On the Characteristics of Weak Interactions

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Abstract: Weak interactions are described in terms of repelling contact between resilient particle bodies or quanta. Then classical conservation laws can be upheld throughout a collision or decay by creating mediator transition-particles of muonic or pionic mass to transfer energy, momentum and charge. Mediator vector bosons $W^{\pm}$, Z^0, created by manoeuvring known conservation laws, can be superseded.

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1 Introduction

The aim of this paper is to show that observed weak interaction processes can be interpreted in terms of low mass intermediate exchange particles, created in situ from local components and collision energy while obeying classical conservation laws. Currently, in the Standard Model (SM) weak interactions are described in terms of the exchange of super-massive vector bosons W^+, W^-, Z^0, which materialise from the vacuum by evading conservation laws; where (M_W = 80.379GeV/c^2), (M_{Zo} = 91.1876GeV/c^2). For example, a neutron of mass 0.939565 GeV/c^2 calls for a W^- boson to enable its spontaneous decay into a proton, electron and anti-neutrino. At the same instant, the vacuum also produces an equal amount of negative energy with spin. Such a scheme also applies to decay of a muon and pion, so these lowly particles are enabled by a latent supply of super-massive particles and unimaginable spinning negative energy, plus time reversal. Similarly, during the mildest and most violent collisions, classical conservation laws must be evaded. This Standard Model philosophy has been accommodating experimental results, but it needs to be reviewed from time to time. Confidence in the findings will depend upon one's view of reality throughout an interaction process.

2 General examples

The weak interaction is described herein as a non-binding scattering process due to repelling contact between springy resilient particles and quanta, while satisfying the classical energy budget. Detailed designs of particle structures have been given by Wayte, Papers 1 (proton and neutron), 2 (muon), 3 (electron), 4 (mesons). All particles and antiparticles have non-singular dimensions, with complex design structure consisting of positive energy and forward running time. They can be distinguished by their opposite helicity, for example, an electron and its neutrino have internal left-handed helicity while a positron and its anti-neutrino have internal right-handed helicity. The physical reality of these helices has been confirmed by the observed differences between neutrino and antineutrino off electron or nucleon scattering experiments.

2.1 Proton and neutron weak interactions

A model of the neutron (Wayte, Paper 1) consists of a proton orbited by a metastable heavy-electron, see Figure 1. The proton contains 3 trineons (roughly analogous to quarks in the SM) travelling around the spin-loop at the velocity of light. Each trineon has gluons which emit colour quanta around the spin-loop plus an external nuclear force field. There is also an electric field emitted at velocity of light. The trineons with their fields constitute the whole proton mass. As shown in Papers 1, 2, 3, 4, a particle's mass consists of energy travelling at the velocity of light in a complex structure of helical loops-within-loops, and a radial external field. This explains why Dirac’s electron theory implies a material velocity of (+/- $\boldsymbol{c}$). Therefore, the SM's proposed Higgs ether field is not applicable.

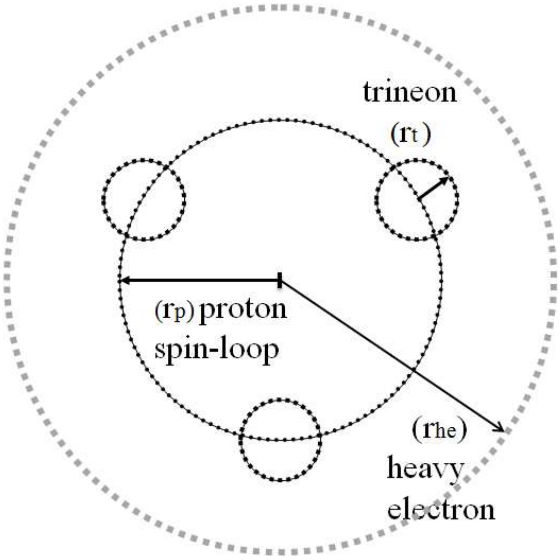

Fig.1 Basic model of the neutron

The proton spin-loop radius is the Compton radius for proton mass ($r_p = \hbar/m_p c = 0.2103\text{fm}$ for $m_p = 938.272\text{MeV/c}^2$), while the individual trineons have a radius (r_t) which is smaller by factor [137(2/π)], that is ($r_t = 2.4106\text{x}10^{-3}$fm). This finite radius of a trineon removes theoretical divergences, which occur for singular quarks in QCD.

Now, in the SM, the interaction range of the W^- boson is given by its Compton radius ($r_w = \hbar/M_w c = 2.4547\text{x}10^{-3}$fm). This may be compared with the proton and trineon radii:

$$\frac{r_p}{r_w} = \frac{M_w}{m_p} = \frac{80.3795\text{GeV}}{0.938272\text{GeV}} \approx 137\left(\frac{2}{\pi}\right) = \frac{r_p}{r_t} \ , \qquad (2.1a)$$

so, the interaction range (r_w) is approximately the trineon radius (r_t). Herein, this will be taken to infer that a trineon is the real cause of neutron decay, by repulsive interaction with the metastable heavy-electron. Then, theory of this weak force mechanism needs a Yukawa-type potential U(r), to describe the effective weak charge and size of a *trineon*:

$$\frac{1}{r^2}\frac{d}{dr}\left(r^2\frac{dU(r)}{dr}\right) = \frac{1}{R^2}U(r) \quad , \qquad (2.1b)$$

$$U(r) = \frac{g}{4\pi r}e^{-\frac{r}{R}}. \qquad (2.1c)$$

Radius (r) is the independent variable, with characteristic range of the potential ($R = r_t$), and (g) behaves like a weak charge. There is no prerequisite to postulate a virtual mass ($M_W \approx 137(2/\pi)m_p$) for the field quanta because R is representative of the physical size of the interacting trineon itself during contact. Then the probability scattering amplitude for momentum transfer ($\mathbf{q}$) will be expressed in terms of this range, thus:

$$\mathcal{M}(\mathbf{q}) = \frac{-(g\,\hbar)^2}{\mathbf{q}^2+M_W^2c^2} \longrightarrow \frac{-(g\,R)^2}{(\mathbf{q}R/\hbar)^2+1}\;, \qquad (2.1d)$$

which reduces to a constant in the low ($\mathbf{q}$) approximation. Spontaneous generation of super-mass M_W is now considered unreal so the energy, momentum, and charge actually transferred during contact will be quantified as an embryonic transition-particle satisfying conservation laws locally within the interaction. Later in Section 2.6 the transition-particle has muonic or pionic mass in muon-neutrino off electron scattering experiments. For the sake of continuity, it can be labelled W or Z in general, but it has to satisfy the *local* budget within each collision.

2.2 Fermi coupling constant

If we let the weak interaction of the trineon be described by an equivalent Yukawa-type potential of range ($r_t \equiv R$), then for proton or neutron weak interactions, the Fermi coupling constant (G_F) can be expressed in terms of radius (r_t) and a constant weak charge (g_W):

$$\frac{G_F}{\sqrt{2}(\hbar c)^3} = \frac{1}{8\hbar c}\left(\frac{g_W}{M_W c^2}\right)^2 \longrightarrow \frac{(g_W r_t)^2}{8(\hbar c)^3} = \frac{\pi}{2}\left(\frac{{g_W}^2}{4\pi\hbar c}\right)\left[\frac{1}{m_p c^2}\times\frac{1}{137(2/\pi)}\right]^2. \qquad (2.2a)$$

Empirically, $[G_F/(\hbar c)^3 = 1.1663787\times10^{-5}\mathrm{GeV}^{-2}]$ so the weak interaction strength parameter (α_W) evaluates to:

$$\alpha_W = \left(\frac{{g_W}^2}{4\pi\hbar c}\right) \approx (4.820882)\alpha \approx \left(\frac{\pi^2}{2}\right)\left(\frac{e^2}{4\pi\varepsilon_o\hbar c}\right), \qquad (2.2b)$$

where ($\alpha \approx 1/137.036$) is the fine structure constant. Thus, G_F and (α_W) have been related to a *real* trineon of mass ($m_p/3$) and actual radius (r_t): and the weak charge (g_W) is approximately (2.2) times the electronic charge (e). This G_F has been proposed as a constant in all weak interactions, but the physics behind G_F given above has depended upon trineon range (r_t) which pertains to nucleons only. In practise, the empirical value of G_F is based upon theory of the muon lifetime.

The result in Eq.(2.2b) will be discussed later because some investigators exclude the (8) in the denominator of Eq.(2.2a) and work with a more fundamental weak charge, see Eqs.(2.3e,f,g).

2.3 Muon weak interaction

In Paper 2, our model of the muon contains three internal core-clusters, see Figure 2. The muon spin-loop radius is the Compton radius ($r_\mu = \hbar/m_\mu c$), and the core-cluster radius ($r_{\mu c}$) is smaller by 137(2/π) times.

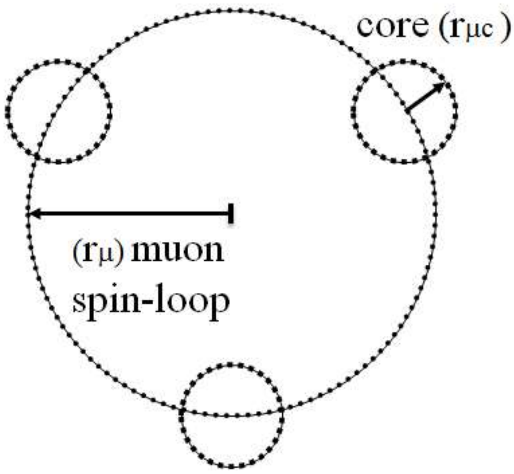

Fig.2 Model of the muon

Let these clusters participate in the weak interactions of a muon, with their body size determining an effective range, analogous to the trineon. Each is proposed to behave like a Yukawa-potential with a characteristic radius ($r_{\mu c}$), and muon mass (m_μ = 105.6583745MeV/c^2). Consequently, the interaction range relative to a trineon is 8.88 times greater, given by:

$$\frac{r_{\mu c}}{r_t} = \frac{r_\mu}{r_p} = \frac{m_p}{m_\mu} \approx 8.880243 \quad . \qquad (2.3a)$$

For the same universal value of G_F, there should exist a smaller coupling constant (charge $g_{\mu w} = g_w/8.88$), and a muonic strength parameter ($\alpha_{\mu w}$) is $(8.88)^2$ times smaller than (α_w):

$$\alpha_{\mu w} = \left(\frac{g_{\mu w}^2}{4\pi\hbar c}\right) = \alpha_w \left(\frac{r_t}{r_{\mu c}}\right)^2 \approx 8.378\alpha^2 \ . \qquad (2.3b)$$

Then for muonic weak interactions, the expression analogous to Eq.(2.2a) should not contain M_W nor (r_t), but employ ($g_{\mu w}$) and ($r_{\mu c}$):

$$\frac{G_F}{\sqrt{2}(\hbar c)^3} = \frac{(g_{\mu w} r_{\mu c})^2}{8(\hbar c)^3} = (\frac{\pi}{2})\alpha_{\mu w} \left[\frac{1}{m_\mu c^2} \times \frac{1}{137(2/\pi)}\right]^2 \ . \qquad (2.3c)$$

This definition of G_F specifically for the muon would be applicable to the standard expression for muon mean lifetime (τ_μ):

$$1/\tau_\mu = \frac{G_F^2 (m_\mu c^2)^5}{192\pi^3 \hbar(\hbar c)^6} = \frac{c}{\lambda_{\mu c}} \left(\frac{\alpha_{\mu w}}{8}\right)^2 \times [\alpha(\pi/2)]^4 \ , \qquad (2.3d)$$

where ($\lambda_{\mu c} = h/m_{\mu c}c$) is the Compton wavelength for the core-cluster mass ($m_{\mu c} = m_\mu/3$).

It is apparent that the term ($\alpha_{\mu w}/8$) in this equation might imply the existence of a more fundamental weak charge ($g_{\mu wf}$) and strength parameter ($\alpha_{\mu wf}$), namely:

$$g_{\mu wf} = (g_{\mu w}/\sqrt{8}\,) , \quad \text{and} \quad \alpha_{\mu wf} = (\alpha_{\mu w}/8) \ . \qquad (2.3e)$$

This could also apply to the other equations with (8) in the denominator. A prime example, proton weak interaction Eqs.(2.2a,b) could yield a fundamental strength parameter (α_{wf}) and weak charge (g_{wf}):

$$\alpha_{wf} = \left(\frac{g_{wf}^2}{4\pi\hbar c}\right) = \frac{\alpha_w}{8} \approx (0.60261) \left(\frac{e^2}{4\pi\varepsilon_o \hbar c}\right), \qquad (2.3f)$$

and,

$$g_{wf} \approx (0.60261^{1/2})\, e \approx (0.77628)\, e \, . \qquad (2.3g)$$

A possible interpretation of this charge ratio could involve the trineon's cross-sectional area (πr_t^2) relative to a theoretical maximum interaction area $(2r_t)^2$:

$$g_{wf} \approx e(0.77628) \approx e \left(\frac{\pi r_t^2}{4 r_t^2}\right) \left(1 - \frac{\pi/2}{137}\right) ; \qquad (2.3h)$$

the final term here indicates that the area is reduced by an edge effect.

2.4 Tauon weak interaction

Let similar expressions exist for weak interactions of the tauon, which is heavier than the proton (m_τ = 1776.86MeV/c^2) and is proposed to have a weak interaction strength parameter analogous to Eq.(2.3b), given by:

$$\alpha_{\tau w} = \alpha_w \left(\frac{r_t}{r_{\tau c}}\right)^2 = \alpha_w \left(\frac{m_\tau}{m_p}\right)^2 \approx 17.289\alpha \ . \qquad (2.4a)$$

And the expression analogous to Eq.(2.3c) specifically for the tauon uses a weak coupling constant (charge $g_{\tau w}$):

$$\frac{G_F}{\sqrt{2}(\hbar c)^3} = \frac{(g_{\tau w} r_{\tau c})^2}{8(\hbar c)^3} = (\frac{\pi}{2})\alpha_{\tau w}\left[\frac{1}{m_\tau c^2} \times \frac{1}{137(2/\pi)}\right]^2 \quad . \qquad (2.4b)$$

2.5 Electron weak interaction

Let weak interaction parameters exist for the electron also, see Perkins p196. Given the format of Eq.(2.3c) and the same value of G_F, then for an electron's weak interactions, let:

$$\frac{G_F}{\sqrt{2}(\hbar c)^3} = \frac{(g_{ew} r_{oe}')^2}{8(\hbar c)^3} = (\frac{\pi}{2})\alpha_{ew}\left[\frac{1}{m_e c^2} \times \frac{1}{137(2/\pi)}\right]^2 \quad , \qquad (2.5a)$$

where [$r_{oe}' = \alpha(\pi/2)(\hbar/m_e c)$] is the proposed electron weak interaction-radius, to behave here analogous to the muon core-cluster radius ($r_{\mu c}$). The electron weak strength factor is then very small at:

$$\alpha_{ew} = \left(\frac{g_{ew}^2}{4\pi\hbar c}\right) \approx \pi\alpha(4\pi\alpha^2)^2 \quad . \qquad (2.5b)$$

The Fermi constant G_F can here be related to the electronic charge/mass ratio:

$$\frac{G_F}{\sqrt{2}(\hbar c)^3} \times \hbar c^5 \approx \left(\frac{e^2/4\pi\varepsilon_o}{m_e^2}\right) \times (4\pi\alpha^2)^3 \ . \qquad (2.5c)$$

So, throughout the above analysis, the weak charge of a particle is proportional to its mass. Thus, a trineon has 8.88 times more weak charge and mass than the muon's core-cluster, but it is 8.88 times smaller in size. Since both these particles consist of mass clumps confined within spin-loops, the weak charge *represents* interaction strength during physical-contact in a collision. Radii (r_t , $r_{\mu c}$, $r_{\tau c}$, r_{oe}') are physical sizes of the vibrating particles, acting as ranges for weak interactions. The constancy of G_F also indicates that these particles with their particular designs of helices within helices must consist of the same fundamental energy, in the form of helical filaments.

2.6 Muon-neutrino scattering off electrons

So far, the weak interaction parameters of a proton or neutron and leptons have been considered without invoking massive exchange bosons to come into existence from vacuum. But during scattering processes, energy, momentum and charge may be conveyed from one particle to the other and be quantified in terms of a transition-particle.

In the SM for muon-neutrino off electron *inelastic* scattering, the cross-section at low energies is given by:

$$\sigma_{\nu eW} = \frac{{G_F}^2}{\pi(\hbar c)^4} \cdot s = \frac{2}{64\pi}\left(\frac{g_W}{M_W c^2}\right)^4 \cdot s \quad . \tag{2.6a}$$

where ($\mathbf{s} = 2m_e c^2 E_\nu$), see Povh et al (2008) p136-8. When the scattering is e*lastic*, the intermediate neutral boson mass M_{Zo} appears in the propagator term but (g_W) is presumed the same, so the cross-section is reduced to:

$$\sigma_{\nu eZo} = \frac{2}{64\pi}\left(\frac{g_W}{M_{Zo} c^2}\right)^4 \cdot s \quad . \tag{2.6b}$$

The ratio of these two cross-sections has an interesting value:

$$\frac{\sigma_{\nu eZo}}{\sigma_{\nu eW}} = \left(\frac{M_W}{M_{Zo}}\right)^4 \approx \left(\frac{7}{9}\right)^2 \approx \left(\frac{m_\mu m_e}{m_{\pi o} m_e}\right)^2 \approx 0.6 \ , \tag{2.6c}$$

where pion mass is ($m_{\pi o} = 134.9768\text{MeV}/c^2$) and ($m_\mu = 105.6583745\text{MeV}/c^2$).

It looks feasible that these scattering processes can be re-interpreted in terms of transition-particles with muonic or pionic masses created directly from the existing local material/energy of the interaction, while obeying classical conservation laws. That is, super-massive bosons are not essential because another interpretation is available:

Inelastically. When an incident muon-neutrino strikes the target electron *inelastically*, a muonic type of transition-particle (W_μ) forms consisting of the neutrino plus negative charge *seized from* the electron. Then the created muon and the residual electron-neutrino exit the collision site. The muonic transition-particle conserves the weak properties of the incident muon-neutrino and target electron, therefore Eq.(2.6a) can properly represent both of these by substituting G_F from Eq.(2.3c) and Eq.(2.5a):

$$\sigma_{\nu eW\mu} = \frac{2}{64\pi}\left[\left(\frac{g_{\mu w} r_{\mu c}}{\hbar c}\right) \times \left(\frac{g_{ew} r_{oe}'}{\hbar c}\right)\right]^2 \cdot s \quad . \tag{2.6d}$$

Elastically. When an incident muon-neutrino strikes an electron *elastically*, a pionic type of transition-particle ($Z_{\pi o}$) may form briefly from the available local material/energy, before returning to the original particles. Figure 3 shows our model of a neutral pion adapted from Paper 4, wherein a spinning quion q^+ and anti-quion q^- orbit around the centre at radius ($r_{o\pi}$). The transition-pion acts with average collision radius/range given by:

$$r_{\pi c} \approx (\hbar/m_{\pi o}c)/[137(2/\pi)] \ . \tag{2.6e}$$

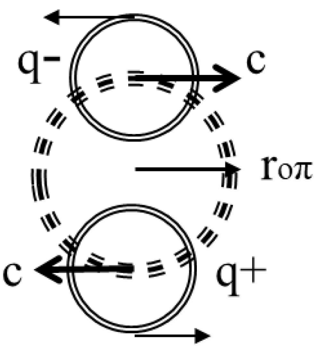

Fig. 3 Model of a transition-pion

And cross-section expression Eq.(2.6b) could properly represent the incident muon-neutrino transformed by a pionic transition-factor, plus the target electron:

$$\sigma_{\nu eZ\pi} = \frac{2}{64\pi}\left[\left(\frac{g_{\mu w} r_{\mu c}}{\hbar c}\right)\left(\frac{g_{\mu w} r_{\pi c}}{g_{\mu w} r_{\mu c}}\right) \times \left(\frac{g_{ew} r_{oe}'}{\hbar c}\right)\right]^2 \cdot s \quad , \tag{2.6f}$$

then the mass ratio $(m_\mu / m_{\pi o})^2$ in Eq.(2.6c) follows. This interpretation agrees by analogy with the photographed result in Martin & Shaw (2008) p219 wherein a muon-neutrino strikes a target neutron to generate a neutral transition-pion, which combines with the electron seized from that neutron, then separates from the residual proton.

Thus, the incident muon-neutrino on target electron may briefly form a transition-particle of muonic or pionic mass before producing the observed particles, while conserving energy, momentum and charge at all times. This is a classical interpretation which appears to be very simple and realistic. It is expected that much of the theory already developed for weak interactions will remain valid because transition-particle mass is not relevant therein.

3 Models of real $W^{\pm}$ and Z^0 bosons

Models of *mesons* derived in Paper 4 will now be extended to identify the observed Z^0 and $W^{\pm}$ bosons simply as super-massive mesons, unconnected to the weak interaction. This means that it is by chance that the $W^{\pm}$ boson possesses a Compton radius (r_W) near to the trineon radius (r_t) in Eq.(2.1a); and consequently, M_W is around 137(2/π) times the proton mass. There also exists by chance a bottomonium meson at 137(2/π) times the muon mass, Υ(1S) $b\tilde{b}$ (9460.3MeV/c^2), see Section 6.2 in Paper 4. The universality of G_F means that the weak charge is proportional to mass, but it is particle interaction range not mass which is fundamental in Eq.(2.1), as demonstrated above by radii (r_t , $r_{\mu c}$, $r_{\tau c}$, $r_{oe'}$). Accordingly, the mass M_W was unspecified and could be attributed to a meson after an extensive search.

The proposed design of a Z^0 boson is based upon a pion model with added spin, consisting of a particle and antiparticle which orbit their centre of mass, see Figure 4. For a Z^0 of mass (M_{Zo} = 91.1876GeV/c^2) and spin-loop radius ($r_z = 2\hbar/M_{Zo}\,c$), half the mass comprises a quion and an anti-quion (different from quarks) with attached colour quanta around the orbit, in order to achieve spin $1\hbar$. The other half mass is in a non-spinning exterior hadronic field emitted from the quion and anti-quion. A quion consists of 10 pearls, each of a bottomonium's quion design and mass ($m_{b\tilde{b}}/2$) which contains 36 pionic mass elements, see Section 6.2 in Paper 4. The anti-quion has similar anti-components. Overall mass is therefore around:

$$M_{Zo} \approx 2 \times \{10 \times (m_{b\tilde{b}}/2)\} \times \left\{1 - \frac{5}{137}\right\} . \qquad (3.1)$$

The mass decrement term (-5/137) represents binding energy lost during creation of Z^0 from the 10 bottomonium mass components. When a Z^0 decays, the two main parts can easily produce particle + antiparticle pairs such as fermions $\mu^- \mu^+$ or hadrons like charmonium $c\tilde{c}$.

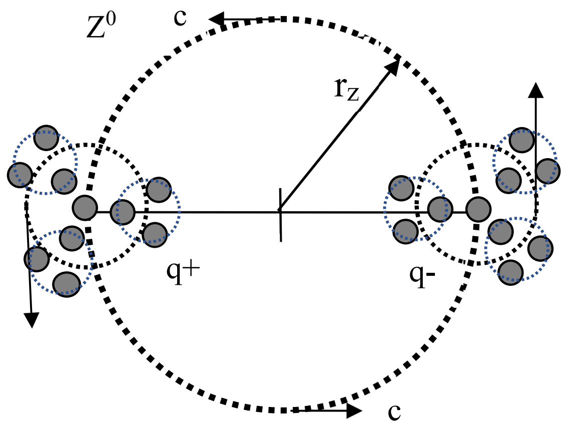

Fig. 4 Simplified design of Z^0

For a $W^\pm$ of mass ($M_W = 80.379 GeV/c^2$) and spin-loop radius ($r_w = 2\hbar/M_W c$), the design is similar to a Z^0 in some respects, see Figure 5. A quion now consists of 9 pearls, each of a bottomonium's quion design containing 36 pionic mass elements. The anti-quion has similar anti-components. Overall mass is approximately:

$$M_{W\pm} \approx 2 \times \{9 \times (m_{b\tilde{b}}/2)\} \times \left\{1 - \frac{2}{37.7}\right\} . \qquad (3.2)$$

The mass decrement term (-2/37.7) represents binding energy lost during creation from the 9 bottomonium mass components. An electronic charge orbits the spin-loop for the W^-, or a positron for the W^+. Upon decay of the W^- boson, a charged lepton can result from the quion and an anti-neutrino from the anti-quion. These must be created by interaction, via colour quanta around the spin-loop, to give them spin $\frac{1}{2}\hbar$ each.

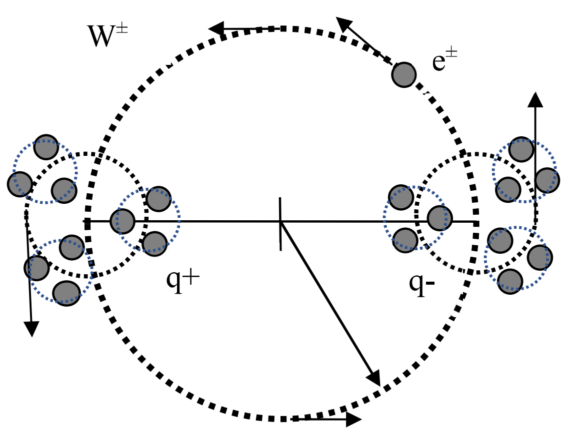

Fig. 5 Simplified design of $W^{\pm}$

Higgs bosons are cited in weak force theory and a new particle CERN(125) has been presented by the ATLAS and CMS Collaborations (2012). Nevertheless, mass is the localised energy already comprising a particle so there is no place for a Higgs field. Therefore, this long sought-after particle appears to be a neutral meson of zero spin, with mass given by:

$$M_{125} \approx 2 \times \left\{(12+2) \times (m_{b\tilde{b}}/2)\left(1-\frac{2}{37.7}\right)\right\} . \qquad (3.3)$$

Here the quion and anti-quion both contain 12 pearls, each of a bottomonium's quion design and mass, and there are also 4 pearls at the centre, as shown in Figure 6. The mass decrement term (-2/37.7) represents binding energy lost during creation from the 14 bottomonium mass components. Clearly this meson can decay into the observed matter/antimatter particles, such as a bottomonium meson.

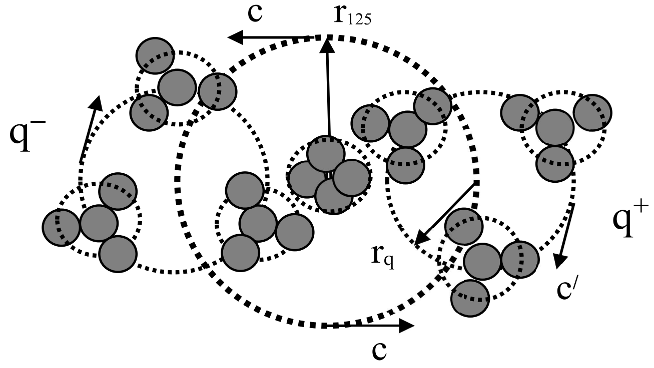

Fig. 6 Component parts for the CERN(125) particle.

4 Conclusion

The weak interaction has been described in terms of repulsive contact between particles and quanta, operating within the classical energy budget. For this, particles have been considered to have predetermined structures, and intermediate particles are of low mass. Super-massive *intermediate* bosons have been judged unreal, so it appears that the Standard Model has been successful at quantifying observations of the weak interaction but unrealistic at explaining the underlying physics. That is, progress in theory has been made by incorporating the yeast effect; conceiving super-massive *intermediate* bosons, spinning negative energy, time-reversal, singularities, and an ether universe. Much of this progress needs to be moderated from the beginning, by applying the laws of conservation.

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