The 4π Quantization of Fundamental Particle Mass

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Taking a symmetric, 4π, and spin quantized view of fundamental particle mass yields a single mass formula that produces the mass values of the proton, the $W^{\pm}$, the electron and electron generations, is limited by the 4π quantized step unit to three generations and gives a potential source for the generational property. This symmetric mass view is in keeping with the measured cosmological constant.

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Introduction

Using a number of experimentally measured values as a base, the Standard Model mathematics is able to produce a significant number of accurate theoretical results. The Standard Model (SM) is in many areas, highly successful.

One area without a finalized solution is particle mass.

The Standard Model does not have a confirmed mechanism for the nature of mass, nor a reason for the specific invariant mass values of the proton and electron, nor the specific mass values of the two higher electron generations, nor why only three generations, nor the nature of the generational property being exchanged in $\nu_\mu + N => \nu_e + p^+ + \mu^-$.

Given the SM view, what has been missed is that the "measured" $W^\pm$ mass of 80398 ± 25 MeV [1], given the uncertainty, is exactly $2m_\mathrm{p}/m_\mathrm{e}$ (3672.30534) times the electron-proton mass symmetry point ($M_\mathrm{sp} = \sqrt{m_\mathrm{p}\ m_\mathrm{e}} = 21.8964832\ MeV$), i.e. 80410.57 MeV.

Thus, if one takes a non-standard symmetric view of the electron, proton and the $W^\pm$ particle masses (fundamental particle masses), then there is a eloquently simple spin quantized fundamental particle mass relationship given by

$$m_x = (2\pi\ S\ \alpha_\mathrm{gc})^{\ S\ C\ M}\ M_\mathrm{sp}\ , \tag{1}$$

where α_gc is 584.4655479, S is the spin quantum number ($\frac{1}{2}$,1), C is the charge quantum number (± 1), and M is the matter type quantum number (matter $= +1$, anti-matter $= -1$).

Equation (1) is not only spin quantized, (1) is also mass up/down and charge up/down symmetric. Thus (1) not only implies that mass is quantized but asks, "Is Nature's fundamental particles mass up/down symmetric?".

It turns out that the spin quantized equation (1) is also a function of $(4\pi)^x$ as are the generational mass ratio's of the electron generations. Thus (1) can be extended to the electron generations as well.

The 4π Definition of Nature's Constants

The new constant $\alpha_{\mathrm{gc}} = \alpha_{\mathrm{cg}}^{-1}$ where experimentally $\alpha_{\mathrm{cg}} = \pi\, m_{\mathrm{p}}/m_{\mathrm{e}}$ and theoretically $\alpha_{\mathrm{cg}} = \pi\varsigma\, (4\pi\varrho)^{-3}$. The fine structure constant $\alpha_{\mathrm{cs}} = \pi\varsigma\, (4\pi\varrho)^{-2}/(2\sqrt{2})$, the charged weak angle $\alpha_{\mathrm{sg}} = 2\sqrt{2}\, (4\pi\varrho)^{-1}$ (.2344 vs .2312 [2]). An uncharged (neutrino) pure theory ($\varrho = 1$) weak angle $\alpha_{\mathrm{sg(1)}} = 2\sqrt{2}(4\pi)^{-1}$ (.2251 vs .2277 [3]). A bare (uncharged) Salam-Weinberg relationship for Z^0 gives $m_{\mathrm{Z}} = m_{\mathrm{W}}(1-\alpha_{\mathrm{cg}})/(1-\alpha_{\mathrm{sg(1)}})^{1/2}$ (91188.6 vs 91187.6 $\pm$ 2.1 MeV [1]). The new constant $\varrho = \alpha_{cs}\ \alpha_{sg(1)}\ m_{\mathrm{p}}/(m_{\mathrm{e}}\ \pi) =$ 0.959973785 and $\varsigma = (4\pi\varrho)^3\ m_{\mathrm{e}}/m_{\mathrm{p}} =$ 0.956090324.

The origin of these definitions is beyond the scope of this paper.

Base mass as a 4π quantization process

The extension of the spin quantized equation (1) to include the electron generations requires rewriting (1) using the theoretical definition of α_{gc} ($\alpha_{\mathrm{cg}}^{-1}$). This results in (1) as

$$m_x = (\ 2S\ (4\pi\varrho)^3/\varsigma)^{(S\ C\ M)} M_{\mathrm{sp}}\ . \tag{2}$$

Equation (2), in addition to being spin quantized indicates that the quantization process for these fundamental particles is a function of $(4\pi)^3$ (as $m_{\mathrm{p}}/m_{\mathrm{e}} = (4\pi\varrho)^3/\varsigma$, then for $\varrho = 1$ $\varsigma = 1$ $m_{\mathrm{p}(1,1)}/m_{\mathrm{e}(1,1)} = (4\pi)^3$). The deviation from the 4π pure theory quantization process is given by the variable ϱ.

Three generations as a 4π quantization process

It turns out that the electron generational mass ratios appear to be $(4\pi\varrho)^x$ related, similar to the $(4\pi\varrho)^3$ relationship for the electron, proton and $W^{\pm}$ masses as seen in (2).

The m_{e_1}/m_{e_0} (μ/e) mass ratio is $\sqrt{2}(4\pi\varrho_1)^{(3-1)}$ where ϱ_1 is .9622204817. The m_{e_2}/m_{e_1} (τ/μ) ratio is $\sqrt{2}(4\pi\varrho_2)^{(3-2)}$ where ϱ_2 is .946279795.

Thus the first (x=1) and second (x=2) generation quantized mass ratio pattern for single generation jumps is $m_{e(x)}/m_{e(x-1)} = \sqrt{2}(4\pi\varrho_n)^{3-x}$ for the two generations, x=(1,2). The change in ϱ_x indicates an increasing deviation from pure theory unity value ($\varrho = 1$) with each generation.

The single generation mass ratio pattern, i.e $\sqrt{2}(4\pi)^{3-x}$, also results in the $(4\pi)^x$ quantized jump for $x = 3$ of $(4\pi)^{(3-3)}$, i.e. no x=3 $(4\pi)^x$ quantized generational transition.

This 4π pattern allows the generational masses to be combined into a single phenomenological equation for $x = \{p, e_n, W\}$,

$$m_x = M_{\mathrm{sp}(n)}\ (2S\ (4\pi\varrho)^3/\varsigma)^{(S\ C\ M)}\ , \tag{3}$$

where $M_{\mathrm{sp}(n)} = M_{\mathrm{sp}}\ S^{-n/2}(4\pi\varrho_n)^{(6Sn-Sn(n+1)))}$ and $\varrho_n = 1 - log(1 + 64.75639\ n/S)/(112S)$ are used and generation n is {0,1,2}.

This gives a m_{e_1} mass of 105.6583668 MeV ($\mu = 105.6583668 \pm .0000038$ MeV [1]) and a m_{e_2} mass of 1776.83 MeV ($\tau = 1776.84 \pm .17$ MeV [1]).

Note that ϱ_n used in equation (3) is not the same as ϱ_x which is the value for the jump between two adjacent generations. However both ϱ_n and ϱ_x tend toward lower values for higher generations.

Also note that ϱ and ϱ_n are deviations from pure theory for two separate frequency components of the quantization process. An intra-particle quantization process minimally requires two intra-particle frequency components.

Equation (3) suggests that one quantization component is associated with the generational property and the generation mass symmetry point $M_{\mathrm{sp}(n)}$ and another quantization component is associated with the particle's base mass/energy value.

Quantization, the Standard Model and QCD

The quantization proposition is not in conflict with the existence of quarks. Rather quantization is the source of the infinite life time stability for the two fundamentally stable particles, while a pseudo-stable quantization state constrains the unstable particle's decay point mass.

Without a stable or pseudo-stable quantization state there is no "persistence" of existence as massed energy, but only photonic energy.

That quark composite particle masses are quantized was first suggested by Nambu [3] and more recently by Palazzi [4]. The quantization increments cited are 35 and 70 MeV which are approximately $M_{\mathrm{sp}}\ \pi/2$ and $M_{\mathrm{sp}}\ \pi$. Thus for example η (547) has n=16 [4] and using $M_{\mathrm{sp}}\ n\pi/2$ gives $m_\eta = M_{\mathrm{sp}}\ 8\pi \simeq 550$.

That quark composites have a pattern of quantization is also seen in the paper by Ne'eman and Sijacki [5], Figure 3. The particles vary about the predicted points and for the (3/2,1) group are approximately $(20, 22, 24)\ \pi\ M_{\mathrm{sp}}$, for the (5/2,2) group are approximately $(24, 26, 28, 30, 32)\ \pi\ M_{\mathrm{sp}}$, and for the (7/2,3) group are approximately $(28, 30, 32, 34, 36, 38, 40)\ \pi\ M_{\mathrm{sp}}$.

Thus the quantization process would be an additional constraint on the particle decay point mass while the types of quarks and SU(3) symmetries of quarks construct the particle variations seen in the "particle zoo".

Quantization process and "new" particles

Equation (1)'s mass and charge symmetry also results in some new particles.

First, (1) implies that the proton can also have generations.

If (3) is correct then there is a second generation proton at about 194 GeV.

Second, (1) indicates a new lepton like spin 1 light $W^{\pm}$ ($lW^{\pm}$) particle ($m_{\mathrm{lW}} \sim 5.96$ KeV). This particle, if viable, is expected to have the same instantaneous decay as the heavy (80 GeV) $W^{\pm}$ particle. It is presently unclear if the quantization process at such low energies (low quantization frequency) is viable.

Even if not viable as an observable massed particle, attempted low energy quantization may result in an enhanced photon production above 5.96 KeV.

When produced as a matter-antimatter pair at higher energies (MeV), if one didn't look for the simultaneously electron-positron neutrino decay components, the spin 1 $lW^{\pm}$ pair decay would look like the production of an electron-positron pair.

The implications of (1), (2) and (3)

Equations (1), (2) and (3) indicate three new important aspects for particle physics.

First, in addition to the (inter-particle?) atomic orbital quantization mechanism of quantum mechanics there is an intra-particle quantization mechanism which gives the fundamental particles their "invariant mass" values.

Second, in addition to the internal quark components that contribute to the systematization of the "particle zoo", there is an additional intra-particle quantization interaction.

A stable intra-particle quantized state can give a reason for stable particles vs the instability of highly perturbed (perturbed-quantized) quark composites. The charged perturbed states eventually decay to the lowest quantization state mass-up charge-up stable particle (i.e. the proton or anti-proton) or to the lowest quantization state mass-down charge-down stable quantization state particle (i.e. the electron or positron).

Though the quantization proposition is not proven, given the accuracy of (1), the 4π nature of (1) as shown in (2) and the 4π similarity of electron generation quantized jumps resulting in (3), and the well known inter-particle quantization, there is significant phenomenological evidence for the quantized mass proposition.

But there is another positive aspect of equation (1), this is the charge and mass symmetry.

The super-symmetric (charge and mass up/down symmetric) view that results from equation (1) can make some fundamental SM problems go away.

The implications of this super-symmetric view

First, the present SM has only a matter anti-matter mass creation process, yet we appear to have a matter only universe. This aspect is presently unaccounted for.

The super-symmetric view indicated by (1) enables the possibility of an alternate mechanism for fundamental particle creation. This alternate process breaks the electron and proton of the same mass ($m_e = m_p$ at $\varrho = (4\pi)^{-1}, \varsigma = 1$) into an electron of lower mass (voided) and a proton of higher mass (compacted), yielding a matter only universe.

Second, given this charged particle symmetry breaking mechanism, the theoretical cosmological constant can be zero and consistent with the observed value. The SM view is 10^{46}, i.e 46 orders of magnitude wrong [6], with no substantive resolution.

The preciseness of the predicted $W^{\pm}$ particle mass of equation (1) and the pattern of quantization shown via (2) and (3) call into question many of the SM views and assumptions about the causality of the observed "invariant mass" values.

However, it is precisely the SM view and symmetry approach that results in these fundamental SM problems. Maybe we should listen to these fundamental problems with more care.

Summary

The reason for the specific "invariant" (base) mass values is fundamental to any complete massed particle theory.

A super-symmetric, i.e. mass and charge symmetric, quantized mass formula (1) is proposed. It is also shown in (2) that this super-symmetric fundamental particle mass equation is also 4π quantized and uses a $(4\pi)^3$ related magnitude.

The electron generation mass ratios can also be produced using a $(4\pi)^x$ magnitude. This indicates that a 4π quantization process is also occurring in the electron generational masses.

Together these can be taken as a strong indication that not only is there a (inter-particle?) quantization process as indicated by QM, but an intra-particle quantization process as well.

From equation (3), the quantization process has minimally two component types. One component type can be associated with the particles mass energy while a second component type can be associated with the generational aspect.

A physical component holding the generational property could explain the second generation property exchange seen in the muon neutrino interaction $\nu_\mu + N \rightarrow \nu_e + P^+ + \mu^-$.

The quantization of equation (1) and (3) is not in conflict with the existence of quarks. A dual approach is suggested where the types and symmetries of quarks construct the variations seen in the "particle zoo" while a quantizing mechanism is the source of the mass value of the fundamental particles and a decay point mass constraint on unstable particles.

The Cosmological Constant Problem and Matter Only Universe Problem are two fundamental problems for the perceived view associated with the Standard Model.

The up/down symmetry of equation (1) naturally suggests an up/down symmetry breaking mechanism that can yield a matter only universe while the same super-symmetric view can also be in keeping with the cosmological constant.

The recognition that there is an intra-particle quantization process may be the first step toward moving the SM from an interaction model of particles, to a naturally massed particle model that produce the known interactions.

> "Physics constitutes a logical system of thought which is in a state of evolution, ... We must always be ready to change these notions - that is to say, the axiomatic basis of physics - in order to do justice to *perceived* facts in the most perfect way logically.
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> Albert Einstein [9]

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