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THE LAW OF BARYOGENESIS AS A GENERATOR OF THE MASS SPECTRUM OF ELEMENTARY PARTICLES.

Abstract. *The mass spectrum of elementary particles, in the form of systematically increasing mass values, is obtained from the fractal mechanism of leptosynthesis and baryosynthesis. A theoretical justification for the mass spectrum of elementary particles is provided. The law of baryogenesis serves as the generator of the mass spectrum of elementary particles. The law of baryogenesis implies mass values for both known and yet undiscovered elementary particles. The generated mass spectrum is represented by multiplets of three mass values each. The mass difference within triplets is very small and less than the mass of an electron. The mass values of elementary particles in the mass spectrum adhere to a strict law, forming a systematic increasing sequence. The regularity in the dynamics of mass values growth of elementary particles is close to the law of increasing numbers in the Mersenne sequence. From the mass spectrum of elementary particles, it follows that the predicted number of undiscovered elementary particles far exceeds the number of known particles. In the mass range from the electron to the deuteron, 56 elementary particles remain undiscovered. Expected mass values are provided for new elementary particles that are yet to be discovered in experiments.*

Keywords: *mass spectrum of elementary particles, law of baryogenesis, leptosynthesis, baryosynthesis, mass defect, triplets of elementary particles, Mersenne numbers.*

1. Introduction

The explanation of the mass spectrum of discovered elementary particles remains one of the unresolved problems in modern physics [1]. The mechanism behind the generation of masses of elementary particles has not been fully disclosed. The analytical derivation of the complete mass spectrum from first principles remains an unsolved task. Attempts to address this issue have been made through the use of empirical formulas [2 - 31]. Nambu Y set out to explain the mass spectrum of elementary particles based on the connection between mass and the fine-structure constant [2]. In 1952, he proposed an empirical formula that generates mass values for elementary particles:

$$m = \frac{N \bullet m_e}{2\alpha} \qquad (1)$$

where N is a positive number, m_e is the mass of the electron, and α is the fine-structure constant.

Empirical formula (1) has been studied by many authors [7 - 21]. Each particle has its own value of N. For example, with N = 27, the formula yields a mass value close to the proton's mass. Nambu's formula provides energy quanta for particle masses: 35, 70, 105, 140 MeV, etc. [9 - 13, 22]. For some elementary particles, the empirical formula allows obtaining mass values with deviations within 1% of the experimental value [4].

Nambu's idea of the connection between the masses of elementary particles and the fine-structure constant found further development in the work of Barut, A. O. [3]. In 1979, Barut proposed an empirical formula for the masses of leptons [3]:

$$m(N) = m_e\left(1 + \frac{3}{2\alpha}\sum_{k=0}^{N} k^4\right) \qquad (2)$$

where N is a positive number, and m_e is the mass of the electron.

Unlike Nambu's formula, Barut's formula relates the fine-structure constant α not to masses but to the difference in masses.

Experimental mass values of elementary particles indicate that the mass spectrum is quantized. Formulas by Nambu and Barut suggest that the quantization of masses of elementary particles is ensured by two fundamental constants — the fine-structure constant α and the electron mass m_e. This research direction was actively pursued by Malcolm H. MacGregor, who introduced the term *'α-quantization'* of masses [9 - 13, 32].

The value of Nambu's and Barut's formulas lies in emphasizing the existence of a dependence of the mass spectrum on two fundamental constants of quantum electrodynamics — the electron mass m_e and the fine-structure constant α. However, the precision of mass values obtained from empirical formulas remains significantly lower than the precision of their experimental values [4, 5].

Both formulas suffer from the lack of theoretical justification and the low accuracy of the obtained mass values. The low accuracy is a consequence of the limited capabilities of empirical formulas, which are not connected to the mechanism of mass formation. Instead of empirical formulas, a theory of the mass spectrum is needed, derived from the mechanism of the origin of elementary particle masses. The theory should explain not only the masses of known particles but also provide predictions for the masses of yet undiscovered particles.

It is evident that the quantization of masses of elementary particles follows a more complex law than the empirical formulas of Nambu and Barut. The law of the mass spectrum cannot be represented by simplified empirical formulas in whole numbers. The law of the mass spectrum must have theoretical justification and derive from the mechanism of the formation of elementary particle masses.

2. Fractal Mechanism of Elementary Particle Synthesis.

The law of mass spectrum formation follows from the fractal mechanism of leptosynthesis and baryosynthesis (Fig. 1). This mechanism serves as the foundation for deducing the law of baryogenesis, which governs the generation of elementary particle masses [33]. The process of synthesizing elementary particles begins with the electron and positron. Matter and antimatter serve as the building materials for elementary particles. According to the law of baryosynthesis, electrons and positrons initially create primary atoms - positronium atoms P_s (Fig. 1). These are the first neutral particles in the process of baryosynthesis. Subsequently, through the attachment of an electron and positron to positronium atoms, charge-conjugate pairs of P_s^- and P_s^+ ions are formed (Fig. 1).

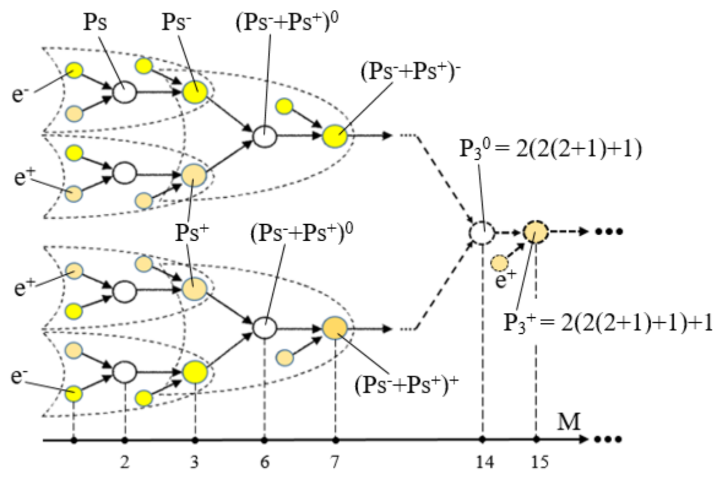

Fig. 1. Fractal Mechanism of Leptosynthesis and Baryosynthesis.

The ions of positronium, when combined, form new neutral particles $(P_s^- + P_s^+)^0$. At the stage of forming P_s^- and P_s^+ ions, and during the formation of neutral particles $(P_s^- + P_s^+)^0$, electrons and positrons act as reactants and catalysts in the process of baryosynthesis.

The catalytic process of synthesizing new elementary particles continues through the attachment of an electron and positron to neutral $(Ps^- + Ps^+)^0$ particles. Charge-conjugate pairs of new elementary particles $(Ps^- + Ps^+)^-$ and $(Ps^- + Ps^+)^+$ are formed, and these particles and antiparticles, through Coulomb interaction, create successive neutral particles P_3^0. The fractal mechanism of elementary particle reduplication is realized ($P_3^0 = 2(2(2+1)+1$, $P_3^{(+)(-)} = 2(2(2+1)+1)+1$). The process repeats and copies itself according to the principle of structure doubling. Throughout the synthesis path, the formation of a new particle or antiparticle is accompanied by a mass defect.

The building material for each elementary particle is the particle and antiparticle of the previous stage. As a result, at each synthesis stage, the previous stage is copied, and the mass is doubled, reduced by the amount of the mass defect.

The fractal mechanism of baryogenesis is represented by the following numerical sequence: 2, 3, 6, 7, 14, 15, 30, 31, 62, 63, 126, 127, 254, 255, 510, 511, 1022, 1023, 2046, 2047, ... This sequence is a set of magic numbers for elementary particles. Magic numbers are new constants of elementary particles. The sequence of magic numbers is a combination of two sequences - Mersenne numbers and doubled Mersenne numbers.

3. Law of Baryogenesis.

The law of baryogenesis (Fig. 2) is derived from the fractal mechanism of leptosynthesis and baryosynthesis [33 - 37]:

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

Fig. 2. Law of Baryogenesis. M_j - magic number of elementary particle, m_j - mass of elementary particle, m_e - mass of the electron, Δm_j - mass defect of elementary particle.

The law of baryogenesis includes new constants of elementary particles [36]. These constants are the magic number M_j of the elementary particle and the mass defect Δm_j of the elementary particle.

4. Magic Numbers of Elementary Particles

The magic number indicates how many electrons and positrons participated in the formation of the corresponding particle or antiparticle. Magic numbers can be represented both as topological formulas and analytical formulas. The formula for calculating the magic numbers of elementary particles with electric charge is as follows:

$$M_j = \underbrace{2(2(\ldots 2(2(2}_{j} + \underbrace{1)+1)+1)+\ldots+1)+1}_{j} = 2^{j+1} - 1 \quad (3)$$

Formula for calculating the magic numbers of elementary particles with zero charge is as follows:

$$M_j = \underbrace{2(2(\ldots 2(2(2}_{j} + \underbrace{1) + 1) + 1) + \ldots + 1)}_{(j-1)} = 2^{j+1} - 2 \quad (4)$$

The fractal mechanism of baryogenesis leads to a fractal triangle that defines the magic numbers of elementary particles and reflects the sequence of stages in the formation of elementary particles. The fractal triangle (Fig. 3) illustrates the mechanism of copying and doubling the previous structure.

$$\mathbf{2 = M_{1,1} = 2}$$
$$\mathbf{2+1 = M_{1,2} = 3}$$
$$\mathbf{2(2+1) = M_{2,1} = 6}$$
$$\mathbf{2(2+1)+1 = M_{2,2} = 7}$$
$$\mathbf{2(2(2+1)+1) = M_{3,2} = 14}$$
$$\mathbf{2(2(2+1)+1)+1 = M_{3,2} = 15}$$
$$\mathbf{2(2(2(2+1)+1)+1) = M_{4,1} = 30}$$
$$\mathbf{2(2(2(2+1)+1)+1)+1 = M_{4,2} = 31}$$
$$\mathbf{2(2(2(2(2+1)+1)+1)+1) = M_{5,1} = 62}$$
$$\mathbf{2(2(2(2(2+1)+1)+1)+1)+1 = M_{5,2} = 63}$$
$$\mathbf{2(2(2(2(2(2+1)+1)+1)+1)+1) = M_{6,1} = 126}$$
$$\mathbf{2(2(2(2(2(2+1)+1)+1)+1)+1)+1 = M_{6,2} = 127}$$
$$\mathbf{\ldots,}$$
$$\mathbf{2(2(\ldots 2(2(2(2+1)+1)+1)+1)+\ldots+1) = M_{j,1} = 2^{j+1} - 2}$$
$$\mathbf{2(2(\ldots 2(2(2(2+1)+1)+1)+1)+\ldots+1)+1 = M_{j,2} = 2^{j+1} - 1}$$

Fig. 3. The fractal triangle depicts the sequence of stages in the formation of elementary particles, the dynamics of the growth of magic numbers of elementary particles, and the mechanism of copying and doubling the previous structure.

Magic numbers of elementary particles form the following numerical sequence:

2, 3, 6, 7, 14, 15, 30, 31, 62, 63, 126, 127, 254, 255, 510, 511, 1022, 1023, 2046, 2047, 4094, 4095, … (5)

The plot of the sequence obtained using Wolfram Alpha looks like (Fig. 4).

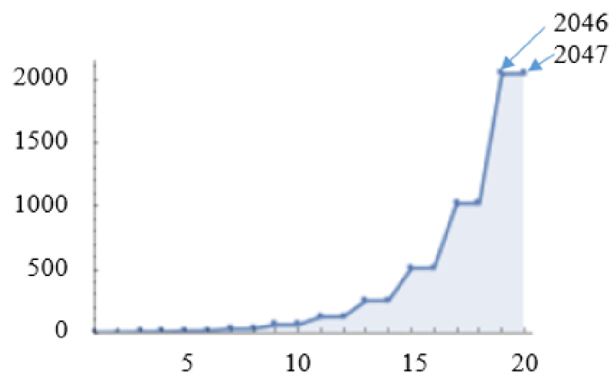

Fig. 4. Plot of the values of magic numbers for the sequence (5).

Each odd magic number corresponds to a pair of electrically charged elementary particles (particle and antiparticle). Each even magic number corresponds to a neutral elementary particle. The sequence of magic numbers (5) is a combination of two sequences. One of the sequences is the Mersenne numbers [38]. Magic numbers of electrically charged elementary particles are Mersenne numbers:

3, 7, 15, 31, 63, 127, 255, 511, 1023, 2047, 4095, … (6)

The recurrence formula for Mersenne numbers is given by:

$$Mj = 2M_{j-1} + 1 \quad (7)$$

The analytical formula for Mersenne numbers is given by:

$$Mj = 2j+1 - 1 \quad (8)$$

The plot for Mersenne numbers obtained using Wolfram Alpha looks like (Fig. 5).

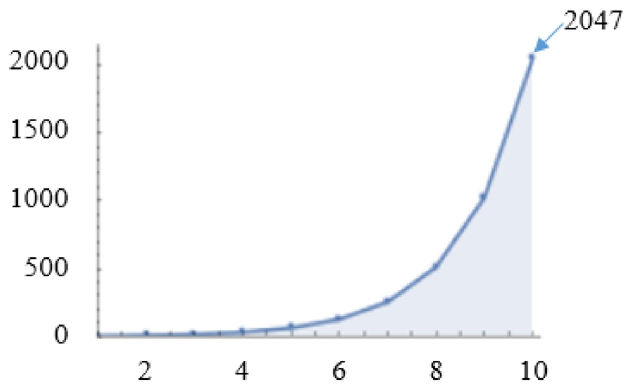

Fig. 5. Plot of the values of magic numbers for the sequence (6).

The second sequence of magic numbers is the doubled Mersenne numbers:

2, 6, 14, 30, 62, 126, 254, 510, 1022, 2046, … (9)

The recurrence formula for doubled Mersenne numbers is given by:

$$Mj = 2M_{j-1} + 2 \quad (10)$$

The analytical formula for doubled Mersenne numbers is given by:

$$Mj = 2j+1 - 2 \quad (11)$$

The proton and antiproton correspond to the Mersenne number $M_{10} = 2047$. A unique feature of the proton and antiproton is that they are the first and only stable elementary particles after the electron and positron. Note that the Mersenne number 2047 also has a special property. It is the first composite Mersenne number with a prime exponent: $2047 = 2^{11} - 1$.

5. Binding Energy and Mass Defect of Elementary Particles.

The mass defect Δmj is a new constant of elementary particles [36]. Its value serves as a quantitative measure of the binding energy of elementary particles. The mass defect arises from the interaction of matter and antimatter during the formation of elementary particles. All elementary particles, except for the electron and positron, have a mass defect acquired during the process of leptosynthesis and baryosynthesis. As a result, the mass of an elementary particle is less than the sum of the masses of the particles and antiparticles involved in the synthesis.

The general formula for calculating the mass defect follows from the fractal mechanism of the structural genesis of elementary particles. It is given by:

$$\Delta m_j = m_e \bullet \sum_{i=1}^{j+1} (2^i - 1) \bullet (1 - k_s^{j+2-i}) \quad (12)$$

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

In the law of baryogenesis (Fig. 2), each magic number M_j is associated with two values of mass defect Δm_{j1} and Δm_{j2}. The formulas for calculating these values are:

$$\Delta m_{j1} = m_e \bullet \sum_{i=1}^{j+1} (2^i - 1) \bullet (1 - k_{s1}^{j+2-i}) \qquad (13)$$

$$\Delta m_{j2} = m_e \bullet \sum_{i=1}^{j+1} (2^i - 1) \bullet (1 - k_{s2}^{j+2-i}) \qquad (14)$$

Constants k_{s1} and k_{s2} are derived from the fine-structure constant α = 0.0072973525693(11) and the number π = 3.14… [36, 37]. Constants k_{s1} = 0.973436969 and k_{s2} = 0.947579533 lead to the generation of two families of elementary particles. The origins of the formation of the two families of elementary particles stem from two modifications of positronium (parapositronium, orthopositronium). The mass defect of an elementary particle determines the binding energy. The mass defect arises in all products of leptosynthesis and baryosynthesis reactions. As a result, the mass of the formed particle or antiparticle is always less than the sum of the masses of the reactants. The mass defect constant is a portion of the mass of the synthesis participants that is lost during synthesis. The magnitude of the mass defect determines the binding energy. The remaining portion of the reactant's mass constitutes the mass of the elementary particle. Both the magic number and the mass defect arise from the fractal mechanism of baryogenesis and are quantitative characteristics of the mechanism of lepton and baryon synthesis. These are new fundamental constants of elementary particles [36].

6. Law of Baryogenesis as a Generator of the Mass Spectrum of Elementary Particles.

The law of baryogenesis generates an increasing mass spectrum of elementary particles as the parameter j changes (Fig. 6). The value of parameter j corresponds to the number of stages in the structural genesis of an elementary particle. At each stage, a new elementary particle is formed. The parameter j takes on values: 1, 2, 3, 4, 5, 6, 7... representing a series of natural numbers.

$$m_j = M_j \bullet m_e - \Delta m_j$$
$$j = 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, \ldots$$

Fig. 6. The law of baryogenesis generates an increasing mass spectrum as the parameter j changes.

The law of baryogenesis generates two families of elementary particles. The first family of elementary particles is represented by masses formed at values of the mass defect determined by formula (13). The second family of elementary particles is represented by masses formed at values of the mass defect determined by formula (14). The complete mass spectrum includes both the masses of known elementary particles and the masses belonging to new particles. Thus, the law of baryogenesis generates the entire possible mass spectrum of elementary particles.

As an example, below are the mass values of elementary particles from the first family as the parameter j varies from 1 to 17. The first family of elementary particles is obtained using the constant k_{s1}=0.973436969. The mass spectrum is presented in tables in Fig. 7 and Fig. 8. Fig. 7 shows the generated mass spectrum of elementary particles with electric charge.

j	Magic number M_j	Mass defect Δm_j	Mass m_j	Note
1	**3**	**0.132m_e**	**2.868 m_e**	**P_s^+, P_s^-**
2	7	0.421m_e	6.579 m_e	?-
3	15	1.100m_e	13.900 m_e	-
4	31	2,585m_e	28.415 m_e	-
5	63	5.704m_e	57.296 m_e	-
6	127	12.114m_e	114.886 m_e	-
7	255	25.126m_e	229.874 m_e	-
8	511	51.367m_e	459.633 m_e	-
9	1023	104.08 m_e	918.915 m_e	-
10	**2047**	**209.78 m_e**	**1837.22 m_e**	**Proton**
11	**4095**	**421.44 m_e**	**3673.56 m_e**	**Deuteron**
12	8191	845.05 m_e	7345.95 m_e	-
13	16383	1692.6 m_e	14690.40 m_e	-
14	32767	3388.02 m_e	29378.98 m_e	-
15	65535	6779.22 m_e	58755.78 m_e	-
16	131071	13562.0 m_e	117509.00 m_e	-
17	262143	27127.9 m_e	235015.10 m_e	-

Fig. 7. Mass spectrum of electrically charged elementary particles of the first family.

In the mass spectrum (Fig. 7), at the first stage of structure genesis with a magical number value of 3, the mass of positronium ions Ps^- and Ps^+ is located. At the tenth stage of structure genesis with a magical number value of 2047, the mass of the proton is found. On the eleventh stage of structure genesis with a magical number value of 4095, the mass of the deuteron is located.

Fig. 8 shows the generated mass spectrum of neutral particles of the first family.

j	Magic number M_j	Mass defect Δm_j	Mass m_j	Note
1	**2**	**0.13 m_e**	**1.87 m_e**	**P_s**
2	6	0.42 m_e	5.58 m_e	-
3	14	1.10 m_e	12.90 m_e	-
4	30	2,59 m_e	27.41 m_e	-
5	62	5.71 m_e	56.29 m_e	-
6	126	12.11 m_e	113.89 m_e	-
7	254	25.12 m_e	228.88 m_e	-
8	510	51.37 m_e	458.63 m_e	-
9	1022	104.08 m_e	917.92 m_e	-
10	2046	209.78 m_e	1836.22 m_e	-
11	**4094**	**421.44 m_e**	**3672.56 m_e**	**Protonium**
12	8190	844.05 m_e	7345.95 m_e	-
13	16382	1692.6 m_e	14689.40 m_e	-
14	32766	3388.02 m_e	29377.98 m_e	-
15	65534	6779.22 m_e	58754.78 m_e	-
16	131070	13562.0 m_e	117508.0 m_e	-
17	262142	27127.9 m_e	235014.1 m_e	-

Fig. 8. Mass spectrum of neutral elementary particles of the first family.

In the mass spectrum (Fig. 8), at the first stage of structure genesis with a magical number value of 2, the mass of positronium Ps is located. On the eleventh stage of structure genesis with a magical number value of 4094, the mass of the proton is found.

As an example, below are the mass values of elementary particles of the second family, varying the parameter j from 1 to 17. The second family of elementary particles is obtained using the constant

k_{s2} = 0.947579533. The mass spectrum is presented in tables on Fig. 9 and Fig. 10. Fig. 9 shows the generated mass spectrum of elementary particles with electric charge.

j	**Magic number** M_j	**Mass defect** Δm_j	**Mass** m_j	**Note**
1	3	0.259 m_e	2.741 m_e	-
2	7	0.822 m_e	6.178 m_e	-
3	15	2.142 m_e	12.858 m_e	-
4	31	5,018 m_e	25.982 m_e	-
5	63	11.045 m_e	51.955 m_e	-
6	127	23.414 m_e	103.586 m_e	-
7	**255**	**48.501 m_e**	**206.499 m_e**	**Muon**
8	511	99.061 m_e	411.939 m_e	-
9	1023	200.59 m_e	822.41 m_e	-
10	2047	404.11 m_e	1642.89 m_e	-
11	4095	811.63 m_e	3283.37 m_e	-
12	8191	1627.15 m_e	6563.85 m_e	-
13	16383	3258.73 m_e	13124.27 m_e	-
14	32767	6522.44 m_e	26244.56 m_e	-
15	65535	13050.4 m_e	52484.60 m_e	-
16	131071	26107.0 m_e	104964.00 m_e	-
17	262143	52220.9 m_e	209922.10 m_e	-

Fig. 9. Mass spectrum of electrically charged elementary particles of the second family.

In the mass spectrum (Fig. 9), on the seventh stage of structure genesis with a magical number value of 255, the mass of the muon is located at 206.499 m_e. The muon belongs to the second family of elementary particles in the mass spectrum. Note that the muon has an anomalously high mass defect.

Fig. 10 shows the generated mass spectrum of neutral particles of the second family.

j	**Magic number** M_j	**Mass defect** Δm_j	**Mass** m_j	**Note**
1	2	0.26 m_e	1.74 m_e	-
2	6	0.83 m_e	5.17 m_e	-
3	14	2.15 m_e	11.85 m_e	-
4	30	5,03 m_e	24.97 m_e	-
5	62	11.05 m_e	50.95 m_e	-
6	126	23.42 m_e	102.58 m_e	-
7	254	48.51 m_e	205.49 m_e	-
8	510	99.07 m_e	410.93 m_e	-
9	1022	200.59 m_e	821.41 m_e	-
10	2046	404.11 m_e	1641.89 m_e	-
11	4094	811.63 m_e	3282.37 m_e	-
12	8190	1627.15 m_e	6562.85 m_e	-
13	16382	3258.73 m_e	13123.27 m_e	-
14	32766	6522.44 m_e	26243.56 m_e	-
15	65534	13050.40 m_e	52483.60 m_e	-
16	131070	26107.00 m_e	104963.00 m_e	-
17	262142	52220.90 m_e	209921.10 m_e	-

Fig. 10. Mass spectrum of neutral elementary particles of the second family.

Some elementary particles from the generated mass spectrum are already known and have been experimentally obtained. Their number is not large. The values of their masses in the mass spectrum are highlighted in the tables. In the mass range from the electron to the deuteron, these are particles and antiparticles associated with magical numbers: 2 (positronium), 3 (positronium ions), 255 (muon and antimuon), 2047 (proton and antiproton), 4094 (protonium), 4095 (deuteron and antideuteron). The spectrum of masses obtained from the law of bariogenesis shows that in this range, there are many more new unknown particles and antiparticles than there are known ones. They are yet to be obtained in experiments. The expected mass values for new elementary particles are provided in the tables (Fig. 7 - Fig. 10).

7. Triplets in the mass spectrum of elementary particles.

From the tables (Fig. 7 - Fig. 10), it can be observed that elementary particles cluster into triplets, with three particles having similar mass values (Fig. 11).

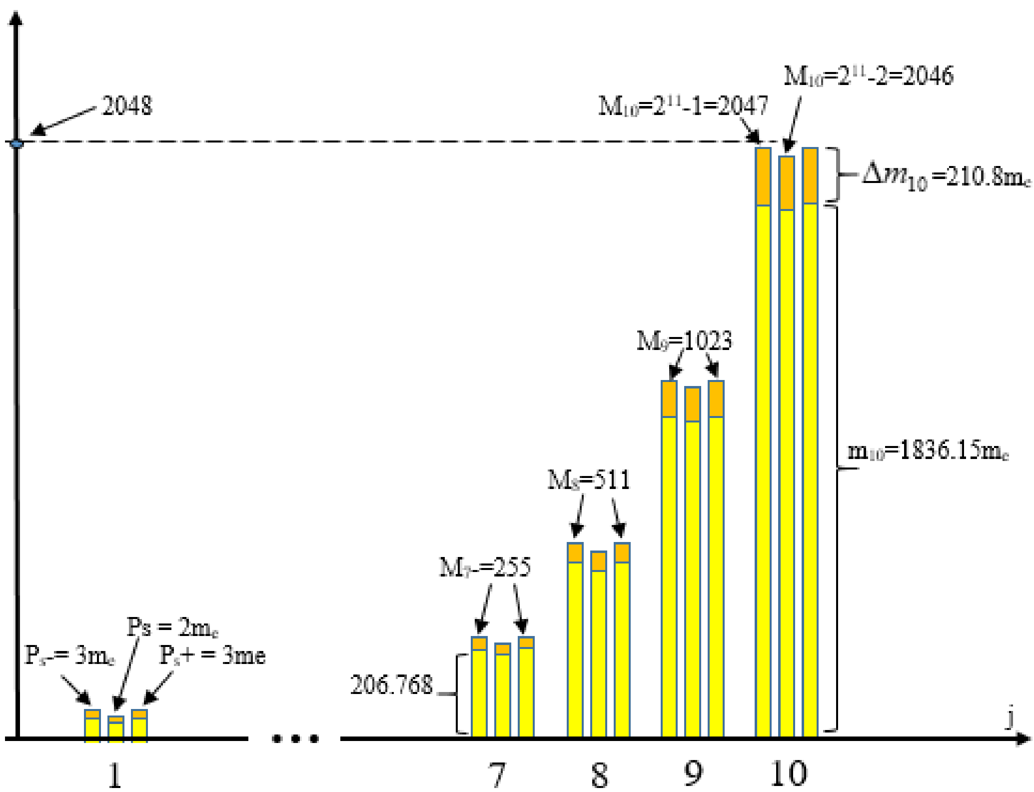

Fig. 11. Triplets of elementary particles in the range from positronium to proton. M - magical numbers, Ps - positronium, Ps^+, Ps^- - positronium ions, M_7 - magical number of muon, M_{10} - magical number of proton, Δm_{10} - proton mass defect, m_{10} - proton mass, yellow - mass of elementary particle, red - mass defect, j - stage number of baryosynthesis.

Each value of j in the law of bariogenesis corresponds to a triplet of masses of the first family and a triplet of masses of the second family. Accordingly, the triplet of masses belongs to the triplet of elementary particles. Triplets are formed by an electrically charged particle and antiparticle and a neutral particle. With each odd magical number, two electrically charged particles and an antiparticle are associated. With each even magical number, a neutral elementary particle is associated. Within the triplet, elementary particles have very close mass values. The particle and antiparticle have equal mass values. The mass of the neutral particle in the triplet is less than the mass of the charged particle by an amount close to the mass of the electron. The mass differences within triplets are very insignificant and are smaller in magnitude than the mass of the electron. This will create difficulties in the experimental detection of new particles.

8. Features of mass quantization of elementary particles

The quantization of masses of elementary particles occurs according to the fractal mechanism of reduplication (Fig. 1). In this case, integer quantization does not take place. From the mass spectrum (Fig. 7 - Fig.10), it can be seen that the ratio of masses of neighboring particles is close to integers but not equal to integers. The ratio of adjacent masses only asymptotically approaches an integer equal to 2 over an infinite interval:

$$\lim_{j\to\infty}\frac{m_j}{m_{j-1}} = 2\ . \qquad (15)$$

The same applies to the ratio of mass defects and the ratio of magical numbers:

$$\lim_{j\to\infty}\frac{\Delta m_j}{\Delta m_{j-1}} = 2. \qquad (16)$$

$$\lim_{j\to\infty}\frac{M_j}{M_{j-1}} = 2\ . \qquad (17)$$

Throughout the entire range of generated masses of elementary particles, there are no integer mass ratios. The law of mass quantization is more complex and cannot be represented by a simple empirical formula based on integer quantization. This can explain the reasons for the limited capabilities of empirical formulas that have been proposed as generators of the spectrum of elementary particle masses.

9. Conclusion

Instead of empirical formulas, the spectrum of elementary particle masses is derived from the law of bariogenesis. In turn, the law of bariogenesis is derived from the fractal mechanism of leptosynthesis and baryosynthesis. Therefore, the analytical representation of the mass spectrum has theoretical justification. The obtained complete mass spectrum explains both the mass spectrum of known elementary particles and provides a forecast for the mass spectrum of yet undiscovered elementary particles. From the obtained complete mass spectrum of elementary particles, it follows that the predicted number of undiscovered elementary particles far exceeds the number of known particles. The number of known elementary particles in the mass spectrum constitutes a very small fraction. Known elementary particles are only fragmentarily represented in the complete mass spectrum. For example, in the mass range from the electron to the deuteron, the complete mass spectrum contains 68 particles and antiparticles. This includes 35 elementary particles of the first family and 33 elementary particles of the second family. Out of these 68 particles, only the electron, positron, positronium, positronium ions, muon, proton, protonium, deuteron, and their antiparticles have been experimentally obtained. The remaining 56 elementary particles are yet to be discovered. Expected mass values for new particles are provided in the tables.

Neutron, antineutron, pions, kaons, tau lepton, and other elementary particles are not presented in the mass spectrum tables. The reason is that these are composite particles [33, 35]. Composite elementary particles form a separate additional family of elementary particles. The family of composite elementary particles requires deeper study. Composite elementary particles are formed in a more complex way. They are formed by the combination of particles and antiparticles from the generated mass spectrum [33]. Composite elementary particles are created from particles and antiparticles of the first and second families. The mechanism of formation of composite elementary particles requires separate investigation.

10. Conclusions

1. The mechanism of generation of elementary particle masses is the fractal mechanism.

2. Instead of empirical formulas, the law of bariogenesis is employed as a generator for the spectrum of elementary particle masses.

3. The law of bariogenesis generates the mass spectrum by varying the parameter j. The parameter j takes values: 1, 2, 3, 4, 5, 6, 7... and represents a series of natural numbers.

$$m_j = M_j \bullet m_e - \Delta m_j$$
$$j = 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 \ldots$$

4. The law of bariogenesis generates the entire possible spectrum of elementary particle masses. The generated mass spectrum is represented by both known elementary particles and undiscovered elementary particles.

5. An explanation of the mass spectrum for known elementary particles is provided, along with a forecast for the mass spectrum of yet undiscovered elementary particles.

6. The mass spectrum indicates that the number of undiscovered particles far exceeds the number of known particles.

7. The generated mass values of elementary particles are presented in triplets, formed by close mass values.

8. An anomalous value of mass defect is identified for the muon and antimuon.

9. The mass spectrum reveals the existence of three families of elementary particles. The masses of two families directly follow from the law of bariogenesis, while the third family is formed by a combination of particles and antiparticles from the first and second families.

10. In the mass range from the electron to the deuteron, 56 elementary particles remain undiscovered. Expected mass values are provided for elementary particles that are yet to be discovered in experiments.

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