On Basic Physical Properties of Baryon Matter According to the Non-Standard Model

Daniele Sasso*

Abstract

The concept of nucleon with two values of isospin, deduced from Heisenberg's idea, is one of fundamental concepts on the baryon matter in the Standard Model that considers proton and neutron are two different physical states of the same elementary particle (isotopic symmetry). In the Non-Standard Model proton and neutron are two fully different particles with regard to mass, electric charge and spin (in SM the two particles have the same spin); moreover proton is a really elementary stable particle while neutron is a non-elementary unstable particle. The complete differentiation of proton and neutron implies a review of both the concept of baryon matter and the physical behaviour of baryon particles that in the new Model, when they are in the unstable state, emit on the decay baryon neutrinos. Specifically charged unstable baryons emit neutrinos inside the hard radiation of the delta band (δ-Y radiation with $f \geq 1{,}13 \times 10^{23}$Hz) and neutral unstable baryons emit neutrinos inside the soft radiation of the delta band (3×10^{21}Hz$\leq f < 1{,}13 \times 10^{23}$Hz).

1. Introduction

As per Maxwell's equations a variable electric current generates an electromagnetic field that propagates in the space-time through a continuous wave. Similarly an accelerated electric charge and provided with non-inertial motion represents a variable nanocurrent that generates an electromagnetic nanofield which propagates in the space-time through an electromagnetic nanowave in the form of energy quantum[1]. Like accelerated electron[2], therefore also accelerated proton emits or absorbs radiant energy.
After defining main physical properties of proton we examine the physical behaviour of the accelerated proton and we observe it has in the Non-Standard Model (NSM) a similar behaviour to the accelerated electron with a negative value of baryon mass (baryon antimass) for greater velocities than the critical speed.
Let us consider then typical processes of decay for some unstable baryon particles, which can be found generally in the scientific literature, and we point out that there are different processes of decay for charged unstable baryons and for neutral unstable baryons, just as it happens for mesons[3].
Let us raise at last the following question: do masses of both leptons and baryons have the same physical nature?

*e_mail: dgsasso@alice.it

2. Physical properties of proton

Proton is an elementary particle which together with neutron composes the stable atom nucleus. Proton is a very stable particle also at the free state outside the nucleus. Main physical properties of proton are:

a. resting mass m_p (baryon mass) equal to $1{,}67 \times 10^{-27}$Kg $=1836{,}1m_e=938{,}25\text{MeV}/c^2$ where m_e is the lepton electrodynamic mass of resting electron
b. resting intrinsic equivalent energy equal to 938,25MeV=0,938GeV
c. positive electric charge equal to +1 where the unitary charge is the electron negative charge in absolute value
d. positive semi-integer spin equal to $+\hbar/2$ (proton is a fermion)
e. equivalent wavelength $\lambda=1{,}32 \times 10^{-15}$ m=1,32fm.

This value of wavelength represents Compton's wavelength and it is constant because depends only on the intrinsic energy of resting particle.
De Broglie's wavelength instead depends on particle momentum and therefore on its velocity; it coincides with Compton's wavelength when for proton we assume the photon speed v=c.
As a consequence of the property (e.) we can also claim the conventional equivalent ray of proton is equal to $0{,}66 \times 10^{-15}$ m=0,66fm.
In SM proton has a complex structure composed of one tern of quarks, in NSM we will prove proton has an electrodynamic behaviour.
Proton is a very stable particle and its average life has been calculated greater than 10^{33} years, which is an immense lifetime.
Until now the proton decay doesn't have been observed, anyway a few theorize that a possible canal of decay could be

$$p^+ \longrightarrow e^+ + \pi^o \qquad (1)$$

If this process of decay will be confirmed as an experiment a common physical nature would be presumable for protons as for leptons.
Anyway proton has a very high degree of stability like electron and the decay process described in (1) is highly improbable.
Electron leptonic mass has electrodynamic nature and by a process of acceleration it is possible to obtain from it two gamma quanta of energy[2], the first at the speed of light and the second at the critical speed, everyone with frequency equal to $0{,}6 \times 10^{20}$Hz. We know also that if further accelerated to greater speeds than the critical speed, electron generates unstable particles belonging to its subfamily[3][4] with succeeding production of delta radiation on the decay.
For proton we are able to calculate from the property (e.) the equivalent characteristic frequency ($f=c/\lambda$) which is equal to $2{,}26 \times 10^{23}$Hz.

The same value of frequency can be obtained from the property (b.) considering the resting intrinsic energy of proton given by E_p=938,25MeV for which

$$f = \frac{m_p c^2}{h} = \frac{1836{,}1 \times 0{,}511 \times 10^{6} \times 1{,}6 \times 10^{-19}}{6{,}63 \times 10^{-34}} = 2{,}26 \times 10^{23}\ \text{Hz} \qquad (2)$$

We deduce that equivalent energy quantum associated with the proton mass belongs the band of delta radiation[4].
Proton p^+ has, like all elementary particles, an antiparticle $p^- = \underline{p}^+$, called antiproton, which has the same physical properties as proton unless those associated with the electric charge (equal to −1) like the spin which is equal to −ħ/2 for antiproton[5].

3. Proton acceleration in the Non-Standard Model

Maxwell' s equations demonstrate any accelerated electric charge, negative or positive, and provided therefore with non-inertial motion, is a variable nanocurrent that emits electromagnetic energy: consequently it is valid also for accelerated proton. We have proved[2] in NSM the emission of radiant energy from accelerated electron happens at the expense of the electrodynamic mass of electron in the shape of energy quanta, and that this quantum emission of energy is equal exactly to the kinetic energy acquired by an equivalent non-electrodynamic physical system.
Let us want now to examine the behaviour of accelerated proton in the Non-Standard Model, accepting that also for proton the emission of radiant energy happens at the expense of its mass.
Resting proton has an intrinsic energy $E_{io}=m_p c^2$ and at the speed v an equivalent kinetic energy $E_c=m_p v^2/2$. The intrinsic energy at the speed v is $E_i=m_p^+ c^2$ for which from the energy balance we obtain

$$E_{io} - E_c = E_i \qquad (3)$$

$$m_p c^2 - \frac{m_p v^2}{2} = m_p^+ c^2 \qquad (4)$$

from which

$$m_p^+ = m_p \left(1 - \frac{1}{2}\frac{v^2}{c^2}\right) \qquad (5)$$

If our considerations are correct, we deduce from the relation (5) the accelerated proton has a similar behaviour to electron and therefore also proton mass has electrodynamic nature.
Consequently at the speed of light c mass of the accelerated proton becomes half ($m_p/2$) and the residual half is emitted in the shape of energy quantum hf where the frequency is equal to

$$f = \frac{m_p c^2}{2h} = 1{,}13 \times 10^{23}\,\text{Hz} \qquad (6)$$

From the relation (6) we deduce emitted quantum belongs to the delta band.
At the critical speed v_c=1,41c proton emits a second delta quantum with the same value of energy with respect to the first.
We observe also positive baryon mass of proton decreases when the speed increases, becomes zero at the critical speed and for greater speeds than the critical speed it is negative (baryon antimass) with the beginning of stability problems for the particle. So proton, like electron, is stable at smaller speeds than the critical speed and becomes unstable for greater speeds.
All that can be represented by a graph like in fig.1

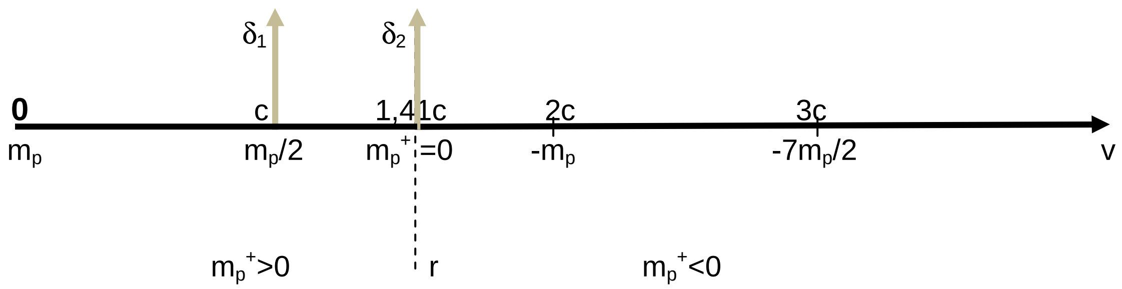

Fig.1 Graph relating to the behaviour of the accelerated proton. The r dotted line separates the stable behaviour of the proton (left) from the unstable behaviour (right).

From this graphic representation and from the relation (5) we deduce that the behaviour of accelerated proton is altogether similar to accelerated electron, but while electron accelerated to the critical speed emits two gamma quanta, proton accelerated to the same speed emits two delta quanta of energy. Moreover we deduce also mass of accelerated proton can be greater than the mass of resting proton, in absolute value, only for negative values.
Because also electron mass can be greater than the resting mass, in absolute value, only for negative values, we deduce yet the important consequence that the resting mass of proton is the most great positive value of real electrodynamic mass with regards to elementary particles.
These conclusions prove there is a perfect symmetry between the physical behaviour of both leptons and baryons.
We can assume that the frequency given by the (6) is, inside the delta band, the frequency of separation between the under-band of soft delta frequencies ($3 \times 10^{21} \div 1{,}13 \times 10^{23}$)Hz and the under-band of hard frequencies (δ−Y radiation) which are greater than $1{,}13 \times 10^{23}$ Hz.

4. Proton subfamily

As per an idea proposed by Heisenberg in 1932, proton and neutron would be the two different physical states of the same particle so called nucleon (isotopic symmetry). These two states would differ from each other, besides in electric charge and mass, also in the physical property, so called isospin, which can assume only two conventional values: +1/2 for proton and −1/2 for neutron.
This physical property was accepted in the Standard Model and it was used in order to explain the stability of nucleus by the strong nuclear force which opposes the electric force of repulsion among nuclear protons that would cause the nuclear decomposition if it operated by itself.
In the Non-Standard Model proton and neutron are two altogether different particles with different values of spin[5], besides mass and electric charge. Proton then is a stable elementary particle while neutron is an unstable non-elementary particle with a complex structure composed of one proton and one electron. The nuclear stability is explained in NSM assigning the strong nulear force a different physical nature. Moreover in the NSM baryon particles can have negative values of mass like particles of the electron subfamily, i.e. the NSM anticipates the existence of accelerated baryon particles with any value of negative mass, which depends only on the assumed speed, as it happens for leptonic particles.
Let us examine now only a few baryon particles (tab.1), reminding in the NSM the spin q_s is strictly associated with the electric charge Q by the relationship[2][5]

$$q_s = \frac{k}{n}\,\frac{\hbar}{2e}\,Q \qquad (7)$$

Because free particles have k=n, then the (7) becomes

$$q_s = \frac{\hbar}{2e}\,Q = \pm\frac{k}{2}\,\hbar \qquad (8)$$

where $Q=\pm ke$ and k is an integer number. In the relation (8) the positive sign must be considered if the particle has positive charge and the negative sign if the particle has negative charge. Moreover as per (8) neutral baryons (Q=0) have zero spin.
Charged baryons are really elementary particles and they become unstable when their speed is greater than the critical speed. In that case both mass and kinetic energy become negative. It means charged baryons, like charged leptons, have electrodynamic behaviour.
As neutral leptons also neutral baryons aren’ t elementary particles but complex particles composed of more elementary particles. Their mass is always positive and their instability depends only on an excess of energy with respect to the less unstable state at low energy. It means neutral complex particles don’ t have electrodynamic behaviour, even though component particles are electrodynamic.

Baryon	**Mass**	**Energy [GeV]**	**Electric charge**	**Spin**	**Average life τ_m [s]**
Proton	m_p=1836,1m_e	0,938	+1	+(1/2)ħ	practically infinite
lambda Λ^o	2183,1m_e=1,189m_p	1,12	0	0	$2{,}63\times10^{-10}$
sigma Σ^+	−2327,6m_e=−1,268m_p	−1,19	+1	+(1/2)ħ	$8{,}1\times10^{-11}$
sigma Σ^-.	−2343,1m_e=−1,276m_p	−1,20	−1	−(1/2)ħ	$1{,}5\times10^{-10}$
sigma Σ^o	2333,6m_e=1,274m_p	1,19	0	0	$7{,}4\times10^{-20}$
Csi Ξ^-	−2585,6m_e=−1,412m_p	−1,32	−1	−(1/2)ħ	$1{,}7\times10^{-10}$
Csi Ξ^o	2573m_e=1,405m_p	1,31	0	0	$2{,}9\times10^{-10}$
omega Ω^-	−3273m_e=−1,787m_p	−1,67	−1	−(1/2)ħ	$8{,}2\times10^{-11}$
delta Δ^+	−2410,96m_e=−1,31m_p	−1,23	+1	+(1/2)ħ	$5{,}58\times10^{-24}$
delta Δ^o	2410,96m_e=1,31m_p	1,23	0	0	$5{,}58\times10^{-24}$
delta Δ^-	−2410,96m_e=−1,31m_p	−1,23	−1	−(1/2)ħ	$5{,}58\times10^{-24}$
delta Δ^{++}	−2410,96m_e=−1,31m_p	−1,23	+2	+ħ	$5{,}58\times10^{-24}$

Tab.1 Main physical properties of the most important baryons with the spin values calculated as per the relation (8) valid in the Non-Standard Model.

In Table1 it is possible to observe a few interesting aspects:

a. Negative masses of unstable charged baryons are a bit greater, in absolute value, than the mass of resting proton, unlike negative masses of unstable leptons that can be greatest with respect to the mass of resting electron.
b. Unstable neutral baryons have positive mass and zero spin.
c. The presence, among unstable charged baryons, of the baryon Δ^{++} with double positive electric charge that generates a double value of spin.
d. Average lives of unstable baryons are about 10^{-10} s except the average life of both the baryon Σ^o (about 10^{-20} s) and baryons Δ (about 10^{-24} s).

5. Decay of baryonic particles

The following processes of decay, considered in tab.2, valid for unstable baryons are deduced from the scientific literature:

1. $\Lambda^o \longrightarrow p^+ + \pi^-$; $\Lambda^o \longrightarrow n + \pi^o$
2. $\Sigma^+ \longrightarrow p^+ + \pi^o$; $\Sigma^+ \longrightarrow n + \pi^+$
3. $\Sigma^o \longrightarrow \Lambda^o + \gamma$
4. $\Sigma^- \longrightarrow n + \pi^-$
5. $\Xi^- \longrightarrow \Lambda^o + \pi^-$
6. $\Xi^o \longrightarrow \Lambda^o + \pi^o$
7. $\Omega^- \longrightarrow \Lambda^o + \pi^-$; $\Omega^- \longrightarrow \Xi^o + \pi^-$; $\Omega^- \longrightarrow \Xi^- + \pi^o$
8. $\Delta^+ \longrightarrow n + \pi^+$; $\Delta^+ \longrightarrow p^+ + \pi^o$
9. $\Delta^o \longrightarrow n + \pi^o$; $\Delta^o \longrightarrow p^+ + \pi^-$
10. $\Delta^- \longrightarrow n + \pi^-$
11. $\Delta^{++} \longrightarrow p^+ + \pi^+$

Tab.2 Typical decays of baryons considered in tab.1

From these processes of decay we can deduce the following considerations:

a. All, charged and neutral, unstable baryons decay directly or through intermediate decays to protons.
b. Intermediate decays happen through neutron which is in its turn unstable and decays to one proton through the process[5] $n \longrightarrow p^+ + e^- + \nu_e$.
c. As per decay processes written in tab.2 proton represents the only parent of the family of baryonic particles.

With regard to the Non-Standard Model we can do the following further considerations:

d. Neutral unstable baryons can be considered neutrons which are in a state of high energy. Their instability is due just to an excess of energy with respect to the minimum state of energy and therefore their instability doesn't involve negative baryonic mass as instead it happens for unstable charged baryons. On this account in tab.1 positive mass has been assigned to unstable neutral baryons and negative mass to unstable charged baryons.

e. Antiproton appears never in observed processes of decay and this situation must be still further investigated above all with regard to the decay of negative charged unstable baryons.

We understand therefore decay processes considered in tab.2 present, inside the SM, a few inconsistencies for which we want now, inside the NSM, to examine specifically the single processes of decay that are considered in that table and to that end it is convenient to distinguish charged baryons from neutral baryons as for mesons.

6. Decay processes of charged baryons

a. Let us begin to consider the particle Σ^+ that presents in tab.2 two typical decay processes

$$\Sigma^+ \longrightarrow p^+ + \pi^o \qquad (9)$$
$$\Sigma^+ \longrightarrow n + \pi^+ \qquad (10)$$

The decay described in (9) shows that the proton and the pion π^o are the decay products of the unstable baryon Σ^+. Making the appropriate calculations it is possible to observe the relation (9) presents a mass lack of $228m_e$ and an energy lack of 116,5 MeV which aren't easily explicable.
This inconsistency induces to think the decay described in (9) must be replaced in the Non-Standard Model with the most realistic process of decay

$$\Sigma^+ \longrightarrow p^+ + \delta_\Sigma^+ \qquad (11)$$

where $\delta_{\Sigma+}$ represents the bayon neutrino of the particle Σ^+.
Considering data in tab.1 we deduce the neutrino $\delta_{\Sigma+}$ has a quantum energy of 2,18 GeV and a frequency of $5{,}14_x10^{23}$Hz that belongs to the hard under-band of the delta band (δ-Y radiation).
It is too manifest that the decay process described in the relation (10) presents the inconsistency, acceptable only in SM because of the isotopic symmetry, that an unstable positive baryon can decay freely to an intermediate neutron with charge zero, which then decays to one proton in a very longer time. This type of decay is meaningless in NSM.

b. On the same account the decay process of unstable negative baryon Σ^-, represented in tab.2, must be replaced with the decay process

$$\Sigma^- \longrightarrow p^- + \delta_\Sigma^- \qquad (12)$$

where p^- is the antiproton and δ_Σ^- is the Σ^- neutrino which presents an energy of 2,136 GeV and a delta-Y frequency of $5{,}15 \times 10^{23}$Hz.
The relation (12) states that antiproton can be a product of the decay process of a negative charged baryon.

c. What was said for the particle Σ^- is valid also for the particle Ξ^- whose decay process, described in tab.2 and valid in SM, must be replaced in NSM with the most realistic process of decay

$$\Xi^- \longrightarrow p^- + \delta_\Xi^- \qquad (13)$$

where the baryonic neutrino δ_Ξ^- has an energy of 2,26 GeV and a delta-Y frequency of $5{,}5 \times 10^{23}$ Hz.

d. The unstable baryon Ω^- presents in tab.2 the following three decays

$$\Omega^- \longrightarrow \Lambda^o + \pi^- \quad ; \quad \Omega^- \longrightarrow \Xi^o + \pi^- \quad ; \quad \Omega^- \longrightarrow \Xi^- + \pi^o \qquad (14)$$

that, after due consideration, can be replaced in NSM with the following decay process

$$\Omega^- \longrightarrow p^- + \delta_\Omega^- \qquad (15)$$

where the baryonic neutrino δ_Ω^- presents an energy of 2,61 GeV and a delta-Y frequency of $6{,}3 \times 10^{23}$Hz.

e. For the unstable baryon Δ^+ we consider in NSM the following decay process

$$\Delta^+ \longrightarrow p^+ + \delta_{\Delta+} \qquad (16)$$

where the baryonic neutrino δ_Δ^+ presents an energy of 2,17 GeV and a delta-Y frequency of $5{,}2 \times 10^{23}$Hz.

f. Similarly the unstable baryon Δ^- generates the following decay process

$$\Delta^- \longrightarrow p^- + \delta_\Delta^- \qquad (17)$$

where the baryonic neutrino δ_{Δ}^{-} presents the same values of energy and frequency of the baryonic neutrino $\delta_{\Delta+}$.

g. At last the unstable baryon Δ^{++}, which has the unusual property about the positive electric charge equal to the double of the elementary charge, presents in NSM the following decay process

$$\Delta^{++} \longrightarrow p^{+} + e^{+} + \delta_{\Delta++} \qquad (18)$$

that replaces the decay $\Delta^{++} \longrightarrow p^{+} + \pi^{+}$ described in tab.2.
Leaving out the contribution in mass and energy of the positron which is smallest with respect to proton, the baryonic neutrino $\delta_{\Delta++}$ has the same values of energy and frequency of barionic neutrinos $\delta_{\Delta+}$ e $\delta_{\Delta-}$.
From the examination of baryonic neutrinos emitted by unstable charged baryons we deduce that these unstable charged particles generate quanta at very high energy with highest frequencies and greater than $1{,}13 \times 10^{23}$Hz. This value of frequency is the inferior limit of the high under-band of the delta radiation which we called δ−Y radiation.
In the end in tab.3 characteristic speeds of charged baryons have been calculated as per the relation (5) and travelled distances before decaying are deduced from average lives of the same baryons.

Baryon	**characteristic speed**	**travelled distance [mm]**
sigma Σ^{+}	$1{,}506v_c=2{,}123c$	51,59
sigma Σ^{-}	$1{,}509v_c=2{,}127c$	95,72
Csi Ξ^{-}	$1{,}553v_c=2{,}190c$	111,70
omega Ω^{-}	$1{,}670v_c=2{,}354c$	57,91
delta Δ^{+}	$1{,}520v_c=2{,}143c$	$35{,}87 \times 10^{-13}$
delta Δ^{-}	$1{,}520v_c=2{,}143c$	$35{,}87 \times 10^{-13}$
delta Δ^{++}	$1{,}520v_c=2{,}143c$	$35{,}87 \times 10^{-13}$

Tab.3 Speeds of unstable charged baryons and travelled distances before decaying.

We can observe unstable charged baryons, considered in tab.3, have a bit greater speeds than the double of the speed of light and travelled distances are of the order of the hundred of mm , except particles Δ that instead travel smallest distances because of their smallest average life.

7. Neutral baryons

In the Non-Standard Model we have assumed that unstable neutral leptons are physical states at high energy of the unstable positronium at low energy, similarly we assume that unstable neutral baryons are physical states at high energy of the unstable neutron at low energy and this assumption is justified greatly by decay processes of particles Λ^o , Σ^o , Ξ^o , Δ^o described in tab.2 which here we write again

$$
\begin{aligned}
&\Lambda^o \longrightarrow n + \pi^o \\
&\Sigma^o \longrightarrow \Lambda^o + \gamma \\
&\Xi^o \longrightarrow \Lambda^o + \pi^o \\
&\Delta^o \longrightarrow n + \pi^o
\end{aligned}
\tag{19}
$$

We observe that all considered decay processes produce directly or indirectly one neutron at low energy which then because of its intrinsic instability, with average life of about 900 seconds, decays to one proton and to one electron according to the process[5]

$$
n \longrightarrow p^+ + e^- + \nu_e \tag{20}
$$

We observe also that all decay processes described in (19) don' t respect fully the Conservation Principle of Energy before and after the decay. On this account decay processes described in (19) are replaced in NSM with the following processes

$$
\begin{aligned}
&\Lambda^o \longrightarrow n + \delta_\Lambda{}^o \\
&\Sigma^o \longrightarrow n + \delta_\Sigma{}^o \\
&\Xi^o \longrightarrow n + \delta_\Xi{}^o \\
&\Delta^o \longrightarrow n + \delta_\Delta{}^o
\end{aligned}
\tag{21}
$$

in which $\delta_\Lambda{}^o$, $\delta_\Sigma{}^o$, $\delta_\Xi{}^o$, $\delta_\Delta{}^o$ are neutrinos of neutral baryons with the following quantum values of energy

$$
\begin{aligned}
&E(\delta_\Lambda{}^o) = 180 \text{ MeV} \\
&E(\delta_\Sigma{}^o) = 250 \text{ MeV} \\
&E(\delta_\Xi{}^o) = 370 \text{ MeV} \\
&E(\delta_\Delta{}^o) = 290 \text{ MeV}
\end{aligned}
\tag{22}
$$

and with the following values of frequency

$$f(\delta_\Lambda{}^o) = 4{,}3 \times 10^{22} Hz$$
$$f(\delta_\Sigma{}^o) = 6{,}0 \times 10^{22} Hz \qquad (23)$$
$$f(\delta_\Xi{}^o) = 8{,}2 \times 10^{22} Hz$$
$$f(\delta_\Delta{}^o) = 7{,}0 \times 10^{22} Hz$$

We note that while neutrinos of charged baryons belong to the hard under-band of the delta radiation (radiation $\delta-Y$ with $f \geq 1{,}13 \times 10^{23}$Hz), neutrinos of neutral baryons belong to the soft under-band of the delta radiation (soft delta with 3×10^{21}Hz$\leq f < 1{,}13 \times 10^{23}$Hz).
Like for the leptonic matter we are able now to assert that baryonic matter embraces in the order the Non-Standard Model three subfamilies:

a. Proton subfamily (elementary particles)
b. Antiproton subfamily (elementary particles)
c. Neutron subfamily (complex particles)

In the beginning of this paper we raised the following specific question: do masses of both leptons and baryons have the same physical nature?
As per what we have demonstrated in this paper the two masses have the same physical behaviour and the same electrodynamic nature but it isn' t sufficient for claiming they have completely the same physical nature.
In fact a few important aspects concerning the two particle families don't have been clarified enough yet, as for example the quark prospective structure.
This structure is altogether absent in the family of leptonic particles while the question could be still open as regards the family of baryonic particles, even though the electrodynamic nature would exclude the possibility of a complex structure. Anyway it is clear that all elementary charged particles, whether leptons or baryons, belong to the same family of electrodynamic particles.

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