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BARYOGENESIS LAW: METHOD OF OBTAINING THE STRONG INTERACTION COUPLING CONSTANT FROM THE BARYOGENESIS LAW.

Abstract: *The value of the strong interaction coupling constant, α_s, is not predicted by the Standard Model theory and is known from experiments. This article proposes a method for obtaining the constant from the Baryogenesis Law. The constant is directly calculated from the mass defect of elementary particles, presenting a novel approach to investigating the strong interaction coupling constant. This method unveils the mechanism of the constant's origin from the mass defect of elementary particles, providing new insights into the precision of α_s. The calculated value from the Baryogenesis Law, $\alpha_s(mZ^0) = 0.1172(18)$, aligns well with the experimental value. A range of values for the constant is determined, ensuring its physical significance. The Baryogenesis Law reveals that the strong interaction coupling constant, α_s, is not an independent constant, establishing its connection with the fine structure constant α. The dependent status of α_s and its link with the fine structure constant indicates a profound connection between the two fundamental interactions – electromagnetic and strong.*

Keywords: *strong interaction coupling constant, Baryogenesis Law, leptosynthesis, baryosynthesis, mass defect, Mersenne numbers, doubled Mersenne numbers.*

1. Introduction

The strong interaction coupling constant, αs, is a fundamental physical parameter in the Standard Model of particle physics [1]. Both theoretical and experimental research extensively focus on understanding this constant [2-14]. Knowledge of strong coupling is essential for comprehending both high-energy and hadronic phenomena [15].

While the value of the electromagnetic interaction coupling constant, α, is known with high precision today ($\alpha = 7.2973525693(11) \times 10^{-3}$), the accuracy of the strong interaction coupling constant, $\alpha_s(mZ^0) = 0.1170 \pm 0.0019$, is significantly lower [16, 17]. Altarelli's predicted value in 1989, estimated based on the mass of the Z-boson, $\alpha_s(mZ^0) \approx 0.11 \pm 0.01$, has not seen substantial improvement in recent years. The most accurate experimental value, $\alpha_s(mZ^0) = 0.1170 \pm 0.0019$, is presented in [16, 17]. Such precision is evidently insufficient for calculations employing α_s.

This article proposes a method for obtaining the strong interaction coupling constant from the Baryogenesis Law. This method involves directly calculating its value from the mass defect of elementary particles. This novel approach to investigating the strong interaction coupling constant reveals the mechanism of its origin and opens new possibilities for addressing the precision issue of α_s.

2. Baryogenesis Law

The Baryogenesis Law is derived from the fractal mechanism of baryogenesis [19-21] (Fig. 1):

$$m_j = M_j \bullet m_e - \Delta m_j$$

Fig. 1. Baryogenesis Law. M_j - magic number of elementary particle, m_j - mass of elementary particle, m_e - electron mass, Δm_j - mass defect of elementary particle.

The formulation of the Baryogenesis Law is as follows: "*The mass of an elementary particle is equal to the sum of the masses of electrons and positrons involved in baryosynthesis, reduced by the magnitude of their total mass defect.*" The Baryogenesis Law is derived from the fractal mechanism of baryosynthesis, in which antiparticles play a crucial role in the formation of protons and neutrons.

The Baryogenesis Law is derived and formulated using two new constants of elementary particles: the magic number of an elementary particle and the mass defect of an elementary particle. The magic number indicates how many electrons and positrons participated in the formation of the corresponding particle or antiparticle.

The values of magic numbers are computed from fractal formulas. The fractal formula for charged particles is given by [19-21]:

$$M = 2(2(...2(2(2+1)+1)+1)+...+1)+1 \qquad (1)$$

The fractal formula for neutral particles is:

$$M = 2(2(...2(2(2+1)+1)+1)+...+1) \qquad (2)$$

The magic numbers of elementary particles form the following sequence of numbers:

2, 3, 6, 7, 14, 15, 30, 31, 62, 63, 126, 127, 254, 255, 510, 511, 1022, 1023, 2046, 2047, 4094, … (3)

Each odd magic number corresponds to a pair of electrically charged elementary particles, while each even magic number corresponds to a neutral elementary particle. Some elementary particles are already known and experimentally obtained. From the sequence (3) in the range 2 - 4095, these include particles associated with the numbers: 2 (positronium), 3 (positronium ions), 255 (muon), 2047 (proton), 4094 (protonium), 4095 (deuteron). The Baryogenesis Law suggests that there are more particles and antiparticles yet to be discovered in this range, awaiting experimental confirmation.

The magic numbers of electrically charged elementary particles are Mersenne numbers [22]:

3, 7, 15, 31, 63, 127, 255, 511, 1023, 2047, 4095, … (4)

The magic numbers of neutral elementary particles are doubled Mersenne numbers:

$$2, 6, 14, 30, 62, 126, 254, 510, 1022, 2046, \dots \qquad (5)$$

Magic numbers can be represented both as topological and analytical formulas. The formula for particles and antiparticles with electric charge is given by:

$$M_j = \underbrace{2(2(\dots 2(2(2}_{j} \underbrace{+1)+1)+1)+\dots+1)+1}_{j} = 2^{j+1} - 1 \qquad (6)$$

The formula for particles and antiparticles with zero charge is as follows:

$$M_j = \underbrace{2(2(\dots 2(2(2}_{j} \underbrace{+1)+1)+1)+\dots+1)}_{(j-1)} = 2^{j+1} - 2 \qquad (7)$$

3. Mass defect of elementary particles.

The mass defect is a new constant of elementary particles. Its value is a quantitative measure of the binding energy of elementary particles. The mass defect arises as a result of the interaction between matter and antimatter during the formation of an elementary particle. All elementary particles, except for the electron and positron, have a mass defect that they acquire during the processes of leptosynthesis and bariosynthesis. As a result, the mass of an elementary particle is less than the sum of the masses of the particles and antiparticles participating in the synthesis.

The general formula for calculating the mass defect is derived from the fractal mechanism of the structurogenesis of elementary particles. It is expressed as:

$$\Delta m_j = m_e \bullet \sum_{i=1}^{j+1} (2^i - 1) \bullet (1 - k_s^{j+2-i}) \qquad (8)$$

where: m_e - mass of the electron, Δm_j - mass defect of the elementary particle, k_s - constant including the fine-structure constant.

Each magical number M_j is associated with two values of the mass defect Δm_{j1} and Δm_{j2} (Fig. 2).

$$\Delta m_{j1} = m_e \bullet \sum_{i=1}^{j+1} (2^i - 1) \bullet (1 - k_{s1}^{j+2-i})$$

$$\Delta m_{j2} = m_e \bullet \sum_{i=1}^{j+1} (2^i - 1) \bullet (1 - k_{s2}^{j+2-i}) \quad (9)$$

Fig. 2. Formulas for calculating mass defect.

The constant k_{s1} allows obtaining the magnitude of the mass defect for "heavy" particles. The constant k_{s2} allows obtaining the magnitude of the mass defect for "light" particles. The origins of the formation of "light" and "heavy" particles should be sought in two modifications of positronium (parapositronium, orthopositronium). Equivalent formulas for calculating constants k_{s1} and k_{s2} are as follows [24]:

$$k_{s1} = \frac{133.395907639\ldots}{137.03599908\ldots} = \sqrt[10]{D_0} \bullet \alpha^2 = \frac{\alpha}{\sqrt[20]{\pi \bullet 10^{-43}}} = \sqrt[20]{\frac{\pi_2}{\pi}} = 0.973436969 \quad (10)$$

$$k_{s2} = \frac{129.85250805\ldots}{137.03599908\ldots} = (\sqrt[10]{D_0} \bullet \alpha^2)^2 = \frac{\alpha^2}{\sqrt[10]{\pi \bullet 10^{-43}}} = \sqrt[10]{\frac{\pi_2}{\pi}} = 0.947579533 \quad (11)$$

Fig. 3. Formulas for calculating constants k_{s1} and k_{s2}. Where: α - fine-structure constant, π = 3.14..., π2 = 1.8336084, D_0 - Dirac's large number ($D_0 = 4.16561\ldots \times 10^{42}$).

From equations (8) - (11), it follows that the mass defect has a dependence on the fine-structure constant α. The mass defect of an elementary particle determines the binding energy. Mass defect arises in all products of leptosynthesis and bariosynthesis reactions. In these reactions, electrons, positrons, and more complex particles and antiparticles are involved. As a result, the mass of the formed particle or antiparticle is always less than the sum of the masses of the reactants. The constant of mass defect is the part of the mass of the synthesis participants that is 'spent' on binding energy. The remaining part of the mass of the reactants is the mass of the elementary particle. Both the magical number and the mass defect result from the fractal mechanism of baryogenesis and are quantitative characteristics of the mechanism of lepton and baryon synthesis.

4. Strong interaction coupling constant from the baryogenesis law.

The force of interaction in the field theory is characterized by the corresponding coupling constant. For strong interaction, this constant is α_s. The mass defect determines the magnitude of the binding energy for a system of interacting objects. With the emergence of the new constant of elementary particles - the mass defect Δm_j, the direct calculation of the strong interaction coupling constant becomes possible using the formula (Fig. 4):

$$\alpha_{sj} = \frac{\Delta m_j}{m_j} \qquad (12)$$

Fig. 4. Formula for the direct calculation of the strong interaction coupling constant. Where: Δm_j - mass defect of elementary particle; m_j - mass of elementary particle.

The value of the strong interaction coupling constant αs indicates what part of the mass of an elementary particle is the mass defect. This imposes a strict constraint on the range of possible values of the strong interaction coupling constant αs. Values $\alpha_s \geq 1$ have no physical meaning. From equations (9) - (12), it follows that the strong interaction coupling constant αs is not an independent constant. Its value depends on the constants k_{s1} and k_{s2} (Fig. 3), which are related to the fine-structure constant α. The high precision of the fine-structure constant α opens the possibility of obtaining a more accurate value of the strong interaction coupling constant α_s.

5. Calculating the strong interaction coupling constant $\alpha_s(mZ^0)$ from the baryogenesis law.

It is customary to obtain the value of the strong interaction coupling constant at the particle energy level of 91.1876±0.0021 GeV [23]. The baryogenesis law allows obtaining the calculated values of the following constants for a particle with zero charge and a mass of mmes = 178449(4)m_e (91.1876±0.0021 GeV/c²):

- magical number;
- calculated value of the particle mass;
- mass defect.

These constants provide the opportunity for the direct determination of the strong interaction coupling constant $\alpha_s(mZ^0)$ from the baryogenesis law. The boson fractal is represented by the following combined fractal (Fig. 5).

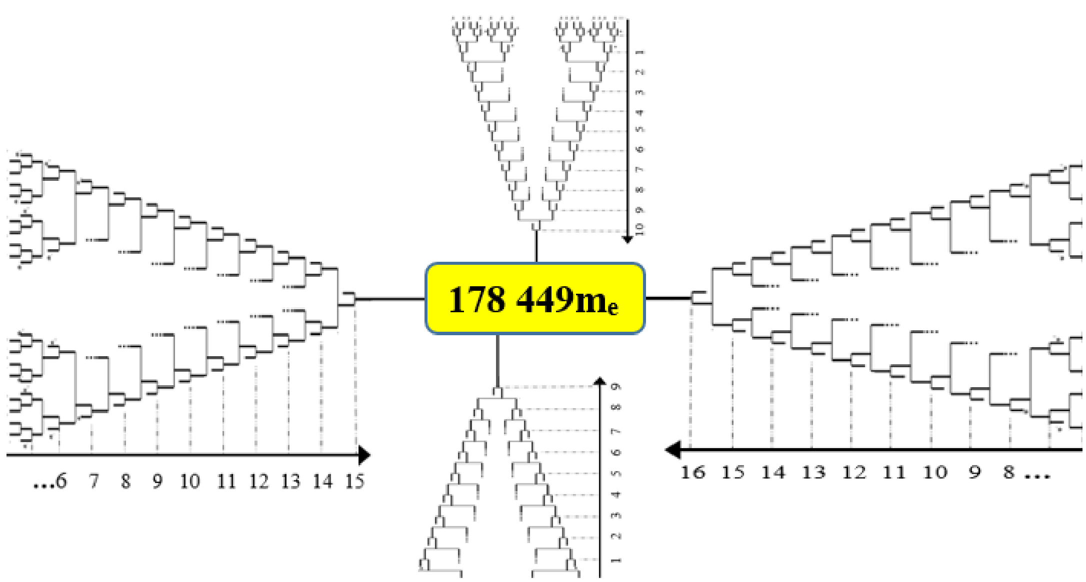

Fig. 5. Combined fractal of a particle with zero charge and a mass of 178449m_e.

The combined fractal of a particle with a mass of 178449m_e includes the fractal of an antiproton (P_{10}), the fractal of particle P_9, the fractal of particle P_{15}, and the fractal of an antiparticle P_{16}.

The calculated value of the particle mass is obtained from the baryogenesis law (Fig. 1):

$$m_z = M_z \bullet m_e - \Delta m_z \qquad (13)$$

The magical number M_z of the boson, which is part of the baryogenesis law, is obtained as the sum of magical numbers of particles and antiparticles P_{16}, P_{15}, P_{10}, P_9:

$$M_z = P_{16} + P_{15} + P_{10} + P_9 = 2^{17}+2^{16}+2^{11}+2^{10} - 4 = 199676 \qquad (14)$$

The magical numbers for the antiproton and particle P_9 are obtained in [19]. They are calculated using fractal formulas:

$$M_{10} = P_{10} = 2(2(2(2(2(2(2(2(2(2+1)+1)+1)+1)+1)+1)+1)+1)+1)+1 = 2^{11} - 1 = 2047 \qquad (15)$$

$$M_9 = P_9 = 2(2(2(2(2(2(2(2(2+1)+1)+1)+1)+1)+1)+1)+1)+1 = 2^{10} - 1 = 1023 \qquad (16)$$

The magical numbers for particle P_{15} and antiparticle P_{16} are calculated using formulas:

$$M_{16} = P_{16} = 2(2(...2(2(2+1)+1)+1)+...+1) = 2^{17} - 1 = 131071 \qquad (17)$$

$$M_{15} = P_{15} = 2(2(...2(2(2+1)+1)+1)+...+1) = 2^{16} - 1 = 65535 \qquad (18)$$

The calculated mass defects for particles and antiparticles P_{16}, P_{15}, P_{10}, P_9 are obtained from the formula:

$$\Delta m_j = m_e \bullet \sum_{i=1}^{j+1} (2^i - 1) \bullet (1 - k_{s1}^{j+2-i}) \qquad (19)$$

where: m_e - the mass of the electron, k_{s1} = 0.9734369693, j - follows from the relationship: $M_j = 2^{j+1} - 1$.

The mass defects of particles and antiparticles P_{16}, P_{15}, P_{10}, P_9 have the following values:

$$\Delta m_{16} = m_e \bullet \sum_{i=1}^{17} (2^i - 1) \bullet (1 - k_{s1}^{18-i}) = 13562 m_e \qquad (20)$$

$$\Delta m_{15} = m_e \bullet \sum_{i=1}^{16} (2^i - 1) \bullet (1 - k_{s1}^{17-i}) = 6779 m_e \qquad (21)$$

$$\Delta m_{10} = m_e \bullet \sum_{i=1}^{11} (2^i - 1) \bullet (1 - k_{s1}^{12-i}) = 210 m_e \qquad (22)$$

$$\Delta m_9 = m_e \bullet \sum_{i=1}^{10} (2^i - 1) \bullet (1 - k_{s1}^{11-i}) = 104 m_e \qquad (23)$$

The mass defect when combining particles and antiparticles P_{16}, P_{15}, P_{10}, P_9 in the final stage of boson structurogenesis is unknown. Therefore, the overall mass defect will be somewhat underestimated. Due to this, the calculated value of the boson mass will be slightly overestimated. The excess will be by the amount of the mass defect arising from the combination of P_{16}, P_{15}, P_{10}, P_9. Considering the large mass of the boson, the error is expected to be insignificant.

The overall mass defect throughout the boson synthesis path is equal to the sum of mass defects at all stages of its structurogenesis. This sum includes:

1. Mass defect of antiparticle P_{16} ($13562m_e$).
2. Mass defect of particle P_{15} ($6779m_e$).
3. Mass defect of antiparticle P_{10} ($210m_e$).
4. Mass defect of particle P_9 ($104m_e$).
5. Mass defect when combining P_{16}, P_{15}, P_{10}, P_9 (unknown).

The sum of calculated mass defects gives a value of $20655m_e$:

$$\Delta m = 13562m_e + 6779m_e + 210m_e + 104m_e = 20655m_e \qquad (24)$$

From equation (16), we obtain the value of the boson mass:

$$m_z = 199676\ m_e - 20655\, m_e = 179021\, m_e \qquad (25)$$

The calculated value of the particle mass ($179021m_e$) is very close to the experimental value of the Z boson mass (m_{mes} = $178449m_e$). Taking into account the mass defect at the final stage of structurogenesis, the calculated mass value will be even closer to the experimental value.

Thus, the following boson constants are obtained:

- magical number M_z = 199676;
- mass defect Δm_z = $20655m_e$;
- calculated mass m_z = $179021m_e$.

These obtained boson constants allow calculating the lower value of the strong interaction coupling constant $\alpha_s(mZ^0)$ directly from the baryogenesis law.

$$\alpha_s(mZ^0) = \Delta m_z/m_z = 20655m_e/179021m_e = 0{,}1154\ldots \qquad (26)$$

The calculated value of $\alpha_s(mZ^0)$ = 0.1154 falls within the range of experimental values [16, 17].

6. Calculating the constant $\alpha_s(mZ^0)$ from the baryogenesis law using the experimental value of the boson mass.

In addition to the value $\alpha_s(mZ^0)$ = 0.1154, the baryogenesis law allows obtaining the value of the strong interaction coupling constant using the experimental value of the boson mass (m_{mes} = $178449(4)m_e$). To do this, we obtain the following mass defect value Δm_2 from the baryogenesis law:

$$\Delta m_2 = M_z m_e - m_{mes} = 199676m_e - 178449(4)m_e = 21227(4)m_e \qquad (27)$$

From equation (12), we obtain the value of the strong interaction coupling constant α_s(mZ0):

$$\alpha s(mZ0) = \Delta m2 / mmes = 21227(4)me / 178449(4)me = 0.118952(25) \qquad (28)$$

Thus, the baryogenesis law suggests that the value of the strong interaction coupling constant $\alpha s(mZ^0)$ is in the range from 0.1154 to 0.118977. This corresponds to the most accurate experimental value $\alpha_s(mZ^0)$ = 0.1170 ± 0.0019 [16, 17].

7. Conclusion

A method for calculating the strong interaction coupling constant α_s from the baryogenesis law has been found. The baryogenesis law reveals the mystery of the origin of the strong interaction coupling constant α_s. The constant αs is obtained as the ratio of the mass defect of an elementary particle to its mass. The magnitude of the strong interaction coupling constant αs indicates what part of the mass of an elementary particle is the mass defect. This imposes a strict constraint on the range of possible values of the strong interaction coupling constant αs. Values $\alpha_s \geq 1$ lose physical meaning. Of particular interest is the connection of the strong interaction coupling constant α_s with the fine-structure constant α. This result requires further in-depth study. The dependent status of the strong interaction constant indicates the presence of a profound connection between two fundamental interactions - electromagnetic and strong.

8. Conclusions

1. A method for obtaining the strong interaction coupling constant αs from the baryogenesis law by directly calculating its value from the mass defect of elementary particles is proposed. The formula for the direct calculation of the constant αs is as follows:

$$\alpha_{sj} = \frac{\Delta m_j}{m_j}$$

2. The formula for calculating the mass defect is as follows:

$$\Delta m_j = m_e \bullet \sum_{i=1}^{j+1} (2^i - 1) \bullet (1 - k_s^{j+2-i})$$

where: m_e - the mass of the electron, Δm_j - the mass defect of elementary particle, k_s - a constant including the fine-structure constant.

3. The strong interaction coupling constant for the mass of the boson $\alpha_s(mZ^0)$ is calculated from the baryogenesis law using a computational method. Its value $\alpha_s(mZ^0) = 0.1172(18)$ is in good agreement with experimental data.

4. The value of the strong interaction coupling constant αs indicates the proportion of the mass of an elementary particle that is the mass defect. This imposes a strict constraint on the range of possible values for the strong interaction coupling constant αs. Values $\alpha_s \geq 1$ lose physical meaning.

5. The baryogenesis law shows that the strong interaction coupling constant αs is not an independent constant. It has a complex dependence represented by a fractal formula and is linked to the fine-structure constant α.

6. The high precision of the fine-structure constant α opens the possibility of obtaining a more accurate value of the strong interaction coupling constant α_s.

7. The dependent status of the strong interaction coupling constant indicates the existence of a profound connection between two fundamental interactions - electromagnetic and strong.

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