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A NEW THEORY OF PARTICLE PHYSICS ABOUT COUPLING SYSTEM AND REGULAR MULTIVARIATE STATE

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ABSTRACT

In this paper, some particle science issues are considered and studied: Why the electric charge can not be fraction for any particles? Why composite particles are easy to split and the mass has decreased? Why the fundamental particles with identical quantum numbers have the unequal mass? These scientific problems are solved by establishing new particle theories: The mechanism of regular multivariate states is proposed to explain the characteristics of fundamental particles, The coupling theory of particle systems is proposed to explain the mass characteristics of composite particles. The scientific analysis of these mechanisms and theories are consistent with the experimental results of many particles, and according to these mechanisms and theories can derive many new particles.

Keywords: Particle Physics, Coupling Theory, Regular Multivariate State, Fundamental Particle, Composite Particle, Particle System, Quantum Number, Singularity Number, Hadron, Lepton

1. INTRODUCTION

The establishment of the standard model of particle physics is one of the important achievements of physics in the 20th century. It can describe the properties of quark, lepton, photon, gluon, intermediate boson, and Higgs particle, as well as the three basic interactions Terasawa & Scholer (1989), Chupp (1990), Ellis & Wilson (2001). At present, there are many research directions in particle physics, such as hadron physics, heavy flavor physics, lepton physics, neutrino physics, accurate test of standard model, symmetry and symmetry destruction, standard model expansion, etc. These works have even played an important role in the study of the evolution of the universe De Yoreo et al. (2015), Wang et al. (2020), Wang et al. (2020), Chris & Roy (1986), Pais (1999). About multidisciplinary scientific researches, some existing excellent scientific theories have been well explained and described Ma (2020), Ma (2017), Ma (2017), Ma (2018), Ma (2020), Ma (2022), Ma (2023), Suggest that all humanity implement sustainable development Ma (2021).

In modern particle physics theory, some scientific problems are difficult to solve: In the description of quark theory, the electric charge can be fraction, but it cannot be found in real experiments, why? In the experiment, it was clearly found that composite particles are easy to split, and the summation mass of component particles is inevitably less than the mass of the original particles, why? Three neutrinos are fundamental particles with identical quantum numbers, but the mass is not equal, why?

Regarding the aforementioned particle science issues that need to be solved, I have been thinking and researching for many years: Firstly, the principle of electric charge eigenstates is proposed to derive the quantum number constraint equation, and fundamentally explain the singularity numbers of composite particles Ma (2020). In this paper, I proposed the mechanism of regular multivariate states to explain the characteristics of fundamental particles, I also proposed the coupling theory of particle systems to explain the mass characteristics of composite particles, The scientific analysis of these mechanisms and theories are consistent with the experimental results of many particles, The detailed analysis and specific expressions are as follows (Emphasis: In this paper, the unit of mass is only positioned in megaelectron volt: MeV).

2. COMPREHENSIVE ANALYSIS OF PARTICLE PHYSICS

- **Regular multivariate state theory**: For fundamental particles, the state elements must be regular, so fundamental particle must be uniformly constructed by several regular state elements in the three-dimensional state space.
- **Particle pair construction mechanism**: Two particles with special relationship with each other can form particle pair, The particle pairs have very effective coupling effects, So particle pairs mainly act as components in composite particles, and cannot exist alone in spacetime.
- **Theory of composite particle systems**: Composite particles are systems composed of fundamental particles, The construction of the system must have leading and auxiliary members. Therefore in a composite particle, Solitary particles can only have one or none, Particle pairs can have multiple.
- **Coupling theory of mass variation**: The mass of composite particles is less than the sum mass of component particles, This is because that the component members increase their mass under the coupling effect, So it is necessary to calculate the mass variation based on the coupling effect of particles and particle pairs.

2.1. PARTICLE PRINCIPLE AND FORCE EFFECTS

Symmetry, balance, and electric charge eigenstate are the three Principles of particle science. Symmetry determines the generation of particles; Balance ensures the stability of particles; The electric charge eigenstates establish the quantum number equation of particles and classification of particles.

About weak nuclear force and strong nuclear force, all particles with mass have weak nuclear forces, only hadrons have strong nuclear forces; The common characteristic of these two forces is external absorption and internal repulsion, so any particle must have an equilibrium distance. When two particles interact with each other: If the distance between particles is greater than the equilibrium distance, forming attraction effect; If the distance is less than the equilibrium distance, forming repulsion effect. So, these two forces play a very important role in the composition of composite particles.

The force effects of electric charges are same charge repulsion and different charge attraction, the interaction of electrons has different effects in particles of different systems such as composite particles and fundamental particles, so the analysis of electricity has different effects in different particles and structures.

2.2. PARTICLE SYSTEM CLASSIFICATION THEORY

Particle system classification: All particles can be classified into two systems: fundamental particles and composite particles, and all composite particles are constructed by fundamental particles. According to the structural characteristics of particles: Fundamental particles belong to only one system; Composite particles can be divided into five subsystems: Eigenstate composite particle, Non eigenstate composite particle, Atomic nucleus, Atomic, Molecule.

In the study of particles, the main focus is on the study of fundamental particles and eigenstate composite particles. Fundamental particles and eigenstate composite particles are achieved through the principle of electric charge eigenstates, the quantum number constraint equation is expressed as follows:

$$\frac{s}{2} + i_3 + \frac{b}{2} - q = \begin{cases} 0 & \text{(hadron)} \\ \pm 1 & \text{(lepton)} \end{cases} \tag{1}$$

In this paper, for the convenience of expression, j is used instead of $b/2$, i is used instead of i_3, the concept represented is consistent, so the quantum number constraint equation is expressed as follows:

$$\frac{s}{2} + i + j - q = \begin{cases} 0 & \text{(hadron)} \\ \pm 1 & \text{(lepton)} \end{cases} \tag{2}$$

According to the expression in the above equation (2): For eigenstate composite particles, the quantum numbers must comply with this formula; For fundamental particles, the quantum numbers must comply with this formula and satisfy the condition: $j = \pm 1/2, s = 0$.

2.3. GAUGE COMBINATION THEORY OF COMPOSITE PARTICLES

Composite particles are generated by combining fundamental particles, but the combination of particles is not arbitrary, so we need to propose the gauge theory of particle combinations.

- **Fundamental particles**: Fundamental particles generate based on the principle that symmetry and balance; Types of fundamental particles are not many: All fundamental particles have weak nuclear forces and universal gravitation, Some fundamental particles have strong nuclear forces and electric forces.

- **Particle pairs**: Particle pairs are formed from fundamental particles, these particle pairs are formed by positive and negative particles or particles of the same family. Particle pairs cannot exist alone in spacetime, so they are not particles. Particle pairs are organs of composite particles, because particle pairs have significant coupling effects with each other, so coupled particle pairs generate related composite particles under the dominance of the master.
- **Component models**: Particle pairs and fundamental particles as components of composite particles, in composite particles there two positions: one is the dominant position, and the other is the assisting position. The dominant position is the model that the dominant particle or dominant particle pair express the composite particle type; The assisting position is the model that particle pairs interact to construct composite particle; Moreover there are coupling models between the particle pairs respectively at the dominant position and assisting position.
- **Singularity numbers**: Some eigenstate composite particles have singularity numbers, some eigenstate composite particles have no singularity numbers, why? According to the gauge combination theory of composite particles, Singularity originate the ability of certain special particle pairs for composite particles at the assisting position, So introducing the number of this special particle pair as singularity number s. Essentially the singularity of composite particles trigger changes in isospin, So this is the expression of the correlation between the third isospin component and singularity number: $i = \sum_{n=1}^{N} i_n \pm s/2$.

2.4. MASS CHANGE THEORY BASED ON COUPLING MECHANISM

The interaction between particles can cause mass variation, the mass variation is related to particle categories, coupled model and system structures etc. On the mass variation of composite particles, three quality coupling models need to be clearly proposed, and the mass variation rates (f_i, f_j) are closely related to quantum numbers (*i*,*j*).

- **The mass by fundamental particles coupling:** Particle pairs are formed by the interaction of fundamental particles, the category and quantum number of particles have the coupling effect on the mass increase or decrease. Category effect: Particle and its antiparticle can couple to increase mass; Particle and its homologous antiparticle can couple to increase mass. Quantum number effect: $(j_1 = -j_2 \Rightarrow f_j > 0)$, $(i_1 = i_2 \Rightarrow f_i > 0)$, $(i_1 = -i_2 \Rightarrow f_i < 0)$. For fundamental particles coupling: $\Delta m > 0$.
- **The mass variation by particle pairs individual coupling** : Under the condition of individual coupling of particle pairs, the mass variation can be analyzed by these particle description quantity: Quantum number of particle pairs, The coupling position of particle pairs, The total numbers of fundamental particles in two particle pairs, The mass elements of fundamental particles. Possible outcomes: $\Delta m > 0$ or $\Delta m < 0$
- **The mass variation by particle pairs complex coupling:** When a pair is in a composite particle or has a strong interaction with other pairs, The coupling between this particle pair and other particle pairs is not individual

coupling, So defining this coupling as complex coupling. Essentially the mass variation Δm caused by complex coupling between two particles is the change of simple mass variation Δm, this simple mass variation Δm is mass variation by particle pairs individual coupling. Based on the relational simple mass variation Δm, analyzing the state change of particle pairs, and analyzing the quantum number effect of particle pairs due to different positions; Thus, the mass variation by particle pairs complex coupling can be calculated: $\Delta m \quad = k \cdot \Delta m + \psi$.

3. ANALYSIS THEORY OF FUNDAMENTAL PARTICLES

3.1. ANALYSIS OF REGULAR MULTIVARIATE STATES OF FUNDAMENTAL PARTICLES

Fundamental particles must have symmetry and conservation, the expression of states must be quantized, so fundamental particles must be in a regular multivariate state. Real space is three-dimensional, the dimension of particle states is also three-dimensional, so can introduce quantum numbers (F, E, K) to respectively express the number of state elements, the number of element boundaries and the number of element vertexes. According to the principles of symmetry, balance and quantization, the regular multivariate states of fundamental particles are consistent with the regular polyhedron of geometry, so the state element quantum numbers can be expressed by Euler formula:

$$F - E + K = 2 \tag{3}$$

In this expression (3), (F, E, K) must be the integers, and locate the positive multivariate state with three dimension. Furthermore, introducing quantum numbers (n, r): $n = 2E/F$is the boundary quantum number of the state element, $r = 2E/K$ is the vertex quantum number of the state element. Due to the limitations of three-dimensional states, positive multivariate mechanism and integer quantum number, the calculation results are as follows:

$$\begin{pmatrix} F \\ E \\ K \\ n = 2E/F \\ r = 2E/K \end{pmatrix} = \begin{pmatrix} 4 \\ 6 \\ 4 \\ 3 \\ 3 \end{pmatrix}, \begin{pmatrix} 8 \\ 12 \\ 6 \\ 3 \\ 4 \end{pmatrix}, \begin{pmatrix} 6 \\ 12 \\ 8 \\ 4 \\ 3 \end{pmatrix}, \begin{pmatrix} 12 \\ 30 \\ 20 \\ 5 \\ 3 \end{pmatrix}, \begin{pmatrix} 20 \\ 30 \\ 12 \\ 3 \\ 5 \end{pmatrix} \tag{4}$$

According to this calculation results, it can be known that there are only 5 fundamental particles. Firstly, derive the category of fundamental particles based on the expression of quantum numbers; For the fundamental particles with mass, the quantum numbers are explicit: $s = 0, i = \pm 1/2, j = \pm 1/2$; According to the principle of charge eigenstates, the quantum number constraint equation for eigenstate particles has been derived as follows:

$$i + j - q = t = \begin{cases} 0 : & (\text{hadron}) \\ \pm 1 : & (\text{lepton}) \end{cases} \tag{5}$$

For the convenience of analysis, here we first focus on deriving the expression of positive particles: The quantum number of positive fundamental particles is $j = 1/2$; The quantum number i of parity must have a comprehensive correlation with (n, r, j), namely $i = sign(r - n) \cdot j$; Charge quantum number : $q = sin(\frac{n-1}{2}\pi)$. According on this theoretical analysis, The relevant calculations of quantum numbers are as follows:

$$\begin{pmatrix} F \\ n, r \\ j \\ i = sign(r-n) \cdot j \\ q = sin((n-1)\pi/2) \\ t = i + j - q \end{pmatrix} = \begin{pmatrix} 4 \\ 3,3 \\ 1/2 \\ 1/2 \\ 0 \\ 1 \end{pmatrix}, \begin{pmatrix} 8 \\ 3,4 \\ 1/2 \\ 1/2 \\ 0 \\ 1 \end{pmatrix}, \begin{pmatrix} 6 \\ 4,3 \\ 1/2 \\ -1/2 \\ -1 \\ 1 \end{pmatrix}, \begin{pmatrix} 12 \\ 5,3 \\ 1/2 \\ -1/2 \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 20 \\ 3,5 \\ 1/2 \\ 1/2 \\ 0 \\ 1 \end{pmatrix} \quad (6)$$

According to the derivation of the above equation（6）and the expression of quantum number constraint equation （5）, it is clear that: $F = (4,8,6,20)$ represents Leptons, $F = 12$represent Hadron; And in the expression of leptons: $F = 6$represent Electron, $F = (4,8,20)$ represent Neutrino.

Under the condition of clear quantum number and category of particles, the analysis of specific particles need to be derived from the expression of mass. **Here I propose the theory of mass analysis**: In the positive multivariate state, the state element and the mass element are consistent, n is the number of boundaries of mass element, so the mass of a state element is directly proportional to its area; Under these $n = (3,4,5)$ conditions, according to the calculation method of geometric surface elements, the area of a state element is expressed as follows:

$$n = 3: S_3 = \frac{l^2}{4} tan(\frac{60}{180}\pi), n = 4: S_4 = l^2, n = 5: S_5 = \frac{5l^2}{4} tan(\frac{54}{180}\pi) \quad (7)$$

We already know that $(E = 12, n = 4)$ is electron, and the mass of electron is $0.485 Mev$, so assuming $S_4 = l^2 = 0.485$; By substituting this experimental value into the equation above, the area of the state element can be calculated:

$$S_4 = l^2 = 0.485 \Rightarrow S_3 = \frac{l^2}{4} tan(\frac{60}{180}\pi) = 0.21, S_5 = \frac{5l^2}{4} tan(\frac{54}{180}\pi) = 0.8344 \quad (8)$$

The mass is related to (i, j) and (F, K), specifically $(i + j + K)$ is direct proportion in the comprehensive effect about mass, however the effect of F is related to (t, n, r). So the mass of a fundamental particle is a comprehensive effect by quantum number (i, j, t), number of state element (F, K), and boundary number of state element (n, r). The comprehensive expression of the association between these number is as follows:

$$\omega = a \cdot n + b \cdot r = \begin{cases} n + r: n = r \Rightarrow a = b = 1 \\ n - r: n > r \Rightarrow a = 1, b = -1 \\ r - n: r > n \Rightarrow a = -1, b = 1 \end{cases} \quad (9)$$

$$\begin{pmatrix} F,K \\ n,r,t \\ i,j \\ \omega = a\cdot n + b\cdot r \\ \varepsilon = sin(\pi/\omega) \\ \beta = i + j + K + (t-\varepsilon)\cdot F/2 \end{pmatrix} = \begin{pmatrix} 4,4 \\ 3,3,1 \\ 0.5,0.5 \\ 6 \\ 1/2 \\ 6 \end{pmatrix}, \begin{pmatrix} 8,6 \\ 3,4,1 \\ 0.5,0.5 \\ 1 \\ 0 \\ 11 \end{pmatrix}, \begin{pmatrix} 6,8 \\ 4,3,1 \\ -0.5,0.5 \\ 1 \\ 0 \\ 11 \end{pmatrix}, \begin{pmatrix} 12,20 \\ 5,3,0 \\ -0.5,0.5 \\ 2 \\ 1 \\ 14 \end{pmatrix}, \begin{pmatrix} 20,12 \\ 3,5,1 \\ 0.5,0.5 \\ 2 \\ 1 \\ 13 \end{pmatrix} \quad (10)$$

In the expression of the above equation (10), β is the index of 10. Defining the area S_n of the state element as mass element. Introducing MeV as the mass unit, so $10^{-11}$is introduced as the unit adjustment value. Under these inferences, the expression of mass is $m_n = S_n \times 10^{-11} \times 10^{\beta} MeV$, the calculations are as follows:

$$\begin{pmatrix} F,n,r \\ i,j,q \\ S_n \\ \beta \\ m = S_n \times 10^{-11} \times 10^{\beta} \\ \text{Experiment}(MeV) \end{pmatrix} = \begin{pmatrix} 4,3,3 \\ 0.5,0.5,0 \\ 0.21 \\ 6 \\ 0.21\times 10^{-5} \\ v_e: 0.2\times 10^{-5} \end{pmatrix}, \begin{pmatrix} 8,3,4 \\ 0.5,0.5,0 \\ 0.21 \\ 11 \\ 0.21 \\ v_\mu: 0.2 \end{pmatrix}, \begin{pmatrix} 6,4,3 \\ -0.5,0.5,-1 \\ 0.485 \\ 11 \\ 0.485 \\ e: 0.51 \end{pmatrix}, \begin{pmatrix} 12,5,3 \\ -0.5,0.5,0 \\ 0.8344 \\ 14 \\ 834.4 \\ n_0: 834 \end{pmatrix}, \begin{pmatrix} 20,3,5 \\ 0.5,0.5,0 \\ 0.21 \\ 13 \\ 21 \\ v_\tau: 19 \end{pmatrix} \quad (11)$$

Compare the calculated and experimental values of mass, and according to the expression of fundamental particle quantum numbers: It can be confirmed that: $F = (4,8,20)$ is three neutrinos (v_e, v_μ, v_τ), $F = 6$is electron e^-, and $F = 12$is fundamental neutron n_0; It is known that $F = (4,8,6,20)$ are four leptons, so can be inferred from F,n,r: $(4,3,3),(6,4,3) \Rightarrow r_4 = 3, r_6 = 3 \Rightarrow r_4 = r_6$ that v_e and e^- are fellow particles. On the fundamental particles of the eigenstate, $(j > 0)$ describe positive particle, $(j < 0)$ describe antiparticle. For positive particles and antiparticles of the same kind: quantum numbers are opposite, the mass is equal; therefore, only 10 fundamental particles, which are expressed as follows:

$$\begin{pmatrix} F,n,r \\ +(i,j,q) \\ -(i,j,q) \\ \text{particle} \\ \text{antiparticle} \\ \text{mass }(MeV) \end{pmatrix} = \begin{pmatrix} 4,3,3 \\ 0.5,0.5,0 \\ -0.5,-0.5,0 \\ v_e^+ \\ v_e^- \\ v_e: 0.21\times 10^{-5} \end{pmatrix}, \begin{pmatrix} 8,3,4 \\ 0.5,0.5,0 \\ -0.5,-0.5,0 \\ v_\mu^+ \\ v_\mu^- \\ v_\mu: 0.21 \end{pmatrix}, \begin{pmatrix} 6,4,3 \\ -0.5,0.5,-1 \\ 0.5,-0.5,1 \\ e^- \\ e^+ \\ e: 0.48 \end{pmatrix}, \begin{pmatrix} 12,5,3 \\ -0.5,0.5,0 \\ 0.5,-0.5,0 \\ n_0^+ \\ n_0^- \\ n_0: 834 \end{pmatrix}, \begin{pmatrix} 20,3,5 \\ 0.5,0.5,0 \\ -0.5,-0.5,0 \\ v_\tau^+ \\ v_\tau^- \\ v_\tau: 21 \end{pmatrix} \quad (12)$$

3.2. THE THEORY OF PAIRS FORMED BY FUNDAMENTAL PARTICLES INTERACTION

The theory of pairs formed by fundamental particles interaction: Two fundamental particles can form particle pair through interaction, the performance of particle pair is determined by the effects of interaction. The interaction effects of fundamental particles need to be analyzed from three aspects: **(1) Force effect**: Under the action of strong and weak forces, particles can form an equilibrium state; Under conditions dominated by electricity, electrons with the same charge repel and cannot approach each other, electrons with different charges are infinitely close and lose each other. **(2) Similar particle effects**: The interaction effect and equilibrium state between the same kind particles are effective, especially positive particles and antiparticles are more effective. **(3) Cognate particle effect**, There is also a familial relationship among particles of the same kind, typical particles are electron and electric neutrino (e, v_e), this group of particles can effectively form particle pairs. Considering these three effects comprehensively, two typical particle pairs can be predicted.

P-A pair: positive particle and its antiparticle can generate pair under the action of strong or weak forces, so the coupling between particle and its antiparticle is expressed as P-A Pair. The interaction force between positive and negative electrons is a combination of electric force and weak force, and electric force is stronger than weak force, therefore positive and negative electrons disappear with each other to produce photons when they approach infinitely, so cannot generate P-A Pair.

Based on the analysis of the above theory, in these 10 elementary particles can generate 4 P-A pairs.

$$\begin{pmatrix} F,n,r \\ \text{Pair} \\ i,j,q \\ \text{Force} \end{pmatrix} = \begin{pmatrix} 4,3,3 \\ \{v_e^-,\ v_e^+\} \\ 0,0,0 \\ ? \end{pmatrix}, \begin{pmatrix} 8,3,4 \\ \{v_\mu^-,\ v_\mu^+\} \\ 0,0,0 \\ ? \end{pmatrix}, \begin{pmatrix} 6,4,3 \\ \{e^\pm\} \to \gamma \\ \\ \end{pmatrix}, \begin{pmatrix} 12,5,3 \\ \{n_0^-,\ n_0^+\} \\ 0,0,0 \\ \text{strong} \end{pmatrix}, \begin{pmatrix} 20,3,5 \\ \{v_\tau^-,\ v_\tau^+\} \\ 0,0,0 \\ ? \end{pmatrix} \tag{13}$$

E-C pair: charged elementary particle (e^-, e^+) and its cognate antiparticle (v_e^-, v_e^+) can form particle pair, which is expressed as E-C pair. The quantum number of E-C pair is (-1, 0, -1) or (1, 0, 1). The E-C pair of electrons plays a significant role in the construction of composite particles, the expression of E-C pair is as follows:

$$e^- + v_e^- \to \{e^-, v_e^-\}: (-1,0,-1);\ e^+ + v_e^+ \to \{e^+, v_e^+\}: (1,0,1) \tag{14}$$

Performance analysis of particle pairs: According to the expression of the quantum number constraint equation, the quantum numbers of these 6 particle pairs are exactly the expression of Bose hadron quantum numbers, whether these pairs have hadron properties remains to be analyzed. Firstly, it is clear that the P-A pair $\{n_0^-, n_0^+\}$generated by Fermi hadron $n_0^\pm$ must be Bose hadron, so whether the P-A pairs generated by leptons have hadron properties need to be analogized with $\{n_0^-, n_0^+\}$:

$$\begin{aligned} &\{n_0^-, n_0^+\}: n = 5, r = 3 \Rightarrow n \cdot x + r \cdot y = z, x \neq 0, y \neq 0, x \neq y\text{:Hadron standard} \\ &\{v_e^-, v_e^+\}: n = 3, r = 3 \Rightarrow 3 \cdot x + 3 \cdot y = z = 5 \cdot x + 3 \cdot y \Rightarrow x = 0\text{:No} \\ &\{v_\mu^-, v_\mu^+\}: n = 3, r = 4 \Rightarrow 3 \cdot x + 4 \cdot y = z = 5 \cdot x + 3 \cdot y \Rightarrow \\ &\qquad\qquad = 2x\text{:Yes} \\ &\{v_\tau^-, v_\tau^+\}: n = 3, r = 5 \Rightarrow 3 \cdot x + 5 \cdot y = z = 5 \cdot x + 3 \cdot y \Rightarrow x = y\text{:No} \end{aligned} \tag{15}$$

According to the analysis of the above equation (15), only $\{v_\mu^-, v_\mu^+\}$ has the hadron effect, so this particle pair can have two positions in composite particles: in the dominant position which represent the model of Bose hadrons, described as $\{v_\mu^-, v_\mu^+\}_d$; and in the assisting position which represent the particle singularity, described as $\{v_\mu^-, v_\mu^+\}_s$. Obviously: These two types of particle pairs based on fundamental particles, composite particles mainly contain 4 particle pairs:

$$\{e, v_e\} \Rightarrow \begin{pmatrix} \{e^-, v_e^-\} \\ \{e^+, v_e^+\} \end{pmatrix}; \{v_\mu^-, v_\mu^+\} \Rightarrow \begin{pmatrix} \{v_\mu^-, v_\mu^+\}_s \\ \{v_\mu^-, v_\mu^+\}_d \end{pmatrix} \tag{16}$$

4. THE MASS COUPLING EFFECT OF PARTICLE INTERACTIONS

The interaction between particles can cause mass variation, the mass variation is related to particle categories, environmental model, and system structures etc. On the mass variation of composite particles, three quality coupling models need to be clearly proposed, and the mass variation rates are closely related to quantum numbers (i, j), so we firstly propose this general expression about mass:

$$\begin{aligned} & m_1 = m_{01} \times 10^a, m_2 = m_{02} \times 10^b \\ & m = m_1 + m_2 + (m_{01} + m_{02}) \cdot (f_i + f_j) \times 10^c \\ & \Rightarrow \Delta m = (m_{01} + m_{02}) \cdot (f_i + f_j) \times 10^c \\ & \Rightarrow \Delta m \quad = k \cdot \Delta m + \psi \end{aligned} \tag{17}$$

In the expression of the above equation (17), $\Delta m$is the mass variation of paired coupling of fundamental particles and the separate coupling of particle pairs, Δm is the mass variation of the complex coupling of particle pairs and composite particles, the specific analysis and calculation are as follows.

4.1. THEORETICAL CALCULATION OF MASS FOR PARTICLE PAIRS FORMED BY FUNDAMENTAL PARTICLES

P-A pair and E-C pair are formed by the interaction of fundamental particles, the category and quantum number of particles have the coupling effect on the mass increase or decrease. The specific expression based on particle category and quantum number is as follows:

$$\begin{aligned} & N\text{:The number of fundamental particles in particle pair} \\ & \omega_j = \begin{pmatrix} 1: j_1 = -j_2 \\ -1: j_1 = j_2 \end{pmatrix}; \omega_i = \begin{pmatrix} -1: i_1 = -i_2 \\ 1: i_1 = i_2 \end{pmatrix}; \lambda_j = \begin{pmatrix} 1\text{:E-C pair} \\ 3\text{:P-A pair} \end{pmatrix}; \lambda_i = \begin{pmatrix} 2\text{:E-C pair} \\ 1\text{:P-A pair} \end{pmatrix} \\ & f_j = \frac{\omega_j}{N} \cdot \lambda_j; f_i = \frac{\omega_i}{N} \cdot \lambda_i; m_1 = m_{01} \times 10^a; m_2 = m_{02} \times 10^b \\ & m = m_1 + m_2 + (m_{01} + m_{02}) \cdot (f_i + f_j) \times 10^c \end{aligned} \tag{18}$$

- **Mass calculation of E-C pairs is as follows:**

$$\begin{aligned} & \{e^-, v_e^-\} = (e^- + v_e^-) = (-1/2, 1/2, -1) + (-1/2, -1/2, 0) = (-1, 0, -1) \\ & \Rightarrow \omega_j = 1, \omega_i = 1, m_1 = 0.48 \times 10^0, m_2 = 0.21 \times 10^{-5}, N = 2, c = 2 \\ & \Rightarrow \lambda_j = 1, \lambda_i = 2 \Rightarrow f_j = 1/2, f_i = 1 \\ & \Rightarrow m = 0.48 + 0.21 \times 10^{-5} + (0.48 + 0.21) \times (1 + 1/2) \times 10^2 = 103.98 \\ & \Rightarrow \{e^-, v_e^-\}, \{e^+, v_e^+\}: m_e = 103.98 \doteq 104 \end{aligned} \tag{19}$$

- **Mass calculation of P-A pairs is as follows:**

$$\begin{aligned} & \{v_\mu^-, v_\mu^+\} = (v_\mu^- + v_\mu^+) = (-1/2, -1/2, 0) + (1/2, 1/2, 0) = (0, 0, 0) \\ & \Rightarrow \omega_j = 1, \omega_i = -1, m_1 = 0.21 \times 10^0, m_2 = 0.21 \times 10^0, N = 2, c = 2 \end{aligned}$$

$$\Rightarrow \lambda_j = 3, \lambda_i = 1 \Rightarrow f_j = 3/2, f_i = -1/2$$
$$\Rightarrow m = 0.21 + 0.21 + (0.21 + 0.21) \times (3/2 - 1/2) \times 10^2 = 42.42 \quad (20)$$
$$\Rightarrow \{v_\mu^+, v_\mu^-\}_s, \{v_\mu^+, v_\mu^-\}_d : m_\mu = 42.42 \doteq 42$$

4.2. THE MASS CHANGE CAUSED BY INDIVIDUAL COUPLING OF TWO PARTICLE PAIRS

The particle pairs in composite particles have two positions: one is the dominant position, and the other is the assisting position. For the convenience of expression in the following formulas: D-P represent the dominant position, and A-P represent the assisting position.

Under separate coupling conditions of these four particle pairs, $\{e^-, v_e^-\}\{e^+, v_e^+\}$ $\{v_\mu^-, v_\mu^+\}_s$ are in assisting position A-P, $\{v_\mu^-, v_\mu^+\}_d$ is in the dominant position D-P. So, the change in mass of particles under individual coupling conditions varies depending on their positions. The derivation of the change in mass due to the coupling of particle pairs is as follows:

$$\begin{pmatrix} \text{coupling pair} \\ n, r \\ i, j, q \\ mass: MeV \end{pmatrix} = \begin{pmatrix} \{e^-, v_e^-\} \\ (4,3),(3,3) \\ -1,0,-1 \\ m_e = 104 \end{pmatrix}, \begin{pmatrix} \{e^+, v_e^+\} \\ (4,3),(3,3) \\ 1,0,1 \\ m_e = 104 \end{pmatrix}, \begin{pmatrix} \{v_\mu^+, v_\mu^-\}_s \\ (3,4),(3,4) \\ 0,0,0 \\ m_\mu = 42 \end{pmatrix}, \begin{pmatrix} \{v_\mu^+, v_\mu^-\}_d \\ (3,4),(3,4) \\ 0,0,0 \\ m_\mu = 42 \end{pmatrix} \quad (21)$$

$$\begin{pmatrix} x = \text{number of } (n + r = 7) \\ y = \text{number of } (n + r = 6) \\ n_m = \text{main } n = 3 \\ r_m = \text{main } r = 4 \end{pmatrix}; \begin{matrix} \omega_i = \begin{pmatrix} -1: i_1 = -i_2 \\ 1: i_1 \neq -i_2 \end{pmatrix} \\ \omega_j = \begin{pmatrix} 1: j_1 = -j_2 \\ -1: j_1 \neq -j_2 \end{pmatrix} \end{matrix}; \begin{pmatrix} i_1 = i_2 : (0,0) \Rightarrow k_1 = k_2 = \begin{pmatrix} 0.1\text{:AP+AP} \\ 0.01\text{:DP+AP} \end{pmatrix} \\ i_1 = -i_2 : (1,-1) \Rightarrow k_1 = k_2 = 0.1\text{:electron} \\ i_1 \neq i_2 : (0, \pm 1) \Rightarrow \begin{pmatrix} k_1 = k_2 = 0.1\text{:DP+AP} \\ k_1 = 0.01\text{: AP+AP} \\ k_2 = 0.1\text{: AP+AP} \end{pmatrix} \end{pmatrix}$$

$$z = \begin{pmatrix} y\text{:AP+AP} \\ -y\text{:DP+AP} \\ 0: \pm\text{electron} \\ -2: y = 0\text{,DP+AP} \end{pmatrix}; \beta = 10^{-1} \times \begin{pmatrix} 5: i_1 + i_2 = 0\text{, DP+AP} \\ 1: i_1 + i_2 \neq 0\text{,AP+AP}; \\ 0\text{:general conditions} \end{pmatrix}$$

Number of basic particles: $N = 4;\ m_{01} = m_1, m_{02} = m_2, c = 0,$ (22)

$$\lambda = n_m \cdot (n_m + r_m) \cdot (x + z) \cdot k_1 + r_m \cdot (r_m - n_m) \cdot (x - y + \beta) \cdot k_2$$
$$f_i = \frac{\omega_i}{\lambda}, f_j = \frac{\omega_j}{N} \Rightarrow \Delta m = (m_1 + m_2) \cdot (f_i + f_j)$$
$$\Rightarrow \Delta m = (m_1 + m_2) \cdot \left(\frac{\omega_i}{n_m \cdot (n_m + r_m) \cdot (x + z) \cdot k_1 + r_m \cdot (r_m - n_m) \cdot (x - y + \beta) \cdot k_2} + \frac{\omega_j}{N}\right)$$

- **Mass variation by coupling of positive and negative electron pairs**

$\{e^-, v_e^-\} + \{e^+, v_e^+\}: (-1,0,-1) + (1,0,1) = (0,0,0) \Rightarrow N = 4, \omega_i = -1, \omega_j = -1, x = 2,$

$y = 2, z = 0, k_1 = 0.1, k_2 = 0.1, \beta = 0, m_1 = m_2 = 104, n_m = 3, r_m = 4$

$$\Delta m = (m_1 + m_2) \cdot \left(\frac{\omega_i}{n_m \cdot (n_m + r_m) \cdot (x + z) \cdot k_1 + r_m \cdot (r_m - n_m) \cdot (x - y + \beta) \cdot k_2} + \frac{\omega_j}{N}\right) \quad (23)$$

$$\Delta m_{ee} = (208) \times (\frac{-1}{3 \times (3+4) \times (2+0) \times 0.1 + 4 \times (4-3) \times (2-2+0) \times 0.1} + \frac{-1}{4}) = -101.5 \doteq -102$$

- **Mass variation by coupling of electron pair and singularity pair**

$$\{e, v_e\} + \{v_\mu^-, v_\mu^+\}_s : \pm(1,0,1) + (0,0,0) = \pm(1,0,1) \Rightarrow m_1 = 104, m_2 = 42, n_m = 3, r_m = 4, N = 4$$

$$\omega_i = 1, \omega_j = -1, x = 3, y = 1, z = y = 1, k_1 = 0.01, k_2 = 0.1, \beta = 10^{-1} \times (5-4) = 0.1$$

$$\Delta m = (m_1 + m_2) \cdot (\frac{\omega_i}{n_m \cdot (n_m + r_m) \cdot (x+z) \cdot k_1 + r_m \cdot (r_m - n_m) \cdot (x - y + \beta) \cdot k_2} + \frac{\omega_j}{N}) \quad (24)$$

$$\Delta m_{es} = (104 + 42) \times (\frac{1}{3 \times (3+4) \times (3+1) \times 0.01 + 4 \times (4-3) \times (3-1+0.1) \times 0.1} + \frac{-1}{4}) = 50.4 \doteq 50$$

- **Mass variation by coupling of singularity pair and singularity pair**

$$\{v_\mu^-, v_\mu^+\}_s + \{v_\mu^-, v_\mu^+\}_s : (0,0,0) + (0,0,0) = (0,0,0) \Rightarrow N = 4, \omega_i = 1, \omega_j = -1, x = 4, y = 0, z = 0$$

$$k_1 = 0.1, k_2 = 0.1, \beta = 0, m_1 = m_2 = 42, n_m = 3, r_m = 4$$

$$\Delta m = (m_1 + m_2) \cdot (\frac{\omega_i}{n_m \cdot (n_m + r_m) \cdot (x+z) \cdot k_1 + r_m \cdot (r_m - n_m) \cdot (x - y + \beta) \cdot k_2} + \frac{\omega_j}{N}) \quad (25)$$

$$\Delta m_{ss} = (42 + 42) \times (\frac{1}{3 \times (3+4) \times (4+0) \times 0.1 + 4 \times (4-3) \times (4-0+0) \times 0.1} + \frac{-1}{4}) = -12.6 \doteq -13$$

- **Mass variation by coupling of singularity pair and dominant pair**

$$\{v_\mu^-, v_\mu^+\}_s + \{v_\mu^-, v_\mu^+\}_d : (0,0,0) + (0,0,0) = (0,0,0) \Rightarrow m_1 = m_2 = 42, n_m = 3, r_m = 4, N = 4$$

$$\Rightarrow \omega_i = 1, \omega_j = -1, x = 4, y = 0, z = -2, k_1 = 0.01, k_2 = 0.01, \beta = 0.5$$

$$\Delta m = (m_1 + m_2) \cdot (\frac{\omega_i}{n_m \cdot (n_m + r_m) \cdot (x+z) \cdot k_1 + r_m \cdot (r_m - n_m) \cdot (x - y + \beta) \cdot k_2} + \frac{\omega_j}{N}) \quad (26)$$

$$\Delta m_{sd} = (42 + 42) \times (\frac{1}{3 \times (3+4) \times (4-2) \times 0.01 + 4 \times (4-3) \times (4-0+0.5) \times 0.01} + \frac{-1}{4}) = 119 \doteq 120$$

- **Mass variation by coupling of electron pair and dominant pair**

$$\{e, v_e\} + \{v_\mu^-, v_\mu^+\}_d : (\pm1,0,\pm1) + (0,0,0) = (\pm1,0,\pm1) \Rightarrow m_1 = 104, m_2 = 42, n_m = 3, r_m = 4$$

$$\Rightarrow N = 4, \omega_i = 1, \omega_j = -1, x = 3, y = 1, z = -1, k_1 = 0.1, k_2 = 0.1, \beta = 0$$

$$\Delta m = (m_1 + m_2) \cdot \left(\frac{\omega_i}{n_m \cdot (n_m + r_m) \cdot (x + z) \cdot k_1 + r_m \cdot (r_m - n_m) \cdot (x - y + \beta) \cdot k_2} + \frac{\omega_j}{N}\right) \quad (27)$$

$$\Delta m_{ed} = (104 + 42) \times \left(\frac{1}{3 \times (3 + 4) \times (3 - 1) \times 0.1 + 4 \times (4 - 3) \times (3 - 1 + 0) \times 0.1} + \frac{-1}{4}\right) = -7.3 \doteq -7$$

4.3. THE THEORY OF MASS CHANGES CAUSED BY THE COUPLING OF INDIVIDUAL PARTICLE PAIR AND COMPOSITE PARTICLE PAIRS

When the pair is in a composite particle or has early coupling with other pairs, the coupling effect between this pair and another pair varies under these conditions, so this coupling is defined as complex coupling. The mass variation caused by complex coupling between two particles is the change in mass variation under individual coupling conditions, the specific analysis and expression are as follows:

$k =$ The ratio of the interaction with the coupling mass of other states $= \left(\pm\frac{1}{2}\right), (\pm1), (\pm2)$

$x =$ The number of fundamental particles in particle pairs and composite particle

$y =$ The quantum number effect of dominant particle or dominant pair $= \left(\begin{matrix}\pm1: j = 1/2 \\ \pm2: j = 0\end{matrix}\right.$

$h =$ Quantum effects of mass increase or decrease $= \left(\begin{matrix}\pm1 \\ \pm1/2\end{matrix}\right.$ (28)

$$\Rightarrow \psi = h \cdot (x + y), \Delta m = k \cdot \Delta m + \psi = k \cdot \Delta m + h \cdot (x + y)$$

- **Mass variation by complex coupling of electron pair and singularity pair:**

$$\{v_\mu^-, v_\mu^+\}_s + \frac{1}{2}(\{e^-, v_e^-\} + \{e^+, v_e^+\}) : (0,0,0) + \frac{1}{2}[(-1,0,-1) + (1,0,1)]$$

$$\Rightarrow k = \frac{1}{2}, h = \frac{1}{2}, x = 6, y = -2, \Delta m_{se} = 50 \Rightarrow \Delta m_{se} = k \cdot \Delta m_{se} + h \cdot (x + y) \quad (29)$$

$$\Rightarrow \Delta m_{es} = \frac{1}{2} \times 50 + \frac{1}{2} \times (6 - 2) = 27$$

- **Mass variation by complex coupling of singularity pair and Fermi composite particles:**

$$\{v_\mu^-, v_\mu^+\}_s + p = \{v_\mu^-, v_\mu^+\}_s + (\{e, v_e\} + n_0) : (0,0,0) + (\pm1,0,\pm) + (\mp\frac{1}{2}, \pm\frac{1}{2}, 0)$$

$$\Rightarrow k = \frac{1}{2}, h = 1, x = 5, y = 1, \Delta m_{se} = 50 \Rightarrow \Delta m_{sp} = k \cdot \Delta m_{se} + h \cdot (x + y) \quad (30)$$
$$\Rightarrow \Delta m_{sp} = \frac{1}{2} \times 50 + 1 \times (5 + 1) = 31$$

- **Mass variation by complex coupling of singularity pair and Bose composite particles**:

$$\{v_\mu^-, v_\mu^+\}_s + \pi^0 = \{v_\mu^-, v_\mu^+\}_s + (\{e^-, v_e^-\} + \{e^+, v_e^+\} + \{v_\mu^-, v_\mu^+\}_d): 2(0,0,0) + (-1,0,-1) + (1,0,1)$$
$$s \approx d \Rightarrow k_{se} = 2, k_{ss} = 1, h = -1, x = 8, y = -2, \Delta m_{es} = 27, \Delta m_{ss} = -13 \quad (31)$$
$$\Rightarrow \Delta m_{s\pi} = \sum k \cdot \Delta m + h \cdot (x + y) = 2 \times 27 - 1 \times 13 - 1 \times (8 - 2) = 35$$

- **Mass variation by complex coupling of electron pair and Fermi composite particles (electric charge is common)**:

$$\{e^+, v_e^+\} + p^+ = \{e^+, v_e^+\} + (\{e^+, v_e^+\} + n_0^+): (1,0,1) + (1,0,1) + (-\frac{1}{2}, \frac{1}{2}, 0)$$
$$\Rightarrow k = -1, h = -1, x = 5, y = -1, \Delta m_{ee} = -102 \Rightarrow \Delta m_{ep}^c = k \cdot \Delta m_{ee} + h \cdot (x + y) \quad (32)$$
$$\Rightarrow \Delta m_{ep}^c = -1 \times (-102) - 1 \times (5 - 1) = 98$$

- **Mass variation by complex coupling of electron pair and Fermi composite particles (electric charge is opposite):**

$$\{e^-, v_e^-\} + p^+ = \{e^-, v_e^-\} + (\{e^+, v_e^+\} + n_0^+): (-1,0,-1) + (1,0,1) + (-\frac{1}{2}, \frac{1}{2}, 0)$$
$$\Rightarrow k = \frac{1}{2}, h = \frac{1}{2}, x = 5, y = -1, \Delta m_{ee} = -102 \Rightarrow \Delta m_{ep}^o = k \cdot \Delta m_{ee} + h \cdot (x + y) \quad (33)$$
$$\Rightarrow \Delta m_{ep}^o = \frac{1}{2} \times (-102) + \frac{1}{2} \times (5 - 1) = -51 + 2 = -49$$

- **Mass variation by complex coupling of electron pair and Bose composite particles**

$$\{e, v_e\} + \pi^0 = \{e, v_e\} + (\{e^-, v_e^-\} + \{e^+, v_e^+\} + \{v_\mu^-, v_\mu^+\}_d): (\pm 1,0,\pm 1) + (1,0,1) + (-1,0,-1) + (0,0,0)$$
$$e^+ + e^- \Rightarrow k_{ee}^c = -1, k_{ee}^o = \frac{1}{2}, k_{es} = \frac{1}{3}, h = -1, x = 8, y = 3 \times 2/2 = 3 \Rightarrow \Delta m_{ee} = -102, \Delta m_{se} = 27$$
$$\Rightarrow \Delta m_{e\ \pi} = \sum k \cdot \Delta m + \cdot (x + y) = -1 \times (-102) + \frac{1}{2} \times (-102) + \frac{1}{3} \times 27 - 1 \times (8 + 3) = 49 \quad (34)$$

5. THE PARTICLE PAIRS COUPLING THEORY OF EIGENSTATE COMPOSITE PARTICLE

Eigenstate composite particle are generated by coupling of particle pairs and dominant pairs or dominant particles; This coupling has two positions: one is the dominant position D-P, the second is the assisting position A-P.

In dominant position D-P: dominant fundamental particles: (v_μ, v_τ, n_0); dominant pair is $\{v_\mu^-, v_\mu^+\}_d$; dominant Fermi composite particles:p; dominant Bose composite particle: π^0.

In assisting position A-P: Only electron pairs and singularity pair $\{e^-, v_e^-\}$ $\{e^+, v_e^+\}$ $\{v_\mu^-, v_\mu^+\}_s$.

For a eigenstate composite particle, the Mass, the Quantum numbers and the particle pair numbers are interrelated to each other; Under conditions dominated by fundamental particles or particle pair, the theoretical analysis is expressed as follows:

Number of Q electron pairs: $x = 1,2,3$; Number of -Q electron pairs: $y = x - 1, x$
Number of singularity pairs: $s = 0,1,x$; Quantum number of components: i_n, j_n, q_n
Total number of pairs and dominant particle: $N = x + y + s + 1$

$$\Rightarrow j = \sum_{n=1}^{N} j_n, i \pm \frac{s}{2} = \sum_{n=1}^{N} i_n, q = \sum_{n=1}^{N} q_n, t = \pm\frac{s}{2} + i + j - q \tag{35}$$

$$m = m_d + (x+y)\cdot m_e + s\cdot m_\mu + y\cdot \Delta m_{ee} + 2\cdot y\cdot s\cdot \Delta m_{es} + (x-y)\cdot s\cdot \Delta m_{es} + s\cdot(s-1)\cdot \Delta m_{ss}$$

- **Eigenstate composite leptons dominated by fundamental neutrinos**
  1) **Composite lepton composed by elementary particle pair and fundamental neutrino**

$$\{e, v_e\} + v_\mu = (\pm1,0,\pm1) + (\mp\frac{1}{2}, \mp\frac{1}{2}, 0) = \begin{pmatrix} (1/2,-1/2,1) = \mu^+ \\ (-1/2,1/2,-1) = \mu^- \end{pmatrix}$$
$$\Rightarrow x = 1, y = 0, s = 0, m_d = m_v = 0.21, m_e = 104 \tag{36}$$
$$\Rightarrow m = m_e + m_v = 104 + 0.21 = 104.21$$

  2) **Composite lepton composed by composite particle pair and fundamental neutrino**

$$\mu^- = \{e^-, v_e^-\} + v_\mu^+, \mu^-: (-1/2,1/2,-1), v_\mu^-: (-1/2,-1/2,0) \Rightarrow \{\mu^-, v_\mu^-\} = (\{e^-, v_e^-\} + v_\mu^+) + v_\mu^-$$
$$\Rightarrow m_1 = 104\times 10^0, m_2 = 21\times 10^{-2}, f_j = 1/2, f_i = 4/5 + 0.1/5, c = 1$$
$$\Rightarrow m_{\mu v} = m_1 + m_2 + (m_{01} + m_{02})\cdot(f_i + f_j)\times 10^c = 104 + 0.21 + (104 + 21)\cdot(4/5 + 0.1/5 + 1/2)\times 10$$
$$\Rightarrow m_{\mu v} = 1754.2 \doteq 1754$$
$$\Rightarrow \tau = \{\mu, v_\mu\} + v_\tau = (\pm1,0,\pm1) + (\mp1/2, \mp1/2, 0) = \begin{pmatrix} (1/2,-1/2,1) = \tau^+ \\ (-1/2,1/2,-1) = \tau^- \end{pmatrix} \tag{37}$$
$$\Rightarrow m_\tau = m_{\mu v} + m_{\tau v} = 1754 + 21 = 1775$$

- **Eigenstate composite hadrons dominated by a fundamental hadron**

$$x=1,2,3;\ y=x-1,x;\ s\le x\Rightarrow s=0,1,x;\ N=x+y+s+1$$

$$j=\sum_{n=1}^{N}j_n,\ i\pm\frac{s}{2}=\sum_{n=1}^{N}i_n,\ q=\sum_{n=1}^{N}q_n,\ t=\pm\frac{s}{2}+i+j-q,\ \text{Dominant}: n_0$$

$$\Rightarrow m_d=834,\ m_e=104,\ m_\mu=42,\ \Delta m_{ee}=-102,\ \Delta m_{es}^{\prime}=27,\ \Delta m_{es}=50,\ \Delta m_{ss}=-13$$

$$m=834+(x+y)\cdot 104+s\cdot 42-y\cdot 102+2\cdot y\cdot s\cdot 27+(x-y)\cdot s\cdot 50-s\cdot(s-1)\cdot 13$$

$$\begin{pmatrix} x,y,s \\ \frac{s}{2},i,j,q \\ \text{Calculated} \\ \text{experiment} \\ \text{particle name} \end{pmatrix}=\begin{pmatrix} 1,0,0 \\ \pm(\frac{0}{2},\frac{1}{2},\frac{1}{2},1) \\ 938 \\ 938.27 \\ p^{\pm} \end{pmatrix}\begin{pmatrix} 1,1,0 \\ \pm(\frac{0}{2},\frac{-1}{2},\frac{1}{2},0) \\ 940 \\ 939.57 \\ n \end{pmatrix}\begin{pmatrix} 1,1,1 \\ \pm(\frac{-1}{2},0,\frac{1}{2},0) \\ 1036 \\ \\ \end{pmatrix}\begin{pmatrix} 2,1,0 \\ \pm(\frac{0}{2},\frac{1}{2},\frac{1}{2},1) \\ 1044 \\ \\ \end{pmatrix}\begin{pmatrix} 2,1,1 \\ \pm(\frac{-1}{2},1,\frac{1}{2},1) \\ 1190 \\ 1189.37 \\ \Sigma^{\pm} \end{pmatrix} \quad (38.1)$$

$$=\begin{pmatrix} 2,1,2 \\ \pm(-\frac{2}{2},\frac{3}{2},\frac{1}{2},1) \\ 1310 \\ \\ \end{pmatrix}\begin{pmatrix} 2,2,0 \\ \pm(\frac{0}{2},\frac{-1}{2},\frac{1}{2},0) \\ 1046 \\ \\ \end{pmatrix}\begin{pmatrix} 2,2,1 \\ \pm(\frac{-1}{2},0,\frac{1}{2},0) \\ 1196 \\ 1192.64 \\ \Sigma^{0} \end{pmatrix}\begin{pmatrix} 2,2,2 \\ \pm(\frac{-2}{2},\frac{1}{2},\frac{1}{2},0) \\ 1320 \\ 1314.83 \\ \Xi^{0} \end{pmatrix}\begin{pmatrix} 3,2,0 \\ \pm(\frac{0}{2},\frac{1}{2},\frac{1}{2},1) \\ 1150 \\ \\ \end{pmatrix}\begin{pmatrix} 3,2,1 \\ \pm(\frac{-1}{2},1,\frac{1}{2},1) \\ 1350 \\ \\ \end{pmatrix}$$

$$=\begin{pmatrix} 3,2,2 \\ \pm(\frac{-2}{2},\frac{3}{2},\frac{1}{2},1) \\ 1524 \\ \\ \end{pmatrix}\begin{pmatrix} 3,2,3 \\ \pm(\frac{-3}{2},2,\frac{1}{2},1) \\ 1672 \\ 1672.45 \\ \Omega^{\pm} \end{pmatrix}\begin{pmatrix} 3,3,0 \\ \pm(\frac{0}{2},\frac{-1}{2},\frac{1}{2},0) \\ 1152 \\ \\ \end{pmatrix}\begin{pmatrix} 3,3,1 \\ \pm(\frac{-1}{2},0,\frac{1}{2},0) \\ 1356 \\ \\ \end{pmatrix}\begin{pmatrix} 3,3,2 \\ \pm(\frac{-2}{2},\frac{1}{2},\frac{1}{2},0) \\ 1534 \\ 1534 \\ \Xi^{*} \end{pmatrix}\begin{pmatrix} 3,3,3 \\ \pm(\frac{-3}{2},1,\frac{1}{2},0) \\ 1686 \\ \\ \end{pmatrix} \quad (38.2)$$

- **Eigenstate composite hadrons dominated by a dominant particle pair**

$$x=1,2;\ y=x-1,x;\ s\le x\Rightarrow s=0,1,x;\ N=x+y+s+1$$

$$j=\sum_{n=1}^{N}j_n,\ i\pm\frac{s}{2}=\sum_{n=1}^{N}i_n,\ q=\sum_{n=1}^{N}q_n,\ t=\pm\frac{s}{2}+i+j-q,\ \text{Dominant}: \{v_\mu^-,v_\mu^+\}_d$$

$$m_d=42,\ m_e=104,\ m_\mu=42,\ \Delta m_{ee}=-102,\ \Delta m_{es}^{\prime}=27,\ \Delta m_{es}=50,\ \Delta m_{ed}=-7,\ \Delta m_{ss}=-13,\ \Delta m_{sd}=120$$

$$m=42+(x+y)\cdot 104+s\cdot 42-y\cdot 102+2\cdot y\cdot s\cdot 27+(x-y)\cdot s\cdot 50-(x+y)\cdot 7+s\cdot 120-s\cdot(s-1)\cdot 13$$

$$\begin{pmatrix} x,y,s \\ \frac{s}{2},i,j,q \\ \text{Calculated} \\ \text{experiment} \\ \text{particle name} \end{pmatrix}=\begin{pmatrix} 1,0,0 \\ \pm(1,0,1) \\ 139 \\ 139.57 \\ \pi^{\pm} \end{pmatrix}\begin{pmatrix} 1,1,0 \\ \pm(0,0,0) \\ 134 \\ 134.98 \\ \pi^{0} \end{pmatrix}\begin{pmatrix} 1,1,1 \\ \pm(\frac{-1}{2},\frac{1}{2},0,0) \\ 350 \\ \\ \end{pmatrix}\begin{pmatrix} 2,1,0 \\ \pm(1,0,1) \\ 231 \\ \\ \end{pmatrix}\begin{pmatrix} 2,1,1 \\ \pm(\frac{1}{2},\frac{1}{2},0,1) \\ 497 \\ 493.68 \\ K^{\pm} \end{pmatrix}\begin{pmatrix} 2,1,2 \\ \pm(-1,2,0,1) \\ 737 \\ \\ \end{pmatrix} \quad (39.1)$$

$$\begin{pmatrix} x,y,s \\ \frac{s}{2},i,j,q \\ \text{Calculated} \\ \text{experiment} \\ \text{particle name} \end{pmatrix}=\begin{pmatrix} 2,2,0 \\ \pm(0,0,0) \\ 226 \\ \\ \end{pmatrix}\begin{pmatrix} 2,2,1 \\ \pm(-\frac{1}{2},\frac{1}{2},0,0) \\ 496 \\ 497.67 \\ K^{0} \end{pmatrix}\begin{pmatrix} 2,2,2 \\ \pm(-1,1,0,0) \\ 740 \\ \\ \end{pmatrix}\begin{pmatrix} 3,2,0 \\ \pm(1,0,1) \\ 323 \\ \\ \end{pmatrix}\begin{pmatrix} 3,2,1 \\ \pm(\frac{1}{2},\frac{1}{2},0,1) \\ 643 \\ \\ \end{pmatrix}\begin{pmatrix} 3,2,2 \\ \pm(-1,2,0,1) \\ 937 \\ \\ \end{pmatrix} \quad (39.2)$$

- **Eigenstate composite hadrons dominated by a composite Fermi hadron**

$$x=0,1,2;y=x,x+1;s\le x+1\Rightarrow s=0,1,x+1;N=x+y+s+1$$

$$j=\sum_{n=1}^{N}j_n,i\pm\frac{s}{2}=\sum_{n=1}^{N}i_n,q=\sum_{n=1}^{N}q_n,t=\pm\frac{s}{2}+i+j-q,\text{Dominant}:P^{\pm};m_d=938,m_e=104,m_{\mu}=42$$

$$\Delta m_{ee}=-102,\Delta m_{es}^{\square}=27,\Delta m_{es}=50,\Delta m_{ss}=-13,\Delta m_{ep}^{c}=98,\Delta m_{ep}^{o}=-49,\Delta m_{sp}^{\square}=31\ \Rightarrow m=m_d+$$

$$(x+y)\cdot m_e+s\cdot m_{\mu}+x\cdot\Delta m_{ee}+2\cdot x\cdot s\cdot\Delta m_{es}^{\square}+(y-x)\cdot s\cdot\Delta m_{es}+x\cdot\Delta m_{ep}^{c}+y\cdot\Delta m_{ep}^{o}+s\cdot\Delta m_{sp}^{\square}+s\cdot(s-1)\cdot\Delta m_{ss}$$

$$m=938+(x+y)\cdot 104+s\cdot 42-x\cdot 102+2\cdot x\cdot s\cdot 27+(y-x)\cdot s\cdot 50+x\cdot 98-y\cdot 49+s\cdot 31-s\cdot(s-1)\cdot 13$$

$$\begin{pmatrix} x,y,s \\ \frac{s}{2},i,j,q \\ \text{Calculated} \\ \text{experiment} \\ \text{particle name} \end{pmatrix}=\begin{pmatrix} 0,1,0 \\ \pm(\frac{-1}{2},\frac{1}{2},0) \\ 993 \\ \\ \end{pmatrix}\begin{pmatrix} 0,1,1 \\ \pm(\frac{-1}{2},0,\frac{1}{2},0) \\ 1116 \\ 1115.68 \\ \Lambda \end{pmatrix}\begin{pmatrix} 1,1,0 \\ \pm(0,\frac{1}{2},\frac{1}{2},1) \\ 1090 \\ \\ \end{pmatrix}\begin{pmatrix} 1,1,1 \\ \pm(\frac{-1}{2},1,\frac{1}{2},1) \\ 1220 \\ 1232 \\ \Delta \end{pmatrix}\begin{pmatrix} 1,1,2 \\ \pm(-1,\frac{3}{2},\frac{1}{2},1) \\ 1321 \\ 1321.31 \\ \Xi^{\pm} \end{pmatrix} \quad (40.1)$$

$$\begin{pmatrix} x,y,s \\ \frac{s}{2},i,j,q \\ \text{Calculated} \\ \text{experiment} \\ \text{particle name} \end{pmatrix}=\begin{pmatrix} 1,2,0 \\ \pm(\frac{-1}{2},\frac{1}{2},0) \\ 1148 \\ \\ \end{pmatrix}\begin{pmatrix} 1,2,1 \\ \pm(\frac{-1}{2},0,\frac{1}{2},0) \\ 1325 \\ \\ \end{pmatrix}\begin{pmatrix} 1,2,2 \\ \pm(-1,\frac{1}{2},\frac{1}{2},0) \\ 1476 \\ \\ \end{pmatrix}\begin{pmatrix} 2,2,0 \\ \pm(\frac{1}{2},\frac{1}{2},1) \\ 1248 \\ \\ \end{pmatrix}\begin{pmatrix} 2,2,1 \\ \pm(-\frac{1}{2},1,\frac{1}{2},1) \\ 1429 \\ \\ \end{pmatrix}$$

$$=\begin{pmatrix} 2,2,2 \\ \pm(-1,\frac{3}{2},\frac{1}{2},1) \\ 1584 \\ \\ \end{pmatrix}\begin{pmatrix} 2,2,3 \\ \pm(\frac{-3}{2},2,\frac{1}{2},1) \\ 1713 \\ \\ \end{pmatrix}\begin{pmatrix} 2,3,0 \\ \pm(\frac{-1}{2},\frac{1}{2},0) \\ 1303 \\ \\ \end{pmatrix}\begin{pmatrix} 2,3,1 \\ \pm(\frac{-1}{2},0,\frac{1}{2},0) \\ 1534 \\ 1534 \\ \Xi^{*} \end{pmatrix}\begin{pmatrix} 2,3,2 \\ \pm(-1,\frac{1}{2},\frac{1}{2},0) \\ 1739 \\ \\ \end{pmatrix}\begin{pmatrix} 3,3,3 \\ \pm(-\frac{3}{2},1,\frac{1}{2},0) \\ 1918 \\ \\ \end{pmatrix} \quad (40.2)$$

- **Eigenstate composite hadrons dominated by a composite Bose hadron**

$$x=1,2;y=x-1,x;s=0,1,x,x+1;N=x+y+s+1$$

$$j=\sum_{n=1}^{N}j_n,i\pm\frac{s}{2}=\sum_{n=1}^{N}i_n,q=\sum_{n=1}^{N}q_n,t=\pm\frac{s}{2}+i+j-q,\text{Dominant}:\pi^0$$

$$m_d=135,m_e=104,m_{\mu}=42,\Delta m_{ee}=-102,\Delta m_{es}^{\square}=27,\Delta m_{es}=50,\Delta m_{e\pi}^{\square}=49,\Delta m_{ss}=-13,\Delta m_{s\pi}^{\square}=35$$

$$m=m_d+(x+y)\cdot m_e+s\cdot m_{\mu}+y\cdot\Delta m_{ee}+2\cdot y\cdot s\cdot\Delta m_{es}^{\square}+(x-y)\cdot s\cdot\Delta m_{es}+(x+y)\cdot\Delta m_{e\pi}^{\square}+s\cdot\Delta m_{s\pi}^{\square}+s\cdot(s-1)\cdot\Delta m_{ss}$$

$$m=135+(x+y)\cdot 104+s\cdot 42-y\cdot 102+2\cdot y\cdot s\cdot 27+(x-y)\cdot s\cdot 50+(x+y)\cdot 49+s\cdot 35-s\cdot(s-1)\cdot 13$$

$$\begin{pmatrix} x,y,s \\ \frac{s}{2},i,j,q \\ \text{Calculated} \\ \text{experiment} \\ \text{particle name} \end{pmatrix}=\begin{pmatrix} 1,0,0 \\ \pm(\frac{0}{2},1,0,1) \\ 288 \\ \\ \end{pmatrix}\begin{pmatrix} 1,0,1 \\ \pm(\frac{1}{2},\frac{1}{2},0,1) \\ 415 \\ \\ \end{pmatrix}\begin{pmatrix} 1,0,2 \\ \pm(-\frac{2}{2},2,0,1) \\ 516 \\ \\ \end{pmatrix}\begin{pmatrix} 1,1,0 \\ \pm(\frac{0}{2},0,0,0) \\ 339 \\ \\ \end{pmatrix}\begin{pmatrix} 1,1,1 \\ \pm(-\frac{1}{2},\frac{1}{2},0,0) \\ 470 \\ \\ \end{pmatrix} \quad (41.1)$$

$$\begin{pmatrix} x,y,s \\ \frac{s}{2},i,j,q \\ \text{Calculated} \\ \text{experiment} \\ \text{particle name} \end{pmatrix}=\begin{pmatrix} 1,1,2 \\ \pm(-\frac{2}{2},1,0,0) \\ 575 \\ \\ \end{pmatrix}\begin{pmatrix} 2,1,0 \\ \pm(\frac{0}{2},1,0,1) \\ 492 \\ \\ \end{pmatrix}\begin{pmatrix} 2,1,1 \\ \pm(-\frac{1}{2},\frac{3}{2},0,1) \\ 673 \\ \\ \end{pmatrix}\begin{pmatrix} 2,1,2 \\ \pm(-\frac{2}{2},2,0,1) \\ 828 \\ \\ \end{pmatrix} \quad (41.2)$$

$$\begin{pmatrix} x,y,s \\ \frac{s}{2},i,j,q \\ \text{Calculated} \\ \text{experiment} \\ \text{particle name} \end{pmatrix} = \begin{pmatrix} 2,1,3 \\ \pm(\frac{3}{2},\frac{-1}{2},0,1) \\ 975 \\ 958 \\ \eta^{*} \end{pmatrix} \begin{pmatrix} 2,2,0 \\ \pm(\frac{0}{2},0,0,0) \\ 543 \\ 549 \\ \eta \end{pmatrix} \begin{pmatrix} 2,2,1 \\ \pm(-\frac{1}{2},\frac{1}{2},0,0) \\ 728 \\ \\ \end{pmatrix} \begin{pmatrix} 2,2,2 \\ \pm(-\frac{2}{2},1,0,0) \\ 887 \\ 892 \\ K^{*} \end{pmatrix} \begin{pmatrix} 2,2,3 \\ \pm(-\frac{3}{2},\frac{3}{2},0,0) \\ 1020 \\ 1020 \\ \phi \end{pmatrix}$$

- **A summary of the eigenstate composite particles analyzed in this theory**
  1) The 21 composite particles that have been experimentally verified are exactly the same as the analysis of this theory in terms of quantum number and mass, According to the coexistence mechanism of positive and negative particles, these 21 particles can be expanded to 42 particles. This theory precisely proves that $(P^{\pm}, n)$ are composite particles, not fundamental particles; also fundamental neutron$n_0$exist and require experimental verification.
  2) This theory precisely proves that the essence of electric charge is the effect of electrons, and the electric charge of any other particles is only provided by electrons, so the amount of electric charge cannot be a fraction.
  3) In the analysis of this theory, there are 40 particles that are currently unknown whether they really exist, and it is very likely that some of them do exist and some do not. Specifically, based on the quantum numbers and masses derived from this theory, some particles can be demonstrated through experiments.
  4) The splitting results of composite particles are diverse, according to the description of composite particles in this theory, the examples of splitting results for some known and unknown particles are as follows:

$$\begin{aligned} p^{+} &= (\{e^{+}, v_e^{+}\} + n_0), n = (\{e^{+}, v_e^{+}\} + \{e^{-}, v_e^{-}\} + n_0) \to p^{+} + e^{-} + v_e^{-} \\ &\to n_0 + e^{+} + v_e^{+} + e^{-} + v_e^{-} \\ \pi^{+} &= (\{e^{+}, v_e^{+}\} + \{v_\mu^{-}, v_\mu^{+}\}), \pi^{0} = (\{e^{+}, v_e^{+}\} + \{v_\mu^{-}, v_\mu^{+}\} + \{e^{-}, v_e^{-}\}) \to \pi^{+} + e^{-} + v_e^{-} \\ &\to \mu^{+} + v_\mu^{+} + e^{-} + v_e^{-} \\ \Sigma^{+} &= (2\{e^{+}, v_e^{+}\} + \{e^{-}, v_e^{-}\} + \{v_\mu^{-}, v_\mu^{+}\} + n_0) \to \pi^{0} + p^{+} \to \pi^{+} + e^{-} + v_e^{-} + p^{+} \\ &\to \pi^{+} + n \qquad (42) \\ ? &= \begin{pmatrix} x, y, s{:}2,1,2 \\ mass{:}\,1310 \end{pmatrix} = (2\{e^{+}, v_e^{+}\} + \{e^{-}, v_e^{-}\} + 2\{v_\mu^{-}, v_\mu^{+}\} + n_0) \to \pi^{0} + \pi^{+} + n_0 \\ &\to \pi^{-} + p^{+} + \mu^{+} + v_\mu^{+} \end{aligned}$$

6. SUMMARY

If the regular multivariate states mechanism proposed in this article is correct for the expression of fundamental particles, Electrons are the only source of electric charges, So the amount of electric charge in any composite particle is the number of electrons. If the coupling theory of particle systems is effective, The mass variation of composite particles can be effectively explained, The types of composite particles are also related to this theory. In the theoretical research of this article, many new particles have also been derived, Whether these new particles really exist remains to be experimentally verified.

CONFLICT OF INTERESTS

None.

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