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REMARKS ON THE STANDARD MODEL

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Abstract: This paper (1) augments Pauli matrices to three by three with the interpretation of rigid motions in three spaces, thereby re-examines Dirac spinors, (2) distinguishes the electromagnetic wave energy density term in the Lagrangian of the Standard Model that contains symmetric electromagnetic fields from the asymmetric electromagnetic fields in Maxwell equations, and therefore questions if the Lagrangian of the Standard Model actually contains electromagnetic interactions, wherein the sideways magnetic force and the radial electric force are fundamentally different, and (3) re-interpret the weak and the strong nuclear forces, where we give a simple proof of the CPT theorem and the consequent baryon asymmetry.

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1. Introduction

This paper makes some remarks on the Standard Model. We extend the rank of Pauli matrices from two to three and reduce the dimensionality of Dirac spinors from four to one, as based on our previous work [4], which identified the wave-function ψ of a particle with the magnitude of its underlying electromagnetic

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field $\|\mathbf{E}\|$ existing in the invisible universe of a combined spacetime (diagonal) 4-manifold consisting of particle-waves. It is by casting ψ in a physical universe of energies that the probability densities of positions of the particle $|\psi|^2$ are accordingly identified with the energy densities $\epsilon_o \|\mathbf{E}\|^2$ of the particle's associated electromagnetic field. Consequently, the model of a combined spacetime 4-manifold is free from the non-spacetime constructs from quantum mechanics, such as the intrinsic spins. Within this framework, we will give our interpretations of the nuclear forces, but for electromagnetism we cast doubt on its very existence in the Lagrangian of the Standard Model, without even resorting to our proposed model for the Universe (see [4]); briefly said, the product of the Maxwell field curvature tensor with its Hodge dual, although giving the desired energy densities of a free electromagnetic wave, cannot be factored asymmetrically to extract the needed electromagnetism for an electroweak unification while leaving the other factor containing $\mathbf{E}/c^2$.

Section 2 below contains 4 subsections, successively for: (1) Pauli matrices and Dirac spinors, (2) electromagnetism, (3) the weak force, and (4) the strong force. Finally, Section 3 concludes with some summary remarks.

2. The Standard Model

2.1. The Setup of The Dirac Spinors

The Pauli matrices appear in the pair of differential equations for the probability amplitudes ψ_1 and ψ_2 of the "up" and "down" spin states of an electron in a magnetic field $\mathbf{B} = (B_x, B_y, B_z)$ with magnetic moment μ (cf. [1], III-10-12, 13, 14 and 11-1, 2, 3, 4):

$$i\hbar\dot{\psi}_{1,2} = -\mu\,(B_x\sigma_x + B_y\sigma_y + B_z\sigma_z)\,\psi_{1,2}. \tag{2.1}$$

To express the spin states ψ_1 and ψ_2 of 180° apart as two linearly independent vectors in $\mathbb{R}^3$ for calculation, the literature treats:

(i) ψ_1 and ψ_2 as x and y in

$$\sigma_x = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}_{(x,y)}, \tag{2.2}$$

(ii) ψ_1 and ψ_2 as x and z in

$$\sigma_z = \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}_{(x,z)}, \tag{2.3}$$

and (iii) ψ_1 and ψ_2 as y and z in

$$\sigma_y = \begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix}_{(x,y)} \equiv \begin{pmatrix} 0 & 0 \\ 0 & -1 \\ 1 & 0 \end{pmatrix}_{(x,y,z)} \quad \text{(cf. [4])}. \tag{2.4}$$

We now have the following 3×3 representations of the Pauli matrices that observes

$$\begin{aligned} \sigma_i^2 &= I,\ i = x, y, z, & (2.5)\\ \sigma_{ij} &= -\sigma_{ji}\ \forall i \neq j, \text{ as projected onto the } (x,y)\text{-plane}, & (2.6)\\ \sigma_x\sigma_y &= i\sigma_z,\ \sigma_y\sigma_z = i\sigma_x, \sigma_z\sigma_x = i\sigma_y, & (2.7)\\ & \quad \text{as projected onto the } (x,y)\text{-plane}. \end{aligned}$$

$$\sigma_x = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}_{(x,y)} \equiv \begin{pmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & -1 \end{pmatrix}_{(x,y,z)}, \tag{2.8}$$

representing a rigid motion of $x \to y$, $y \to x$, $z \to -z$.

$$\sigma_z = \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}_{(x,z)} \equiv \begin{pmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & -1 \end{pmatrix}_{(x,y,z)}, \tag{2.9}$$

representing a rigid motion of $x \to x$, $y \to -y$, $z \to -z$.

$$\begin{aligned} \sigma_y &= \begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix}_{(x,y)} \equiv \begin{pmatrix} 0 & -i & 0 \\ i & 0 & 0 \\ 0 & 0 & i \end{pmatrix}_{(x,y,z)} \\ &\equiv \begin{pmatrix} 0 & 0 & 1 \\ 0 & -1 & 0 \\ 1 & 0 & 0 \end{pmatrix}_{(x,y,z)}, \end{aligned} \tag{2.10}$$

representing a rigid motion of $x \to z$, $y \to -y$, $z \to x$. For expository references, we record the following matrix pair-products:

$$\begin{aligned} \begin{pmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & -1 \end{pmatrix}_z \begin{pmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & -1 \end{pmatrix}_x &= \begin{pmatrix} 0 & 1 & 0 \\ -1 & 0 & 0 \\ 0 & 0 & 1 \end{pmatrix}; \qquad (2.11)\\ \begin{pmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & -1 \end{pmatrix}_x \begin{pmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & -1 \end{pmatrix}_z &= \begin{pmatrix} 0 & -1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{pmatrix}. \end{aligned}$$

Note that $\sigma_{xz} = -\sigma_{zx}$ as projected onto the $(x, y) - plane$.

$$\begin{pmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & -1 \end{pmatrix}_x \begin{pmatrix} 0 & -i & 0 \\ i & 0 & 0 \\ 0 & 0 & i \end{pmatrix}_y = \begin{pmatrix} i & 0 & 0 \\ 0 & -i & 0 \\ 0 & 0 & -i \end{pmatrix}; \tag{2.12}$$

$$\begin{pmatrix} 0 & -i & 0 \\ i & 0 & 0 \\ 0 & 0 & i \end{pmatrix}_y \begin{pmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & -1 \end{pmatrix}_x = \begin{pmatrix} -i & 0 & 0 \\ 0 & i & 0 \\ 0 & 0 & -i \end{pmatrix}.$$

Again note that $\sigma_{xy} = -\sigma_{yx}$ as projected onto the $(x, y) - plane$.

$$\begin{pmatrix} 0 & -i & 0 \\ i & 0 & 0 \\ 0 & 0 & i \end{pmatrix}_y \begin{pmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & -1 \end{pmatrix}_z = \begin{pmatrix} 0 & i & 0 \\ i & 0 & 0 \\ 0 & 0 & -i \end{pmatrix}; \tag{2.13}$$

$$\begin{pmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & -1 \end{pmatrix}_z \begin{pmatrix} 0 & -i & 0 \\ i & 0 & 0 \\ 0 & 0 & i \end{pmatrix}_y = \begin{pmatrix} 0 & -i & 0 \\ -i & 0 & 0 \\ 0 & 0 & -i \end{pmatrix}.$$

Still, $\sigma_{yz} = -\sigma_{zy}$ as projected onto the $(x, y) - plane$.

We remark that the three columns across Pauli matrices refer to the same motions by three frames, which is only necessary for treating spin-up and spin-down, lying on a straight line, as two linearly independent vectors. Take the first columns of σ_x, σ_z, and σ_y in order; the described motion is for a left-handed electron-wave to spin at the point

$$\begin{aligned} W &\equiv (-1, 0, 0) \text{ with momentum direction } N \equiv \begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix} \text{ to} \\ N &\equiv (0, 1, 0) \text{ with momentum direction } E \equiv \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix} \text{ to} \\ E &\equiv (1, 0, 0) \text{ with momentum direction } T \equiv \begin{pmatrix} 0 \\ i \\ 0 \end{pmatrix} \equiv \begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix}, \end{aligned} \tag{2.14}$$

where $i \in \mathbb{C}$ is necessitated for a 90°-rotation onto a different plane.

Here we make a special note that *the reverse sequence*,

$$\begin{aligned} \sigma_y &\to \sigma_z \to \sigma_x, \text{ is for the right-handed electron-wave, or} \\ &\text{equivalently, a left-hand electron-wave with time reversed.} \end{aligned} \tag{2.15}$$

Now the second column of σ_x along with the third column of σ_z and the second column of σ_y, i.e., $\{E, B, S\}$, (where the different alignment of the columns is due to Pauli matrices being compressed from 3×3 to 2×2), represents redundant information to that from the first columns, $\{N, E, T\}$, since by a frame transformation $\mathfrak{R}$ one has $\mathfrak{R}(N, E, T) = (E, B, S)$

$$\equiv \begin{pmatrix} 0 & 1 & 0 \\ 0 & 0 & -1 \\ -1 & 0 & 0 \end{pmatrix} \begin{pmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & -1 \\ 0 & -1 & 0 \end{pmatrix}. \tag{2.16}$$

If we apply $\mathfrak{R}$ to (E, B, S), then we get $(B, N \equiv -S, W \equiv -E)$, corresponding to the third column of σ_x, the second column of σ_z with the sign changed, and the third column of σ_y with the sign changed (note that here the two sign reversals are due to the interchange of the second and the third columns of the augmented σ_z, which had been the compressed 2×2 Pauli matrices, i.e., a consideration of preserving the orientation).

Since Pauli matrices underlie Dirac spinors and in the above we have recast Pauli matrices in 3-spaces, we now re-examine the spinor structure. To begin with, in [4] we noted that the Dirac equation does not square to Einstein mass-shell equation, since upon squaring, any of the four time derivatives in $\left\{\left(i\hbar\frac{\partial}{\partial t}\right)_j \mid j = 1, 2, 3, 4\right\}$ that is to be operated onto a specific wavefunction of the four wavefunctions in Dirac spinors would erroneously be applied simultaneously to two (different) wavefunctions. I.e., the square-root approach to the mass-shell equation by Dirac is not mathematically valid; as such, anti-particles do not arise from Dirac equation, and the four wavefunctions responsible for matter, anti-matter, and the two spin states reduce to one wavefunction by three different frames. It then follows that the gamma matrices that underlie the Lagrangian of the Standard Model are of questionable status.

2.2. The Electromagnetic Interaction

The electromagnetic interaction term in the Lagrangian of the Standard Model contains the inner product $\epsilon_o c^2 F_{\mu\nu}F^{\mu\nu} \equiv$

$$\begin{aligned} & \epsilon_o c^2 \begin{pmatrix} 0 & E_x & E_y & E_z \\ -E_x & 0 & -B_z & B_y \\ -E_y & B_z & 0 & -B_x \\ -E_z & -B_y & B_x & 0 \end{pmatrix} \\ & \cdot \begin{pmatrix} 0 & -E_x/c^2 & -E_y/c^2 & -E_z/c^2 \\ E_x/c^2 & 0 & -B_z & B_y \\ E_y/c^2 & B_z & 0 & -B_x \\ E_z/c^2 & -B_y & B_x & 0 \end{pmatrix} \\ = \; & 2\left(-\epsilon_o \left\|\mathbf{E}\right\|^2 + \epsilon_o c^2 \left\|\mathbf{B}\right\|^2\right), \end{aligned} \tag{2.17}$$

where, as a foresight, the product equals 0 J/m^3 for an electromagnetic wave, and the underlying Minkowski metric adopts the form $\eta := (-1,1,1,1)_{diag}$ so that

$$(0, E_x, E_y, E_z)\,\eta\left(0, -E_x/c^2, E_y/c^2, E_z/c^2\right)^T = -c^{-2}\left\|\mathbf{E}\right\|^2. \tag{2.18}$$

A short-hand formulation of $\epsilon_o c^2 F_{\mu\nu}F^{\mu\nu}$ by setting $c = 1$ (as a pure number) and omitting the physical constants can be found in, e.g., [11], where, with notation adapted to this paper,

$$F = \mathbf{E}\cdot(d\mathbf{x}\wedge dt) + \frac{1}{2}B\cdot(d\mathbf{x}\otimes d\mathbf{x}), \text{ with} \tag{2.19}$$

$$ds^2 = -dt^2 + (d\mathbf{x})^2 \tag{2.20}$$

as the underlying metric.

Here we first verify $F \equiv \epsilon_o c^2 F_{\mu\nu}F^{\mu\nu}$ as below:

$$\begin{aligned} d\mathbf{x} &\equiv (dx, dy, dz), \\ (dx\wedge dt)(\mathbf{E}, \mathbf{e}_t) &= \frac{1}{2}(-E_x\cdot 1 + 0\times 0) = -\frac{1}{2}E_x, \\ (dy\wedge dt)(\mathbf{E}, \mathbf{e}_t) &= -\frac{1}{2}E_y, \\ (dz\wedge dt)(\mathbf{E}, \mathbf{e}_t) &= -\frac{1}{2}E_z, \end{aligned} \tag{2.21}$$

so that

$$\mathbf{E}\cdot((d\mathbf{x}\wedge dt)(\mathbf{E}, \mathbf{e}_t)) = -\frac{1}{2}\left\|\mathbf{E}\right\|^2. \tag{2.22}$$

$$d\mathbf{x}\otimes d\mathbf{x} \equiv \sum_{i,j} dx_i \otimes dx_j,\ i,j \in \{1,2,3\} \text{ with} \quad (2.23)$$
$$x_1 \equiv x,\ x_2 \equiv y,\ x_3 \equiv z.$$

$(d\mathbf{x}\otimes d\mathbf{x})$ is to be applied successively to $(\mathbf{B},\mathbf{e}_x)$, $(\mathbf{B},\mathbf{e}_y)$, and $(\mathbf{B},\mathbf{e}_z)$, where all the cross-terms are zero, e.g.,

$$(dx \otimes dy)(\mathbf{B},\mathbf{e}_x) = B_x \cdot 0 = 0. \quad (2.24)$$

Thus, $(dx_i \otimes dx_i)(\mathbf{B},\mathbf{e}_i) = B_i,\ i = x,y,z$, and

$$\frac{1}{2}B \cdot \left((d\mathbf{x}\otimes d\mathbf{x})(\mathbf{B},\mathbf{e}_i)_{i=1,2,3}\right) = \frac{1}{2}\|\mathbf{B}\|^2. \quad (2.25)$$

Finally,

$$F\left((\mathbf{E},\mathbf{e}_t);(\mathbf{B},\mathbf{e}_x),(\mathbf{B},\mathbf{e}_y),(\mathbf{B},\mathbf{e}_z)\right) = -\frac{1}{2}\left(\|\mathbf{E}\|^2 - \|\mathbf{B}\|^2\right). \quad (2.26)$$

We next derive the laws of Ampere's and Faraday's in Maxwell equations by applying the Hodge star operator to F for a stationary solution, i.e., (see [12], pp. 960-961),

$$\mathbf{J} \equiv \mu_o J^\nu = \partial_\mu F^{\mu\nu} \equiv d * F, \text{ and} \quad (2.27)$$
$$0 = \partial_{[\lambda}F_{\mu\nu]}, \text{ the Maxwell-Bianchi equations.} \quad (2.28)$$

For Ampere's law, we have

$$\mu_o J^1 = \partial_0 F^{01} + \partial_2 F^{21} + \partial_3 F^{31} \quad (2.29)$$
$$\equiv \frac{\partial}{\partial t}\left(-E_x/c^2\right) + \frac{\partial}{\partial y}B_z + \frac{\partial}{\partial z}(-B_y),$$

$$\mu_o J^2 = \partial_0 F^{02} + \partial_1 F^{12} + \partial_3 F^{32} \quad (2.30)$$
$$\equiv \frac{\partial}{\partial t}\left(-E_y/c^2\right) + \frac{\partial}{\partial x}(-B_z) + \frac{\partial}{\partial z}B_x,$$

and

$$\mu_o J^3 = \partial_0 F^{03} + \partial_1 F^{13} + \partial_3 F^{23} \quad (2.31)$$
$$\equiv \frac{\partial}{\partial t}\left(-E_z/c^2\right) + \frac{\partial}{\partial x}B_y + \frac{\partial}{\partial y}(-B_x),$$

so that

$$curl\mathbf{B} = \frac{1}{c^2}\frac{\partial \mathbf{E}}{\partial t} + \mathbf{J}, \text{ i.e., Ampere's law.} \quad (2.32)$$

For Faraday's law, we have

$$\begin{aligned} 0 &= \partial_0 F_{12} + \partial_1 F_{20} + \partial_2 F_{01} \\ &\equiv \frac{\partial}{\partial t}(-B_z) + \frac{\partial}{\partial x}(-E_y) + \frac{\partial}{\partial y}E_x, \end{aligned} \tag{2.33}$$

$$\begin{aligned} 0 &= \partial_0 F_{23} + \partial_2 F_{30} + \partial_3 F_{02} \\ &\equiv \frac{\partial}{\partial t}(-B_x) + \frac{\partial}{\partial y}(-E_z) + \frac{\partial}{\partial z}E_y, \end{aligned} \tag{2.34}$$

and

$$\begin{aligned} 0 &= \partial_0 F_{31} + \partial_3 F_{10} + \partial_1 F_{03} \\ &\equiv \frac{\partial}{\partial t}(-B_y) + \frac{\partial}{\partial z}(-E_x) + \frac{\partial}{\partial x}E_z, \end{aligned} \tag{2.35}$$

so that

$$curl E = -\frac{\partial \mathbf{B}}{\partial t}, \text{ i.e., Faraday's law.} \tag{2.36}$$

From the above, we see that in order to derive the laws of Ampere's and Faraday's, the energy-density term in Equation (2.17), $-\epsilon_o \|\mathbf{E}\|^2 + \epsilon_o c^2 \|\mathbf{B}\|^2$, must be factored into $F_{\mu\nu}$ and $F^{\mu\nu}$, i.e., Equation (2.18) ,

$$(0, E_x, E_y, E_z)\,\eta\left(0, -E_x/c^2, E_y/c^2, E_z/c^2\right)^T = -c^{-2}\|\mathbf{E}\|^2,$$

and this step is invalid since by definition

$$\begin{aligned} \|\mathbf{E}\|^2 &:= \mathbf{E}\cdot\mathbf{E} \text{ and} \\ \left\|c^{-1}\mathbf{E}\right\|^2 &= (0, E_x/c, E_y/c, E_z/c)\cdot(0, E_x/c, E_y/c, E_z/c). \end{aligned} \tag{2.37}$$

Factoring $2\left(-\epsilon_o \|\mathbf{E}\|^2 + \epsilon_o c^2 \|\mathbf{B}\|^2\right)$ in the Lagrangian into $\epsilon_o c^2 F_{\mu\nu}F^{\mu\nu}$ is to factor a square as a rectangle, to extract $F_{\mu\nu}$ to enter into the lepton terms for a presence of electromagnetism for unifying electromagnetism with the weak force (cf. [7], p. 121, [3], p. 335: "The Weinberg-Salam model, ..., is a curious amalgam of the weak and electromagnetic interactions. Strictly speaking, it is not a "unified field theory" of the weak and electromagnetic interactions (see [2, 10]), since we must introduce two distinct coupling constants g and g' for the $SU(2)$ and $U(1)$ interactions."). $2\left(-\epsilon_o \|\mathbf{E}\|^2 + \epsilon_o c^2 \|\mathbf{B}\|^2\right)$ is of an electromagnetic wave in free space, where $\mathbf{E}$ and $\mathbf{B}$ are totally symmetric by defining $c := \frac{3\times 10^8 m}{s} \equiv \frac{s}{s} = 1$, with only 3 degrees of freedom in spacetime; as such, there is no justification to factor $2\left(-\epsilon_o \|\mathbf{E}\|^2 + \epsilon_o c^2 \|\mathbf{B}\|^2\right)$ asymmetrically as the above into $\epsilon_o c^2 F_{\mu\nu} F^{\mu\nu}$ (Equation (2.18)). While electromagnetism implies electromagnetic waves by Maxwell equations, the converse is not true. That is, while an electron-wave can generate electromagnetic waves, electromagnetic waves do not have electric charges. To be sure, in [12] (pp. 960-961) the factorization of $2\left(-\epsilon_o \|\mathbf{E}\|^2 + \epsilon_o c^2 \|\mathbf{B}\|^2\right)$ is actually

$$\epsilon_o c^2 \begin{pmatrix} 0 & E_x/c & E_y/c & E_z/c \\ -E_x/c & 0 & -B_z & B_y \\ -E_y/c & B_z & 0 & -B_x \\ -E_z/c & -B_y & B_x & 0 \end{pmatrix} \begin{pmatrix} 0 & -E_x/c & -E_y/c & -E_z/c \\ E_x/c & 0 & -B_z & B_y \\ E_y/c & B_z & 0 & -B_x \\ E_z/c & -B_y & B_x & 0 \end{pmatrix}, \tag{2.38}$$

which does not deduce Maxwell equations, i.e., a mistake in the Text. We should also note that although a simple differentiation of (2.38) leads to a stationary condition for the electromagnetic $4 - \textit{potential}$ $\mathbf{A}_{1+3}$,

$$\Box^2 \mathbf{A}_{1+3} = 0, \tag{2.39}$$

with $\Box^2$ being the 4-dimensional Laplacian (or D'Alembertian), Equation (2.39) does not deduce Maxwell equations (despite the converse).

2.3. The Weak Interaction

By our model in [4], before the Big Bang there had been a universe $M^{[2]}$ consisting of pure electromagnetic waves; due to the extraordinarily large gravitational constant $G^{[2]}$ of $M^{[2]}$, a Black Hole B in $M^{[2]}$ came into being; the center of B by its infinite energy density transformed electromagnetic waves into particle-waves, opening up a combined spacetime 4-manifold $M^{[1]} \times B$, the Big Bang, when electromagnetic waves traveling in opposite directions collided at the center of B resulting in photon-waves, (anti) lepton-waves and (anti) quark-waves by the different osculating angles at the collision. Because the Pauli matrix σ_y can be generalized into

$$\begin{pmatrix} 0 & a - bi \\ a + bi & 0 \end{pmatrix}, \tag{2.40}$$

we derived the spinning motions of all the particle-waves directly from the mass-shell equation (see [4]). As such, we postulated that the electric charge of a particle was in proportion to the osculating angle between the colliding electromagnetic waves at the Big Bang:

$$\begin{aligned} &90^\circ \text{ for (anti) electron-waves,} \\ &60^\circ \text{ for (anti) up-quark-waves,} \\ &30^\circ \text{ for (anti) down-quark-waves, and} \\ &0^\circ \text{ for (anti) neutrino-waves;} \end{aligned} \quad (2.41)$$

moreover, the three generations of fermions resulted from their winding numbers being $0, 1$ and 2 around their spinning circles S^1. We now make the following notation:

Denote the semi-circle $S^1_{x\in[-1,1],y\geq 0}$ by 0. As projected onto the $(y,z)-plane$,

$$\begin{aligned} 1 &\equiv 0 \text{ rotated clockwise by } 30^\circ, \\ 2 &\equiv 0 \text{ rotated clockwise by } 60^\circ, \\ 3 &\equiv 0 \text{ rotated clockwise by } 90^\circ, \end{aligned} \quad (2.42)$$

$\forall \{a,b\} \subset \{0,1,2,\cdots,11,12\equiv 0\}$:

(i) (a) for a *left-handed particle-wave*, $a < b$ implies a negative charge and $a > b$, a positive charge, and (b) for a *left-handed anti-particle-wave*, $a < b$ implies a positive charge and $a > b$, a negative charge;

(ii) (a) for a *right-handed particle-wave*, $a > b$ implies a negative charge and $a < b$, a positive charge, and (b) for a *right-handed anti-particle-wave*, $a > b$ implies a positive charge and $a < b$, a negative charge;

(iii) denote $W \equiv (-1,0,0)$ and $E \equiv (1,0,0)$, for a (regular) particle,

$$\begin{aligned} (a,b)_W \ :&= (\text{a field energy outflow beginning at } W \text{ along the} \\ &\text{plane indicated by } a \text{ to } E\text{, followed by its inflow} \\ &\text{from } E \text{ along the plane indicated by } b \text{ back to } W); \end{aligned} \quad (2.43)$$

(iv) for an anti-particle,

$$\begin{aligned} (a,b)_E \ :&= (\text{a field energy outflow beginning at } E \text{ along the} \\ &\text{plane indicated by } a \text{ to } W\text{, followed by its inflow} \\ &\text{from } W \text{ along the plane indicated by } b \text{ back to } E); \end{aligned} \quad (2.44)$$

(v) for (regular) particles $\forall a \in \{0,1,2,3\}$

$$e^-_L := (a, a+3)_{W(L)} \text{ and } e^-_R := (a+3, a)_{W(R)} \quad (2.45)$$

(note that the parenthetical (L) and (R) represent redundant information due to the known negative charge of e^- and the above stipulations (i) and (ii)),

$$u_L \quad : \quad = (a+2, a)_{W(L)} \text{ and } u_R := (a, a+2)_{W(R)}\,, \tag{2.46}$$
$$d_L \quad : \quad = (a, a+1)_{W(L)} \text{ and } d_R := (a+1, a)_{W(R)}\,, \tag{2.47}$$
$$\gamma_L \quad : \quad = (a, a+6)_{W,L} \text{ and } \gamma_R := (a+6, a)_{W,R}\,, \text{ and} \tag{2.48}$$
$$\nu_L \quad : \quad = (a, a+\epsilon)_{W(L)} \text{ and } \nu_R := (a+\epsilon, a)_{W(R)}\,, \tag{2.49}$$

where

$$\lim_{0<\epsilon\to 0} \nu_R = \lim_{0<\epsilon\to 0} \nu_L = (a, a)_W \equiv \nu_{(L)}, \tag{2.50}$$

a form to serve the CPT theorem in the following.

(vi) for anti-particles $\forall a \in \{6, 7, 8, 9\}$

$$e_L^+ \quad : \quad = (a, a+3)_{E(L)} \text{ and } e_R^+ := (a+3, a)_{E(R)}\,, \tag{2.51}$$
$$\bar{u}_L \quad : \quad = (a+2, a)_{E(L)} \text{ and } \bar{u}_R := (a, a+2)_{E(R)}\,, \tag{2.52}$$
$$\bar{d}_L \quad : \quad = (a, a+1)_{E(L)} \text{ and } \bar{d}_R := (a+1, a)_{E(R)}\,, \tag{2.53}$$
$$\bar{\nu}_L \quad : \quad = (a, a+\epsilon)_{E(L)} \text{ and } \bar{\nu}_R := (a+\epsilon, a)_{E(R)}\,. \tag{2.54}$$

From the above presentation of ν, we see at once why there are only left-handed neutrinos. Also, it is from the osculating *angle* $\angle(a, b)$ that (1) electric charges arise, by causing a spacetime curvature that affects geodesics in analogy with energy causing gravity (cf. [5]) and (2) rest masses arise, by causing the spinning motion to take a necessary pause at the angle so as not to violate the law of conservation of angular momentum. We now provide the following illustrations:

Example 1. $\gamma_L + \gamma_L = (0, 6)_{W,L} + (3, 9)_{E,L} \to (0, 3)_{W(L)} + (6, 9)_{E(L)} = e_L^- + e_L^+$.

Example 2. $\gamma_L + \gamma_R = (0, 6)_{W,L} + (9, 3)_{E,R} \to (0, 9)_W + (6, 3)_E \equiv (3, 12 \equiv 0)_W + (9, 6)_E = e_R^- + e_R^+$, with a permutation of $a \to a+3$ around the circle.

Example 3. $\gamma_R + \gamma_L = (6, 0)_{W,R} + (3, 9)_{E,L} \to (6, 3)_{W(R)} + (0 \equiv 12, 9)_{E(R)} \equiv (3, 12 \equiv 0)_W + (9, 6)_E = e_R^- + e_R^+$, with a permutation of $a \to a-3$ around the circle.

Example 4. $\gamma_R + \gamma_R = (6, 0)_{W,R} + (9, 3)_{E,R} \to (6, 9)_W + (0 \equiv 12, 3)_E \equiv (3, 6)_{W(L)} + (9, 0 \equiv 12)_{E(L)} = e_L^- + e_L^+$, with a permutation of $a \to a-3$ around the circle.

Example 5. $\gamma_L + \gamma_L = (0,6)_{W,L} + (2,8)_{E,L} \to (0,2)_{W(R)} + (6,8)_{E(R)} = u_R + \bar{u}_R$.

Example 6. $\gamma_L + \gamma_L = (2,8)_{W,L} + (0,6)_{E,L} \to (2,0)_{W(L)} + (8,6)_{E(L)} = u_L + \bar{u}_L$.

Example 7. $\gamma_L + \gamma_R = (2,8)_{W,L} + (6,0)_{E,R} = (2,6)_W + (8,0 \equiv 12)_E \to \left[(2,5)_{W(L)} + (5,6)_{W(L)}\right] + \left[(8,11)_{E(L)} + (11,12)_{E(L)}\right] = e_L^- + d_L + e_L^+ + \bar{d}_L$.

We now express Z_0, $W^{\pm}$ and the Higgs boson H:

(1) $Z_0 = (0,6)_{W,L} + (6+\epsilon,\epsilon)_{W,R}$, where $(6+\epsilon,\epsilon)$ denotes no field cancellation between the two opposite energy flows $(0,6)_{W,L}$ and $(6,0)_{W,R}$; the notation means that Z_0 is a single photon-wave alternating between being left-handed and right-handed, which may be compared with the neutrino-wave $\nu = (0,0)_{W(L)}$ composed of a half-circle rotation and its reverse energy flows.

(2) $W^- = d_L + u_R = (0,1)_{W(L)} + (1+\epsilon,3)_{W(R)}$, so that

$$\begin{aligned} W^- + u_L &= (0,1)_{W(L)} + (1+\epsilon,3)_{W(R)} + (3,1)_{W(L)} \\ &\to (0,1)_{W(L)} = d_L \text{ as } \epsilon \to 0, \end{aligned} \tag{2.55}$$

where $(1,3)_{W(R)} + (3,1)_{W(L)} \equiv 0\ J/m^3$ by field superposition, and

$$u_R \equiv \bar{u}_L \tag{2.56}$$

by the CPT theorem:

$$u_R = (1,3)_{W(R)} \to^P (7,9)_{W(R)} \to^C (7,9)_{E(R)} \to^T (9,7)_{E(L)} = \bar{u}_L. \tag{2.57}$$

To be precise, there exist exactly four alternatives to cover a circle S^1 with a real line $\mathbb{R}$: $\left(\pm S^1\right) \times (\pm\mathbb{R})$, where

$$\begin{aligned} S^1 \times \mathbb{R} &\equiv \left(-S^1\right) \times (-\mathbb{R}) \text{ and} & (2.58)\\ S^1 \times (-\mathbb{R}) &\equiv \left(-S^1\right) \times \mathbb{R}, & (2.59) \end{aligned}$$

with *frequency defined as the absolute value of the winding numbers of the covering.* As such,

$$(t,x,y,z) \equiv (-t,-x,-y,-z)\,. \tag{2.60}$$

We note that our parity reversal refers to a $180^\circ - rotation$ of a ball B^3 around the $x - axis$; that is, we treat anti-podes $\subset S^1$ as $\{(left, right)_\theta \mid \theta \in [0,2\pi)\}$

by frames $\{F_\theta\}$. We now give a very simple proof, within our framework, of the CPT theorem (which originated from the quantum mechanical setup; see, e.g., [9]):

$$\begin{aligned}(t,x,y,z) &\rightarrow {}^P(t,x,-y,-z) \rightarrow^C (t,-x,-y,-z)\\ &\rightarrow {}^T(-t,-x,-y,-z)\\ &\equiv (t,x,y,z)\,,\ QED,\end{aligned} \tag{2.61}$$

where the charge reversal is effected by interchanging W and E as the beginning points of the energy flows by the definitions from Equations (2.43) and (2.44). To sum up,

$$T\ :\ (a,b)_W \rightarrow (b,a)_W \quad \text{(handedness)} \tag{2.62}$$

$$C\ :\ (a,b)_W \rightarrow (a,b)_E \quad \text{(beginning point by the definition)} \tag{2.63}$$

$$P\ :\ (a,b)_W \rightarrow (a+6,b+6)_W \rightarrow^C (a+6,b+6)_E \ \text{(anti-particle).} \tag{2.64}$$

The above showed $W^- + u_L \rightarrow d_L$; we also show here $W^- \rightarrow e_L^- + \bar{\nu}_L$:

$$\begin{aligned}W^- &= d_L + u_R = (0,1)_{W(L)} + (1+\epsilon,3)_{W(R)} \\ &= (0,3)_{W(L)} + (1+\epsilon,1)_W \\ &= e_L^- + (7,7+\epsilon)_E \ \text{(PCT theorem)} \\ &= e_L^- + \bar{\nu}_L.\end{aligned} \tag{2.65}$$

(3) $W^+ = \bar{d}_L + \bar{u}_R = (6,7)_{E(L)} + (7+2\epsilon, 9+4\epsilon)_{E(R)}$, where $(6,7)_{E(L)} = (1,0)_{W(R)}$ (by PCT) and $(7+2\epsilon,9+4\epsilon)_{E(R)} = (3+4\epsilon,1+2\epsilon)_{W(L)}$ (by PCT) , so that

$$\begin{aligned}W^+ + d_L &= (1,0)_{W(R)} + (3+4\epsilon,1+2\epsilon)_{W(L)} + (0,1)_{W(L)} \\ &\rightarrow (3,1)_{W(L)} = u_L.\end{aligned} \tag{2.66}$$

From the above, we see that for any anti-particle-wave separated from pair-creation, we have the following identity:

$$q_L \equiv \bar{q}_R \text{ and } q_R \equiv \bar{q}_L, \tag{2.67}$$

where the separation readily causes a parity reversal and a combined reversal of charge (the interchange between E and W) and time (between R and L) establishes the CPT invariance. As such, fundamentally there is just one kind of matter (see [6, 8] for experimental observations).

(4) $H = (0,1)_{W(L)} + (3\epsilon, 1+3\epsilon)_{E(L)} + (1+\epsilon, 3)_{W(R)} + (1+2\epsilon, 3+4\epsilon)_{E(R)}$ (so that charge $\to 0$, spin $\to 0$, as $\epsilon \to 0$; the different multiples of ϵ are to prevent field cancellations),

and $H + 2\gamma \to$

$$
\begin{aligned}
& \left[(0,1)_{W(L)} + (1+\epsilon,3)_{W(R)}\right] \\
& + \left[(3\epsilon, 1+3\epsilon)_{E(L)} + (1+2\epsilon, 3+4\epsilon)_{E(R)}\right] \\
\to\ & \left[(0,1)_{W(L)} + (1+\epsilon,3)_{W(R)}\right] \\
& + \left[(6,7)_{E(L)} + (7+2\epsilon, 9+4\epsilon)_{E(R)}\right] \\
=\ & W^- + W^+,
\end{aligned}
\tag{2.68}
$$

or $H + 2\gamma \to$

$$
\begin{aligned}
& \left[(0,1)_{W(L)} + (6,7)_{E(L)}\right] + \left[(1+\epsilon,3)_{W(R)} + (7+2\epsilon, 9+4\epsilon)_{E(R)}\right] \\
\to\ & \left[(0,6)_{W,L} + (1,7)_{E,L}\right] + \left[(1+\epsilon, 7+2\epsilon)_{W,L} + (3, 9+4\epsilon)_{E,L}\right] \\
\to\ & \left[(0,6)_{W,L} + (7,1)_{W,R}\right] + \left[(1,7)_{W,L} + (9,3)_{W,R}\right] \\
\to\ & \left[(0,6)_{W,L} + (6+\epsilon,\epsilon)_{W,R}\right] + \left[(1,7)_{W,L} + (7+\epsilon, 1+\epsilon)_{W,R}\right] \\
=\ & Z_0 + Z_0.
\end{aligned}
\tag{2.69}
$$

2.4. The Strong Interaction

By our model in [4], the particle of a particle-wave in the combined universe $M^{[1]} \times B$, being a point, causes a mini black hole b in $M^{[1]}$ opening to $B \subset M^{[2]}$, i.e., $b \subset \left(M^{[1]} \cap B\right) \subset M^{[2]}$; the boundary of b has vanishing spacetime by the Schwarzchild metric, so that by the quotient-space topology the entire boundary ∂b is identified as one point. Hence the three quark-waves in a baryon, by having their mini black holes connected (with the radii greatly increased due to the additional electromagnetic force in addition to gravity, see [4]), are identified as one baryon-wave, manifested as the strong force. By this description, it appears that the strong force does not lend to easy calculation; as such, to the extent that QCD provides useful experimental predictions, it serves as computational algorithms for our model.

3. Summary Remarks

The Standard Model is founded upon quantum mechanics, which without a spacetime to contain waves, has no other alternatives but to interpret waves as probability amplitudes, leading to abstract mathematical constructs and the deduced results therein, such as the gauge theoretic construct. In the case of electromagnetism, as we noted in the above Section 2.2, in order to apply the Hodge star operation to interpret electromagnetism as gauge curvatures, one has to make an add hoc asymmetric factorization $F_{\mu\nu}F^{\mu\nu}$ from the electromagnetic wave, which is invalid by the symmetry of $(\mathbf{E}, \mathbf{B})$ in electromagnetic waves. We also note that the nearly universal unit-less expositions in the literature can lead to mistakes; take for instance $c^2 curl\mathbf{B} = \frac{\partial \mathbf{E}}{\partial t}$ expressed as $curl\mathbf{B} = \frac{\partial \mathbf{E}}{\partial t}$. It has been said that the Standard Model is incomplete; one cannot but wonder if it has serious fundamental flaws; here we quote [3], p. 363: "The Standard Model is certainly not the final theory of particle interactions. It was created by crudely splicing the electroweak theory and the theory of quantum chromodynamics (QCD). It cannot explain the origin of the quark masses or the various coupling constants. The theory is rather unwieldly and inelegant." The Higgs field H appears to us, tentatively, as Nature's mechanism to take the square-root of the mass-shell equation to arrive at W^- and W^+, which in turn change the character of particles.

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