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# THE MUON MYSTERY: The Origin of the Muon. Fractal of the muon. Law of muon structural genesis. Unified mechanism of muon, proton, neutron, and deuteron mass origin.

***Abstract.*** *This article proposes an unusual mechanism of muon structurogenesis in which the particle is formed with the involvement of antimatter. When positrons (antimatter) and electrons (matter) combine, they create particles more complex than positronium. Despite its apparent paradoxical nature, this mechanism has allowed for the discovery of the law of muon structurogenesis. Fundamental muon constants have been obtained from the law of muon structurogenesis. These muon constants have not been obtainable within the framework of the standard model. The muon structurogenesis mechanism predicts the existence of numerous new particles that have not yet been detected. The muon structurogenesis mechanism also predicts the mass spectrum of elementary particles. The proposed structurogenesis mechanism is a general mechanism for all elementary particles, from positronium to the proton. It is a universal mechanism of synthesis in nature. The fallacy of the concept of matter predominance over antimatter in the modern Universe is demonstrated. From the law of muon structurogenesis, it follows that the violation of lepton number conservation is not related to the symmetry or asymmetry of matter and antimatter in the modern Universe. The non-conservation of lepton number and baryon number occurs even under complete symmetry between matter and antimatter.*

***Keywords:*** *Muon Mystery, muon fractal, mass defect, muon origin, matter, antimatter, electron, positron, positronium, muon mass origin, mass spectrum of elementary particles.*

## 1. Introduction

Muon was discovered in 1937. Since its discovery, muons have continuously surprised scientists. The anomalous magnetic moment of muons remains unexplained. The large number of muons observed in experiments also lacks an explanation [1-6]. Muon is considered a structureless particle. The mechanism of muon formation is still not understood. The birth of muons is observed as a result of pion decay. In this article, we do not consider particle decay reactions. Instead, we investigate the mechanism of particle and antiparticle synthesis. We examine the mechanism of muon structurogenesis, which involves antimatter. A similar mechanism was studied by us in [7, 8] for proton structurogenesis. In [7, 8], a fractal mechanism of proton structurogenesis was proposed. This mechanism is based on the interaction of electrons and positrons, leading to the formation of positronium and further mass growth according to a fractal algorithm. Such a structurogenesis mechanism occurs with the participation of antimatter while maintaining symmetry between matter and antimatter. Further mass growth occurs through the attachment of electrons and positrons to positronium and other neutral particles. This mechanism explains the origin of muon mass. It is a universal synthesis mechanism that is impossible without antimatter. In this mechanism, electrons and positrons act as reactants and catalysts in the structurogenesis reaction of elementary particles.

## 2. Muon Fractal.

The muon fractal has the following form (Fig. 1):

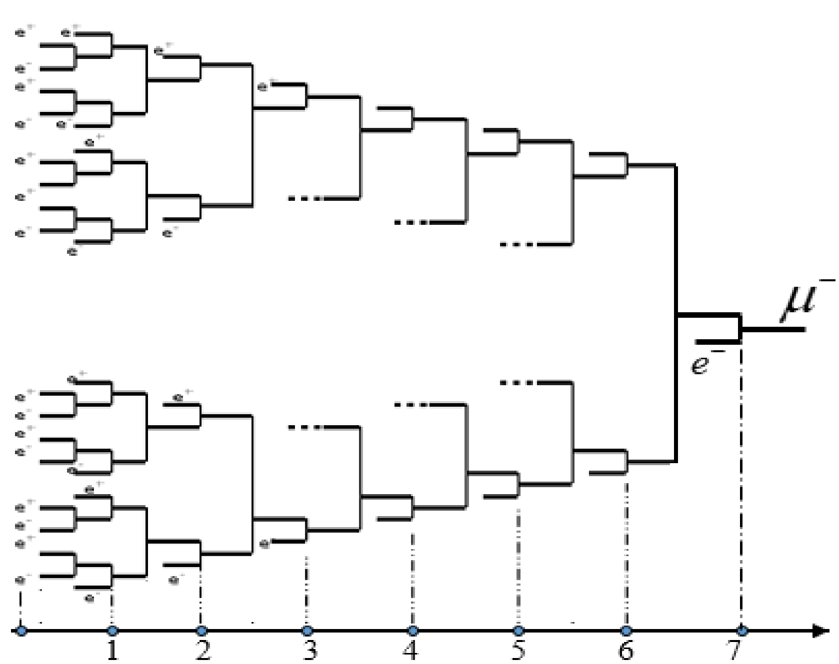


Figure 1. Muon fractal. $e^-$ - electrons, $e^+$ - positrons, $\mu^-$ - muon.

Muon formation occurs through seven stages of structurogenesis. This dynamic process is represented by the muon fractal. The fractal begins with elementary cells of the muon fractal. The elementary cells of the muon fractal depict the first charge-conjugated real formations after positronium.

The muon fractal is a self-similar geometric structure. Nodes and branches of the geometric structure correspond to particles and antiparticles. The muon fractal portrays the dynamics of muon formation. The complete muon fractal is formed by successive replication of the elementary cell on an increasing scale. At each stage, the previous structure is doubled. The muon fractal depicts the sequence of formation of all unstable particles from positronium to muon. The muon fractal sequentially forms seven self-similar structures. They replicate the elementary cell of the fractal according to the $2^n$ law of scaling.

Muon structurogenesis begins with electrons and positrons. The combination of electrons and positrons leads to the formation of charge-neutral positronium particles. These are unstable particles. The lifetime of parapositronium is 0.1244 ns. The lifetime of orthopositronium is three orders of magnitude longer - 138.6 ns. For elementary particles, this is a significant time interval. Within this time, an additional electron or positron can attach to positronium, leading to the formation of a new particle or antiparticle. Attachment of an electron to positronium results in the formation of an electrically charged particle with a negative charge. Attachment of a positron to positronium results in the formation of an electrically charged particle with a positive charge. Charged conjugated particles interact with each other through the electric force. The process then repeats. The larger-scale process copies the smaller-scale process.

## 3. Muon fractal formula.

The muon fractal formula is given by [7, 8]:

$$P_\mu = 2(2(2(2(2(2(2+1)+1)+1)+1)+1)+1)+1 \qquad (1)$$

Figure 2. Muon fractal formula. The fractal formula represents the seven stages of muon structurogenesis. The muon fractal formula provides an important characteristic - the muon magic

number 255. The fractal formula is based on a construction of the form (2+1). It corresponds to a graphical form (Figure 3). This is the elementary cell of the fractals of all elementary particles [7, 8]:

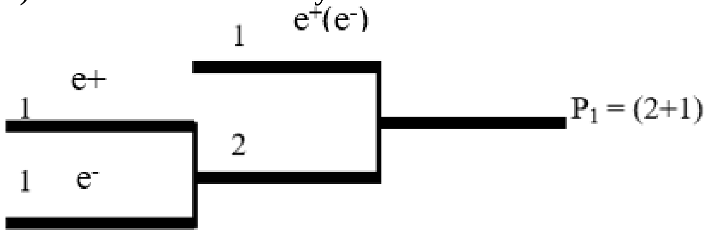


Figure 3. Elementary cell of fractals for all elementary particles. $e^+$ - positrons (antimatter), $e^-$ - electrons (matter).

The muon fractal is formed through 7 stages. Each stage has its own fractal formula. The sequence of fractal formulas is represented by the "muon fractal triangle" (Figure 4).

$$\mathbf{P_1 = 2+1}$$
$$\mathbf{P_2 = 2(2+1)+1}$$
$$\mathbf{P_3 = 2(2(2+1)+1)+1}$$
$$\mathbf{P_4 = 2(2(2(2+1)+1)+1)+1}$$
$$\mathbf{P_5 = 2(2(2(2(2+1)+1)+1)+1)+1}$$
$$\mathbf{P_6 = 2(2(2(2(2(2+1)+1)+1)+1)+1)+1}$$
$$\mathbf{P_7 = 2(2(2(2(2(2(2+1)+1)+1)+1)+1)+1)+1}$$

Figure 4. Fractal formulas depicting the seven stages of structurogenesis from positronium to muon.

The first step is the formation of positronium (Ps). Then, an electron (or positron) attaches to positronium. This completes the first stage of structurogenesis, $P_1$. In the muon fractal, these events correspond to the elementary cells of the muon fractal (Figure 1, Figure 3). The fractal triangle (Figure 4) consists of fractal formulas for self-similar conjugated geometric structures. Within the self-similar geometric structures, there is an intermediate state representing a neutral particle. These states are quantitatively represented by corresponding fractal formulas. The fractal formulas for charge-conjugated particles and the fractal formulas for neutral particles are shown in Figure 5.

| **Fractal formula** | **Number** |
|---|---|
| $P_s = P_{1\text{-}1} = 1+1$ | 2 |
| $P_{1\text{-}2} = 2+1$ | 3 |
| $P_{2\text{-}1} = 2(2+1)$ | 6 |
| $P_{2\text{-}2} = 2(2+1)+1$ | 7 |
| $P_{3\text{-}1} = 2(2(2+1)+1)$ | 14 |
| $P_{3\text{-}2} = 2(2(2+1)+1)+1$ | 15 |
| $P_{4\text{-}1} = 2(2(2(2+1)+1)+1)$ | 30 |
| $P_{4\text{-}2} = 2(2(2(2+1)+1)+1)+1$ | 31 |
| $P_{5\text{-}1} = 2(2(2(2(2+1)+1)+1)+1)$ | 62 |
| $P_{5\text{-}2} = 2(2(2(2(2+1)+1)+1)+1)+1$ | 63 |
| $P_{6\text{-}1} = 2(2(2(2(2(2+1)+1)+1)+1)+1)$ | 126 |
| $P_{6\text{-}2} = 2(2(2(2(2(2+1)+1)+1)+1)+1)+1$ | 127 |
| $P_{7\text{-}1} = 2(2(2(2(2(2(2+1)+1)+1)+1)+1)+1)$ | 254 |
| $P_{7\text{-}2} = 2(2(2(2(2(2(2+1)+1)+1)+1)+1)+1)+1$ | 255 |

Figure 5. Complete fractal triangle of muon structurogenesis.

Each fractal formula corresponds to its own magic number. The fractal triangle contains quantitative information about all intermediate unstable particles in the range from positronium to muon.

## 4. Muon fractal magic numbers

The following sequence of magic numbers characterizes the muon fractal (Figure 6).

$$M = 1, 1, 2, 3, 6, 7, 14, 15, 30, 31, 62, 63, 126, 127, 254, 255.$$

Figure 6. Muon fractal magic numbers.

The initial magic numbers of the muon fractal are presented in Figure 7.

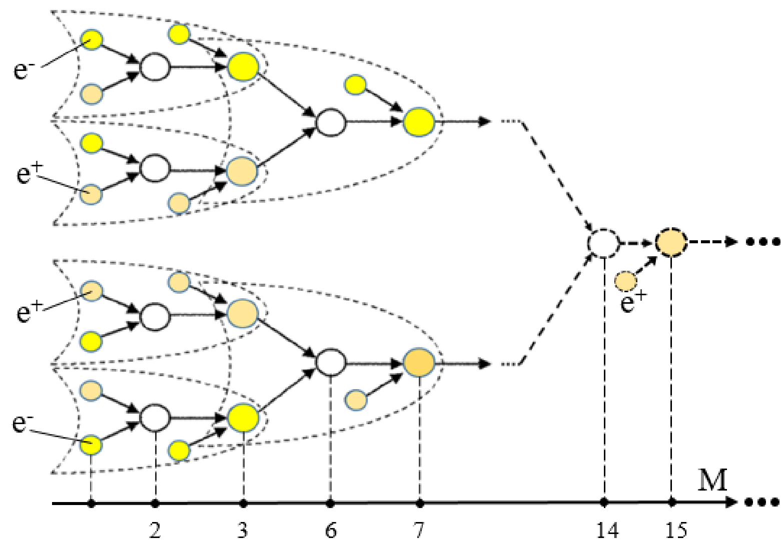


Figure 7. Initial magic numbers of the muon fractal. M - magic numbers; $e^-$ - electrons; $e^+$ - positrons; yellow - particles with negative charge (matter); orange - antiparticles with positive charge (antimatter).

Magic numbers indicate how many electrons and positrons were involved in the formation of the corresponding particle or antiparticle. Magic numbers are constants of elementary particles. They are included in equations for calculating the mass of elementary particles.

The number 255 is the magic number of the muon. It is the muon constant. This number indicates how many electrons (matter) and positrons (antimatter) participated in the formation of the muon. From the muon fractal, it follows that the number of electrons required for muon formation is 128, and the number of positrons required is 127.

## 5. Muon mass defect

In [7, 8], a new constant for elementary particles was introduced - the mass defect. The muon fractal shows that the muon is formed step by step from primary particles of matter (electrons) and particles of antimatter (positrons). At each step and stage, a new particle or antiparticle is synthesized. These particles and antiparticles precede the muon. The particles synthesized from electrons and positrons are new independent particles. Their synthesis is accompanied by a mass defect. The muon mass defect consists of the mass defects of the intermediate particles and antiparticles that precede the muon. The muon mass defect is a new muon constant. The value of the muon mass defect is directly calculated from the muon fractal.

## 6. Origin of muon mass

The muon fractal and the muon fractal formula allow us to obtain new fundamental constants of the muon and the value of the muon mass. The number 255 is the magic number of the muon. It is a new muon constant. It directly follows from the muon fractal and is calculated using the fractal formula (1) of the muon. This number indicates how many particles of matter (electrons) and antimatter (positrons) participated in the formation of the muon.

In [8], a generalized equation for the law of structurogenesis of elementary particles is presented:

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

Figure 8. Generalized equation for the law of structurogenesis of elementary particles. $M_j$ - magic number of the elementary particle, $m_j$ - mass of the particle, $m_e$ - mass of the electron, $\Delta m_j$ - mass defect of the elementary particle.

The equation for the mass of the muon follows from the generalized equation for the law of structurogenesis of elementary particles. The muon mass law includes the muon magic number 255 and is given by:

$$m_\mu = 255 \bullet m_e - \Delta m_\mu \qquad (2)$$

where: $m_e$ - mass of the electron, 255 - muon magic number, $\Delta m_\mu$ - muon mass defect.

The magic number 255 is calculated using the muon fractal formula (1). The muon mass defect is derived from the muon fractal and is calculated using the formulas:

$$\Delta m_{\mu 1} = m_e \bullet \sum_{i=1}^{8} (2^i - 1) \bullet (1 - k_{s1}^{9-i}) \qquad (3)$$

$$\Delta m_{\mu 2} = m_e \bullet \sum_{i=1}^{8} (2^i - 1) \bullet (1 - k_{s2}^{9-i}) \qquad (4)$$

where: $m_e$ - mass of the electron, $\Delta m_{\mu 1}$ - mass defect of the "heavy" muon, $\Delta m_{\mu 2}$ - mass defect of the "light" muon, $k_{s1}$, $k_{s2}$ - constants defining the muon mass defect, $k_{s1}$ = 0.9734369693, $k_{s2}$ = 0.947579533 [8, 9, 10].

Using the constant $k_{s1}$ = 0.9734369693, equations (3) and (4) yield the following values for the muon mass defect:

$$\Delta m_{\mu 1} = 25.126 \bullet m_e \qquad (5)$$

$$\Delta m_{\mu 2} = 48.495 \bullet m_e \qquad (6)$$

Formulas (2), (3), and (4) provide the following values for the muon mass:

$$m_{\mu 1} = 255 \bullet m_e - \Delta m_{\mu 1} = m_e(255 - 25.126) = 229.87 \bullet m_e \qquad (7)$$

$$m_{\mu 2} = 255 \bullet m_e - \Delta m_{\mu 2} = m_e(255 - 48.495) = 206.505 \bullet m_e \qquad (8)$$

The obtained value of the fundamental constant 206.505 from the muon fractal is very close to the experimental value from CODATA (206.768 2830).

The value of 228.7me represents the mass of an unknown particle. It is possible that a "muon twin" called the "heavy muon" exists. This particle should be searched for in experiments. The origins of the light and heavy muons are likely to be found in two modifications of positronium (parapositronium, orthopositronium).

The muon constants are given in the table in Figure 9.

| **Name** | **Value** |
|---|---|
| Fractal formula for the muon | $P_p = P_{10} = 2(2(2(2(2(2(2(2(2(2+1)+1)+1)+1)+1)+1)+1)+1)+1)+1$ |
| Magic number of the muon | 255 |
| Number of electrons | 128 |
| Number of positrons | 127 |
| Mass of initial particles and antiparticles | 255 $m_e$ |
| Muon mass defect 1 | 25.126 $m_e$ |
| Muon mass defect 2 | 48.495$m_e$ |
| Muon - electron mass ratio | 206.505 |
| Ratio of mass defect constant to magic number | 0,103 $m_e$ |

Figure 9. Constants of the muon.

## 7. Constants of the hypothetical particle represented by the elementary cell of the muon fractal.

Let's obtain the constants of the hypothetical particle represented by the elementary cell of the fractal (Figure 10).

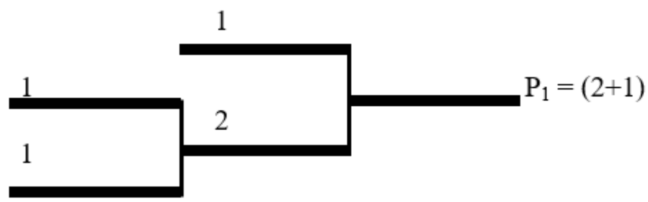


Figure 10. Elementary cell of the muon fractal and its fractal formula.

The mass law of the hypothetical particle is given by:

$$m = 3 \bullet m_e - \Delta m \qquad (9)$$

The mass defect is calculated using the formulas:

$$\Delta m_1 = m_e \bullet \sum_{i=1}^{2} (2^i - 1) \bullet (1 - k_{s1}^{3-i}) \qquad (10)$$

$$\Delta m_2 = m_e \bullet \sum_{i=1}^{2} (2^i - 1) \bullet (1 - k_{s2}^{3-i}) \qquad (11)$$

Quantitative characteristics of the elementary cell of the muon fractal and the constants of the corresponding elementary particles are provided in the table in Figure 11.

| Name | Value |
|---|---|
| Fractal formula | $P_1 = 2+1$ |
| Magic number | 3 |
| Total number of particles and antiparticles | 3 |
| Dimensionless mass defect constant of a "light" particle | 0.2594 |
| Dimensionless mass defect constant of a "heavy" particle | 0.1321 |
| Mass of "light" particle | 2,7406 $m_e$ |
| Mass of "heavy" particle | 2,8679 $m_e$ |

Figure 11. Quantitative characteristics of the particles represented by the elementary cell of the muon fractal.

## 8. Fractal of the Deuteron

The fractal of deuteron has the following form (Figure 12):

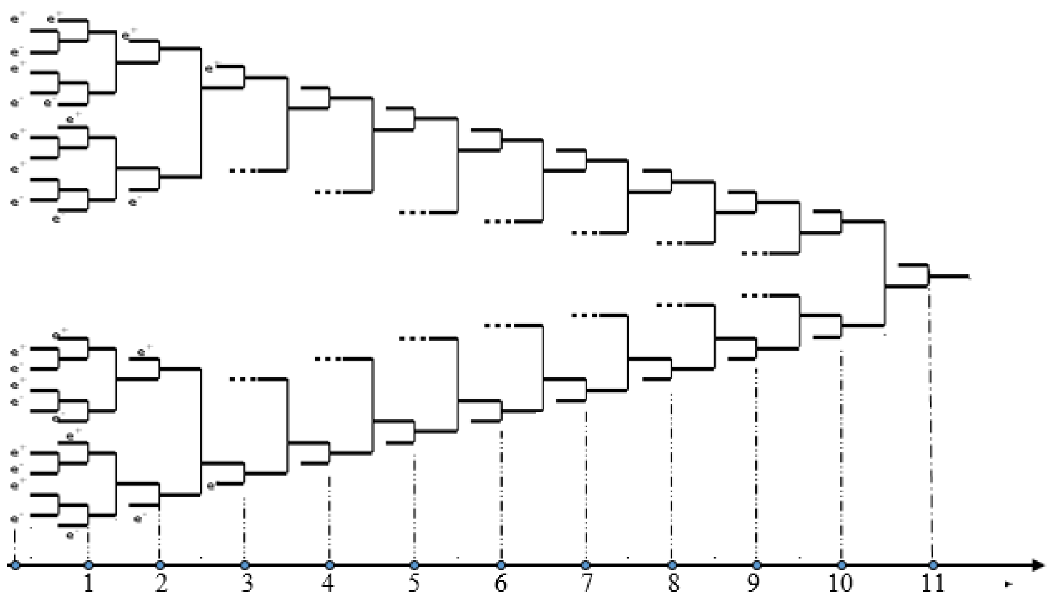


Figure 12. Fractal of the Deuteron. Eleven stages of structurogenesis of the deuteron. e- - electrons, e+ - positrons.

The formation of the deuteron occurs through eleven stages of structurogenesis. This process is dynamically represented by the deuteron fractal, which starts with the elementary cells of the fractal.

## 9. Deuteron fractal formula.

The deuteron fractal formula has the following form:

$$P_d = 2(2(2(2(2(2(2(2(2(2(2+1)+1)+1)+1)+1)+1)+1)+1)+1)+1)+1$$

Figure 13. Deuteron fractal formula.

The fractal formula (Figure 13) represents eleven stages of the deuteron's structurogenesis. The deuteron fractal formula provides an important characteristic - the deuteron number 4095. The underlying structure of the fractal formula follows the (2+1) construction, which corresponds to its graphical form (Figure 5). This is the elementary cell of the fractals of all elementary particles. The sequence of fractal formulas is presented by the "deuteron fractal triangle" (Figure 14).

$$
\begin{aligned}
&\mathbf{P_1 = 2+1}\\
&\mathbf{P_2 = 2(2+1)+1}\\
&\mathbf{P_3 = 2(2(2+1)+1)+1}\\
&\mathbf{P_4 = 2(2(2(2+1)+1)+1)+1}\\
&\mathbf{P_5 = 2(2(2(2(2+1)+1)+1)+1)+1}\\
&\mathbf{P_6 = 2(2(2(2(2(2+1)+1)+1)+1)+1)+1}\\
&\mathbf{P_7 = 2(2(2(2(2(2(2+1)+1)+1)+1)+1)+1)+1}\\
&\mathbf{P_8 = 2(2(2(2(2(2(2(2+1)+1)+1)+1)+1)+1)+1)+1}\\
&\mathbf{P_9 = 2(2(2(2(2(2(2(2(2+1)+1)+1)+1)+1)+1)+1)+1)+1}\\
&\mathbf{P_{10} = 2(2(2(2(2(2(2(2(2(2+1)+1)+1)+1)+1)+1)+1)+1)+1)+1}\\
&\mathbf{P_{11} = 2(2(2(2(2(2(2(2(2(2(2+1)+1)+1)+1)+1)+1)+1)+1)+1)+1)+1}
\end{aligned}
$$

Figure 14. Fractal formulas representing eleven stages of structurogenesis from positronium to the deuteron.

Within the self-similar geometric structures of the deuteron fractal, there are intermediate states corresponding to neutral unstable particles. These states are quantitatively represented by the corresponding fractal formulas. Fractal formulas for charged particles and fractal formulas for neutral particles preceding the deuteron are presented in Figure 15.

| **Fractal formula** | **Number** |
|---|---|
| $P_s = P_{1\text{-}1} = 1+1$ | 2 |
| $P_{1\text{-}2} = 2+1$ | 3 |
| $P_{2\text{-}1} = 2(2+1)$ | 6 |
| $P_{2\text{-}2} = 2(2+1)+1$ | 7 |
| $P_{3\text{-}1} = 2(2(2+1)+1)$ | 14 |
| $P_{3\text{-}2} = 2(2(2+1)+1)+1$ | 15 |
| $P_{4\text{-}1} = 2(2(2(2+1)+1)+1)$ | 30 |
| $P_{4\text{-}2} = 2(2(2(2+1)+1)+1)+1$ | 31 |
| $P_{5\text{-}1} = 2(2(2(2(2+1)+1)+1)+1)$ | 62 |
| $P_{5\text{-}2} = 2(2(2(2(2+1)+1)+1)+1)+1$ | 63 |
| $P_{6\text{-}1} = 2(2(2(2(2(2+1)+1)+1)+1)+1)$ | 126 |
| $P_{6\text{-}2} = 2(2(2(2(2(2+1)+1)+1)+1)+1)+1$ | 127 |
| $P_{7\text{-}1} = 2(2(2(2(2(2(2+1)+1)+1)+1)+1)+1)$ | 254 |
| $P_{7\text{-}2} = 2(2(2(2(2(2(2+1)+1)+1)+1)+1)+1)+1$ | 255 |
| $P_{8\text{-}1} = 2(2(2(2(2(2(2(2+1)+1)+1)+1)+1)+1)+1)$ | 510 |
| $P_{8\text{-}2} = 2(2(2(2(2(2(2(2+1)+1)+1)+1)+1)+1)+1)+1$ | 511 |
| $P_{9\text{-}1} = 2(2(2(2(2(2(2(2(2+1)+1)+1)+1)+1)+1)+1)+1)$ | 1022 |
| $P_{9\text{-}2} = 2(2(2(2(2(2(2(2(2+1)+1)+1)+1)+1)+1)+1)+1)+1$ | 1023 |
| $P_{10\text{-}1} = 2(2(2(2(2(2(2(2(2(2+1)+1)+1)+1)+1)+1)+1)+1)+1)$ | 2046 |
| $P_{10\text{-}2} = 2(2(2(2(2(2(2(2(2(2+1)+1)+1)+1)+1)+1)+1)+1)+1)+1$ | 2047 |
| $P_{11\text{-}1} = 2(2(2(2(2(2(2(2(2(2(2+1)+1)+1)+1)+1)+1)+1)+1)+1)+1)$ | 4094 |
| $P_d = P_{11\text{-}2} = 2(2(2(2(2(2(2(2(2(2(2+1)+1)+1)+1)+1)+1)+1)+1)+1)+1)+1$ | 4095 |

Figure 15. Complete fractal triangle for all steps and stages of deuteron structurogenesis.

Each fractal formula corresponds to its own magic number. The fractal triangle contains quantitative information about all intermediate particles in the range from positronium to the deuteron.

## 10. Magic numbers of the deuteron fractal.

The deuteron fractal is characterized by the following sequence of magic numbers (Figure 16):

M = 1, 1, 2, 3, 6,7,14,15,30,31,62,63,126,127,254,255,510,511, 1022, 1023, 2046, 2047, 4094, 4095.

Figure 16. Magic numbers of the deuteron fractal.

The number 4095 is the magic number of the deuteron. It is a constant of the deuteron. This number indicates how many electrons (matter) and positrons (antimatter) participated in the formation of the deuteron. According to the deuteron fractal, the number of electrons required for the formation of the deuteron is 2047, and the number of positrons required is 2048.

## 11. Origin of the deuteron mass.

The deuteron fractal and the deuteron fractal formula allow us to obtain new fundamental constants of the deuteron and the value of the deuteron mass. The mass law of the deuteron is as follows:

$$m_d = 4095 \bullet m_e - \Delta m_d \qquad (12)$$

where: me - mass of the electron, 4095 - magic number of the deuteron, $\Delta m_d$ - mass defect of the deuteron.

The mass defect of the deuteron follows from the deuteron fractal and is calculated using the formulas:

$$\Delta m_{d1} = m_e \bullet \sum_{i=1}^{12} (2^i - 1) \bullet (1 - k_{s1}^{13-i}) \qquad (13)$$

$$\Delta m_{d2} = m_e \bullet \sum_{i=1}^{12} (2^i - 1) \bullet (1 - k_{s2}^{13-i}) \qquad (14)$$

where: $m_e$ - mass of the electron, $\Delta m_{d1}$ - mass defect of the "heavy" deuteron, $\Delta m_{d2}$ - mass defect of the "light" deuteron, $k_{s1}$, $k_{s2}$ - constants defining the mass defect of the deuteron, $k_{s1}$ = 0.9734369693, $k_{s2}$ = 0.947579533 [8, 9].

Equations (13) and (14) yield the following values for the mass defect of the deuteron:

$$\Delta m_{d1} = 421.437 \bullet m_e \qquad (15)$$

$$\Delta m_{d2} = 838 \bullet m_e \qquad (16)$$

Formulas (12), (15), and (16) provide the following values for the mass of the deuteron:

$$m_{d1} = 4095 \bullet m_e - \Delta m_{d1} = m_e (4095 - 421.437) = 3673.5 \bullet m_e \qquad (17)$$

$$m_{d2} = 4095 \bullet m_e - \Delta m_{d2} = m_e (4095 - 838) = 3256 \bullet m_e \qquad (18)$$

The obtained value of the fundamental constant md/me = 3673.5 from the deuteron fractal is very close to the experimental value of CODATA (md/me = 3670.482 967 88).

The value of 3256 me represents the mass of an unknown particle. It is possible that a "twin" of the deuteron, a "light deuteron," exists. This particle should be sought in experiments. The origins of the formation of the light and heavy deuteron should be sought in two modifications of positronium (para-positronium, ortho-positronium).

The constants of the deuteron are provided in the table in Figure 17.

| Name | Value |
|---|---|
| Fractal formula for the Deuteron | $P_d = 2(2(2(2(2(2(2(2(2(2(2+1)+1)+1)+1)+1)+1)+1)+1)+1)+1)+1$ |
| Magic number of the Deuteron | $M_d = 4095$ |
| Number of electrons | 2047 |
| Number of positrons | 2048 |
| Mass of initial particles and antiparticles | 4095 $m_e$ |
| Deuteron mass defect 1 | 421.437 $m_e$ |
| Deuteron mass defect 2 | 838 $m_e$ |
| Deuteron - electron mass ratio 1 | $m_d/m_e = 3673.5$ |
| Deuteron - electron mass ratio 2 | 3256 |
| Ratio of mass defect constant to mass of initial particles and antiparticles | 0,103 |

Figure 17. Constants of the deuteron.

## 12. Fractal of Neutron and the origin of neutron mass.

The neutron fractal has the following form (Figure 18):

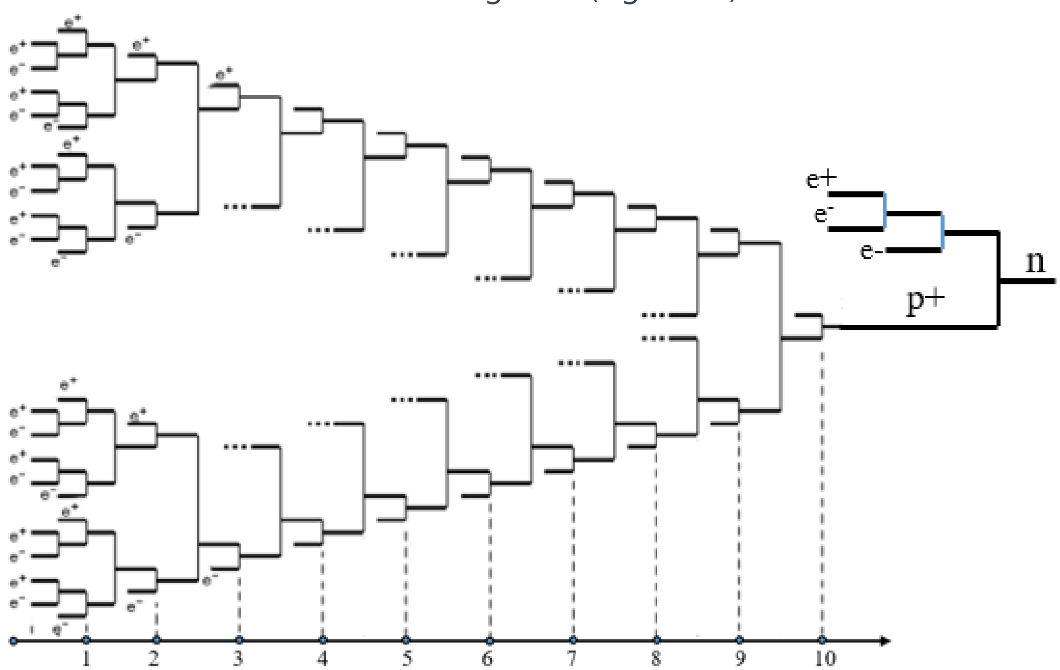


Figure 18. Fractal of Neutron.

The neutron fractal is a combined fractal. It includes the proton fractal and the elementary cell of the fractal. A negatively charged particle with a mass of 2.7406$m_e$ (Figure 11) interacts with a proton to form a neutron. The fractal formula of the neutron is as follows:

$$\mathbf{P_n = P_{10} + P_1 = 2(2(2(2(2(2(2(2(2(2+1)+1)+1)+1)+1)+1)+1)+1)+1)+1 + (2+1)}$$

Figure 19. Fractal formula of the neutron.

The magic number of the neutron is 2050. This means that the neutron is formed with the participation of 1025 electrons and 1025 positrons. Both the negatively charged particle with a mass of 2.7406$m_e$ and the proton lose part of their mass during the interaction. The additional mass defect of the proton is obtained using the constant $k_{s1} = 0.9734369693$:

$$\Delta m_1 = 2.7406\, m_e (1 - k_{s1}) = 0.072798\, m_e \qquad (19)$$

The mass defect of the elementary particle represented by the elementary cell of the fractal is obtained using the constant $k_{s2}$ = 0.947579533:

$$\Delta m_2 = 2.7406\, m_e (1 - k_{s2}) = 0.143663\, m_e \qquad (20)$$

The value of the neutron mass is:

$$m_n = 1836.15267343 \bullet m_e + 2.7406 \bullet m_e - 0.072798\, m_e - 0.143663 = 1838.68 m_e \qquad (21)$$

The obtained value of the fundamental constant $m_n/m_e$ = 1838.68 from the neutron fractal is very close to the experimental value of CODATA ($m_n/m_e$ = 1838.683 661 73).

The constants of the neutron are provided in the table in Figure 20.

| **Name** | **Value** |
|---|---|
| Fractal formula | $\mathbf{P_n = P_{10} + P_1}$ |
| Magic number | $M_n$ = 2050 |
| Number of electrons | 1025 |
| Number of positrons | 1025 |
| Mass of initial particles and antiparticles | 2050 $m_e$ |
| Neutron mass defect | 211,32$m_e$ |
| Neutron-electron mass ratio | $m_n/m_e$ = 1838.68 |
| Ratio of mass defect constant to mass of initial particles and antiparticles | 0,103 |

Figure 20. Constants of the neutron.

During the decay of the neutron, the particle represented by the elementary cell of the fractal releases an electron. The remaining part annihilates with an energy of 0.78233341 MeV. The decay reaction of the neutron can be represented as follows:

$$\mathrm{n} \longrightarrow \mathrm{p}^+ + \mathrm{e}^- + 0{,}78233341\ \mathrm{MeV}$$

Figure 21. Neutron decay reaction.

## 13. Antimatter in the Muon

According to the Dirac equation, matter and antimatter should be symmetrical with respect to each other. The symmetry between matter and antimatter existed in the early universe. This is related to the symmetry of the birth of electrons and positrons.

The fractal of muon shows that the symmetry between matter and antimatter is not violated during the muon's structurogenesis process. The muon is formed with the participation of 128 electrons and 127 positrons. Just as there was symmetry between matter (electrons) and antimatter (positrons) at the initial stage, the symmetry between matter and antimatter is not violated during the proton's structurogenesis process. The fractal of muon shows that electrons (matter) and positrons (antimatter) participate in equal amounts during structurogenesis. Only at the final (7th) stage does the electron (matter) complete the formation of the muon. From the initial symmetrical composition of electrons and positrons, one positron remains free for each muon. This free positron participates in the formation of the antimuon, which creates conditions for the continuation of the structurogenesis of other particles and antiparticles.

## 14. Leptosynthesis involving matter and antimatter

Instead of the annihilation channel of matter and antimatter, Nature chose the synthesis channel. Leptosynthesis is impossible without antimatter. Electrons and positrons are both reactants and catalysts in the leptosynthesis reaction. Without electrons and positrons, positronium cannot form. Without electrons and positrons, muons cannot form. The process develops according to a fractal algorithm of doubling and replication of previous structures. Through this beautiful mechanism, matter and antimatter "created muons from themselves."

## 15. Paradoxical mechanism of muon structurogenesis

Muon owes its birth to antimatter. Muons could not have formed without antimatter. Without antimatter, the process of structurogenesis cannot continue beyond muons to protons. Nature skillfully hides antimatter both inside unstable elementary particles and inside protons. Everything that exists in Nature is composed half of antimatter and half of matter. Thanks to antimatter, the synthesis of all elementary particles occurs. This is an amazing and paradoxical solution to the problem of antimatter in the Universe!

## 16. New constants of elementary particles

More accurate values of new constants of elementary particles follow from the law of structurogenesis (Figure 22).

| Particle | Magic number (M) | Ratio of particle mass to electron mass $m/m_e$ (CODATA) | Mass defect $\Delta m$ | $\Delta m$ /m |
|---|---|---|---|---|
| Muon | 255 | 206.768 2830 | 48.231717 $m_e$ | 0.2332 |
| Proton | 2047 | 1836.152 673 43 | 210.84732657 $m_e$ | 0.11483 |
| Neutron | 2050 | 1838.683 661 73 | 211.31633827 $m_e$ | 0.11493 |
| Deuteron | 4095 | 3670.482 967 88 | 424.51703212 $m_e$ | 0.11565 |

Figure 22. New constants of elementary particles.

## 17. Conclusions

1. There are many undiscovered elementary particles with masses ranging from the electron mass to the muon mass and beyond to the proton mass. A forecast of the masses of new elementary particles is given for their discovery in experiments.

2. Non-conservation of lepton number is not related to the symmetry breaking of matter and antimatter. Non-conservation of lepton number and non-conservation of baryon number occur under complete symmetry of matter and antimatter.

3. The muon fractal and the mechanism of muon structurogenesis reveal the fallacy of the inference of the predominance of matter over antimatter in the modern Universe.

4. Without antimatter, the process of structurogenesis of elementary particles is impossible. Positron (antimatter) and electron (matter) act as simultaneous catalysts and reactants in the reactions of leptosynthesis and baryosynthesis.

5. A general law of structurogenesis of elementary particles has been obtained, which provides the mass spectrum of elementary particles. The law of structurogenesis of elementary particles has the form:

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

where: me - electron mass, Mj - magic number, - mass defect.

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