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Inside and Outside Quantum Vacuum

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Abstract The main objective of this paper is to propose new interpretations of certain phenomena that are still enigmatic in the standard theory of the Universe. This research is based on two assumptions. The first indicates that quantum vacuum may be split in portions inside which particles of matter are confined. The second assumption considers that the electrical charge is quantified as the third unit of the universal charge and similarly, the spin is carried by a particle which can generate one of the two possible states of spin. From these two postulates, three processes have been streamlined, which are: i) the electrical neutrality proton/electron, ii) the radioactivity β and iii) the kaon decay. A new representation of both elementary and composite particles is proposed.

Keywords Spin-charge separation, Elementary particles, Radioactivity β, Kaon decay

1. Introduction

The standard theory of the Universe explains with great success the evolution of the Universe from a time equal to 10-46 second after the Big Bang. This description was improved by the "string theory" which presents elementary particles differently. However, these theories do not propose any plausible explanations for several issues. For instance, the phenomena below remain unclear:

- The electrical neutrality proton-electron,
- The interpretation of some reactivity modes such as the radioactivity β or the kaon decay.

In order to provide an explanation for the above-mentioned phenomena, first, there is a need to introduce a different perspective on the description of elementary particles. The quest for the description of elementary particles has begun since the Greek civilization. The concept of atom as elementary particle of matter and its indivisibility was not a scientific concept in Greece but a philosophical one called atomism.

Handling the energy of fire, energy widely available and accessible, it is possible to separate molecules to obtain atoms. Atoms were really considered as the ultimate particles of matter division and so considered as elementary particles when the manipulated energy is of the order of a few electron volts (eV). This status was soon dethroned by the nucleus and the electrons. But it was necessary to move to a new energy scale of the order of MeV. The controlled manipulation of higher energy in GeV showed that the nuclei are themselves composed of protons and neutrons called nucleons and that they are formed by an assembly of quarks. Therefore, the end of the indivisibility quest cannot be declared yet. In the following article, the term "unitary particle" replaces that of elementary particle. This new term defines a stable entity in a given energy range and possibly consisting of smaller particles.

A new look at the elementality [1] of the electron is also introduced in this work. A recent article [2] used a provocative title, "Not-quite-so-elementary, my dear electron", to popularize the thesis of the "non elementality" of the electron. Both theoretical and experimental researches emphasize the fact that the electron is not an elementary particle. Since 1982, some works [3–5] suggest that the electron is formed by three "quasi-particles" namely the holon, spinon and orbiton. The quasi-particle term is used to differentiate a situation in situ from a full observation of materialized particle. Later in 1996, Kim et al. [6] reported that their experimental work agrees with Kugel and Khomskii [3] theory managing to separate electric charge from spin behavior. This was confirmed by the work of Jompol et al. [7] Finally, in 2012, Schlappa et al. [8] claimed to have demonstrated the existence of the third quasiparticle that is the orbiton. In these experiments, the electron is subjected to a confining under constraints at a very low temperature near zero Kelvin. Several experimental studies [9,10] have since supported this separation between the electron properties to generate significant advances in electronics [10] or magnetism. [12]

In addition, it is accepted that the electric charge of the electron is no longer elementary. [13] Since the famous experiment of Millikan [14], it has been considered that the electric charge is quantized in units of the charge of an electron. The fractional quantum Hall effect [15,16] (FQHE), is a phenomenon observed in the conduction properties of a two-dimensional electron gas subjected to an

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intense magnetic field. Its interpretation gives rise to fractional charge of quasi-particles that carry the current. The existence of fractional charge was theoretically predicted by Laughlin. [15] Direct observation of fractional charges, especially in -e/3, has been, since, generalized. [17,18]

Moreover, the vacuum concept has always anguished humanity. An initial definition of the phenomenon confuses it with the concept of nothingness. However, in ancient Greece, the vacuum was regarded as formed by invisible and undetectable Ether. The standard theory of the Universe introduces the definition of the quantum vacuum. This vacuum is a concentration of matter and antimatter (M/AM). Its fluctuations allow simultaneous creation of a pair of particle/antiparticle (P/AP). The vacuum could therefore consist of a fundamental substrate (at the quantum scale) such as an elastic solid medium, a fluid or a Higgs condensate. [19-24]

This document presents a theory [25] that is based on two assumptions with regard to the definition of vacuum and elementary particles. The second part of this article will attempt to explain the three problems listed above, namely: i) The electrical neutrality proton-electron ii) The interpretation of some reactivity modes such as radioactivity β or kaon decay modes.

2. Results and Discussion

2.1. Postulate 1: The Hidden Particle H̆

In this work we assume that quantum vacuum may be breakable. Each detectable materialized particle would be the consequence of the confinement of its constituents in a vacuum portion H̆ (half-round H, from the word hidden because it is undetectable) that is separate from the rest of the quantum vacuum. This separation cannot be complete and thus the confinement portion H̆ keeps a formal link with the vacuum-tank and becomes itself an energy reservoir.

We note H̆ that part of the vacuum that is detached without denying it. We always keep this accentuation curve on any quantity which would be undetectable. H̆ keeps on it both particles and their antiparticles that will be available during any exchange of energy or matter process. So, vacuum and matter are interrelated and continuous in interaction. One can take from vacuum matter and antimatter and can also restore to it matter and antimatter.

This vision is based on observations and interpretations of proton composition from the electron-proton collider HERA experiences. [26] A proton is recognized as formed by three quarks living in a boiling “soup” of quarks/antiquark pairs and gluons. These particles are constantly created and annihilated generating an "inner life." However, no explanation has been offered for the existence of this “soup”. A recent paper [27] entitled “Inside the Proton the Most Complicated Thing You Could Possibly Imagine” related that a charm quark and charm antiquark have been detected inside proton. Another work has even highlighted a movement of quarks inside the nucleus in the presence of an external electromagnetic field. [28] It is interesting to note that the interaction of particles such electron with the quantum vacuum has been recently proposed. [29]

2.2. Postulate 2: Electric and Spin Charges Units

To introduce this theory, I must refer to the detection of the electron fractional charges we have recounted above. The e/3 value was observed and this allows us to link it to the electric charge of quarks. In addition, it is now accepted that the electron is formed by at least two quasi-particles separately describing the spin and electric charge.

We cannot understand the nature of the fine structure of the electron without deepening the process of matter creation and differentiation. Indeed, the fact that the material is electrically neutral imposes a causal relationship in the process of formation of nuclear nuclei (therefore nucleons and so therefore quarks) on the one hand and leptons on the other hand. No physical rule imposes the quantization of the electric charge. In reality, in our Universe, the materialized unit charge is the charge of a proton or an electron. Actually, the elementary electric charge is defined as one of a positron/electron despite the fact that quarks have fractional charges into thirds. Keeping the analogy with the positive matter, we can imagine that we detect unitary status of the electric charge in the electron which is preserved and perpetuated in the energy range experienced in our Universe. Under extreme strain conditions in the presence of a strong magnetic field, the electric charge of the electron exhibits fractionality.

The second postulate stipulates that there are at least two types of independent original unitary particles and their antiparticles: the electric charge and spin units. The former is a scalar particle with a unitary charge (u.e.) equal to e/3. The latter is a spin particle (s.p.), vectorially sensitive to the electromagnetic field associated with quantum numbers ms and of value ħ/2. Our approach can accommodate a unit electric charge even sub-multiple of e/3 like e/6 or e/12.

An internal organizational strength governs the separation and bonding of the original particles "enemy brothers" to form quasi-particles inside the portion H̆ and the divisibility of the vacuum.

2.3. Applications

2.3.1. Formation Process of Material Particles

Electrical neutrality is one of the few laws of nature that has never been violated. The charges on the electron and proton are equal but opposite, and their numbers are equal because matter is neutral. The standard theory of the Universe describes the step of forming leptons independently of quarks one. Indeed, leptons and quarks are considered as independent elementary particles. Some theories seek a common ancestor whose decay can lead to the simultaneous formation of quarks and leptons. It is very difficult to believe in the elementality of these particles despite the fact that there is no formal proof of existence of a fine structure within them. Even the number 48 (6 quarks, 6 leptons, their antiparticles and their duplication when we consider their helicity) is too large to maintain the honour of ultimacy. We hear more and more about of the Zoo of elementary particles. [30] Although quarks and leptons are each divided into three families or generations, the difference lies in the mass and life span. They share the electric charges and the spin for each pair of a family.

The novelty of this work is the assumption of simultaneity concerning the formation of leptons and quarks from the quantum vacuum. It is a guarantee of total charge neutrality conservation. The diversity of matter particle considered as elementary can be rationalized from the existence of only electric charge and spin units. We will focus on the first-generation quark (u and d) and leptons (electron and neutrino).

Table 1. Distribution of Electric Charge Units for the 1st Generation of "Elementary" Particles. x, y, z, x', y' and z' Design any Number of Unit Charges (u.e.)

u.e.	Electron		Quark u		Quark d		Positron		Quark $\bar{u}$		Quark $\bar{d}$	
1/3	0	x	2	y	0	z	3	x'	0	y'	1	z'
-1/3	3	3+x	0	y-2	1	z+1	0	x'-3	2	y'+2	0	z'-1
Sum	-1		2/3		-1/3		+1		-2/3		1/3	

The transition to other generations is just a mass/energy problem so that does not change the mechanisms that we will discuss. A distribution of these electrical charge units is specified in Table 1. We can see that the number of unit particles is not important in itself, and only the difference between positive and negative particles can be observed. In addition, any partition of a set of unit charges may lead either to matter or to antimatter. Take the simple example of the hydrogen atom (Figure 1).

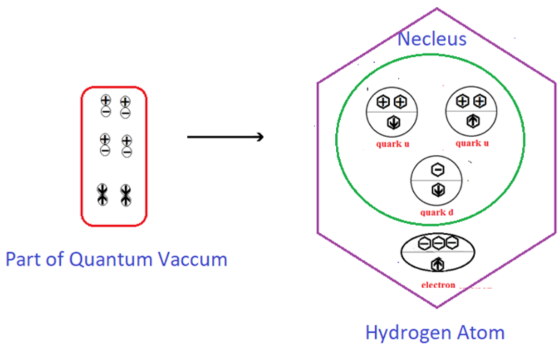

Figure 1. Simultaneous formation of hydrogen atom from quantum vacuum

Table 2. Symbols electric charges and spin units inside and outside of quantum vacuum

	Electric charge		Spin charge	
Materialized quasi-particle outside vacuum				
Pair of unitary charges inside vacuum				

To differentiate the charge materialized from that inside the quantum vacuum, we adopt the notation indicated in Table 2. The downward arrows are associated with the spin states of the particles and those pointing upwards are for antiparticles. In addition, we will differentiate generation particles by the number of outer circles. A circle will be used for the first generation of quarks, two circles for the second generation and three circles to the third generation. Ellipses will replace circles for leptons.

The proton is formed by two quarks u, d quark and the electron e^-. These particles contain at least $(1(d)+0(u)+3(e^-))$ unitary negative charges of -1/3 and $(2*2(u)+0(d)+0(e^-))$ positives charges of 1/3 and any number of P/AP pairs. Consider now the case of an anti-hydrogen atom. It is shaped by two quarks $\bar{u}$, a quark $\bar{d}$ and positron. These particles are distributed in $(1(\bar{d})+0(\bar{u})+3(e^+))$ positives charges of 1/3 and $(2*2(\bar{u})+0(\bar{d})+0(e^+))$ negatives charges of -1/3 and any number of P/AP.

With a set of four-unit electric charges of each type, we can recover the charge distribution of electron/proton or positron/antiproton. This reasoning naturally explains a first enigma of nature that is the strictly equal charges of the proton and the electron. By they use four positive and 4 negative charge units, the total is neutral in type. The proton and electron were separated into two quasi-particles in the quantum vacuum and once they appear materialized, they have exactly the same electric charge but opposite signs. However, a pair of spin particles is separated in two spin unit charge and each one is integrated in the proton or electron structure.

Our model easily interprets why we have not yet been able to separate the quarks from a proton. Indeed, this separation must be accompanied by the decomposition of the electron into three holons of charge -1/3 and of a P/AP pair into a positive holon and a negative holon to ensure the electrical neutrality of each isolated quark. Indeed, the counter-ions of each u quark are two negatives u.e. while that of the d quark is a positive u.e.

2.3.2. β Decay

In a decay process, vacuum plays a particular role is that of providing as many P/PA pairs as necessary to satisfy the conservation laws of spin parity or electric charge. If the starting particle has a half-integer spin, a fermion, then there will necessarily create new fermions. If the initial particle is a boson, it can keep the integer spin and create bosons or separate the pair of spins and create fermions. Figure 2 shows the process of β^+ and β^- decays. The radioactivity β^-

(Figure 2 and 3a) can be described by the fact that neutron (udd) transforms into a proton (uud) with the emission of an electron and an antineutrino. It can be summarized in the mutation of a quark d into a quark u with the emission of an electron and an antineutrino. Just counting charge units (Figure 3) and spin particles leads to easily interpret the β^- decay by a distribution of starting charges in three quasiparticles before their separation into three materialized particles. Indeed, the d quark has an excess negative unit charge.

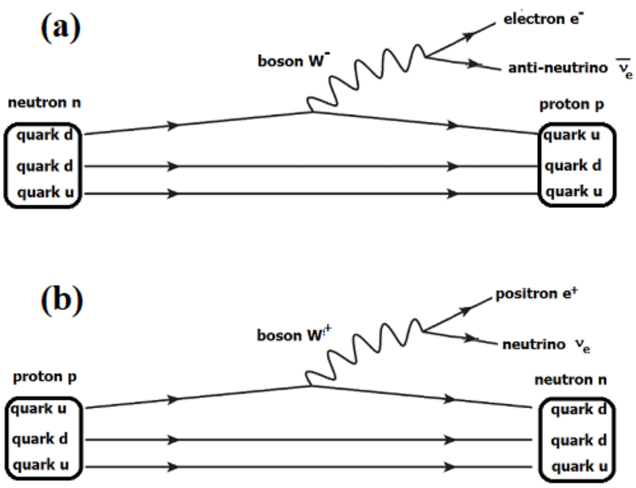

Figure 2. Diagram of: a) β^- and b) β^+ decays

We just have to separate two pairs of opposing electric charge units to allow the gathering three negative charge units to create an electron. This operation leaves two positive charges forming the quark u. We must also adjust the spin states. The quark has spin 1/2 as has each of the created particles. So, we just have to split a pair of spins. We will have three spin units to distribute separately. As the charge distribution leads to two materialized particles (electron and quark u), a third particle without electric charge is created with a spin 1/2 which is the antineutrino.

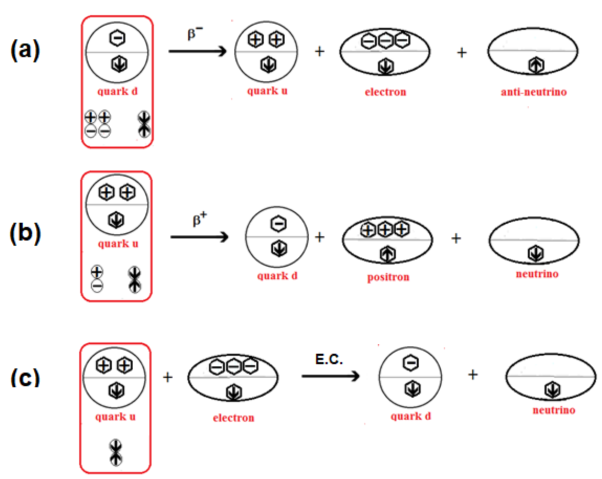

Figure 3. Representation of electric charge and spin distributions during the disintegration process: a) β^-, b) β^+ and c) Electron capture

The radioactivity β^+ (Figure 3 b) can be represented by a similar way that β^- decay. The same diagram in Figure 3a can be used to interpret the electron capture decay process roughly as the inverse process of β^- decay. The fusion of the u quark and the electron generates the presence of a single negative u.e. necessary for the formation of the d quark. As the two spinons of the quark u and the electron must associate, a pair of spin of the particle $\breve{\boldsymbol{H}}$ is distributed in the quark d and the neutrino (Figure 3c).

2.3.3. The Kaon

A special feature of the kaon is that it has several competing decay modes at the same time. The most important ones are indicated by the following equations:

$K^+ \rightarrow \mu^+ + \nu_\mu$	(63,4%)	mode 1
$K^+ \rightarrow \pi^+ + \pi^0$	(21,1%)	mode 2
$K^+ \rightarrow 2\pi^+ + \pi^-$	(5,6%)	mode 3
$K^+ \rightarrow e^+ + \pi^0 + \nu_e$	(5%)	mode 4

The kaon K^+ is formed by the 2nd generation anti-quark $\bar{s}$ with an electric charge of 1/3 and the quark u with a charge of 2/3 (Figure 4). It brings the total charge to +1. The spin of the particle is zero. Mode 1 is the most likely and leads to the formation of two 2nd generation leptons that are a positively charged anti-muon and one muonic neutron. This mode does not require the use of any P/PA from vacuum.

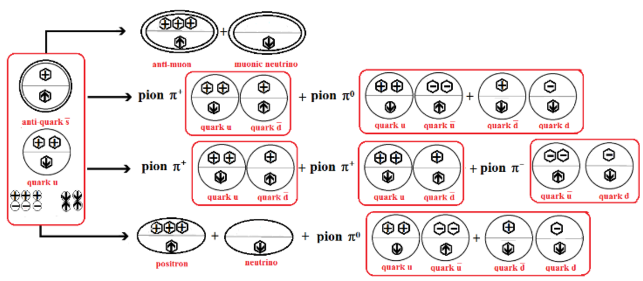

Figure 4. Kaon decay modes

Mode 2 is quite different from mode 1 and is three times less likely. It leads to the formation of π^+ and π^0 pions. The first particle recovers all the positive charge and is formed by the quarks u and $\bar{d}$ while the second pion is neutral and is formed by the combination of $u\bar{u}$ and $d\bar{d}$. Each of these six products has one spin particle. The formed compounds use six positive charges 1/3 (2 for each quark u and 1 for each quark $\bar{d}$) and 3 negative charges -1/3 (2 for quark $\bar{u}$ and 1 for quark d). The reaction requires the destruction of 3 pairs of electric charges (1/3; -1/3) and 2 spin pairs.

Mode 3 is similar to mode 2 with the difference of distribution of four quarks u, $\bar{u}$ d and $\bar{d}$ in pions π^+ and π^- instead of π^0.

Mode 4 highlights the transformation of 2nd quarks generation in 1st leptons generation. The reduction of the masses generates the creation of π^0 pion.

3. Conclusions

This paper has proposed new interpretations of certain phenomena that still hold an enigma status in the standard theory of the Universe. Two assumptions have been reported in this work. The first assumed that the quantum vacuum can be scored in portions of the vacuum noted $\breve{H}$ able to confine matter particles. The second defines the electrical charge as being quantified as the third unit of the universal charge and similarly, the spin as being carried by a particle that can generate one of two possible states of spin. From these two postulates, three processes have been streamlined, which are: i) the electrical neutrality proton /electron, ii) the β emission and iii) the decay of kaon. A new notation formalism differentiating materialized particles from expected particles inside quantum vacuum is proposed in order to better visualize the studied processes. Interpretation of fundamental forces in relation with quantum vacuum is in progress.

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