LIGHTEST SUPERSYMMETRIC PARTICLE IS A

SELF-CONJUGATED NEUTRAL ELECTRON

Antonio PUCCINI

Neurophysiologist of Health Ministry, Naples-Italy

ABSTRACT

Analyzing the neutron decay, or β-decay (*βd*), our calculations and evaluations show that the 3rd particle emitted with the *βd* (required by Pauli and Fermi to compensate for a noticeable energy gap) can be identified in an electron free of electric charge, that is a neutral electron: e° (instead of a neutrino).
In the various Supersymmetric Models, there is the existence of a particle with a limited mass, which can never collapse in a lighter particle: the so-called *Lightest Supersymmetric Particle* (LSP). To date, this LSP has never been detected in any experiment. Examining the potential properties attributed to that particle in the various Supersymmetric Models, it seems to see a close analogy with features likely to be related to e°. Indeed, from a more in-depth examination, it appears that the properties of the two considered particles are completely superimposable, as if the two particles could be interchangeable, that is, identifiable in one another. It seems interesting to note that in our model we give particular attention to the fundamental property attributable both to the LSP and to the e°, i.e. the *symmetry* (represented by ***C***, or *charge conjugation*), detectable by: $\bar{e}^\circ = \mathbf{C}(e^\circ) = e^\circ$

INTRODUCTION

To justify the possible existence of an electron free of charge, we must begin with the neutron decay analysis, or negative β-decay (βd^-). We know that with βd^- first a proton and an electron are emitted. Calculations show immediately a big mass-energy gap. In fact, the neutron weighs $1.67492728\cdot10^{-24}$[g], while the proton weighs $1.67262171\cdot10^{-24}$[g]; on its turn the electron weighs $9.1093826\cdot10^{-28}$[g]. The mass difference between neutron and proton corresponds to Δ_M ($0.00230557\cdot10^{-24}$[g]), that is $\Delta_M = 2.30557\cdot10^{-27}$[g]. According to the mass-energy conversion factors, if we consider that "1 MeV is about $1.782\cdot10^{-27}$[g]" [1], and follow the *cgs* metric system, we have:

$$(2.30557/1.782)\cdot10^{-27}[\text{g}] = 1.29381\ \text{MeV/c}^2 \qquad (1).$$

This is the energy value that in the βd^- must be carried away by an electron(or β radiation) , in order to safeguard the energy balance in this process. The energy value expressed in Eq.(1) represents the maximum value of the energy spectrum ($\eta = E_{max}$) of the β radiation emitted with *βd*. The minimum energy carried away by an electron corresponds to 0.511MeV, thus the value of Eq.(1) is more than double than the energy of an electron not particularly accelerated. With the decay of the neutron, instead, the β ray is accelerated to a very high speed, showing a marked kinetic energy(E_{kin}). Nevertheless, only in very limited circumstances, and coincidentally, the total energy carried away by the β radiation is able to compensate for the difference in mass-energy between neutron and proton. For some years it was not possible to find a solution, until there was *a master strike*. It is well known that it was Pauli to think that in the disintegration of the neutron (*N*), or *βd*, in addition to the proton (*P*) and the electron with negative electric charge (e^-), in order to compensate for the energy gap , a 3rd particle was also emitted, without electric charge, and having the same mass and spin of the electron [2]. This concept was subsequently shared by

Fermi, who said : "We still have the problem of knowing the laws of forces acting between the particles making up the nucleus. It has indeed, in this regard, in the continuous spectrum of β rays, some clues that, according to Bohr, this would suggest that perhaps in these new unknown laws even the Principle of Conservation of Energy is not valid any more; unless we admit –together with Pauli - the existence of the so-called *neutrino*, that is a hypothetical electrically neutral particle having a mass of the order of magnitude of the electron mass. This, for its enormous penetrating power, escapes any current detection method, and its kinetic energy helps to restore the energy balance in the β disintegrations" [3]. These concepts were represented by Fermi through the mathematical formalism of so-called negative β decay (βd^-):

$$N \rightarrow P + e^- + \bar{\upsilon} \qquad (2),$$

where $\bar{\upsilon}$ is the anti-neutrino. Thus let's consider the value of the *minimum energy* of an electron, i.e. the so-called Z*ero Point Energ*y[4]: it is equal to 0.511 MeV. Now, if we subtract this value from the energy value expressed by Eq.(1), we obtain the value of the energy that could be covered by the 3rd particle of the βd, denoted by Δ_E:

$$\Delta_E = 0.78281 \text{ MeV} \qquad (3).$$

This value exceeds the 53.14 % the energy of an electron *at rest*. But it is worth pointing out that this is the maximum value the 3rd particle can reach (considering that at the same time the e^- is emitted too). This does not mean that it always has so much energy, rather the contrary. In fact in the value expressed by Eq.(1) we must also consider the E_{kin} of the β-ray, whose energy spectrum, as Fermi had reported [5][6], may also coincide with the entire energy value described by Eq.(1).

Thus, from the analysis of the βd, we seem to catch two important results: 1) The total energy of the emitted charged electron can fluctuate *randomly* (depending on the intensity of acceleration) in a precise range between 1.29381MeV and 0.511MeV. 2) The energy the 3rd particle can acquire, should fluctuate, still *randomly* distributed between 0.78281MeV and 0.511MeV. These values are perfectly adequate if we consider that the 3rd particle of the βd is represented by an e°. The anti-e°(ē°) too issued with the βd^- should show an E_{kin} at least equivalent to the e^-'s. In fact, the basic requirements originally requested by Pauli and Fermi for the ν, i.e. for the 3rd particle or missing particle in the βd, defined by several authors as a *ghost particle* (*GP*), are essentially three: 1) it is electrically neutral; 2) it has the mass of an electron; 3) it has the same spin of the electron[2][3][5][6]. Well, why not to think immediately to a neutral electron (e°)? All requests would be satisfied. It seems the most logical answer, and physically more than adequate to meet the demands of Pauli and Fermi. Even in this way the energy balance in the β disintegration is restored, thus safeguarding the Laws of Conservation of Mass and Energy and at the same time safeguarding the Law of Conservation of Electric Charge and Angular Momentum[7]. Moreover, we want to emphasize that referring to this 3rd neutral particle emitted with theβd, Pauli wrote: "it has spin ½ and its mass should be of the same order of magnitude of the electrons" [2]. That is, Pauli's opinion, this 3rd particle should be a fermion, with the mass of the electron, but without carrying electric charge: you could really think of an electron without electric charge, a neutral electron (e°).

DISCUSSION

It could be said that the same results reached by an e° are obtained similarly even with a neutrino(ν). And then: e° does not exist, this is an invention! The only known electrons are those carrying an electric charge: e^- and e^+. Yet even the ν, when suggested by Pauli, was an invention. Moreover the ν was a particle totally unknown, invented from scratch. Indeed, it was forced to introduce in Physics, *compulsorily*, a new family of particles, with their own characteristics, and with presumed properties quite different from the other elementary particles known at the time. The e°, instead, refers to one of the fundamental particles more widespread in nature, even if only those electrically charged are known. In addition, a not negligible result, with the e° it is not necessary to invent a new category of particles to be added to the Standard Model (SM), maintaining the symmetry of the SM and further simplifying it (according to the *reductionist* approach preferably adopted in Physics).

Yet, one might object: why the e° has never been detected, even accidentally? Electron decay products emerge continuously in the *colliders*! But it is clear: the crucial difference lies in the fact that we are talking about electrons without electricity charge, they do not interact with matter for all the same reasons neutrinos (ν_s) do not interfere.

In short, let's try to understand why the third particle emitted by the βd does not interact at all with the matter, so it has never been seen directly: 1) Being a leptonic particle, whether it matches the ν, or it is represented by e°, it follows that it is insensitive to the Strong Interaction (SI). 2) Being neutral particles (one of the primary requirements dictated by Pauli and Fermi), they are insenitive to Electro-Magnetic Interaction too. 3) Its very small mass makes it very weakly subject to Gravity Interaction (GI), although it is sensitive to such interaction. In this regard Feynman reminds us: "The gravitational activation between two objects is extremely weak: the GI between two electrons is less than the electrical strength of a 10^{-40} factor (or maybe 10^{-41})" [1]. Furthermore, considering that the GI action in itself is extremely weak, and considering that the particle in question travels at very high speed, hence it proves insensitive to the GI. 4) In addition, the 3rd particle emitted with βd^- is right-handed, just as the hypothetical $\bar{\upsilon}$ (or the possible $\bar{e}°$), so it is even more elusive, since it is also insensitive to Weak Interaction(WI). But even considering the respective particles, which are levorotatory, and therefore potentially sensitive to WI, they are essentially unaffected. First of all because the very high acceleration with which the 3rd particle is issued (both in βd_s and in the process of nuclear fusion) makes this particle travel undoubtedly with relativistic speed, reducing in this way the time the WI - and the GI - can exercise their action[7]. Moreover the WI action is notoriously weak, and quite *slow*($\approx 10^{-8}$ seconds) compared to the GI and SI, thus it is even more difficult that it may prevail on the E_{kin} the 3rd particles travels. The WI acts only on a short distance, which restricts even more the possibilities of such a particle to interact since, as it can be seen from our calculations, the maximum distance WI bosons can travel corresponds to $1.543 \cdot 10^{-15}$ [cm] for W^+ and W^- particles, and $1.36 \cdot 10^{-15}$[cm] for Z° particles [8]. So, even e°, despite being sensitive to the WI (since it is levorotatory), should be able to cross every *weak field* undisturbed.

Among the first to calculate this very low interope of the third particle was Hans Bethe, who, as Feynman told his Cal Tech students, first saw how the nuclear kilns worked within the stellar *core*. After several calculations, Bethe and Peierls wrote that it would be impossible to detect a ν, since this would pass, without interacting, through a lead wall of over 3500 light years [9]. It must be added that the very small cross section (σ) of such a particle causes it can more easily pass through the matter without interacting with it. In fact, the σ of ν "was found to have a value as small as 10^{-44} [cm^2] and brought Bethe and Peierls to conclude that one *obviously* would never be able to see a ν" [10]. This same value was confirmed in 1959 by Reines and Cowan [11], who revealed that the cross section (σ) of the electronic ν was equal to:

$$\sigma = (11 \pm 2.6)10^{-44}[cm^2] \quad (4).$$

It is really a very small cross section. In comparison, as Fermi tells us, the σ of slow neutrons, is between 10^{-24}[cm^2] and 10^{-21} [cm^2] [12]. In this respect Rasetti (the founder, together with Fermi of the School of Physics of *via Panisperna*) reminds us: "The ν can cross the matter very easily, that's why it has very little propensity to interact with matter, not only because it is very small, but also because it travels at very high speeds for which it remains near to atomic nuclei – with which it could possibly interact - for a time which is too short to allow a reaction. In order to have any effect, the ν_s in their movement should fully center the nucleus of an atom, however it is such a rare event that it is estimated that these strange creatures would be able to cross a wall of a few light years thickness without finding any obstacle "[13].

In our view, actually, there are two fundamental considerations that make us believe that the third particle of the βd may be a e°, instead of a ν:

1) A basic point might be that every time it was considered that ν had been detected, they were always *indirect detection* thanks to traces left by a *ghost particle* never directly identified. It is the detection of the impacts' effects, such as the Cherenkov Effect (*CE*), to prove the existence of ν, although it might be another particle to induce the *CE*[14]. In Nature the *CE* is only elicited by electrons. The electrons of the atmospheric molecules, hit by cosmic rays at high altitude, are accelerated at very high speed, so emitting those photons that give consistency to the so-called *Cherenkov Light*[15][16][17]. One thing we can be certain about the results of all *indirect detection* of the *v*: they only show the *traces* left by a *ghost particle*, that is, the 3rd particle released with the βd_s , a particle never detected *de visu*. The 3rd particle emitted with βd has been likened to a thief who has left clear and unequivocal evidence of his wrongdoing, but has never been seen in the face. In this regard Rasetti adds: "*Indirect evidence of an event*, is similar, to make a simile, to the discovery of a thief that nobody saw. If a person, returned home after a short absence, discovered that some furnishings are misplaced and some valuable object are missing, he would believe that at home entered a thief, even if the thief wasn't seen by anyone" [13]. I.e., it is only possible to see the effects of the actions of the thief but it is not possible to know his identity. This can be any person, since we do not know his face, the figure. So it is for the ν : we only know it is a particle that should meet certain requirements, such as those required by Pauli and Fermi. But that does not mean, in our view, that we have to accept - as a *dogma* – that the 3rd particle emitted with βd_s should be identified, unquestionably, with ν. In favour of our hypothesis, that in βd what is released is a e° instead of a ν (more precisely an ē° in βd^- and an e° in the βd^+), is the fact that the main detection techniques of ν all use the *CE*: a phenomenon *naturally* induced by electrons. So it's no wonder if it is still an electron, this time without electric charge, to induce the various *CEs* highlighted during the *surveys* carried out by Reines and Cowan[18], or at the Superkamiokande, or the Subdury Neutrno Observatory(SNO), or elsewhere.
2) The second reason that lets us perplex in considering ν as the 3rd particle of the βd is due to the value attributed to its mass. Initially the Standard Model had considered ν massless, just like a Weyl Spynor . Later, after the Superkamiokande experiment, also the ν was considered a massive particle, though having a mass much lower than the electron. This limitation was inferred from the observations of Supernova 1987A, for which it had been assumed that the mass of the electronic ν (ν_e) was <5.8 eV[19]. Why this limit? Because the neutrinos (ν_s) of this supernova arrived on Earth a few hours before the visible light; so they "must have traveled at a speed very close to that of light. Since lighter particles travel faster than heavier ones, scientists have concluded that the mass of ν is very small" [19]. Literature show these values have remained the same for the mass of the *v*. Accordingly, to compensate for the energy gap emerging from the disintegration of a single neutron, it would take about a hundred *v* to represent the third particle. There is something which is not working. Unless we admit that ν is much heavier, or even that it is another type of particle, however neutral, and conforms to Pauli and Fermi's requests. According to these requests, as mentioned above, we have to think of another particle, equally free of charge, but able to satisfy all three requests: the e°. With this particle, in fact, we would also meet the last property required by Pauli and Fermi for the 3rd particle of the βd: "that is a hypothetical electrically neutral particle having a mass of the order of magnitude of the electron mass"[3].

   Thus, either it is the *ghost particle*(*GP*), or the 3rd particle emitted with βd to match the ν, or it is the possible e°, one of the two should represent the lightest elementary particle in nature. In fact, Rasetti adds: “The ν is the smallest object human beings have ever met”[13]. Obviously this may also apply to e°. Indeed, Rasetti’s words make us think of another particle too, which has not been traced up until now: the so-called *Lightest Supersymmetric Particle* (LSP). In almost all Supersymmetric Models [20] [21], as Randall reminds us, "a superparticle will not decay in only a particle of the Standard Model. At the end of the decay there is another super particle (lighter): in fact, the superparticles appear (or disappear) always coupled. After the decay of a superparticle, there will be another super particle, more stable as lighter, that is the LSP: it is the one that cannot decay into anything else. Cosmicological considerations assume that the LSP does not carry any kind of charge (i.e. neither electric charge nor *weak charge* or color charge). Thus, the LSP will not interact with any of the Large Hadron Collider (LHC) detection devices. In practical terms, whenever a superparticle is produced and decayed, there will be a loss of *momentum* and energy transported beyond the detector (which does not notice the passage because there was no particle decay in the Standard Model). But the LSP's footprint is, precisely, an energy deficit"[22]. Even in this case, what is described with respect to LSP, is entirely consistent with the features attributed to the third particle of the βd, whether it is the presumed *v*, or another neutral particle such as, for example, the e°. The latter, moreover, could not be detectable in the LHC, as for the ν. In this respect the Randall states: "Though ν_s are very light and, consequently, largely to the energetic reach of colliders, it is not possible to detect them directly in the LHC, since they don’t have an electric charge: their interaction in detectors is extremely weak. The interaction of ν is so weak that even if every second $50{\cdot}10^{12}\nu_s$ come down from the sun, we had no idea before physical books told us. Although ν_s are so difficult to be observe, Pauli managed to hypothesize their existence: it was a 'desperate way out'. It remains to be resolved the issue of how ν can be experimentally identify. Since they don’t have any electric charge and interact so weakly, the ν_s escape the detectors without leaving any trace. Then how is it possible to affirm their presence in an experiment conducted at the LHC? The principle of conservation of *momentum*, such as energy, has never been experimentally refuted. Thus, if the *momentum* of the particles produced at the end of a certain event, measured in the detector of particles, is less than the *momentum* at the beginning of the event, this means that there has been another particle, or particles, that have escaped detection and have taken away the *momentum* missing in the assessment of the event. This kind of reasoning led Pauli to infer the existence of ν. In the same way today we are aware of the existence of particles that interact weakly, apparently invisibles. We still have the question of how to know exactly which particle it is, among the number of potential particles that could leave no trace in the detector. Based on the knowledge of processes authorized by the Standard Model (SM), we know that ν_s are good candidates to represent non-detected items. Reflecting on the possibility that new discoveries come out at the LHC, it is important to keep in mind this way of relating to the problem. What has been said about ν is also applicable to other possible new uncharged particles or having such a weak charge to be not directly detectable. In these cases to understand what the underlying reality is we can only combine theoretical considerations with experimental evaluations on the missing energy. This is the reason why the *airtightness* of the detectors, with the consequent recognition, though the most accurate, of all the collision *momenta* is so important. In short, even the LHC detectors, considered among the most reliable and sophisticated in the world, are not able to discern the dilemma of secure identity of the 3rd particle emitted in the process of βd.” [22]. Similarly, Randall points out that although the LSP does not leave any trace in the LHC, "its experimental apparatus will, however, result in a lack of energy and *momentum*. To get to the conclusion that a certain amount of *momentum* is lacking, it is used the same reasoning as in the case of neutrinos determination: the amount of missing *momentum* could be interpreted, ultimately, as the clue of an escaped superparticle, although nothing exotic has been produced. That is, when recording the event there will be a lack of *momentum* and energy, but their absence would be noticed: this is the proof of the existence of new particles"[22]. In short, it seems to us that the LSP is completely superimposable to the third particle of the βd, which in its turn should, in our opinion, coincide with the e°.

With reference to the LSP, Maiani writes: "An important motivation for the existence of Supersymmetry is that LSP is probably a stable neutral particle, with spin ½, and quite light, also referred to as *neutralino* " [23]. The LSP characteristics described by Maiani, seem to fit perfectly with e°'s, that is, a neutral, relatively light and stable particle: in fact the e° too, as LSP, cannot decay in any other particle.

Randall states: "It is remarkable that in a supersymmetrical model, different particles - such as bosons and fermions - can be exchanged with each other. Each particle has its own superparticle companion, characterized by the same mass and the same 'charges', but of opposite quantum-mechanical type. For example, the electron, which is a fermion, has a boson as supersymmetric companion which is called *s-electron*"[22].

As it can be inferred from its name, LSP must be characterized, first of all, by a strong *symmetry*. In this regard, it is very interesting to note that in our model, where we consider the LSP equivalent to an e°, this *symmetry* is even more pronounced, even *perfect*. And why? First of all because the examined particle, in our model, should have its own particle as supersymmetric companion. To be precise, the LSP, indeed the e° which, placed in front of a mirror identifies with its antiparticle; i.e. particle and antiparticle differ only in the spin, which are antiparallel:

$$\bar{e}° = \boldsymbol{C}(e°) = e° \qquad (5),$$

where $\bar{e}°$ is the neutral anti-electron and ***C*** (or *charge conjugation*) represents precisely the symmetry properties as expressed by this equation. If we want to describe Eq. (5) specifically referenced to LSP, we have:

$$\overline{LSP} = \boldsymbol{C}(LSP) = LSP \qquad (6),$$

where $\overline{\text{LSP}}$ is the anti-particle of LSP. In this regard, Penrose writes: "The operation that replaces each particle with its antiparticle is denoted by ***C***. A physical interaction that is invariant with respect to the replacement of the particles with their antiparticles (and vice versa) is called ***C***-invariant. The spatial reflection (specular reflection) is denoted by **P** (which stands for *parity*). Weak Interactions (Wis) are not invariant neither with respect to **P**, nor with respect to ***C***, but they are invariant with respect to the *combined* operation ***C*P** (= **P*C***). We can assume that ***C*P** is performed by an unusual mirror, in which each particle is reflected in its antiparticle. We note that ***C*P** operation causes a left-handed particle is reflected in its right-handed antiparticle"[24].

Such an interpretation that a particle like a fermion, neutral for accuracy, can identify with its antiparticle, derives from the last work of Ettore Majorana, titled: 'A Symmetric Theory of Electrons and Positrons'. In this work the Author writes: "We limit ourselves to the description of an essentially new theory for particles not endowed with an electric charge (neutrons and the hypothetical neutrinos)" [25].

From this work it seems significant to extrapolate the following equations:

$$U'(q) = RU(-q) \qquad (7),$$

with $R = i\,\rho_1\,\sigma_y$ and $R^2 = -1$. Majorana describes Eq.(7): "the behaviour of U under space reflection can be conveniently defined keeping into account that a simultaneous change of sign of U has no physical significance, as already implied by other reasons. Similarly, for a time reflection"[25], we have:

$$U'(q,t) = i\rho_2\,U(q,-t) \qquad (8),$$

where t indicates the time. The author continues: "It is remarkable, however, that the part of formalism which refers to U (or V) can be considered, in itself, as the theoretical descriptions of some material system, in conformity with the general methods of quantum mechanics. The fact that this reduced formalism cannot be applied to the description of positive and negative electrons may well be attributed to the presence of the electric charge, and it does not invalidate the statement that, at the present level of knowledge, equations related to the *anti-commutability relations* constitute the simplest theoretical representation of neutral particles. The advantage of this procedure, with respect to the elementary interpretation of the Dirac equations, is that there is now no need to assume the existence of antineutrons or antineutrinos "[25] meant as distinct antiparticles from the respective particles. Majorana adds: “In the place of massless quanta, we have particles with a finite rest mass and also for them we have two available polarization states. In the present case, as in the case of the electromagnetic radiation, the half-quanta of rest energy and momentum are present, except that they appear with the opposite sign, in apparent connection with the different statistic. They do not constitute a specific difficulty, and they must be considered simply as additive constants, with no physical significance. Similarly to the case of light quanta, it is not possible to describe with eigenfunctions the states of such particles. In the present case, however, the presence of a rest mass allows one to consider the *non relativistic approximation*, where all the motions of elementary quantum mechanics apply, obviously. The non relativistic approximation may be useful primarily in the case of the heavy particles (neutrons)” [25]. In this regard Edoardo Amaldi, he too, like Majorana, one of *the boys of via Panisperna* (as well as the first chief of the CERN in Geneve), writes: "In the theory proposed by Majorana, in which he proposes a new representation of the Dirac matrices $\Upsilon\mu$ (μ = 1,2,3,4), which has the following properties: 1)Unlike what happens in the original Dirac’s representation, in Majorana’s representation the 4 Υ_μ matrices have the same reality properties of the four-vector χ_μ≡r,*ict*; or, if one takes all the real space-time coordinates, associated with a pseudo-Euclidean metric, all four are real. 2) In this representation, Dirac’s equation relating to a free fermion is with real coefficients, thus its solutions are broken into a real part and an imaginary one, each of them meets separately the mentioned equation. But each of these real solutions, just as a consequence of its reality, has two very important properties: the first is that it gives rise to a quadruple vector with zero electric charge. It follows that the real solutions of Dirac’s equation must correspond to fermions free of both electric charge and magnetic moment. The second result of the reality of the fermionic field Ψ is that the corresponding field operator must be Hermitian, so that its degrees of freedom are halved and there is no more distinction between fermion and antifermion. Majorana in his work suggested that the neutron or neutrino, or both particles, were corpuscles of this type that is neutral corpuscles identified with the corresponding anticorpuscles. 3) Examing Dirac’s equation related to a fermion placed in an electromagnetic field, written in Majorana representation, it comes that to represent a load corpuscle it is just sufficient to take a Ψ combination of two real solutions. The fermionic field generates a quadruple vector with electric charge not exactly null due to the interference terms between the two real fields: it also enjoys the known properties for a scalar field that the conjugate field operator with respect to the charge (i.e. the operator which describes a particle of opposite charge to that of corpuscle considered) is obtained by applying the operator Ψ to Hermitian conjugation operator. There has not yet been a definite answer to the question whether Majorana corpuscles, i.e. particles characterized by the equality with own anti-particle, exist in nature, or do not exist at all"[26]. Weinberg states: “Dirac's theory claimed as his greatest triumph the prediction of the existence of the positron, the electron’s antiparticle, which was discovered a few years later in cosmic rays. From the point of view of Quantum Field Theory there is, however, no reason why a spin ½ particle should have a distinct antiparticle. In some theories half-integer spin particles are antiparticle of themselves, even though so far none of them has been found”[27]. Therefore it comes out that the neutral particle showed by Majorana (or Majorana's Spynor), which we think can be superimposed to an e°, is also *self-conjugated*, i.e. it identifies with its antiparticle (with the exception of the spin: antiparallel), as he shows with Eq. (7). If we want to represent the *Majorana Self-Conjugated Spynor*, we have:

$$\bar{S}_M = \boldsymbol{C}(S) = S_M \qquad (9),$$

where $\bar{S}_M$ is the antiparticle of the *Majorana's Spinor* (S_M).
Like the third particle emitted with the *βd*, as for the e° or supposed *ν*, the LSP has escaped up until now to any detection, so much so that according to Maiani "the observation of the LSP would complete our Knowledge of the Universe"[23]. This is also the case for the third particle of the *βd* (very probably an e° instead of a *ν*)[7], which should be diffused in the cosmos in a number of 10^9 or 10^{10} for each nucleon (just like in the case of photons [28][29].

CONCLUSIONS

Yet, even if the LSP coincides with the e°, there remains an unresolved problem, which already existed assuming the $\bar{\boldsymbol{\upsilon}}$ as the 3rd particle of the *βd⁻,* related to the ē° too. Please note that the problem arises because they are both antiparticles. And why is this a problem? Because they are dextrorotatory. On the contrary, the respective particles are levorotatory, therefore sensitive to WI and also the *weak charge* that permeates the Higgs field (HF)[30][31][32]. According to Standard Model(SM) all particles have a null intrinsic mass. The problem can be solved by postulating the existence of a *complex scalar field* permeating the space: the HF. Following Lee and Yang's insights [33], we now know that only left-handed particles would tend to interact, to mate with this HF, acquiring an energy at rest which is not null, which for almost all respects is analogous to a value of mass at rest, then describable as a parameter mass. As it is well known the mechanism just described is the so-called Higgs Mechanism(HM). The HM requires the intervention of a permeating particle the HF, i.e. the Higgs Boson(HB), which mass is between 125 and 126.5 GeV[34]. The maximum limit of the HB range, i.e. the maximum distance the HB can take, is slightly smaller than range of WI's bosons[8]. Our calculations show a very small range of HB action, exactly $9.8828\cdot10^{-16}$ [cm] [35]. The HM is valid for left-handed particles, in contrast $\bar{\upsilon}$ and ē° are right-handed, so they are insensitive even to WI's action. For the same reasons, since they are not sensitive to the *weak charge* (Dirac's particles are) *,* $\bar{\upsilon}$ and ē° cannot acquire mass through HM[22]. Yet it is now asserted that the *ν* is a massive particle, so this is the real enigma: how does $\bar{\upsilon}$ acquire mass(or for it the ē°, which in this model should coincide with the *$\overline{LSP}$*), and in what quantity? At this point, it seems necessary a new Physics, still to be understood, capable of describing in what ways, and through which mechanisms, an anti-lepton without electric charge, and insensitive to the weak charge (being right-handed) can equally acquire mass, without using HM, at least as it is currently described. Unless we think that there may be another type of HM, in this case interacting with neutral right-handed antileptons, so that even these can gain mass, and *without breaking the symmetry*. Under such circumstances the $\bar{\upsilon}$ temporary acquisition of mass, would *overshadow symmetry*. In this case, it would be necessary to understand whether those leptons can get mass through one Higgs Boson, or there are two distinct Higgs Bosons, one of which would interact selectively with right-handed leptons. Randall states: "We have no certainty about the precise set of particles involved in the HM. For example if the *breaking of the electroweak symmetry* was to be attributed to 2 Higgs fields, rather than to one. However, there are other models that hypothesize more complex *Higgs sectors*, with even more articulated consequences. For example: Supersymmetric models provide higher number of particles in the Higgs sector. In that case we would always expect to find a Higgs Boson, but its interactions should be different from those deducible by a model that includes only one Higgs particle "[22].
We have listed the various reasons why we find it much more congenial that the third particle of the *βd* is an e°, instead of a ν. So we discussed the reasons why the e° could represent the LSP. As we have shown through equations (5) and (6), the symmetry that should be implied in the LSP, besides expressing the principal and most peculiar property of that particle, it is also present in e°. These two equations are

identical: only the name of the represented particle changes. However, it seems to us most appropriate and natural to consider the LSP to be identifiable with the e°, as well as for the various reasons exposed during the work, without having to invent new particles: as in the case of the LSP itself, or as in the case of *ν*. However, the e° refers to one of the fundamental particles more widespread in nature, even if only those electrically charged are known. Moreover, as shown in Eqs. (5) and (6), both the e° and LSPs are characterized by a *mirror symmetry*, underlined by the presence of ***C*** (or charge conjugation) in this equation. What does it mean? It means that, for instance, the probable e° identifies with its antiparticle($\bar{e}$°); they are the same particle: one is the mirror image of the other, just as described by Majorana through Eq.(7). Namely the e° is a *self-conjugated* fermion: the mirror image shows the same particle, but with a spin rotating in the opposite direction. That is, the particle has always a rotating spin in one direction, and the so-called antiparticle, on the contrary, revolves in the opposite direction (just as when we see a rotating ball in front of the mirror: it is the same object).

In addition, the e° can be considered as a stable particle, since it could never decay into a lighter particle, similarly to what happens with LSP.

In short, since the LSP may correspond to an e°, the equation (6) may coincide with Eq. (5). Besides, bearing in mind that Equation (5) shows a *neutral self-conjugated particle*, that is particle and antiparticle are identical, with the only difference that the first is always left-handed (↓), while the second is right-handed (↑), we can simplify it further in the following way:

$$\downarrow e^\circ \equiv \bar{e}^\circ \uparrow \qquad (10).$$

As it can be seen, equation (10) shows a perfect symmetry: both when it refers to the represented particle, and when it refers to the underlying LSP, we think it can be identifiable with the e°.

REFERENCES

1) Feynman R.P,, “QED”, ©1985 by Richard P. Feynman; Adelphi ed.(Milano) 1989,164,183.
2) Pauli W., Letter to partecipants of the Conference in Tubingien(1930), Septiem Conseil de Physique Solvay, 6th December1930.
3) Fermi E., “Le ultime particelle costitutive della materia”, 22° Meeting Società Italiana per la Propensione delle Scienze(SIPS),Bari 13/10/1933;Proceedings SIPS ,Roma 1934,Vol.2,pag. 7-14.
4) Puccini A., “About the Zero Point Energy, Zero Point Mass, Zero Point Temperature and Zero Point Motion in the Subatomic World and Photonics”, Progress In Electromagnetics Research Symposium Proceedings, Suzhou, China, Sept. 12-16, 2011, 1169-1171.
5) Fermi E.,“Tentativo di una teoria dell’emissione dei raggi β”,La Ricerca Scientifica,1933,4,491-495.
6) Fermi E., “Tentativo di una teoria dei raggi β”, Il Nuovo Cimento,1934,11,1-19.
7) Puccini A., “Neutral Electron Instead of Neutrino: A New Beta-Decay Model“, viXra.org, Nuclear and Atomic Physics : 1706.0202
8) Puccini A., “On the Boson’s Range of the Weak Nuclear Force”, viXra.org, Nuclear and Atomic Physics: 1705.0351
9) Bethe H. and Peierls R., “The Neutrino”, Nature 1934,133,532.
10) Amaldi E., “Beta Decay Opens the Way to Weak Interactions”, Journal de Physique, Colloque C8, supplement au n°18,Tome 43, 1982,261-300.
11) Reines F.and Cowan C.L., “Free Antineutrino Absorption Cross Section”, Phys.Rev.,1959,113,237-279.
12) Fermi E., “Atomi Nuclei Particelle”, Boringhieri Ed.(Torino) 2009,137,130.
13) Rasetti F., www.cosediscienza.it/fisica/02_neutrino.htm
14) Puccini A., “Why Gamma Photons Induce Cherenkov Effect”, Progress in Electromagnetics Research Symposium Proceedings, Moskow, Russia, August 19-23, 2012, 343-347.
15) Cherenkov P.A., “Visible emission of clean liquids by action of ϒ radiation”, Doklady Akademii Nauk SSSR, 2, 451,1934.

16) Puccini A., “Uncertainty Principle and Electromagnetic Waves”, Journal of Electromagnetic Waves and Applications,2005,19,7,885-890.
17) Puccini A., “Quantum Mechanics Suggests that Photons with Different Energy Do Not Travel at the Same Speed”, Session 2P2: Electromagnetic Theory and Design on the Optical Dispersive Materials, Invisible Cloak and Photonic Crystals, Progress in Electromagnetics Research Symposium Proceedings , Marrakesh, Morocco, Mar. 20-23, 2011, 729-733.
18) Reines F. and Cowan C.L., “The Neutrino”, Nature, vol.178, 446-449, September 1,1956.
19) Mirizzi A., ”Neutrini e Supernovae”, Ithaca: Viaggio nella Scienza,2015,VI,72.
20) Volkov D.V., Akulov V.P. “Is the Neutrino a Goldstone Particle?”, Phys.Lett. B, 46,1,109-110,1973.
21) Wess J., Zumino B. “A lagrangian model invariant under supergauge transformations”, Phys.Lett. B, 49, 1, 52-54, 1974.
22) Randall L., “Knocking on Heaven’s Door”,© Lisa Randall 2011-2012;il Saggiatore ed.(Milano) 2012,256, 320-321,317.
23) Maiani L., “I prossimi obiettivi nella Fisica delle Particelle Elementari” in Menzinger F. “L’Italia al CERN. Le ragioni di un successo”, Cap.1.1, Publisher INFN Laboratori Nazionali di Frascati, 1995.
24) Penrose R., “The Road to Reality”, ©2004 Roger Penrose; RCS Libri Ed.(Milano),2005,638.
25) Majorana E. ,”Teoria Simmetrica dell’’Elettrone e del Positrone”, Il Nuovo Cimento,1937, 14, 171-184.
26) Amaldi E., “Ettore Majorana, a 50 anni dalla sua scomparsa“, Il Nuovo Saggiatore,1988,4,13-26.
27) Weinberg S. in “It Must Be Beatiful. Great Equations of Modern Science“, Granta Publications, London, ©Graham Farmelo,2002; Il Saggiatore Ed.(Milano),2005,347-351.
28) Weinberg S., “The First Three Minutes. A Modern View of the Origin of the Universe”, Mondadori Ed. (Milano),1977,44,65-66.
29) Puccini A., “The Missing Mass in the Universe May Be Represented by the Dynamic-mass of the Photons”, Session 3P1: Optics and Photonics, Progress in Electromagnetics Research Symposium Proceedings, Cambridge (Ma), USA, July 5-8, 2010, 816-818.
30) Englert F. and Brout R., “Broken Symmetry and the Mass of Gauge Vector Mesons”, Phys.Rev. Lett.,13,321-323,1964.
31) Higgs P.W., “Broken Symmetries and the Masses of Gauge Bosons”, Phys.Rev.Lett.13,508-509, 1964.
32) Guralnik G.S., Hagen C.R. and Kibble T.W.B., “Global Conservation Laws and Massless Particles”, Phys.Rev.Lett.,13,585-587,1964
33) Lee T.D. and Yang C.N., ”Question of Parity Conservation in Weak Interactions”, Phys.Rev 1956,104,254-258.
34) CERN Seminar, “Latest update in the search for the Higgs boson”, Geneve , 4th July, 2012; http://cms.web.cern.ch/ and http://atlas.ch/
35) Puccini A., “On the Higgs Boson’s Range”, viXra.org, Quantum Physics :1705.0250