# The "W" Particle and the Weak Force Mechanism

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The "W" particle is the "black box" of the weak force. The W "mediates" transformations of identity 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 90 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 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 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 neutrinos, photons, mesons, leptons, 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. 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 X) are "metric" particles, composed simply of a very dense spacetime metric derived from the very early, energy dense Universe - much like the multidimensional, massive particles of "string" theory. The IVBs may in fact be unrecognized examples of "strings". The huge mass of these particles is due to the binding energy needed to compress, convolute, and maintain the metric of spacetime in these particular forms.

A metric particle, mediator, or catalyst functions by engulfing 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, enabling 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 that they can react with each other in ways which are impossible when they are separated by the distances of ordinary spacetime. In particular, particles can "feel satisfied" that certain conservation parameters will be observed, such as charge, spin, momentum, etc., due to their intimate proximity within the embracing scaffolding of the dense metric. Particles can safely exchange charges, swap places, trade identities, and annihilate one another, all within the close confines of the W because the metric structure of this particle produces a surrogate coupling between them that guarantees all their conservation requirements. The W acts simply as a metric catalyst while the virtual quantum "sea" provides the diversity of reactants and products.

Below I list 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, producing a muon and antimuon neutrino:

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

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:

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

Here I show the W coupling a muon-antimuon particle pair (drawn from the virtual quantum “sea”) with the negative pion 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 electric charge of the pion is conserved by the antimuon's partner, and the pion's $\underline{u}$ and d quarks can undergo a matter-antimatter annihilation, now possible because their electric charge has been transferred to the muon and their momentum has been coupled to the product particles by the metric scaffold of the W.

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 square 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 rather than the "black box" we have now. In addition, notice that in the case of baryon decay 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. This observation does not apply to the decay pathways of the mesons themselves, as in those cases we are always 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.

**Lepton Decays**

(μ = muon, τ = tau, ν = neutrino, γ = photon)

(antiparticles underlined; lifetimes in seconds; mass in MeV)

1) muon $\mu^-$ $\underline{\mu}^+$ mass 105.7 lifetime $2.2\text{x}10^{-6}$

principle decay products:

a) electron, electron and muon neutrinos (98.6%):

$$\mu^-[\underline{e}^+ \text{ x } e^-]W^- \text{ --- } \nu\mu + \underline{\nu e} + e^-$$

b) electron, electron and muon neutrinos, plus a photon (1.4%):

$$\mu^-[\underline{e}^+ \text{ x } e^-]W^- \text{ --- } \nu\mu + \underline{\nu e} + e^- + \gamma$$

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

principle decay products:

a) muon, muon and tau neutrinos (18.5%):

$$\tau^-[\underline{\mu}^+ \text{ x } \mu^-]W^- \text{ --- } \nu\tau + \underline{\nu\mu} + \mu^-$$

b) electron, electron and tau neutrinos (16.2%):

$$\tau^-[\underline{e}^+ \text{ x } e^-]W^- \text{ --- } \nu\tau + \underline{\nu e} + e^-$$

c) hadron$^-$, neutrals (37%) similar to:

$$\tau^-[u\underline{d}^+ \text{ x } \underline{u}d^-]W^- \text{ --- } \nu\tau + \underline{u}d^-$$

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

$$\tau^-[(u\underline{d}^+ \ x \ \underline{u}d^-)(u\underline{d}^+ \ x \ \underline{u}d^-)]W^- \ \text{---} \ \nu\tau + \underline{u}d^- + (u\underline{d}^+ \ x \ \underline{u}d^-)$$

## Meson Decays

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

1) pion $u\underline{d}^+$  $\underline{u}d^-$ mass 139.6 lifetime $2.6\text{x}10^{-8}$
principle decay products:

a) muon neutrino, antimuon (100%):

$$u\underline{d}^+[\mu^- \ x \ \underline{\mu}^+]\underline{W}^+ \ \text{---} \ \nu\mu + \underline{\mu}^+$$

b) antimuon neutrino, muon (100%):

$$\underline{u}d^-[\underline{\mu}^+ \ x \ \mu^-]W^- \ \text{---} \ \underline{\nu\mu} + \mu^-$$

2) Kaon $u\underline{s}^+$  $\underline{u}s^-$ mass 493.7 lifetime $1.2\text{x}10^{-8}$
principle decay products:

a) antimuon neutrino, muon (63.5%):

$$\underline{u}s^-[\underline{\mu}^+ \ x \ \mu^-]W^- \ \text{---} \ \underline{\nu\mu} + \mu^-$$

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

$$u\underline{s}^+[\underline{u}d^- \ x \ u\underline{d}^+]\underline{W}^+ \ \text{---} \ u\underline{u} + u\underline{d}^+$$

c) 2 positive pions, 1 negative pion (5.6%):

$$u\underline{s}^+[\underline{u}d^- \ x \ u\underline{d}^+ \ x \ d\underline{d}]\underline{W}^+ \ \text{---} \ u\underline{d}^+ + \underline{u}d^- + u\underline{d}^+$$

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

$$u\underline{s}^+[\underline{u}d^- \ x \ u\underline{d}^+ \ x \ u\underline{u}]\underline{W}^+ \ \text{---} \ u\underline{u} + u\underline{d}^+ + u\underline{u}$$

e) muon antineutrino, muon, neutral pion (3.2%):

$$\underline{u}s^-[\underline{\mu}^+ \ x \ \mu^- \ x \ u\underline{u}]W^- \ \text{---} \ \underline{\nu\mu} + \mu^- + u\underline{u}$$

f) electron antineutrino, electron, neutral pion (4.8%):

$$\underline{u}s^-[\underline{e}^+ \ x \ e^- \ x \ u\underline{u}]W^- \ \text{---} \ \underline{\nu e} + e^- + u\underline{u}$$

3a) neutral kaons $\underline{d}s$ $\underline{s}d$ mass 497.7 lifetime "Short": $0.9\text{x}10^{-10}$ "Long": 5x10-8 ("Long" is a superposition of $\underline{d}s$ and $d\underline{s}$)
principle decay modes $\underline{d}s$ or $\underline{s}d$ ("Short"):

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

$$d\underline{s}[u\underline{d}^+ \ x \ \underline{u}d^-]W \ \text{---} \ u\underline{d}^+ + \underline{u}d^-$$

b) 2 neutral pions (31.4%):

$$d\underline{s}[d\underline{d} \ x \ d\underline{d}]W \ \text{---} \ d\underline{d} + d\underline{d}$$

3b) principle decay modes $\underline{d}s/\underline{s}d$ ("Long"):

a) 3 neutral pions (21.5%):

$$\underline{d}s/d\underline{s}[\underline{d}d\ x\ \underline{d}d\ x\ \underline{d}d]W\ \text{---}\ \underline{d}d + \underline{d}d + \underline{d}d$$

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

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

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

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

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

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

## Baryon Decays

1) neutron udd (neutral) mass 939.6 lifetime $9.25x10^2$

principle decay products (“beta” decay):

a) proton plus electron plus electron antineutrino (100%):

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

2) lambda dsu (neutral) mass 1115.6 lifetime $2.6x10^{-10}$

principle decay products:

a) proton plus negative pion (64.2%):

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

b) neutron plus neutral pion (35.8%):

$$dsu[\underline{d}d\ x\ d\underline{d}]W\ \text{---}\ ddu\ x\ d\underline{d}$$

3) Sigma $uus^+$ mass 1189.4 lifetime $0.8x10^{-10}$

principle decay products:

a) proton + neutral pion (51.6%):

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

b) neutron + positive pion (48.4%):

$$uus^+[\underline{u}d^-\ x\ u\underline{d}^+\ x\ \underline{d}d]\underline{W}^+\ \text{---}\ ddu + u\underline{d}^+$$

4) Sigma $dds^-$ mass 1197 lifetime $1.5x10^{-10}$

principle decay products:

a) neutron + negative pion (100%):

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

5) Xi ssu (neutral) mass 1315 lifetime 2.9x10$^{-10}$
principle decay products:

a) lambda plus neutral pion (100%):

$$ssu[\underline{d}d \text{ x } d\underline{d}]W \text{ --- } dsu + d\underline{d}$$

6) Xi ssd$^{-}$ mass 1321.3 lifetime 1.6x10$^{-10}$
principle decay products:

a) lambda plus negative pion (100%):

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

7) Omega sss$^{-}$ mass 1672.5 lifetime 0.8x10$^{-10}$
principle decay products:

a) lambda plus negative kaon (68.6%):

$$sss^{-}[\underline{s}u^{+} \text{ x } s\underline{u}^{-} \text{ x } d\underline{d}]W^{-} \text{ --- } dsu + s\underline{u}^{-}$$

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

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

c) Xi- plus neutral pion (8%):

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

## Proton and Leptoquark Decays

1) proton decay uud$^{+}$ (hypothetical) mediated by both X and W
principal decay products (similar to $\underline{tau}^{+}$ decay products):

a) hadron$^{+}$, neutrals including leptoquark neutrino:

$$X[uud^{+}(\underline{u}d^{-} \text{ x } u\underline{d}^{+})]\underline{W}^{+} \text{ --- } vlq + u\underline{d}^{+}$$

b) 3 hadrons$^{+\,-}$, neutrals including leptoquark neutrino:

$$X[uud^{+}(\underline{u}d^{-} \text{ x } u\underline{d}^{+})(\underline{u}d^{-} \text{ x } u\underline{d}^{+})]\underline{W}^{+} \text{ --- } vlq + u\underline{d}^{+} + (\underline{u}d^{-} + u\underline{d}^{+})$$

2) leptoquark decay lq ($^{+\,-}$, neutral) (hypothetical - during Big Bang or Creation Event only; asymmetries in this decay are the source of the material Universe)
Principle decay products (from the asymmetric decay of an electrically neutral leptoquark-antileptoquark pair):

a) heavy neutral baryon, leptoquark neutrino, heavy neutral mesons similar to:

$$X[\underline{lq} \text{ x } lq(\underline{\tau}\tau \text{ x } \underline{\tau}\tau)]W \text{ --- } \underline{\nu lq} + bbt + (\underline{\tau}\tau + \underline{\tau}\tau)$$

$$X[\underline{lq} \times lq(\underline{\tau}\tau \times \underline{\tau}\tau)]W \text{ --- } \underline{\nu lq} + bbt + (\underline{\tau}\tau + \underline{\tau}\tau)$$

b) same, more mesons, charged and neutral

(In a leptoquark, the quarks are compressed by the X to leptonic size, vanishing the color charge (asymptotic freedom). An electrically neutral leptoquark should decay like a very heavy neutral lepton, via the W. In the pair shown, the quarks of the unreacted leptoquark expand under their mutual repulsion to form the heavy baryon. Once these quarks have expanded, the baryon cannot undergo leptonic decay due to the explicit presence of the color charge).

**References:**

CRC Handbook of Chemistry and Physics, 65th edition, 1984-5. CRC Press, Inc.

**Links:**

Symmetry Principles of the Unified Field Theory
Identity Charge and the Weak Force
Table of Particles
The System of Matter
The Hourglass Diagrams
The Formation of Matter and the Origin of Information
Homepage Mirror Site: http://members.home.net/m.guest/Spacetime