Is Fundamental Particle Mass 4π Quantized?

Robert A. Stone Jr.
1313 Connecticut Ave, Bridgeport, CT 06484, USA
E-mail: robert.a.stone.jr@gmail.com

The Standard Model lacks an explanation for the specific mass values of the fundamental particles. This is to report that a single spin quantized mass formula can produce the masses of the proton, the W, and the three electron generations. The 4π mass quantization pattern limits the electron generations to three, while the particle's generational property is one of the components of the proposed intra-particle quantization process. Although the developed relationships are presently phenomenological, so was Bohr's atomic quantization proposal that lead to quantum mechanics.

1 Introduction

In an attempt to understand the reason for particle mass values, several authors have looked for mass relationships among the known particles.

Nambu [1] suggested that quark composite particle mass may be quantized, showing a 70 MeV quantization pattern.

Palazzi [2] (2007) revisits this hypothesis for mesons showing that this quantization pattern is statistically real.

Ne'eman and Sijacki [3] use the SL(4,R) group and spin (1/2,3/2,5/2, etc.) to produce the Regge trajectory like behavior of quark particle masses suggesting the possibility that mass may be spin quantized.

What has not been seen is that given the experimental and theoretical uncertainty, the measured $W^{\pm}$ mass of 80398 ± 25 MeV [4] is exactly $2m_{\mathrm{p}}/m_{\mathrm{e}}$ (3672.30534) times the mass value symmetrically between the electron and the proton ($\sqrt{m_p\, m_e} = 21.89648319$ MeV), i.e. 80410.57 MeV.

2 Fundamental particle mass, a spin quantized process?

Taking a mass symmetric approach to fundamental particle mass leads to an eloquently simple spin quantized mass relationship between the stable spin 1/2 electron and proton mass and the unstable spin 1 $W^{\pm}$ particle mass given by

$$m_x = M_{\mathrm{sp}} \left(2S\, m_p/m_e\right)^{(SCM)}, \qquad (1)$$

where x is {p,e,W}, the mass symmetry point M_{sp} is 21.89648319 MeV, S is the spin quantum number $\{\frac{1}{2},1\}$, C is the charge quantum number $\{\pm 1\}$, and M is the matter type quantum number {matter = +, anti-matter = −}.

Thus equation (1) is both mass and charge up/down symmetric, spin quantized and indicates Nature may be fundamentally mass symmetric.

As indicated in §9, this mass up/down symmetry is in keeping with the measured cosmological constant.

3 Nature's constants, as functions of 4π

Proposing natures coupling constants are a function of 4π and the fine structure coupling constant and the weak (angle) coupling constant are connected to mass, yields the following 4π definitions.

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 [5]), where "g" is the other force that couples to produce the weak coupling constant. The relationship to mass is $\pi m_{\mathrm{e}}/m_{\mathrm{p}} = \alpha_{\mathrm{cs}}\alpha_{\mathrm{sg}} = \alpha_{\mathrm{cg}} = \pi\varsigma(4\pi\varrho)^{-3}$ and thus $m_{\mathrm{p}}/m_{\mathrm{e}} = (4\pi\varrho)^3/\varsigma$. The uncharged (neutrino) weak angle $\alpha_{\mathrm{sg}(1)} = 2\sqrt{2}(4\pi 1)^{-1}$ (~.2251 vs .2277 [6]). The new constant $\varrho = \alpha_{cs}\,\alpha_{sg(1)}\, m_{\mathrm{p}}/(m_{\mathrm{e}}\,\pi) = 0.959973785$ and $\varsigma = (4\pi\varrho)^3\, m_{\mathrm{e}}/m_{\mathrm{p}} = 0.956090324$.

4 Fundamental particle mass, a 4π quantized process?

Equation (1) rewritten with the 4π definition of $m_{\mathrm{p}}/m_{\mathrm{e}}$ results in

$$m_x = M_{\mathrm{sp}} \left(2S\,(4\pi\varrho)^3/\varsigma\right)^{(SCM)}. \qquad (2)$$

In addition to being spin quantized, equation (2) indicates that the fundamental particle mass quantization process is a function of $(4\pi)^x$. For example, the pure theory $m_{\mathrm{p}(1,1)}/m_{\mathrm{e}(1,1)}$ ratio ($\varrho = 1, \varsigma = 1$) is exactly $(4\pi)^3$ where the deviation from the pure theory 4π quantization process is given by ϱ.

5 Three electron generations, a 4π quantized process?

The electron generational mass ratios also appear to be a function of $(4\pi\varrho_x)^x$ or more precisely $(4\pi\varrho_x)^{(3-x)}$.

The first ($x = 1$) mass ratio μ to e (i.e $m_{\mathrm{e}_1}/m_{\mathrm{e}_0}$) is $\sqrt{2}(4\pi\varrho_1)^{(3-1)}$ where $\varrho_1 = .962220482$ while the second ($x = 2$) mass ratio $m_{\mathrm{e}_2}/m_{\mathrm{e}_1}$ is $\sqrt{2}(4\pi\varrho_2)^{(3-2)}$ with $\varrho_2 = .946279794$.

Note that ϱ and ϱ_x are believed to be the deviation from pure theory for two separate frequency components of the quantization processes.

Thus the form of the first and second (x=1,2) generation mass ratios $(m_{\mathrm{e}(x)}/m_{\mathrm{e}(x-1)})$ is $\sqrt{2}(4\pi\varrho_x)^{3-x}$. The deviation from the generational pure theory 4π quantization process increases (smaller ϱ_x) with higher generations.

This $\sqrt{2}(4\pi)^{3-x}$ pattern also results in the $x = 3$ mass ratio $(m_{\mathrm{e}_3}/m_{\mathrm{e}_2})$ of $(4\pi)^{(3-3)}$, i.e. no higher $(4\pi)^x$ quantized mass states and thus no higher generations.

The similarity of 4π quantization allows the fundamental particle equation (1) to be combined with the generational relationship into a single phenomenological equation given by,

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

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}.

From (3), the m_{e_1} (μ) mass is 105.6583668 MeV (μ = 105.6583668 ± .0000038 MeV [4]) and the m_{e_2} (τ) mass is 1776.83 MeV (τ = 1776.84 ± .17 MeV [4]).

Remember that even though both ϱ_n, and ϱ represent deviations from the pure theory $(4\pi)^x$ quantization nature of these particles' masses, their cause is understood to be related to two separate quantization process components.

6 The Standard Model and quantization

First, the quantization proposition is not in conflict with the existence of quarks. Rather quantization is an additional constraint. The quantization proposition is that if there is a (pseudo-) stable frequency quantized state, then there is an observed (persistent) massed particle resulting in;

1) a specific stable quantization state energy/mass or

2) a pseudo-stable quantized decay mass value.

Thus the quantization process constrains the stable particle base mass or unstable particle decay point mass while the types and symmetries of quarks construct the particle variations seen in the "particle zoo".

That quark composite particle masses are quantized was first suggested by Nambu [1] and recently statistically validated by Palazzi [2]. The quantization increments cited are 70 (n=integer) and 35 MeV (n=odd or n=even) which are approximately $M_{\mathrm{sp}}\;\pi$ and $M_{\mathrm{sp}}\;\pi/2$. Thus for example η (547) has n=16 [2] and using $M_{\mathrm{sp}}\; n\pi/2$ gives $m_\eta = M_{\mathrm{sp}}\; 8\pi \simeq 550$.

A Regge trajectory like spin quantum number based quantization pattern is given by Ne'eman and Sijacki [3] where the particle's measured mass vary about the predicted points. For the (3/2,1) group the points are approximately $(20, 22, 24)\;\pi\; M_{\mathrm{sp}}$, for the (5/2,2) group they are approximately $(24, 26, 28, 30, 32)\;\pi\; M_{\mathrm{sp}}$, and for the (7/2,3) group they are approximately $(28, 30, 32, 34, 36, 38, 40)\;\pi\; M_{\mathrm{sp}}$.

Second, a quantizing mechanism as fundamental to the nature of massed particles is a natural explanation given QM's quantized nature.

Third, an intra-particle quantization process minimally needs two intra-particle frequency components. Equation (3) suggests one component is related to the particle's "invariant" mass/energy and a second component is related to the generational mass symmetry point. A generational component could be the source for and thus explain the generational exchange seen in the muon neutrino nucleon interaction $\nu_\mu + N \to P^+ + \mu^-$. The generational component's effect on the charged particle mass symmetry point is $M_{\mathrm{sp}(n)}$.

Is the massed particle a "quantized photon"?

Is the first photonic component of the quantization process the underlying reason for the universality of Maxwell's equations for both photons and charged particles?

Is the second quantizing component responsible for the intra-particle mass and charge quantization, for the generational property, as well as the (inter-particle?) quantization of QM?

7 Equation 1 and new particles

If quantization is the source of (1) then, quark structure permitting, there may be a second generation proton. From the phenomenological equation (3), $m_{\mathrm{p}_2} \simeq 194$ GeV. This second generation proton is within LHC's capabilities.

Note that equation (3) is phenomenological and another option exists for merging the electron generations.

Equation (1) also indicates the possibility of a new "lepton like" (mass down charge down) spin 1 light $W^\pm$ particle with a mass of ~ 5.96 KeV (m_{lW}). If such low frequency/energy quantization is possible, the $lW^\pm$'s decay, like the $W^\pm$'s decay, would be instantaneous. At KeV energy, attempted quantization may only result in enhanced photon production. At MeV energies, $lW^\pm$ pair production with instantaneous decay would look like an electron positron pair production but would actually be $lW^- \to e^- + \overline{\nu}$ and $lW^+ \to e^+ + \nu$ decays.

Finally, the super-symmetric (charge and mass symmetric) view that results from equation (1) can make some fundamental Standard Model problems go away.

8 The matter only universe problem

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 the charge and mass up/down symmetry of (1) and (2) enables the possibility of an alternate mechanism for fundamental particle creation.

This alternate process symmetrically breaks the electron and proton of the same mass (for eq. (2), at $\varrho = (4\pi)^{-1}$, $\varsigma = 1$, $m_e = m_p$) into a proton of higher mass (up) and an electron of lower mass (down), yielding a matter only universe.

9 The cosmological constant problem

Given the symmetric mass up/down symmetry breaking of (2) that produces a matter only universe, the symmetry breaking contribution to the cosmological constant can be zero and thus consistent with the observed cosmological constant value. Based on the Standard Model's view, QCD's contribution to the cosmological constant produces a value that is off by 10^{46}, i.e 46 orders of magnitude wrong [7], with no substantive resolution. Using the Standard Model view for the electroweak contribution results in an even greater error.

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 Standard Model views and assumptions about the causality of the observed "invariant mass" values.

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

10 Summary

The Standard Model is highly successful in many areas, especially QM and QED. One of the open questions for the Standard Model is the cause of the specific invariant mass values of fundamental particles.

The accepted Standard Model view hides the fact that the measured $W^{\pm}$ mass of 80398 ± 25 MeV [4] is exactly $2m_{\rm p}/m_{\rm e}$ (3672.30534) times the mass value symmetrically between the electron and the proton ($M_{\rm sp} = (m_{\rm p}\, m_{\rm e})^{1/2}$) and the Standard Model gives no reason for the electron generations nor their masses.

A mass and charge symmetric, 4π quantized and spin quantized mass formula is given that produces the exact $W^{\pm}$ particle mass. The electron generation mass ratios can be produced using a 4π related magnitude, i.e $m_{{\rm e}(x)}/m_{{\rm e}(x-1)} = \sqrt{2}(4\pi\varrho_x)^{3-x}$ for x=(1,2).

The common 4π formulation allows the single mass formula (3) to produce the masses of the proton, the W, and the three electron generations.

Equations (1), (2) and (3) strongly suggest several new aspects.

First, in addition to the atomic orbital quantization of QM, there is an intra-particle quantization mechanism which gives the fundamental particles and generations their invariant mass values.

Second, the fundamental particle quantization process is spin $\{\frac{1}{2},1\}$ and 4π quantized.

Third, equation (1) indicates that nature is actually highly symmetric, being charge and mass up/down symmetric.

This symmetry allows for the possibility of an alternate matter creation process for the early universe which results in creating only matter.

In addition the mass and charge super-symmetric view of equation (1) should yield a near zero cosmological constant in keeping with the observed value.

A quantization proposition is not in conflict with the existence of quarks.

A dual approach is required to explain the 4π and spin mass pattern of equation (1), the 4π electron generation mass pattern, and Palazzi's [2] results.

This dual approach involves a quantizing mechanism as the source of the stability and mass value of the spin 1/2 particles, the mass values of the fundamental $W^{\pm}$ particles, and the decay point mass of quark composites, while the types and symmetries of quarks construct the variations seen in the "particle zoo".

The quantized view of equation (3) indicates that one of the intra-particle quantization components can be the source for the generational identity and a foundation for the generational exchange seen in the muon neutrino interaction $\nu_\mu + N \to P^{+} + \mu^{-}$.

Is "A quantized form of energy." the answer to the question "What is mass?".

If relationship (1) and the quantization interpretation of (1), (2) and (3) are fundamental, then the recognition of an intra-particle quantization process is required to move the Standard Model to a massed particle model.

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