Original Article

Towards a Theory of Everything Part II

Introduction of Consciousness in Schrödinger Equation and Standard Model

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Abstract

Theory of everything must include consciousness. **In Part I** of this series of 3 articles, the subjective experience (SE) aspect of consciousness was introduced in classical physics by examining the invariance of various components of theories under PE-SE transformations, where PEs (proto-experiences) are precursors of SEs. We found that (i) classical physics is invariant under the PE-SE transformation, (ii) potential SEs are embedded in space-time geometry for the structure of space-time in superposed form, (iii) potential SEs can move with spatiotemporal coordinates of matter for matter field because both mental and material aspects are always together in the dual-aspect-dual-mode *optimal* PE-SE framework, and (iv) our specific SE is the result of matching and selection processes and can change with space and time. For example, experiencing *redness* has neural correlates of V4/V8/VO-red-green neural-net with *redness* state. When a subject moves, the specific SE *redness* also moves with the subject's correlated neural-net. **In the current Part II**, the SE aspect of consciousness is introduced in orthodox quantum physics by examining its invariance under the PE-SE transformations. We found that the followings are invariant under the PE-SE transformations: Schrödinger equation, current, Dirac Lagrangian, the Lagrangian for a charged self-interacting scalar field, and Standard Model (the Lagrangian for free gauge field and Lagrangian for the electromagnetic interaction of a charged scalar field). **In Part III** the SE aspect of consciousness will be introduced to unify it with fundamental forces in loop quantum gravity and string theory of modern quantum physics. All parts together lead us towards the theory of everything.

Key Words: **t**heory of everything, proto-experiences, subjective experiences, PE-SE transformations, superposition, orthodox quantum physics, Schrödinger equation, self–interacting scalar field, Standard Model, Higgs Mechanism, fundamental forces

NeuroQuantology 2010; 3: 304-313

1. Introduction

Theory of everything (TOE) must include consciousness in addition to the unification of gravitational, electromagnetic, weak, and strong forces. For this purpose, our development has 3 parts: the introduction of subjective experiences (SEs) and/or proto-

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experiences (PEs) aspect of consciousness in classical physics (**Part I**), orthodox quantum physics (**Part II**), and modern quantum physics (loop quantum gravity (LQG) and string theory) (**Part III**).

Abbreviations and symbols list

EM: electromagnetic
$g_{\mu\nu}$: metric tensor
H_1 : *superposition* based hypothesis
H_2: *superposition-then-integration* based hypothesis
H_3 : *integration* based hypothesis
I : stimulus intensity
Λ : the cosmological constant
LQG : loop quantum gravity (LQG)
PE(s) : proto-experience(s)
$R_{\mu\nu}$: Ricci curvature tensor
R : Ricci scalar curvature
SE(s) : subjective experience(s)
$T_{\mu\nu}$: the stress-energy tensor
TOE : Theory of Everything
V4 : visual area 4
V8 : visual area 8
VO : ventral-occipital cortex

In Part I (Vimal, 2010c) of this series of three articles, the SE aspect of consciousness was introduced in classical physics. The methodology was to examine the invariance of critical components of theories under PE-SE transformations. PEs are precursors of SEs.[2] In classical physics, the invariant entities under the PE-SE transformations are: electromagnetic strength tensor, electromagnetic stress-energy tensor, the electromagnetic theory (Maxwell's equations), Newtonian gravitational field, special theory of relativity and Lorentz transformation, geodesic equation, general theory of relativity: Ricci curvature tensor $R_{\mu\nu}$, Ricci scalar curvature R, the stress-energy tensor $T_{\mu\nu}$, and the metric tensor $g_{\mu\nu}$ (generalization of the gravitational field). From this development, we concluded that (i) potential SEs are embedded in space-time geometry for the structure of space-time in superposed form, (ii) potential SEs can move with spatiotemporal coordinates of matter for matter field because, for example in H_1, they are superposed in the mental aspect of matter since both mental and material aspects are always together in a dual-aspect view, and (iii) our specific SE is the result of matching and selection processes and can change with space and time. For example, the neural correlates of experiencing *redness* is the V4/V8/VO-red-green neural-net with redness state. When a subject moves, the specific SE *redness* also moves with the subject's correlated neural-net. These finding are consistent with the dual-aspect-dual-mode *optimal* PE-SE framework (Vimal, 2008a; Vimal, 2008b; Vimal, 2009a; Vimal, 2009b; Vimal, 2009c; Vimal, 2009d; Vimal, 2009e; Vimal, 2010a; Vimal, 2010b). It is argued that since this *optimal* framework (that has the least number of problems) is valid at all three levels (classical, quantum, and subquantum physics), the introduction of consciousness in classical, quantum, and subquantum physics is also valid.

In the current Part II, our goal is to introduce the SE aspect of consciousness in orthodox quantum physics using the same methodology of examining invariance of theories under PE-SE transformations which also include that used in Part I (Vimal, 2010c). We find that the followings are invariant under the PE-SE transformations: Schrödinger equation, current, Dirac Lagrangian, the Lagrangian for a charged self–interacting scalar field, and Standard Model (the Lagrangian for free gauge field and Lagrangian for the electromagnetic interaction of a charged scalar field (Higgs Mechanism)) using orthodox quantum physics.

[2] According to (Vimal, 2010b), "Under hypothesis H_1, PEs are precursors of SEs in the sense that PEs are superposed [potential] SEs in unexpressed form in the mental aspect of every entity from which a specific SE is selected [via matching and selection process in brain-environment system]. Under hypotheses H_2 and H_3, PEs are precursors of SEs in the sense that SEs somehow arise or emerge from PEs".

In Part III (Vimal, 2010d), the SE aspect of consciousness will be introduced in modern quantum physics that includes loop quantum gravity (LQG) and string theory of quantum physics using the same methodology of examining their invariance. It will be shown that LQG and string theory are also invariant under the PE-SE transformations. We conclude that all parts together lead us towards the theory of everything.

2. Introducing Consciousness in Orthodox Quantum Physics

In this article, we focus on introducing the SE aspect of consciousness in orthodox quantum physics as discussed in Section 1 for Part II.

2.1. *The relevant PE-SE transformations*

"According to psychophysics, SE has logarithmic relationship with stimulus intensity (I): brightness or luminance is proportional to log(I), i.e. I is proportional to the exponential of (brightness or luminance). According to hypothesis $\mathbf{H_1}$ (or $\mathbf{H_2}$), the multiple possible [or potential] subjective experiences (or proto-experiences for $\mathbf{H_2}$) are superposed in the mental aspects of strings or elementary particles. This is represented by

$\mathcal{E}(\sigma,\tau) = [\sum_k \beta_k f(\varepsilon_k(\sigma,\tau))]$, where ε_k is k^th^ SE for hypothesis H_1: superposition is necessary **(1a)**

$\mathcal{E}(\sigma,\tau) = [\sum_k \beta_k f(\varepsilon_k(\sigma,\tau))]$, where ε_k is k^th^ PE (not SE) for $\mathbf{H_2}$: superposition is necessary **(1b)**

$\mathcal{E}(\sigma,\tau) = \beta f(\varepsilon(\sigma,\tau))$, where ε is PE (not SE) for hypothesis $\mathbf{H_3}$: no superposition **(1c)**

where $\mathcal{E}(\sigma,\tau)$ represents the superposition of [potential] SEs/PEs $\varepsilon_k(\sigma,\tau)$ in the mental aspect of an entity (such as boson, fermion, string, field, potential, etc); τ is time-like parameter for the entity, such as time t; σ is space-like parameter for the entity, such as x, y, z; $f(\varepsilon_k(\sigma,\tau))$ is a function of SE/PE ε_k, which could simply be equal to $\varepsilon_k(\sigma,\tau)$. β_k is the superposition-coefficient, where the subscript k represents k^{th} experience; k=1 to N_{SE}; N_{SE} is the maximum number of experiences, which is very large; therefore, specificity is zero. The square of the coefficient $[\beta_k]^2$ for the mental aspect is the probability (index of possibility) of the k^{th} experience. For hypothesis $\mathbf{H_3}$, k=1, i.e., there is one PE in the mental aspect of each entity; there is no superposition, rather a micro or macro entity has its PE in its mental aspect; hypothesis $\mathbf{H_3}$ is the dual-aspect quantum panpsychism. The parameters (σ,τ) are precisely the same for both material and mental aspect, which are like two sides of the same coin in the dual-aspect view; in other words, $\mathcal{E}(\sigma,\tau)$ or $\varepsilon_k(\sigma,\tau)$ are attached to corresponding entity and hence they are exactly the same as that of the entity; if entity moves, then $\mathcal{E}(\sigma,\tau)$ or $\varepsilon_k(\sigma,\tau)$ moves with it and is never separated from each other" (Vimal, 2010c).

The relevant PE-SE transformations for this article are as follows:

Scalar potential in quantum physics can be transformed as:

$$\phi \to \phi' = (\phi - \hbar \partial_t \mathcal{E}) \quad \textbf{(2a)}$$

where $\hbar$ is reduced Planck constant.

Vector potential:

$$A \to A' = A + \nabla \mathcal{E} \quad \textbf{(2b)}$$

Vector potential can also be written as:

$$A_\mu \to A'_\mu = A_\mu - (1/e)\partial_\mu \mathcal{E} \quad \textbf{(2c)}$$

where e is a charge and μ = 0, 1, 2, 3.

The PE-SE transformation for a wavefunction ψ associated with the mental aspect of matter field related to a particle in an electromagnetic field is as follows:

Wavefunction

$$\psi \to \psi' = e^{j\mathcal{E}} \psi \quad \text{for (2a)-(2b)} \qquad \textbf{(2d)}$$

where j represents the mental aspect and q is a charge.

Wave function can also be transformed as,

$$\psi \to \psi' = e^{j\mathcal{E}} \psi \quad \text{for (2c, 2f-2h)} \qquad \textbf{(2e)}$$

Differential operator

$$\partial_\mu \to D_\mu = \partial_\mu - iq\partial_\mu \mathrm{E} \qquad \textbf{(2f)}$$

Bosonic field

$$\mathrm{B}_\mu \to \mathrm{B}'_\mu = \mathrm{B}_\mu - (1/g)\partial_\mu \mathrm{E} \qquad \textbf{(2g)}$$

where g is a gauge coupling constant.

W-bosonic field

$$\mathrm{W}^i_\mu \to \mathrm{W}'^i_\mu = \mathrm{W}^i_\mu - (1/g)\partial_\mu \mathrm{E} + \epsilon^{ijk}\mathrm{E}^j \mathrm{W}^k_\mu \qquad \textbf{(2h)}$$

where ϵ^{ijk} are the structure constants of SU(2).

2.2. *Schrödinger equation*

The Schrödinger equation describes how the quantum state (that could have material and mental aspect) of a physical system changes in time. The quantum state, also called a wave function or state vector, is the most complete description that can be given to a physical system. Solutions to Schrödinger equation describe not only atomic and subatomic systems, electrons and atoms, but also macroscopic systems, possibly even the whole universe. Therefore, we would like to examine if this equation is invariant under the PE-SE transformation.

For a general quantum system, the Schrödinger equation is:

$$\hat{H}\psi(\sigma,\tau) = i\hbar\partial_t\psi(\sigma,\tau) \qquad \textbf{(3)}$$

where i is the imaginary unit, $\psi(\sigma,\tau)$ is the wave function (which is the probability amplitude for different configurations of the system), and $\hat{H}$ is the Hamiltonian operator.

For a particle in an electromagnetic field,

$$\hat{H} = [(\hbar^2/2m)(-i\nabla - qA)^2 + q\phi] \qquad \textbf{(4)}$$

and the related Schrödinger equation (Section 1.2.1 and Eq. (1.11) of (Novaes, 2000)) is:

$$[(\hbar^2/2m)(-i\nabla - qA)^2 + q\phi]\psi(\sigma,\tau) = i\hbar\partial_t\psi(\sigma,\tau) \quad \textbf{(5)}$$

Where electric and magnetic fields can be described in terms of the potentials $A_\mu = (\phi, A)$ as:

$$E = -\nabla\phi - \partial_t A \qquad \textbf{(6a)}$$

$$\mathrm{B} = \nabla \times A \qquad \textbf{(6b)}$$

These fields remain exactly the same when we make the PE-SE transformations (2a, 2b) in the potentials (in analogy to gauge transformation as in Eq. (1.10) of (Novaes, 2000)):

$$\phi \to \phi' = (\phi - \hbar\partial_t\mathcal{E}) \text{ and} \qquad \textbf{(7a)}$$

$$A \to A' = A + \nabla\mathcal{E} \qquad \textbf{(7b)}$$

Eq. (5) can be written in a compact form as

$$(1/2m)(-i\mathrm{D})^2\psi = iD_0\psi \qquad \textbf{(8)}$$

where

$$D = \hbar(\nabla - iqA) \quad \text{and} \qquad (9a)$$

$$D_o = \hbar\partial_t + iq\phi \qquad (9b)$$

$$(-iD)^2\psi = -\hbar(\nabla - iqA)\hbar(\nabla - iqA)\psi \qquad (10a)$$

$$= -\hbar^2[(\nabla - iqA)(\nabla\psi - iqA\psi)] \qquad (10b)$$

$$= -\hbar^2[(\nabla(\nabla\psi - iqA\psi) - iqA(\nabla\psi - iqA\psi)] \qquad (10c)$$

$$= -\hbar^2[\nabla^2\psi - iq(\nabla A)\psi - iqA\nabla\psi - iqA\nabla\psi - (qA)^2\psi] \qquad (10d)$$

$$= -\hbar^2[\nabla^2\psi - iq(\nabla A)\psi - i2qA\nabla\psi - (qA)^2\psi] \qquad (10e)$$

If we make the PE-SE transformation, $(\phi, A) \to (\phi', A')$ in (8) and (9a,b), we need to investigate if the new field ψ' describes the same physics, where ψ' is solution of the Schrödinger equation

$$(1/2m)(-iD')^2\psi' = iD_o'\psi' \qquad (11)$$

where

$$D' = \hbar(\nabla - iqA') \quad \text{and} \qquad (12a)$$

$$D_o' = \hbar\partial_t + iq\phi' \qquad (12b)$$

The relevant PE-SE transformation in the mental aspect of matter field can be re-written from Eq. (2d) as,

$$\psi \to \psi' = e^{jq\mathcal{E}}\psi \qquad (13)$$

The derivative of ψ' transforms as,

$$D'\psi' = \hbar(\nabla - iqA')\psi' \qquad (14a)$$

$$= \hbar(\nabla - iqA - iq\nabla\mathcal{E})e^{jq\mathcal{E}}\psi \qquad (14b)$$

$$= \hbar e^{jq\mathcal{E}}[jq\psi\nabla\mathcal{E} + \nabla\psi - iqA\psi - iq\psi\nabla\mathcal{E}] \qquad (14c)$$

$$= \hbar e^{jq\mathcal{E}}[\nabla\psi - iqA\psi] \qquad (14d)$$

$$= e^{jq\mathcal{E}} D\psi \qquad (14e)$$

$$\text{where} \quad i = j = \sqrt{-1} \qquad (14f)$$

$$(-iD')^2\psi' = -D'D'\psi' \qquad (15a)$$

Using (12a) and (14d) in (15a), the right hand side of (15a) becomes,

$$= -\hbar(\nabla - iqA')\hbar e^{jq\mathcal{E}}(\nabla\psi - iqA\psi) \qquad (15b)$$

$$= -\hbar(\nabla - iqA - iq\nabla\mathcal{E})\hbar e^{jq\mathcal{E}}(\nabla\psi - iqA\psi) \qquad (15c)$$

$$= -\hbar^2 e^{jq\mathcal{E}}[jq(\nabla\mathcal{E})\nabla\psi + q(\nabla\mathcal{E})qA\psi + \nabla^2\psi - iq(\nabla A)\psi - iq(\nabla\psi)A - iqA\nabla\psi - q^2A^2\psi - iq(\nabla\mathcal{E})\nabla\psi - q(\nabla\mathcal{E})qA\psi] \qquad (15d)$$

$$= -\hbar^2 e^{jq\mathcal{E}}[\nabla^2\psi - iq(\nabla A)\psi - 2iqA\nabla\psi - q^2A^2\psi] \qquad (15e)$$

$$= e^{jq\mathcal{E}}(-iD)^2\psi \quad \text{from Eq. (10e)} \qquad (15f)$$

This implies

$$D'^2\psi' = e^{jq\mathcal{E}} D^2\psi \qquad (16)$$

Similarly, we have for D_0,

$$D_o'\psi' = (\hbar\partial_t + iq\phi')\psi' \qquad (17a)$$

$$= (\hbar\partial_t + iq\phi - i\hbar q\partial_t\mathcal{E})e^{jq\mathcal{E}}\psi \qquad (17b)$$

$$= e^{jq\mathcal{E}}(j\hbar q\psi\partial_t\mathcal{E} + \hbar\partial_t\psi + iq\phi\psi - i\hbar q\psi\partial_t\mathcal{E}) \qquad (17c)$$

$$= e^{jq\mathcal{E}}(\hbar\partial_t\psi + iq\phi\psi) \qquad (17d)$$

$$= e^{jq\mathcal{E}}(\hbar\partial_t + iq\phi)\psi \qquad (17e)$$

$$= e^{jq\mathcal{E}} D_o\psi \qquad (17f)$$

Substituting $(-iD')^2\psi'$ from (15f) and $D_o'\psi'$ from (17f) in (11), we get,

$$(1/2m)e^{jq\mathcal{E}}(-iD)^2\psi = i e^{jq\mathcal{E}} D_o\psi \qquad (18a)$$

$$\text{or} \quad (1/2m)(-iD)^2\psi = iD_o\psi \qquad (18b)$$

It should be noted that the wavefunction ψ in (13) and its derivatives $D\psi$ in (14e), $D^2\psi$ in (16), and $D_0\psi$ in (17f) all transform exactly in the same way: they are all multiplied by the same phase factor, $e^{jq\mathcal{E}}$. Therefore, the Schrödinger equation (11) for ψ' becomes

$$(1/2m)(-iD')^2\psi' = (1/2m)(-i)^2 D'^2\psi' \qquad (19a)$$

$$= (1/2m)(-i)^2 e^{jq\mathcal{E}} D^2\psi \quad \text{from Eq. (16)} \qquad (19b)$$

$$= e^{jq\mathcal{E}}(1/2m)(-iD)^2\psi \qquad (19c)$$

$$= e^{jq\mathcal{E}} iD_o\psi \quad \text{from Eq. (8)} \qquad (19d)$$

$$= iD_o'\psi' \quad \text{from Eq. (17f)} \qquad (19e)$$

Furthermore, both ψ and ψ' describe the same physics, since $|\psi|^2 = |\psi'|^2$. In order to get the invariance for all observables, the following substitution must be made:

$$\nabla \to D; \quad \partial_t \to D_0 \qquad \textbf{(20)}$$

Thus, the Schrödinger equation described by (8) is invariant under the PE-SE transformation as shown in (19) where both ψ and ψ' describe the same physics.

2.3. *Invariance of 'current' J under the PE-SE transformation*

The current can be expressed as:

$$J = (-i\hbar/2m)[\psi^*(\nabla\psi) - (\nabla\psi)^*\psi] \qquad \textbf{(21)}$$

The use of the relevant PE-SE transformation (2d) and the substitution (20) in (21) leads to

$$J' = (-i\hbar/2m)[\psi^{*}{}'(D'\psi') - (D'\psi')^*\psi'] \qquad \textbf{(22a)}$$

$$= (-i\hbar/2m)e^{-jq\mathcal{E}}e^{jq\mathcal{E}}[\psi^*(D\psi)] - [(D\psi)^*\psi] \qquad \textbf{(22b)}$$

$$= (-i\hbar/2m)[\psi^*(D\psi) - (D\psi)^*\psi] \qquad \textbf{(22c)}$$

$$= J \qquad \textbf{(22d)}$$

Thus, the 'current' J is invariant under the PE-SE transformation (2d).

2.4. *Lagrangian, Electromagnetic Strength Tensor, and Quantum Electrodynamics*

2.4.1. The Dirac Lagrangian

It can be written as (Section 1.2.1 of (Novaes, 2000)),

$$\mathsf{L}_\psi = \psi^*(i\gamma^\mu\partial_\mu - e\gamma^\mu A_\mu - m)\psi \qquad \textbf{(23)}$$

where γ^μ are Dirac gamma matrices.

The PE-SE transformations (2e, 2c) related to ψ and A_μ are as follows:

$$\psi \to \psi' = e^{j\mathcal{E}}\psi \qquad \textbf{(24)}$$

$$A_\mu \to A'_\mu = (A_\mu - (1/e)\partial_\mu\mathcal{E}) \qquad \textbf{(25)}$$

Applying these transformations in Eq. (23), we get,

$$\mathsf{L}_\psi \to \mathsf{L}'_\psi = \psi'^*(i\gamma^\mu\partial_\mu - e\gamma^\mu A'_\mu - m)\psi' \qquad \textbf{(26a)}$$

$$= e^{-j\mathcal{E}}\psi^*(i\gamma^\mu\partial_\mu - e\gamma^\mu A_\mu + \gamma^\mu\partial_\mu\mathcal{E} - m)e^{j\mathcal{E}}\psi \qquad \textbf{(26b)}$$

$$= \psi^*(ij\gamma^\mu\partial_\mu\mathcal{E} + i\gamma^\mu\partial_\mu - e\gamma^\mu A_\mu + \gamma^\mu\partial_\mu\mathcal{E} - m)\psi \qquad \textbf{(26c)}$$

$$= \psi^*(-\gamma^\mu\partial_\mu\mathcal{E} + i\gamma^\mu\partial_\mu - e\gamma^\mu A_\mu + \gamma^\mu\partial_\mu\mathcal{E} - m)\psi \qquad \textbf{(26d)}$$

as $ij = -1$

$$= \psi^*(i\gamma^\mu\partial_\mu - e\gamma^\mu A_\mu - m)\psi \qquad \textbf{(26e)}$$

$$= \mathsf{L}_\psi \qquad \textbf{(26f)}$$

Thus, the Dirac Lagrangian is invariant under the PE-SE transformations given in Eqs. (24) and (25).

2.4.2. The Lagrangian for a charged self–interacting scalar field

It can be written as (Section 1.3 and Eq. 1.21 of (Novaes, 2000)):

$$\mathsf{L}_s = (\partial_\mu\psi^*)(\partial^\mu\psi) - V(\psi^*\psi) \qquad \textbf{(27)}$$

with a potential,

$$V(\psi^*\psi) = \mu^2(\psi^*\psi) + \lambda(\psi^*\psi)^2 \qquad \textbf{(28)}$$

This Lagrangian is also invariant under the PE-SE transformations (2d) and (2f), which are re-written as,

$$\psi \to \psi' = e^{jq\mathcal{E}}\psi \qquad \textbf{(29)}$$

$$\partial_\mu \to D_\mu = \partial_\mu - iq\partial_\mu \mathrm{E} \quad \textbf{(30)}$$

$$\Rightarrow \psi'^*\psi' = e^{-j\mathcal{E}}\psi^* e^{j\mathcal{E}}\psi$$

$$= \psi^*\psi$$ (invariant under the PE-SE transformations (2d) and (2f)) **(31a)**

$$\Rightarrow V'(\psi'^*\psi') = V'(\psi'^*\psi')$$ (invariant under the PE-SE transformation(2d) and (2f)) **(31b)**

$$\partial^\mu\psi \to D^\mu\psi'$$

$$= (\partial^\mu - iq\partial^\mu\mathcal{E})e^{jq\mathcal{E}}\psi \quad \textbf{(32a)}$$

$$= e^{jq\mathcal{E}}(jq\psi\partial^\mu\mathcal{E} + \partial^\mu\psi - iq\psi\partial^\mu\mathcal{E}) \quad \textbf{(32b)}$$

$$= e^{jq\mathcal{E}}\partial^\mu\psi \quad \text{where } j=i=\sqrt{-1} \quad \textbf{(32c)}$$

$$\mathrm{L}_s \to \mathrm{L}'_s = (\partial_\mu\psi'^*)(\partial^\mu\psi') - V'(\psi'^*\psi') \quad \textbf{(33a)}$$

$$= e^{-jq\mathcal{E}}(\partial_\mu\psi^*)e^{jq\mathcal{E}}(\partial^\mu\psi) - V(\psi^*\psi)$$

from (31b) & (32c) **(33b)**

$$= (\partial_\mu\psi^*)(\partial^\mu\psi) - V(\psi^*\psi) \quad \textbf{(33c)}$$

$$= \mathrm{L}_s \quad \text{from (27)} \quad \textbf{(33d)}$$

Thus the Lagrangian for a charged self–interacting scalar field is invariant under the PE-SE transformations (29) and (30).

2.5. *Standard Model*

"The Standard Model of particle physics is a theory of three of the four known fundamental interactions and the elementary particles that take part in these interactions. These particles make up all visible matter in the universe. The standard model is a gauge theory of the electroweak and strong interactions with the gauge group SU(3)×SU(2)×U(1)."

2.5.1. Free Lagrangian for the gauge fields in the Standard Model

We can investigate if the free Lagrangian for the gauge fields is invariant under the PE-SE transformations. The relevant Lagrangian (Section 2.1.3 and Eq. 2.9 of (Novaes, 2000)) is:

$\mathrm{L_g} = \mathrm{L}_{\text{gaugae}}$

$$= (-1/4)[W^i_{\mu\nu}W^{i\mu\nu} + B_{\mu\nu}B^{\mu\nu}] \quad \textbf{(34)}$$

where $W^i_{\mu\nu}$ and $B_{\mu\nu}$ are W-bosons (i=1, 2, 3) and B-boson gauge fields corresponding to SU(2) and U(1) generators, respectively. The strength tensors for these gauge fields (Section 2.1.3 of (Novaes, 2000)) are:

$$W^i_{\mu\nu} = \partial_\mu W^i_\nu - \partial_\nu W^i_\mu + g\epsilon^{ijk}W^j_\mu W^k_\nu] \quad \textbf{(35)}$$

$$\mathrm{B}_{\mu\nu} = \partial_\mu \mathrm{B}_\nu - \partial_\nu \mathrm{B}_\mu \quad \textbf{(36)}$$

where g is gauge coupling constant and ϵ^{ijk} are the structure constants of SU(2). The PE-SE transformations (2e), (2g), and (2h) related to ψ, B_μ and W^i_μ, respectively, are as follows:

$$\psi \to \psi' = e^{j\mathcal{E}}\psi \quad \textbf{(37)}$$

$$\mathrm{B}_\mu \to \mathrm{B}'_\mu = \mathrm{B}_\mu - (1/g)\partial_\mu \mathrm{E} \quad \textbf{(38)}$$

$$\mathrm{W}^i_\mu \to \mathrm{W}'^i_\mu = \mathrm{W}^i_\mu - (1/g)\partial_\mu \mathrm{E} + \epsilon^{ijk}\mathrm{E}^j \mathrm{W}^k_\mu \quad \textbf{(39)}$$

$$\mathrm{B}_{\mu\nu} \to \mathrm{B}'_{\mu\nu} = \partial_\mu \mathrm{B}'_\nu - \partial_\nu \mathrm{B}'_\mu$$

$$= \partial_\mu[\mathrm{B}_\nu - (1/g)\partial_\nu \mathrm{E}] - \partial_\nu[\mathrm{B}_\mu - (1/g)\partial_\mu \mathrm{E}] \quad \textbf{(40a)}$$

$$= \partial_\mu \mathrm{B}_\nu - (1/g)\partial_\mu\partial_\nu \mathrm{E} - \partial_\nu \mathrm{B}_\mu - (1/g)\partial_\nu\partial_\mu \mathrm{E} \quad \textbf{(40b)}$$

$$= \partial_\mu \mathrm{B}_\nu - \partial_\nu \mathrm{B}_\mu \quad \text{because } \partial_\mu\partial_\nu \mathrm{E} = \partial_\nu\partial_\mu \mathrm{E} \quad \textbf{(40c)}$$

$$= \mathrm{B}_{\mu\nu} \quad \text{from (36)} \quad \textbf{(40d)}$$

$$W^i_{\mu\nu} \to W'^i_{\mu\nu}$$

$$= \partial_\mu W'^i_\nu - \partial_\nu W'^i_\mu + g\,\epsilon^{ijk}\ W^j_\mu\ W^k_\nu \quad \textbf{(41a)}$$

$$= \partial_\mu[W^i_\nu - (1/g)\partial_\nu \mathrm{E} + \epsilon^{ijk}\ \mathrm{E}^j\ W^k_\nu] - \partial_\nu[W^i_\mu - (1/g)\partial_\mu \mathrm{E} + \epsilon^{ijk}\ \mathrm{E}^j\ W^k_\mu] + g\,\epsilon^{ijk}\ W^j_\mu\ W^k_\nu \quad \textbf{(41b)}$$

$$= \partial_\mu W^i_\nu - (1/g)\partial_\mu\partial_\nu \mathrm{E} + \epsilon^{ijk}(\partial_\mu \mathrm{E}^j)W^k_\nu + \epsilon^{ijk}\mathrm{E}^j\partial_\mu W^k_\nu - \partial_\nu W^i_\mu + (1/g)\partial_\nu\partial_\mu \mathrm{E} - \epsilon^{ijk}W^k_\mu\partial_\nu \mathrm{E}^j - \epsilon^{ijk}\mathrm{E}^j\partial_\nu W^k_\mu + g\,\epsilon^{ijk}\ W^j_\mu\ W^k_\nu \quad \textbf{(41c)}$$

$= \partial_\mu W_\nu^i - \partial_\nu W_\mu^i + g\, e^{ijk}\ W_\mu^j\ W_\nu^k$ **(41d)**

$= W_{\mu\nu}^i$ from (35) **(41e)**

Since the mass term for the gauge bosons like $(g, e^{ijk}, W_\mu^j, W_\nu^k)$ in (41a) is not gauge invariant (Novaes, 2000), it is assumed that it is also not PE-SE invariant to make it consistent with physics. Therefore, it is not transformed. The PE-SE transformation follows very closely with gauge transformation.

The substitution of (40d) and (41e) in (34) leads to the invariance of Lagrangian under the PE-SE transformation:

$$\mathcal{L}_g \rightarrow \mathcal{L}'_g = \mathcal{L}_g \quad \textbf{(42)}$$

2.5.2. Mass Problem (Higgs Mechanism): Lagrangian for the electromagnetic interaction of a charged scalar field

A problem with Standard Model is how to give mass to the weak gauge bosons, quarks, and leptons without breaking the gauge symmetry of Lagrangian. This is necessary for a renormalizable field theory. The Lagrangian for describing the electromagnetic (EM) interaction of a charged scalar field (spin 0) in U(1) gauge theory can be written as (Eq. (17) of (Roy, 1999)):

$$\mathrm{L}_{em} = (\partial_\mu - ieA_\mu)\psi^*(\partial^\mu + ieA^\mu)\psi - \mu^2(\psi^*\psi) - \lambda(\psi^*\psi)^2 - (1/4)\mathcal{F}_{\mu\nu}\mathcal{F}^{\mu\nu} \quad \textbf{(43)}$$

$$\mathcal{F}_{\mu\nu} = \partial_\mu A_\nu - \partial_\nu A_\mu \quad \textbf{(44)}$$

where A_μ is the EM field (photon), $\mathcal{F}_{\mu\nu}$ is the corresponding field tensor, μ is Higgs quadratic coupling, λ is Higgs self-coupling strength, and ∂_μ is the momentum operator. The first term of the Lagrangian represents scalar kinetic energy and gauge interaction, the middle term represents the scalar mass and self-interaction, and the last term represents the gauge kinetic energy. The gauge symmetric scalar mass term, $\mu^2(\phi^*\phi)$, is used to give mass to W and Z bosons, the quarks, and leptons.

We investigate if the following PE-SE transformations (2e) and (2c) lead to the invariance of the Lagrangian L_{em} :

$$\phi \rightarrow \phi' = e^{j\mathcal{E}}\phi \quad \textbf{(45)}$$

$$A_\mu \rightarrow A'_\mu = (A_\mu - (1/e)\partial_\mu \mathcal{E}) \quad \textbf{(46)}$$

Using (45), we get:

$$\phi'^*\phi' = e^{-j\mathcal{E}}\phi^*\, e^{j\mathcal{E}}\phi = \phi^*\phi \quad \textbf{(47)}$$

which is invariant under the PE-SE transformation (45).

Using (45) for the PE-SE transformation and (28) for V, we get:

$$V'(\phi'^*\phi') = \mu^2(\phi'^*\phi') + \lambda(\phi'^*\phi')^2$$
$$= \mu^2(\phi^*\phi) + \lambda(\phi^*\phi)^2$$
$$= V(\phi^*\phi) \quad \textbf{(48)}$$

which is invariant under the PE-SE transformation (2e).

The electromagnetic strength tensor $F_{\mu\nu}$ is invariant under the PE-SE transformation (2c) from Section 2.2 of (Vimal, 2010c):

$\mathcal{F}_{\mu\nu} \rightarrow \mathcal{F}'_{\mu\nu} = \partial_\mu A'_\nu - \partial_\nu A'_\mu =$

$\partial_\mu [A_\nu - (1/e)✫_\nu\mathcal{E}] - \partial_\nu [A_\nu - (1/e)✫_\mu\mathcal{E}]$ **(49 a)**

$= \partial_\mu A_\nu - (1/e)\, \partial_\mu ✫_\nu\mathcal{E} - \partial_\nu A_\mu + (1/e)\, \partial_\nu ✫_\mu\mathcal{E}$ **(49b)**

$= \partial_\mu A_\nu - \partial_\nu A_\mu$ as $\partial_\mu ✫_\nu\mathcal{E} = \partial_\nu ✫_\mu\mathcal{E}$ **(49c)**

$= \mathcal{F}_{\mu\nu}$ **(49d)**

Applying the PE-SE transformations (45) and (46) in the first term of (43), we get:

$\mathrm{L}_{emI} \rightarrow \mathrm{L}'_{emI}$

$$= (\partial_\mu - ieA'_\mu)\phi'^*(\partial^\mu + ieA'^\mu)\phi' \quad \textbf{(50a)}$$

$$= (\partial_\mu - ieA_\mu + i\partial_\mu E)(e^{-jE}\phi^*)$$
$$(\partial_\mu + ieA_\mu - i\partial_\mu E)(e^{jE}\phi) \quad \textbf{(50b)}$$

$$= e^{-jE} e^{jE} [(-j\partial_\mu E\phi^* + \partial_\mu\phi^* - ieA_\mu\phi^* + i\partial_\mu E\phi^*)$$
$$(j\partial_\mu E\phi + \partial_\mu\phi + ieA_\mu\phi - i\partial_\mu E\phi)] \quad \textbf{(50c)}$$

$$= (\partial_\mu - ieA_\mu)\phi^*(\partial_\mu + ieA_\mu)\phi \quad \textbf{(50d)}$$

$$= L_{emI} \quad \textbf{(50e)}$$

Using (47), (49), and (50e) in (43), we find that the Lagrangian (43) for the EM interaction of a charged scalar field is invariant under the PE-SE transformations (45) and (46).

To sum up, the Standard Model is invariant under the relevant PE-SE transformations.

3. Conclusions

3.1. Goal: Introducing consciousness in physics: Our goal is to introduce the subjective experience (SE) aspect of consciousness in classical physics (Part I: (Vimal, 2010c)), in orthodox quantum physics (Part II: current goal: Section 2), and in modern quantum physics (Part III: (Vimal, 2010d)) by using the methodology of investigating invariance in critical components of respective theories under the PE-SE transformations.

3.2. Invariance of orthodox quantum physics under PE-SE transformations: We found that the followings in orthodox quantum physics are invariant under the PE-SE transformations: Schrödinger equation, current, Dirac Lagrangian, the Lagrangian for a charged self–interacting scalar field, Standard Model (the Lagrangian for free gauge field and Lagrangian for the electromagnetic interaction of a charged scalar field (Higgs Mechanism)). We find that orthodox quantum physics is invariant under the PE-SE transformations.

3.3. Invariance of classical physics and modern quantum physics under PE-SE transformations: Under the PE-SE transformations, (a) in Part I (Vimal, 2010c), we found that classical physics is invariant, and (b) in Part III (Vimal, 2010d), it will be shown that modern quantum physics is invariant.

3.4. TOE: From above, it is possible to unify consciousness with known four fundamental forces, which leads us closer to the theory of everything.

Acknowledgments
The work was partly supported by VP-Research Foundation Trust and Vision Research Institute research Fund. Author would like to thank (1) anonymous reviewers, Matti Pitkänen, Serge Patlavskiy, Manju-Uma C. Pandey-Vimal, Vivekanand Pandey Vimal, Shalini Pandey Vimal, and Love (Shyam) Pandey Vimal for their critical comments, suggestions, and grammatical corrections, (2) Ronald J. MacGregor (MacGregor and Vimal, 2008) for his qualitative initial help in introducing string theory in the PE-SE framework (Vimal, 2008b). The author is also affiliated with Vision Research Institute, 428 Great Road, Suite 11, Acton, MA 01720 USA; Dristi Anusandhana Sansthana, A-60 Umed Park, Sola Road, Ahmedabad-61, Gujrat, India; Dristi Anusandhana Sansthana, c/o NiceTech Computer Education Institute, Pendra, Bilaspur, C.G. 495119, India; and Dristi Anusandhana Sansthana, Sai Niwas, East of Hanuman Mandir, Betiahata, Gorakhpur, U.P. 273001, India.

Competing interest statement
The author declares that he has no competing financial interests.

References

MacGregor RJ, Vimal RLP. Consciousness and the Structure of Matter. Journal of Integrative Neuroscience 2008; 7(1): 75-116.

Novaes SF. Standard Model: An Introduction. http://arxiv.org/abs/hep-ph/0001283 2000.

Roy DP. Basic Constituents of Matter and their Interactions A Progress Report. http://arxiv.org/abs/hep-ph/9912523 1999.

Vimal RLP. Attention and Emotion. The Annual Review of Biomedical Sciences (ARBS) 2008a; 10: 84-104.

Vimal RLP. Proto-experiences and Subjective Experiences: Classical and Quantum Concepts. Journal of Integrative Neuroscience. 2008b; 7(1): 49-73.

Vimal RLP. Dual Aspect Framework for Consciousness and Its Implications: West meets East for Sublimation Process. In: Derfer G, Wang Z and Weber M, editors. The Roar of Awakening. A Whiteheadian Dialogue Between Western Psychotherapies and Eastern Worldviews. Vol 3 of Whitehead Psychology Nexus Studies. Frankfurt / Lancaster: Ontos Verlag, 2009a: 39-70.

Vimal RLP. The Most Optimal Dual-Aspect-Dual-Mode Framework for Consciousness: Recent Development. In: Weber M, editor. Chromatikon: Yearbook of Philosophy in Process, 2009b: 295-307.

Vimal RLP. Necessary Ingredients of Consciousness: Integration of Psychophysical, Neurophysiological, and Consciousness Research for the Red-Green Channel. Vision Research Institute: Living Vision and Consciousness Research 2009c; 2(1): 1-40.

Vimal RLP. Subjective Experience Aspect of Consciousness Part I - Integration of Classical, Quantum, and Subquantum Concepts. NeuroQuantology 2009d; 7(3): 390-410.

Vimal RLP. Subjective Experience Aspect of Consciousness Part II: Integration of Classical and Quantum Concepts for Emergence Hypothesis. NeuroQuantology 2009e; 7(3): 411-434.

Vimal RLP. Matching and selection of a specific subjective experience: conjugate matching and subjective experience. Journal of Integrative Neuroscience 2010a; 9(2): 193-251.

Vimal RLP. On the Quest of Defining Consciousness. Mind and Matter 2010b; 8(1): 93-121.

Vimal RLP. Towards a Theory of Everything Part I - Introduction of Consciousness in Electromagnetic Theory, Special and General Theory of Relativity. NeuroQuantology 2010c; 8(2): 206-230.

Vimal RLP. Towards a Theory of Everything Part III - Introduction of Consciousness in Loop Quantum Gravity and String Theory and Unification of Experiences with Fundamental Forces. NeuroQuantology 2010d; 8. In press.