Weak interaction: Reassembly of particules

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Abstract

The Standard Model interprets the weak interaction, e.g. neutron beta decay, to be a short-range field carried by the W and Z bosons. In that interpretation the short range arises because of the heavy mass of the W and Z bosons. This paper reconceptualises the weak interaction and the bosons. The cordus HED notation was used to work out the field structures of the bosons, giving $W^{-}(r.^{1.\underline{1}}\ .a_{.\underline{1}}^{\underline{1}.1}\ .t_{\underline{1}}^{1})$ *and* $W^{+}(\ r_{1.\underline{1}}^{\cdot}\ .a_{1}\ .t)$*. The theory suggests that there is no single Z boson, but several varieties. Cordus suggests that the W and Z bosons do not exist in the form of 0D point particles with static characteristics, but instead are complex structures undergoing dynamic assembly and disassembly processes. The conventional concept that the bosons change the flavour of the quark is questioned. Instead the model shows that the bosons not the cause or the mechanism for the change, but merely the by-products and waste process stream from the conversion process. The neutrino-antineutrino annihilation process is modelled and predicted to result in either an electron-positron pair and two photons, or four photons.*

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1 Introduction

A companion paper has identified the structure of the neutrino and antineutrino [1], particularly the discrete field structures. This was achieved by analysing the beta decay processes.

This paper extends the concepts to the broader set of reactions in which the neutrinos are involved. The structure of the W and Z bosons is identified, and a conceptual model started for decay processes in general. These explanations are given in terms of the cordus conjecture [2].

2 Background

Weak interaction

The weak interaction is fundamentally one of neutrinos involved in the process of decay of particles. The Standard Model proposes that the weak interaction is carried by W and Z bosons: W^+, W^- and Z (neutral).

The emission or absorption of a W^+ or W^- boson changes the electric charge and spin, and changes the quark flavour type. The Z boson does not change the charge, hence ‘neutral current interaction’, but can change spin. The bosons, which have been inferred from experimental

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observation, are heavy: they have mass much greater than the proton. The Z boson decays into various different particle-antiparticle pairs, such as the neutrino and the complementary antineutrino. Higher energy Z bosons may decay into higher generation neutrino-antineutrinos, and have shorter lives.

Cordus model for the neutrino

The cordus conjecture [3] proposes that the particle is *not* a zero-dimensional point as orthodox physics assumes, but rather a two-ended internal structure, which we call a 'particule'.[2]

A particule has a field structure at each of its two reactive ends. This consists of three hyff threads, one in each of three orthogonal axes [r], [a], [t]. These threads extend out into space from the reactive end. When energised, a hyffon pulse is transmitted along the thread, and hence the field is discrete. Positive and negative charge correspond to the direction of propagation of these pulses. The reactive ends are energised in turn at the frequency of the particule. Extensions of this idea accommodate the electric field, magnetism, and gravitation [4]. The hyff emission directions (HED) have a hand, called ma to differentiate it from other hand-like concepts in quantum mechanics, and this determines the matter and antimatter species [5].

A new modelling method, called HED notation, was created to represent these discrete field structures [6]. This was used to work out the structures of the neutrino and antineutrino [1]:

$$\text{Antineutrino: } \underline{v} = \underline{v}(r_{\underline{1}}^{\underline{1}}\ .a\ .t_{\underline{1}}^{\underline{1}})\ \text{etc}$$

$$\text{Neutrino } v = v(r_1^{\ 1}\ .a\ .t_1^{1})\ \text{etc}$$

In this notation x^1 represents a -1/3 charge in the x axis in the matter hand, x_1 is +1/3 charge in matter hand, $x^{\underline{1}}$ is -1/3 charge in antimatter hand, and $x_{\underline{1}}$ is +1/3 charge in antimatter. See Figure 1 for the equivalent physical representation.

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[2] The cordus conjecture is that all particles, e.g. photons and electrons, have a specific internal structure of a *cordus,* comprising two *reactive ends*, with a *fibril* joining them. The reactive ends are a small finite *span* apart, and energised (typically in turn) at a frequency, at which time they behave like a particle. When energised they emit a transient force pulse along a line called a *hyperfine fibril (hyff),* and this makes up the field. We call this a cordus 'particule', and stress it is very different to the zero-dimensional point assumed by conventional physics.

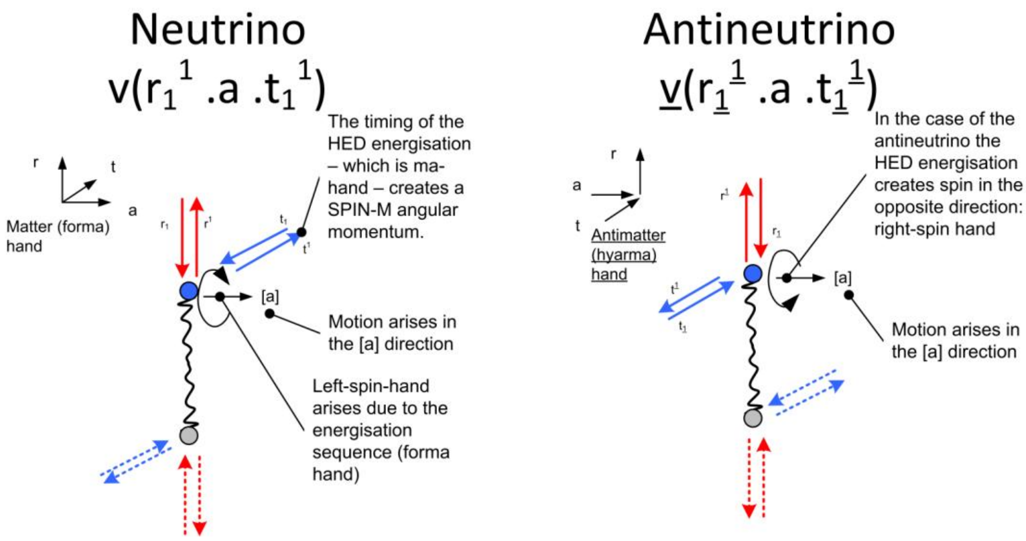

Figure 1: The cordus structure for the neutrino and antineutrino. The diagrams show the spatial arrangement of the discrete field structures (hyffons) in the three hyff emission directions (HEDS). The $v(r_1{}^{1} .a .t_1{}^{1})$ variants are shown, and other arrangements are considered possible via colour-change. The diagram also shows how the unique spin directions arise for these two particules. Note that the primary difference between matter and antimatter is the ma-hand, which is the energisation sequence of the HEDs.

We now extend the work to determine the field structures for the W and Z bosons.

3 W and Z bosons reconceptualised

The standard model of QM explains all the beta decay effects as the emission of a particle of one sort or another: the W^-, W^+, and Z bosons. Bosons are also produced in proton-proton collisions. In these cases the disassembly process has additional kinetic energy to consume, so higher generation outputs become possible, and hence more complex output combinations (channels). Now that we have a structure for the neutrino, we can also model the boson behaviour.

3.1 W- boson

In the conventional description, β- decay *causes* a d quark in the neutron to emit a W^- boson and thereby convert into a u quark, to make a proton. The W^- boson then decays into an electron and an antineutrino. Thus d=>u+W^- followed by W^- => e + $\underline{v}$. We can readily model this in HED notation [1] to work out the structure of the W^- boson.

First, express the d quark in HED notation, and then by inspection add charge-neutral incipient hyffon-antihyffon twin-pairs ($x\uparrow = x_{\underline{1}}{}^{1}$ and $x\downarrow = x_1{}^{\underline{1}}$), see [1]. These pairs may be created in any HED position, [r], [a], or [t]. They are applied where required to form the u quark structure. Then expand these pairs to create a transitional assembly O:

$$d(r^1 .a .t) => O(r_{\downarrow}{}^{1} .a_{\downarrow\uparrow} .t_{\uparrow})$$
$$=> O(r_1{}^{1.\underline{1}} .a_{1.\underline{1}}{}^{\underline{1}.1} .t_{\underline{1}}{}^{1})$$

Next, partition out the hyffons for the known output, which is the u quark, and relegate the residual hyffons into a secondary structure O_1:

$$=> u(r_1 .a_1 .t) + O_1(r.^{1.\underline{1}} .a_{.\underline{1}}^{\underline{1}.1} .t_{\underline{1}}^{1})$$

Then partition off the hyffons for the next most energetic output, which is the electron. The residual hyffons are placed into another secondary structure O_2, which we recognise as the antineutrino:

$$=> u + e(r^1 .a^1 .t^1) + O_2(r.^{\underline{1}} .a_{.\underline{1}}^{\underline{1}} .t_{\underline{1}})$$

$$=> u + e + \underline{v}(r.^{\underline{1}} .a_{.\underline{1}}^{\underline{1}} .t_{\underline{1}})$$

This model gives the W^- boson as the O_1 structure, i.e.:

$$W^- = W^-(r.^{1.\underline{1}} .a_{.\underline{1}}^{\underline{1}.1} .t_{\underline{1}}^{1})$$

This structure does indeed have a unit negative charge overall, but it achieves that with a mix of hyffons of different hand (1 and $\underline{1}$), i.e. matter and antimatter components. This amalgam structure would be highly unstable, and this qualitatively describes why it decays so fast.

In the above model for the W^- boson, we applied all the incipient hyffon twin-pairs at the outset. However another possibility is that they are applied in stages as required. In that case, there would not be a single structure for the boson but rather an evolving structure. Either way we do not favour the concept of a W^- boson as a particle, but rather see it as a dynamic *process* of hyffon re-arrangement.

2.2 W+ boson

A similar rationale gives the W+ boson as follows:

$$p => n + \underline{e} + v$$

The equivalent quark structure is:

$$uud => udd + \underline{e} + v$$

Now, consider only the one quark that changes:

$$u => d + W^+$$

Then add the charge-neutral incipient hyffon-antihyffon twin-pairs (↑ and ↓) required to form the d quark structure. Then expand these pairs to create a transitional assembly ‘O’:

$$u(r_1 .a_1 .t) => O(r_{1\uparrow}^{\cdot} .a_1 .t_{\downarrow}) => O(r_{1.\underline{1}}^{1} .a_1 .t_1^{\underline{1}})$$

Extract the d quark and place the remaining hyffons in a secondary structure O_1:

$$=> d(r^1 .a .t) + O_1(r_{1.\underline{1}}^{\cdot} .a_1 .t_1^{\underline{1}})$$

This model gives the W^- boson as the O_1 structure, i.e.:

$$W^+ = W^+(r_{1.\underline{1}}^{\cdot} .a_1 .t_1^{\underline{1}})$$

This also has unit positive charge, but is also made of contrary handed hyff. Similar comments apply as for the W^- boson regarding poor stability.

3.3 Z boson

The Z boson is known to decay into various outcomes: electron-positron, neutrino-antineutrino, or quark-antiquark. In HED notation these are as follow.

Electron-positron

$$e(r^{1}\ .a^{1}\ .t^{1}) + \underline{e}(r_{\underline{1}}\ .a_{\underline{1}}\ .t_{\underline{1}}) => Z_1(r_{\underline{1}}^{1}\ .a_{\underline{1}}^{1}\ .t_{\underline{1}}^{1}) => 2y$$

So that process is simply the positronium annihilation [6, 7], and the Z boson is identified as $Z_1(r_{\underline{1}}^{1}\ .a_{\underline{1}}^{1}\ .t_{\underline{1}}^{1})$. This is indeed neutral.

Neutrino-antineutrino

The neutrino-antineutrino pair has the following structure:

$$v(r_{1.1}^{\ 1.1}\ .a\ .t) + \underline{v}(r_{\underline{1.1}}^{\underline{1.1}}\ .a\ .t) => Z_2(r_{1.1}^{\ 1.1}{}_{\underline{1.1}}^{\underline{1.1}}\ .a.t)$$

In this case the Z boson is identified as $Z_2(r_{1.1}^{\ 1.1}{}_{\underline{1.1}}^{\underline{1.1}}\ .a.t)$. This is neutral regarding charge, but is not the same as the Z_1 boson.

U Quark-antiquark

The boson is determined as Z_3:

$$u(r_1\ .a_1\ .t) + \underline{u}(r^{\underline{1}}\ .a^{\underline{1}}\ .t) => Z_3(r_1^{\underline{1}}\ .a_1^{\underline{1}}\ .t)$$

In this case the Z boson is identified as $Z_3(r_1^{\underline{1}}\ .a_1^{\underline{1}}\ .t)$, which is not the same as the other Z bosons.

D Quark-antiquark

The boson is determined as Z_4:

$$d(r^{1}\ .a\ .t) + \underline{d}(r_{\underline{1}}\ .a\ .t) => Z_4(r_{\underline{1}}^{1}\ .a.t)$$

Once again the Z boson, $Z_4(r_{\underline{1}}^{1}\ .a.t)$, is not the same as the other Z bosons. However, we expect that the quark is cloaking some balanced hyffons internally [1].

From this we infer that there is not a single Z boson, but many specific varieties.

3.4 The cordus interpretation of the W and Z bosons

Note that the W and Z bosons have not been directly observed: they are only hypothetical particles. All that is observed is the debris trail, from which the boson is inferred as the origin. But that inference requires a theory, which is the standard model of quantum mechanics, and therefore the bosons are primarily theoretical constructs. This is important to note, because the W and Z bosons are commonly misrepresented as actually existing. They only exist within the theoretical framework of the standard model: they are artefacts of the theory, rather than observed particles.

From the cordus perspective the bosons are simply overloaded or mismatched-hand dynamic structures. Either way, they are unstable. They still have a cordus structure, so the standard model's interpretation of them as 'particles' is legitimate, even if somewhat limiting. They are not so much particles with distinct static identity that *cause* change in quarks, as dynamically changing waste streams.

Why are the bosons so heavy?

From the cordus perspective the reason they have high mass is that their fibrils need a very high frequency to service the overloaded hyffons. That implied extra energy is perhaps momentarily extracted from the fabric. Either that or the presence of so many hyffons creates a greater gravitational effect for the same fundamental energy, i.e. energy and mass are decoupled. We tentatively prefer the first explanation as a working model, but acknowledge that it is an open question.

Higher energy bosons are known to decay faster. Cordus explains this as higher energy particules having higher frequency, hence faster refresh rates of their reactive-ends. In turn, the decay process needs *cycles* of activity, not time per se. Thus higher energy particules can accomplish the necessary disassembly process steps in less time. In short, time is fundamentally the local frequency oscillations of particules, not an absolute variable [4].

3.5 Neutrino-antineutrino annihilation

The neutrino-antineutrino pair is sometimes apparent in the Z boson interactions. The previous section identified its structure:

$$v(r_{1.1}{}^{1.1}\ .a\ .t) + \underline{v}(r_{\underline{1.1}}{}^{\underline{1.1}}\ .a\ .t) => Z_2(r_{1.1}{}^{1.1}{}_{\underline{1.1}}{}^{\underline{1.1}}\ .a.t)$$

We are interested in what this might subsequently decay to. We add hyffon-antihyffon twin-pairs:

$$v + \underline{v} => O_2(r_{1.\underline{1}}{}^{1.\underline{1}}\ .a_{\downarrow\underline{1}}{}^{1}.t_{\uparrow 1}{}^{\underline{1}})$$
$$=> O_2(r_{1.\underline{1}}{}^{1.\underline{1}}\ .a_{1.\underline{1}}{}^{1.\underline{1}}.t_{1.\underline{1}}{}^{\underline{1.1}})$$
$$=> O_{2a}(r_{\underline{1}}{}^{1}\ .a_{\underline{1}}{}^{1}.t_{\underline{1}}{}^{1}) + O_{2b}(r_1{}^{\underline{1}}\ .a_1{}^{\underline{1}}\ .t_1{}^{\underline{1}})$$

The O_{2a} structure is recognised as the positronium annihilation assembly [6, 7], which can go to an electron-antielectron, or two photons. Thus:

$$v + \underline{v} => [(e + \underline{e}) \text{ or } 2y] + O_{2b}(r_1{}^{\underline{1}}\ .a_1{}^{\underline{1}}\ .t_1{}^{\underline{1}})$$

However there is a problem with reducing the $O_{2b}(r_1{}^{\underline{1}}\ .a_1{}^{\underline{1}}\ .t_1{}^{\underline{1}})$ structure, which we term notPositronium. No addition of hyffon-antihyffon pairs (↑ or ↓) will transform it. Superficially it might seem appropriate to partition it into structures $O(r^{\underline{1}}\ .a^{\underline{1}}\ .t^{\underline{1}})$ and $O(r_1\ .a_1\ .t_1)$. But the problem is these structures are not physically seen: they correspond to what we call the antinotElectron $\underline{!e}(r^{\underline{1}}\ .a^{\underline{1}}\ .t^{\underline{1}})$ and the notElectron $!e(r_1\ .a_1\ .t_1)$. Apparently these structures are forbidden in the matter (forma) universe that we inhabit, presumably a consequence of the asymmetry at genesis. Either that, or the notPositronium is an artefact of the cordus HED method.

However, there does not appear to be any constraint on the $O_{2b}(r_1{}^{\underline{1}}\ .a_1{}^{\underline{1}}\ .t_1{}^{\underline{1}})$ structure converting to two photons through annihilation. Thus:

v + $\underline{v}$ => [(e + $\underline{e}$) or 2y] + 2y
=> [(e + $\underline{e}$) + 2y] or [4y]

Thus annihilation of energetic neutrino and antineutrino annihilation is predicted to result in either an electron-positron pair and two photons, or four photons, but not two electron-positron pairs. Less energetic particules may not annihilate at all, but instead revert to a neutrino and antineutrino. So this cordus model predicts an unusual and non-intuitive set of process streams (decay channels) and this may be testable.

We make the assumption that the neutrino *can* absorb photons and thereby attain an energetic state. This is contrary to the prevailing ideas about neutrinos, which is that they do not respond electromagnetically. However we see nothing in the HED model for the neutrino to suggest it is incapable of interacting with photons, either by absorption or emission.

4 Boson lemmas

We made several assumptions above, and these are summarised below as a set of lemmas.

Ma.7 Boson behaviour

Ma.7.1 Boson HED structures
$W^{-} = W^{-}(r.^{1.\underline{1}} .a_{.\underline{1}}^{\underline{1}.1} .t_{\underline{1}}^{1})$
$W^{+} = W^{+}(r_{1.\underline{1}}^{\cdot} .a_{1} .t)$
Z: no single Z boson, but several varieties.

Ma.7.2 W boson mass. Possible mechanisms include one or both of the following

Ma.7.2.1 Their fibrils need a very high frequency to service the overloaded hyffons (preferred model).

Ma.7.2.2 The presence of so many hyffons creates a greater gravitational effect for the same fundamental energy, i.e. energy and mass are decoupled.

Ma.7.3 NotPositronium

Ma.7.3.1 The structure of NotPositronium is $O(r_{1}^{\underline{1}} .a_{1}^{\underline{1}} .t_{1}^{\underline{1}})$.

Ma.7.3.2 It is predicted in the neutrino-antineutrino analysis, but is believed either to be verboten in a matter dominated universe, or an erroneous artefact of the HED method.

Ma.7.3.3 Its components are an antinotElectron $\underline{!e}(r^{\underline{1}} .a^{\underline{1}} .t^{\underline{1}})$ and notElectron $!e(r_{1} .a_{1} .t_{1})$, both of which are likewise verboten.

Ma.7.3.4 NotPositronium can annihilate, even as it forms, to two photons through annihilation.

Ma.7.4 The neutrino can absorb photons and thereby attain an energetic state.

5 Discussion

What has been achieved?

We have used the beta decay outcomes to determine the HED field structure of the W bosons:

$W^{-} = W^{-}(r.^{1.\underline{1}} .a_{.\underline{1}}^{\underline{1}.1} .t_{\underline{1}}^{1})$

$W^{+} = W^{+}(r_{1.\underline{1}}^{\cdot} .a_{1} .t)$

We infer that there is not a single Z boson, but many specific varieties.

We have also modelled the neutrino-antineutrino annihilation process. The results suggest that an annihilation of an energetic neutrino and antineutrino annihilation produces either an electron-positron pair and two photons, or four photons, but not two electron-positron pairs. Less energetic particules may not annihilate at all, but instead revert to a neutrino and antineutrino.

Answers to common questions

The cordus model permits answers to be fielded to some puzzles about the weak interaction.

Why is the weak interaction the only known process for changing the flavour of quarks between u and d?
This is because the flavour-change absolutely requires a neutrino or antineutrino, and these particules are an integral part of the weak interaction.

Why do the W and Z bosons have such large mass?
A high frequency is required to service the large number of hyffons in these temporary structures.

Implications

Conventional physics interprets the weak interaction to be a short-range field, mediated by the bosons. In that interpretation the short range arises because of the heavy mass of the W and Z bosons.

The cordus explanation is radically different, and refutes this interpretation. First, cordus suggests that the W and Z bosons do not exist in the form of 0D point particles with static characteristics, but instead are cordi undergoing dynamic assembly and disassembly processes. 'Particle' is entirely the wrong concept to be using.

Second, there is no single Z boson.

Third, the conventional concept that the bosons change the flavour of the quark is inappropriate, according to the cordus model. The bosons are not the cause or the mechanism for the change, but merely the by-products and waste process stream from the conversion process.

Fourth, the weak interaction is a different category of fundamental force to electrostatic, magnetic, and gravitational forces. The weak interaction is a negotiation of the particule's right to emit HED active field structures in specific direction. These rights are complemented by other particules, hence a bonding force that keeps the particules together.

6 Conclusions

The cordus principle and its HED notation have been used to infer the discrete field structures of the W bosons as follow:

$W^{-} = W^{-}(r.^{1.\underline{1}}\ .a_{.\underline{1}}^{\underline{1}.1}\ .t_{\underline{1}}^{1})$

$W^{+} = W^{+}(\ r_{1.\underline{1}}^{\cdot}\ .a_{1}\ .t)$

Also, there appears not to be a single Z boson, but rather several varieties.

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