses are as reported in the 65th CRC Handbook, Stable Particle Table pages F214 - 220)

1) muon: μ^-, $\underline{\mu}^+$; mass 105.7, lifetime $2.2\text{x}10^{-6}$ = 0.0000022 sec.

In a) and b), muons and positrons ($\underline{e}^+$) annihilate, releasing both their neutrinos. The mass energy of the muon materializes the electron as the remaining member of the virtual positron x electron pairs, conserving electric charge. The electric charge of the W is always the same as the “orphaned” or product member of the particle-antiparticle pair.

Principle decay products:

a) muon neutrino, positron neutrino, electron (98.6%):

$\mu^-[\,\underline{e}^+ \text{ x } e^-\,]W^- \text{ ---> } \mathrm{v}\mu + \underline{ve} + e^-$

b) muon neutrino, positron neutrino, electron, photon (1.4%):

$\mu^-[\,\underline{e}^+ \text{ x } e^-\,]W^- \text{ ---> } \mathrm{v}\mu + \underline{ve} + e^- + y$

2) tau: t^{-}, $\underline{t}^{+}$; mass 1784.2, lifetime $4.6\text{x}10^{-13}$

In a) and b), tau annihilates with antimuon or positron, releasing neutrinos. The mass energy of the tau materializes the muon or electron from the virtual particle x antiparticle pairs, conserving electric charge.

Principle decay products:

a) tau neutrino, muon antineutrino, muon (18.5%):

$t^{-}[\, \underline{\mu}^{+} \text{ x } \mu^{-} \,]W^{-} \text{ ---> } vt + \underline{v\mu} + \mu^{-}$

b) tau neutrino, positron neutrino, electron (16.2%):

$t^{-}[\, \underline{e}^{+} \text{ x } e^{-} \,]W^{-} \text{ ---> } vt + \underline{ve} + e^{-}$

In c) and d), tau and positive pion cancel electric charges, releasing the tau neutrino and allowing the positive pion(s) to self-annihilate. The mass energy of the tau materializes the remaining negative pion(s) from the virtual particle x antiparticle pairs, conserving electric charge.

c) hadron^{-}, neutrino, (37%) similar to:

$t^{-}[\, u\underline{d}^{+} \text{ x } \underline{u}d^{-} \,]W^{-} \text{ ---> } vt + \underline{u}d^{-}$

d) 3 hadrons^{+-}, neutrino, (28.4%) similar to:

$t^{-}[\, (u\underline{d}^{+} \text{ x } \underline{u}d^{-})(u\underline{d}^{+} \text{ x } \underline{u}d^{-}) \,]W^{-} \text{ ---> } vt + \underline{u}d^{-} + (u\underline{d}^{+} \text{ x } \underline{u}d^{-})$

Meson Decays

(Quark flavors and electric charges: u, c, t = $2/3^{+}$; d, s, b = $1/3^{-}$;
charges reversed in antiparticles)

3) pion: $u\underline{d}^{+}$, $\underline{u}d^{-}$; mass 139.6, lifetime $2.6\text{x}10^{-8}$

In a) and b), pion/muon cancel electric charge, releasing the muon's neutrino and allowing the pion to self-annihilate. The energy of annihilation materializes the remaining muon from the virtual particle x antiparticle pair as a product, conserving electric charge.

Principle decay products:

a) muon neutrino, antimuon (100%):

$u\underline{d}^{+}[\ \mu^{-}\ x\ \underline{\mu}^{+}\ ]\underline{W}^{+}$ ---> $v\mu + \underline{\mu}^{+}$

b) muon antineutrino, muon (100%):

$\underline{u}d^{-}[\ \underline{\mu}^{+}\ x\ \mu^{-}\ ]W^{-}$ ---> $\underline{v\mu} + \mu^{-}$

4) Kaon: $u\underline{s}^{+}$, $\underline{u}s^{-}$; mass 493.7, lifetime $1.2x10^{-8}$

In a), b), and c), kaons and leptons cancel electric charges, releasing lepton neutrinos and allowing kaons to self-annihilate. The energy of annihilation materializes all remaining leptons and pions from the virtual particle x antiparticle pairs, conserving electric charge.

Principle decay products:

a) antimuon neutrino, muon (63.5%)

$\underline{u}s^{-}[\ \underline{\mu}^{+}\ x\ \mu^{-}\ ]W^{-}$ ---> $\underline{v\mu} + \mu^{-}$

b) antimuon neutrino, muon, neutral pion (3.2%):

$\underline{u}s^{-}[\ (\underline{\mu}^{+}\ x\ \mu^{-})\ x\ \underline{u}u^{o}\ ]W^{-}$ ---> $\underline{v\mu} + \mu^{-} + \underline{u}u^{o}$

c) positron neutrino, electron, neutral pion (4.8%):

$\underline{u}s^{-}[\ (\underline{e}^{+}\ x\ e^{-})\ x\ \underline{u}u^{o}\ ]W^{-}$ ---> $\underline{ve} + e^{-} + \underline{u}u^{o}$

In d), e), and f), kaons and pions annihilate each other. The energy of annihilation materializes all remaining virtual pions and particle x antiparticle pairs, conserving electric charge.

d) neutral pion, positive pion (21.2%):

$u\underline{s}^{+}[\ (\underline{u}d^{-}\ x\ u\underline{d}^{+})\ \ x\ u\underline{u}^{o}\ ]\underline{W}^{+}$ ---> $u\underline{u}^{o} + u\underline{d}^{+}$

e) 2 positive pions, 1 negative pion (5.6%):<P align=center>

$u\underline{s}^{+}[\ (\underline{u}d^{-}\ x\ u\underline{d}^{+})\ x\ (\underline{u}d^{-}\ x\ u\underline{d}^{+})\ ]\underline{W}^{+}$ ---> $u\underline{d}^{+} + (\underline{u}d^{-}\ x\ u\underline{d}^{+})$

f) 1 positive pion, 2 neutral pions (1.7%):

$u\underline{s}^{+}[\ (\underline{u}d^{-}\ x\ u\underline{d}^{+})\ x\ (u\underline{u}^{o}\ x\ u\underline{u}^{o})\ ]\underline{W}^{+}$ ---> $u\underline{d}^{+} + (u\underline{u}^{o}\ x\ u\underline{u}^{o})$

5) neutral kaons: $d\underline{s}^{o}$, $\underline{d}s^{o}$; mass 497.7, lifetime "Short": $0.9x10^{-10}$

"Short" (referring to lifetime) neutral kaons annihilate with neutral pions, materializing charged or neutral pions from the virtual particle x antiparticle pairs, needed for absorbing and distributing momentum.
Principle decay modes $d\underline{s}^{o}$ or $\underline{d}s^{o}$ ("Short"):

a) positive pion, negative pion (68.6%):

$d\underline{s}^{o}$ or $\underline{d}s^{o}[\ \underline{d}d^{o}\ x\ (\underline{u}d^{-}\ x\ u\underline{d}^{+})\ ]W^{o}$ ---> $(\underline{u}d^{-}\ x\ u\underline{d}^{+})$

b) 2 neutral pions (31.4%):

$d\underline{s}^{o}$ or $\underline{d}s^{o}[\ d\underline{d}^{o}\ x\ (d\underline{d}^{o}\ x\ d\underline{d}^{o})\ ]W^{o}$ ---> $(d\underline{d}^{o}\ x\ d\underline{d}^{o})$

6) Lifetime "Long": $5x10^{-8}$; ("Long" is a superposition of $d\underline{s}^{o}$ and $\underline{d}s^{o}$)

In a) and b),"long" (referring to lifetime) neutral kaons self-annihilate, materializing charged and neutral pions from the virtual particle x antiparticle pairs, necessary for absorbing and distributing momentum. The "long" reaction pathway is more complex than the "short" reaction pathway; apparently the superposition ($d\underline{s}^{o}/\underline{d}s^{o}$) self-annihilates (why wouldn't it?) rather than reacting with the virtual pions; this evidently takes longer and requires more particles in the product to conserve momentum. Hence although the virtual particle x antiparticle complex is identical in both the "short" and "long" decay sequences, the products are different because the "short" annihilates one member of its virtual complex, whereas the "long" does not. In the decays of neutral particles, the problem is not so much charge conservation as momentum conservation.

Principle decay modes $d\underline{s}^{o}/\underline{d}s^{o}$ ("Long"):

a) 3 neutral pions (21.5%):

$$d\underline{s}^o/\underline{d}s^o[\ \underline{d}d^o \text{ x } (\underline{d}d^o \text{ x } \underline{d}d^o)\ ]W^o \text{ ---> } \underline{d}d^o + (\underline{d}d^o + \underline{d}d^o)$$

b) 2 charged, 1 neutral pion (12.4%):

$$ds^o/\underline{d}s^o[\ \underline{d}d^o \text{ x } (u\underline{d}^+ \text{ x } \underline{u}d^-)\ ]W^o \text{ ---> } \underline{d}d^o + (u\underline{d}^+ \text{ x } \underline{u}d^-)$$

In c) and d), "long" neutral kaons self-annihilate, materializing leptons and charged pions from the virtual particle x antiparticle pairs. The W complex includes both pion and lepton virtual particle-antiparticle pairs; the positive leptons react with a negative pion as seen previously in meson decay 3b. All products help absorb and distribute momentum.

c) charged pion, antimuon neutrino, muon (27.1%):

$$d\underline{s}^o/\underline{d}s^o[\ (u\underline{d}^+ \text{ x } \underline{u}d^-)(\underline{\mu}^+ \text{ x } \mu^-)\ ]W^- \text{ ---> } u\underline{d}^+ + \underline{\nu u} + \mu^-$$

d) charged pion, positron neutrino, electron (38.7%):

$$d\underline{s}^o/\underline{d}s^o[\ (u\underline{d}^+ \text{ x } \underline{u}d^-)(\underline{e}^+ \text{ x } e^-)\ ]W^- \text{ ---> } u\underline{d}^+ + \underline{\nu e} + e^-$$

Baryon Decays

Mesons "come into their own" in baryon decays, where we discover their great utility as suppliers of quark flavors and colors to facilitate baryon transformations. Mesons function as alternative carriers of color charge and quark flavor, just as leptons (electrons and neutrinos) function as alternative carriers of electric charge and lepton number ("identity") charge, functions which allow baryons to transform, conserve, neutralize, and cancel their charges without suffering annihilation by antibaryons.

7) neutron: udd^o (neutral); mass 939.6, lifetime $9.25\text{x}10^2$

Neutron decay is very slow (half-life about 15 minutes), both because there is such a small bound energy difference between reactants and products, and because the reaction pathway is complex. The $\underline{d}$ quark of the virtual positive pion annihilates with the d quark in the neutron, replacing it with an up quark, creating a proton. Meanwhile, in a secondary reaction, the remaining negative pion and a positron from a second (leptonic) virtual pair undergo a typical charged pion decay, canceling each other's electric charge and releasing the positron's neutrino. The d and u quarks of the negative pion simply annihilate each other. The mass difference between the neutron and proton produces just enough energy to materialize the electron and positron neutrino, balancing the proton's electric charge, and the reaction's overall lepton "number" ("identity") charge.

Principle decay products ("beta" decay):

a) proton plus positron neutrino plus electron (100%):

$udd^{o}[\ (\underline{d}u^{+} \text{ x } d\underline{u}^{-})(\underline{e}^{+} \text{ x } e^{-})\ ]W^{-} \text{ ---> } udu^{+} + \underline{\nu e} + e^{-}$

8) lambda: dus^{o} (neutral); mass 1115.6, lifetime $2.6\text{x}10^{-10}$

A $\underline{d}$ quark of the virtual positive meson annihilates with the s quark of the lambda, and replaces it with an up quark in reaction a), creating a proton, and a d quark in reaction b), creating a neutron. The annihilation energy materializes the remaining virtual pion in both cases, conserving charge and/or momentum. This reaction is faster than reaction 1) because there is far more available energy from the decay of the heavy s quark, and the reaction pathway is simpler.

Principle decay products:

a) proton plus negative pion (64.2%):

$dus^{o}[\ \underline{d}u^{+} \text{ x } d\underline{u}^{-}\ ]W^{-} \text{ ---> } duu^{+} + d\underline{u}^{-}$

b) neutron plus neutral pion (35.8%):

$dus^{o}[\ \underline{d}d^{o} \text{ x } \underline{d}d^{o}\ ]W^{o} \text{ ---> } dud^{o} \text{ x } \underline{d}d^{o}$

9) Sigma: uus^{+}; mass 1189.4, lifetime $0.8\text{x}10^{-10}$

In a), a $\underline{d}$ quark in the virtual pion annihilates with the s quark of the sigma, replacing it with a d quark to create a proton and simultaneously materializing the remaining neutral pion. In b), both the negative and neutral pion react with sigma s and u quarks, replacing them with d quarks (first the intermediate lambda uds^{o} is formed, which then reacts with the neutral pion $d\underline{d}^{o}$to produce the neutron udd^{o}). The remaining positive pion is materialized to balance electric charge. In both a) and b) the mass energy difference between the s and d quarks fuels the reaction.

Principle decay products:

a) proton + neutral pion (51.6%):

$uus^{+}[\ \underline{d}d^{o}\ x\ \underline{d}d^{o}\ ]\underline{W}^{+}$ ---> $uud^{+} + \underline{d}d^{o}$

b) neutron + positive pion (48.4%):

$uus^{+}[\ d\underline{d}^{o}\ x\ (\underline{u}d^{-}\ x\ u\underline{d}^{+})\ ]\underline{W}^{+}$ ---> $udd^{o} + u\underline{d}^{+}$

10) Sigma: dds^{-}; mass 1197, lifetime $1.5x10^{-10}$

The $\underline{d}$ quark of the positive pion annihilates the s quark in the sigma and replaces it with an up quark, forming a neutron and materializing the remaining negative pion, conserving electric charge.

Principle decay products:

a) neutron + negative pion (100%):

$dds^{-}[\ u\underline{d}^{+}\ x\ \underline{u}d^{-}\ ]W^{-}$ ---> $ddu^{o} + \underline{u}d^{-}$

11) Xi: uss^{o} (neutral); mass 1315, lifetime $2.9x10^{-10}$

A $\underline{d}$ quark from a neutral pion annihilates with the s quark in the xi, replacing it with a d quark; the annihilation energy materializes the remaining neutral pion of the virtual pair.

Principle decay products:

a) lambda plus neutral pion (100%):

$uss^{o}[\ \underline{d}d^{o}\ x\ \underline{d}d^{o}\ ]W^{o}$ ---> $usd^{o} + \underline{d}d^{o}$

12) Xi: dss^{-}; mass 1321.3, lifetime $1.6x10^{-10}$

A $\underline{d}$ quark from a positive pion annihilates with the s quark in the xi, replacing it with an up quark; the annihilation energy materializes the remaining negative pion of the virtual pair, conserving electric charge.

Principle decay products:

a) lambda plus negative pion (100%):

$$dss^{-}[\ u\underline{d}^{+}\ x\ \underline{u}d^{-}\ ]W^{-}\ \text{--->}\ dsu^{o} + \underline{u}d^{-}$$

13) Omega: sss^{-}; mass 1672.5, lifetime $0.8x10^{-10}$

In a), $\underline{s}$ and $\underline{d}$ quarks in the positive and neutral pions of the virtual complex annihilate with two s quarks in the omega, replacing them with u and d quarks; annihilation energy materializes the remaining negative pion, conserving electric charge. (This reaction pathway is similar to 9b, which also changes two quarks.) The intermediate product is the xi sus^{o}, which reacts with the neutral pion $\underline{d}d^{o}$ to form the lambda sud^{o}.

In b), a $\underline{d}$ quark in the positive pion of the virtual pair annihilates with the s quark in the omega, replacing it with an up quark; annihilation energy materializes the remaining negative pion, conserving electric charge.

In c), a $\underline{d}$ quark in one of the neutral virtual pions annihilates with the s quark in the omega, replacing it with a d quark and materializing the remaining neutral pion.

Note how naturally the virtual particle-antiparticle pair mechanism advocated here produces all the exotic products in the three decays of the omega listed below. Recall these are the experimentally observed products as listed in the CRC Handbook. This is strong evidence that the proposed mechanism is the actual pathway used by the W.

Reaction a) is favored overall in spite of its more complex pathway because two of the heavy s quarks can decay simultaneously (or sequentially), releasing more free energy to drive the reaction. Reaction b) is favored over c) because, as is evident from several other comparable decays (see 4 e, f; 5a, b; and 8 a, b) it is more difficult to assemble neutral particle pairs than charged particle pairs - all other things being equal.

Principle decay products:

a) lambda plus negative kaon (68.6%):

$sss^{-}[\,\underline{d}d^{o} \text{ x } (\underline{s}u^{+} \text{ x } s\underline{u}^{-})\,]W^{-} \text{ ---> } sud^{o} + s\underline{u}^{-}$

b) xi (neutral) plus negative pion (23.4%):

$sss^{-}[\,\underline{u}d^{+} \text{ x } u\underline{d}^{-}\,]W^{-} \text{ ---> } ssu^{o} + u\underline{d}^{-}$

c) Xi^{-} plus neutral pion (8%):

$sss^{-}[\,\underline{d}d^{o} \text{ x } \underline{d}d^{o}\,]W^{-} \text{ ---> } ssd^{-} + \underline{d}d^{o}$

Postscript to the Weak Force Mechanism Paper

(revised Sept., 2006)

The particle-antiparticle charge-carrying mechanism that works so well to illustrate the weak force decay pathways of leptons, mesons, and baryons (revealing as well the generic utility of mesons in hadron transformations), may also have some explanatory power for other types of transformations (especially electromagnetic transformations) - as we might expect of such a fundamental process, and in consideration of the electroweak unification.

I will consider only one example of such an electromagnetic transformation: when protons $(uud)^{+}$ are bombarded with negative pions $(\underline{u}d)^{-}$, a negative sigma $(dds)^{-}$ and a positive kaon $(u\underline{s})^{+}$ are readily produced, but the “reciprocal” product of a positive sigma $(uus)^{+}$ and a negative kaon $(\underline{u}s)^{-}$ never occurs. Why this should be true may be seen in terms of the particle-antiparticle charge carrier mechanism (operating this time without the mediation of the weak force IVBs). An external source (the laboratory accelerator) supplies as much energy as is needed to achieve the reaction threshold.

Of the two products here considered (sigma^{-} vs sigma^{+}), there is a straightforward electromagnetic reaction pathway only to the sigma^{-}:

a) $\underline{u}d^{-} + uud^{+}(\underline{u}s^{-} \text{ x } u\underline{s}^{+}) \text{ -----> } dsd^{-} + u\underline{s}^{+}$

In reaction a) the energy of collision between the negative pion and proton creates a kaon x antikaon particle pair; the negative member of this pair reacts with the proton, annihilating an “u” quark in the proton with its anti “$\underline{u}$” quark, and replacing it with an “s” quark. The colliding negative pion likewise reacts with the proton, annihilating an “u” quark and replacing it with a “d” quark. These two (probably simultaneous) reactions produce the negative sigma and materialize the positive kaon of the particle-antiparticle pair, conserving electric charge.

Nothing is involved in this reaction beyond matter-antimatter annihilations of one quark flavor by its corresponding antiflavor, and the substitution of one quark for another from both the negative pion and the negative kaon. However, when we try to reach the sigma+ by an analogous pathway, we find we can do so only with difficulty. The “reciprocal” reaction we are trying to create is:

$$\underline{u}d^- + uud^+ \text{ -----> } uus^+ + \underline{u}s^-$$

Reaction b), however, achieves the desired product only via a difficult two-step pathway:

b1) $\underline{u}d^- + uud^+(\underline{d}s^o \text{ x } d\underline{s}^o) \text{ -----> } dus^o + d\underline{s}^o$

b2) $dus^o(u\underline{s}^+ \text{ x } \underline{u}s^-) \text{ -----> } uus^+ + \underline{u}s^-$

In the second step, the “$\underline{s}$” quark of the antikaon would have to annihilate with the “d” quark of the baryon, rather than with the baryon’s “s” quark, which it would much prefer (producing a proton). Clearly, this improbable two-step reaction can not compete with the single step, straightforward reaction in a). Hence the particle-antiparticle charge-carrying mechanism does seem to have some explanatory power (beyond weak force processes) regarding the pathways of transformation among elementary particles, both with regard to what does happen and what does not.

References:

CRC Handbook of Chemistry and Physics, 65th edition, 1984-5. CRC Press, Inc. Table of Particle Properties (page F-214).

D. J. Gross and F. Wilczek. 1973. Ultraviolet Behavior of Non-Abelian Gauge Theories. Phys. Rev. Lett. 30: 1343.

Links:

Guide to the Papers. Sect. IV: The “W” IVB and the Weak Force
http://www.people.cornell.edu/pages/jag8/sect4.html

Symmetry Principles of the Unified Field Theory
http://www.people.cornell.edu/pages/jag8/appendix.html

Identity Charge and the Weak Force
http://www.people.cornell.edu/pages/jag8/identity.html

Table of Particles
http://www.people.cornell.edu/pages/jag8/partable.html

The System of Matter
http://www.people.cornell.edu/pages/jag8/matter.html

The Formation of Matter and the Origin of Information
http://www.people.cornell.edu/pages/jag8/origin.html

Proton Decay and the "Heat Death" of the Cosmos
http://www.people.cornell.edu/pages/jag8/proton.html

Global and Local Gauge Symmetries of the Weak Force
http://www.people.cornell.edu/pages/jag8/gauge13.html

The Higgs Boson vs the Spacetime Metric
http://www.people.cornell.edu/pages/jag8/higgsx.html

The Higgs Boson and the Evolutionary Eras of the Cosmos (Table)
http://www.people.cornell.edu/pages/jag8/higgstable.html

The Higgs Boson vs the Weak Force IVBs: Part I
http://www.people.cornell.edu/pages/jag8/higgs.html

The Higgs Boson vs the Weak Force IVBs: Parts II, III, IV
http://www.people.cornell.edu/pages/jag8/higgsy.html

HomePage
http://www.people.cornell.edu/pages/jag8/index.html