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Beyond Standard Model: neutrino-antineutrino pairs in nuclear reactions of beta-decay and proton-neutron transmutation.

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Abstract

On examples of different beta-decay reactions, we show that the neutrino-antineutrino pairs should be added as necessary reagents to the equations of the decay reactions where a neutrino or an antineutrino is among the products of the reaction. In our models, quarks and leptons are all made of basic fractional +-e/3 charges. Transfer of basic charges between reagents forms the products of the reaction. We suggest that there is no direct conversion of u-quark to d-quark and visa versa. Each transmutation involves a transfer of basic charges from a neutrino to a quark so the structure of remaining charges in the neutrino is a new quark and the quark receiving the charges is an electron or a positron. We suggest that a neutrino-antineutrino pair should be added as an essential reagent into the equation of the reaction of production of a deuteron out of two protons in the proton-proton chain which is an essential part of the fusion chain of reactions.

1. Introduction

In [1], [2], we suggested that the "elementary" particles, such as quarks, an electron, and neutrinos are all spinning d\structures composed of basic elementary particles with fractional charges +e/3 and -e/3. These basic elementary particles have charge and mass properties but do not have any other intrinsic properties such as spin or magnetic moment. The mass of the basic elementary particles of charge +-e/3 was calculated [1] to be about 1/6 of the electron rest mass.

In [3], we expanded the number of spinning composite structures as the models of elementary particles listed in the Standard Model. In addition to the simplest composite structures with one or none basic elementary charge on the axis of rotation considered in [1], we suggested the composite structures with two or three elementary basic charges on the axis. We calculated form factors of these structures from the condition that the net electrostatic force on each charge located on the axis of rotation must be zero. In that list, we suggested two models of neutrinos: ν_2 composed of two +e/3 basic charges on the axis of rotation and two -e/3 basic charges revolving about the axis, and ν_3 composed of three -e/3 basic charges on the axis of rotation and three revolving +e/3 basic charges. In terms of numbers of positive and negative basic charges in the structures, ν_2 neutrino and its antiparticle $\bar{\nu}_2$ have the same $\left(\frac{+2}{-2}\right)$ composition and differ from each other in what basic particles (negative or positive) are on the axis of rotation. The same can be said about ν_3 and $\bar{\nu}_3$, both having the composition $\left(\frac{+3}{-3}\right)$. In our models, a neutrino and an antineutrino are different particles (not antiparticles of themselves).

We have also calculated axial electric potentials for different composite structures as functions of distance from those structures. It was shown in [4] that the electric potential of particles of negative total charge such as d-quarks (-e/3) and electron (-e) can be positive at small distances from the particle. For the u-quark (its total charge is +2e/3), it was shown that its axial potential at small distances from it can be negative, similar to a potential of a negative point charge. It was suggested that the origin of the strong interaction between quarks is the EM interaction. In [5], we have shown that axial electric potentials of neutrinos (of zero total charge) are not zero and might be not small at small distances from the particles, so the interaction of neutrinos with other particles (including other neutrinos) can be of EM origin. We can expect that due to EM interaction, neutrinos and antineutrinos can form stable pairs and structures if they come close to each other.

Analyzing the available results of different experiments on beta-decays, we came to conclusion that the neutrinos or neutrino-antineutrino pairs are essential components as reagents in all the beta-decay reactions where a neutrino or

antineutrino is among the products of the reaction, so the equations of different beta-decay reactions should be modified.
Examples of the beta-decay reactions are described in [6]. Below we give the interpretation of the decays in terms of basic charges in the model structures of elementary particles.

2. The inverse-β reaction

As described in [6], the inverse-β reaction was used to experimentally prove that an antineutrino takes part in the proton to neutron conversion reaction, with emission of a positron. The equation of the inverse-β reaction is given by the equation $\bar{\nu}_e + p \rightarrow e^+ + n$ (1)

If we write this reaction in terms of particle compositions and considering that $\bar{\nu}_e$ is $\bar{\nu}_2$ with a composition $\left(\frac{+2}{-2}\right)$, as suggested in [4], we can conclude that the equation of the reaction is a balanced equation, where the numbers of positive and negative basic charges are conserved through the reaction. A proton (duu) consists of one d-quark and two u-quarks. In our models, a d-quark composition is $\left(\frac{+1}{-2}\right)$, a u-quark is composed as $\left(\frac{+3}{-1}\right)$, so the proton composition is $\left(\frac{+7}{-4}\right)$. Similarly, the neutron (udd) composition is $\left(\frac{+5}{-5}\right)$. Hence, the inverse-$\beta$ reaction equation, written in terms of compositions of all particles, is

$$\left(\frac{+2}{-2}\right) + \left(\frac{+7}{-4}\right) \rightarrow \left(\frac{+4}{-1}\right) + \left(\frac{+5}{-5}\right) \tag{2}$$

This inverse-β reaction can also be written in terms of quarks and leptons, assuming that one of two u-quarks in the proton is converted into a d-quark, while the other u-quark and the d-quark in the original proton do not change (so they are spectators):

$$\bar{\nu}_e + u \rightarrow e^+ + d \tag{3}$$

In terms of suggested compositions of the particles, the inverse-β reaction (3) can be written as

$$\left(\frac{+2}{-2}\right) + \left(\frac{+3}{-1}\right) \rightarrow \left(\frac{+4}{-1}\right) + \left(\frac{+1}{-2}\right) \tag{4}$$

The equation shows that the inverse beta-reaction is just a transfer of one positive basic charge from the antineutrino to the u-quark. As a result, the u-quark becomes a positron, and the leftover of the antineutrino, with its remaining one positive and two negative basic charges, is a d-quark.

3. The reaction of beta-plus decay

This reaction is usually written as $p \rightarrow n + e^+ + \nu_e$, or, in terms of quarks and leptons, as

$$u \rightarrow d + e^+ + \nu_e\ . \tag{5}$$

This equation is very similar to the inverse-β reaction equation describes above, with the only difference that in addition to the d-quark and a positron, a ν_e neutrino is present in the products of the reaction. In our composite models, as shown in [5], neutrinos have significant non-zero positive or negative electric potentials at the proximity of the particles, so they might tend to form pairs. We suggest that in this case the $\nu_2\bar{\nu}_2$ neutrino-antineutrino pair might be available rather than an individual antineutrino $\bar{\nu}_2$. With the neutrino-antineutrino pair coming close to the u-quark, the pair is separated, one positive basic charge is transferred from the antineutrino $\left(\frac{+2}{-2}\right)$ to the u-quark $\left(\frac{+3}{-1}\right)$ which becomes a positron $\left(\frac{+4}{-1}\right)$, and the $\bar{\nu}_2$ without one positive basic charge is a d-quark which composition is $\left(\frac{+1}{-2}\right)$. The ν_2 as the leftover from the pair is thrown away unchanged. Hence, assuming that $\bar{\nu}_e$ is $\bar{\nu}_2$ with its structure $\left(\frac{+2}{-2}\right)$, equation (5) modified by inclusion of a neutrino-antineutrino pair is balanced now and can be written, in terms of positive and negative basic charges in the composite structures of the participating elementary particles as

$$\left(\frac{+2}{-2}\right)\left(\frac{+2}{-2}\right) + \left(\frac{+3}{-1}\right) \rightarrow \left(\frac{+1}{-2}\right) + \left(\frac{+4}{-1}\right) + \left(\frac{+2}{-2}\right) \tag{6}$$

$(\nu_e\bar{\nu}_e) \ + \ u \ \ \rightarrow \ \ d \ + \ e^+ \ + \ \nu_e$ (7)

In fact, the equation (7) describes the reaction of transmutation of a proton to a neutron. Notice that using our models of quarks and leptons, the transmutation process includes a neutrino-antineutrino pair on a reagent side and is described not as a direct conversion of a u-quark into a d-quark but as the conversion of antineutrino into a d-quark and the u-quark into a positron due to just one basic charge being transferred from one composite particle to the other.

4. **The reaction of beta decay** is usually written as

$n \rightarrow p + e^- + \bar{\nu}_e$ (8)

or, in terms of quarks and leptons, as

$d \rightarrow u + e^- + \bar{\nu}_e$ (9)

Writing equation (9) in terms of particle compositions of positive and negative basic +-e/3 charges we get

$\left(\frac{+1}{-2}\right) \rightarrow \left(\frac{+3}{-1}\right) + \left(\frac{+1}{-4}\right) + \left(\frac{+2}{-2}\right)$ (10)

We see that this equation is not balanced.

The equation will become balanced if a $\nu_3\bar{\nu}_2$ neutrino-antineutrino pair is included in the reaction on the left side:

$(\nu_3\bar{\nu}_2) + d \rightarrow u + e^- + \ \bar{\nu}_2$ (11)

If we write equation (11) in terms of content of the components of the reaction, it is

$\left(\frac{+3}{-3}\right)\left(\frac{+2}{-2}\right) + \left(\frac{+1}{-2}\right) \rightarrow \left(\frac{+3}{-1}\right) + \left(\frac{+1}{-4}\right) + \left(\frac{+2}{-2}\right)$ (12)

$(\nu_3\bar{\nu}_2) +$ d $\rightarrow$ u + e + $\bar{\nu}_2$ (13)

With a neutrino-antineutrino pair$(\nu_3\bar{\nu}_2)$ coming close to a d-quark, the pair is separated, two negative basic charges are transferred from the neutrino $\left(\frac{+3}{-3}\right)$ to the d-quark $\left(\frac{+1}{-2}\right)$ which becomes an electron $\left(\frac{+1}{-4}\right)$, the structure with remaining charges in the neutrino becomes a u-quark $\left(\frac{+3}{-1}\right)$, and $\bar{\nu}_2$ as the leftover from the pair is thrown away unchanged.

The examples of decay processes considered above using our models of quarks and leptons show that including the neutrino-antineutrino pairs as the reagents in the decay processes allows explaining the decay processes as the transfers of basic charges between the particles participating in the reactions. We suggest that the positive and negative basic elementary particles of charge +-e/3 are the basic elements of matter, they are not created anew and are not destroyed, they are present in any composite particle and can join in different structural arrangements to form other composite particles. For example, the beta-decay reaction described above is a conversion of a neutron into a proton, with emission of an electron and an antineutrino. The fact that an electron is not present as a component of a nucleus but is created in the beta-minus-decay nuclear reaction is consistent with our models of electron, u-quark, d-quark, and neutrinos. Basing on the assumption that the elementary basic charges are present in reagents of the nuclear process and re-arrange to form other structures (the products of the nuclear reaction), we suggested in [8] that the total numbers of positive and negative basic elementary charges should be conserved in any nuclear reaction.

Applying the principle of conservation of numbers of positive and negative basic elementary charges to the reactions of beta-decays, we can conclude that the equations should be changed to include neutrino-antineutrino pairs on the reagent side. The examples also show that, for example, the process of a proton to a neutron conversion can be explained as not a direct conversion of one of two u-quark in a proton to a d-quark but rather as a double conversion: due to a single basic charge transfer, a u-quark is converted to a positron and a neutrino is converted to a d-quark. This speaks in favor of our suggestion that there are no such separate types of the elementary particles as quarks and leptons. We suggest expanding the definitions of the types of elementary particles and consider that **quarks, electron-like particles, and neutrinos are all members of the same family of composite particles (quarks)** that can convert from one to another by transferring the basic elementary charges between the composite particles of the same family (quarks). Simple composite particles (quarks) as the member of the same family of particles can join in different combinations and form more complex viable particles such as mesons, baryons, and other particles.

Analyzing the near-field axial potentials of different composite particles [5], we can conclude that the strength of interaction is about the same in the structures of different total charge: 0 or +-e/3 or +-2e/3 or +-e. Therefore, we can suggest that the interactions between the spinning composite particles of the same family (that include quarks and leptons) are all based on the electromagnetic interactions between the basic charges of the composite particles consisting of those basic elementary charges. As a result, both the strong and the weak interactions between the

members of this expanded quark family can be explained as originating from the electromagnetic interaction in or between the composite particles, be they charged or neutral.

Let us consider one more example of a decay – the decay of a muon to an electron, an electron antineutrino, and a muon neutrino. This decay is considered in [7] as an example of application of the rules used in the Standard model for explaining different nuclear reactions. We will apply the stated above principle of conservation of numbers of positive and negative basic charges to show that the unbalanced equation of this reaction becomes balanced if we add the neutrino-antineutrino pair to the reagent side of the equation, as we did in the decay equations described above. We consider an electron, with the total charge of -e, to be a spinning composite structure made of one positive basic charge +e/3 and four negative basic charges -e/3 so its composition is $\left(\frac{+1}{-4}\right)$. A muon, with its charge of -e, might be a spinning composite structure with 2 positive basic charges on the axis of rotation and 5 negative basic charges revolving about the axis, as considered in [3], so its composition is $\left(\frac{+2}{-5}\right)$. Similarly, we assumed above that $\bar{\nu}_e$ is $\bar{\nu}_2$, the composite structure with 2 negative basic charges on the axis and 2 positive basic charges revolving about the axis, so its composition is $\left(\frac{+2}{-2}\right)$. We can assume that ν_μ is the neutral structure with 3 negative basic charges on the axis and 3 positive basic charges revolving about the axis, considered in [3], so its composition is $\left(\frac{+3}{-3}\right)$.
The equation of muon decay is usually written as

$$\mu^- \rightarrow e^- + \bar{\nu}_e + \nu_\mu \qquad (14)$$

If we write it in terms of contents of corresponding composite structures, it is obviously unbalanced:

$$\left(\frac{+2}{-5}\right) \rightarrow \left(\frac{+1}{-4}\right) + \left(\frac{+2}{-2}\right) + \left(\frac{+3}{-3}\right) \qquad (15)$$

But if we add the neutrino-antineutrino pair $(\nu_2\bar{\nu}_2)$ at the left (the reagent) side of the equation, as we did in other decay reactions described above, the equation becomes balanced:

$$\left(\frac{+2}{-2}\right)\left(\frac{+2}{-2}\right) + \left(\frac{+2}{-5}\right) \rightarrow \left(\frac{+1}{-4}\right) + \left(\frac{+2}{-2}\right) + \left(\frac{+3}{-3}\right) \qquad (16)$$

We suggest that the muon decay equation should be written as

$$(\nu_e\bar{\nu}_e) + \mu^- \rightarrow e^- + \bar{\nu}_e + \nu_\mu \qquad (17)$$

(Note that we can conclude that, since the antineutrino is present at the left and at the right, it participates in this reaction only because the neutrino ν_e needed for this reaction is available not individually but as a part of the $(\nu_e\bar{\nu}_e)$ pair. This is consistent with the reverse muon decay reaction $\nu_e + \mu^- \rightarrow e^- + \nu_\mu$).

As shown in [5], neutrinos and antineutrinos, as particles of zero total charge, can have a non-zero electric potential, and that can result in electromagnetic interaction between the particles of zero total charge. We suggested in [5] that those neutral neutrinos and antineutrinos, when they occur at close distance from each other, can attract each other and form neutral compositions, neutrino-antineutrino pairs. Each pair, being neutral, has a positive electric axial potential at one end and a negative one at the other end of the pair. The pairs can come close to each other, attract each other, and form different neutral compositions of these pairs – linear, two-dimensional (like rings) or three-dimensional (like buckyballs). Neutrinos and compositions of them might constitute a bank of bounded basic elementary charges. These neutral compositions might be present everywhere in space, form networks that can be polarized by electric and magnetic fields and be available for different reactions between the composite particles.

One of very important reactions where the neutrino-antineutrino participation might be crucial is the reaction of conversion of a proton to a neutron as a part of the proton-proton chain in the nuclear fusion process. Neutrons are needed to form ${}_1^2H$ nuclei as a part of the fusion chain of reactions. The reaction of conversion of two proton to a deuteron is commonly shown as

$${}_1^1H + {}_1^1H \rightarrow {}_1^2H + \beta^+ + \nu_e \qquad (18)$$

which in fact is equivalent to conversion of one proton to a neutron with the resulting neutron bonding then to another proton and forming a deuteron nucleus. The reaction of converting a proton to a neutron can be described as conversion of one of two u-quarks of a proton (duu) into a d-quark with the resulting structure be a neutron (udd), and that reaction is the reaction of beta-plus decay described in terms of basic charge contents of the composite structures

in our example of a beta-plus decay, equations (5), (6), and (7) above. If we add the neutrino-antineutrino pair to the reagent side of the equation of the reaction of conversion of two protons into a deuteron, the reaction can be described as follows: if a $(\nu_2\bar{\nu}_2)$ pair comes close to a u-quark $\binom{+3}{-1}$ of one of two protons, the pair is separated, the u-quark takes one positive basic charge from antineutrino $\binom{+2}{-2}$ and becomes a positron with the composition $\binom{+4}{-1}$. The leftover $\binom{+1}{-2}$ from the antineutrino is a d-quark, and the neutrino ν_2 as a leftover from the $(\nu_2\bar{\nu}_2)$ pair is thrown away unchanged. Then the newly formed neutron combines with the second proton to form a deuteron.
We suggest that the $(\nu_2\bar{\nu}_2)$ neutrino-antineutrino pair is a missed participant in the reaction (18), so the reaction (18) as a part of the fusion chain of reactions should be written instead as

$$(\nu_e\bar{\nu}_e) + {}^1_1H + {}^1_1H \rightarrow {}^2_1H + \beta^+ + \nu_e \qquad (19)$$

The rate of this reaction can depend on many factors, and one of them might be the availability of the $(\nu_2\bar{\nu}_2)$ pairs at the location where the reaction occurs. If this is the case, changing this factor might help to regulate the rate of the fusion reaction.

Conclusion.

In our models of composite particles as consisting of just two types of elementary basic charges, +e/3 and -e/3, the axial electric potential of any elementary particle as a function of a distance from the particle differs from the potential of a point chargeof the toa=tal charge of the particle. The electric potential of neutrinos is not zero at close distances from neutrinos. As we suggested in our previous paper, the total numbers of basic charges of each of the two types are conserved in any nuclear reaction. That means that the basic elementary charges present in the reactants can join in different combinations to form the products of the reaction. On examples of different beta-decay reactions, we show that the neutrino-antineutrino pairs should be considered as necessary components of the reactions. We suggest that in the proton-neutron transmutation reaction a transfer of a positive basic elementary charge from an antineutrino to a u-quark converts that quark into a position, and the antineutrino with the remaining basic charges is a new d-quark. A similar process happens in the neutron-proton transmutation. We suggest that neutrino-antineutrino pairs are essential reagents in the reaction of production of a deuteron out of two protons in the proton-proton chain which isan essential part of the fusion chain of reactions.

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