CASSIOPEIA'S ToE

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Weak Interactions – Wonderful Asymmetry

If we can adequately visualize the Weak Interactions in this model, we are definitely on the right track. Although Electroweak unification is a marvelous mathematical reality of broken symmetry, we will visualize the Weak Interactions in their own Field. And at really really short range, the Weak Interaction is stronger than the Electromagnetic Interaction. But for massive particles, the Potential falls as …

$$V(x) = -K\frac{1}{r}e^{-mr}$$

The very heavy W and Z gauge bosons make this an extremely short-range interaction -- much smaller than the diameter of a single proton, but that range is still huge compared to the scale of space quanta. So that short distance is not an impediment in the wormhole view and we begin with the standard wormhole visualization of letting the field bosons be the wormholes themselves actually shaping the space. But there are 3 different wormhole fields associated with the Weak Interactions. The W bosons cause particle decay, while the Z causes scattering (notably with neutrinos and also between other fermions and the Higgs field.)

Let's begin with a short discussion that involves Parity and Chirality. There are actually two different electron states because of the nature of spin. There is one state in which the electron spin is "left handed" in relation to its direction of travel. (If this electron were coming at you, the spin would be clockwise.). And the other state is the opposite spin and we will call it a "right handed" electron (e_L and e_R). And, the thing is, they are very different. e_L carries Weak hypercharge and interacts with the Weak Interaction. BUT e_R does not!!! It does not carry hypercharge and does not interact Weakly! This is what we call Parity Violation. The two states are mirror images of one another, and yet they behave differently in Weak Interactions.

Now the physical electron that exists all around us is a particle that oscillates back and forth between these two states. Let's throw in a little Higgs to help us understand this oscillation and what it has to do with mass. Normally two states with different charges cannot mix (remember "charge" refers to more than the electric charge), but the Higgs field allows this to happen. Picture the Higgs Field as a large reservoir of energy existing everywhere in space (we will visualize it as the Higgs Field, and there are (random) wormholes everywhere in this Field). Visualize a left-handed electron, e_L that is happily chugging along. It emits a Z boson and changes into a right-handed electron, e_R. Now normally the right-handed version, which does not interact with the Weak Interaction, could not oscillate back since it cannot emit its own Z boson. But since it DOES interact with the Higgs field and since the Higgs field itself DOES interact with the Weak Interaction, this enables the [Higgs + e_R] combination to emit a Z boson and oscillate back to the left-handed e_L. And what happens to those emitted Z bosons? They magically get absorbed by the huge "heat-sink" of the Higgs Field and disappear. So the coupling of e_L and e_R to the Higgs field gives the electron mass – true – but it also let's them oscillate back and forth which they could not do on their own.

Why does e_L carry Weak hypercharge and interact Weakly while e_R does not? What does that look like in the wormhole view? We visualize spin as a rotation of the wormhole itself (or at lest the rotation of the vibration-mode that maintains the wormhole). And we simply represent negative, left-handed fermions as having a coupling to the Weak Field while negative, right-handed fermions do not. It is also true that positive, right-handed fermions also couple Weakly, while positive, left-handed fermions do not.

OK, but we need to represent negative, left-handed fermions as coupling to the HIGGS but not coupling to the Weak. How do we do that if we represent Weak-Higgs as one field? We might need to represent the Weak-Higgs field as a field of paired wormholes – one of the wormhole pair is the weak-wormhole and the other is the Higgs. So while the e_L couples to both of this pair, the e_R only couples to the higgs. Mayber we represent the double wormhole as a twisted spiral, or something similar – double and yet single.

Weak Interactions, Higgs, Symmetry Breaking

The Higgs Field actually has three separate fields – One for the Boson that gives fermions mass, and two more that connect only to the W boson.

Start with ElectroWeak as a combined Field, and electric charge and hypercharge are one and the same. Those E-W wormholes (of two types – ***W*** and B) were massless, and Higgs was nowhere to be seen. Along comes the Higgs Field with 4 types of wormhole bosons. Three of these couple to the ***W*** and B creating four new types of wormhole W^+ W^- Z^0 and γ -- the photon (gamma = γ). And the 4th new type of wormhole boson is the Higgs that gives mass to fermions. This 4th boson is the only one still independently observable to us because the other three are inextricably married to the intermediate vector bosons W^+ W^- Z^0 .

Because the Weak Interactions violate so many symmetries, we have to question what is different here. What is Parity and what does a P violation look like? What is Charge Conjugation and what doe C violation look like? What does CP violation look like? And of course if there is CP violation and yet CPT still holds, then we must ask what does Time Reversal (T) violation look like?

And along the way, we may add support to the hypothesis that CP violation is the source of the matter – antimatter imbalance in our universe.

We will also try to visualize the Higgs mechanism in the symmetry breaking that gives the Intermediate Vector Bosons a large mass.

Since the "Left-Handed Lagrangian" that is used for the Weak Interactions only works on left-handed fermions, we see that spin (and chirality) is an important part of the symmetry breaking – and since the Weak Field gauge bosons are the only ones with mass and therefore have chirality different from helicity, let's approach this from that angle.

We also want to ask why the Generations are important in CP violation (could they be excited states of the 1st generation). If CP symmetry breaking is caused by a mixture of states (of the generations) then why aren't other interactions also affected by this mixture of states approach?

PARITY VIOLATION

https://www.quantumdiaries.org/2011/06/19/helicity-chirality-mass-and-the-higgs/
https://www.quantumdiaries.org/2010/02/14/lets-draw-feynman-diagams/
http://www.physicsmatt.com/blog/2015/6/17/and-explanation-of-the-higgs-boson

Consider a down quark decaying via the weak interaction to an up quark…

$$d \rightarrow u + e^{-} + \bar{\nu}_e$$

We can consider the down quark to be a superposition of left-handed and right-handed (chiral) states. From the asymmetry in the direction of emission of the resultant electrons in the original Wu experiment in 1956, it is concluded that the Weak Interaction only involves the left-handed portion of the down quark. And generalized – ONLY left-handed, negatively charged fermions interact Weakly (and right-handed positively charged anti-fermions). If the down quark (or any weakly interacting fermion) did not have mass, then the oscillation between left-handedness and right-handedness would not happen. Particles that travel at the speed of light (massless) have a constant chirality and helicity since there is no frame transformation that switches the projection of spin onto the direction of momentum from one handedness to the other.

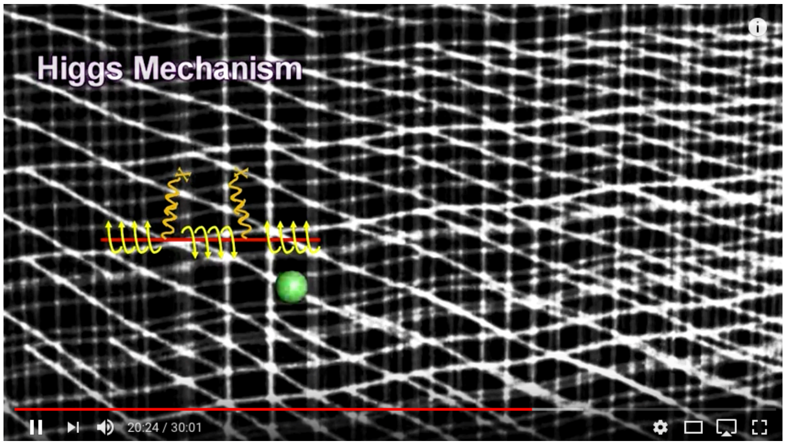
(If right-handed neutrinos exist, they would not interact Weakly – and their only mode of interaction would be Gravity. Thus they could be "dark matter". This is also true for left-handed anti-neutrinos?.)

So the W bosons will only interact with left-chiral electrons (negative charge) and right-chiral positrons (positive charge). Said another way, the W will couple to a charge -1 left-handed particle but will not couple to a charge -1 right-handed particle. This means there is an electron and an anti-electron as well as a positron and an anti-positron. The single-state positron is not always an anti-electron (single-state). Because the electron is left-chiral and the anti-positron is right-chiral. They both have charge -1 but are distinguishable by how they interact Weakly.

Now because these particles have mass, the PHYSICAL particles that we call electrons oscillate between these left-handed and right-handed states. (as does the down quark we talked about above). The PHYSICAL electron oscillates between being a left-handed electron and a right-handed "anti-positron" (electric charge remains -1 always but the handedness oscillates) And the W boson can only interact with the left-handed electron part. There are really TWO ELECTRONS… e_L and e_R … the first interacts Weakly the second does not. Left-Chiral electron and Right-Chiral electron. The first carries Weak-Charge – the second does not! If the spin doesn't change (and it can't for Angular Momentum arguments – WHAT is it that changes between e_L and e_R ???

Let's represent chirality as the helical direction of twist of the wormhole in relation to the one-way direction of passage (time). Then we can show that the helical twist of a right-handed electron into the Weak-Field CANCELS out the left-handed twist of all the bosons in a way that the right-handed electron decouples from the Weak Field entirely.

SO a la Dirac, the electron we see physically is a state oscillating between these two chiral states of the electron. In fact the frequency of that oscillation is proportional to the mass of the particle. The faster the oscillation, the more massive is the particle. Anyway the electron e_L gives off a virtual Z and turns into a e_R. The Z boson on the other hand interacts with the Higgs field that is omnipresent and does little to change the enormous sea. A short time later, the e_R does the reverse… again emitting (absorbing?) a Z boson and turning into an e_L and once again, the Z boson interacts with the Higgs field and disappears. Normally the e_R could not interact with the Z boson since it carries no hypercharge. But because it interacts with the Higgs and the Higgs carries Hypercharge, the e_R "borrows" hypercharge from the Higgs and can then interact with the Z boson to oscillate back to an e_L.



https://www.youtube.com/watch?v=xG_YtASz7gY

Since the photon has no weak hypercharge, it cannot use the Z boson to interact with the Higgs field – so it cannot oscillate and has no mass.
https://www.youtube.com/watch?v=xG_YtASz7gY

In the wormhole view, the second creates no wormholes in the Weak-Field

It is the HIGGS that induces the mixing between these particles. The Higgs itself carries a Weak Charge. When it “acquires” a vacuum expectation value, it breaks the conservation of weak charge – or “provides” the missing weak charge and allows the mixing of e_L and e_R even though they have different quantum numbers in the Weak Charge area.

In a very different way, the Higgs field gives masses to the W and Z gauge bosons. The Higgs is visualized as a scalar energy field that populates all of space. In the wormhole view, it is a Field where the wormholes always exist. Although they quantum mechanically come and go, the average expectation value is that that do exist. There are four bosons that are created in this way, but three of them are permanently coupled to the W and Z bosons… that is to say, that when the W and Z bosons come into existence as virtual particles in a Weak Field, they are always accompanied by one type of the 3 Higgs-Mechanism bosons.

Since the Higgs carries a weak hypercharge, does it generate its own Field of W and Z bosons??? YES

Consider chirality and spin and charge together… ONLY left-handed, negatively charged fermions interact Weakly (and right-handed positively charged anti-fermions). So the direction of the charge-wormhole together with the direction it is spinning are the deciding factors as to whether it interacts with the Weak Interaction. A negative-charge wormhole like the ones the electron generates must be spinning counterclockwise or else the wormholes don't couple to the Weak gauge bosons like the W (weak field)

So we need to visualize why this is so as well as for the opposite charge AND spin—need to define handedness in terms of spin AND charge

Possibly, if the magnetic moment is opposite the weak-field spin, there is no coupling? Does the Weak field generate a "weak moment" similar to the magnetic moment?

Or is it associated with the anti-symmetric nature of spinors?

Weak-Charge wormholes – the W bosons are spinning. And that spin could either be aligned or opposite the electric charge oriented spin that gives rise to the magnetic moment. This suggests the direction of the Weak charge wormholes is important.