

## Electroweak gauge fields, particles, and antiparticles arise from probability

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RÉSUMÉ. Particules, antiparticules et champs de même que les champs de jauge électromagnétiques sont déduits des probabilités des événements physiques à condition que ces éléments soient représentés par des spineurs.

*ABSTRACT. Probabilities of events are expressed by the spinor functions and by operators of a probability creation and by operators of a probability annihilation. The motion equations in form of the Dirac equations with the additional fields are obtained for these spinor functions. Some of these additional fields behave as the gauge fields and others behave as the mass members. Such motion equations, contained all five elements of Clifford's pentad, is invariant for the electroweak gauge transformations. The creation operators and the annihilation operators of particles and antiparticles obtained from these probabilistic functions. The motion equation of the  $U(2)$  Yang-Mills field components is formulated similarly to the Klein-Gordon equation with the nonzero mass.*

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### 1 Introduction

In this article I do not construct a model for the particles physics but there I try to find the Quantum Theory principles which can be logically obtained from probabilities of physical events under the expression of these probabilities by spinors. Almost all basic principles prove to be of such kind.

I call an event, occurred at single point of the space-time, as *a point event*.

In Part 2 of this article probabilities of point events are expressed by the spinor functions and by *operators of a probability creation and a probability annihilation*. These operators are similar to the field operators of Quantum Fields Theory. The motion equations in form of the Dirac equations with the additional fields are obtained for the spinor functions. Some of these additional fields behave as the mass members and others behave as the gauge fields.

A *3+1 vector of a probability current* and *3-vectors of a average velocity* and of a *local velocity for the probability propagation* are defined by these motion equations.

Further I use the following denotation:

$$1_2 \stackrel{def}{=} \begin{bmatrix} 10 \\ 01 \end{bmatrix}, 0_2 \stackrel{def}{=} \begin{bmatrix} 00 \\ 00 \end{bmatrix},$$

the Pauli matrices:

$$\sigma_1 = \begin{pmatrix} 01 \\ 10 \end{pmatrix}, \sigma_2 = \begin{pmatrix} 0-i \\ i 0 \end{pmatrix}, \sigma_3 = \begin{pmatrix} 1 0 \\ 0-1 \end{pmatrix}.$$

A set  $\tilde{C}$  of complex  $n \times n$  matrices is called as *Clifford's set* [1] if the following conditions are fulfilled:

if  $\alpha_k \in \tilde{C}$  and  $\alpha_r \in \tilde{C}$  then  $\alpha_k \alpha_r + \alpha_r \alpha_k = 2\delta_{k,r}$ ;

if  $\alpha_k \alpha_r + \alpha_r \alpha_k = 2\delta_{k,r}$  for all elements  $\alpha_r$  of set  $\tilde{C}$  then  $\alpha_k \in \tilde{C}$ .

If  $n = 4$  then Clifford's set either contains 3 matrices (*Clifford's triplet*) or contains 5 matrices (*Clifford's pentad*).

There exist only six Clifford's pentads[1]: one *light pentad*  $\beta$ :

$$\beta^{[1]} \stackrel{def}{=} \begin{bmatrix} \sigma_1 & 0_2 \\ 0_2 - \sigma_1 \end{bmatrix}, \beta^{[2]} \stackrel{def}{=} \begin{bmatrix} \sigma_2 & 0_2 \\ 0_2 - \sigma_2 \end{bmatrix}, \beta^{[3]} \stackrel{def}{=} \begin{bmatrix} \sigma_3 & 0_2 \\ 0_2 - \sigma_3 \end{bmatrix}, \quad (1)$$

$$\gamma^{[0]} \stackrel{def}{=} \begin{bmatrix} 0_2 1_2 \\ 1_2 0_2 \end{bmatrix}, \quad (2)$$

$$\beta^{[4]} \stackrel{def}{=} i \cdot \begin{bmatrix} 0_2 & 1_2 \\ -1_2 & 0_2 \end{bmatrix}; \quad (3)$$

three *chromatic* pentads and two *taste* pentads [2].

In this paper I consider the motion equations such that these equations contain only the light pentad elements. Such equations are called the equations for a *leptonn* motion <sup>1</sup>.

The Dirac equation contains only four elements of Clifford's pentads. Three of these elements (1) conform to three space coordinates and the fourth element (2) either constitutes the mass member or conforms to the time coordinate. But Clifford's pentad contains five elements. Certainly, the fifth element (3) of the pentad should be added to the motion equation. Hence the Dirac equation mass part will hold two members. Moreover, if two additional quasi-space coordinates [3] will be put in accordance to these two Clifford's pentads mass elements ((2) and (3)) then the homogeneous Dirac equation will be obtained. All the five elements of Clifford's pentads and all the five space coordinates are equal in quality in this equation. The magnitudes of all the local velocities are equal to unit at such five-dimensional space.

The redefined in this way motion equation is invariant for rotations at the 2-space of the fourth and the fifth coordinates. In Part 3 this transformation defines a field, similar to *B*-boson field.

In Part 4 *operators of a particles creation and a particles annihilation* are denoted as the Fourier transformations of the corresponding operators for probability and antiparticles are denoted in the standard way.

In Part 5 here are considered all unitary transformations on the two-masses functions such that these transformations retain the probability 4-vector. The adequate to electroweak gauge fields transformations exist among these unitary transformations. These electroweak unitary transformations are expressed by rotations at the 2-space of the fourth and the fifth coordinates, too.

The motion equations are invariant for these transformations. The massless field  $W_{\mu,\nu}$  is denoted in usual way, but the motion equations for the fields  $W_\mu$  are similar to the Klein-Gordon equation with nonzero mass.

The massless field *A* and the massive field *Z* are denoted in standard way by the fields *B* and *W*.

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<sup>1</sup>I use the terms "leptonn", "bosonn" etc with double "nn". for the distinguishing of the physical notions and the logically receiving notions.

## 2 Hamiltonians

Let us denote:

$\mathbf{e}_1, \mathbf{e}_2, \mathbf{e}_3$  are the Cartesian basis vectors;

$$\mathbf{x} \stackrel{def}{=} (x_1\mathbf{e}_1 + x_2\mathbf{e}_2 + x_3\mathbf{e}_3);$$

$$x_0 \stackrel{def}{=} t;$$

$$\int d^3\mathbf{x} \stackrel{def}{=} \int dx_1 \int dx_2 \int dx_3;$$

$$\partial_k \stackrel{def}{=} \partial/\partial x_k;$$

$$\partial_t \stackrel{def}{=} \partial_0 \stackrel{def}{=} \partial/\partial t;$$

$$\partial'_k \stackrel{def}{=} \partial/\partial x'_k.$$

Let  $\wp(t, \mathbf{x})$  be any occurred in point  $(t, \mathbf{x})$  event and let a real function  $\rho_\wp(t, \mathbf{x})$  be the *probability density* of this event. That is for each domain  $D$  ( $D \subseteq R^3$ ):

$$\int_D d^3\mathbf{x} \cdot \rho_\wp(t, \mathbf{x}) = \mathbf{P}(\exists \mathbf{x} \in D : \wp(t, \mathbf{x}))$$

with  $\mathbf{P}$  as a probability function.

Let  $\varphi_j(t, \mathbf{x})$  ( $j \in \{1, 2, 3, 4\}$ ) be some complex solution of the following equation:

$$\sum_{j=1}^4 \varphi_j^*(t, \mathbf{x}) \varphi_j(t, \mathbf{x}) = \rho_\wp(t, \mathbf{x}). \quad (4)$$

I consider only events, fulfilled to the following condition: there exists some tiny real positive number  $h$  such that if  $|x_r| \geq \frac{\pi}{h}$  ( $r \in \{1, 2, 3\}$ ) then

$$\varphi_j(t, \mathbf{x}) = 0.$$

Here is suitable to choose this number such that  $h$  equals the Planck constant for our devices. But maybe somewhere exist devices of other structure such that another value for  $h$  will required.

Let  $(V)$  be denoted as the following:  $\mathbf{x} \in (V)$  if and only if  $|x_r| \leq \frac{\pi}{h}$  for  $r \in \{1, 2, 3\}$ . That is:

$$\int_{(V)} d^3\mathbf{x} = \int_{-\frac{\pi}{h}}^{\frac{\pi}{h}} dx_1 \int_{-\frac{\pi}{h}}^{\frac{\pi}{h}} dx_2 \int_{-\frac{\pi}{h}}^{\frac{\pi}{h}} dx_3.$$

If

$$\bar{\mathbf{x}}(t) \stackrel{def}{=} \int d^3\mathbf{x} \cdot \mathbf{x} \rho_\varphi(t, \mathbf{x})$$

then  $\bar{\mathbf{x}}(t)$  is an average coordinate of the event  $\varphi$  and:

$$\bar{\mathbf{x}}(t) = \int d^3\mathbf{x} \cdot \mathbf{x} \sum_{j=1}^4 \varphi_j^*(t, \mathbf{x}) \varphi_j(t, \mathbf{x}),$$

and an average velocity of the event  $\varphi$  probability is:

$$\begin{aligned} \bar{\mathbf{v}}(t) &= \partial_t \bar{\mathbf{x}}(t) = \\ &= \int d^3\mathbf{x} \cdot \mathbf{x} \sum_{j=1}^4 \left( \begin{array}{l} (\partial_t \varphi_j^*(t, \mathbf{x})) \varphi_j(t, \mathbf{x}) \\ + \varphi_j^*(t, \mathbf{x}) (\partial_t \varphi_j(t, \mathbf{x})) \end{array} \right). \end{aligned} \quad (5)$$

$\bar{\mathbf{v}}(t)$  is not a velocity of any particle but  $\bar{\mathbf{v}}(t)$  is an attribute of a probability propagation at the space-time.

Because

$$\beta_{j,k}^{[s]*} = \beta_{k,j}^{[s]}$$

and  $\varphi_j(t, \pm\infty) = 0$  then from (5):

$$\bar{\mathbf{v}}(t) = - \int d^3\mathbf{x} \cdot \sum_{s=1}^3 \mathbf{e}_s \sum_{k=1}^4 \sum_{j=1}^4 \varphi_j^*(t, \mathbf{x}) \beta_{j,k}^{[s]} \varphi_k(t, \mathbf{x}).$$

Denote:

$$\beta^{[0]} \stackrel{def}{=} -1_4 \stackrel{def}{=} - \begin{bmatrix} 1_2 & 0_2 \\ 0_2 & 1_2 \end{bmatrix}$$

and

$$j_\alpha \stackrel{def}{=} - \sum_{k=1}^4 \sum_{j=1}^4 \varphi_j^* \beta_{j,k}^{[\alpha]} \varphi_k \quad (6)$$

with  $\alpha \in \{0, 1, 2, 3\}$  and  $j_0 \stackrel{def}{=} -\rho_\varphi(t, \mathbf{x})$ . Hence

$$\mathbf{j} = j_1 \mathbf{e}_1 + j_2 \mathbf{e}_2 + j_3 \mathbf{e}_3$$

is the probability current for which:

$$\bar{\mathbf{v}}(t) = \int d^3\mathbf{x} \cdot \mathbf{j}(t, \mathbf{x}).$$

If

$$\mathbf{j} \stackrel{def}{=} \rho_\varphi \mathbf{u} \tag{7}$$

then

$$\bar{\mathbf{v}}(t) = \int d^3\mathbf{x} \cdot \rho_\varphi(t, \mathbf{x}) \mathbf{u}(t, \mathbf{x}).$$

$\mathbf{u}$  is called as a *local probability velocity of event*  $\varphi$ .

Let  $j \in \{1, 2, 3, 4\}$ ,  $k \in \{1, 2, 3, 4\}$

Let  $\langle t, \mathbf{x} \rangle$  be any space-time point. Denote value of function  $\varphi_k$  at this point as  $\varphi_k|_{\langle t, \mathbf{x} \rangle} = A_k$  and value of function  $\partial_t \varphi_j - \sum_{s=1}^4 \sum_{\alpha=1}^3 \beta_{j,s}^{[\alpha]} \partial_\alpha \varphi_s$  at this point as  $(\partial_t \varphi_j - \sum_{s=1}^4 \sum_{\alpha=1}^3 \beta_{j,s}^{[\alpha]} \partial_\alpha \varphi_s)|_{\langle t, \mathbf{x} \rangle} = C_j$ . There  $A_k$  and  $C_j$  are complex numbers. Hence the following equations set:

$$\left\{ \sum_{k=1}^4 z_{j,k} A_k = C_j; \right\}$$

is a set of 4 algebraic linear equations with 16 complex unknown numbers  $z_{k,j}$ . This set has got solutions by the Kronecker-Capelli theorem. Hence for every point  $\langle t, \mathbf{x} \rangle$  there exists such complex number  $z_{j,k}|_{\langle t, \mathbf{x} \rangle}$ .

Let  $Q_{j,k}$  be a complex functions such that in every point  $\langle t, \mathbf{x} \rangle$ :  $Q_{j,k}|_{\langle t, \mathbf{x} \rangle} = z_{j,k}|_{\langle t, \mathbf{x} \rangle}$ .

Therefore for every  $\varphi$  there exist complex functions  $Q_{j,k}$  such that the  $\varphi$  dependence upon  $t$  is characterized by the following differential equations<sup>2</sup>:

$$\partial_t \varphi_j = \sum_{k=1}^4 \left( \beta_{j,k}^{[1]} \partial_1 + \beta_{j,k}^{[2]} \partial_2 + \beta_{j,k}^{[3]} \partial_3 + Q_{j,k} \right) \varphi_k. \tag{8}$$

From the continuity equation  $(\partial_t \rho_\varphi + \text{div} \mathbf{j} = 0)$ :  $Q_{j,k}^* = -Q_{k,j}$ .

In that case if

$$\hat{H}_{j,k} \stackrel{def}{=} i \left( \beta_{j,k}^{[1]} \partial_1 + \beta_{j,k}^{[2]} \partial_2 + \beta_{j,k}^{[3]} \partial_3 + Q_{j,k} \right)$$

then  $\hat{H}$  is called as *the hamiltonian* of the moving with equation (8).

Let  $\mathbf{H}$  be some Hilbert space such that some linear operators  $\psi_j(\mathbf{x})$  act on elements of  $\mathbf{H}$ . And these operators have got the following properties:

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<sup>2</sup>This set of equations is similar to the Dirac equation with the mass matrix [4], [5], [6]. I choose form of this set of equations in order to describe behaviour of  $\rho_\varphi(t, \mathbf{x})$  by spinors and by the Clifford's set elements.

1.  $\mathbf{H}$  contains the element  $\Phi_0$  such that:

$$\Phi_0^\dagger \Phi_0 = 1$$

and

$$\psi_j \Phi_0 = 0, \Phi_0^\dagger \psi_j^\dagger = 0;$$

2.

$$\psi_j(\mathbf{x}) \psi_j(\mathbf{x}) = 0$$

and

$$\psi_j^\dagger(\mathbf{x}) \psi_j^\dagger(\mathbf{x}) = 0;$$

3.

$$\left\{ \psi_{j'}^\dagger(\mathbf{y}), \psi_j(\mathbf{x}) \right\} \stackrel{Def}{=} \psi_{j'}^\dagger(\mathbf{y}) \psi_j(\mathbf{x}) + \psi_j(\mathbf{x}) \psi_{j'}^\dagger(\mathbf{y}) = \delta(\mathbf{y} - \mathbf{x}) \delta_{j',j} \quad (9)$$

Let us denote  $\Psi(t, \mathbf{x})$  as the following:

$$\Psi(t, \mathbf{x}) \stackrel{def}{=} \sum_{j=1}^4 \varphi_j(t, \mathbf{x}) \psi_j^\dagger(\mathbf{x}) \Phi_0 \quad (10)$$

From (9):

$$\Psi^\dagger(t, \mathbf{x}') \Psi(t, \mathbf{x}) = \sum_{j=1}^4 \varphi_j^*(t, \mathbf{x}') \varphi_j(t, \mathbf{x}) \delta(\mathbf{x}' - \mathbf{x}).$$

That is from (4):

$$\int dx' \cdot \Psi^\dagger(t, \mathbf{x}') \Psi(t, \mathbf{x}) = \rho_\varphi(t, \mathbf{x}).$$

I call operator  $\psi^\dagger(\mathbf{x})$  as a *creation operator* and  $\psi(\mathbf{x})$  is called as an *annihilation operator of the event  $\varphi$  probability at point  $\mathbf{x}$* . Operator  $\psi^\dagger(\mathbf{x})$  is not an operator of a particle creation at point  $\mathbf{x}$  but it is an operator, changing probability of event  $\varphi$  at this point. The similar is for  $\psi(\mathbf{x})$ .

If  $\mathcal{H}(t, \mathbf{x})$  is denoted as:

$$\mathcal{H}(t, \mathbf{x}) \stackrel{def}{=} \sum_{j=1}^4 \psi_j^\dagger(\mathbf{x}) \sum_{k=1}^4 \hat{H}_{j,k}(t, \mathbf{x}) \psi_k(\mathbf{x}) \quad (11)$$

then  $\mathcal{H}(t, \mathbf{x})$  is called as *the hamiltonian density* of this hamiltonian.

From (10):

$$-i \int d^3\mathbf{x} \cdot \mathcal{H}(t, \mathbf{x}) \Psi(t, \mathbf{x}_0) = \partial_t \Psi(t, \mathbf{x}_0).$$

Therefore a hamiltonian density defines the temporal behaviour of probability at a space point.

Formula (8) has got the following matrix form:

$$\partial_t \varphi = \left( \beta^{[1]} \partial_1 + \beta^{[2]} \partial_2 + \beta^{[3]} \partial_3 + \widehat{Q} \right) \varphi, \tag{12}$$

with

$$\varphi = \begin{bmatrix} \varphi_1 \\ \varphi_2 \\ \varphi_3 \\ \varphi_4 \end{bmatrix}$$

and

$$\widehat{Q} = \begin{bmatrix} i\vartheta_{1,1} & i\vartheta_{1,2} - \varpi_{1,2}i\vartheta_{1,3} - \varpi_{1,3}i\vartheta_{1,4} - \varpi_{1,4} \\ i\vartheta_{1,2} + \varpi_{1,2} & i\vartheta_{2,2} & i\vartheta_{2,3} - \varpi_{2,3}i\vartheta_{2,4} - \varpi_{2,4} \\ i\vartheta_{1,3} + \varpi_{1,3}i\vartheta_{2,3} + \varpi_{2,3} & i\vartheta_{3,3} & i\vartheta_{3,4} - \varpi_{3,4} \\ i\vartheta_{1,4} + \varpi_{1,4}i\vartheta_{2,4} + \varpi_{2,4}i\vartheta_{3,4} + \varpi_{3,4} & i\vartheta_{4,4} \end{bmatrix}$$

with  $\varpi_{j,k} = \text{Re}(Q_{j,k})$  and  $\vartheta_{1,2} = \text{Im}(Q_{j,k})$ .

Let  $\Theta_0, \Theta_3, \Upsilon_0$  and  $\Upsilon_3$  be the solution of the following system of equations:

$$\begin{cases} -\Theta_0 + \Theta_3 - \Upsilon_0 + \Upsilon_3 = \vartheta_{1,1}; \\ -\Theta_0 - \Theta_3 - \Upsilon_0 - \Upsilon_3 = \vartheta_{2,2}; \\ -\Theta_0 - \Theta_3 + \Upsilon_0 + \Upsilon_3 = \vartheta_{3,3}; \\ -\Theta_0 + \Theta_3 + \Upsilon_0 - \Upsilon_3 = \vartheta_{4,4} \end{cases}.$$

Let  $\Theta_1, \Upsilon_1, \Theta_2, \Upsilon_2, M_0, M_4, M_{1,0}, M_{1,4}, M_{2,0}, M_{2,4}, M_{3,0}, M_{3,4}$  be the solutions of the following systems of equations:

$$\begin{cases} \Theta_1 + \Upsilon_1 = \vartheta_{1,2}; \\ -\Theta_1 + \Upsilon_1 = \vartheta_{3,4}; \end{cases} \quad \begin{cases} -\Theta_2 - \Upsilon_2 = \varpi_{1,2}; \\ \Theta_2 - \Upsilon_2 = \varpi_{3,4}; \end{cases} \quad \begin{cases} M_0 + M_{3,0} = \vartheta_{1,3}; \\ M_0 - M_{3,0} = \vartheta_{2,4}; \end{cases}$$



$$\begin{cases} M_4 + M_{3,4} = \varpi_{1,3}; \\ M_4 - M_{3,4} = \varpi_{2,4}; \end{cases}$$

$$\begin{cases} M_{1,0} - M_{2,4} = \vartheta_{1,4}; \\ M_{1,0} + M_{2,4} = \vartheta_{2,3}; \end{cases}$$

$$\begin{cases} M_{1,4} - M_{2,0} = \varpi_{1,4}; \\ M_{1,4} + M_{2,0} = \varpi_{2,3}. \end{cases}$$

From (12):

$$\begin{aligned} & (\partial_t + i\Theta_0 + i\Upsilon_0\gamma^{[5]})\varphi = \\ & = \left( \begin{array}{c} \sum_{k=1}^3 \beta^{[k]} (\partial_k + i\Theta_k + i\Upsilon_k\gamma^{[5]}) + iM_0\gamma^{[0]} + iM_4\beta^{[4]} \\ -iM_{1,0}\gamma_\zeta^{[0]} - iM_{1,4}\zeta^{[4]} - \\ -iM_{2,0}\gamma_\eta^{[0]} - iM_{2,4}\eta^{[4]} - \\ -iM_{3,0}\gamma_\theta^{[0]} - iM_{3,4}\theta^{[4]} \end{array} \right) \varphi \quad (13) \end{aligned}$$

with

$$\gamma^{[5]} \stackrel{def}{=} \begin{bmatrix} 1_2 & 0_2 \\ 0_2 & -1_2 \end{bmatrix}.$$

Here summands

$$\begin{aligned} & -iM_{1,0}\gamma_\zeta^{[0]} - iM_{1,4}\zeta^{[4]} - \\ & -iM_{2,0}\gamma_\eta^{[0]} - iM_{2,4}\eta^{[4]} - \\ & -iM_{3,0}\gamma_\theta^{[0]} - iM_{3,4}\theta^{[4]} \end{aligned}$$

contain the chromatic pentads elements [2] and

$$\sum_{k=1}^3 \beta^{[k]} (\partial_k + i\Theta_k + i\Upsilon_k\gamma^{[5]}) + iM_0\gamma^{[0]} + iM_4\beta^{[4]}$$

contains only the light pentad elements. I call the following sum

$$\widehat{H}_l \stackrel{def}{=} \sum_{k=1}^3 \beta^{[k]} (i\partial_k - \Theta_k - \Upsilon_k\gamma^{[5]}) - M_0\gamma^{[0]} - M_4\beta^{[4]} \quad (14)$$

as the lepton hamiltonian.

**3 Rotation of  $x_5 O x_4$  and  $B$ -bosonn**

If denote (6):

$$j_4 \stackrel{def}{=} -\varphi^* \beta^{[4]} \varphi \text{ and } j_5 \stackrel{def}{=} -\varphi^* \gamma^{[0]} \varphi$$

and (7):

$$\rho_\varphi(t, \mathbf{x}) u_4 \stackrel{def}{=} j_4 \text{ and } \rho_\varphi(t, \mathbf{x}) u_5 \stackrel{def}{=} j_5,$$

then

$$u_1^2 + u_2^2 + u_3^2 + u_4^2 + u_5^2 = 1.$$

Hence, only all the five elements of the Clifford pentad lend the entire kit of the velocity components. Two more "space" coordinates  $x_5$  and  $x_4$  should be added to our three  $x_1, x_2, x_3$  for the completeness. These additional coordinates can be chosen such that

$$-\frac{\pi}{h} \leq x_5 \leq \frac{\pi}{h}, -\frac{\pi}{h} \leq x_4 \leq \frac{\pi}{h}.$$

$x_4$  and  $x_5$  are not coordinates of any physics events. Hence our devices do not detect these coordinates as our space coordinates.

Let us denote:

$$\begin{aligned} \tilde{\varphi}(t, x_1, x_2, x_3, x_5, x_4) &\stackrel{def}{=} \varphi(t, x_1, x_2, x_3) \cdot \\ &\cdot (\exp(-i(x_5 M_0(t, x_1, x_2, x_3) + x_4 M_4(t, x_1, x_2, x_3)))) \end{aligned}$$

In this case the motion equation for the leptonn hamiltonian (14) is the following:

$$\left( \sum_{\mu=0}^3 \beta^{[\mu]} (i\partial_\mu - \Theta_\mu - \Upsilon_\mu \gamma^{[5]}) + \gamma^{[0]} i\partial_5 + \beta^{[4]} i\partial_4 \right) \tilde{\varphi} = 0. \quad (15)$$

Let  $g_1$  be some positive real number and for  $\mu \in \{0, 1, 2, 3\}$ :  $F_\mu$  and  $B_\mu$  be the solutions of the following system of the equations:

$$\begin{cases} -0.5g_1 B_\mu + F_\mu = -\Theta_\mu - \Upsilon_\mu; \\ -g_1 B_\mu + F_\mu = -\Theta_\mu + \Upsilon_\mu. \end{cases}$$

Let *the charge matrix* be denoted as the following:

$$Y \stackrel{def}{=} - \begin{bmatrix} 1_2 & 0_2 \\ 0_2 & 1_2 \end{bmatrix}.$$

Hence from (15):

$$\left( \sum_{\mu=0}^3 \beta^{[\mu]} (i\partial_\mu + F_\mu + 0.5g_1 Y B_\mu) + \gamma^{[0]} i\partial_5 + \beta^{[4]} i\partial_4 \right) \tilde{\varphi} = 0. \quad (16)$$

Let  $\chi(t, x_1, x_2, x_3)$  be any real function and:

$$\tilde{U}(\chi) \stackrel{def}{=} \begin{bmatrix} \exp(i\frac{\chi}{2}) 1_2 & 0_2 \\ 0_2 & \exp(i\chi) 1_2 \end{bmatrix}. \quad (17)$$

The motion equation (16) is invariant for the following transformation (rotation of  $x_4 O x_5$ ):

$$\begin{aligned} x_4 &\rightarrow x'_4 = x_4 \cos \frac{\chi}{2} - x_5 \sin \frac{\chi}{2}; \\ x_5 &\rightarrow x'_5 = x_5 \cos \frac{\chi}{2} + x_4 \sin \frac{\chi}{2}; \\ x_\mu &\rightarrow x'_\mu = x_\mu \text{ for } \mu \in \{0, 1, 2, 3\}; \\ Y &\rightarrow Y' = \tilde{U}^\dagger Y \tilde{U} = Y; \\ \tilde{\varphi} &\rightarrow \tilde{\varphi}' = \tilde{U} \tilde{\varphi}, \\ B_\mu &\rightarrow B'_\mu = B_\mu - \frac{1}{g_1} \partial_\mu \chi, \\ F_\mu &\rightarrow F'_\mu = F_\mu. \end{aligned} \quad (18)$$

Hence  $B_\mu$  is similar to the  $B$ -boson field from Standard Model. I call it as  $B$ -bosonn.

Let  $\epsilon_\mu$  ( $\mu \in \{1, 2, 3, 4\}$ ) be the basis such that in this basis the light pentad has got the form (1).

Spinor functions of type

$$\frac{h}{2\pi} \exp(-ih(sx_4 + nx_5)) \epsilon_k$$

with integer  $n$  and  $s$  make up an orthonormal basis of some space (let us denote this space as  $\mathfrak{S}$ ) with the following scalar product:

$$\tilde{\varphi} * \tilde{\chi} \stackrel{def}{=} \int_{-\frac{\pi}{h}}^{\frac{\pi}{h}} dx_5 \int_{-\frac{\pi}{h}}^{\frac{\pi}{h}} dx_4 \cdot (\tilde{\varphi}^\dagger \cdot \tilde{\chi}). \quad (19)$$

In this case from (6):

$$\tilde{\varphi} * \beta^{[\mu]} \tilde{\varphi} = -j_\mu \quad (20)$$

for  $\mu \in \{0, 1, 2, 3\}$ .

The Fourier series for  $\tilde{\varphi}(t, \mathbf{x}, x_5, x_4)$  has got the following form:

$$\begin{aligned} & \tilde{\varphi}(t, \mathbf{x}, x_5, x_4) = \\ & = \sum_{n,s} \phi(t, \mathbf{x}, n, s) \frac{\hbar}{2\pi} \exp(-ih(nx_5 + sx_4)). \end{aligned} \quad (21)$$

The integer numbers  $n$  and  $s$  be called as *mass numbers* for  $\tilde{\varphi}$  and  $\sqrt{n^2 + s^2}$  is called as the mass for  $\tilde{\varphi}$ .

#### 4 The one-mass state, particles and antiparticles.

Let (21):

$$\tilde{\varphi}(t, \mathbf{x}, x_5, x_4) = \exp(-ihn x_5) \sum_{j=1}^4 \phi_j(t, \mathbf{x}, n, 0) \epsilon_j$$

with  $n$  as some natural number. In that case the hamiltonian has got the following form from (16):

$$\hat{H} = \sum_{k=1}^3 \beta^{[k]} i \partial_k + hn \gamma^{[0]} + \hat{G}$$

with

$$\hat{G} \stackrel{def}{=} \sum_{\mu=0}^3 \beta^{[\mu]} (F_\mu + 0.5g_1 Y B_\mu).$$

If

$$\hat{H}_0 \stackrel{def}{=} \sum_{k=1}^3 \beta^{[k]} i \partial_k + hn \gamma^{[0]} \quad (22)$$

then the functions

$$u_1(\mathbf{k}) \exp(-ih\mathbf{k}\mathbf{x}) \text{ and } u_2(\mathbf{k}) \exp(-ih\mathbf{k}\mathbf{x})$$

with

$$u_1(\mathbf{k}) \stackrel{def}{=} \frac{1}{2\sqrt{\omega(\mathbf{k}) (\omega(\mathbf{k}) + n)}} \begin{bmatrix} \omega(\mathbf{k}) + n + k_3 \\ k_1 + ik_2 \\ \omega(\mathbf{k}) + n - k_3 \\ -k_1 - ik_2 \end{bmatrix}$$

and

$$u_2(\mathbf{k}) \stackrel{def}{=} \frac{1}{2\sqrt{\omega(\mathbf{k})(\omega(\mathbf{k})+n)}} \begin{bmatrix} k_1 - ik_2 \\ \omega(\mathbf{k}) + n - k_3 \\ -k_1 + ik_2 \\ \omega(\mathbf{k}) + n + k_3 \end{bmatrix}$$

are the eigenvectors of  $\widehat{H}_0$  with the eigenvalue  $\omega(\mathbf{k}) \stackrel{def}{=} \sqrt{\mathbf{k}^2 + n^2}$  and the functions

$$u_3(\mathbf{k}) \exp(-ih\mathbf{k}\mathbf{x}) \text{ and } u_4(\mathbf{k}) \exp(-ih\mathbf{k}\mathbf{x})$$

with

$$u_3(\mathbf{k}) \stackrel{def}{=} \frac{1}{2\sqrt{\omega(\mathbf{k})(\omega(\mathbf{k})+n)}} \begin{bmatrix} -\omega(\mathbf{k}) - n + k_3 \\ k_1 + ik_2 \\ \omega(\mathbf{k}) + n + k_3 \\ k_1 + ik_2 \end{bmatrix}$$

and

$$u_4(\mathbf{k}) \stackrel{def}{=} \frac{1}{2\sqrt{\omega(\mathbf{k})(\omega(\mathbf{k})+n)}} \begin{bmatrix} k_1 - ik_2 \\ -\omega(\mathbf{k}) - n - k_3 \\ k_1 - ik_2 \\ \omega(\mathbf{k}) + n - k_3 \end{bmatrix}$$

are the eigenvectors of  $\widehat{H}_0$  with the eigenvalue  $-\omega(\mathbf{k})$ .

Here  $u_\mu(\mathbf{k})$  form an orthonormal basis in the space, spanned on vectors  $\epsilon_\mu$ .

Let :

$$b_{r,\mathbf{k}} \stackrel{def}{=} \left(\frac{h}{2\pi}\right)^3 \sum_{j'=1}^4 \int_{(V)} d^3\mathbf{x}' \cdot e^{ih\mathbf{k}\mathbf{x}'} u_{r,j'}^*(\mathbf{k}) \psi_{j'}(\mathbf{x}')$$

In that case

$$\psi_j(\mathbf{x}) = \sum_{\mathbf{k}} e^{-ih\mathbf{k}\mathbf{x}} \sum_{r=1}^4 b_{r,\mathbf{k}} u_{r,j}(\mathbf{k}) \quad (23)$$

with

$$\sum_{\mathbf{k}} \stackrel{def}{=} \sum_{k_1=-\infty}^{\infty} \sum_{k_2=-\infty}^{\infty} \sum_{k_3=-\infty}^{\infty} ;$$

and in this case

$$\begin{aligned} \{b_{s,\mathbf{k}'}^\dagger, b_{r,\mathbf{k}}\} &= \left(\frac{\hbar}{2\pi}\right)^3 \delta_{s,r} \delta_{\mathbf{k},\mathbf{k}'}, \\ \{b_{s,\mathbf{k}'}^\dagger, b_{r,\mathbf{k}}^\dagger\} &= 0 = \{b_{s,\mathbf{k}'}, b_{r,\mathbf{k}}\}, \\ b_{r,\mathbf{k}} \Phi_0 &= 0. \end{aligned} \tag{24}$$

The hamiltonian density (11) for  $\widehat{H}_0$  is the following:

$$\mathcal{H}_0(\mathbf{x}) = \sum_{j=1}^4 \psi_j^\dagger(\mathbf{x}) \sum_{k=1}^4 \widehat{H}_{0,j,k} \psi_k(\mathbf{x}).$$

Hence from (23):

$$\int_{(V)} d^3\mathbf{x} \cdot \mathcal{H}_0(\mathbf{x}) = \left(\frac{2\pi}{\hbar}\right)^3 \sum_{\mathbf{k}} \hbar\omega(\mathbf{k}) \cdot \left(\sum_{r=1}^2 b_{r,\mathbf{k}}^\dagger b_{r,\mathbf{k}} - \sum_{r=3}^4 b_{r,\mathbf{k}}^\dagger b_{r,\mathbf{k}}\right)$$

Let the Fourier transformation for  $\varphi$  be the following:

$$\varphi_j(t, \mathbf{x}) = \sum_{\mathbf{p}} \sum_{r=1}^4 c_r(t, \mathbf{p}) u_{r,j}(\mathbf{p}) e^{-i\mathbf{h}\mathbf{p}\mathbf{x}}$$

with

$$c_r(t, \mathbf{p}) \stackrel{def}{=} \left(\frac{\hbar}{2\pi}\right)^3 \sum_{j'=1}^4 \int_{(V)} d^3\mathbf{x}' \cdot u_{r,j'}^*(\mathbf{p}) \varphi_{j'}(t, \mathbf{x}') e^{i\mathbf{h}\mathbf{p}\mathbf{x}'}$$

I call a function  $\varphi_j(t, \mathbf{x})$  as an *ordinary function* if there exists some real positive number  $L$  such that

if  $|p_1| > L$  or/and  $|p_2| > L$  or/and  $|p_3| > L$  then  $c_r(t, \mathbf{p}) = 0$ .

In that case I denote:

$$\sum_{\mathbf{p} \in \Xi} \stackrel{def}{=} \sum_{p_1=-L}^L \sum_{p_2=-L}^L \sum_{p_3=-L}^L .$$

If  $\varphi_j(t, \mathbf{x})$  is an ordinary function then:

$$\varphi_j(t, \mathbf{x}) = \sum_{\mathbf{p} \in \Xi} \sum_{r=1}^4 c_r(t, \mathbf{p}) u_{r,j}(\mathbf{p}) e^{-i\mathbf{h}\mathbf{p}\mathbf{x}}.$$

Hence from (10):

$$\Psi(t, \mathbf{x}) = \sum_{\mathbf{p}} \sum_{r=1}^4 \sum_{\mathbf{k}} \sum_{r'=1}^4 c_r(t, \mathbf{p}) e^{ih(\mathbf{k}-\mathbf{p})\mathbf{x}} \sum_{j=1}^4 u_{r',j}^*(\mathbf{k}) u_{r,j}(\mathbf{p}) b_{r',\mathbf{k}}^\dagger \Phi_0$$

and

$$\int_{(V)} d^3\mathbf{x} \cdot \Psi(t, \mathbf{x}) = \left(\frac{2\pi}{h}\right)^3 \sum_{\mathbf{p}} \sum_{r=1}^4 c_r(t, \mathbf{p}) b_{r,\mathbf{p}}^\dagger \Phi_0.$$

If denote:

$$\tilde{\Psi}(t, \mathbf{p}) \stackrel{def}{=} \left(\frac{2\pi}{h}\right)^3 \sum_{r=1}^4 c_r(t, \mathbf{p}) b_{r,\mathbf{p}}^\dagger \Phi_0$$

then

$$\int_{(V)} d^3\mathbf{x} \cdot \Psi(t, \mathbf{x}) = \sum_{\mathbf{p}} \tilde{\Psi}(t, \mathbf{p})$$

and

$$H_0 \tilde{\Psi}(t, \mathbf{p}) = \left(\frac{2\pi}{h}\right)^3 \sum_{\mathbf{k}} h\omega(\mathbf{k}) \cdot \left( \sum_{r=1}^2 c_r(t, \mathbf{k}) b_{r,\mathbf{k}}^\dagger \Phi_0 - \sum_{r=3}^4 c_r(t, \mathbf{k}) b_{r,\mathbf{k}}^\dagger \Phi_0 \right).$$

$H_0$  is equivalent to the following operator:

$$\tilde{H}_0 \stackrel{def}{=} \left(\frac{2\pi}{h}\right)^3 \sum_{\mathbf{k} \in \Xi} h\omega(\mathbf{k}) \cdot \left( \sum_{r=1}^2 b_{r,\mathbf{k}}^\dagger b_{r,\mathbf{k}} - \sum_{r=3}^4 b_{r,\mathbf{k}}^\dagger b_{r,\mathbf{k}} \right).$$

on the set of ordinary functions.

Because from (24)

$$b_{r,\mathbf{k}}^\dagger b_{r,\mathbf{k}} = \left(\frac{h}{2\pi}\right)^3 - b_{r,\mathbf{k}} b_{r,\mathbf{k}}^\dagger$$

then

$$\begin{aligned} \tilde{H}_0 = & \left(\frac{2\pi}{h}\right)^3 \sum_{\mathbf{k} \in \Xi} h\omega(\mathbf{k}) \left( \sum_{r=1}^2 b_{r,\mathbf{k}}^\dagger b_{r,\mathbf{k}} + \sum_{r=3}^4 b_{r,\mathbf{k}} b_{r,\mathbf{k}}^\dagger \right) - \\ & - h \sum_{\mathbf{k} \in \Xi} \omega(\mathbf{k}). \end{aligned} \quad (25)$$

Let:

$$\begin{aligned}
 v_{(1)}(\mathbf{k}) &\stackrel{def}{=} \gamma^{[0]} u_3(\mathbf{k}), \\
 v_{(2)}(\mathbf{k}) &\stackrel{def}{=} \gamma^{[0]} u_4(\mathbf{k}), \\
 u_{(1)}(\mathbf{k}) &\stackrel{def}{=} u_1(\mathbf{k}), \\
 u_{(2)}(\mathbf{k}) &\stackrel{def}{=} u_2(\mathbf{k})
 \end{aligned} \tag{26}$$

and let:

$$\begin{aligned}
 d_1(\mathbf{k}) &\stackrel{def}{=} -b_3^\dagger(-\mathbf{k}), \\
 d_2(\mathbf{k}) &\stackrel{def}{=} -b_4^\dagger(-\mathbf{k}).
 \end{aligned}$$

In that case:

$$\psi_j(\mathbf{x}) = \sum_{\mathbf{k}} \sum_{\alpha=1}^2 \left( e^{-i\hbar\mathbf{k}\mathbf{x}} b_{\alpha,\mathbf{k}} u_{(\alpha),j}(\mathbf{k}) + e^{i\hbar\mathbf{k}\mathbf{x}} d_{\alpha,\mathbf{k}}^\dagger v_{(\alpha),j}(\mathbf{k}) \right)$$

and from (25) the Wick-ordered hamiltonian has got the following form:

$$: \bar{H}_0 : = \left( \frac{2\pi}{h} \right)^3 h \sum_{\mathbf{k} \in \Xi} \omega(\mathbf{k}) \sum_{\alpha=1}^2 \left( b_{\alpha,\mathbf{k}}^\dagger b_{\alpha,\mathbf{k}} + d_{\alpha,\mathbf{k}}^\dagger d_{\alpha,\mathbf{k}} \right).$$

Here  $b_{\alpha,\mathbf{k}}^\dagger$  are called as *creation operators* and  $b_{\alpha,\mathbf{k}}$  are called as *annihilation operators* of *n-leptonn* with the *momentum*  $\mathbf{k}$  and the *spin index*  $\alpha$ ;  $d_{\alpha,\mathbf{k}}^\dagger$  are called as *creation operators* and  $d_{\alpha,\mathbf{k}}$  are *annihilation operators* of *anti-n-leptonn* with the *momentum*  $\mathbf{k}$  and *spin index*  $\alpha$ .

Functions:

$$u_{(1)}(\mathbf{k}) \exp(-i\hbar\mathbf{k}\mathbf{x}) \text{ and } u_{(2)}(\mathbf{k}) \exp(-i\hbar\mathbf{k}\mathbf{x})$$

are called as *the basic n-leptonn functions* with momentum  $\mathbf{k}$  and

$$v_{(1)}(\mathbf{k}) \exp(i\hbar\mathbf{k}\mathbf{x}) \text{ and } v_{(2)}(\mathbf{k}) \exp(i\hbar\mathbf{k}\mathbf{x})$$

are called as *the anti-n-leptonn basic functions* with momentum  $\mathbf{k}$ .

Therefore there arise particles and antiparticles from probabilities of point events.



**5 The bi-mass state [7], [8]**

We consider subspace of space  $\mathfrak{S}$  spanned by the following subbasis:

$$j = \left\langle \begin{array}{l} \frac{\hbar}{2\pi} \exp(-ih(s_0x_4)) \epsilon_1, \frac{\hbar}{2\pi} \exp(-ih(s_0x_4)) \epsilon_2, \\ \frac{\hbar}{2\pi} \exp(-ih(s_0x_4)) \epsilon_3, \frac{\hbar}{2\pi} \exp(-ih(s_0x_4)) \epsilon_4, \\ \frac{\hbar}{2\pi} \exp(-ih(n_0x_5)) \epsilon_1, \frac{\hbar}{2\pi} \exp(-ih(n_0x_5)) \epsilon_2, \\ \frac{\hbar}{2\pi} \exp(-ih(n_0x_5)) \epsilon_3, \frac{\hbar}{2\pi} \exp(-ih(n_0x_5)) \epsilon_4 \end{array} \right\rangle$$

with some natural  $s_0$  and  $n_0$ . Denote this subspace as  $\mathfrak{S}_j$ .

Let  $U$  be any linear transformation at the space  $\mathfrak{S}_j$  (see Appendix) such that for any  $\tilde{\varphi} : \text{if } \tilde{\varphi} \in \mathfrak{S}_j \text{ then}$

$$-(U\tilde{\varphi})^\dagger * \beta^{[\mu]} (U\tilde{\varphi}) = j_\mu \tag{27}$$

for  $\mu \in \{0, 1, 2, 3\}$  (20).

For every such transformation there exist real functions  $\chi(t, \mathbf{x})$ ,  $\alpha(t, \mathbf{x})$ ,  $a(t, \mathbf{x})$ ,  $b(t, \mathbf{x})$ ,  $c(t, \mathbf{x})$ ,  $q(t, \mathbf{x})$ ,  $u(t, \mathbf{x})$ ,  $v(t, \mathbf{x})$ ,  $k(t, \mathbf{x})$ ,  $s(t, \mathbf{x})$  such that

$$U = \exp(i\alpha) \tilde{U}(\chi) U^{(-)} U^{(+)}$$

with  $\tilde{U}(\chi)$  as denoted by (17) and  $U^{(-)}$  and  $U^{(+)}$  have got the following matrix form in the basis  $j$ :

$$U^{(-)}(t, \mathbf{x}) = S(a(t, \mathbf{x}), b(t, \mathbf{x}), c(t, \mathbf{x}), q(t, \mathbf{x}))$$

with

$$a^2(t, \mathbf{x}) + b^2(t, \mathbf{x}) + c^2(t, \mathbf{x}) + q^2(t, \mathbf{x}) = 1$$

and

$$S(a, b, c, q) \stackrel{def}{=} \begin{bmatrix} (a + ib) 1_2 & 0_2 & (c + iq) 1_2 & 0_2 \\ 0_2 & 1_2 & 0_2 & 0_2 \\ (-c + iq) 1_2 & 0_2 & (a - ib) 1_2 & 0_2 \\ 0_2 & 0_2 & 0_2 & 1_2 \end{bmatrix},$$

and

$$U^{(+)}(t, \mathbf{x}) = R(u(t, \mathbf{x}), v(t, \mathbf{x}), k(t, \mathbf{x}), s(t, \mathbf{x})) \tag{28}$$

with

$$u^2(t, \mathbf{x}) + v^2(t, \mathbf{x}) + k^2(t, \mathbf{x}) + s^2(t, \mathbf{x}) = 1$$

and

$$R(u, v, k, s) \stackrel{def}{=} \begin{bmatrix} 1_2 & 0_2 & 0_2 & 0_2 \\ 0_2 & (u + iv) 1_2 & 0_2 & (k + is) 1_2 \\ 0_2 & 0_2 & 1_2 & 0_2 \\ 0_2 & (-k + is) 1_2 & 0_2 & (u - iv) 1_2 \end{bmatrix}. \tag{29}$$

$U^{(+)}$  correspond to antileptonns since  $R = S\gamma^{[5]}$  (26).

Let us consider  $U^{(-)}$ .

Let us denote:

$$\ell_o \stackrel{def}{=} \iota_o(a, b, q, c), \ell_* \stackrel{def}{=} \iota_*(a, b, q, c)$$

with

$$\iota_o(a, b, q, c) \stackrel{def}{=} \frac{1}{2\sqrt{(1-a^2)}} \begin{bmatrix} (b + \sqrt{(1-a^2)}) 1_4 & (q - ic) 1_4 \\ (q + ic) 1_4 & (\sqrt{(1-a^2)} - b) 1_4 \end{bmatrix}$$

and

$$\iota_*(a, b, q, c) \stackrel{def}{=} \frac{1}{2\sqrt{(1-a^2)}} \begin{bmatrix} (\sqrt{(1-a^2)} - b) 1_4 & (-q + ic) 1_4 \\ (-q - ic) 1_4 & (b + \sqrt{(1-a^2)}) 1_4 \end{bmatrix}.$$

If

$$\partial_\mu U^{(-)\dagger} = U^{(-)\dagger} \partial_\mu \tag{30}$$

for  $\mu \in \{0, 1, 2, 3\}$  then the leptonn hamiltonian is invariant for the following global transformation:

$$\begin{aligned} \tilde{\varphi} &\rightarrow \tilde{\varphi}' = U^{(-)} \tilde{\varphi}, \\ x_4 &\rightarrow x'_4 = (\ell_o + \ell_*) ax_4 + (\ell_o - \ell_*) \sqrt{1-a^2} x_5, \\ x_5 &\rightarrow x'_5 = (\ell_o + \ell_*) ax_5 - (\ell_o - \ell_*) \sqrt{1-a^2} x_4, \\ x_\mu &\rightarrow x'_\mu = x_\mu. \end{aligned} \tag{31}$$

Let (30) does not hold true and:

$$K \stackrel{def}{=} \sum_{\mu=0}^3 \beta^{[\mu]} (F_\mu + 0.5g_1 Y B_\mu). \tag{32}$$

In that case from (16) the motion equation has got the following form:

$$\left( K + \sum_{\mu=0}^3 \beta^{[\mu]} i \partial_\mu + \gamma^{[0]} i \partial_5 + \beta^{[4]} i \partial_4 \right) \tilde{\varphi} = 0. \tag{33}$$

Hence for the following transformations:

$$\begin{aligned}
\tilde{\varphi} &\rightarrow \tilde{\varphi}' \stackrel{def}{=} U^{(-)} \tilde{\varphi}, \\
x_4 &\rightarrow x'_4 \stackrel{def}{=} (\ell_o + \ell_*) a x_4 + (\ell_o - \ell_*) \sqrt{1 - a^2} x_5, \\
x_5 &\rightarrow x'_5 \stackrel{def}{=} (\ell_o + \ell_*) a x_5 - (\ell_o - \ell_*) \sqrt{1 - a^2} x_4, \\
x_\mu &\rightarrow x'_\mu \stackrel{def}{=} x_\mu, \text{ for } \mu \in \{0, 1, 2, 3\}, \\
K &\rightarrow K'
\end{aligned} \tag{34}$$

with

$$\partial_4 U^{(-)} = U^{(-)} \partial_4 \text{ and } \partial_5 U^{(-)} = U^{(-)} \partial_5$$

this equation has got the following form (see Appendix):

$$\left( \begin{array}{c} U^{(-)\dagger} K' U^{(-)} + \\ + \sum_{\mu=0}^3 \beta^{[\mu]} i (\partial_\mu + U^{(-)\dagger} (\partial_\mu U^{(-)})) + \gamma^{[0]} i \partial_5 + \beta^{[4]} i \partial_4 \end{array} \right) \tilde{\varphi} = 0. \tag{35}$$

Therefore if

$$K' = K - i \sum_{\mu=0}^3 \beta^{[\mu]} (\partial_\mu U^{(-)}) U^{(-)\dagger} \tag{36}$$

then the equation (33) is invariant for the local transformation (34).

Let  $g_2$  be some positive real number.

If design  $(a, b, c, q)$  form  $U^{(-)}$ :

$$W_\mu^0, \stackrel{def}{=} -\frac{2}{g_2 q} \left( \begin{array}{c} q (\partial_\mu a) b - q (\partial_\mu b) a + (\partial_\mu c) q^2 + \\ + a (\partial_\mu a) c + b (\partial_\mu b) c + c^2 (\partial_\mu c) \end{array} \right)$$

$$W_\mu^1, \stackrel{def}{=} -\frac{2}{g_2 q} \left( \begin{array}{c} (\partial_\mu a) a^2 - b q (\partial_\mu c) + a (\partial_\mu b) b + \\ + a (\partial_\mu c) c + q^2 (\partial_\mu a) + c (\partial_\mu b) q \end{array} \right)$$

$$W_\mu^2, \stackrel{def}{=} -\frac{2}{g_2 q} \left( \begin{array}{c} q (\partial_\mu a) c - a (\partial_\mu a) b - b^2 (\partial_\mu b) - \\ - c (\partial_\mu c) b - (\partial_\mu b) q^2 - (\partial_\mu c) q a \end{array} \right)$$

and

$$W_\mu \stackrel{def}{=} \begin{bmatrix} W_\mu^0, 1_2 & 0_2 (W_\mu^1, -iW_\mu^2,) 1_2 0_2 \\ 0_2 & 0_2 & 0_2 & 0_2 \\ (W_\mu^1, +iW_\mu^2,) 1_2 0_2 & -W_\mu^0, 1_2 & 0_2 & 0_2 \\ 0_2 & 0_2 & 0_2 & 0_2 \end{bmatrix}$$

then

$$-i \left( \partial_\mu U^{(-)} \right) U^{(-)\dagger} = \frac{1}{2} g_2 W_\mu, \tag{37}$$

and from (37), (32), (36), (33):

$$\left( \sum_{\mu=0}^3 \beta^{[\mu]} i \left( \partial_\mu - i0.5g_1 B_\mu Y - i\frac{1}{2}g_2 W_\mu - iF_\mu \right) + \gamma^{[0]} i \partial'_5 + \beta^{[4]} i \partial'_4 \right) \tilde{\varphi}' = 0. \tag{38}$$

Let

$$U' \stackrel{def}{=} S(a', b', c', q').$$

In this case if

$$U'' \stackrel{def}{=} U' U^{(-)}$$

then there exist some real functions  $a''(t, \mathbf{x})$ ,  $b''(t, \mathbf{x})$ ,  $c''(t, \mathbf{x})$ ,  $q''(t, \mathbf{x})$  such that  $U''$  has got the similar form:

$$U'' \stackrel{def}{=} S(a'', b'', c'', q'').$$

If

$$\ell''_o \stackrel{def}{=} \iota_o(a'', b'', q'', c''), \ell''_* \stackrel{def}{=} \iota_*(a'', b'', q'', c'');$$

$$\begin{aligned} \tilde{\varphi} &\rightarrow \tilde{\varphi}'' \stackrel{def}{=} U'' \tilde{\varphi}, \\ x_4 &\rightarrow x''_4 \stackrel{def}{=} (\ell''_o + \ell''_*) a'' x_4 + (\ell''_o - \ell''_*) \sqrt{1 - a''^2} x_5, \\ x_5 &\rightarrow x''_5 \stackrel{def}{=} (\ell''_o + \ell''_*) a'' x_5 - (\ell''_o - \ell''_*) \sqrt{1 - a''^2} x_4, \\ x_\mu &\rightarrow x''_\mu \stackrel{def}{=} x_\mu, \text{ for } \mu \in \{0, 1, 2, 3\}, \\ K &\rightarrow K'' \stackrel{def}{=} \sum_{\mu=0}^3 \beta^{[\mu]} \left( F_\mu + 0.5g_1 Y B_\mu + \frac{1}{2}g_2 W''_\mu \right) \end{aligned} \tag{39}$$

then from (37):

$$W''_\mu = -\frac{2i}{g_2} \left( \partial_\mu \left( U' U^{(-)} \right) \right) \left( U' U^{(-)} \right)^\dagger.$$

Hence:

$$W''_\mu = -\frac{2i}{g_2} (\partial_\mu U') U'^\dagger - \frac{2i}{g_2} U' \left( \partial_\mu U^{(-)} \right) U^{(-)\dagger} U'^\dagger,$$

i.e. from (37):

$$W''_{\mu} = U' W_{\mu} U'^{\dagger} - \frac{2i}{g_2} (\partial_{\mu} U') U'^{\dagger} \quad (40)$$

as in Standard Model.

The motion equation of the Yang-Mills SU(2) field at the space without matter (for instance [9] or [10] ) has got the following form:

$$\partial^{\nu} \mathbf{W}_{\mu\nu} = -g_2 \mathbf{W}^{\nu} \times \mathbf{W}_{\mu\nu}$$

with:

$$\mathbf{W}_{\mu\nu} = \partial_{\mu} \mathbf{W}_{\nu} - \partial_{\nu} \mathbf{W}_{\mu} + g_2 \mathbf{W}_{\mu} \times \mathbf{W}_{\nu}$$

and

$$\mathbf{W}_{\mu} = \begin{bmatrix} W_{\mu}^0 \\ W_{\mu}^1 \\ W_{\mu}^2 \end{bmatrix}.$$

Hence the motion equation for  $W_{\mu}^0$ , is the following:

$$\begin{aligned} \partial^{\nu} \partial_{\nu} W_{\mu}^0 &= g_2^2 (W^{2,\nu} W_{\nu}^2 + W^{1,\nu} W_{\nu}^1) W_{\mu}^0 - \\ &\quad - g_2^2 (W^{1,\nu} W_{\mu}^1 + W^{2,\nu} W_{\mu}^2) W_{\nu}^0 + \\ &\quad + g_2 \partial^{\nu} (W_{\mu}^1 W_{\nu}^2 - W_{\mu}^2 W_{\nu}^1) + \\ + g_2 (W^{1,\nu} \partial_{\mu} W_{\nu}^2 &- W^{1,\nu} \partial_{\nu} W_{\mu}^2 - W^{2,\nu} \partial_{\mu} W_{\nu}^1 + W^{2,\nu} \partial_{\nu} W_{\mu}^1) + \\ &\quad + \partial^{\nu} \partial_{\mu} W_{\nu}^0, \end{aligned} \quad (41)$$

with  $g_{0,0} = 1$ ,  $g_{1,1} = g_{2,2} = g_{3,3} = -1$  (i.e.:  $W^{\nu} W_{\nu} = W^0 W_0 - W^1 W_1 - W^2 W_2 - W^3 W_3$ . For the gauging with  $W_0 = 0$ :  $W^{\nu} W_{\nu} = - (W^1 W_1 + W^2 W_2 + W^3 W_3)$  ).

$W_{\mu}^1$ , and  $W_{\mu}^2$ , satisfy to similar equations.

This equation can be reformed as the following:

$$\begin{aligned} \partial^{\nu} \partial_{\nu} W_{\mu}^0 &= [g_2^2 (W^{2,\nu} W_{\nu}^2 + W^{1,\nu} W_{\nu}^1 + W^{0,\nu} W_{\nu}^0)] \cdot W_{\mu}^0 - \\ &\quad - g_2^2 (W^{1,\nu} W_{\mu}^1 + W^{2,\nu} W_{\mu}^2 + W^{0,\nu} W_{\mu}^0) W_{\nu}^0 + \\ &\quad + g_2 \partial^{\nu} (W_{\mu}^1 W_{\nu}^2 - W_{\mu}^2 W_{\nu}^1) + \\ + g_2 (W^{1,\nu} \partial_{\mu} W_{\nu}^2 &- W^{1,\nu} \partial_{\nu} W_{\mu}^2 - W^{2,\nu} \partial_{\mu} W_{\nu}^1 + W^{2,\nu} \partial_{\nu} W_{\mu}^1) + \\ &\quad + \partial^{\nu} \partial_{\mu} W_{\nu}^0. \end{aligned}$$

This equation looks like to the Klein-Gordon equation of field  $W_{\mu}^0$ , with mass

$$g_2 [- (W^{2,\nu} W_{\nu}^2 + W^{1,\nu} W_{\nu}^1 + W^{0,\nu} W_{\nu}^0)]^{\frac{1}{2}}. \quad (42)$$

and with the additional terms of the  $W_\mu^0$ , interactions with others components of  $\mathbf{W}$ .

”Mass” (42) is invariant for the following transformations:

$$\begin{cases} W_r^{k,\prime} = W_r^k \cos \lambda - W_s^k \sin \lambda, \\ W_s^{k,\prime} = W_r^k \sin \lambda + W_s^k \cos \lambda; \end{cases}$$

$$\begin{cases} W_0^{k,\prime} = W_0^k \cosh \lambda - W_s^k \sinh \lambda, \\ W_s^{k,\prime} = W_s^k \cosh \lambda - W_0^k \sinh \lambda \end{cases}$$

with real number  $\lambda$  and  $r \in \{1, 2, 3\}$  and  $s \in \{1, 2, 3\}$ , and (42) is invariant for global weak isospin transformation  $U'$ :

$$W'_\nu \rightarrow W''_\nu = U' W_\nu U'^\dagger$$

but is not invariant for local transformation (40)

Equation (41) can be simplified as follows:

$$\begin{aligned} \sum_\nu g_{\nu,\nu} \partial^\nu \partial_\nu W_\mu^0 = & \left[ g_2^2 \sum_{\nu \neq \mu} g_{\nu,\nu} \left( (W_\nu^2)^2 + (W_\nu^1)^2 \right) \right] \cdot W_\mu^0 - \\ & - g_2^2 \sum_{\nu \neq \mu} g_{\nu,\nu} \left( W^{1,\nu} W_\mu^1 + W^{2,\nu} W_\mu^2 \right) W_\nu^0 - \\ & + g_2 \sum_\nu g_{\nu,\nu} \partial^\nu \left( W_\mu^1 W_\nu^2 - W_\mu^2 W_\nu^1 \right) + \\ + g_2 \sum_\nu g_{\nu,\nu} \left( W^{1,\nu} \partial_\mu W_\nu^2 - W^{1,\nu} \partial_\nu W_\mu^2 - W^{2,\nu} \partial_\mu W_\nu^1 + W^{2,\nu} \partial_\nu W_\mu^1 \right) + \\ & + \partial_\mu \sum_\nu g_{\nu,\nu} \partial^\nu W_\nu^0. \end{aligned}$$

(here no of summation over indexes  $\nu$ ; the summation is expressed by  $\sum$ ).

In this equation the form

$$g_2 \left[ - \sum_{\nu \neq \mu} g_{\nu,\nu} \left( (W_\nu^2)^2 + (W_\nu^1)^2 \right) \right]^{\frac{1}{2}}$$

varies at space, but this does not contain  $W_\mu^0$ , and locally acts as mass, i.e. this does not allow to particles of this field to behave as a massless ones.

Let

$$\begin{aligned} \alpha & \stackrel{def}{=} \arctan \frac{g_1}{g_2}, \\ Z_\mu & \stackrel{def}{=} \left( W_\mu^0 \cos \alpha - B_\mu \sin \alpha \right), \\ A_\mu & \stackrel{def}{=} \left( B_\mu \cos \alpha + W_\mu^0 \sin \alpha \right). \end{aligned}$$

In that case:

$$\sum_{\nu} g_{\nu,\nu} \partial_{\nu} \partial_{\nu} W_{\mu}^0 = \cos \alpha \cdot \sum_{\nu} g_{\nu,\nu} \partial_{\nu} \partial_{\nu} Z_{\mu} + \sin \alpha \cdot \sum_{\nu} g_{\nu,\nu} \partial_{\nu} \partial_{\nu} A_{\mu}.$$

If

$$\sum_{\nu} g_{\nu,\nu} \partial_{\nu} \partial_{\nu} A_{\mu} = 0$$

then

$$m_Z = \frac{m_W}{\cos \alpha}$$

with  $m_W$  from (42). This is almost as in Standard Model.

## 6 Conclusion

Therefore we ourselves choose the expression of a probability in the form (4). We ourselves introduce a creation operator and an annihilation operator of an event probability. We ourselves add two more quasispace coordinates to our three and etc. That is we construct the logical structure such that there are inevitable particles, antiparticles and gauge bosons. Sort of answer is defined by sort of question.

Thus we ourselves make up the rules of the probabilistic information processing in the form of the laws of the quantum theory. And the values of parameters are depend on the structure of our devices.

This is likely that Universe gives us only probabilities of events. But the physics laws, operating these probabilities, are the result of our device structure properties and of the logic behavior of our language. If the other methods of the information receiving and processing can exist somewhere then the physical laws of the other shape must operate there. Thus the quantum theory is only one amongst possible ways for the processing of a probabilistic information.

## 7 Appendix. Operations at space $\mathfrak{S}_j$

Let  $\tilde{\varphi} \in \mathfrak{S}_j$ . That is:

$$\tilde{\varphi}(t, \mathbf{x}, x_5, x_4) = \left( \begin{array}{l} \exp(-ihs_0x_4) \sum_{r=1}^4 \phi_r(t, \mathbf{x}, 0, s) \epsilon_r \\ + \exp(-ihn_0x_5) \sum_{j=5}^8 \phi_j(t, \mathbf{x}, n, 0) \epsilon_j \end{array} \right).$$

Let linear operators  $\beta$  and  $K$  act in the basis  $\epsilon_k$  and the linear operator  $U^{(-)}$  acts at space  $\mathfrak{S}_j$ .

In this case if

$$U^{(-)} = \begin{bmatrix} U_{1,1}U_{1,2} \\ U_{2,1}U_{2,2} \end{bmatrix}$$

at basis  $j$  with  $U_{j,r}$  as  $4 \times 4$  matrices then  $U_{j,r}$  act at basis  $\epsilon_k$ , too.

Example of calculation:

$$\begin{aligned} & (K - \beta U^{(-)}) \tilde{\varphi} = \\ & = (K - \beta U^{(-)}) \left( \begin{array}{l} \exp(-ihs_0x_4) \sum_{r=1}^4 \phi_r(t, \mathbf{x}, 0, s) \epsilon_r \\ + \exp(-ihn_0x_5) \sum_{j=5}^8 \phi_j(t, \mathbf{x}, n, 0) \epsilon_j \end{array} \right) \\ & = (K - \beta U^{(-)}) \exp(-ihs_0x_4) \sum_{r=1}^4 \phi_r(t, \mathbf{x}, 0, s) \epsilon_r \\ & + (K - \beta U^{(-)}) \exp(-ihn_0x_5) \sum_{j=5}^8 \phi_j(t, \mathbf{x}, n, 0) \epsilon_j \\ & = K \exp(-ihs_0x_4) \sum_{r=1}^4 \phi_r(t, \mathbf{x}, 0, s) \epsilon_r \\ & - \beta U \exp(-ihs_0x_4) \sum_{r=1}^4 \phi_r(t, \mathbf{x}, 0, s) \epsilon_r \\ & + K \exp(-ihn_0x_5) \sum_{j=5}^8 \phi_j(t, \mathbf{x}, n, 0) \epsilon_j \\ & - \beta U \exp(-ihn_0x_5) \sum_{j=5}^8 \phi_j(t, \mathbf{x}, n, 0) \epsilon_j \\ & = \exp(-ihs_0x_4) \sum_{r=1}^4 \phi_r(t, \mathbf{x}, 0, s) K \epsilon_r \\ & - \beta \exp(-ihs_0x_4) \left( \begin{array}{l} U_{1,1} \sum_{r=1}^4 \phi_r(t, \mathbf{x}, 0, s) \epsilon_r \\ + U_{1,2} \sum_{j=5}^8 \phi_j(t, \mathbf{x}, n, 0) \epsilon_j \end{array} \right) \\ & + \exp(-ihn_0x_5) \sum_{j=5}^8 \phi_j(t, \mathbf{x}, n, 0) K \epsilon_j \\ & - \beta \exp(-ihn_0x_5) \left( \begin{array}{l} U_{2,1} \sum_{r=1}^4 \phi_r(t, \mathbf{x}, 0, s) \epsilon_r \\ + U_{2,2} \sum_{j=5}^8 \phi_j(t, \mathbf{x}, n, 0) \epsilon_j \end{array} \right) \\ & = \exp(-ihs_0x_4) \sum_{r=1}^4 \phi_r(t, \mathbf{x}, 0, s) K \epsilon_r \\ & - \beta \exp(-ihs_0x_4) \left( \begin{array}{l} \sum_{r=1}^4 \phi_r(t, \mathbf{x}, 0, s) U_{1,1} \epsilon_r \\ + \sum_{j=5}^8 \phi_j(t, \mathbf{x}, n, 0) U_{1,2} \epsilon_j \end{array} \right) \\ & + \exp(-ihn_0x_5) \sum_{j=5}^8 \phi_j(t, \mathbf{x}, n, 0) K \epsilon_j \\ & - \beta \exp(-ihn_0x_5) \left( \begin{array}{l} \sum_{r=1}^4 \phi_r(t, \mathbf{x}, 0, s) U_{2,1} \epsilon_r \\ + \sum_{j=5}^8 \phi_j(t, \mathbf{x}, n, 0) U_{2,2} \epsilon_j \end{array} \right) \\ & = \exp(-ihs_0x_4) \sum_{r=1}^4 \phi_r(t, \mathbf{x}, 0, s) K \epsilon_r \\ & - \exp(-ihs_0x_4) \left( \begin{array}{l} \sum_{r=1}^4 \phi_r(t, \mathbf{x}, 0, s) \beta U_{1,1} \epsilon_r \\ + \sum_{j=5}^8 \phi_j(t, \mathbf{x}, n, 0) \beta U_{1,2} \epsilon_j \end{array} \right) \end{aligned}$$



$$\begin{aligned}
& + \exp(-ihn_0x_5) \sum_{j=5}^8 \phi_j(t, \mathbf{x}, n, 0) K\epsilon_j \\
& - \exp(-ihn_0x_5) \left( \sum_{r=1}^4 \phi_r(t, \mathbf{x}, 0, s) \beta U_{2,1}\epsilon_r \right. \\
& \quad \left. + \sum_{j=5}^8 \phi_j(t, \mathbf{x}, n, 0) \beta U_{2,2}\epsilon_j \right).
\end{aligned}$$

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