Article

Inaugural Issue

Prespacetime Model of Elementary Particles, Four Forces & Consciousness

Huping Hu* & Maoxin Wu

ABSTRACT

A prespacetime model of elementary particles, four forces and consciousness has been formulated, which illustrates how the self-referential hierarchical spin structure of the prespacetime provides a foundation for creating, sustaining and causing evolution of elementary particles through matrixing processes embedded in said prespacetime. The prespacetime model reveals the creation, sustenance and evolution of fermions, bosons and spinless entities each comprised of an external wave function or external object and an internal wave function or internal object located respectively in an external world and an internal world of a dual-world universe. The prespacetime model provides a unified causal structure for weak interaction, strong interaction, electromagnetic interaction, gravitational interaction, quantum entanglement, consciousness and brain function. The prespacetime model provides a unique tool for teaching, demonstration, rendering, and experimentation related to subatomic and atomic structures and interactions, quantum entanglement generation, gravitational mechanisms in cosmology, structures and mechanisms of consciousness, and brain functions.

Key Words: prespacetime, four forces, consciousness, spin, existence

1. INTRODUCTION

In prespacetime we contemplate

The beauty and awe of what we have gradually discovered over the last several years or rather what prespacetime has lead us to are so ecstatic that the first author has been struggling through days and nights to put them in proper written form (also see Hu & Wu, 2001-2009). In part, the breakthrough came as we struggled to find answers to fundamental questions posed by our own experimental results (Hu & Wu, 2006b, 2006c, 2006d & 2007a) that call for drastic changes in our own world view.

*Corresponding author: Huping Hu, Ph.D., J.D. Address: QuantumDream, Inc., P.O. Box 267, Stony Brook, NY 11790, USA. E-mail: hupinghu@quantumbrain.org Note: This work was completed on 12/21/2009 and modified to this current version on 01/08/2010. The models and applications described in this work are the subject of a provisional patent application (App. No. 61/288333) filed with USPTO on 12/20/2009.

However, we are aware that we can only strive for perfection, completeness and correctness in our comprehensions and writings because we ourselves are limited and imperfect. So, here we offer fellow truth seekers and our readers what we have comprehended and written with the caveat "we are imperfect but humble."

This work is organized as follows. In § 2, we shall use words and drawings to lay out the prespacetime ontology of the principle of existence. In § 3, we shall express in mathematics the principle of existence in the order of: (1) scientific genesis in a nutshell; (2) self-referential Matrix Law and its metamorphoses; (3) additional forms of Matrix Law; (4) scientific genesis of primordial entities (elementary particles); and (5) scientific genesis of composite entities. In § 4, we shall discuss: (1) metamorphous prespacetime view of the existence & the essence of spin; (2) the determinant view & the meaning of Klein-Gordon equation; (3) the meaning of Schrodinger equation & quantum potential; and (4) the third State of matter. In § 5 through § 8, we shall discuss weak, electromagnetic, strong and gravitational interactions respectively. In § 9, we shall focus on the essence of consciousness and the mechanism of human conscious experience. In § 10, we shall discuss some applications, make some predictions and pose and answer some anticipated fundamental questions related to this work. Finally, in § 11, we shall conclude this work. §11 are followed by a dedication, tribute, acknowledgments, a note and [self-] references.

2. ONTOLOGY

In words and drawings we illustrate

In the beginning there was prespacetime $\mathbf{e}^{\mathbf{h}}$ by itself $\mathbf{e}^0$ =1materially empty but restless. And it began to imagine through primordial self-referential spin $1=\mathbf{e}^0=\mathbf{e}^{\mathbf{i}M-\mathbf{i}M}=\mathbf{e}^{\mathbf{i}M}\mathbf{e}^{-\mathbf{i}M}=\mathbf{e}^{-\mathbf{i}M}/\mathbf{e}^{-\mathbf{i}M} = \mathbf{e}^{\mathbf{i}M}/\mathbf{e}^{\mathbf{i}M}$…such that it created the external object to be observed and internal object as observed, separated them into external world and internal world, caused them to interact through self-referential Matrix Law and thus gave birth to the Universe which it has since sustained and made to evolve.

In this Universe, prespacetime (ether), represented by Euler number **e**, is the ground of existence and can form external and internal wave functions as external and internal objects (each pair forms an elementary entity) and interaction fields between elementary entities which accompany the imaginations of the prespacetime. The prespacetime can be self-acted on by self-referential Matrix Law $\boldsymbol{L_M}$. The prespacetime has imagining power $\boldsymbol{i}$ to project external and internal objects by projecting, e.g., external and internal phase $\pm M = \pm(Et-\mathbf{p}\cdot\mathbf{x})/\hbar$ at the power level of prespacetime. The Universe so created is a dual-world comprising of the external world to be observed and internal world as observed under each relativistic frame $x^\mu=(t, \mathbf{x})$. In one perspective of prespacetime view, the internal world (which by convention has negative energy) is the negation/image of the external world (which by convention has positive energy). The absolute frame of reference is the prespacetime. Thus, if prespacetime stops imagining ($\mathbf{h}=\boldsymbol{i}0=0$), the Universe would disappear into materially nothingness $\mathbf{e}^{\boldsymbol{i}0}=\mathbf{e}^0=1$.

The accounting principle of the dual-world is conservation of zero. For example, the total energy of an external object and its counterpart, the internal object, is zero. Also in this dual-world, self-gravity is the nonlocal self-interaction (wave mixing) between an external object in the external world and its negation/image in the internal world, that is, the negation appears to its external counterpart as a black hole *visa versa*. Gravity is the nonlocal interaction (quantum entanglement) between an external object with the internal world as a whole. Some other most basic conclusions are: (1) the two spinors of the Dirac electron or positron are respectively the external and internal objects of the electron or positron; (2) the electric and magnetic fields of a linear photon are respectively the external and internal objects of a photon which are always self-entangled; (3) the proton is likely a spatially confined (hadronized) positron through imaginary momentum (downward self-reference); and (4) a neutron is likely comprised of an unspinized (spinless) proton and a bound and spinized electron. In this dual-world, prespacetime has both transcendental and immanent properties/qualities. The transcendental aspect of prespacetime is the origin of primordial self-referential spin (including the self-referential Matrix Law) and it projects the external and internal worlds through spin and, in turn, the immanent aspect of prespacetime observes the external world as the observed internal world through the said spin. Human consciousness is a limited and particular version of this dual-aspect prespacetime such that we have limited free will and limited observation which is mostly classical at macroscopic levels but quantum at microscopic levels.

Before mathematical presentations, we draw below several diagrams illustrating the hypothesis of how prespacetime created the Universe comprising of the external world and the internal world (the dual-world) and how the external object and internal object and the external world and internal world interact.

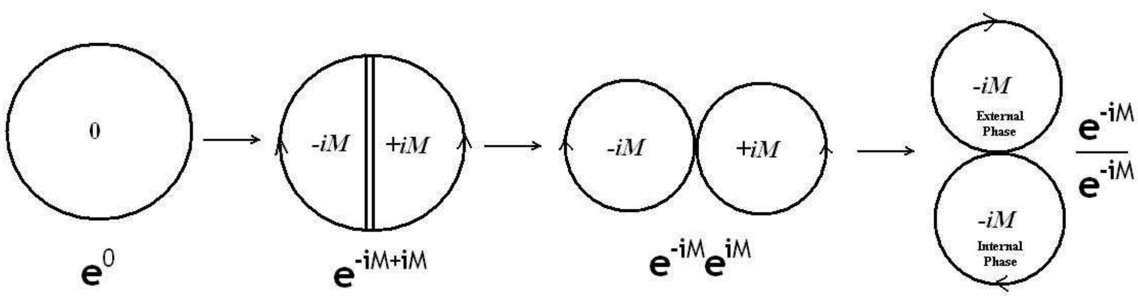

Figure2.1. Illustration of primordial phase distinction

As shown in Figure 2.1, a primordial phase distinction (dualization), e.g., $\pm M=\pm(Et-\mathbf{p}\cdot\mathbf{r})/\hbar$, was made at the power level of prespacetime through imagination ***i***. At the ground level of prespacetime, this is $\mathbf{e}^0=\mathbf{e}^{\mathbf{i}M-\mathbf{i}M}=\mathbf{e}^{\mathbf{i}M}\mathbf{e}^{-\mathbf{i}M}=\mathbf{e}^{-\mathbf{i}M}/\,\mathbf{e}^{-\mathbf{i}M}=\mathbf{e}^{\mathbf{i}M}/\,\mathbf{e}^{\mathbf{i}M}$….

The primordial phase distinction in Figure 2.1 is accompanied by matrixing of **e** into: (1) external and internal wave functions as external and internal objects, (2) interaction fields (e.g., gauge fields) for interacting with other elementary entities, and (3) self-acting and self-referential Matrix Law, which accompany the imaginations of the prespacetime at the power level so as to enforce (maintain) the accounting principle of conservation of zero, as illustrated in Figure 2.2.

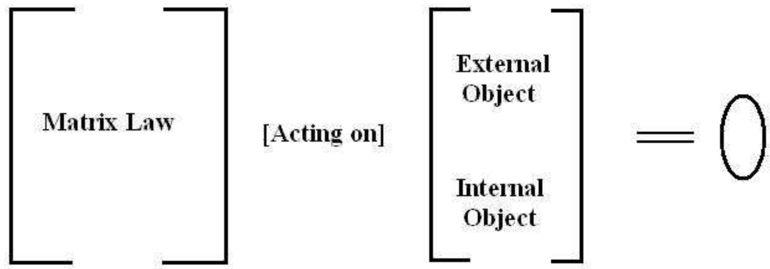

Figure2.2 Prespacetime Equation

Figure 2.3 shows from another perspective of the relationship among external object, internal object and the self-acting and self-referential Matrix Law. According to our ontology, self-interactions (self-gravity) are quantum entanglement between the external object and the internal object.

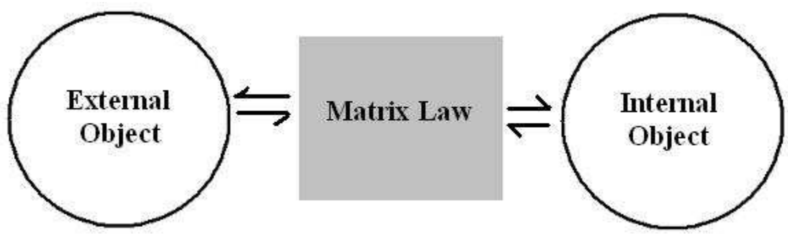

Figure2.3 Self-interaction between external and internal objects of a quantum entity

As shown in Figure 2.4, the two worlds interact with each other through gravity or quantum entanglement since gravity is an aspect of quantum entanglement (Hu & Wu, 2006). Importantly, the interactions within the external world obey classical and relativistic physical laws with influence of the internal world on external world shown as gravity macroscopically, quantum effect (e.g., quantum potential) microscopically, and light speed c as interaction speed limit, *visa versa*.

Please note that, although in Figure 2.4 prespacetime is shown as a strip, both the dualized external world and internal world are embedded in prepacetime.

The above ideas (ontology) were forced upon us by our recent theoretical and experimental studies (Hu & Wu, 2006a-d, 2007a). Among other things, we experimentally demonstrated that gravity is the manifestation of quantum entanglement (*Id.*). We materially live in the external world but experience the external world through its negation, the internal world in the relativistic frame x^{μ}=(t, **x**) attached to each of our bodies. Interactions within the external world and the internal world are local interactions and conform to special theory of relativity. But interactions across the dual world are nonlocal interactions (quantum entanglement). Strong interaction is likely spatially confining nonlocal self-interaction and nonlocal interaction among spatially confined fermions (hadrons).

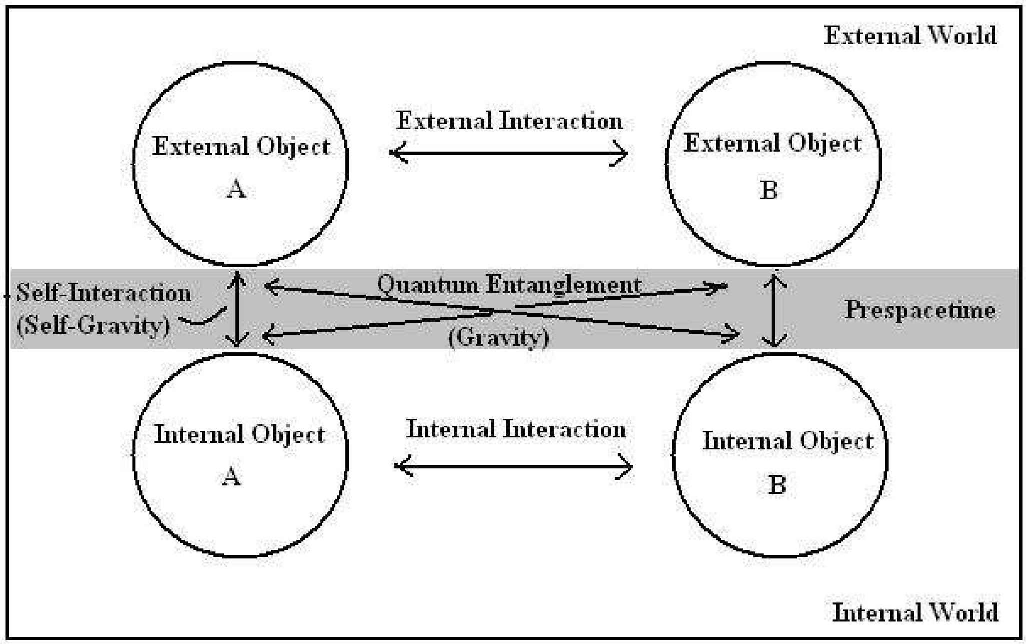

Figure2.4 Interactions in the Dual-World

Therefore, the meaning of the special theory of relativity is that the speed limit *c* is only applicable in each of the dual worlds but not interactions between the dual worlds. Indeed, the reason that no external object can move faster than the speed of light and the same gets heavier and heavier as its speed approaches the speed of light is due to its increased quantum entanglement with the internal world through its counterpart the internal object.

3. MATHEMATICS

In mathematics we express

3.1 Scientific Genesis in a Nutshell

It is our comprehension that:

Prespacetime=Omnipotent, Omnipresent & Omniscient Being/State = ONE (3.1)

Prespacetime creates, sustains and causes evolution of primordial entities (elementary particles) in prespacetime by self-referential spin as follows:

$$1 = e^h = e^{i0} = 1e^{i0} = L_1 e^{-iM+iM} = L_e L_i^{-1}\left(e^{-iM}\right)\left(e^{-iM}\right)^{-1} \rightarrow$$
$$\begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix}\begin{pmatrix} A_e e^{-iM} \\ A_i e^{-iM} \end{pmatrix} = L_M \begin{pmatrix} A_e \\ A_i \end{pmatrix} e^{-iM} = L_M \begin{pmatrix} \psi_e \\ \psi_i \end{pmatrix} = L_M \psi = 0 \tag{3.2}$$

In expression (3.2), e is Euler number representing prespacetime (ether), h above e represents the power of the prespacetime, i is imaginary unit representing the imagination of prespacetime, ±M is content of imagination i, L_1=1 is the Law of One of prespacetime before matrixization, L_e is external law, L_i is internal law, $L_{M,e}$ is external matrix law, and $L_{M,i}$ is internal matrix law, L_M is the self-referential Matrix Law in prespacetime comprised of external and internal matrix laws which governs elementary entities and conserves zero, $A_e e^{-iM} = \psi_e$ is external wave function (external object), $A_i e^{-iM} = \psi_i$ is internal wave function (internal object)and ψ is the complete wave function (object/entity in the dual-world as a whole).

Alternatively, prespacetime creates, sustains and causes evolution of primordial entities in the prespacetime by self-referential spin as follows:

$$0 = 0e^h = 0e^{i0} = L_0 e^{-iM+iM} = \left(\mathrm{Det}M_E + \mathrm{Det}M_m + \mathrm{Det}M_{\mathbf{p}}\right)\left(e^{-iM}\right)\left(e^{-iM}\right)^{-1} \rightarrow$$
$$\begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix}\begin{pmatrix} A_e e^{-iM} \\ A_i e^{-iM} \end{pmatrix} = L_M \begin{pmatrix} A_e \\ A_i \end{pmatrix} e^{-iM} = L_M \begin{pmatrix} \psi_e \\ \psi_i \end{pmatrix} = L_M \psi = 0 \tag{3.3}$$

where L_0 is the Law of Zero of the prespacetime as defined by fundamental relationship (3.4) below, *Det* means determinant and M_E , M_m and $M_{\mathbf{p}}$ are respectively matrices with $\pm E$, $\pm m$ and $\pm|\mathbf{p}|$ as elements and E^2, $-m^2$ and $-\mathbf{p}^2$ as determinants.

Prespacetime spins as $1=\mathbf{e}^{i0}=\mathbf{e}^{iM-iM}=\mathbf{e}^{iM}\mathbf{e}^{-iM}=\mathbf{e}^{-iM}/\mathbf{e}^{-iM}=\mathbf{e}^{iM}/\mathbf{e}^{iM}$…before matrixization. Prespacetime also spins through self-acting and self-referential Matrix Law L_M after matrixization which acts on external object and internal object to cause them to interact with each other as further described below.

3.2 Self-Referential Matrix Law and Its Metamorphoses

The Matrix Law $\begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix} = L_M$ of the prespacetime is derived from the following fundamental relationship:

$$E^2 - m^2 - \mathbf{p}^2 = L_0 = 0 \tag{3.4}$$

through self-reference within this relationship which accompanies the imagination (spin *i*) in the Head. For simplicity, we have set c=1 in equation (3.4) and will set $c=\hbar=1$ through out this work unless indicated otherwise. Expression (3.4) was discovered by Einstein.

In the presence of an interacting field of a second primordial entity such as an electromagnetic potential $A^\mu = (\phi, \mathbf{A})$, equation (3.4) becomes the following for an elementary entity with electric charge e:

$$(E - e\phi)^2 - m^2 - (\mathbf{p} - e\mathbf{A})^2 = L_0 = 0 \tag{3.5}$$

One form of the Matrix Law of the prespacetime is derived through self-reference as follows:

$$L = 1 = \frac{E^2 - m^2}{\mathbf{p}^2} = \left(\frac{E-m}{-|\mathbf{p}|}\right)\left(\frac{-|\mathbf{p}|}{E+m}\right)^{-1} \tag{3.6}$$

$$\rightarrow \frac{E-m}{-|\mathbf{p}|} = \frac{-|\mathbf{p}|}{E+m} \rightarrow \frac{E-m}{-|\mathbf{p}|} - \frac{-|\mathbf{p}|}{E+m} = 0$$

where $|\mathbf{p}| = \sqrt{\mathbf{p}^2}$. Matrixing left-land side of the last expression in (3.6) such that $\mathrm{Det}(L^M) = E^2 - m^2 - \mathbf{p}^2 = 0$ so as to satisfy the fundamental relationship (3.4) in the determinant view, we have:

$$\begin{pmatrix} E-m & -|\mathbf{p}| \\ -|\mathbf{p}| & E+m \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix} = L_M \tag{3.7}$$

Indeed, expression (3.7) can also be obtained from expression (3.4) through self-reference as follows:

$$0 = E^2 - m^2 - \mathbf{p}^2 = Det\begin{pmatrix} E & 0 \\ 0 & E \end{pmatrix} + Det\begin{pmatrix} -m & 0 \\ 0 & m \end{pmatrix} + Det\begin{pmatrix} 0 & -|\mathbf{p}| \\ -|\mathbf{p}| & 0 \end{pmatrix} \quad (3.8)$$

Matrixing expression (3.8) by removing determinant sign *Det*, we have:

$$\begin{pmatrix} E & 0 \\ 0 & E \end{pmatrix} + \begin{pmatrix} -m & 0 \\ 0 & m \end{pmatrix} + \begin{pmatrix} 0 & -|\mathbf{p}| \\ -|\mathbf{p}| & 0 \end{pmatrix} = \begin{pmatrix} E-m & -|\mathbf{p}| \\ -|\mathbf{p}| & E+m \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix} = L_M \quad (3.9)$$

After fermionic spinization:

$$|\mathbf{p}| = \sqrt{\mathbf{p^2}} = \sqrt{-Det(\boldsymbol{\sigma}\cdot\mathbf{p})} \rightarrow \boldsymbol{\sigma}\cdot\mathbf{p} \quad (3.10)$$

where $\boldsymbol{\sigma} = (\sigma_1, \sigma_2, \sigma_3)$ are Pauli matrices:

$$\sigma_1 = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix} \quad \sigma_2 = \begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix} \quad \sigma_3 = \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix} \quad (3.11)$$

expression (3.7) becomes:

$$\begin{pmatrix} E-m & -\boldsymbol{\sigma}\cdot\mathbf{p} \\ -\boldsymbol{\sigma}\cdot\mathbf{p} & E+m \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix} = L_M = E - \boldsymbol{\alpha}\bullet\mathbf{p} - \beta\mathrm{m} = E - H \quad (3.12)$$

where $\boldsymbol{\alpha} = (\alpha_1, \alpha_2, \alpha_3)$ and β are Dirac matrices and $H = \boldsymbol{\alpha}\bullet\mathbf{p} + \beta\mathrm{m}$ is the Dirac Hamiltonian. Expression (3.12) governs fermions in Dirac form such as Dirac electron and positron and we propose that expression (3.7) governs the third state of matter (unspinized or spinless entity/particle) with electric charge *e* and mass *m* such as a meson or a meson-like particle. Bosonic Spinization of expression (3.7) $|\mathbf{p}| = \sqrt{\mathbf{p^2}} \longrightarrow \mathbf{s}\cdot\mathbf{p}$ shall be discussed later.

If we define:

$$Det_\sigma\begin{pmatrix} E-m & -\boldsymbol{\sigma}\cdot\mathbf{p} \\ -\boldsymbol{\sigma}\cdot\mathbf{p} & E+m \end{pmatrix} = (E-m)(E+m) - (-\boldsymbol{\sigma}\cdot\mathbf{p})(-\boldsymbol{\sigma}\cdot\mathbf{p}) \quad (3.13)$$

We get:

$$Det_\sigma\begin{pmatrix} E-m & -\boldsymbol{\sigma}\cdot\mathbf{p} \\ -\boldsymbol{\sigma}\cdot\mathbf{p} & E+m \end{pmatrix} = \left(E^2 - m^2 - \mathbf{p}^2\right)I_2 = 0 \quad (3.14)$$

Thus, fundamental relationship (3.4) is also satisfied under the determinant view of expression (3.13). Indeed, we can also obtain the following conventional determinant:

$$Det\begin{pmatrix} E-m & -\boldsymbol{\sigma}\cdot\mathbf{p} \\ -\boldsymbol{\sigma}\cdot\mathbf{p} & E+m \end{pmatrix} = \left(E^2-m^2-\mathbf{p}^2\right)^2 = 0 \tag{3.15}$$

One kind of metamorphosis of expressions (3.6) - (3.14) is respectively as follows:

$$L = 1 = \frac{E^2-\mathbf{p}^2}{m^2} = \left(\frac{E-|\mathbf{p}|}{-m}\right)\left(\frac{-m}{E+|\mathbf{p}|}\right)^{-1} \tag{3.16}$$

$$\rightarrow \frac{E-|\mathbf{p}|}{-m} = \frac{-m}{E+|\mathbf{p}|} \rightarrow \frac{E-|\mathbf{p}|}{-m} - \frac{-m}{E+|\mathbf{p}|} = 0$$

$$\begin{pmatrix} E-|\mathbf{p}| & -m \\ -m & E+|\mathbf{p}| \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix} = L_M \tag{3.17}$$

$$0 = E^2 - m^2 - \mathbf{p}^2 = Det\begin{pmatrix} E & 0 \\ 0 & E \end{pmatrix} + Det\begin{pmatrix} 0 & -m \\ -m & 0 \end{pmatrix} + Det\begin{pmatrix} -|\mathbf{p}| & 0 \\ 0 & |\mathbf{p}| \end{pmatrix} \tag{3.18}$$

$$\begin{pmatrix} E & 0 \\ 0 & E \end{pmatrix} + \begin{pmatrix} 0 & -m \\ -m & 0 \end{pmatrix} + \begin{pmatrix} -|\mathbf{p}| & 0 \\ 0 & |\mathbf{p}| \end{pmatrix} = \begin{pmatrix} E-|\mathbf{p}| & -m \\ -m & E+|\mathbf{p}| \end{pmatrix} \tag{3.19}$$

$$\begin{pmatrix} E-\boldsymbol{\sigma}\cdot\mathbf{p} & -m \\ -m & E+\boldsymbol{\sigma}\cdot\mathbf{p} \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix} = L_M \tag{3.20}$$

$$Det_\sigma\begin{pmatrix} E-\boldsymbol{\sigma}\cdot\mathbf{p} & -m \\ -m & E+\boldsymbol{\sigma}\cdot\mathbf{p} \end{pmatrix} = (E-\boldsymbol{\sigma}\cdot\mathbf{p})(E+\boldsymbol{\sigma}\cdot\mathbf{p}) - (-m)(-m) \tag{3.21}$$

$$Det_\sigma\begin{pmatrix} E-\boldsymbol{\sigma}\cdot\mathbf{p} & -m \\ -m & E+\boldsymbol{\sigma}\cdot\mathbf{p} \end{pmatrix} = \left(E^2 - \mathbf{p}^2 - m^2\right)I_2 = 0 \tag{3.22}$$

Expression (3.17) is the unspinized Matrix Law in Weyl (chiral) form and it is connected to expression (3.7) by Hadamard matrix $H = \frac{1}{\sqrt{2}}\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$:

$$H\begin{pmatrix} E-m & -|\mathbf{p}| \\ -|\mathbf{p}| & E+m \end{pmatrix}H^{-1} = \begin{pmatrix} E-|\mathbf{p}| & -m \\ -m & E+|\mathbf{p}| \end{pmatrix} \tag{3.23}$$

Expression (3.20) is spinized Matrix Law in Weyl (chiral) form and it is connected to expression (3.12) by 4x4 Hadamard matrix:

$$H\begin{pmatrix} E-m & -\boldsymbol{\sigma}\cdot\mathbf{p} \\ -\boldsymbol{\sigma}\cdot\mathbf{p} & E+m \end{pmatrix}H^{-1}=\begin{pmatrix} E-\boldsymbol{\sigma}\cdot\mathbf{p} & -m \\ -m & E+\boldsymbol{\sigma}\cdot\mathbf{p} \end{pmatrix} \tag{3.24}$$

Another kind of metamorphosis of expressions (3.6) - (3.14) is respectively as follows:

$$L=1=\frac{E^2}{m^2+\mathbf{p}^2}=\left(\frac{E}{-m+i|\mathbf{p}|}\right)\left(\frac{-m-i|\mathbf{p}|}{E}\right)^{-1} \tag{3.25}$$

$$\rightarrow \frac{E}{-m+i|\mathbf{p}|}=\frac{-m-i|\mathbf{p}|}{E}\rightarrow \frac{E}{-m+i|\mathbf{p}|}-\frac{-m-i|\mathbf{p}|}{E}=0$$

$$\begin{pmatrix} E & -m-i|\mathbf{p}| \\ -m+i|\mathbf{p}| & E \end{pmatrix}=\begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix}=L_M \tag{3.26}$$

$$0=E^2-m^2-\mathbf{p}^2=Det\begin{pmatrix} E & 0 \\ 0 & E \end{pmatrix}+Det\begin{pmatrix} 0 & -m \\ -m & 0 \end{pmatrix}+Det\begin{pmatrix} 0 & -i|\mathbf{p}| \\ i|\mathbf{p}| & 0 \end{pmatrix} \tag{3.27}$$

$$\begin{pmatrix} E & 0 \\ 0 & E \end{pmatrix}+\begin{pmatrix} 0 & -m \\ -m & 0 \end{pmatrix}+\begin{pmatrix} 0 & -i|\mathbf{p}| \\ i|\mathbf{p}| & 0 \end{pmatrix}=\begin{pmatrix} E & -m-i|\mathbf{p}| \\ -m+i|\mathbf{p}| & E \end{pmatrix} \tag{3.28}$$

$$\begin{pmatrix} E & -m-i\boldsymbol{\sigma}\cdot\mathbf{p} \\ -m+i\boldsymbol{\sigma}\cdot\mathbf{p} & E \end{pmatrix}=\begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix}=L_M \tag{3.29}$$

$$Det_\sigma\begin{pmatrix} E & -m-i\boldsymbol{\sigma}\cdot\mathbf{p} \\ -m+i\boldsymbol{\sigma}\cdot\mathbf{p} & E \end{pmatrix}=EE-(-m-i\boldsymbol{\sigma}\cdot\mathbf{p})(-m+i\boldsymbol{\sigma}\cdot\mathbf{p}) \tag{3.30}$$

$$Det_\sigma\begin{pmatrix} E & -m-i\boldsymbol{\sigma}\cdot\mathbf{p} \\ -m+i\boldsymbol{\sigma}\cdot\mathbf{p} & E \end{pmatrix}=(E^2-m^2-\mathbf{p}^2)I_2=0 \tag{3.31}$$

Indeed, $Q=m+i\boldsymbol{\sigma}\cdot\mathbf{p}$ is a quaternion and $Q^*=m-i\boldsymbol{\sigma}\cdot\mathbf{p}$ is its conjugate. So we can rewrite expression (3.29) as:

$$\begin{pmatrix} E & -Q \\ -Q^* & E \end{pmatrix}=\begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix}=L_M \tag{3.32}$$

Expression (3.26) is connected to expression (3.7) by unitary matrix $HS=\frac{1}{\sqrt{2}}\begin{pmatrix} 1 & i \\ 1 & -i \end{pmatrix}$:

$$HS\begin{pmatrix} E-m & -|\mathbf{p}| \\ -|\mathbf{p}| & E+m \end{pmatrix}(HS)^{-1} = \begin{pmatrix} E & -m-i|\mathbf{p}| \\ -m+i|\mathbf{p}| & E \end{pmatrix} \tag{3.33}$$

Similarly, expression (3.12) is connected to expression (3.29) by 4x4 matrix *HS*:

$$HS\begin{pmatrix} E-m & -\boldsymbol{\sigma}\cdot\mathbf{p} \\ -\boldsymbol{\sigma}\cdot\mathbf{p} & E+m \end{pmatrix}(HS)^{-1} = \begin{pmatrix} E & -m-i\boldsymbol{\sigma}\cdot\mathbf{p} \\ -m+i\boldsymbol{\sigma}\cdot\mathbf{p} & E \end{pmatrix} \tag{3.34}$$

Yet another kind of metamorphosis of expressions (3.6), (3.7) & (3.12) is respectively as follows:

$$L = 1 = \frac{E^2 - m^2}{\mathbf{p}^2} = \left(\frac{E+m}{-|\mathbf{p}|}\right)\left(\frac{-|\mathbf{p}|}{E-m}\right)^{-1} \tag{3.35}$$

$$\rightarrow \frac{E+m}{-|\mathbf{p}|} = \frac{-|\mathbf{p}|}{E-m} \rightarrow \frac{E+m}{-|\mathbf{p}|} - \frac{-|\mathbf{p}|}{E-m} = 0$$

$$\begin{pmatrix} E+m & -|\mathbf{p}| \\ -|\mathbf{p}| & E-m \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix} = L_M \tag{3.36}$$

$$\begin{pmatrix} E+m & -\boldsymbol{\sigma}\cdot\mathbf{p} \\ -\boldsymbol{\sigma}\cdot\mathbf{p} & E-m \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix} = L_M = E - \boldsymbol{\alpha}\bullet\mathbf{p} + \beta m \tag{3.37}$$

If m=0, we have from expressions (3.6) - (3.14):

$$L = 1 = \frac{E^2}{\mathbf{p}^2} = \left(\frac{E}{-|\mathbf{p}|}\right)\left(\frac{-|\mathbf{p}|}{E}\right)^{-1} \tag{3.38}$$

$$\rightarrow \frac{E}{-|\mathbf{p}|} = \frac{-|\mathbf{p}|}{E} \rightarrow \frac{E}{-|\mathbf{p}|} - \frac{-|\mathbf{p}|}{E} = 0$$

$$\begin{pmatrix} E & -|\mathbf{p}| \\ -|\mathbf{p}| & E \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix} = L_M \tag{3.39}$$

$$0 = E^2 - \mathbf{p}^2 = Det\begin{pmatrix} E & 0 \\ 0 & E \end{pmatrix} + Det\begin{pmatrix} 0 & -|\mathbf{p}| \\ -|\mathbf{p}| & 0 \end{pmatrix} \tag{3.40}$$

$$\begin{pmatrix} E & 0 \\ 0 & E \end{pmatrix} + \begin{pmatrix} 0 & -|\mathbf{p}| \\ -|\mathbf{p}| & 0 \end{pmatrix} = \begin{pmatrix} E & -|\mathbf{p}| \\ -|\mathbf{p}| & E \end{pmatrix} \tag{3.41}$$

After fermionic spinization $|\mathbf{p}| \to \boldsymbol{\sigma} \cdot \mathbf{p}$, expression (3.39) becomes:

$$\begin{pmatrix} E & -\boldsymbol{\sigma}\cdot\mathbf{p} \\ -\boldsymbol{\sigma}\cdot\mathbf{p} & E \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix} = L_M \tag{3.42}$$

which governs massless fermion (neutrino) in Dirac form.

After bosonic spinization:

$$|\mathbf{p}| = \sqrt{\mathbf{p}^2} = \sqrt{-(Det(\mathbf{s}\cdot\mathbf{p}+I_3)-Det(I_3))} \to \mathbf{s} \cdot \mathbf{p} \tag{3.43}$$

expression (3.39) becomes:

$$\begin{pmatrix} E & -\mathbf{s}\cdot\mathbf{p} \\ -\mathbf{s}\cdot\mathbf{p} & E \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix} = L_M \tag{3.44}$$

where $\mathbf{s} = (s_1, s_2, s_3)$ are spin operators for spin 1 particle:

$$s_1 = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & -i \\ 0 & i & 0 \end{pmatrix} \quad s_2 = \begin{pmatrix} 0 & 0 & i \\ 0 & 0 & 0 \\ -i & 0 & 0 \end{pmatrix} \quad s_3 = \begin{pmatrix} 0 & -i & 0 \\ i & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix} \tag{3.45}$$

If we define:

$$Det_s \begin{pmatrix} E & -\mathbf{s}\cdot\mathbf{p} \\ -\mathbf{s}\cdot\mathbf{p} & E \end{pmatrix} = (E)(E) - (-\mathbf{s}\cdot\mathbf{p})(-\mathbf{s}\cdot\mathbf{p}) \tag{3.46}$$

We get:

$$Det_s \begin{pmatrix} E & -\mathbf{s}\cdot\mathbf{p} \\ -\mathbf{s}\cdot\mathbf{p} & E \end{pmatrix} = \left(E^2 - \mathbf{p}^2\right) I_3 - \begin{pmatrix} p_x^2 & p_x p_y & p_x p_z \\ p_y p_x & p_y^2 & p_y p_z \\ p_z p_x & p_z p_y & p_z^2 \end{pmatrix} \tag{3.47}$$

To obey fundamental relationship (3.4) in determinant view (3.46), we shall require the last term in (3.47) acting on the external and internal wave functions respectively to produce null result (zero) in source-free zone as discussed later. We propose that expression (3.39) governs massless particle with unobservable spin (spinless). After bosonic spinization, the spinless and massless particle gains its spin 1.

Another kind of metamorphosis of expressions (3.18) - (3.22) when m=0 is respectively as follows:

$$0 = E^2 - \mathbf{p}^2 = Det\begin{pmatrix} E & 0 \\ 0 & E \end{pmatrix} + Det\begin{pmatrix} -|\mathbf{p}| & 0 \\ 0 & |\mathbf{p}| \end{pmatrix} \tag{3.48}$$

$$\begin{pmatrix} E & 0 \\ 0 & E \end{pmatrix} + \begin{pmatrix} -|\mathbf{p}| & 0 \\ 0 & |\mathbf{p}| \end{pmatrix} = \begin{pmatrix} E-|\mathbf{p}| & 0 \\ 0 & E+|\mathbf{p}| \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix} = L_M \tag{3.49}$$

$$\begin{pmatrix} E-\boldsymbol{\sigma}\cdot\mathbf{p} & 0 \\ 0 & E+\boldsymbol{\sigma}\cdot\mathbf{p} \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix} = L_M \tag{3.50}$$

$$\begin{pmatrix} E-\mathbf{s}\cdot\mathbf{p} & 0 \\ 0 & E+\mathbf{s}\cdot\mathbf{p} \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix} = L_M \tag{3.51}$$

$$Det_s\begin{pmatrix} E-\mathbf{s}\cdot\mathbf{p} & 0 \\ 0 & E+\mathbf{s}\cdot\mathbf{p} \end{pmatrix} = (E - \mathbf{s}\cdot\mathbf{p})(E + \mathbf{s}\cdot\mathbf{p}) \tag{3.52}$$

$$Det_s\begin{pmatrix} E-\mathbf{s}\cdot\mathbf{p} & 0 \\ 0 & E+\mathbf{s}\cdot\mathbf{p} \end{pmatrix} = \left(E^2 - \mathbf{p}^2\right)I_3 - \begin{pmatrix} p_x^2 & p_x p_y & p_x p_z \\ p_y p_x & p_y^2 & p_y p_z \\ p_z p_x & p_z p_y & p_z^2 \end{pmatrix} \tag{3.53}$$

Again, we shall require the last term in expression (3.53) acting on external and internal wave functions respectively to produce null result (zero) in source-free zone in order to satisfy fundamental relationship (3.4) in the determinant view (3.52) as further discussed later.

Importantly, if E=0, we have from expression (3.4):

$$-m^2 - \mathbf{p}^2 = 0 \tag{3.54}$$

Thus, if prespacetime allows timeless forms of Matrix Law, we can derive, for example, from (3.7) and (3.17) the following:

$$\begin{pmatrix} -m & -|\mathbf{p}| \\ -|\mathbf{p}| & +m \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix} = L_M \tag{3.55}$$

$$\begin{pmatrix} -|\mathbf{p}| & -m \\ -m & +|\mathbf{p}| \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix} = L_M \tag{3.56}$$

The above forms further degenerate, if m=0, as in the case of a massless particle.

Further, if |**p**|=0, we have from expression (3.4):

$$E^2 - m^2 = 0 \tag{3.57}$$

Thus, if prespacetime allows spaceless forms of Matrix Law, we can derive, for example, from (3.7) and (3.17) the following:

$$\begin{pmatrix} E-m & 0 \\ 0 & E+m \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix} = L_M \tag{3.58}$$

$$\begin{pmatrix} E & -m \\ -m & E \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix} = L_M \tag{3.59}$$

The significance of these forms of Matrix Law shall be elucidated later. We suggest for now that the timeless forms of Matrix Law govern external and internal wave functions (self-fields) which play the roles of timeless gravitons, that is, they mediate time-independent interactions through space (momentum) quantum entanglement. On the other hand, the spaceless forms of Matrix Law govern the external and internal wave functions (self-fields) which play the roles of spaceless gravitons, that is, they mediate space (distance) independent interactions through proper time (mass) entanglement.

The above metamorphoses of the self-referential Matrix Law of prespacetime are derived from one-tier matrixization (self-reference) and two-tier matrixization (self-reference) based on the fundamental relationship (3.4). The first-tier matrixization makes distinctions in time (energy), proper time (mass) and undifferentiated space (total momentum) that involve scalar unit 1 and imaginary unit (spin) i. Then the second-tier matrixization makes distinction in three-dimensional space (three-dimensional momentum) based on spin $\boldsymbol{\sigma}$, $\boldsymbol{s}$ or other spin structure if it exists.

3.3 Additional Forms of Matrix Law

If prespacetime allows partial distinction within first-tier self-referential matrixization, we obtain, for example, the following additional forms of Matrix Law $\begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix} = L_M$:

$$\begin{pmatrix} \sqrt{E^2-m^2} & -|\mathbf{p}| \\ -|\mathbf{p}| & \sqrt{E^2-m^2} \end{pmatrix} \quad (3.60) \qquad \begin{pmatrix} \sqrt{E^2-m^2} & -\boldsymbol{\sigma}\cdot\mathbf{p} \\ -\boldsymbol{\sigma}\cdot\mathbf{p} & \sqrt{E^2-m^2} \end{pmatrix} \quad (3.61)$$

$$\begin{pmatrix} \sqrt{E^2-m^2}-|\mathbf{p}| & 0 \\ 0 & \sqrt{E^2-m^2}+|\mathbf{p}| \end{pmatrix} \quad (3.62) \quad \begin{pmatrix} \sqrt{E^2-m^2}-\boldsymbol{\sigma}\cdot\mathbf{p} & 0 \\ 0 & \sqrt{E^2-m^2}+\boldsymbol{\sigma}\cdot\mathbf{p} \end{pmatrix} \quad (3.63)$$

$$\begin{pmatrix} \sqrt{E^2-\mathbf{p}^2} & -m \\ -m & \sqrt{E^2-\mathbf{p}^2} \end{pmatrix} \quad (3.64) \quad \begin{pmatrix} \sqrt{E^2-\mathbf{p}^2}-m & 0 \\ 0 & \sqrt{E^2-\mathbf{p}^2}+m \end{pmatrix} \quad (3.65)$$

$$\begin{pmatrix} E & -\sqrt{m^2+\mathbf{p}^2} \\ \sqrt{m^2+\mathbf{p}^2} & E \end{pmatrix} \quad (3.66) \quad \begin{pmatrix} E-\sqrt{m^2+\mathbf{p}^2} & 0 \\ 0 & E+\sqrt{m^2+\mathbf{p}^2} \end{pmatrix} \quad (3.67)$$

$$\begin{pmatrix} \sqrt{E^2-m^2-\mathbf{p}^2} & 0 \\ 0 & \sqrt{E^2-m^2-\mathbf{p}^2} \end{pmatrix} \quad (3.68)$$

Bosonic versions of expressions (3.61) and (3.63) are obtained by replacing $\boldsymbol{\sigma}$ with $\mathbf{S}$.

If prespacetime creates spatial self-confinement of an elementary entity through imaginary momentum $\mathbf{p}_i$ (downward self-reference such that $m^2>E^2$) we have:

$$m^2 - E^2 = -\mathbf{p}_i^2 = -p_{i,1}^2 - p_{i,2}^2 - p_{i,3}^2 = (i\mathbf{p}_i)^2 = -Det(\boldsymbol{\sigma}\cdot i\mathbf{p}_i) \quad (3.69)$$

that is:

$$E^2 - m^2 - \mathbf{p}_i^2 = 0 \quad (3.70)$$

Therefore, allowing imaginary momentum (downward self-reference) for an elementary entity, we can derive the following Matrix Law in Dirac-like form:

$$\begin{pmatrix} E-m & -|\mathbf{p}_i| \\ -|\mathbf{p}_i| & E+m \end{pmatrix} = (L_{M,e} \quad L_{M,i}) = L_M \quad (3.71)$$

$$\begin{pmatrix} -m & -\boldsymbol{\sigma}\cdot\mathbf{p}_i \\ -\boldsymbol{\sigma}\cdot\mathbf{p}_i & +m \end{pmatrix} = (L_{M,e} \quad L_{M,i}) = L_M \quad (3.72)$$

Also, we can derive the following Matrix Law in Weyl-like (chiral-like) form:

$$\begin{pmatrix} E-|\mathbf{p}_i| & -m \\ -m & +|\mathbf{p}_i| \end{pmatrix} = (L_{M,e} \quad L_{M,i}) = L_M \quad (3.73)$$

$$\begin{pmatrix} E-\boldsymbol{\sigma}\cdot\mathbf{p}_i & -m \\ -m & E+\boldsymbol{\sigma}\cdot\mathbf{p}_i \end{pmatrix} = (L_{M,e} \quad L_{M,i}) = L_M \quad (3.74)$$

Bosonic versions of expressions (3.72) and (3.74) are obtained by replacing $\boldsymbol{\sigma}$ with $\mathbf{s}$. It is likely that the above additional forms of self-referential Matrix Law govern different particles in the particle zoo as discussed later.

3.4 Scientific Genesis of Primordial Entities (Elementary Particles)

Therefore, prespacetime creates, sustains and causes evolution of a free plane-wave fermion such as an electron in Dirac form as follows:

$$1 = e^h = e^{i0} = 1e^{i0} = Le^{-iM+iM} = \frac{E^2-m^2}{\mathbf{p}^2} e^{-ip^\mu x_\mu + ip^\mu x_\mu} = \tag{3.75}$$

$$\left(\frac{E-m}{-|\mathbf{p}|}\right)\left(\frac{-|\mathbf{p}|}{E+m}\right)^{-1}\left(e^{-ip^\mu x_\mu}\right)\left(e^{-ip^\mu x_\mu}\right)^{-1} \to$$

$$\frac{E-m}{-|\mathbf{p}|} e^{-ip^\mu x_\mu} = \frac{-|\mathbf{p}|}{E+m} e^{-ip^\mu x_\mu} \to \frac{E-m}{-|\mathbf{p}|} e^{-ip^\mu x_\mu} - \frac{-|\mathbf{p}|}{E+m} e^{-ip^\mu x_\mu} = 0$$

$$\to \begin{pmatrix} E-m & -|\mathbf{p}| \\ -|\mathbf{p}| & E+m \end{pmatrix} \begin{pmatrix} a_{e,+} e^{-ip^\mu x_\mu} \\ a_{i,-} e^{-ip^\mu x_\mu} \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix} \begin{pmatrix} \psi_{e,+} \\ \psi_{i,-} \end{pmatrix} = L_M \psi = 0$$

$$\to \begin{pmatrix} E-m & -\boldsymbol{\sigma}\cdot\mathbf{p} \\ -\boldsymbol{\sigma}\cdot\mathbf{p} & E+m \end{pmatrix} \begin{pmatrix} A_{e,+} e^{-ip^\mu x_\mu} \\ A_{i,-} e^{-ip^\mu x_\mu} \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix} \begin{pmatrix} \psi_{e,+} \\ \psi_{i,-} \end{pmatrix} = L_M \psi = 0$$

that is:

$$\begin{pmatrix} (E-m)\psi_{e,+} = \boldsymbol{\sigma}\cdot\mathbf{p}\,\psi_{i,-} \\ (E+m)\psi_{i,-} = \boldsymbol{\sigma}\cdot\mathbf{p}\,\psi_{e,+} \end{pmatrix} \text{ or } \begin{pmatrix} i\partial_t\psi_{e,+} - m\psi_{e,+} = -i\boldsymbol{\sigma}\cdot\nabla\psi_{i,-} \\ i\partial_t\psi_{i,-} + m\psi_{i,-} = -i\boldsymbol{\sigma}\cdot\nabla\psi_{e,+} \end{pmatrix} \tag{3.76}$$

where substitutions $E \to i\partial_t$ and $\mathbf{p} \to -i\nabla$ have been made so that components of L_M can act on external and internal wave functions. Equation (3.76) also has free spherical wave solution in the form:

$$\psi = \begin{pmatrix} \psi_{e,+} \\ \psi_{i,-} \end{pmatrix} = \begin{pmatrix} S_{e,+} e^{-iEt} \\ S_{i,-} e^{-iEt} \end{pmatrix} \tag{3.77}$$

Alternatively, prespacetime creates, sustains and causes evolution of a free plane-wave fermion such as the electron in Dirac form as follows:

$$0 = 0e^{h} = 0e^{i0} = L_0 e^{-iM+iM} = \left(E^2 - m^2 - \mathbf{p}^2\right) e^{-ip^{\mu}x_{\mu}+ip^{\mu}x_{\mu}} = \tag{3.78}$$

$$\left(Det\begin{pmatrix} E & 0 \\ 0 & E \end{pmatrix} + Det\begin{pmatrix} -m & 0 \\ 0 & m \end{pmatrix} + Det\begin{pmatrix} 0 & -|\mathbf{p}| \\ -|\mathbf{p}| & 0 \end{pmatrix}\right)\left(e^{-ip^{\mu}x_{\mu}}\right)\left(e^{-ip^{\mu}x_{\mu}}\right)^{-1} \rightarrow$$

$$\left(\begin{pmatrix} E & 0 \\ 0 & E \end{pmatrix} + \begin{pmatrix} -m & 0 \\ 0 & m \end{pmatrix} + \begin{pmatrix} 0 & -|\mathbf{p}| \\ -|\mathbf{p}| & 0 \end{pmatrix}\right)\begin{pmatrix} a_{e,+}e^{-ip^{\mu}x_{\mu}} \\ a_{i,-}e^{-ip^{\mu}x_{\mu}} \end{pmatrix} = \begin{pmatrix} E-m & -|\mathbf{p}| \\ -|\mathbf{p}| & E+m \end{pmatrix}\begin{pmatrix} a_{e,+}e^{-ip^{\mu}x_{\mu}} \\ a_{i,-}e^{-ip^{\mu}x_{\mu}} \end{pmatrix} = 0$$

$$\rightarrow \begin{pmatrix} E-m & -\boldsymbol{\sigma}\cdot\mathbf{p} \\ -\boldsymbol{\sigma}\cdot\mathbf{p} & E+m \end{pmatrix}\begin{pmatrix} A_{e,+}e^{-ip^{\mu}x_{\mu}} \\ A_{i,-}e^{-ip^{\mu}x_{\mu}} \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix}\begin{pmatrix} \psi_{e,+} \\ \psi_{i,-} \end{pmatrix} = L_M \psi = 0$$

Prespacetime creates, sustains and causes evolution of a free plane-wave antifermion such as a positron in Dirac form as follows:

$$1 = e^{h} = e^{i0} = 1e^{i0} = Le^{+iM-iM} = \frac{E^2 - m^2}{\mathbf{p}^2} e^{+ip^{\mu}x_{\mu}-ip^{\mu}x_{\mu}} = \tag{3.79}$$

$$\left(\frac{E-m}{-|\mathbf{p}|}\right)\left(\frac{-|\mathbf{p}|}{E+m}\right)^{-1}\left(e^{+ip^{\mu}x_{\mu}}\right)\left(e^{+ip^{\mu}x_{\mu}}\right)^{-1} \rightarrow$$

$$\frac{E-m}{-|\mathbf{p}|}e^{+ip^{\mu}x_{\mu}} = \frac{-|\mathbf{p}|}{E+m}e^{+ip^{\mu}x_{\mu}} \rightarrow \frac{E-m}{-|\mathbf{p}|}e^{+ip^{\mu}x_{\mu}} - \frac{-|\mathbf{p}|}{E+m}e^{+ip^{\mu}x_{\mu}} = 0$$

$$\rightarrow \begin{pmatrix} E-m & -|\mathbf{p}| \\ -|\mathbf{p}| & E+m \end{pmatrix}\begin{pmatrix} a_{e,-}e^{+ip^{\mu}x_{\mu}} \\ a_{i,+}e^{+ip^{\mu}x_{\mu}} \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix}\begin{pmatrix} \psi_{e,-} \\ \psi_{i,+} \end{pmatrix} = L_M \psi = 0$$

$$\rightarrow \begin{pmatrix} E-m & -\boldsymbol{\sigma}\cdot\mathbf{p} \\ -\boldsymbol{\sigma}\cdot\mathbf{p} & E+m \end{pmatrix}\begin{pmatrix} A_{e,-}e^{+ip^{\mu}x_{\mu}} \\ A_{i,+}e^{+ip^{\mu}x_{\mu}} \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix}\begin{pmatrix} \psi_{e,-} \\ \psi_{i,+} \end{pmatrix} = L_M \psi = 0$$

or

$$0 = 0e^{h} = 0e^{i0} = L_0 e^{-iM+iM} = \left(E^2 - m^2 - \mathbf{p}^2\right) e^{-ip^{\mu}x_{\mu}+ip^{\mu}x_{\mu}} = \tag{3.80}$$

$$\left(Det\begin{pmatrix} E & 0 \\ 0 & E \end{pmatrix} + Det\begin{pmatrix} -m & 0 \\ 0 & m \end{pmatrix} + Det\begin{pmatrix} 0 & -|\mathbf{p}| \\ -|\mathbf{p}| & 0 \end{pmatrix} \right)\left(e^{+ip^{\mu}x_{\mu}}\right)\left(e^{+ip^{\mu}x_{\mu}}\right)^{-1} \rightarrow$$

$$\left(\begin{pmatrix} E & 0 \\ 0 & E \end{pmatrix} + \begin{pmatrix} -m & 0 \\ 0 & m \end{pmatrix} + \begin{pmatrix} 0 & -|\mathbf{p}| \\ -|\mathbf{p}| & 0 \end{pmatrix} \right)\begin{pmatrix} a_{e,-}e^{+ip^{\mu}x_{\mu}} \\ a_{i,+}e^{+ip^{\mu}x_{\mu}} \end{pmatrix} = \begin{pmatrix} E-m & -|\mathbf{p}| \\ -|\mathbf{p}| & E+m \end{pmatrix}\begin{pmatrix} a_{e,-}e^{+ip^{\mu}x_{\mu}} \\ a_{i,+}e^{+ip^{\mu}x_{\mu}} \end{pmatrix} = 0$$

$$\rightarrow \begin{pmatrix} E-m & -\boldsymbol{\sigma}\cdot\mathbf{p} \\ -\boldsymbol{\sigma}\cdot\mathbf{p} & E+m \end{pmatrix}\begin{pmatrix} A_{e,-}e^{+ip^{\mu}x_{\mu}} \\ A_{i,+}e^{+ip^{\mu}x_{\mu}} \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix}\begin{pmatrix} \psi_{e,-} \\ \psi_{i,+} \end{pmatrix} = L_M\psi = 0$$

Similarly, prespacetime creates, sustains and causes evolution of a free plane-wave fermion in Weyl (chiral) form as follows:

$$1 = e^{h} = e^{i0} = 1e^{i0} = Le^{-iM+iM} = \frac{E^2-\mathbf{p}^2}{m^2}e^{-ip^{\mu}x_{\mu}+ip^{\mu}x_{\mu}} =$$

$$\left(\frac{E-|\mathbf{p}|}{-m}\right)\left(\frac{-m}{E+|\mathbf{p}|}\right)^{-1}\left(e^{-ip^{\mu}x_{\mu}}\right)\left(e^{-ip^{\mu}x_{\mu}}\right)^{-1} \rightarrow \tag{3.81}$$

$$\frac{E-|\mathbf{p}|}{-m}e^{-ip^{\mu}x_{\mu}} = \frac{-m}{E+|\mathbf{p}|}e^{-ip^{\mu}x_{\mu}} \rightarrow \frac{E-|\mathbf{p}|}{-m}e^{-ip^{\mu}x_{\mu}} - \frac{-m}{E+|\mathbf{p}|}e^{-ip^{\mu}x_{\mu}} = 0$$

$$\rightarrow \begin{pmatrix} E-|\mathbf{p}| & -m \\ -m & E+|\mathbf{p}| \end{pmatrix}\begin{pmatrix} a_{e,l}e^{-ip^{\mu}x_{\mu}} \\ a_{i,r}e^{-ip^{\mu}x_{\mu}} \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix}\begin{pmatrix} \psi_{e,l} \\ \psi_{i,r} \end{pmatrix} = L_M\psi = 0$$

$$\rightarrow \begin{pmatrix} E-\boldsymbol{\sigma}\cdot\mathbf{p} & -m \\ -m & E+\boldsymbol{\sigma}\cdot\mathbf{p} \end{pmatrix}\begin{pmatrix} A_{e,l}e^{-ip^{\mu}x_{\mu}} \\ A_{i,r}e^{-ip^{\mu}x_{\mu}} \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix}\begin{pmatrix} \psi_{e,l} \\ \psi_{i,r} \end{pmatrix} = L_M\psi = 0$$

that is:

$$\begin{pmatrix} (E-\boldsymbol{\sigma}\cdot\mathbf{p})\psi_{e,l} = m\psi_{i,r} \\ (E+\boldsymbol{\sigma}\cdot\mathbf{p})\psi_{i,r} = m\psi_{e,l} \end{pmatrix} \quad \text{or} \quad \begin{pmatrix} i\partial_t\psi_{e,l} + i\boldsymbol{\sigma}\cdot\nabla\psi_{e,l} = m\psi_{i,r} \\ i\partial_t\psi_{i,r} - i\boldsymbol{\sigma}\cdot\nabla\psi_{i,-} = m\psi_{e,l} \end{pmatrix} \tag{3.82}$$

Alternatively, prespacetime creates, sustains and causes evolution of a free plane-wave fermion in Weyl (chiral) form as follows:

$$0 = 0e^{h} = 0e^{i0} = L_0 e^{-iM+iM} = \left(E^2 - m^2 - \mathbf{p}^2\right) e^{-ip^{\mu}x_{\mu}+ip^{\mu}x_{\mu}} = \tag{3.83}$$

$$\left(Det\begin{pmatrix} E & 0 \\ 0 & E \end{pmatrix} + Det\begin{pmatrix} 0 & -m \\ -m & 0 \end{pmatrix} + Det\begin{pmatrix} -|\mathbf{p}| & 0 \\ 0 & |\mathbf{p}| \end{pmatrix}\right)\left(e^{-ip^{\mu}x_{\mu}}\right)\left(e^{-ip^{\mu}x_{\mu}}\right)^{-1} \rightarrow$$

$$\left(\begin{pmatrix} E & 0 \\ 0 & E \end{pmatrix} + \begin{pmatrix} 0 & -m \\ -m & 0 \end{pmatrix} + \begin{pmatrix} -|\mathbf{p}| & 0 \\ 0 & |\mathbf{p}| \end{pmatrix}\right)\begin{pmatrix} a_{e,l} e^{-ip^{\mu}x_{\mu}} \\ a_{i,r} e^{-ip^{\mu}x_{\mu}} \end{pmatrix} = \begin{pmatrix} E-|\mathbf{p}| & -m \\ -m & E+|\mathbf{p}| \end{pmatrix}\begin{pmatrix} a_{e,l} e^{-ip^{\mu}x_{\mu}} \\ a_{i,r} e^{-ip^{\mu}x_{\mu}} \end{pmatrix} = 0$$

$$\rightarrow \begin{pmatrix} E-\boldsymbol{\sigma}\cdot\mathbf{p} & -m \\ -m & E+\boldsymbol{\sigma}\cdot\mathbf{p} \end{pmatrix}\begin{pmatrix} A_{e,l} e^{-ip^{\mu}x_{\mu}} \\ A_{i,r} e^{-ip^{\mu}x_{\mu}} \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix}\begin{pmatrix} \psi_{e,l} \\ \psi_{i,r} \end{pmatrix} = L_M \psi = 0$$

Prespacetime creates, sustains and causes evolution of a free plane-wave fermion in another form as follows:

$$1 = e^{h} = e^{i0} = 1e^{i0} = Le^{-iM+iM} = \frac{E^2}{m^2+\mathbf{p}^2} e^{-ip^{\mu}x_{\mu}+ip^{\mu}x_{\mu}} = \tag{3.84}$$

$$\left(\frac{E}{-m+i\varepsilon|\mathbf{p}|}\right)\left(\frac{-m-i|\mathbf{p}|}{E}\right)^{-1}\left(e^{-ip^{\mu}x_{\mu}}\right)\left(e^{-ip^{\mu}x_{\mu}}\right)^{-1} \rightarrow \frac{E}{-m+i|\mathbf{p}|} e^{-ip^{\mu}x_{\mu}} =$$

$$\frac{-m-i|\mathbf{p}|}{E} e^{-ip^{\mu}x_{\mu}} \rightarrow \frac{E}{-m+i|\mathbf{p}|} e^{-ip^{\mu}x_{\mu}} - \frac{-m-i|\mathbf{p}|}{E} e^{-ip^{\mu}x_{\mu}} = 0$$

$$\rightarrow \begin{pmatrix} E & -m-i|\mathbf{p}| \\ -m+i|\mathbf{p}| & E \end{pmatrix}\begin{pmatrix} a_e e^{-ip^{\mu}x_{\mu}} \\ a_i e^{-ip^{\mu}x_{\mu}} \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix}\begin{pmatrix} \psi_e \\ \psi_i \end{pmatrix} = L_M \psi = 0$$

$$\rightarrow \begin{pmatrix} E & -m-i\boldsymbol{\sigma}\cdot\mathbf{p} \\ -m+i\boldsymbol{\sigma}\cdot\mathbf{p} & E \end{pmatrix}\begin{pmatrix} A_e e^{-ip^{\mu}x_{\mu}} \\ A_i e^{-ip^{\mu}x_{\mu}} \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix}\begin{pmatrix} \psi_e \\ \psi_i \end{pmatrix} = L_M \psi = 0$$

$$\rightarrow \begin{pmatrix} E & -Q \\ -Q^{*} & E \end{pmatrix}\begin{pmatrix} A_e e^{-ip^{\mu}x_{\mu}} \\ A_i e^{-ip^{\mu}x_{\mu}} \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix}\begin{pmatrix} \psi_e \\ \psi_i \end{pmatrix} = L_M \psi = 0$$

that is:

$$\begin{pmatrix} E\psi_e = (m + i\boldsymbol{\sigma}\cdot\mathbf{p})\psi_i \\ E\psi_i = (m - i\boldsymbol{\sigma}\cdot\mathbf{p})\psi_e \end{pmatrix} \quad \text{or} \quad \begin{pmatrix} i\partial_t\psi_e = m\psi_i + \boldsymbol{\sigma}\cdot\nabla\psi_i \\ i\partial_t\psi_i = m\psi_e - \boldsymbol{\sigma}\cdot\nabla\psi_i \end{pmatrix} \tag{3.85}$$

Alternatively, prespacetime creates, sustains and causes evolution of a free plane-wave fermion in another form as follows:

$$0 = 0e^h = 0e^{i0} = L_0 e^{-iM+iM} = \left(E^2 - m^2 - \mathbf{p}^2\right)e^{-ip^\mu x_\mu + ip^\mu x_\mu} =$$

$$\left(Det\begin{pmatrix} E & 0 \\ 0 & E \end{pmatrix} + Det\begin{pmatrix} 0 & -m \\ -m & 0 \end{pmatrix} + Det\begin{pmatrix} 0 & -i|\mathbf{p}| \\ i|\mathbf{p}| & 0 \end{pmatrix}\right)\left(e^{-ip^\mu x_\mu}\right)\left(e^{-ip^\mu x_\mu}\right)^{-1} \rightarrow$$

$$\left(\begin{pmatrix} E & 0 \\ 0 & E \end{pmatrix} + \begin{pmatrix} 0 & -m \\ -m & 0 \end{pmatrix} + \begin{pmatrix} 0 & -i|\mathbf{p}| \\ i|\mathbf{p}| & 0 \end{pmatrix}\right)\begin{pmatrix} a_e e^{-ip^\mu x_\mu} \\ a_i e^{-ip^\mu x_\mu} \end{pmatrix} = \begin{pmatrix} E & -m - i|\mathbf{p}| \\ -m + i|\mathbf{p}| & E \end{pmatrix}\begin{pmatrix} a_e e^{-ip^\mu x_\mu} \\ a_i e^{-ip^\mu x_\mu} \end{pmatrix} = 0$$

$$\rightarrow \begin{pmatrix} E & -m - i\boldsymbol{\sigma}\cdot\mathbf{p} \\ -m + i\boldsymbol{\sigma}\cdot\mathbf{p} & E \end{pmatrix}\begin{pmatrix} A_e e^{-ip^\mu x_\mu} \\ A_i e^{-ip^\mu x_\mu} \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix}\begin{pmatrix} \psi_e \\ \psi_i \end{pmatrix} = L_M \psi = 0$$

$$\rightarrow \begin{pmatrix} E & -Q \\ -Q^* & E \end{pmatrix}\begin{pmatrix} A_e e^{-ip^\mu x_\mu} \\ A_i e^{-ip^\mu x_\mu} \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix}\begin{pmatrix} \psi_e \\ \psi_i \end{pmatrix} = L_M \psi = 0 \tag{3.86}$$

Prespacetime creates, sustains and causes evolution of a linear plane-wave photon as follows:

$$1 = e^h = e^{i0} = 1e^{i0} = Le^{-iM+iM} = \frac{E^2}{\mathbf{p}^2} e^{-ip^\mu x_\mu + ip^\mu x_\mu} =$$

$$\tag{3.87}$$

$$\left(\frac{E}{-|\mathbf{p}|}\right)\left(\frac{-|\mathbf{p}|}{E}\right)^{-1}\left(e^{-ip^\mu x_\mu}\right)\left(e^{-ip^\mu x_\mu}\right)^{-1} \rightarrow$$

$$\frac{E}{-|\mathbf{p}|}e^{-ip^\mu x_\mu} = \frac{-|\mathbf{p}|}{E}e^{-ip^\mu x_\mu} \rightarrow \frac{E}{-|\mathbf{p}|}e^{-ip^\mu x_\mu} - \frac{-|\mathbf{p}|}{E}e^{-ip^\mu x_\mu} = 0$$

$$\rightarrow \begin{pmatrix} E & -|\mathbf{p}| \\ -|\mathbf{p}| & E \end{pmatrix} \begin{pmatrix} a_{e,+} e^{-ip^{\mu}x_{\mu}} \\ a_{i,-} e^{-ip^{\mu}x_{\mu}} \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix} \begin{pmatrix} \psi_{e,+} \\ \psi_{i,-} \end{pmatrix} = L_M \psi = 0$$

$$\rightarrow \begin{pmatrix} E & -\mathbf{s}\cdot\mathbf{p} \\ -\mathbf{s}\cdot\mathbf{p} & E \end{pmatrix} \begin{pmatrix} \mathbf{E}_{0e,+} e^{-ip^{\mu}x_{\mu}} \\ i\mathbf{B}_{0i,-} e^{-ip^{\mu}x_{\mu}} \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix} \begin{pmatrix} \psi_{e,+} \\ \psi_{i,-} \end{pmatrix} = L_M \psi_{photon} = 0$$

Alternatively, prespacetime creates, sustains and causes evolution of the linear plane-wave photon as follows:

$$0 = 0e^{h} = 0e^{i0} = L_0 e^{-iM+iM} = \left(E^2 - \mathbf{p}^2\right) e^{-ip^{\mu}x_{\mu}+ip^{\mu}x_{\mu}} = \qquad (3.88)$$

$$\left(Det\begin{pmatrix} E & 0 \\ 0 & E \end{pmatrix} + Det\begin{pmatrix} 0 & -|\mathbf{p}| \\ -|\mathbf{p}| & 0 \end{pmatrix} \right) \left(e^{-ip^{\mu}x_{\mu}} \right) \left(e^{-ip^{\mu}x_{\mu}} \right)^{-1} \rightarrow$$

$$\left(\begin{pmatrix} E & 0 \\ 0 & E \end{pmatrix} + \begin{pmatrix} 0 & -|\mathbf{p}| \\ -|\mathbf{p}| & 0 \end{pmatrix} \right) \begin{pmatrix} a_{e,+} e^{-ip^{\mu}x_{\mu}} \\ a_{i,-} e^{-ip^{\mu}x_{\mu}} \end{pmatrix} = \begin{pmatrix} E & -|\mathbf{p}| \\ -|\mathbf{p}| & E \end{pmatrix} \begin{pmatrix} a_{e,+} e^{-ip^{\mu}x_{\mu}} \\ a_{i,-} e^{-ip^{\mu}x_{\mu}} \end{pmatrix} = 0$$

$$\rightarrow \begin{pmatrix} E & -\mathbf{s}\cdot\mathbf{p} \\ -\mathbf{s}\cdot\mathbf{p} & E \end{pmatrix} \begin{pmatrix} \mathbf{E}_{0e,+} e^{-ip^{\mu}x_{\mu}} \\ i\mathbf{B}_{0i,-} e^{-ip^{\mu}x_{\mu}} \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix} \begin{pmatrix} \psi_{e,+} \\ \psi_{i,-} \end{pmatrix} = L_M \psi_{photon} = 0$$

This photon wave function can be written as:

$$\psi_{photon} = \begin{pmatrix} \psi_{e,+} \\ \psi_{i,-} \end{pmatrix} = \begin{pmatrix} \mathbf{E} \\ i\mathbf{B} \end{pmatrix} = \begin{pmatrix} \mathbf{E_0} e^{-i(\omega t - \mathbf{k}\cdot\mathbf{x})} \\ i\mathbf{B_0} e^{-i(\omega t - \mathbf{k}\cdot\mathbf{x})} \end{pmatrix} = \begin{pmatrix} \mathbf{E_0} \\ i\mathbf{B_0} \end{pmatrix} e^{-i(\omega t - \mathbf{k}\cdot\mathbf{x})} \qquad (3.89)$$

After the substitutions $E \rightarrow i\partial_t$ and $\mathbf{p} \rightarrow -i\nabla$, we have from the last expression in (3.87):

$$\begin{pmatrix} i\partial_t & i\mathbf{S}\cdot\nabla \\ i\mathbf{S}\cdot\nabla & i\partial_t \end{pmatrix} \begin{pmatrix} \mathbf{E} \\ i\mathbf{B} \end{pmatrix} = 0 \rightarrow \begin{pmatrix} \partial_t \mathbf{E} = \nabla\times\mathbf{B} \\ \partial_t \mathbf{B} = -\nabla\times\mathbf{E} \end{pmatrix} \qquad (3.90)$$

where we have used the relationship $\mathbf{S}\cdot(-i\nabla) = \nabla\times$ to derive the latter equations which together with $\nabla\cdot\mathbf{E} = \mathbf{0}$ and $\nabla\cdot\mathbf{B} = \mathbf{0}$ are the Maxwell equations in the source-free vacuum.

Prespacetime creates a neutrino in Dirac form, if prespacetime does, by replacing the last step of expression (3.87) with the following:

$$\rightarrow\begin{pmatrix} E & -\boldsymbol{\sigma}\cdot\mathbf{p} \\ -\boldsymbol{\sigma}\cdot\mathbf{p} & E \end{pmatrix}\begin{pmatrix} a_{e,+}e^{-ip^{\mu}x_{\mu}} \\ a_{i,-}e^{-ip^{\mu}x_{\mu}} \end{pmatrix}=\begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix}\begin{pmatrix} \psi_{e,+} \\ \psi_{i,-} \end{pmatrix}=L_M\psi=0 \qquad (3.91)$$

Prespacetime creates, sustains and causes evolution of a linear plane-wave antiphoton as follows:

$$1=e^{h}=e^{i0}=1e^{i0}=Le^{-iM+iM}=\frac{E^2}{\mathbf{p}^2}e^{-ip^{\mu}x_{\mu}+ip^{\mu}x_{\mu}}=$$

$$\left(\frac{E}{-|\mathbf{p}|}\right)\left(\frac{-|\mathbf{p}|}{E}\right)^{-1}\left(e^{+ip^{\mu}x_{\mu}}\right)\left(e^{+ip^{\mu}x_{\mu}}\right)^{-1}\rightarrow \qquad (3.92)$$

$$\frac{E}{-|\mathbf{p}|}e^{+ip^{\mu}x_{\mu}}=\frac{-|\mathbf{p}|}{E}e^{+ip^{\mu}x_{\mu}}\rightarrow\frac{E}{-|\mathbf{p}|}e^{+ip^{\mu}x_{\mu}}-\frac{-|\mathbf{p}|}{E}e^{+ip^{\mu}x_{\mu}}=0$$

$$\rightarrow\begin{pmatrix} E & -|\mathbf{p}| \\ -|\mathbf{p}| & E \end{pmatrix}\begin{pmatrix} \psi_{e,-} \\ \psi_{i,+} \end{pmatrix}=\begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix}\begin{pmatrix} \psi_{e,-} \\ \psi_{i,+} \end{pmatrix}=L_M\psi=0$$

$$\rightarrow\begin{pmatrix} E & -\mathbf{s}\cdot\mathbf{p} \\ -\mathbf{s}\cdot\mathbf{p} & E \end{pmatrix}\begin{pmatrix} i\mathbf{B}_{0e,-}e^{+ip^{\mu}x_{\mu}} \\ \mathbf{E}_{0i,+}e^{+ip^{\mu}x_{\mu}} \end{pmatrix}=\begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix}\begin{pmatrix} \psi_{e,-} \\ \psi_{i,+} \end{pmatrix}=L_M\psi_{antiphoton}=0$$

This antiphoton wave function can also be written as:

$$\psi_{antiphoton}=\begin{pmatrix} \psi_{e,-} \\ \psi_{i,+} \end{pmatrix}=\begin{pmatrix} i\mathbf{B} \\ \mathbf{E} \end{pmatrix}=\begin{pmatrix} i\mathbf{B}_{\mathbf{0}}e^{i(\omega t-\mathbf{k}\cdot\mathbf{x})} \\ \mathbf{E}_{\mathbf{0}}e^{i(\omega t-\mathbf{k}\cdot\mathbf{x})} \end{pmatrix}=\begin{pmatrix} i\mathbf{B}_{\mathbf{0}} \\ \mathbf{E}_{\mathbf{0}} \end{pmatrix}e^{i(\omega t-\mathbf{k}\cdot\mathbf{x})} \qquad (3.93)$$

Prespacetime creates an antineutrino in Dirac form, if Prespacetime does, by replacing the last step of expression (3.93) with the following:

$$\rightarrow\begin{pmatrix} E & -\boldsymbol{\sigma}\cdot\mathbf{p} \\ -\boldsymbol{\sigma}\cdot\mathbf{p} & E \end{pmatrix}\begin{pmatrix} a_{e,-}e^{+ip^{\mu}x_{\mu}} \\ a_{i,+}e^{+ip^{\mu}x_{\mu}} \end{pmatrix}=\begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix}\begin{pmatrix} \psi_{e,-} \\ \psi_{i,+} \end{pmatrix}=L_M\psi=0 \qquad (3.94)$$

Prespacetime creates, sustains and causes evolution of chiral plane-wave photons as follows:

$$0 = 0e^{h} = 0e^{i0} = L_0 e^{-iM+iM} = \left(E^2 - \mathbf{p}^2\right)e^{-ip^{\mu}x_{\mu}+ip^{\mu}x_{\mu}} = \tag{3.95}$$

$$\left(Det\begin{pmatrix} E & 0 \\ 0 & E \end{pmatrix} + Det\begin{pmatrix} -|\mathbf{p}| & 0 \\ 0 & |\mathbf{p}| \end{pmatrix}\right)\left(e^{-ip^{\mu}x_{\mu}}\right)\left(e^{-ip^{\mu}x_{\mu}}\right)^{-1} \rightarrow$$

$$\left(\begin{pmatrix} E & 0 \\ 0 & E \end{pmatrix} + \begin{pmatrix} -|\mathbf{p}| & 0 \\ 0 & |\mathbf{p}| \end{pmatrix}\right)\begin{pmatrix} a_{e,l}e^{-ip^{\mu}x_{\mu}} \\ a_{i,r}e^{-ip^{\mu}x_{\mu}} \end{pmatrix} = \begin{pmatrix} E-|\mathbf{p}| & 0 \\ 0 & E+|\mathbf{p}| \end{pmatrix}\begin{pmatrix} a_{e,l}e^{-ip^{\mu}x_{\mu}} \\ a_{i,r}e^{-ip^{\mu}x_{\mu}} \end{pmatrix} = 0$$

$$\rightarrow \begin{pmatrix} E-\mathbf{s}\cdot\mathbf{p} & 0 \\ 0 & E+\mathbf{s}\cdot\mathbf{p} \end{pmatrix}\begin{pmatrix} A_{e,l}e^{-ip^{\mu}x_{\mu}} \\ A_{i,r}e^{-ip^{\mu}x_{\mu}} \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix}\begin{pmatrix} \psi_{e,l} \\ \psi_{i,r} \end{pmatrix} = L_M \psi = 0$$

that is, $\psi_{e,l}$ and $\psi_{i,r}$ are decoupled from each other and satisfy the following equations respectively:

$$\begin{pmatrix} (E - \mathbf{s}\cdot\mathbf{p})\psi_{e,l} = 0 \\ (E + \mathbf{s}\cdot\mathbf{p})\psi_{i,r} = 0 \end{pmatrix} \quad \text{or} \quad \begin{pmatrix} \partial_t\psi_{e,l} + \mathbf{s}\cdot\nabla\psi_{e,l} = 0 \\ \partial_t\psi_{i,r} - \mathbf{s}\cdot\nabla\psi_{i,r} = 0 \end{pmatrix} \tag{3.96}$$

which have the following respective solutions:

$$\psi = \begin{pmatrix} \psi_{e,l} \\ \psi_{i,r} \end{pmatrix} = \begin{pmatrix} \mathbf{E} + i\mathbf{B} \\ \mathbf{E} - i\mathbf{B} \end{pmatrix} = \begin{pmatrix} \left(\mathbf{E_0} + i\mathbf{B_0}\right)e^{i(\omega t - \mathbf{k}\cdot\mathbf{x})} \\ \left(\mathbf{E_0} - i\mathbf{B_0}\right)e^{i(\omega t - \mathbf{k}\cdot\mathbf{x})} \end{pmatrix} \tag{3.97}$$

Both $\partial_t\psi_{e,l} + \mathbf{s}\cdot\nabla\psi_{e,l} = 0$ and $\partial_t\psi_{i,r} - \mathbf{s}\cdot\nabla\psi_{i,r} = 0$ produce the Maxwell equation in the source-free vacuum as shown in the second expression of (3.90).

Prespacetime creates neutrinos in Weyl (chiral) forms, if prespacetime does, by replacing the last step of expression (3.95) with the following:

$$\rightarrow \begin{pmatrix} E-\sigma\cdot\mathbf{p} & 0 \\ 0 & E+\sigma\cdot\mathbf{p} \end{pmatrix}\begin{pmatrix} A_{e,l}e^{-ip^{\mu}x_{\mu}} \\ A_{i,r}e^{-ip^{\mu}x_{\mu}} \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix}\begin{pmatrix} \psi_{e,l} \\ \psi_{i,r} \end{pmatrix} = L_M \psi = 0 \tag{3.98}$$

that is, $\psi_{e,l}$ and $\psi_{i,r}$ are decoupled from each other and satisfy the following equations respectively:

$$\begin{pmatrix} (E - \boldsymbol{\sigma}\cdot\mathbf{p})\psi_{e,l} = 0 \\ (E + \boldsymbol{\sigma}\cdot\mathbf{p})\psi_{i,r} = 0 \end{pmatrix} \quad \text{or} \quad \begin{pmatrix} \partial_t\psi_{e,l} + \boldsymbol{\sigma}\cdot\nabla\psi_{e,l} = 0 \\ \partial_t\psi_{i,r} - \boldsymbol{\sigma}\cdot\nabla\psi_{i,r} = 0 \end{pmatrix} \tag{3.99}$$

Prespacetime likely creates and sustains timeless (instantaneous) external and internal wave functions (timeless graviton) of a mass *m* in Dirac form as follows:

$$1 = e^h = e^{i0} = 1e^{i0} = Le^{-iM+iM} = \frac{-m^2}{\mathbf{p}^2}e^{-iM+iM} = \tag{3.100}$$

$$\left(\frac{-m}{-|\mathbf{p}|}\right)\left(\frac{-|\mathbf{p}|}{+m}\right)^{-1}\left(e^{-iM}\right)\left(e^{-iM}\right)^{-1} \rightarrow$$

$$\frac{-m}{-|\mathbf{p}|}e^{-iM} = \frac{-|\mathbf{p}|}{+m}e^{-iM} \rightarrow \frac{-m}{-|\mathbf{p}|}e^{-iM} - \frac{-|\mathbf{p}|}{+m}e^{-iM} = 0$$

$$\rightarrow \begin{pmatrix} -m & -|\mathbf{p}| \\ -|\mathbf{p}| & +m \end{pmatrix}\begin{pmatrix} g_{D,e}e^{-iM} \\ g_{D,i}e^{-iM} \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix}\begin{pmatrix} V_{D,e} \\ V_{D,i} \end{pmatrix} = L_M V_D = 0$$

We will determine the form of imaginary content *M* in expression (3.100) later.

Alternatively, prespacetime likely creates and sustains timeless (instantaneous) external and internal wave functions (timeless graviton) of a mass *m* in Dirac form as follows:

$$0 = 0e^h = 0e^{i0} = L_0 e^{-iM+iM} = \left(m^2 - \mathbf{p}^2\right)e^{-iM+iM} = \tag{3.101}$$

$$\left(Det\begin{pmatrix} -m & 0 \\ 0 & +m \end{pmatrix} + Det\begin{pmatrix} 0 & -|\mathbf{p}| \\ -|\mathbf{p}| & 0 \end{pmatrix}\right)\left(e^{-iM}\right)\left(e^{-iM}\right)^{-1} \rightarrow$$

$$\left(\begin{pmatrix} -m & 0 \\ 0 & +m \end{pmatrix} + \begin{pmatrix} 0 & -|\mathbf{p}| \\ -|\mathbf{p}| & 0 \end{pmatrix}\right)\begin{pmatrix} g_{D,e}e^{-iM} \\ g_{D,i}e^{-iM} \end{pmatrix} = \begin{pmatrix} -m & -|\mathbf{p}| \\ -|\mathbf{p}| & +m \end{pmatrix}\begin{pmatrix} g_{D,e}e^{-iM} \\ g_{D,i}e^{-iM} \end{pmatrix} = 0$$

Similarly, prespacetime likely creates and sustains timeless (instantaneous) external and internal wave functions (timeless graviton) of a mass *m* in Weyl (chiral) form as follows:

$$1 = e^h = e^{i0} = 1e^{i0} = Le^{-iM+iM} = \frac{-m^2}{\mathbf{p}^2}e^{-iM+iM} = \tag{3.102}$$

$$\left(\frac{-|\mathbf{p}|}{-m}\right)\left(\frac{-m}{+|\mathbf{p}|}\right)^{-1}\left(e^{-iM}\right)\left(e^{-iM}\right)^{-1} \rightarrow$$

$$\frac{-|\mathbf{p}|}{-m}e^{-iM} = \frac{-m}{+|\mathbf{p}|}e^{-iM} \rightarrow \frac{-|\mathbf{p}|}{-m}e^{-iM} - \frac{-m}{+|\mathbf{p}|}e^{-iM} = 0$$

$$\rightarrow \begin{pmatrix} -|\mathbf{p}| & -m \\ -m & +|\mathbf{p}| \end{pmatrix}\begin{pmatrix} g_{W,e}e^{-iM} \\ g_{W,i}e^{-iM} \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix}\begin{pmatrix} V_{W,e} \\ V_{W,i} \end{pmatrix} = L_M V_W = 0$$

Again, we will determine the form of the imaginary content *M* in expression (3.102) later.

Alternatively, prespacetime likely creates and sustains timeless (instantaneous) external and internal wave functions (timeless graviton) of a mass *m* in Weyl (chiral) form as follows:

$$0 = 0e^{h} = 0e^{i0} = L_0 e^{-iM+iM} = \left(m^2 - \mathbf{p}^2\right)e^{-iM+iM} = \tag{3.103}$$

$$\left(Det\begin{pmatrix} -|\mathbf{p}| & 0 \\ 0 & +|\mathbf{p}| \end{pmatrix} + Det\begin{pmatrix} 0 & -m \\ -m & 0 \end{pmatrix}\right)\left(e^{-iM}\right)\left(e^{-iM}\right)^{-1} \rightarrow$$

$$\left(\begin{pmatrix} -|\mathbf{p}| & 0 \\ 0 & +|\mathbf{p}| \end{pmatrix} + \begin{pmatrix} 0 & -m \\ -m & 0 \end{pmatrix}\right)\begin{pmatrix} g_{W,e}e^{-iM} \\ g_{W,i}e^{-iM} \end{pmatrix} = \begin{pmatrix} -m & -|\mathbf{p}| \\ -|\mathbf{p}| & +m \end{pmatrix}\begin{pmatrix} g_{W,e}e^{-iM} \\ g_{w,i}e^{-iM} \end{pmatrix} = 0$$

Prespacetime likely creates and sustains spaceless (space/distance independent) external and internal wave functions of a mass *m* in Dirac form as follows:

$$0 = 0e^{h} = 0e^{0} = L_0 e^{-iM+iM} = \left(E^2 - m^2\right)e^{-imt+imt} = \tag{3.104}$$

$$\left(Det\begin{pmatrix} E & 0 \\ 0 & E \end{pmatrix} + Det\begin{pmatrix} -m & 0 \\ 0 & +m \end{pmatrix}\right)\left(e^{-imt}\right)\left(e^{-imt}\right)^{-1} \rightarrow$$

$$\left(\begin{pmatrix} E & 0 \\ 0 & E \end{pmatrix} + \begin{pmatrix} -m & 0 \\ 0 & +m \end{pmatrix}\right)\begin{pmatrix} g_{D,e}e^{-imt} \\ g_{D,i}e^{-imt} \end{pmatrix} = \begin{pmatrix} E-m & 0 \\ 0 & E+m \end{pmatrix}\begin{pmatrix} g_{D,e}e^{-imt} \\ g_{D,i}e^{-imt} \end{pmatrix} = 0$$

Similarly, prespacetime likely creates and sustains spaceless (space/distance independent) external and internal wave functions of a mass *m* in Weyl (chiral) form as follows:

$$1 = e^{h} = e^{0} = 1e^{0} = Le^{-iM+iM} = \frac{E^2}{m^2}e^{-imt+imt} = \tag{3.105}$$

$$\left(\frac{E}{-m}\right)\left(\frac{-m}{E}\right)^{-1}\left(e^{-imt}\right)\left(e^{-imt}\right)^{-1} \rightarrow$$

$$\frac{E}{-m}e^{-imt} = \frac{-m}{E}e^{-imt} \rightarrow \frac{E}{-m}e^{-imt} - \frac{-m}{E}e^{-imt} = 0$$

$$\rightarrow \begin{pmatrix} E & -m \\ -m & E \end{pmatrix}\begin{pmatrix} g_{W,e}e^{-imt} \\ g_{W,i}e^{-imt} \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix}\begin{pmatrix} V_{W,e} \\ V_{W,i} \end{pmatrix} = L_M V_W = 0$$

Alternatively, prespacetime likely creates and sustains spaceless (space/distance independent) external and internal wave functions of a mass *m* in Weyl (chiral) form as follows:

$$0 = 0e^{h} = 0e^{i0} = L_0 e^{-iM+iM} = \left(E^2 - m^2\right)e^{-imt+imt} =$$

$$\left(Det\begin{pmatrix} -E & 0 \\ 0 & +E \end{pmatrix} + Det\begin{pmatrix} 0 & -m \\ -m & 0 \end{pmatrix}\right)\left(e^{-imt}\right)\left(e^{-imt}\right)^{-1} \rightarrow \tag{3.106}$$

$$\left(\begin{pmatrix} E & 0 \\ 0 & E \end{pmatrix} + \begin{pmatrix} 0 & -m \\ -m & 0 \end{pmatrix}\right)\begin{pmatrix} g_{W,e}e^{-imt} \\ g_{W,i}e^{-imt} \end{pmatrix} = \begin{pmatrix} E & -m \\ -m & E \end{pmatrix}\begin{pmatrix} g_{W,e}e^{-imt} \\ g_{w,i}e^{-imt} \end{pmatrix} = 0$$

Prespacetime likely creates, sustains and causes evolution of a spatially self-confined entity such as a proton through imaginary momentum $\mathbf{p}_i$ (downward self-reference such that $m^2 > E^2$) in Dirac form as follows:

$$1 = e^{h} = e^{i0} = 1e^{i0} = Le^{+iM-iM} = \frac{E^2 - m^2}{\mathbf{p}_i^2} e^{+ip^{\mu}x_{\mu} - ip^{\mu}x_{\mu}} =$$

$$\left(\frac{E-m}{-|\mathbf{p}_i|}\right)\left(\frac{-|\mathbf{p}_i|}{E+m}\right)^{-1}\left(e^{+ip^{\mu}x_{\mu}}\right)\left(e^{+ip^{\mu}x_{\mu}}\right)^{-1} \rightarrow \tag{3.107}$$

$$\frac{E-m}{-|\mathbf{p}_i|}e^{+ip^{\mu}x_{\mu}} = \frac{-|\mathbf{p}_i|}{E+m}e^{+ip^{\mu}x_{\mu}} \rightarrow \frac{E-m}{-|\mathbf{p}_i|}e^{+ip^{\mu}x_{\mu}} - \frac{-|\mathbf{p}_i|}{E+m}e^{+ip^{\mu}x_{\mu}} = 0$$

$$\rightarrow \begin{pmatrix} E-m & -|\mathbf{p}_i| \\ -|\mathbf{p}_i| & E+m \end{pmatrix}\begin{pmatrix} s_{e,-}e^{+iEt} \\ s_{i,+}e^{+iEt} \end{pmatrix} = \left(L_{M,e} \quad L_{M,i}\right)\begin{pmatrix} \psi_{e,-} \\ \psi_{i,+} \end{pmatrix} = L_M \psi = 0 \tag{3.108}$$

After spinization of expression (3.108), we have:

$$\rightarrow \begin{pmatrix} E-m & -\boldsymbol{\sigma}\cdot\mathbf{p}_i \\ -\boldsymbol{\sigma}\cdot\mathbf{p}_i & E+m \end{pmatrix}\begin{pmatrix} S_{e,-}e^{+iEt} \\ S_{i,+}e^{+iEt} \end{pmatrix} = \left(L_{M,e} \quad L_{M,i}\right)\begin{pmatrix} \psi_{e,-} \\ \psi_{i,+} \end{pmatrix} = L_M \psi = 0 \tag{3.109}$$

As discussed later, it is likely that expression (3.108) governs the confinement structure of the unspinized proton in Dirac form through imaginary momentum $\mathbf{p}_i$ and, on the other hand, expression (3.109) governs the confinement structure of spinized proton through $\mathbf{p}_i$.

Alternatively, prespacetime likely creates, sustains and causes evolution of the spatially self-confined entity such as a proton in Dirac form as follows:

$$0=0e^{h}=0e^{i0}=L_0e^{iM-iM}=\left(E^2-m^2-\mathbf{p}_i^2\right)e^{+ip^{\mu}x_{\mu}-ip^{\mu}x_{\mu}}= \tag{3.110}$$

$$Det\begin{pmatrix}E & 0\\ 0 & E\end{pmatrix}+\left(Det\begin{pmatrix}-m & 0\\ 0 & m\end{pmatrix}+Det\begin{pmatrix}0 & -|\mathbf{p}_i|\\ -|\mathbf{p}_i| & 0\end{pmatrix}\right)\left(e^{+ip^{\mu}x_{\mu}}\right)\left(e^{+ip^{\mu}x_{\mu}}\right)^{-1}\rightarrow$$

$$\left(\begin{pmatrix}E & 0\\ 0 & E\end{pmatrix}+\begin{pmatrix}-m & 0\\ 0 & m\end{pmatrix}+\begin{pmatrix}0 & -|\mathbf{p}_i|\\ -|\mathbf{p}_i| & 0\end{pmatrix}\right)\begin{pmatrix}s_{e,-}e^{+iEt}\\ s_{i,+}e^{+iEt}\end{pmatrix}=\begin{pmatrix}E-m & -|\mathbf{p}_i|\\ -|\mathbf{p}_i| & E+m\end{pmatrix}\begin{pmatrix}s_{e,-}e^{+iEt}\\ s_{i,+}e^{+iEt}\end{pmatrix}=0$$

$$\rightarrow\begin{pmatrix}E-m & -|\mathbf{p}_i|\\ -|\mathbf{p}_i| & E+m\end{pmatrix}\begin{pmatrix}s_{e,-}e^{+iEt}\\ s_{i,+}e^{+iEt}\end{pmatrix}=\begin{pmatrix}L_{M,e} & L_{M,i}\end{pmatrix}\begin{pmatrix}\psi_{D,e}\\ \psi_{D,i}\end{pmatrix}=L_M\psi_D=0$$

$$\rightarrow\begin{pmatrix}E-m & -\boldsymbol{\sigma}\cdot\mathbf{p}_i\\ -\boldsymbol{\sigma}\cdot\mathbf{p}_i & E+m\end{pmatrix}\begin{pmatrix}S_{e,-}e^{+iEt}\\ S_{i,+}e^{+iEt}\end{pmatrix}=\begin{pmatrix}L_{M,e} & L_{M,i}\end{pmatrix}\begin{pmatrix}\psi_{D,e}\\ \psi_{D,i}\end{pmatrix}=L_M\psi_D=0$$

Thus, an unspinized and spinized antiproton in Dirac form may be respectively governed as follows:

$$\begin{pmatrix}E-m & -|\mathbf{p}_i|\\ -|\mathbf{p}_i| & E+m\end{pmatrix}\begin{pmatrix}s_{e,+}e^{-iEt}\\ s_{i,-}e^{-iEt}\end{pmatrix}=\begin{pmatrix}L_{M,e} & L_{M,i}\end{pmatrix}\begin{pmatrix}\psi_{D,e}\\ \psi_{D,i}\end{pmatrix}=L_M\psi_D=0 \tag{3.111}$$

$$\begin{pmatrix}E-m & -\boldsymbol{\sigma}\cdot\mathbf{p}_i\\ -\boldsymbol{\sigma}\cdot\mathbf{p}_i & E+m\end{pmatrix}\begin{pmatrix}S_{e,+}e^{-iEt}\\ S_{i,-}e^{-iEt}\end{pmatrix}=\begin{pmatrix}L_{M,e} & L_{M,i}\end{pmatrix}\begin{pmatrix}\psi_{D,e}\\ \psi_{D,i}\end{pmatrix}=L_M\psi_D=0 \tag{3.112}$$

Similarly, prespacetime likely creates, sustains and causes evolution of a spatially self-confined entity such as a proton through imaginary momentum $\mathbf{p}_i$ (downward self-reference) in Weyl (chiral) form as follows:

$$1=e^{h}=e^{i0}=1e^{i0}=(L)_m e^{+ip^{\mu}x_{\mu}-ip^{\mu}x_{\mu}}=\frac{E^2-\mathbf{p}_i^2}{m^2}e^{+ip^{\mu}x_{\mu}-ip^{\mu}x_{\mu}}= \tag{3.113}$$

$$\left(\frac{E-|\mathbf{p}_i|}{-m}\right)\left(\frac{-m}{E+|\mathbf{p}_i|}\right)^{-1}\left(e^{+ip^{\mu}x_{\mu}}\right)\left(e^{+ip^{\mu}x_{\mu}}\right)^{-1}\rightarrow$$

$$\frac{E-|\mathbf{p}_i|}{-m}e^{+ip^{\mu}x_{\mu}}=\frac{-m}{E+|\mathbf{p}_i|}e^{+ip^{\mu}x_{\mu}M}\rightarrow\frac{E-|\mathbf{p}_i|}{-m}e^{+ip^{\mu}x_{\mu}}-\frac{-m}{E+|\mathbf{p}_i|}e^{+ip^{\mu}x_{\mu}}=0$$

$$\rightarrow\begin{pmatrix}E-|\mathbf{p}_i| & -m\\ -m & E+|\mathbf{p}_i|\end{pmatrix}\begin{pmatrix}s_{e,r}e^{+iEt}\\ s_{i,l}e^{+iEt}\end{pmatrix}=\begin{pmatrix}L_{M,e} & L_{M,i}\end{pmatrix}\begin{pmatrix}\psi_{e,r}\\ \psi_{i,l}\end{pmatrix}=L_M\psi=0 \tag{3.114}$$

After spinization of expression (3.114), we have:

$$\rightarrow\begin{pmatrix} E-\boldsymbol{\sigma}\cdot\mathbf{p}_i & -m \\ -m & E+\boldsymbol{\sigma}\cdot\mathbf{p}_i \end{pmatrix}\begin{pmatrix} S_{e,r}e^{+iEt} \\ S_{i,l}e^{+iEt} \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix}\begin{pmatrix} \psi_{e,r} \\ \psi_{i,l} \end{pmatrix} = L_M\psi = 0 \qquad (3.115)$$

It is likely that expression (3.114) governs the structure of the unspinized proton in Weyl form and expression (3.115) governs the structure of spinized proton in Weyl form.

Alternatively, prespacetime likely creates, sustains and causes evolution of a spatially self-confined entity such as a proton in Weyl (chiral) form as follows:

$$0 = 0e^h = 0e^{i0} = L_0 e^{iM-iM} = \left(E^2 - m^2 - \mathbf{p}_i^2\right)e^{+ip^\mu x_\mu - ip^\mu x_\mu} = \qquad (3.116)$$

$$\left(Det\begin{pmatrix} E & 0 \\ 0 & E \end{pmatrix} + Det\begin{pmatrix} -|\mathbf{p}_i| & 0 \\ 0 & +|\mathbf{p}_i| \end{pmatrix} + Det\begin{pmatrix} 0 & -m \\ -m & 0 \end{pmatrix}\right)\left(e^{+ip^\mu x_\mu}\right)\left(e^{+ip^\mu x_\mu}\right)^{-1} \rightarrow$$

$$\left(\begin{pmatrix} E & 0 \\ 0 & E \end{pmatrix} + \begin{pmatrix} -|\mathbf{p}_i| & 0 \\ 0 & +|\mathbf{p}_i| \end{pmatrix} + \begin{pmatrix} 0 & -m \\ -m & 0 \end{pmatrix}\right)\begin{pmatrix} s_{e,r}e^{+iEt} \\ s_{i,l}e^{+iEt} \end{pmatrix} = \begin{pmatrix} E-|\mathbf{p}_i| & -m \\ -m & E+|\mathbf{p}_i| \end{pmatrix}\begin{pmatrix} s_{e,r}e^{+iEt} \\ s_{i,l}e^{+iEt} \end{pmatrix} = 0$$

$$\rightarrow\begin{pmatrix} E-|\mathbf{p}_i| & -m \\ -m & E+|\mathbf{p}_i| \end{pmatrix}\begin{pmatrix} s_{e,r}e^{+iEt} \\ s_{i,l}e^{+iEt} \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix}\begin{pmatrix} \psi_{e,r} \\ \psi_{i,l} \end{pmatrix} = L_M\psi = 0 \qquad (3.117)$$

$$\rightarrow\begin{pmatrix} E-\boldsymbol{\sigma}\cdot\mathbf{p}_i & -m \\ -m & E+\boldsymbol{\sigma}\cdot\mathbf{p}_i \end{pmatrix}\begin{pmatrix} S_{e,r}e^{+iEt} \\ S_{i,l}e^{+iEt} \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix}\begin{pmatrix} \psi_{e,r} \\ \psi_{i,l} \end{pmatrix} = L_M\psi = 0 \qquad (3.118)$$

Thus, an unspinized and spinized antiproton in Weyl form may be respectively governed as follows:

$$\begin{pmatrix} E-|\mathbf{p}_i| & -m \\ -m & E+|\mathbf{p}_i| \end{pmatrix}\begin{pmatrix} s_{e,l}e^{-iEt} \\ s_{i,r}e^{-iEt} \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix}\begin{pmatrix} \psi_{e,l} \\ \psi_{i,r} \end{pmatrix} = L_M\psi = 0 \qquad (3.119)$$

$$\begin{pmatrix} E-\boldsymbol{\sigma}\cdot\mathbf{p}_i & -m \\ -m & E+\boldsymbol{\sigma}\cdot\mathbf{p}_i \end{pmatrix}\begin{pmatrix} S_{e,l}e^{-iEt} \\ S_{i,r}e^{-iEt} \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix}\begin{pmatrix} \psi_{e,l} \\ \psi_{i,r} \end{pmatrix} = L_M\psi = 0 \qquad (3.120)$$

3.4 Scientific Genesis of Composite Entities

Then, prespacetime may create, sustain and cause evolution of a neutron in Dirac form which is comprised of an unspinized proton:

$$\left(\begin{pmatrix} E-e\phi-m & -|\mathbf{p}_i - e\mathbf{A}| \\ -|\mathbf{p}_i - e\mathbf{A}| & E-e\phi+m \end{pmatrix}\begin{pmatrix} s_{e,-}e^{+iEt} \\ s_{i,+}e^{+iEt} \end{pmatrix} = 0\right)_p \qquad (3.121)$$

and a spinized electron:

$$\left(\begin{pmatrix} E+e\phi-V-m & -\boldsymbol{\sigma}\cdot(\mathbf{p}+e\mathbf{A}) \\ -\boldsymbol{\sigma}\cdot(\mathbf{p}+e\mathbf{A}) & E+e\phi-V+m \end{pmatrix}\begin{pmatrix} S_{e,+}e^{-iEt} \\ S_{i,-}e^{-iEt} \end{pmatrix}=0\right)_e \tag{3.122}$$

as follows:

$$1=e^h=e^{i0}e^{i0}=1e^{i0}1e^{i0}=\left(Le^{-iM+iM}\right)_p\left(Le^{-iM+iM}\right)_e \tag{3.123}$$

$$=\left(\frac{E^2-m^2}{\mathbf{p}_i^2}e^{+ip^\mu x_\mu-ip^\mu x_\mu}\right)_p\left(\frac{E^2-m^2}{\mathbf{p}^2}e^{-ip^\mu x_\mu+ip^\mu x_\mu}\right)_e=$$

$$\left(\left(\frac{E-m}{-|\mathbf{p}_i|}\right)\left(\frac{-|\mathbf{p}_i|}{E+m}\right)^{-1}\left(e^{+ip^\mu x_\mu}\right)\left(e^{+ip^\mu x_\mu}\right)^{-1}\right)_p\left(\left(\frac{E-m}{-|\mathbf{p}|}\right)\left(\frac{-|\mathbf{p}|}{E+m}\right)^{-1}\left(e^{-ip^\mu x_\mu}\right)\left(e^{-ip^\mu x_\mu}\right)^{-1}\right)_e$$

$$\rightarrow\left(\frac{E-m}{-|\mathbf{p}_i|}e^{+ip^\mu x_\mu}=\frac{-|\mathbf{p}_i|}{E+m}e^{+ip^\mu x_\mu}\right)_p\left(\frac{E-m}{-|\mathbf{p}|}e^{-ip^\mu x_\mu}=\frac{-|\mathbf{p}|}{E+m}e^{-ip^\mu x_\mu}\right)_e$$

$$\rightarrow\left(\frac{E-m}{-|\mathbf{p}_i|}e^{+ip^\mu x_\mu}-\frac{-|\mathbf{p}_i|}{E+m}e^{+ip^\mu x_\mu}=0\right)_p\left(\frac{E-m}{-|\mathbf{p}|}e^{-ip^\mu x_\mu}-\frac{-|\mathbf{p}|}{E+m}e^{-ip^\mu x_\mu}=0\right)_e$$

$$\rightarrow\left(\begin{pmatrix} E-m & -|\mathbf{p}_i| \\ -|\mathbf{p}_i| & E+m \end{pmatrix}\begin{pmatrix} s_{e,-}e^{+iEt} \\ s_{i,+}e^{+iEt} \end{pmatrix}=0\right)_p\left(\begin{pmatrix} E-m & -|\mathbf{p}| \\ -|\mathbf{p}| & E+m \end{pmatrix}\begin{pmatrix} s_{e,+}e^{-iEt} \\ s_{i,-}e^{-iEt} \end{pmatrix}=0\right)_e$$

$$\rightarrow\begin{pmatrix} \left(\begin{pmatrix} E-e\phi-m & -|\mathbf{p}_i-e\mathbf{A}| \\ -|\mathbf{p}_i-e\mathbf{A}| & E-e\phi+m \end{pmatrix}\begin{pmatrix} s_{e,-}e^{+iEt} \\ s_{i,+}e^{+iEt} \end{pmatrix}=0\right)_p \\ \\ \left(\begin{pmatrix} E+e\phi-V-m & -\boldsymbol{\sigma}\cdot(\mathbf{p}+e\mathbf{A}) \\ -\boldsymbol{\sigma}\cdot(\mathbf{p}+e\mathbf{A}) & E+e\phi-V+m \end{pmatrix}\begin{pmatrix} S_{e,+}e^{-iEt} \\ S_{i,-}e^{-iEt} \end{pmatrix}=0\right)_e \end{pmatrix}_n$$

In expressions (3.121), (3.122) and (3.123), $(\ )_p$, $(\ )_e$ and $(\ )_n$ indicate proton, electron and neutron respectively. Further, unspinized proton has charge e, electron has charge –e, $\left(A^\mu=(\phi,\mathbf{A})\right)_p$ and $\left(A^\mu=(\phi,\mathbf{A})\right)_e$ are the electromagnetic potentials acting on unspinized proton and tightly bound spinized electron respectively, and $(V)_e$ is a binding potential from the unspinized proton acting on the spinized electron causing tight binding as discussed later.

If $\left(A^{\mu}=(\phi,\mathbf{A})\right)_p$ is negligible due to the fast motion of the tightly bound spinized electron, we have from the last expression in (3.123):

$$\rightarrow\begin{pmatrix}\left(\begin{pmatrix}E-m & -|\mathbf{p}_i| \\ -|\mathbf{p}_i| & E+m\end{pmatrix}\begin{pmatrix}s_{e,-}e^{+iEt} \\ s_{i,+}e^{+iEt}\end{pmatrix}=0\right)_p \\ \\ \left(\begin{pmatrix}E+e\phi-V-m & -\boldsymbol{\sigma}\cdot(\mathbf{p}+e\mathbf{A}) \\ -\boldsymbol{\sigma}\cdot(\mathbf{p}+e\mathbf{A}) & E+e\phi-V+m\end{pmatrix}\begin{pmatrix}S_{e,+}e^{-iEt} \\ S_{i,-}e^{-iEt}\end{pmatrix}=0\right)_e\end{pmatrix}_n \tag{3.124}$$

Experimental data on charge distribution and *g*-factor of neutron seem to support a neutron comprising of an unspinized proton and a tightly bound spinized electron.

The Weyl (chiral) form of the last expression in (3.123) and expression (3.124) are respectively as follows:

$$\begin{pmatrix}\left(\begin{pmatrix}-e\phi-|\mathbf{p}_i-e\mathbf{A}| & -m \\ -m & -e\phi+|\mathbf{p}_i-e\mathbf{A}|\end{pmatrix}\begin{pmatrix}s_{e,r}e^{+iEt} \\ s_{i,l}e^{+iEt}\end{pmatrix}=0\right)_p \\ \\ \left(\begin{pmatrix}E+e\phi-V-\boldsymbol{\sigma}\cdot(\mathbf{p}+e\mathbf{A}) & -m \\ -m & E+e\phi-V+\boldsymbol{\sigma}\cdot(\mathbf{p}+e\mathbf{A})\end{pmatrix}\begin{pmatrix}S_{e,l}e^{-iEt} \\ S_{i,r}e^{-iEt}\end{pmatrix}=0\right)_e\end{pmatrix}_n \tag{3.125}$$

$$\begin{pmatrix}\left(\begin{pmatrix}E-|\mathbf{p}_i| & -m \\ -m & E+|\mathbf{p}_i|\end{pmatrix}\begin{pmatrix}s_{e,r}e^{+iEt} \\ s_{i,l}e^{+iEt}\end{pmatrix}=0\right)_p \\ \\ \left(\begin{pmatrix}E+e\phi-V-\boldsymbol{\sigma}\cdot(\mathbf{p}+e\mathbf{A}) & -m \\ -m & E+e\phi-V+\boldsymbol{\sigma}\cdot(\mathbf{p}+e\mathbf{A})\end{pmatrix}\begin{pmatrix}S_{e,l}e^{-iEt} \\ S_{i,r}e^{-iEt}\end{pmatrix}=0\right)_e\end{pmatrix}_n \tag{3.126}$$

Then, prespacetime may create, sustain and cause evolution of a hydrogen atom comprising of a spinized proton:

$$\left(\begin{pmatrix}E-e\phi-m & -\boldsymbol{\sigma}\cdot(\mathbf{p}_i-e\mathbf{A}) \\ -\boldsymbol{\sigma}\cdot(\mathbf{p}_i-e\mathbf{A}) & E-e\phi+m\end{pmatrix}\begin{pmatrix}S_{e,-}e^{+iEt} \\ S_{i,+}e^{+iEt}\end{pmatrix}=0\right)_p \tag{3.127}$$

and a spinized electron:

$$\left(\begin{pmatrix}E+e\phi-m & -\boldsymbol{\sigma}\cdot(\mathbf{p}+e\mathbf{A}) \\ -\boldsymbol{\sigma}\cdot(\mathbf{p}+e\mathbf{A}) & E+e\phi+m\end{pmatrix}\begin{pmatrix}S_{e,+}e^{-iEt} \\ S_{i,-}e^{-iEt}\end{pmatrix}=0\right)_e \tag{3.128}$$

in Dirac form as follows:

$$1 = e^h = e^{i0}e^{i0} = 1e^{i0}1e^{i0} = \left(Le^{-iM+iM}\right)_p \left(Le^{-iM+iM}\right)_e \tag{3.129}$$

$$= \left(\frac{E^2-m^2}{\mathbf{p}_i^2} e^{+ip^\mu x_\mu - ip^\mu x_\mu}\right)_p \left(\frac{E^2-m^2}{\mathbf{p}^2} e^{-ip^\mu x_\mu + ip^\mu x_\mu}\right)_e =$$

$$\left(\left(\frac{E-m}{-|\mathbf{p}_i|}\right)\left(\frac{-|\mathbf{p}_i|}{E+m}\right)^{-1}\left(e^{+ip^\mu x_\mu}\right)\left(e^{+ip^\mu x_\mu}\right)^{-1}\right)_p \left(\left(\frac{E-m}{-|\mathbf{p}|}\right)\left(\frac{-|\mathbf{p}|}{E+m}\right)^{-1}\left(e^{-ip^\mu x_\mu}\right)\left(e^{-ip^\mu x_\mu}\right)^{-1}\right)_e$$

$$\rightarrow \left(\frac{E-m}{-|\mathbf{p}_i|} e^{+ip^\mu x_\mu} = \frac{-|\mathbf{p}_i|}{E+m} e^{+ip^\mu x_\mu}\right)_p \left(\frac{E-m}{-|\mathbf{p}|} e^{-ip^\mu x_\mu} = \frac{-|\mathbf{p}|}{E+m} e^{-ip^\mu x_\mu}\right)_e$$

$$\rightarrow \left(\frac{E-m}{-|\mathbf{p}_i|} e^{+ip^\mu x_\mu} - \frac{-|\mathbf{p}_i|}{E+m} e^{+ip^\mu x_\mu} = 0\right)_p \left(\frac{E-m}{-|\mathbf{p}|} e^{-ip^\mu x_\mu} - \frac{-|\mathbf{p}|}{E+m} e^{-ip^\mu x_\mu} = 0\right)_e$$

$$\rightarrow \left(\begin{pmatrix} E-m & -|\mathbf{p}_i| \\ -|\mathbf{p}_i| & E+m \end{pmatrix}\begin{pmatrix} s_{e,-}e^{+iEt} \\ s_{i,+}e^{+iEt} \end{pmatrix} = 0\right)_p \left(\begin{pmatrix} E-m & -|\mathbf{p}| \\ -|\mathbf{p}| & E+m \end{pmatrix}\begin{pmatrix} s_{e,+}e^{-iEt} \\ s_{i,-}e^{-iEt} \end{pmatrix} = 0\right)_e$$

$$\rightarrow \begin{pmatrix} \left(\begin{pmatrix} E-e\phi-m & -\boldsymbol{\sigma}\cdot(\mathbf{p}_i-e\mathbf{A}) \\ -\boldsymbol{\sigma}\cdot(\mathbf{p}_i-e\mathbf{A}) & E-e\phi+m \end{pmatrix}\begin{pmatrix} S_{e,-}e^{+iEt} \\ S_{i,+}e^{+iEt} \end{pmatrix} = 0\right)_p \\ \\ \left(\begin{pmatrix} E+e\phi-m & -\boldsymbol{\sigma}\cdot(\mathbf{p}+e\mathbf{A}) \\ -\boldsymbol{\sigma}\cdot(\mathbf{p}+e\mathbf{A}) & E+e\phi+m \end{pmatrix}\begin{pmatrix} S_{e,+}e^{-iEt} \\ S_{i,-}e^{-iEt} \end{pmatrix} = 0\right)_e \end{pmatrix}_h$$

In expressions (3.127), (3.128) and (3.129), $(\;)_p$, $(\;)_e$ and $(\;)_h$ indicate proton, electron and hydrogen atom respectively. Again, proton has charge e, electron has charge –e, and $\left(A^\mu = (\phi, \mathbf{A})\right)_p$ and $\left(A^\mu = (\phi, \mathbf{A})\right)_e$ are the electromagnetic potentials acting on spinized proton and spinized electron respectively.

Again, if $\left(A^\mu = (\phi, \mathbf{A})\right)_p$ is negligible due to fast motion of the orbiting spinized electron, we have from the last expression in (3.129):

$$\rightarrow\begin{pmatrix}\left(\begin{pmatrix}E-m & -\boldsymbol{\sigma}\cdot\mathbf{p}_i\\ -\boldsymbol{\sigma}\cdot\mathbf{p}_i & E+m\end{pmatrix}\begin{pmatrix}S_{e,-}e^{+iEt}\\ S_{i,+}e^{+iEt}\end{pmatrix}=0\right)_p\\ \\ \left(\begin{pmatrix}E+e\phi-m & -\boldsymbol{\sigma}\cdot(\mathbf{p}+e\mathbf{A})\\ -\boldsymbol{\sigma}\cdot(\mathbf{p}+e\mathbf{A}) & E+e\phi+m\end{pmatrix}\begin{pmatrix}S_{e,+}e^{-iEt}\\ S_{i,-}e^{-iEt}\end{pmatrix}=0\right)_e\end{pmatrix}_h \quad (1.130)$$

The Weyl (chiral) form of the last expression in (3.129) and expression (3.130) are respectively as follows:

$$\begin{pmatrix}\left(\begin{pmatrix}E-e\phi-\boldsymbol{\sigma}\cdot(\mathbf{p}_i-e\mathbf{A}) & -m\\ -m & E-e\phi+\boldsymbol{\sigma}\cdot(\mathbf{p}_i-e\mathbf{A})\end{pmatrix}\begin{pmatrix}S_{e,r}e^{+iEt}\\ S_{i,l}e^{+iEt}\end{pmatrix}=0\right)_p\\ \\ \left(\begin{pmatrix}E+e\phi-\boldsymbol{\sigma}\cdot(\mathbf{p}+e\mathbf{A}) & -m\\ -m & E+e\phi+\boldsymbol{\sigma}\cdot(\mathbf{p}+e\mathbf{A})\end{pmatrix}\begin{pmatrix}S_{e,l}e^{-iEt}\\ S_{i,r}e^{-iEt}\end{pmatrix}=0\right)_e\end{pmatrix}_h \quad (3.131)$$

$$\begin{pmatrix}\left(\begin{pmatrix}E-\boldsymbol{\sigma}\cdot\mathbf{p}_i & -m\\ -m & E+\boldsymbol{\sigma}\cdot\mathbf{p}_i\end{pmatrix}\begin{pmatrix}S_{e,r}e^{+iEt}\\ S_{i,l}e^{+iEt}\end{pmatrix}=0\right)_p\\ \\ \left(\begin{pmatrix}E+e\phi-\boldsymbol{\sigma}\cdot(\mathbf{p}+e\mathbf{A}) & -m\\ -m & E+e\phi+\boldsymbol{\sigma}\cdot(\mathbf{p}+e\mathbf{A})\end{pmatrix}\begin{pmatrix}S_{e,l}e^{-iEt}\\ S_{i,r}e^{-iEt}\end{pmatrix}=0\right)_e\end{pmatrix}_h \quad (3.132)$$

4. METAMORPHOUS PRESPACETIME VIEW

4.1. Metamorphoses & the Essence of Spin

The preceding sections make it clear that the particle e^0 of prespacetime can take many different forms as different primordial entities and, further, can have different manifestations as different wave functions and/or fields in different contexts even as a single primordial entity. For example, the wave functions of an electron can take the Dirac, Weyl, quaternion or determinant form respectively in different contexts depending on the questions one asks and the answer one seeks. However, the answer one gets is determined by the free will of prespacetime commonly termed as the measurement problem and is understood currently as the randomness of Nature. For another example, depending on the context, the manifestations of an entity such as an electron can take the form of a bi-spinor $(\psi_e, \psi_i)^T$ in spinized self-interaction and bi-vector $(\mathbf{E}, i\mathbf{B})^T$ or electromagnetic potential $A^u=(\phi, \mathbf{A})$ in electromagnetic interactions. Further, these forms are self-contained through their respective self-referential Matrix Law.

Now, if we ask the question how prespacetime creates a free fermion, we have shown several versions of it. If we ask the question how an entity participates in weak interaction, the answer is: through fermionic spinization and unspinization. If we ask the question how an entity participates in the strong interaction, the answer is: imaginary momentum (downward self-reference). If we ask the question how an entity participates in an electromagnetic interaction, the answer is: through bosonic spinization and unspinization. If we ask the question, how an entity participates in a gravitational interaction, the answer is: through a timeless, spaceless and/or massless external and internal wave function in prespacetime.

Further, this work also makes it clear that primordial self-referential spin in prespacetime is hierarchical and that it is the cause of primordial distinctions for creating the self-referential entities in the dual world. There are several levels of spin: (1) spin in the power level in prespacetime making primordial external and internal phase distinctions of external and internal wave functions; (2) spin of the prespacetime on the ground level making primordial external and internal wave functions which accompanies the primordial phase distinctions; (3) self-referential mixing of these wave functions through Matrix Law before spatial spinization (energy/time spin); (4) unconfining spatial spin through spatial spinization (electromagnetic and weak interaction) for creating bosonic and fermionic entities; and (5) confining spatial spin (strong interactions) creating the appearance of quarks through imaginary momentum (downward self-reference).

4.2. The Determinant View & the Meaning of Klein-Gordon Equation

In the determinant view, the Matrix Law collapses into Klein-Gordon form as shown in § 3 but so far we have not defined the form of the wave function as a result of the said collapse. Here, we propose that the external and internal wave functions (objects) form a special product state $\psi_e \psi_i^*$ with ψ_i^* containing the hidden variables, quantum potentials or self-gravity as shown below, *visa versa*.

From the following equations for unspinized free particle in Dirac and Weyl form respectively:

$$\begin{pmatrix} E-m & -|\mathbf{p}| \\ -|\mathbf{p}| & E+m \end{pmatrix} \begin{pmatrix} \psi_{e,+} \\ \psi_{i,-} \end{pmatrix} = L_M \psi_D = 0 \tag{4.1}$$

and

$$\begin{pmatrix} E-|\mathbf{p}| & -m \\ -m & E+|\mathbf{p}| \end{pmatrix} \begin{pmatrix} \psi_{e,l} \\ \psi_{i,r} \end{pmatrix} = L_M \psi_W = 0 \tag{4.2}$$

we respectively obtained the following equations in the determinant view (Klein Gordon form):

$$\begin{pmatrix} (DetL_M)\psi_{e,+}\psi^*_{i,-} = (E^2 - m^2 - \mathbf{p}^2)\psi_{e,+}\psi^*_{i,-} = 0 \\ (E^2 - m^2 - \mathbf{p}^2)\psi_{e,+} = 0 \\ (E^2 - m^2 - \mathbf{p}^2)\psi^*_{i,-} = 0 \end{pmatrix} \tag{4.3}$$

and

$$\begin{pmatrix} (DetL_M)\psi_{e,l}\psi^*_{i,r} = (E^2 - \mathbf{p}^2 - m^2)\psi_{e,l}\psi^*_{i,r} = 0 \\ (E^2 - \mathbf{p}^2 - m^2)\psi_{e,l} = 0 \\ (E^2 - \mathbf{p}^2 - m^2)\psi^*_{i,r} = 0 \end{pmatrix} \tag{4.4}$$

By way of an example, equation (4.1) has the following plane-wave solution:

$$\begin{pmatrix} \psi_{e,+} = a_{e,+}e^{-i(Et-\mathbf{p}\cdot\mathbf{x})} \\ \psi_{e,-} = a_{i,-}e^{-i(Et-\mathbf{p}\cdot\mathbf{x})} \end{pmatrix} \tag{4.5}$$

from which we have:

$$\psi_{e,+}\psi^*_{i,-} = \left(a_{e,+}e^{-i(Et-\mathbf{p}\cdot\mathbf{x})}\right)_e \left(a^*_{i,-}e^{+i(Et-\mathbf{p}\cdot\mathbf{x})}\right)_i \tag{4.6}$$

where

$$\begin{pmatrix} (Et - \mathbf{p}\cdot\mathbf{x})_e = \phi_e \\ -(Et - \mathbf{p}\cdot\mathbf{x})_i = \phi_i \end{pmatrix} \tag{4.7}$$

are respectively the external and internal phase in the determinant view. The variables in $\psi^*_{i,-}$ play the roles of hidden variables to $\psi_{e,+}$ which would be annihilated, if $\psi^*_{i,-}$ were allowed to merged with $\psi_{e,+}$. Indeed, if relativistic mass in the external wave function $\psi_{e,+}$ is considered to be inertial mass, then the relativistic mass in the conjugate internal wave function $\psi^*_{i,-}$ plays the role of gravitational mass. We will discuss quantum potential later.

Similarly, from the following equations for spinized free fermion in Dirac and Weyl form respectively:

$$\begin{pmatrix} E-m & -\boldsymbol{\sigma}\cdot\mathbf{p} \\ -\boldsymbol{\sigma}\cdot\mathbf{p} & E+m \end{pmatrix}\begin{pmatrix} \psi_{e,+} \\ \psi_{i,-} \end{pmatrix} = L_M\psi = 0 \tag{4.8}$$

and

$$\begin{pmatrix} E-\boldsymbol{\sigma}\cdot\mathbf{p} & -m \\ -m & E+\boldsymbol{\sigma}\cdot\mathbf{p} \end{pmatrix}\begin{pmatrix} \psi_{e,l} \\ \psi_{i,r} \end{pmatrix} = L_M\psi = 0 \tag{4.9}$$

where $\psi_D=(\psi_{e,+}, \psi_{i,-})^T=(\psi_1,\psi_2, \psi_3, \psi_4)^T$ and $\psi_W=(\psi_{e,l}, \psi_{i,r})^T=(\phi_1, \phi_2, \phi_3, \phi_4)^T$, we respectively obtained following equations in the determinant view (Klein Gordon form):

$$\begin{pmatrix} (Det_\sigma L_M)\psi_{e,+}\psi^*_{i,-} = (E^2 - m^2 - \mathbf{p}^2)I_2\psi_{e,+}\psi^*_{i,-} = 0 \\ (E^2 - m^2 - \mathbf{p}^2)\psi_1 = 0 \\ (E^2 - m^2 - \mathbf{p}^2)\psi_2 = 0 \\ (E^2 - m^2 - \mathbf{p}^2)\psi^*_3 = 0 \\ (E^2 - m^2 - \mathbf{p}^2)\psi^*_4 = 0 \end{pmatrix} \tag{4.10}$$

and

$$\begin{pmatrix} (Det_\sigma L_M)\psi_{e,l}\psi^*_{i,r} = (E^2 - \mathbf{p}^2 - m^2)I_2\psi_{e,l}\psi^*_{i,r} = 0 \\ (E^2 - \mathbf{p}^2 - m^2)\phi_1 = 0 \\ (E^2 - \mathbf{p}^2 - m^2)\phi_2 = 0 \\ (E^2 - \mathbf{p}^2 - m^2)\phi^*_3 = 0 \\ (E^2 - \mathbf{p}^2 - m^2)\phi^*_4 = 0 \end{pmatrix} \tag{4.11}$$

In the presence of electromagnetic potential $A^\mu = (\phi, \mathbf{A})$, we have from equations (4.1) and (4.2) the following equations:

$$\begin{pmatrix} E - e\phi - m & -|\mathbf{p}\text{-}e\mathbf{A}| \\ -|\mathbf{p}\text{-}e\mathbf{A}| & E - e\phi + m \end{pmatrix}\begin{pmatrix} \psi_{e,+} \\ \psi_{i,-} \end{pmatrix} = L_M\psi_D = 0 \tag{4.12}$$

and

$$\begin{pmatrix} E - e\phi - |\mathbf{p}\text{-}e\mathbf{A}| & -m \\ -m & E - e\phi + |\mathbf{p}\text{-}e\mathbf{A}| \end{pmatrix}\begin{pmatrix} \psi_{e,l} \\ \psi_{i,r} \end{pmatrix} = L_M\psi_W = 0 \tag{4.13}$$

from which we respectively obtained the following equations in the determinant view (Klein Gordon form):

$$\begin{pmatrix} (DetL_M)\psi_{e,+}\psi^*_{i,-} = ((E - e\phi)^2 - m^2 - (\mathbf{p}\text{-}e\mathbf{A})^2)\psi_{e,+}\psi^*_{i,-} = 0 \\ ((E - e\phi)^2 - m^2 - (\mathbf{p}\text{-}e\mathbf{A})^2)\psi_{e,+} = 0 \\ ((E - e\phi)^2 - m^2 - (\mathbf{p}\text{-}e\mathbf{A})^2)\psi^*_{i,-} = 0 \end{pmatrix} \tag{4.14}$$

and

$$\begin{pmatrix} (DetL_M)\psi_{e,l}\psi^*_{i,r} = ((E - e\phi)^2 - (\mathbf{p}\text{-}e\mathbf{A})^2 - m^2 + \alpha\beta - \beta\alpha)\psi_{e,l}\psi^*_{i,r} = 0 \\ ((E - e\phi)^2 - (\mathbf{p}\text{-}e\mathbf{A})^2 - m^2 + \alpha\beta - \beta\alpha)\psi_{e,l} = 0 \\ ((E - e\phi)^2 - (\mathbf{p}\text{-}e\mathbf{A})^2 - m^2 + \alpha\beta - \beta\alpha)\psi^*_{i,r} = 0 \end{pmatrix} \tag{4.15}$$

where $\alpha = E - e\phi$ and $\beta = |\mathbf{p}\text{-}e\mathbf{A}|$. After spinization of equations (4.12) and (4.13), we have:

$$\begin{pmatrix} E - e\phi - m & -\boldsymbol{\sigma}\cdot(\mathbf{p}\text{-}e\mathbf{A}) \\ -\boldsymbol{\sigma}\cdot(\mathbf{p}\text{-}e\mathbf{A}) & E - e\phi + m \end{pmatrix}\begin{pmatrix} \psi_{e,+} \\ \psi_{i,-} \end{pmatrix} = L_M\psi_D = 0 \tag{4.16}$$

and

$$\begin{pmatrix} E-e\phi-\boldsymbol{\sigma}\cdot(\mathbf{p}\text{-}e\mathbf{A}) & -m \\ -m & E-e\phi+\boldsymbol{\sigma}\cdot(\mathbf{p}\text{-}e\mathbf{A}) \end{pmatrix}\begin{pmatrix} \psi_{e,l} \\ \psi_{i,r} \end{pmatrix} = L_M \psi_W = 0 \qquad (4.17)$$

from which we respectively obtained the following equations in the determinant view (Klein Gordon form):

$$\begin{pmatrix} (Det_\sigma L_M)\psi_{e,+}\psi^*_{i,-} = \left((E-e\phi)^2 - m^2 - (\mathbf{p}\text{-}e\mathbf{A})^2 + e\boldsymbol{\sigma}\cdot\mathbf{B}\right)I_2\psi_{e,+}\psi^*_{i,-} = 0 \\ \left((E-e\phi)^2 - m^2 - (\mathbf{p}\text{-}e\mathbf{A})^2 + e\boldsymbol{\sigma}\cdot\mathbf{B}\right)I_2\psi_{e,+} = 0 \\ \left((E-e\phi)^2 - m^2 - (\mathbf{p}\text{-}e\mathbf{A})^2 + e\boldsymbol{\sigma}\cdot\mathbf{B}\right)I_2\psi^*_{i,-} = 0 \end{pmatrix} \qquad (4.18)$$

and

$$\begin{pmatrix} (Det_\sigma L_M)\psi_{e,l}\psi^*_{i,r} = \left((E-e\phi)^2 - (\mathbf{p}\text{-}e\mathbf{A})^2 - m^2 + e\sigma\cdot\mathbf{B}\text{-}ie\sigma\cdot\mathbf{E}\right)I_2\psi_{e,l}\psi^*_{i,r} = 0 \\ \left((E-e\phi)^2 - (\mathbf{p}\text{-}e\mathbf{A})^2 - m^2 + e\sigma\cdot\mathbf{B}\text{-}ie\sigma\cdot\mathbf{E}\right)I_2\psi_{e,l} = 0 \\ \left((E-e\phi)^2 - (\mathbf{p}\text{-}e\mathbf{A})^2 - m^2 + e\sigma\cdot\mathbf{B}\text{-}ie\sigma\cdot\mathbf{E}\right)I_2\psi^*_{i,r} = 0 \end{pmatrix} \qquad (4.19)$$

In equations (4.16) and (4.17), the couplings of **E** and/or **B** with spin **σ** are either implicit or hidden. These interactions are due to self-referential Matrix Law L_M which causes mixing of the external and internal wave functions. However, in the determinant view, these interactions are made explicit as shown in equations (4.18) and (4.19) respectively.

4.3. The Meaning of Schrodinger Equation & Quantum Potential

It can be shown that the following Schrodinger Equation is the non-relativistic approximation of equation (4.3) or (4.4):

$$i\partial_t\psi = H\psi = -\frac{1}{2m}\nabla^2\psi \qquad (4.20)$$

where $\psi = \psi_{\mathrm{Re}} + i\,\psi_{\mathrm{Im}}$. Equation (4.20) can be written as two coupled equations:

$$\begin{pmatrix} \partial_t\psi_{\mathrm{Re}} = H\psi_{\mathrm{Im}} \\ \partial_t\psi_{\mathrm{Im}} = -H\psi_{\mathrm{Re}} \end{pmatrix} \quad \text{or} \quad \begin{pmatrix} \partial_t & -H \\ H & \partial_t \end{pmatrix}\begin{pmatrix} \psi_{\mathrm{Re}} \\ \psi_{\mathrm{Im}} \end{pmatrix} = 0 \qquad (4.21)$$

The above equation describes the non-relativistic self-reference of the wave components ψ_{Re} and ψ_{Im} due to spin *i*. If we designate ψ_{Re} as external object, ψ_{Im} is the internal object. It is the non-relativistic approximation of the determinant view of an unspinized particle (Klein-Gordon form) with self-referential interaction reduced to spin *i* and contained in the wave function from which the quantum potential *Q* can be extracted.

For example, in the case:

$$\psi_{e,+}\psi^*_{i,-} = a_{e,+}e^{-i(Et-\mathbf{p}\cdot\mathbf{x})}a_{i,-}e^{+i(Et-\mathbf{p}\cdot\mathbf{x})} \approx \psi = \rho e^{-iS}e^{+i\zeta} \qquad (4.22)$$

where $a_{e,+}$ and $a_{i,-}$ are real, ζ contains the hidden variables and:

$$\begin{pmatrix} \rho = a_{e,+}a_{i,-} \\ S = \left(E_p t - \mathbf{p}\cdot\mathbf{x}\right)_e \\ \zeta = \left(E_p t - \mathbf{p}\cdot\mathbf{x}\right)_i \\ E_p = \dfrac{\mathbf{p}^2}{2m} \end{pmatrix} \tag{4.23}$$

we can derive the following quantum potential (details will be given elsewhere):

$$Q = -\frac{1}{2m}(\nabla\zeta)^2 = \left(-\frac{\mathbf{p}^2}{2m}\right)_i = \left(-E_p\right)_i \tag{4.24}$$

which originates from spin *i* in:

$$\psi_{i,-}^* = a_{i,-}e^{i(Et-\mathbf{p}\cdot\mathbf{x})} \approx a_{i,-}e^{+imt}e^{+i\zeta} \tag{4.25}$$

Q would negate the non-relativistic kinetic energy of the external wave function if the external wave function and the conjugate internal wave function would merge.

Further, it can be shown that the Pauli Equation is the non-relativistic approximation of equation (4.18) which is the determinant view of a fermion in an electromagnetic field in Dirac form:

$$i\partial_t\begin{pmatrix}\varphi_1\\ \varphi_2\end{pmatrix} = \left(\frac{1}{2m}\left(-i\nabla - e\mathbf{A}\right)^2 - \frac{e}{2m}\boldsymbol{\sigma}\cdot\mathbf{B} + e\phi\right)\begin{pmatrix}\varphi_1\\ \varphi_2\end{pmatrix} \tag{4.24}$$

It contain non-relativistic self-reference due to both spin i and $\boldsymbol{\sigma}$ and will be treated elsewhere in detail when and if time permits.

4.4 The Third State of Matter

Traditionally, a scalar (spinless) particle is presumed to be described by the Klein-Gordon equation and is classified as a boson. However, in this work we have suggested that Kein-Gordon equation is a determinant view of a fermion, boson or an unspinized entity (spinlesson) in which the external and internal wave functions (objects) form a special product state $\psi_e\psi_i^*$ with ψ_i^* as the origin of hidden variable, quantum potentials or self-gravity. The unspinized entity (spinlesson) is neither a boson nor a fermion but may be classified as a third state of matter described by the unspinized equation in Dirac or Weyl (chiral) form, for example:

$$\begin{pmatrix} E-m & -|\mathbf{p}| \\ -|\mathbf{p}| & E+m \end{pmatrix}\begin{pmatrix} a_{e,+}e^{-ip^{\mu}x_{\mu}} \\ a_{i,-}e^{-ip^{\mu}x_{\mu}} \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix}\begin{pmatrix}\psi_{e,+}\\ \psi_{i,-}\end{pmatrix} = L_M\psi = 0 \tag{4.25}$$

$$\begin{pmatrix} E-|\mathbf{p}| & -m \\ -m & E+|\mathbf{p}| \end{pmatrix}\begin{pmatrix} a_{e,l}e^{-ip^{\mu}x_{\mu}} \\ a_{i,r}e^{-ip^{\mu}x_{\mu}} \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix}\begin{pmatrix} \psi_{e,l} \\ \psi_{i,r} \end{pmatrix} = L_M\psi = 0 \tag{4.26}$$

The hadronized versions of the above equations in which the momentum is imaginary are respectively as follows:

$$\begin{pmatrix} E-m & -|\mathbf{p}_i| \\ -|\mathbf{p}_i| & E+m \end{pmatrix}\begin{pmatrix} s_{e,+}e^{-iEt} \\ s_{i,-}e^{-iEt} \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix}\begin{pmatrix} \psi_{e,+} \\ \psi_{i,-} \end{pmatrix} = L_M\psi = 0 \tag{4.27}$$

$$\begin{pmatrix} E-|\mathbf{p}_i| & -m \\ -m & E+|\mathbf{p}_i| \end{pmatrix}\begin{pmatrix} s_{e,l}e^{-iEt} \\ s_{i,r}e^{-iEt} \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix}\begin{pmatrix} \psi_{e,l} \\ \psi_{i,r} \end{pmatrix} = L_M\psi = 0 \tag{4.28}$$

The third state of matter may not be subject to the statistical behavior of either bosons or fermions. The wave functions of a fermion and boson are respectively a bispinor and bi-vector but that of the third state (spinlesson) is two-component complex scalar field. The third state of matter is the precursor of both fermionic and bosonic matters/fields before fermionic or bosonic spinization. Thus, we suggest that it steps into the shoes played by the Higgs field in the standard model which so far has not been found. Further, in this scenario, mass is created by the self-referential spin (imagination) of prespacetime.

5. WEAK INTERACTION

Weak interaction is an expressive process (emission or radiation) through fermionic spinization with or without intermediary bosonic spinization and the associated reverse process (capture or absorption). There are two possible kinds of mechanisms at play. One kind is the direct fermionic spinization of an unspinized massive particle as shown in § 3:

$$|\mathbf{p}| = \sqrt{\mathbf{p}^2} = \sqrt{-Det(\boldsymbol{\sigma}\cdot\mathbf{p})} \rightarrow \boldsymbol{\sigma}\cdot\mathbf{p} \tag{5.1}$$

that is, for example:

$$\begin{pmatrix} E-m & -|\mathbf{p}| \\ -|\mathbf{p}| & E+m \end{pmatrix}\begin{pmatrix} \psi_e \\ \psi_i \end{pmatrix} = 0 \rightarrow \begin{pmatrix} E-m & -\sigma\cdot\mathbf{p} \\ -\sigma.\mathbf{p} & E+m \end{pmatrix}\begin{pmatrix} \psi_e \\ \psi_i \end{pmatrix} = 0 \tag{5.2}$$

and the following reverse process:

$$\boldsymbol{\sigma}\cdot\mathbf{p} \rightarrow \sqrt{-Det(\boldsymbol{\sigma}\cdot\mathbf{p})} = \sqrt{\mathbf{p}^2} = |\mathbf{p}| \tag{5.3}$$

that is, for example:

$$\begin{pmatrix} E-m & -\sigma\cdot\mathbf{p} \\ -\sigma.\mathbf{p} & E+m \end{pmatrix}\begin{pmatrix} \psi_e \\ \psi_i \end{pmatrix} = 0 \rightarrow \begin{pmatrix} E-m & -|\mathbf{p}| \\ -|\mathbf{p}| & E+m \end{pmatrix}\begin{pmatrix} \psi_e \\ \psi_i \end{pmatrix} = 0 \tag{5.4}$$

Processes (5.1) and (5.3) only conserve spin in the dual world as a whole. If they hold in reality, neutrino may not be needed in the weak interaction as currently understood or assumed.

Accordingly, beta decay of a neutron may involve the spinizing process (5.1) during which an unspinized proton (or electron) gains its spin 1/2 and a bound spinized electron becomes free as follows:

(1) Spinless Proton → Spinized Proton → Release of Bound Electron; or

(2) Spinless Electron → Spinized Electron → Release of Spinized Electron.

Process (1) seems in closer agreement with experimental data on *g*-factor and charge density of neutron. There is no exchange particle involved in process (1) or (2). In neutron synthesis from proton and electron, if it exists, the reverse process (5.3) occurs during which a spinized proton (or electron) loses its spin and free electron becomes tightly bound to proton.

We suggest that the following equation governs free unspinized particles having mass *m* and electric charge *e* respectively but spinless, that is, they are pion-like particles or pion particles $\pi^{\pm}$ themselves (their combination generates π^0):

$$\begin{pmatrix} E-m & -|\mathbf{p}| \\ -|\mathbf{p}| & E+m \end{pmatrix}\begin{pmatrix} \psi_e \\ \psi_i \end{pmatrix}=0 \quad \text{or} \quad \begin{pmatrix} (E-m)\psi_e = |\mathbf{p}|\psi_i \\ (E+m)\psi_i = |\mathbf{p}|\psi_e \end{pmatrix} \tag{5.5}$$

After spinization through (5.1), we arrive at Dirac equation:

$$\begin{pmatrix} E-m & -\sigma\cdot\mathbf{p} \\ -\sigma\cdot\mathbf{p} & E+m \end{pmatrix}\begin{pmatrix} \psi_e \\ \psi_i \end{pmatrix}=0 \quad \text{or} \quad \begin{pmatrix} (E-m)\psi_e = \boldsymbol{\sigma}\cdot\mathbf{p}\,\psi_i \\ (E+m)\psi_i = \boldsymbol{\sigma}\cdot\mathbf{p}\,\psi_e \end{pmatrix} \tag{5.6}$$

Assuming a plane wave $\psi_{e,+} = e^{-ip^{\mu}x_{\mu}}$ exists for equation (5.5), we obtain the following solution for said equation (π^--like plane-wave solution):

$$\begin{pmatrix} \psi_{e,+} \\ \psi_{i,-} \end{pmatrix} = \sqrt{\frac{E+m}{2E}}\begin{pmatrix} e^{-ip^{\mu}x_{\mu}} \\ \frac{|\mathbf{p}|}{E+m} e^{-ip^{\mu}x_{\mu}} \end{pmatrix} = N\begin{pmatrix} 1 \\ \frac{|\mathbf{p}|}{E+m} \end{pmatrix} e^{-ip^{\mu}x_{\mu}} \tag{5.7}$$

where N is a normalization factor and where we have utilized the following relation for an energy eigenstate:

$$(E+m)\psi_{i,-} = |\mathbf{p}|\psi_{e,+} \rightarrow \psi_{i,-} = \frac{|\mathbf{p}|}{E+m}\psi_{e,+} \tag{5.8}$$

After spinization of solution (5.7):

$$\begin{pmatrix} 1 \\ \dfrac{|\mathbf{p}|}{E+m} \end{pmatrix} \rightarrow \begin{pmatrix} 1 & 0 \\ 0 & 1 \\ \multicolumn{2}{c}{\dfrac{\boldsymbol{\sigma}\cdot\mathbf{p}}{E+m}} \end{pmatrix} = \begin{pmatrix} 1 & 0 \\ 0 & 1 \\ \dfrac{p_z}{E+m} & \dfrac{p_x - ip_y}{E+m} \\ \dfrac{p_x + ip_y}{E+m} & \dfrac{-p_z}{E+m} \end{pmatrix} \tag{5.9}$$

we arrive at the free plane-wave electron solution for Dirac equation (5.6):

$$\begin{pmatrix} \psi_{e,+}^{\uparrow} \\ \psi_{i,-} \end{pmatrix} = \sqrt{\frac{E+m}{2E}} \begin{pmatrix} 1 \\ 0 \\ \dfrac{p_z}{E+m} \\ \dfrac{p_x+ip_y}{E+m} \end{pmatrix} e^{-ip^{\mu}x_{\mu}} \quad \text{and} \quad \begin{pmatrix} \psi_{e,+}^{\downarrow} \\ \psi_{i,-} \end{pmatrix} = \sqrt{\frac{E+m}{2E}} \begin{pmatrix} 0 \\ 1 \\ \dfrac{p_x-ip_y}{E+m} \\ \dfrac{-p_z}{E+m} \end{pmatrix} e^{-ip^{\mu}x_{\mu}} \tag{5.10}$$

In the above solutions for external spin up and down respectively, the external spin 1/2 is balanced by the internal spin components which may be deemed as antineutrino such that the total spin in the dual world is still conserved to zero. Therefore, it seems that external spin up or down can be created without the need of a separate antineutrino in beta decay, if any excessive energy ΔE and or momentum $\Delta \boldsymbol{p}$ are allowed to cancel each other in prespacetime:

$$\begin{pmatrix} e^{-i(\Delta Et - \Delta\mathbf{p}\cdot\mathbf{x})} \\ e^{-i(\Delta Et - \Delta\mathbf{p}\cdot\mathbf{x})} \end{pmatrix} \rightarrow e^{-i(\Delta Et - \Delta\mathbf{p}\cdot\mathbf{x})} e^{+i(\Delta Et - \Delta\mathbf{p}\cdot\mathbf{x})t} = e^{-i(\Delta Et - \Delta\mathbf{p}\cdot\mathbf{x}) + i(\Delta Et - \Delta\mathbf{p}\cdot\mathbf{x})} = e^0 = 1 \tag{5.11}$$

Further, if prespacetime allows the following bosonic spinization of massive spinless particle (e.g., as unstable particle with very short life-time):

$$|\mathbf{p}| = \sqrt{\mathbf{p^2}} = \sqrt{-(Det(\mathbf{s}\cdot\mathbf{p}+I_3) - Det(I_3))} \leftrightarrow \mathbf{s}\cdot\mathbf{p} \tag{5.12}$$

that is, for example:

$$\begin{pmatrix} E-m & -|\mathbf{p}| \\ -|\mathbf{p}| & E+m \end{pmatrix} \begin{pmatrix} \psi_e \\ \psi_i \end{pmatrix} = 0 \leftrightarrow \begin{pmatrix} E-m & -\mathbf{s}\cdot\mathbf{p} \\ -\mathbf{s}\cdot\mathbf{p} & E+m \end{pmatrix} \begin{pmatrix} \psi_e \\ \psi_i \end{pmatrix} = 0 \tag{5.13}$$

and/or

$$|\mathbf{p}| = \sqrt{\mathbf{p^2}} = \sqrt{-(Det(\mathbf{s}\cdot\mathbf{p}+I_3) - Det(I_3))} \rightarrow \mathbf{s}\cdot\mathbf{p} \rightarrow (\boldsymbol{\sigma}\cdot\mathbf{p})_1 + (\boldsymbol{\sigma}\cdot\mathbf{p})_2 \tag{5.14}$$

that is, for example:

$$\begin{pmatrix} E-m & -|\mathbf{p}| \\ -|\mathbf{p}| & E+m \end{pmatrix} \begin{pmatrix} \psi_e \\ \psi_i \end{pmatrix} = 0 \rightarrow \begin{pmatrix} E-m & -\mathbf{s}\cdot\mathbf{p} \\ -\mathbf{s}\cdot\mathbf{p} & E+m \end{pmatrix} \begin{pmatrix} \psi_e \\ \psi_i \end{pmatrix} = 0 \tag{5.15}$$

$$\rightarrow\left(\begin{pmatrix} E-m & -\sigma\cdot\mathbf{p} \\ -\sigma\cdot\mathbf{p} & E+m \end{pmatrix}\begin{pmatrix}\psi_e \\ \psi_i\end{pmatrix}=0\right)_1\left(\begin{pmatrix} E & -\sigma\cdot\mathbf{p} \\ -\sigma\cdot\mathbf{p} & E \end{pmatrix}\begin{pmatrix}\psi_e \\ \psi_i\end{pmatrix}=0\right)_2$$

during which transitory states known as vector bosons W^-, W^+ and/or Z^0 appear and disappear, we have from expression (5.14) the second kind of weak interactions. We point out here that only process (5.14) mediates weak interactions since in process (5.12) vector bosons W^-, W^+ and/or Z^0 are just transitory states that do not decay into fermions.

The spinized equation in expression (5.13) for a free massive spin 1 particle may take the following Dirac form:

$$\begin{pmatrix} E-m & -\mathbf{s}\cdot\mathbf{p} \\ -\mathbf{s}\cdot\mathbf{p} & E+m \end{pmatrix}\begin{pmatrix}\psi_{e,+} \\ \psi_{i,-}\end{pmatrix}=L_M\begin{pmatrix}\psi_{e,+} \\ \psi_{i,-}\end{pmatrix}=L_M\begin{pmatrix}\mathbf{E} \\ i\mathbf{B}\end{pmatrix}=L_M\psi=0 \tag{5.16}$$

or

$$\begin{pmatrix} E-m & -\mathbf{s}\cdot\mathbf{p} \\ -\mathbf{s}\cdot\mathbf{p} & E+m \end{pmatrix}\begin{pmatrix}\psi_{e,-} \\ \psi_{i,+}\end{pmatrix}=L_M\begin{pmatrix}\psi_{e,-} \\ \psi_{i,+}\end{pmatrix}=L_M\begin{pmatrix}i\mathbf{B} \\ \mathbf{E}\end{pmatrix}=L_M\psi=0 \tag{5.17}$$

After calculating the determinant:

$$Det_s\begin{pmatrix} E-m & -\mathbf{s}\cdot\mathbf{p} \\ -\mathbf{s}\cdot\mathbf{p} & E+m \end{pmatrix}=(E-m)(E+m)-(-\mathbf{s}\cdot\mathbf{p})(-\mathbf{s}\cdot\mathbf{p}) \tag{5.18}$$

We obtain the following:

$$Det_s\begin{pmatrix} E-m & -\mathbf{s}\cdot\mathbf{p} \\ -\mathbf{s}\cdot\mathbf{p} & E+m \end{pmatrix}=\left(E^2-\mathbf{p}^2-m^2\right)I_3-\begin{pmatrix} p_x^2 & p_xp_y & p_xp_z \\ p_yp_x & p_y^2 & p_yp_z \\ p_zp_x & p_zp_y & p_z^2 \end{pmatrix} \tag{5.19}$$

$$=\left(E^2-\mathbf{p}^2-m^2\right)I_3-M_T$$

As mentioned in § 3, the last term M_T in expression (5.19) makes fundamental relationship $E^2-\mathbf{p}^2-m^2=0$ not to hold in the determinant view (5.18) unless the action of M_T on the external and internal components of the wave function produces null result, that is:

$$M_T\begin{pmatrix}E_x \\ E_y \\ E_z\end{pmatrix}=(p_x+p_y+p_z)\mathbf{P}\cdot\mathbf{E}=\mathbf{0} \tag{5.20}$$

and

$$M_T \begin{pmatrix} B_x \\ B_y \\ B_z \end{pmatrix} = (p_x + p_y + p_z)\mathbf{P} \cdot \mathbf{B} = \mathbf{0} \tag{5.21}$$

Thus, if prespacetime allows these violations to exist transitorily, equations (5.16) and (5.17) may describe free vector bosons W^- and W^+ respectively; their combination then describes free vector boson Z^0 and M_T may be deemed as transitory mass (or mass operator).

In contrast to processes (1) and (2), vector bosons W^- and W^+ or the like mediate the spinization of spinless proton or electron respectively as follows:

(3) Spinless Proton → Spinized Vector Boson W^+ → Spinized Proton + Spinized 2nd Fermion → Release of Bound Electron + Spinized 2nd Fermion; and

(4) Spinless Electron → Spinized Vector Boson W^- → Spinized Electron + Spinized 2nd Fermion → Release of Spinized Electron + Spinized 2nd Fermion.

It is hoped that the metamorphous forms of Matrix Law in § 3, their further metamorphoses and the corresponding wave functions that these laws govern will be able to accommodate all known particles in the particle zoo.

Very importantly, there may be no parity violations in weak interactions such as beta decay as the apparent parity violation in the experiment may simply be explained as a spin polarization effect in which the spin polarization influences the dynamics and directions of the emitted electron in an external magnetic field. Also, there may be no need for Higgs boson to generate mass since mass is generated by self-referential spin at the power level of prespacetime, so the primordial particle of prespacetime is simply 1= $\mathbf{e}^0=\mathbf{e}^{\mathbf{i}M-\mathbf{i}M}$ ….

6. ELECTROMAGNETIC INTERACTION

Electromagnetic interaction is an expressive process (radiation or emission) through bosonic spinization of a massless and spinless entity and the associated reverse process (absorption). There are possibly two kinds of mechanisms at play. One kind is the direct bosonic spinization (spinizing radiation):

$$|\mathbf{p}| = \sqrt{\mathbf{p^2}} = \sqrt{-(Det(\mathbf{s}\cdot\mathbf{p}+I_3)-Det(I_3))} \rightarrow \mathbf{s}\cdot\mathbf{p} \tag{6.1}$$

that is, for example:

$$\begin{pmatrix} E & -|\mathbf{p}| \\ -|\mathbf{p}| & E \end{pmatrix}\begin{pmatrix} \psi_e \\ \psi_i \end{pmatrix} = 0 \rightarrow \begin{pmatrix} E & -\mathbf{s}\cdot\mathbf{p} \\ -\mathbf{s.p} & E \end{pmatrix}\begin{pmatrix} \psi_e \\ \psi_i \end{pmatrix} = 0 \tag{6.2}$$

and the following reverse process (unspinizing absorption):

$$\mathbf{s}\cdot\mathbf{p} \rightarrow \sqrt{-(Det(\mathbf{s}\cdot\mathbf{p}+I_3)-Det(I_3))} = \sqrt{\mathbf{p}^2} = |\mathbf{p}| \tag{6.3}$$

that is, for example:

$$\begin{pmatrix} E & -\mathbf{s}\cdot\mathbf{p} \\ -\mathbf{s.p} & E \end{pmatrix}\begin{pmatrix} \psi_e \\ \psi_i \end{pmatrix} = 0 \rightarrow \begin{pmatrix} E & -|\mathbf{p}| \\ -|\mathbf{p}| & E \end{pmatrix}\begin{pmatrix} \psi_e \\ \psi_i \end{pmatrix} = 0 \tag{6.4}$$

The radiation or absorption of a photon during acceleration of a charged particle may be direct bosonic spinizing or unspinizing process respectively:

(1) Bound Spinless & Massless Particle → Bound Spinized Photon → Free Spinized Photon; and

(2) Free Spinized Photon → Bound Spinized Photon → Bound Spinless & Massless Particle.

These two processes may also occur in nuclear decay and perhaps in other processes. Assuming a plane wave $\psi_{e,+} = e^{-ip^{\mu}x_{\mu}}$ exists for the spinless and massless particle:

$$\begin{pmatrix} E & -|\mathbf{p}| \\ -|\mathbf{p}| & E \end{pmatrix}\begin{pmatrix} \psi_e \\ \psi_i \end{pmatrix} = 0 \quad \text{or} \quad \begin{pmatrix} E\psi_e = |\mathbf{p}|\psi_i \\ E\psi_i = |\mathbf{p}|\psi_e \end{pmatrix} \tag{6.5}$$

we obtain the following solution for this equation:

$$\begin{pmatrix} \psi_{e,+} \\ \psi_{i,-} \end{pmatrix} = \sqrt{\frac{1}{2}}\begin{pmatrix} e^{-ip^{\mu}x_{\mu}} \\ \frac{|\mathbf{p}|}{E}e^{-ip^{\mu}x_{\mu}} \end{pmatrix} = N\begin{pmatrix} 1 \\ \frac{|\mathbf{p}|}{E} \end{pmatrix}e^{-ip^{\mu}x_{\mu}} \tag{6.6}$$

where we have utilized the following relation for an energy eigenstate and N is the normalization factor :

$$E\psi_{i,-} = |\mathbf{p}|\psi_{e,+} \rightarrow \psi_{i,-} = \frac{|\mathbf{p}|}{E}\psi_{e,+} \tag{6.7}$$

After spinization:

$$\frac{|\mathbf{p}|}{E} \rightarrow \frac{\mathbf{s}\cdot\mathbf{p}}{E} = \begin{pmatrix} 0 & \frac{-ip_z}{E} & \frac{ip_y}{E} \\ \frac{ip_z}{E} & 0 & -\frac{ip_x}{E} \\ -\frac{ip_y}{E} & \frac{ip_x}{E} & 0 \end{pmatrix} \tag{6.8}$$

We arrive at the plane-wave solution:

$$\begin{pmatrix}\psi_{e,+}^{x}\\ \psi_{i,-}\end{pmatrix}=\sqrt{\frac{1}{2}}\begin{pmatrix}1\\0\\0\\0\\ \frac{ip_z}{E}\\ \frac{-ip_y}{E}\end{pmatrix}e^{-ip^{\mu}x_{\mu}} \quad \begin{pmatrix}\psi_{e,+}^{y}\\ \psi_{i,-}\end{pmatrix}=\sqrt{\frac{1}{2}}\begin{pmatrix}0\\1\\0\\ \frac{-ip_z}{E}\\0\\ \frac{ip_x}{E}\end{pmatrix}e^{-ip^{\mu}x_{\mu}} \quad \begin{pmatrix}\psi_{e,+}^{z}\\ \psi_{i,-}\end{pmatrix}=\sqrt{\frac{1}{2}}\begin{pmatrix}0\\0\\1\\ \frac{ip_y}{E}\\ \frac{-ip_x}{E}\\0\end{pmatrix}e^{-ip^{\mu}x_{\mu}} \tag{6.9}$$

for the spinized photon equation:

$$\begin{pmatrix}E & -\mathbf{s}\cdot\mathbf{p}\\ -\mathbf{s}\cdot\mathbf{p} & E\end{pmatrix}\begin{pmatrix}\psi_e\\ \psi_i\end{pmatrix}=0 \quad \text{or} \quad \begin{pmatrix}E\psi_e=\mathbf{s}\cdot\mathbf{p}\psi_i\\ E\psi_i=\mathbf{s}\cdot\mathbf{p}\psi_e\end{pmatrix} \tag{6.10}$$

The second kind of electromagnetic interaction is the release (radiation) or binding (absorption) of a spinized photon without unspinization:

(3) Bound Spinized Photon → Free Spinized Photon; and

(4) Free Spinized Photon → Bound Spinized Photon.

Processes (3) and (4) occur at the openings of an optical cavity or waveguide and may also occur in atomic photon excitation and emission and perhaps other processes.

For bosonic spinization $|\mathbf{p}|=\sqrt{\mathbf{p}^2}\rightarrow\mathbf{s}\cdot\mathbf{p}$, the Maxwell equations in the vacuum (c=1; ε_0=1) are as follows:

$$\begin{pmatrix}\begin{pmatrix}E & -\mathbf{s}\cdot\mathbf{p}\\ -\mathbf{s}\cdot\mathbf{p} & E\end{pmatrix}\begin{pmatrix}\mathbf{E}\\ i\mathbf{B}\end{pmatrix}=0\\ \mathbf{p}\cdot\mathbf{E}=0\\ \mathbf{p}\cdot\mathbf{B}=0\end{pmatrix}, \quad \begin{pmatrix}\begin{pmatrix}\partial_t & -\nabla\times\\ \nabla\times & \partial_t\end{pmatrix}\begin{pmatrix}\mathbf{E}\\ \mathbf{B}\end{pmatrix}=0\\ \nabla\cdot\mathbf{E}=0\\ \nabla\cdot\mathbf{B}=0\end{pmatrix} \quad \text{or} \quad \begin{pmatrix}\partial_t\mathbf{E}=\nabla\times\mathbf{B}\\ \partial_t\mathbf{B}=-\nabla\times\mathbf{E}\\ \nabla\cdot\mathbf{E}=0\\ \nabla\cdot\mathbf{B}=0\end{pmatrix} \tag{6.11}$$

If we calculate the determinant:

$$Det_s\begin{pmatrix}E & -\mathbf{s}\cdot\mathbf{p}\\ -\mathbf{s}\cdot\mathbf{p} & E\end{pmatrix}=E\cdot E-(-\mathbf{s}\cdot\mathbf{p})(-\mathbf{s}\cdot\mathbf{p}) \tag{6.12}$$

We obtain the following:

$$Det_s\begin{pmatrix} E & -\mathbf{s}\cdot\mathbf{p} \\ -\mathbf{s}\cdot\mathbf{p} & E \end{pmatrix} = \left(E^2-\mathbf{p}^2\right)I_3 - \begin{pmatrix} p_x^2 & p_x p_y & p_x p_z \\ p_y p_x & p_y^2 & p_y p_z \\ p_z p_x & p_z p_y & p_z^2 \end{pmatrix} = \left(E^2-\mathbf{p}^2\right)I_3 - M_T \tag{6.13}$$

The last term M_T in expression (6.13) makes fundamental relationship $E^2-\mathbf{p}^2=0$ not hold in the determinant view (6.12) unless the action of M_T on the external and internal components of the wave function produces null result, since equations (5.20) and (5.21) only hold in the source-free region.

At the location of a massive charged particle such as an electron or proton, equations (5.20) and (5.21) are also violated by the photon. That is, the photon appears to have mass M_T at the source, thus particle pairs may be created on collision of a photon with a massive charged particle. In the Maxwell equations, these violations are counter-balanced by adding source to the equations as discussed below. The Maxwell equations with source are, in turn, coupled to the Dirac Equation of the fermions such as electron or proton forming the Dirac-Maxwell system as further discussed in § 11. Indeed, if source $j^\mu=(\rho,\mathbf{j})\neq 0$, we have instead:

$$\begin{pmatrix} \begin{pmatrix} E & -\mathbf{s}\cdot\mathbf{p} \\ -\mathbf{s}\cdot\mathbf{p} & E \end{pmatrix}\begin{pmatrix} \mathbf{E} \\ i\mathbf{B} \end{pmatrix} = \begin{pmatrix} -i\mathbf{j} \\ 0 \end{pmatrix} \\ \mathbf{p}\cdot\mathbf{E} = -i\rho \\ \mathbf{p}\cdot\mathbf{B}=0 \end{pmatrix}, \quad \begin{pmatrix} \begin{pmatrix} \partial_t & -\nabla\times \\ \nabla\times & \partial_t \end{pmatrix}\begin{pmatrix} \mathbf{E} \\ \mathbf{B} \end{pmatrix} = \begin{pmatrix} -\mathbf{j} \\ 0 \end{pmatrix} \\ \nabla\cdot\mathbf{E}=\rho \\ \nabla\cdot\mathbf{B}=0 \end{pmatrix} \text{ or } \begin{pmatrix} \partial_t\mathbf{E} = \nabla\times\mathbf{B}-\mathbf{j} \\ \partial_t\mathbf{B} = -\nabla\times\mathbf{E} \\ \nabla\cdot\mathbf{E}=\rho \\ \nabla\cdot\mathbf{B}=0 \end{pmatrix} \tag{6.14}$$

Importantly, we can also choose to use fermionic spinization scheme $|\mathbf{p}|=\sqrt{\mathbf{p^2}}\longrightarrow\boldsymbol{\sigma}\cdot\mathbf{p}$ to describe Maxwell equations. In this case, the Maxwell equation in the vacuum has the form:

$$\begin{pmatrix} E & -\boldsymbol{\sigma}\cdot\mathbf{p} \\ -\boldsymbol{\sigma}\cdot\mathbf{p} & E \end{pmatrix}\begin{pmatrix} \boldsymbol{\sigma}\cdot\mathbf{E} \\ i\boldsymbol{\sigma}\cdot\mathbf{B} \end{pmatrix} = 0 \tag{6.15}$$

which gives:

$$\begin{pmatrix} \partial_t\mathbf{E} = \nabla\times\mathbf{B} \\ \partial_t\mathbf{B} = -\nabla\times\mathbf{E} \\ \nabla\cdot\mathbf{E}=0 \\ \nabla\cdot\mathbf{B}=0 \end{pmatrix} \tag{6.16}$$

If source $j^\mu=(\rho,\mathbf{j})\neq 0$, we have:

$$\begin{pmatrix} E & -\boldsymbol{\sigma}\cdot\mathbf{p} \\ -\boldsymbol{\sigma}\cdot\mathbf{p} & E \end{pmatrix}\begin{pmatrix} \boldsymbol{\sigma}\cdot\mathbf{E} \\ i\boldsymbol{\sigma}\cdot\mathbf{B} \end{pmatrix} = \begin{pmatrix} -i\boldsymbol{\sigma}\cdot\mathbf{j} \\ -i\rho \end{pmatrix} \tag{6.17}$$

which gives:

$$\begin{pmatrix} \partial_t\mathbf{E} = \nabla\times\mathbf{B} - \mathbf{j} \\ \partial_t\mathbf{B} = -\nabla\times\mathbf{E} \\ \nabla\cdot\mathbf{E} = \rho \\ \nabla\cdot\mathbf{B} = 0 \end{pmatrix} \tag{6.18}$$

Therefore, in the fermionic spinization scheme, we have in place of the bi-vector wave function a 4x4 tensor comprising of two bi-spinors (instead of the bi-vector itself) generated by projecting the bi-vector comprised of **E** and ***i*B** to spin $\boldsymbol{\sigma}$.

Further, we point out here that for a linear photon its electric field **E** is the external wave function (external object) and its magnetic field **B** is the internal wave function (internal object). These two fields are always self-entangled and their entanglement is their self-gravity. Therefore, the relation between **E** and **B** in a propagating electromagnetic wave is not that change in **E** induces **B** *visa versa* but that change in **E** is always accompanied by change in **B** *visa versa* due to their entanglement (self-gravity). That is, the relationship between **E** and **B** are gravitational and instantaneous.

7. STRONG INTERACTION

While weak and electromagnetic interactions are expressive processes involving fermionic and bosonic spinizations of spinless entities (the third state of matter) and their respective reverse processes, strong interaction does not involve spinization, that is, strong force is a confining process. It may be assumed that spinless entities in general are unstable and decay through fermionic or bosonic spinization. In order to achieve confinement of a nucleon or stability of the nucleus, we suggest that strong interaction involves imaginary momentum in the confinement zone as illustrated below. There are two types of strong interactions at play. One is the self-confinement of a nucleon such as a proton and the other is the interaction among nucleons such a proton and a neutron.

In the Standard Model, a proton is a composite entity comprised of three quarks confined by massless gluons and the interaction among the nucleons is mediated by mesons comprised of pairs of a quark and an antiquark which in turn interact through gluons. However, since no free quarks have been observed, there is good reason to consider other options. We have suggested in § 3 that the proton may be considered as an elementary particle that accomplishes spatial self-confinement through downward self-reference (imaginary momentum).

Here, we will first derive the condition for producing spatial self-confinement of the nucleon and the nuclear potential known as the Yukawa potential. The equation for a massive but spinless entity in Dirac Form is as follows:

$$\begin{pmatrix} E-m & -|\mathbf{p}| \\ -|\mathbf{p}| & E+m \end{pmatrix}\begin{pmatrix} \psi_e \\ \psi_i \end{pmatrix}=0 \quad \text{or} \quad \begin{pmatrix} (E-m)\psi_e = |\mathbf{p}|\psi_i \\ (E+m)\psi_i = |\mathbf{p}|\psi_e \end{pmatrix} \tag{7.1}$$

Assuming that the wave function has energy eigenstate -*E* (that is, the external and internal wave functions have energy eigenstate -*E* and +*E* respectively in the determinant view), we can write:

$$(E-m)\psi_e = |\mathbf{p}|\psi_i \rightarrow (E-m)e^{+iEt}\phi_e(\mathbf{r}) = |\mathbf{p}|e^{+iEt}\phi_i(\mathbf{r}) \rightarrow (-E-m)\phi_e(\mathbf{r}) = |\mathbf{p}|\phi_i(\mathbf{r}) \tag{7.2}$$

$$(E+m)\psi_i = |\mathbf{p}|\psi_e \rightarrow (E+m)e^{+iEt}\phi_i(\mathbf{r}) = |\mathbf{p}|e^{+iEt}\phi_e(\mathbf{r}) \rightarrow \phi_i(\mathbf{r}) = \frac{|\mathbf{p}|}{-E+m}\phi_e(\mathbf{r}) \tag{7.3}$$

From expressions (7.2) and (7.3), we can derive the following:

$$\left(E^2-m^2-\mathbf{p}^2\right)\phi_i(\mathbf{r})=0 \quad \text{or} \quad \left(E^2-m^2+\nabla^2\right)\phi_i(\mathbf{r})=0 \tag{7.4}$$

Equation (7.4) has radial solution as follows:

$$\phi_i(r) = \frac{1}{4\pi r}e^{-ir\sqrt{E^2-m^2}} \tag{7.5}$$

Then, we have from expression (7.3):

$$\phi_e(r) = \frac{|\mathbf{p}|}{-E-m}\phi_i(r) = \frac{-|\mathbf{p}|}{E+m}\frac{1}{4\pi r}e^{-ir\sqrt{E^2-m^2}} \rightarrow \frac{-\sqrt{E^2-m^2}}{E+m}\frac{1}{4\pi r}e^{-ir\sqrt{E^2-m^2}} \tag{7.6}$$

where we have utilized the following (for reason to be discussed elsewhere):

$$|\mathbf{p}|\phi_i(r) = \sqrt{-\nabla^2}\,\frac{1}{4\pi r}e^{-ir\sqrt{E^2-m^2}} \rightarrow \sqrt{E^2-m^2}\,\frac{1}{4\pi r}e^{-ir\sqrt{E^2-m^2}} \tag{7.7}$$

The complete radial solution of equation (7.1) for energy eigenstate -*E* in Dirac form is:

$$\psi(t,r) = \begin{pmatrix} \psi_{e,-}(t,r) \\ \psi_{i,+}(t,r) \end{pmatrix} = N\begin{pmatrix} \dfrac{-\sqrt{E^2-m^2}}{E+m}\dfrac{1}{4\pi r}e^{+iEt-ir\sqrt{E^2-m^2}} \\ \dfrac{1}{4\pi r}e^{+iEt-ir\sqrt{E^2-m^2}} \end{pmatrix} = N\begin{pmatrix} -\sqrt{\dfrac{E-m}{E+m}} \\ 1 \end{pmatrix}\frac{1}{4\pi r}e^{+iEt-ir\sqrt{E^2-m^2}} \tag{7.8}$$

where N is a normalization factor.

When $m^2>E^2$, that is, when the momentum in $E^2-m^2=\boldsymbol{p}^2$ is imaginary, we have from (7.8):

$$\psi(t,r) = \begin{pmatrix} \psi_{e,-}(t,r) \\ \psi_{i,+}(t,r) \end{pmatrix} = N\begin{pmatrix} \dfrac{-i\sqrt{m^2-E^2}}{E+m}\dfrac{1}{4\pi r}e^{+iEt-r\sqrt{m^2-E^2}} \\ \dfrac{1}{4\pi r}e^{+iEt-r\sqrt{m^2-E^2}} \end{pmatrix} = N\begin{pmatrix} -i\beta \\ 1 \end{pmatrix}\frac{1}{4\pi r}e^{+iEt-r\alpha} \tag{7.9}$$

where $\alpha = \sqrt{m^2 - E^2}$ and $\beta = \sqrt{(m-E)(E+m)^{-1}}$. Now, if we consider the special case of a timeless, spinless but massive entity in which *E=0*, that is, the rest mass is all comprised of imaginary momentum $\mathbf{p}_i$, we have from (7.9):

$$\psi(r) = \begin{pmatrix} \psi_e \\ \psi_i \end{pmatrix} = N \begin{pmatrix} \frac{-i}{4\pi r} e^{-rm} \\ \frac{1}{4\pi r} e^{-rm} \end{pmatrix} = N \begin{pmatrix} -i \\ 1 \end{pmatrix} \frac{1}{4\pi r} e^{-rm} \tag{7.10}$$

Thus, the internal and external wave functions in expression (7.10) have the form of Yukawa potential and its negative imaginary projection, respectively.

We propose that the interior (confinement zone) of an unspinized nucleon is described by wave functions similar to expressions (7.9) or (7.10) and confinement is achieved through downward self-reference (imaginary momentum $\mathbf{p}_i$). Therefore, in this scenario, the three colors of the strong force are the three-dimensional imaginary momentum $\mathbf{p}_i$. Further, another implication of this scenario is that in the Machian quantum universe the timeless edge or outside of this universe (which is embedded in prespacetime) is connected to or simply is the timeless inside of the nucleons.

If we assume that the internal wave function ψ_i (which is self-coupled to the external wave function ψ_e through expression (7.1)) also couples with the external wave function χ_e of another entity (which is also self-coupled to its internal wave function χ_i) as, for example:

$$-g^2 \psi_i \chi_e = -g^2 \frac{1}{4\pi r} e^{-mr} \chi_e = -\frac{g^2}{r} e^{-mr} \chi_e \tag{7.11}$$

where $-g^2$ is a coupling constant, we can write part of the nuclear potential of a nucleon as follows:

$$V = -\frac{g^2}{r} e^{-mr} \tag{7.12}$$

which is in the form of Yukawa Potential. We should point out here that in this work we shall not try to develop a full Hamiltonian for two interacting nucleons.

We now discuss the unspinized and spinized forms of proton. The spinized proton is the commonly known form of proton and we suggest that the unspinized proton may reside in the neutron comprised of the unspinized proton and a spinized electron as illustrated in § 3. The equations for a free unspinized and spinized proton in Dirac Form are respectively as follows:

$$\begin{pmatrix} E-m & -|\mathbf{p}_i| \\ -|\mathbf{p}_i| & E+m \end{pmatrix}\begin{pmatrix} \psi_e \\ \psi_i \end{pmatrix}=0 \tag{7.13}$$

and

$$\begin{pmatrix} E-m & -\boldsymbol{\sigma}\cdot\mathbf{p}_i \\ -\boldsymbol{\sigma}\cdot\mathbf{p}_i & E+m \end{pmatrix}\begin{pmatrix} \psi_e \\ \psi_i \end{pmatrix}=0 \tag{7.14}$$

where $\mathbf{p}_i$ is imaginary momentum. From the above derivation, we may write the wave function of an unspinized proton with external and internal energy eigenstate -E and +E respectively as follows (by convention, electron has positive external energy +E and internal energy –E):

$$\psi(t,r)=\begin{pmatrix} \psi_{e,-}(t,r) \\ \psi_{i,+}(t,r) \end{pmatrix}=N\begin{pmatrix} \frac{-|\mathbf{p}_i|}{E+m}\frac{1}{4\pi r}e^{+iEt-r\alpha} \\ \frac{1}{4\pi r}e^{+iEt-r\alpha} \end{pmatrix}=N\begin{pmatrix} -i\beta \\ 1 \end{pmatrix}e^{+iEt}\frac{1}{4\pi r}e^{-r\alpha} \tag{7.15}$$

In contrast, an unspinized antiproton with external and internal energy eigenstate +E and -E respectively may have the following wave function:

$$\psi(t,r)=\begin{pmatrix} \psi_{e,+}(t,r) \\ \psi_{i,-}(t,r) \end{pmatrix}=N\begin{pmatrix} \frac{1}{4\pi r}e^{-iEt-r\alpha} \\ \frac{|\mathbf{p}_i|}{E+m}\frac{1}{4\pi r}e^{-iEt-r\alpha} \end{pmatrix}=N\begin{pmatrix} 1 \\ i\beta \end{pmatrix}e^{-iEt}\frac{1}{4\pi r}e^{-r\alpha} \tag{7.16}$$

According to this scenario, the nuclear spin of the neutron is solely due to the tightly bound spinized electron. Indeed, experimental data on charge distribution and g-factor of neutron supports this scenario. We further suggest that the nuclear potential causing tight binding of the spinized electron in the neutron may have the form of expression (7.12). Detailed consideration will be given elsewhere.

The wave function of spinized proton described by equation (7.14) can be obtained by spinizing the solution in expression (7.15) as follows:

$$|\mathbf{p}_i|=\sqrt{\mathbf{p}_i^2}=\sqrt{-Det\boldsymbol{\sigma}\cdot\mathbf{p}_i}\rightarrow\boldsymbol{\sigma}\cdot\mathbf{p}_i=-i\boldsymbol{\sigma}\cdot\nabla \tag{7.17}$$

$$=-i\left(\left(\frac{\partial}{\partial_r}+\frac{1}{r}\right)\pm i\frac{j+1/2}{r}\right)I_2=\left(-i\left(\frac{\partial}{\partial_r}+\frac{1}{r}\right)\pm\frac{j+1/2}{r}\right)I_2$$

where j is the total angular momentum number. Choosing j=1/2, we obtain from expression (7.15) two sets of solutions as follows:

$$\psi(t,r)=\begin{pmatrix} \psi_{e,-}(t,r) \\ \psi_{i,+}(t,r) \end{pmatrix}=N\begin{pmatrix} \frac{-(1/r+i\alpha)}{E+m}\frac{1}{4\pi r}e^{+iEt-r\alpha} \\ 0 \\ \frac{1}{4\pi r}e^{+iEt-r\alpha} \\ 0 \end{pmatrix}=N\begin{pmatrix} \frac{-(1/r+i\alpha)}{E+m} \\ 0 \\ 1 \\ 0 \end{pmatrix}\frac{1}{4\pi r}e^{+iEt-r\alpha} \tag{7.18}$$

$$\psi(t,r)=\begin{pmatrix}\psi_{e,-}(t,r)\\ \psi_{i,+}(t,r)\end{pmatrix}=N\begin{pmatrix}0\\ \dfrac{-(-1/r+i\alpha)}{E+m}\dfrac{1}{4\pi r}e^{+iEt-r\alpha}\\ 0\\ \dfrac{1}{4\pi r}e^{+iEt-r\alpha}\end{pmatrix}=N\begin{pmatrix}0\\ \dfrac{-(-1/r+i\alpha)}{E+m}\\ 0\\ 1\end{pmatrix}\frac{1}{4\pi r}e^{+iEt-r\alpha} \tag{7.19}$$

where $\alpha=\sqrt{m^2-E^2}$. In the case of timeless proton (that is, when E=0), we have from expressions (7.18) and (7.19) the following:

$$\psi(t,r)=\begin{pmatrix}\psi_{e,-}(t,r)\\ \psi_{i,+}(t,r)\end{pmatrix}=N\begin{pmatrix}-\left(\dfrac{1}{mr}+i\right)\dfrac{1}{4\pi r}e^{+iEt-mr}\\ 0\\ \dfrac{1}{4\pi r}e^{+iEt-mr}\\ 0\end{pmatrix}=N\begin{pmatrix}-\dfrac{1}{mr}-i\\ 0\\ 1\\ 0\end{pmatrix}e^{+iEt}\frac{1}{4\pi r}e^{-mr} \tag{7.18}$$

$$\psi(t,r)=\begin{pmatrix}\psi_{e,-}(t,r)\\ \psi_{i,+}(t,r)\end{pmatrix}=N\begin{pmatrix}0\\ \left(\dfrac{1}{mr}-i\right)\dfrac{1}{4\pi r}e^{+iEt-mr}\\ 0\\ \dfrac{1}{4\pi r}e^{+iEt-mr}\end{pmatrix}=N\begin{pmatrix}0\\ \dfrac{1}{mr}-i\\ 0\\ 1\end{pmatrix}e^{+iEt}\frac{1}{4\pi r}e^{-mr} \tag{7.19}$$

In this scenario, spinization of unspinized proton causes loss of tight binding of spinized electron to unspinized proton the possible cause of which will be considered elsewhere.

8. GRAVITY (QUANTUM ENTANGLEMENT)

Gravity is quantum entanglement (instantaneous interaction) across the dual-world (see, e.g., Hu & Wu, 2006a-d, 2007a). There are two types of gravity at play. One is self-gravity (self-interaction) between the external object (external wave function) and internal object (internal wave function) of an entity (wave function) governed by the metamorphous Matrix Law described in this work and the other is the quantum entanglement (instantaneous interaction) between two entities or one entity and the dual-world as a whole which may be either attractive or repulsive. As further shown below, gravitational field (graviton) is just the wave function itself which expresses the intensity distribution and dynamics of self-quantum-entanglement (nonlocality) of an entity. Indeed, strong interaction actually is strong quantum entanglement (strong gravity). We point out here that some have suspected that strong interaction is strong gravity.

We focus here on three particular forms of gravitational fields. One is timeless (zero energy) external and internal wave functions (self-fields) that play the role of timeless graviton, that is, they mediate time-independent interactions through space quantum entanglement. The second is spaceless external and internal wave functions (self-fields) that play the role of spaceless graviton, that is, they mediate space (distance) independent interactions through proper time (mass) entanglement. The third is massless external and internal wave functions (self-fields) that play the role of massless graviton, that is, they mediate mass (proper-time) independent interactions through massless energy entanglement. The typical wave function (self-fields) contains all three (timeless, spaceless and massless) components. In addition, the typical wave function also contains components related to fermionic or bosonic spinization.

As shown below, timeless quantum entanglement between two entities accounts for Newtonian gravity. Spaceless and/or massless quantum entanglement between two entities may account for dark matter (also see Hu & Wu, 2006) and the Casimir effect. Importantly, gravitational components related to spinization may account for dark energy (also see Hu & Wu, 2006).

When E=0, we have from fundamental relationship (3.4):

$$-m^2 - \mathbf{p}^2 = 0 \qquad \text{or} \qquad m^2 + \mathbf{p}^2 = 0 \tag{8.1}$$

We can regard expression (8.1) as a relationship governing the Machian quantum universe in which the total energy is zero. Classically, this may be seen as: (1) the rest mass m being comprised of imaginary momentum $\mathbf{P}=i\mathbf{P}_i$, or (2) momentum $\mathbf{P}$ being comprised of imaginary rest mass $m=im_i$.

As shown in § 3, the timeless Matrix Law in Dirac and Weyl form is respectively the following:

$$\begin{pmatrix} -m & -|\mathbf{p}| \\ -|\mathbf{p}| & +m \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix} = L_M \tag{8.2}$$

$$\begin{pmatrix} -|\mathbf{p}| & -m \\ -m & +|\mathbf{p}| \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix} = L_M \tag{8.3}$$

Thus, the equations of the timeless wave functions (self-fields) are respectively as follows:

$$\begin{pmatrix} -m & -|\mathbf{p}| \\ -|\mathbf{p}| & +m \end{pmatrix} \begin{pmatrix} g_{D,e}e^{-iM} \\ g_{D,i}e^{-iM} \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix} \begin{pmatrix} V_{D,e} \\ V_{D,i} \end{pmatrix} = L_M V_D = 0 \tag{8.4}$$

and

$$\begin{pmatrix} -|\mathbf{p}| & -m \\ -m & +|\mathbf{p}| \end{pmatrix} \begin{pmatrix} g_{W,e}e^{-iM} \\ g_{W,i}e^{-iM} \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix} \begin{pmatrix} V_{W,e} \\ V_{W,i} \end{pmatrix} = L_M V_W = 0 \tag{8.5}$$

Equation (8.4) and (8.5) can be respectively rewritten as:

$$\begin{pmatrix} mV_{D,e} = -|\mathbf{p}|V_{D,i} \\ mV_{D,i} = |\mathbf{p}|V_{D,e} \end{pmatrix} \quad \text{or} \quad \begin{pmatrix} V_{D,e} = -\dfrac{|\mathbf{p}|}{m}V_{D,i} \\ V_{D,i} = \dfrac{|\mathbf{p}|}{m}V_{D,e} \end{pmatrix} \tag{8.6}$$

and

$$\begin{pmatrix} mV_{W,e} = |\mathbf{p}|V_{W,i} \\ mV_{W,i} = -|\mathbf{p}|V_{W,e} \end{pmatrix} \quad \text{or} \quad \begin{pmatrix} V_{W,e} = \dfrac{|\mathbf{p}|}{m}V_{W,i} \\ V_{W,i} = -\dfrac{|\mathbf{p}|}{m}V_{W,e} \end{pmatrix} \tag{8.7}$$

To see the coupling of external and internal wave functions (self-fields) in a different perspective we can rewrite (8.6) and (8.7) respectively as follows:

$$\begin{pmatrix} mmV_{D,e}V_{D,i} = \left(-|\mathbf{p}|V_{D,i}\right)\left(|\mathbf{p}|V_{D,e}\right) \\ \left(|\mathbf{p}|V_{D,e}\right)\left(mV_{D,e}\right) = \left(mV_{D,i}\right)\left(-|\mathbf{p}|V_{D,i}\right) \end{pmatrix} \tag{8.8}$$

and

$$\begin{pmatrix} mmV_{W,e}V_{W,i} = \left(|\mathbf{p}|V_{W,i}\right)\left(-|\mathbf{p}|V_{W,e}\right) \\ \left(-|\mathbf{p}|V_{W,e}\right)\left(mV_{W,e}\right) = \left(mV_{W,i}\right)\left(-|\mathbf{p}|V_{W,i}\right) \end{pmatrix} \tag{8.9}$$

From expression (8.6), we can derive the following:

$$\left(m^2 + \mathbf{p}^2\right)V_{D,e} = 0 \quad \text{or} \quad \left(m^2 - \nabla^2\right)V_{D,e} = 0 \tag{8.10}$$

Equation (8.10) has radial solution in the form of Yukawa potential:

$$V_{D,e}(r) = \frac{1}{4\pi r}e^{-mr} \tag{8.11}$$

So in expression (8.4), M=-imr, that is, momentum is comprised of imaginary mass. The external timeless self-field in expression (8.11) has the form of Newton gravitational or Coulomb electric potential at large distance $r\rightarrow\infty$. We have from expression (8.6):

$$V_{D,i} = \frac{|\mathbf{p}|}{m}V_{D,e} = \frac{|\mathbf{p}|}{m}\frac{1}{4\pi r}e^{-mr} \rightarrow i\frac{1}{4\pi r}e^{-mr} \tag{8.12}$$

where we have utilized the following (for reasons to be discussed elsewhere):

$$|\mathbf{p}|V_{D,e} = \sqrt{-\nabla^2}\,\frac{1}{4\pi r}e^{-mr} \rightarrow im\frac{1}{4\pi r}e^{-mr} \tag{8.13}$$

The complete radial solution of equation (8.4) is then:

$$V_D(r) = \begin{pmatrix} V_{D,e} \\ V_{D,i} \end{pmatrix} = N\begin{pmatrix} \dfrac{1}{4\pi r}e^{-mr} \\ i\dfrac{1}{4\pi r}e^{-mr} \end{pmatrix} = N\begin{pmatrix} 1 \\ i \end{pmatrix}\frac{1}{4\pi r}e^{-mr} \tag{8.14}$$

where N is a normalization factor. Indeed, expression (8.7) can have same radial solution as expression (8.6):

$$V_W(r) = \begin{pmatrix} V_{W,e} \\ V_{W,i} \end{pmatrix} = N \begin{pmatrix} \frac{1}{4\pi r} e^{-mr} \\ i\frac{1}{4\pi r} e^{-mr} \end{pmatrix} = N \begin{pmatrix} 1 \\ i \end{pmatrix} \frac{1}{4\pi r} e^{-mr} \tag{8.15}$$

If we assume that the internal self-field $V_{D,i}$ (which is self-coupled to its external self-field $V_{D,e}$ through expression (8.4) or (8.8)) also couples through timeless quantum entanglement with the external wave function ψ_e of another entity of test mass m_t (which is also self-coupled to its internal wave function ψ_i) as, for example:

$$i\kappa m V_{D,i} m_t \psi_e = i\kappa m i \frac{1}{4\pi r} e^{-mr} m_t \psi_e = -G\frac{m}{r} e^{-mr} m_t \psi_e \tag{8.16}$$

where $i\kappa$ is a coupling constant and $G=\kappa/4\pi$ is Newton's Gravitational Constant, we have gravitational potential at large distance $r\rightarrow\infty$ as:

$$V_g = -G\frac{m}{r} \tag{8.17}$$

We should point out here that in this work we shall not try to develop a full Hamiltonian for the two entities interacting through timeless quantum entanglement.

When $|\mathbf{p}|=0$, we have from fundamental relationship (3.4):

$$E^2 - m^2 = 0 \tag{8.18}$$

We can regard expression (8.6) as a relationship governing a spaceless quantum universe. Classically, this may be seen as the rest mass m being comprised of time momentum (energy E). As shown in § 3, the spaceless Matrix Law in Dirac and Weyl form is respectively the following:

$$\begin{pmatrix} E-m & 0 \\ 0 & E+m \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix} = L_M \tag{8.19}$$

and

$$\begin{pmatrix} E & -m \\ -m & E \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix} = L_M \tag{8.20}$$

and the equation of spaceless wave functions (self- fields) are respectively the follows:

$$\begin{pmatrix} E-m & 0 \\ 0 & E+m \end{pmatrix} \begin{pmatrix} g_{D,e} e^{-imt} \\ g_{D,i} e^{-imt} \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix} \begin{pmatrix} V_{D,e} \\ V_{D,i} \end{pmatrix} = L_M V_D = 0 \tag{8.21}$$

and

$$\begin{pmatrix} E & -m \\ -m & E \end{pmatrix}\begin{pmatrix} g_{W,e}e^{-imt} \\ g_{W,i}e^{-imt} \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix}\begin{pmatrix} V_{W,e} \\ V_{W,i} \end{pmatrix} = L_M V_W = 0 \qquad (8.22)$$

The external and internal (spaceless) wave functions $V_{D,e}$ and $V_{D,i}$ in equation (8.21) are decoupled from each other, but those in equation (8.22),$V_{W,e}$ and $V_{W,i}$, are coupled to each other:

$$\begin{pmatrix} EV_{D,e} = mV_{D,e} \\ EV_{D,i} = -mV_{D,i} \end{pmatrix} \quad \text{but} \quad \begin{pmatrix} EV_{W,e} = mV_{W,i} \\ EV_{W,i} = mV_{W,e} \end{pmatrix} \qquad (8.23)$$

It can be easily verified that the solutions to equation (8.21) are in forms of:

$$V_D = \begin{pmatrix} V_{D,e} \\ V_{D,i} \end{pmatrix} = N\begin{pmatrix} 1e^{-imt} \\ 0e^{-imt} \end{pmatrix} = N\begin{pmatrix} 1 \\ 0 \end{pmatrix}e^{-imt} \qquad (8.24)$$

or

$$V_D = \begin{pmatrix} V_{D,e} \\ V_{D,i} \end{pmatrix} = N\begin{pmatrix} 0e^{imt} \\ 1e^{imt} \end{pmatrix} = N\begin{pmatrix} 0 \\ 1 \end{pmatrix}e^{imt} \qquad (8.25)$$

but the solutions to equation (8.22) are in the forms of:

$$V_W = \begin{pmatrix} V_{W,e} \\ V_{W,i} \end{pmatrix} = N\begin{pmatrix} 1e^{-imt} \\ 1e^{-imt} \end{pmatrix} = N\begin{pmatrix} 1 \\ 1 \end{pmatrix}e^{-imt} \qquad (8.26)$$

or

$$V_W = \begin{pmatrix} V_{W,e} \\ V_{W,i} \end{pmatrix} = N\begin{pmatrix} 1e^{imt} \\ 1e^{imt} \end{pmatrix} = N\begin{pmatrix} 1 \\ 1 \end{pmatrix}e^{imt} \qquad (8.27)$$

As we shall illustrate below, most quantum entanglements one speaks of in quantum mechanics are spaceless quantum entanglements (gravity) between two entities; dark matter may be a manifestation of this non-Newtonian gravity; and the Casimir effect may be due to this type of spaceless quantum entanglement or, at least, may have a contribution from spaceless quantum entanglement.

For simplicity, we will consider two masses m_1+m_p and m_2 respectively located at space points 1 and 2. Their respective spaceless wave functions can be written in Weyl form as follows:

$$V_{1W+} = \begin{pmatrix} g_{1W+,e}e^{-i(m_1+m_p)t} \\ g_{1W+,i}e^{-i(m_1+m_p)t} \end{pmatrix} \quad \text{and} \quad V_{2W-} = \begin{pmatrix} g_{2W-,e}e^{-im_2t} \\ g_{2W-,i}e^{-im_2t} \end{pmatrix} \qquad (8.28)$$

which form product state $V_{1W+}V_{2W-}$. After m_p leaves V_{1W+} as an emitted particle and get absorbed by V_{2W-}, we may have the following two additional spaceless wave functions in Weyl form:

$$V_{1W-} = \begin{pmatrix} g_{1W-,e}e^{-im_1 t} \\ g_{1W-,i}e^{-im_1 t} \end{pmatrix} \quad \text{and} \quad V_{2W+} = \begin{pmatrix} g_{2W+,e}e^{-i(m_2+m_p)t} \\ g_{2W+,i}e^{-i(m_2+m_p)t} \end{pmatrix} \tag{8.29}$$

which form product state $V_{1W-}V_{2W+}$. The final spaceless quantum state may be written as follows:

$$V = \frac{1}{\sqrt{2}}\left(V_{1W+}V_{2W-} + V_{1W-}V_{2W+}\right) = \frac{1}{\sqrt{2}}\left(|1+\rangle|2-\rangle + |1-\rangle|2+\rangle\right) \tag{8.30}$$

In this joint spaceless wavefunction, m_1 and m_2 are quantum entangled due to interaction with and through m_p. It is suggested that this space (distance)-independent quantum entanglement (non-Newtonian gravity) between two entities is the cause of dark matter. It is further suggested that this space (distance) independent quantum entanglement (sharing of mass/energy) between two entities after interaction is the cause of or, at least, a contribution to Casimir effect. We should point out here that in this work we shall not try to develop a full Hamiltonian for the two entities interacting through spaceless quantum entanglement.

When m=0, we have from fundamental relationship (3.4):

$$E^2 - \mathbf{p}^2 = 0 \tag{8.31}$$

We can regard expression (8.11) as a relationship governing the massless quantum universe in which the total rest mass (proper time) is zero. Classically, this may be seen as energy E being comprised of momentum **p**. As shown in § 3, the massless Matrix Law in Dirac and Weyl form is respectively the following:

$$\begin{pmatrix} E & -|\mathbf{p}| \\ -|\mathbf{p}| & E \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix} = L_M \tag{8.32}$$

and

$$\begin{pmatrix} E-|\mathbf{p}| & 0 \\ 0 & E+|\mathbf{p}| \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix} = L_M \tag{8.33}$$

and the equations of massless wave functions (self-fields) are respectively the following:

$$\begin{pmatrix} E & -|\mathbf{p}| \\ -|\mathbf{p}| & E \end{pmatrix}\begin{pmatrix} g_{D,e}e^{-iM} \\ g_{D,i}e^{-iM} \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix}\begin{pmatrix} V_{D,e} \\ V_{D,i} \end{pmatrix} = L_M V_D = 0 \tag{8.34}$$

and

$$\begin{pmatrix} E-|\mathbf{p}| & 0 \\ 0 & E+|\mathbf{p}| \end{pmatrix}\begin{pmatrix} g_{W,e}e^{-iM} \\ g_{W,i}e^{-iM} \end{pmatrix} = \begin{pmatrix} L_{M,e} & L_{M,i} \end{pmatrix}\begin{pmatrix} V_{W,e} \\ V_{W,i} \end{pmatrix} = L_M V_W = 0 \tag{8.35}$$

Equations (8.34) and (8.35) have plane-wave solutions. The external and internal (masssless) wave functions $V_{D,e}$ and $V_{D,i}$ in equation (8.34) are coupled with each other, but those in equations (8.35), $V_{W,e}$ and $V_{W,i}$, are decoupled from each other:

$$\begin{pmatrix} EV_{D,e} = |\mathbf{p}|V_{D,i} \\ EV_{D,i} = |\mathbf{p}|V_{D,e} \end{pmatrix} \quad \text{but} \quad \begin{pmatrix} EV_{W,e} = |\mathbf{p}|V_{W,e} \\ EV_{W,i} = -|\mathbf{p}|V_{W,i} \end{pmatrix} \tag{8.36}$$

For eigenstate of E and |**p**|, the solutions to equation (8.34) are in the forms of:

$$V_D = \begin{pmatrix} V_{D,e} \\ V_{D,i} \end{pmatrix} = N \begin{pmatrix} 1e^{-i(\omega t - \mathbf{k}\cdot\mathbf{x})} \\ \frac{|\mathbf{p}|}{E} e^{-i(\omega t - \mathbf{k}\cdot\mathbf{x})} \end{pmatrix} = N \begin{pmatrix} 1 \\ 1 \end{pmatrix} e^{-i(\omega t - \mathbf{k}\cdot\mathbf{x})} \tag{8.37}$$

or

$$V_D = \begin{pmatrix} V_{D,e} \\ V_{D,i} \end{pmatrix} = N \begin{pmatrix} \frac{|\mathbf{p}|}{E} e^{i(\omega t - \mathbf{k}\cdot\mathbf{x})} \\ 1e^{i(\omega t - \mathbf{k}\cdot\mathbf{x})} \end{pmatrix} = N \begin{pmatrix} 1 \\ 1 \end{pmatrix} e^{i(\omega t - \mathbf{k}\cdot\mathbf{x})} \tag{8.38}$$

but the solutions to equation (8.35) are in the forms of:

$$V_W = \begin{pmatrix} V_{W,e} \\ V_{w,i} \end{pmatrix} = N \begin{pmatrix} 1e^{-i(\omega t - \mathbf{k}\cdot\mathbf{x})} \\ 0e^{-i(\omega t - \mathbf{k}\cdot\mathbf{x})} \end{pmatrix} = N \begin{pmatrix} 1 \\ 0 \end{pmatrix} e^{-i(\omega t - \mathbf{k}\cdot\mathbf{x})} \tag{8.39}$$

or

$$V_W = \begin{pmatrix} V_{W,e} \\ V_{W,i} \end{pmatrix} = N \begin{pmatrix} 0e^{i(\omega t - \mathbf{k}\cdot\mathbf{x})} \\ 1e^{i(\omega t - \mathbf{k}\cdot\mathbf{x})} \end{pmatrix} = N \begin{pmatrix} 0 \\ 1 \end{pmatrix} e^{i(\omega t - \mathbf{k}\cdot\mathbf{x})} \tag{8.40}$$

Equations (8.34) and (8.35) describe the self-interaction of external and internal massless and spinless wave functions (self-fields). We can build a quantum-entangled state of two massless and spinless entities similar to that of two spaceless entities. It is suggested that this rest mass-independent quantum entanglement (non-Newtonian gravity) between two massless entities may also contribute to the cause of dark matter (also see, Hu & Wu, 2006).

9. CONSCIOUSNESS

Our experimental results on quantum entanglement of the brain with external substances suggest that consciousness is not located in the brain but associated with prespacetime or simply is prespscetime (Hu & Wu, 2006a-c). Thus, these results support the proposition that the transcendental aspect of consciousness is the basis of reality. Indeed, our view is that reality is an interactive quantum reality centered on consciousness and the interaction between consciousness and reality is the most fundamental self-reference (Hu, 2008b & 2009). The perplexing questions we have tried to answer are: (1) Is quantum reality produced and influenced by consciousness; or (2) is consciousness produced and influenced by quantum reality? As shown in the preceding sections, our answers are that consciousness is both transcendent and immanent, that is, the transcendental aspect of consciousness produces and influences reality through self-referential spin as the interactive output of consciousness and, in turn, reality produces and influences immanent aspect of consciousness as the interactive input to consciousness also through self-referential spin (*Id.*).

We have also been asking the question: Where and what is human consciousness in the big scheme of things? Our answer is that human consciousness is a limited or individualized version of the above dual-aspect consciousness such that we have limited free will and limited observation/experience which is mostly classical at macroscopic levels but quantum at microscopic levels (*Id.*). For example, as a limited transcendental consciousness, we have through free will the choice of what measurement to do in a quantum experiment but not the ability to control the result of measurement (at least not until we can harness the abilities of our consciousness). That is, the result appears to us as random. On the other hand, at the macroscopic level, we also have the choice through free will of what to do but the outcome, depending on context, is sometimes certain and at other times uncertain. Further, as a limited immanent consciousness, we can only observe the measurement result in a quantum experiment that we conduct and experience the macroscopic environment surrounding us as the classical world (*Id.*).

With these "big" questions out of the way, we now focus on some of the details of how human experience (as limited immanent consciousness) is produced through the brain and how human free-will (as limited transcendental consciousness) may operate through the brain. These questions have also been considered by us previously.

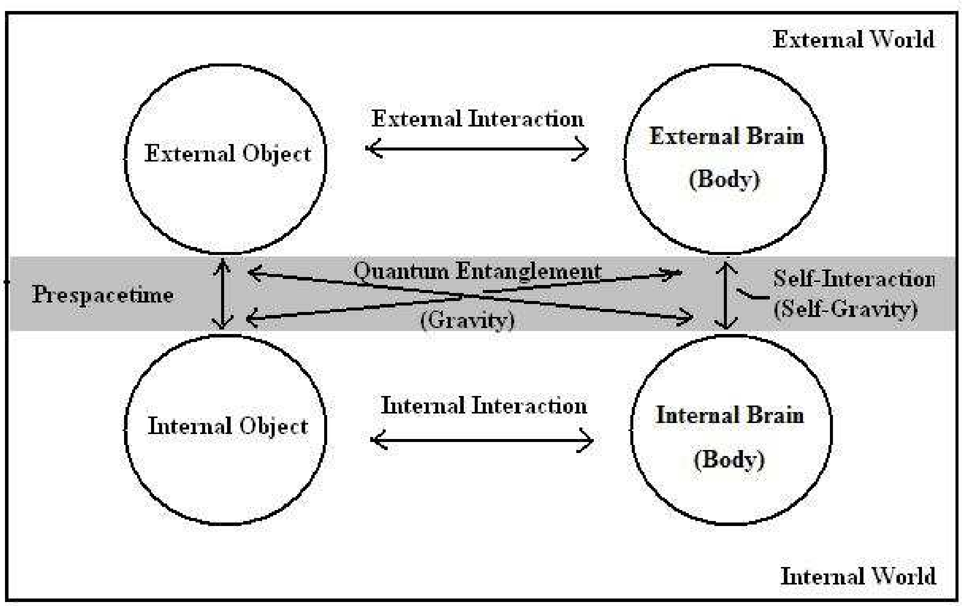

Figure 9.1 Interaction between an object and the brain (body) in the dual-world

As illustrated in Figure 9.1, there are two kinds of interactions between an object (entity) outside the brain (body) and the brain (body). The first and commonly known kind is the direct physical and/or chemical interactions such as sensory input through the eyes. The second and lesser-known but experimentally proven to be true kind is the instantaneous interactions through quantum entanglement. The entire world outside our brain (body) is associated with our brain (body) through quantum entanglement thus influencing and/or generating not only our feelings, emotions and dreams but also the physical, chemical and physiological states of our brain and body.

Importantly, quantum entanglement may participate in sensory experience such as vision, for example, as follows (keep in mind that an interaction with the external world is accompanied by its counterpart interaction with the internal world): (1) A light ray reflected and/or emitted from an object outside the brain enters the eye, gets absorbed, converted and amplified in the retina as propagating action potentials which travel to the central nervous system (CNS); (2) In the CNS, the action potentials drive and influence the mind pixels which according our theory is the nuclei such as protons with net nuclear spins and/or electrons with unpaired spins; and (3) Either the driven or influenced dynamic patterns of the mind-pixels in the internal world form the experience of the object, or more likely our visual experience of the object is the direct experience of the object in the external world through quantum entanglement established by the physical interactions. In the latter case, there is no image of the outside world in the brain. Further, in the case in which the object outside the brain is an image such as a photograph, there also exists the possibility that our visual experience is not only the experience of the photograph as such through quantum entanglement but also the experience of the object within the photograph through additional quantum entanglement. We hope that through careful experiments, we can find out which mechanism is actually true or whether both are true in reality.

The action potentials in the retina, the neural pathways and the CNS are driven by voltage-gated ion channels on neural membranes as embodied by the Hodgkin-Huxley model:

$$\partial_t V_m = -\frac{1}{C_m}\left(\sum_i (V_m - E_i) g_i\right) \tag{9.1}$$

where V_m is the electric potential across the neural membranes, C_m is the capacitance of the membranes, g_i is the *i*th voltage-gated or constant-leak ion channel (also see, Hu & Wu, 2004c & 2004d). The overall effect of the action potentials and other surrounding factors, especially the magnetic dipoles carried by oxygen molecules due to their two unpaired electrons, is that inside the neural membranes and proteins, there exist varying strong electric field **E** and fluctuating magnetic field **B** that are also governed by the Maxwell equation:

$$\begin{pmatrix} E & -\boldsymbol{\sigma}\cdot\mathbf{p} \\ -\boldsymbol{\sigma}\cdot\mathbf{p} & E \end{pmatrix}\begin{pmatrix} \boldsymbol{\sigma}\cdot\mathbf{E} \\ i\boldsymbol{\sigma}\cdot\mathbf{B} \end{pmatrix} = 0 \quad \text{or} \quad \begin{pmatrix} \partial_t\mathbf{E} = \nabla\times\mathbf{B} \\ \partial_t\mathbf{B} = -\nabla\times\mathbf{E} \\ \nabla\cdot\mathbf{E} = 0 \\ \nabla\cdot\mathbf{B} = 0 \end{pmatrix} \tag{9.3}$$

where we have set the classical (macroscopic) electric density and current $j^\mu = (\rho, \mathbf{j}) = 0$ inside the neural membranes. Further, for simplicity, we have not considered the medium effect of the membranes, that is, we have treated the membranes as a vacuum.

Microscopically, electromagnetic fields **E** and **B** or their electromagnetic potential representation $A^\mu = (\phi, \mathbf{A})$:

$$\begin{pmatrix} \mathbf{E} = -\nabla\phi - \partial_t\mathbf{A} \\ \mathbf{B} = \nabla\times\mathbf{A} \end{pmatrix} \tag{9.4}$$

interact with proton of charge *e* and unpaired electron of charge –*e* respectively as the following Dirac-Maxwell systems:

$$\left(\begin{pmatrix} E-e\phi-m & -\boldsymbol{\sigma}\cdot(\mathbf{p}-e\mathbf{A}) \\ -\boldsymbol{\sigma}\cdot(\mathbf{p}-e\mathbf{A}) & E-e\phi+m \end{pmatrix}\begin{pmatrix} \psi_{e,-} \\ \psi_{i,+} \end{pmatrix} = L_M\psi = 0\right)_p \tag{9.5}$$

$$\begin{pmatrix} E & -\boldsymbol{\sigma}\cdot\mathbf{p} \\ -\boldsymbol{\sigma}\cdot\mathbf{p} & E \end{pmatrix}\begin{pmatrix} \boldsymbol{\sigma}\cdot\mathbf{E} \\ i\boldsymbol{\sigma}\cdot\mathbf{B} \end{pmatrix} = \begin{pmatrix} -i\boldsymbol{\sigma}\cdot(\psi^\dagger\beta\boldsymbol{\alpha}\psi) \\ -i(\psi^\dagger\beta\beta\psi) \end{pmatrix}_p \tag{9.6}$$

and

$$\left(\begin{pmatrix} E+e\phi-m & -\boldsymbol{\sigma}\cdot(\mathbf{p}+e\mathbf{A}) \\ -\boldsymbol{\sigma}\cdot(\mathbf{p}+e\mathbf{A}) & E+e\phi+m \end{pmatrix}\begin{pmatrix} \psi_{e,+} \\ \psi_{i,-} \end{pmatrix} = L_M\,\psi = 0\right)_e \tag{9.7}$$

$$\begin{pmatrix} E & -\boldsymbol{\sigma}\cdot\mathbf{p} \\ -\boldsymbol{\sigma}\cdot\mathbf{p} & E \end{pmatrix}\begin{pmatrix} \boldsymbol{\sigma}\cdot\mathbf{E} \\ i\boldsymbol{\sigma}\cdot\mathbf{B} \end{pmatrix} = \begin{pmatrix} -i\boldsymbol{\sigma}\cdot(\psi^\dagger\beta\boldsymbol{\alpha}\psi) \\ -i(\psi^\dagger\beta\beta\psi) \end{pmatrix}_e \tag{9.8}$$

where β and $\boldsymbol{\alpha}$ are Dirac matrices.

In equations (9.5) and (9.7), the interactions (couplings) of **E** and/or **B** with proton and/or electron spin operator $(\boldsymbol{\sigma})_p$ and $(\boldsymbol{\sigma})_e$ are hidden. But they are due to the self-referential Matrix Law which causes mixing of the external and internal wave functions and can be made explicit in the determinant view as follows. For Dirac form, we have:

$$\left(\begin{pmatrix} E-e\phi-m & -\boldsymbol{\sigma}\cdot(\mathbf{p}-e\mathbf{A}) \\ -\boldsymbol{\sigma}\cdot(\mathbf{p}-e\mathbf{A}) & E-e\phi+m \end{pmatrix}\begin{pmatrix} \psi_{e,-} \\ \psi_{i,+} \end{pmatrix} = L_M\psi = 0\right)_p \tag{9.9}$$

$$\rightarrow\left(\begin{pmatrix}(E-e\phi-m)(E-e\phi+m)-\\ (-\boldsymbol{\sigma}\cdot(\mathbf{p}-e\mathbf{A}))(-\boldsymbol{\sigma}\cdot(\mathbf{p}-e\mathbf{A}))\end{pmatrix} I_2\psi_{e,-}\psi^*_{i,+}=0\right)_p$$

$$\rightarrow\left(\left((E-e\phi)^2-m^2-(\mathbf{p}-e\mathbf{A})^2+e\boldsymbol{\sigma}\cdot\mathbf{B}\right)I_2\psi_{e,-}\psi^*_{i,+}=0\right)_p$$

For Weyl (chiral) form, we have:

$$\left(\begin{pmatrix}E-e\phi-\boldsymbol{\sigma}\cdot(\mathbf{p}-e\mathbf{A}) & -m\\ -m & E-e\phi+\boldsymbol{\sigma}\cdot(\mathbf{p}-e\mathbf{A})\end{pmatrix}\begin{pmatrix}\psi_{e,r}\\ \psi_{i,l}\end{pmatrix}=0\right)_p \qquad (9.10)$$

$$\rightarrow\left(\left((E-e\phi-\boldsymbol{\sigma}\cdot(\mathbf{p}-e\mathbf{A}))(E-e\phi+\boldsymbol{\sigma}\cdot(\mathbf{p}-e\mathbf{A}))-m^2\right)I_2\psi_{e,r}\psi^*_{i,l}=0\right)_p$$

$$\rightarrow\left(\left((E-e\phi)^2-m^2-(\mathbf{p}-e\mathbf{A})^2+e\boldsymbol{\sigma}\cdot\mathbf{B}\text{-}ie\boldsymbol{\sigma}\cdot\mathbf{E}\right)I_2\psi_{e,r}\psi^*_{i,l}=0\right)_p$$

These two couplings are also explicitly shown in Dirac-Hestenes formulism or during the process of non-relativistic approximation of the Dirac equation in the present of external electromagnetic potential A^{μ}. We can carry out the same procedures for an electron to show the explicit couplings of $(\boldsymbol{\sigma})_e$ with **E** and **B**.

One effect of the couplings is that the action potentials through **E** and **B** (or A^{μ}) input information into the mind-pixels in the brain (Hu & Wu, 2004c, 2004d & 2008a). Judging from the above Dirac-Maxwell systems, we are inclined to think that said information is likely carried in the temporal and spatial variations of **E** and **B** (frequencies and timing of neural electric spikes and their spatial distributions in the CNS). Another possible effect of the couplings is that they allow the transcendental aspect of consciousness through wave functions (the self fields) of the proton and/or electron to back-influence **E** and **B** (or A^{μ}) which in turn back-affect the action potentials through the Hodgkin-Huxley neural circuits in the CNS (also see, Hu & Wu, 2007d & 2008a).

We will carry out detailed studies of the above sketched possible mechanisms elsewhere. Here we will speculate a bit about how human free-will as a macroscopic quality of limited transcendental consciousness may originate microscopically under the particular high electric voltage environment inside the neural membranes. For example, one possibility is that the human free will as thought or imagination produces changes in the phase of external and internal wave functions:

$$e^{i0}=e^{-i(\Delta Et-\Delta\mathbf{p}\cdot\mathbf{x})+i(\Delta Et-\Delta\mathbf{p}\cdot\mathbf{x})}=\left(e^{-i(\Delta Et-\Delta\mathbf{p}\cdot\mathbf{x})}\right)_e\left(e^{+i(\Delta Et-\Delta\mathbf{p}\cdot\mathbf{x})}\right)_i \qquad (9.13)$$

where $(\,)_e$ and $(\,)_i$ respectively indicate external and internal wave functions, which in turn back-affect **E** and **B** (or A^{μ}) in the high electric voltage neural membranes through the Dirac Maxwell systems illustrated above.

10. APPLICATIONS, PREDICTIONS, QUESTIONS & ANSWERS

As we mentioned earlier, the major breakthrough in this work came in part as we struggled to find answers to fundamental questions posed by our own experimental results (Hu & Wu, 2006b, 2006c, 2006d & 2007a). One of such questions was: How was it possible for a person located in one place to feel the effect of an anesthetic applied to quantum-entangled water sample located at another location without having actually inhaled or ingested said anesthetic? The simplest answer is that our consciousness is not located within spacetime but within prespacetime or is simply prespacetime itself as we have theorized ourselves earlier but might be reluctant to accept without experimental proof (Hu & Wu, 2003, 2004b & 2006a; also see Hu, 2009).

Another key question was: How was it possible for the temperature of a water sample located at one place to increase or decrease against the temperature of its local environment as the quantum-entangled water sample at a different location is manipulated? One answer is that the energies in the two samples can exchange nonlocally. This is permitted within the principle formulated in this work. Yet, another answer is that the external energy and internal energy of the water sample being measured can be created or annihilated locally under the influence of the remote manipulation through quantum entanglement as illustrated in expression (9.13) and (5.11) respectively. This latter answer is also permitted within the principle formulated in this work. Further, it is possible that both these mechanisms are at play. Only further experiments will tell.

Yet a third key question was: How was it possible for the weight of a water sample located at one place to increase or decrease against the gravity of earth at that location as the quantum-entangled water sample at another location is manipulated? One answer is that the weight of the sample being measured can change due to spaceless quantum entanglement with the sample being manipulated as formulated in this work. Further, timeless quantum entanglement as formulated in this work may also play a role in the weight change in the sample being measured.

Indeed, many other applications and predictions can be drawn and they will be considered elsewhere if and when time permits. For now we will list some fundamental questions about existence, life and consciousness and give our answers (some are tentative) to them in the context of the principle of existence illustrated in this work. We hope that these questions and answers will also serve as a response to many anticipated questions related to this work. Finally, we will make some predictions and point out some applications also in the form of the questions and answers below.

Questions & Answers

1. What is the foundation of the Universe? The foundation is prespacetime which is omnipotent, omniscient and omnipresent.

2. Was there something before the Universe was born (if there was a birth)? Yes, prespacetime alone ($1=e^0$) without differentiation or dualization. So, it may be said that $1=\mathbf{e}^0=\mathbf{e}^{\mathbf{i}M-\mathbf{i}M}=\mathbf{e}^{\mathbf{i}M}\mathbf{e}^{-\mathbf{i}M}=\mathbf{e}^{-\mathbf{i}M}/\,\mathbf{e}^{-\mathbf{i}M} = \mathbf{e}^{\mathbf{i}M}/\,\mathbf{e}^{\mathbf{i}M}$…is the primordial particle.

3. How does prespacetime create, sustain and cause evolution of the Universe and all entities in it? Prespacetime does these things by hierarchical self-referential spin of itself at its free will.

4. Why is there materially something instead of nothing? Prespacetime is restless and tends to create, sustain and make evolutions of different entities.

5. How does prespacetime govern the Universe? Prespacetime governs through metamorphous self-referential Matrix Law.

6. What is matter? Matter is a dualized entity (created through hierarchical self-referential spin of prespacetime) comprised of an external wave function (external object) having positive mass/energy by convention and an internal wave function (internal object) having negative mass/energy by convention.

7. What is antimatter? Antimatter is a dualized entity (created through hierarchical self-referential spin of prespacetime) comprised of an external wave function (external object) having negative mass/energy by convention and an internal wave function (internal object) having positive mass/energy by convention.

8. Is energy conserved in the dual-world? Yes, energy is conserved to zero according to the accounting principle of zero.

9. Is energy conserved in the external (internal) world alone? The answer depends on the context. In most natural processes, external (internal) energy is conserved and transformed into different forms without loss due to cancellation between the external and internal worlds. However, in some processes, especially those involving human consciousness and/or intention (free will), energy conservation in the external (internal) world may be slightly violated so that the free will may function. We emphasize here that experimentation is the key to getting scientific answers for these types of questions. Also, violation of energy conservation in the external (internal) world may occur in certain cosmic processes (e.g., in the Sun) or in certain weak interactions as will be considered elsewhere.

10. What is quantum entanglement? It is the interaction and/or connections between the external and internal wave functions (objects) of a single dualized entity or among different dualized entities through prespacetime which is outside spacetime.

11. What is self-interaction, self-gravity or self-quantum entanglement? Self-interaction is the interaction between the external and internal wave functions (objects) according to the prespacetime equation governed by the self-referential Matrix Law.

12. What is strong force? It is likely downward self-reference through imaginary momentum. It is strong gravity (strong quantum entanglement).

13. What is weak force? It is fermionic spinization and unspinization of spinless entities with or without bosonic intermediary spinization.

14. What is electromagnetic force? It is bosonic spinization and unspinization of massless and spinless entity.

15. What is gravity? It is quantum entanglement across the dual world which includes self-gravity or self-quantum-entanglement between the external and internal wave functions (objects) of a single dualized entity and gravity or quantum entanglement among different entities.

16. What is Newtonian Gravity? It is instantaneous action at large distance caused by timeless quantum entanglement.

17. What is dark matter? Our tentative answer is that it is a nonlocal effect caused by spaceless quantum entanglement.

18. What is dark energy? Our tentative answer is that it is a nonlocal effect caused by quantum entanglement associated with fermionic and/or bosonic spinization.

19. What is a black hole, white hole or white-black hole? It is likely that the black hole in the sense of General Relativity is a mathematical artifact since it seems that general relativity does not take the internal world or the negation of external world into consideration. Therefore, it is likely that black holes only *appear* to exist. The internal wave function (object) appears to the external wave function (object) as a black hole, *visa versa*. The external wave function (object) alone appears to be a white hole, so an entity comprised of the external and internal wave functions (objects) appear to be a white-black hole depending on one's perspective.

20. What is the origin of the Casimir Effect? The Casimir effect is or has contribution from spaceless quantum entanglement due to energy/mass exchange between two entities.

21. What is the origin of the quantum effect? The origin is primordial hierarchical self-referential spin of prespacetime.

22. Does Higgs Boson exist? No, it is likely a mathematical artifact due to the particular gauge-invariant Lagrangian formulation.

23. What is information? It is a distinction (either quantitative or qualitative) experienced or perceived by a particular consciousness.

24. What is quantum information? It is a distinction or a state of distinction (either quantitative or qualitative) experienced or perceived by a particular consciousness which is due to a quantum effect such as quantum entanglement.

25. What is the meaning of imaginary unit *i*? It is the most elementary self-referential process. As imagination in prespacetime, it makes phase distinction of an elementary entity and as an element in the Matrix Law it plays a crucial role in self-referential matrixing creation of prespacetime.

26. What is our view on Godel's Incompleteness Theorem? It is a reflection of the self-referential nature of mathematics.

27. What is our understanding of the measurement problem or how the classical world appears? The classical world appears as the result of hierarchical collapsing or focusing of the quantum reality through the free will of unlimited and/or limited transcendental aspect of prespacetime. By way of an example, a stone, mountain or earth appears to a human consciousness as classical object because the unlimited consciousness has already collapsed/focused it for the human consciousness. Therefore, on the macroscopic level, when we are not looking at the moon, the moon is still there and when we throw a stone at two holes, we will be able to observe both the hole the stone will pass through and the location where it will land. On the other hand, microscopically, when we are not measuring the position of an electron, it may be at the location we want to measure or may be not. That is, our limited free will have the choice of where and when to do the measurement but the answer we get appears to be random since the position the electron to be found is determined by the free will of prespacetime.

28. What is consciousness? Consciousness is the basis of quantum reality. It is prespacetime which is omnipotent, omniscient and omnipresent.

29. What is human consciousness? It is a limited or individualized consciousness associated with a particular human brain/body.

30. Does human consciousness reside in human brain? No, the human brain is the interface for human consciousness to experience and interact with the external world.

31. What are spirit, soul and/or mind? They are different aspects or properties of prespacetime which is transcendent, immanent and eternal.

32. What is the essence of The Special Theory of Relativity? The essence of The Special Theory of Relativity is that the speed limit *c* is applicable in interactions in each of the dual

worlds but not interactions across the dual worlds. Indeed, the reason that no external object can move faster than the speed of light and said object gets heavier and heavier as it approaches the speed of light is due to its increased quantum entanglement with the internal world through its counterpart the internal object.

33. What is our opinion on General Theory of Relativity? If the speed of gravitational interaction based on General Relativity is limited to the speed of light, General Relativity goes against experience/experiments and is thus ontologically invalid. Otherwise, it should be derivable from the properties of quantum entanglement. In any case, it may still be used or treated as an effective or approximate theory.

34. What is our view on the second law of thermodynamics? It is approximately valid but may be violated under some circumstances such as when human intention/consciousness or nonlocal processes such as those mediated by quantum entanglement are involved.

35. What is our opinion on the so-called hard problem of consciousness? This problem arises as a defect of the materialistic philosophy of consciousness which denies that consciousness (prespacetime) is the foundation of quantum reality and conscious experience is a feature of the dual-world which is the universe.

36. Where did we come from? Physically/biologically, we came from prespacetime as its creation. Spiritually, we are an inseparable part of prespacetime and our consciousness is limited and/or individualized version of unlimited consciousness.

37. Where are we going? Physically/biologically, we disintegrate or die unless we advance our science to the point where death of our biological body becomes a choice, not unavoidability. Also, we are of the opinion that advancement in science will eventually enable us to transfer or preserve our individual consciousness associated with our ailing or diseased bodies to another biological or artificial host. Spiritually, we may go back to prespacetime or reincarnate into a different form of individual consciousness that may be able to recall its past (but we are not yet sure about the latter point).

38. How does the mind influence the brain? Mind influences the brain through free will which acts on subjective entities (internal objects), which in turn affect objective entities (external objects) through the prespacetime Equation.

39. Do we believe in paranormal phenomena? They are likely real and explainable by quantum entanglement. But the effect is likely very small.

40. What is your opinion on homeopathy? It is likely a real effect and explainable by quantum entanglement. But the effect is very small and clinically maybe ineffective.

41. Do we believe in UFOs? Theoretically, they are plausible.

42. What is the origin of the uncertainty principle? The origin is self-referential spin or zitterbewegung.

43. What is the origin of quantum jump or wave collapse? The free will of prespacetime or unlimited transcendental consciousness in order to observe or experience the universe it created. Remember that our limited free will is part of the unlimted free will of prespacetime since we are part of prespacetime.

44. Is the total entropy of the universe conserved? Yes, it is conserved to zero in the dual world but is not conserved in each world alone.

45. What is your view of the Mach principle? It is our opinion that the Universe is a Machian quantum universe in which the total energy of the dual world is zero.

46. Is information conserved? It is our opinion that information is conserved to zero in the dual world since each distinction in the external world is accompanied by its negation in the internal world. However, information is not conserved in each world alone.

47. What is a graviton? There is no graviton in the sense of a quantum (particle) which mediated gravitational interaction at the speed of light. However, since gravity is quantum entanglement, the wave function of each entity may be treated as a graviton.

48. Does the repulsive gravitational force exist? Maybe - gravity between the electron and proton is possibly repulsive but it needs experimental verification.

49. Is there an absolute reference frame? Yes, it is simply Prespacetime (prespacetime).

11. CONCLUSION

As truth seekers, searching for truth and our origin is the ultimate treasure hunt. Many before us have been on this sacred journey. Some find it spiritually, some got close, some got lost, some gave up, some gave their lives in the process, and some went astray and hostile. Perhaps, scientifically we have gotten closer and/or even been actually there. As proof, we have brought back and reported in our previous papers and this work what we have found and believed to be a few pieces of this great treasure and a practical map for fellow truth seekers to analyze and use. The pieces we found and brought back are both experimental and theoretical. Experimentally, we have demonstrated that: (1) consciousness is associated with or simply is prespacetime and our brain is the vehicle for conscious experiences and operations (feedbacks); and (2) there exists an instantaneous transcendental force (quantum entanglement or gravity) beyond spacetime which makes omnipotence, omnipresence and omniscience of prespacetime possible and feasible. Theoretically, we have presented a detailed model of spin-mediated consciousness previously and, in this work, an ontological and mathematical model (Principle of Existence) centered on prespacetime which through multifaceted and hierarchical self-referential spin creates, sustains, experience and causes evolution of the Universe.

One of the key features of the principle of existence illustrated in this work is the development and use of hierarchical self-referential mathematics in order to accommodate both the transcendental and immanent qualities/properties of prespacetime. Needless to say, this potential new branch/direction of mathematics is in its infancy and we have not attempted to give a systematic presentation in this work. We hope that mathematicians will see the virtue in our work and, indeed, participate in the development of the new mathematics.

To recapitulate, we have in this work constructed a prespacetime model of elementary particles, four forces and consciousness which illustrates how the self-referential hierarchical spin structure of the prespacetime provides a foundation for creating, sustaining and causing evolution of elementary particles through matrixing processes embedded in said prespacetime. The prespacetime model reveals the creation, sustenance and evolution of fermions, bosons and spinless entities each comprised of an external wave function or external object and an internal wave function or internal object located respectively in an external world and an internal world of a dual-world universe. The prespacetime model provides a unified causal structure for weak interaction, strong interaction, electromagnetic interaction, gravitational interaction, quantum entanglement, consciousness and brain function. The prespacetime model provides a unique tool for teaching, demonstration, rendering, and experimentation related to subatomic and atomic structures and interactions, quantum entanglement generation, gravitational mechanisms in cosmology, structures and mechanisms of consciousness, and brain functions.

In the beginning there was prespacetime $\mathbf{e}^{\mathbf{h}}$ by itself $\mathbf{e}^{0}$ =1materially empty but restless. And it began to imagine through primordial self-referential spin $1=\mathbf{e}^{0}=\mathbf{e}^{\mathbf{i}M-\mathbf{i}M}=\mathbf{e}^{\mathbf{i}M}\mathbf{e}^{-\mathbf{i}M}=\mathbf{e}^{-\mathbf{i}M}/\mathbf{e}^{-\mathbf{i}M} = \mathbf{e}^{\mathbf{i}M}/\mathbf{e}^{\mathbf{i}M}$…such that it created the external object to be observed and internal object as observed, separated them into external world and internal world, caused them to interact through self-referential Matrix Law and thus gave birth to the Universe which it has since sustained and made to evolve.

In this Universe, prespacetime (ether), represented by Euler number **e**, is the ground of existence and can form external and internal wave functions as external and internal objects (each pair forms an elementary entity) and interaction fields between elementary entities which accompany the imaginations of the prespacetime. The prespacetime can be self-acted on by self-referential Matrix Law $\boldsymbol{L_M}$. The prespacetime has imagining power $\boldsymbol{i}$ to project external and internal objects by projecting, e.g., external and internal phase $\pm$M $=\pm(Et-\mathbf{p}\cdot\mathbf{x})/\hbar$ at the power level of prespacetime. The Universe so created is a dual-world comprising of the external world to be observed and internal world as observed under each relativistic frame $x^{\mu}=(t, \mathbf{x})$. In one perspective of prespacetime view, the internal world (which by convention has negative energy) is the negation/image of the external world (which by convention has positive energy). The absolute frame of reference is the prespacetime. Thus, if prespacetime stops imagining ($\mathbf{h}=\boldsymbol{i}0=0$), the Universe would disappear into materially nothingness $\mathbf{e}^{\boldsymbol{i}0}=\mathbf{e}^{0}=1$.

The accounting principle of the dual-world is conservation of zero. For example, the total energy of an external object and its counterpart, the internal object, is zero. Also in this dual-world, self-gravity is the nonlocal self-interaction (wave mixing) between an external object in the external world and its negation/image in the internal world, that is, the negation appears to its external counterpart as a black hole *visa versa*. Gravity is the nonlocal interaction (quantum entanglement) between an external object with the internal world as a whole. Some other most basic conclusions are: (1) the two spinors of the Dirac electron or positron are respectively the external and internal objects of the electron or positron; (2) the electric and magnetic fields of a linear photon are respectively the external and internal objects of a photon which are always self-entangled; (3) the proton is likely a spatially confined (hadronized) positron through imaginary momentum (downward self-reference); and (4) a neutron is likely comprised of an unspinized (spinless) proton and a bound and spinized electron. In this dual-world, prespacetime has both transcendental and immanent properties/qualities. The transcendental aspect of prespacetime is the origin of primordial self-referential spin (including the self-referential Matrix Law) and it projects the external and internal worlds through spin and, in turn, the immanent aspect of prespacetime observes the external world as the observed internal world through the said spin. Human consciousness is a limited and particular version of this dual-aspect prespacetime such that we have limited free will and limited observation which is mostly classical at macroscopic levels but quantum at microscopic levels.

We materially live in the external world but experience the external world through its negation, the internal world in the relativistic frame $x^{\mu}=(t, \mathbf{x})$ attached to each of our bodies. Interactions within the external world and the internal world are local interactions and conform to special theory of relativity. But interactions across the dual world are nonlocal interactions (quantum entanglement). Strong interaction is likely spatially confining nonlocal self-interaction and nonlocal interaction among spatially confined fermions (hadrons). Therefore, the meaning of the special theory of relativity is that the speed limit c is only applicable in each of the dual world but not interactions between the dual-world. Indeed, the reason that no external object can move faster than the speed of light and the same gets heavier and heavier as its speed approach the speed of light is due to its increased quantum entanglement with the internal world through its counterpart the internal object.

Dedication, Tribute & Acknowledgements:

We dedicate this work to prespacetime the light of which has shone on us and the truth of which we strive to reveal at its appointed time and place in this living Universe which is its making. We further dedicate this work to the Spiritual Giants such as Moses, Jesus, Muhammad, Buddha, the originator of Hinduism and the originator of Tao.

We honor and pay tribute to those who have, directly or indirectly but greatly, contributed towards the advancement and/or reconciliation of Science and Spirituality. They include but not limited to Pythagoras, Laozi, Socrates, Plato, Aristotle, Archimedes, Zhang Heng, Plotinus, Ibn al-Haytham, Ibn Arabi, Muhammad Rumi, Thomas Aquinas, Nicolaus Copernicus, Francis Bacon, Galileo Galilei, Giordano Bruno, Johannes Kepler, Isaac

Newton, Leonhard Euler, Dante_Alighieri, Leonardo da Vinci, Thomas Jefferson, Abraham Lincoln, Rene Decartes,Gottfried Leibniz, Baruch Spinoza,William Blake, James Clark Maxwell, Gustav Fechner, Ernst Mach, Alfred N. Whitehead, Gregor Mendel, Charles Darwin, Helena P. Blavatsky, Annie Besant, Walter Russell, Sri Aurobindo, William James, Max Planck, Albert Einstein, Arthur Eddington, Neil Bohr, Louis de Broglie, Erwin Schrodinger, Werner Heisenberg, Wolfgang Pauli, Paul Dirac, Hermann Weyl, David J. Bohm, John S. Bell, Thomas Edison, Nicola Tesla, Hua Luogeng, Nikolai A. Kozyrev, Carl Jung, Teilhard Chardin, Franklin Merrell-Wolff, John C. Lilly, Buckminster Fuller, Wilhelm Reich, Martin Luther King, Jr., Walt Disney, Alfred_Nobel, John Templeton, Francis Crick, Freeman Dyson, James Watson, David Hestenes, Paul Laffoley, Dick Richardson, Brian Josephson, Rubert Sheldrake and Edgar Mitchell. Some among them have greatly inspired and/or influenced our work.

We acknowledge here all of our teachers and schools from elementary to graduate and professional schools for our educations, training and the opportunities bestowed upon us by them. We especially thank the first author's Ph.D. advisor, Professor Harold M. Swartz, his M.Sc. advisor, Professor Rongliang Zheng, and Physics Professor Yishi Duan who originally directed him to the study of biophysics. We also acknowledge here a special friend of the first author, Fu Kung, who for four years during 1979-1983 assisted him with his needs of physics textbooks. In addition to the individuals mentioned above, we further acknowledge all other scholars, authors and writers whose original work in print publications or on the Internet may bear relevance to our own (See note below).

We thank our parents, children and other family members for their everlasting and unconditional love and support. We thank all the editors of journals and online archives who have either seen the virtues in our work or have been tolerant enough to let the same appear in their respective publications and/or online archives. Among them we thank especially the Chief Editor of NeuroQuantology, Dr. Sultan Tarlaci. We thank our past and current friends, colleagues, employees, clients and the institutions, firms and companies for which we worked and/or are still working for, especially Mount Sinai Medical Center & Worldco, LLC. Last but not least, we thank our Motherland, our Adopted Home, Mao Zedong and Deng Xiaoping which and whom in the large scheme of things have played important roles in shaping our lives and destinies.

Note: The first author mentions here the works of the following individuals (by no mean exhaustive) for they either bore relevance or lead him to other scholars' work. Alain Aspect, Jose B. Almeida, Harold Aspden, John C. Baez, Imants Baruss, Asim O. Barut, Jacques Benveniste, James R. Bogan, Istvan Bokkon, Carl Brannen, Ronald Bryan, Robert N. Boyd, Reginald T. Cahill, David Chalmers, Geoffrey Chew, Elio Conte, Paulo N. Correa, Alexandra N. Correa, Brenda J. Dunne, Richard Feynman, Anthony Freeman, Peter Gariev, D.L. Van Gent, Tepper L Gill, Nicolas Gisin, Tobius Gleim, Danielle Graham, de Haas, Stuart Hameroff, Steven Harnad, Basil J. Hiley, Douglas Hofstadter, Gerard 't Hooft, Robert G. Jahn, Gerald Kaiser, Alex Kaivarainen, Louis H. Kauffman, Jaime Keller, Robert M. Kiehn, Y.S. Kim, Alexey A. Kryukov, Alexander G. Kyriakos, Steven Lehar, Leon Maurer, Thomas J. McFarlane, Burinskii Makhlin, Arnold Mindell, Ezra ((Ted) Newman, Guang-jiong Ni, Oleg A. Olkhov, John Paily, Roger Penrose, Michael Persinger, Mitja Perus, N. Vivian Pope, Harold Puthoff, Dmitri Rabounski, Dean Radin, Diego L. Rapoport, Elizabeth A. Rauscher, Steven M. Rosen, Peter Rowlands, Peter Russell, Yuri Rylov, Giovanni Salesi, Ruggero M. Santilli, Mednel Sachs, Jack Sarfatti, Alexander A.

Shpilman, B. J. Sidharth, Florentin Smarandache, Frank D. (Tony) Smith, Lee Smolin, Dan Solomon, Jr., Henry Stapp, Victor Stenger, Tuomo Suntola, Doug Sweetser, Sultan Tarlaci, William Tiller, Jacek Turski, Cornelio G. Valdenebro, Max Velmans, John A. Wheeler, Fed A. Wolf, Milo Wolff, Arthur M. Young, J. C. Yoon, Dainis Zeps. However, this note should not be construed as an endorsement of the views and/or results in some of these works nor should it be construed as an indication that all these works contain original and/or valid results. In addition, the first author has also made acquaintances with spiritual individuals among whom are Amar[xx]eth, Ala[x] O[x]iver, Pei[x]i T[x]ng, to mention a few.

[SELF-]REFERENCE

Hu, H. & Wu, M. Mechanism of anesthetic action: oxygen pathway perturbation hypothesis. Med. Hypotheses 2001a: 57: 619-627. Also see arXiv 2001b; physics/0101083.

Hu, H. & Wu, M. Spin-mediated Prespacetime theory. arXiv 2002; quant-ph/0208068. Also see Med. Hypotheses 2004a: 63: 633-646.

Hu, H. & Wu, M. Spin as primordial self-referential process driving quantum mechanics, spacetime dynamics and Prespacetime. NeuroQuantology 2004b; 2:41-49. Also see Cogprints: ID2827 2003.

Hu, H. & Wu, M. Action potential modulation of neural spin networks suggests possible role of spin in memory and Prespacetime. NeuroQuantology 2004c; 2:309-316. Also see Cogprints: ID3458 2004d.

Hu, H. & Wu, M. Thinking outside the box: the essence and implications of quantum entanglement. NeuroQuantology 2006a; 4: 5-16.

Hu, H. & Wu, M. Photon induced non-local effect of general anesthetics on the brain. NeuroQuantology 2006b 4: 17-31. Also see Progress in Physics 2006c; v3: 20-26.

Hu, H. & Wu, M. Evidence of non-local physical, chemical and biological effects supports quantum brain. NeuroQuantology 2006d; 4: 291-306. Also see Progress in Physics 2007a; v2: 17-24.

Hu, H. & Wu, M. Thinking outside the box II: the origin, implications and applications of gravity and its role in Prespacetime. NeuroQuantology 2007b; 5: 190-196.

Hu, H. & Wu, M. On dark chemistry: what's dark matter and how mind influences brain through proactive spin. NeuroQuantology 2007c; 5: 205-213.

Hu, H. & Wu, M. Concerning spin as mind-pixel: how mind interacts with the brain through electric spin effects. NeuroQuantology 2008a; 6: 26-31.

Hu, H. The state of science, religion and Prespacetime. NeuroQuantology 2008b; 6: 323-332.

Hu, H. Quantum enigma - physics encounters Prespacetime (book review). Psyche 2009; 15: 1-4.