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A STUDY OF THE NEUTRINO MASS BY THE HEISENBERG UNCERTAINTY PRINCIPLE

Physics

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ABSTRACT

The Heisenberg Principle of Uncertainty, which set limits for what we can know about the atomic sub-world. Looking at the distance atoms, we enter the quantum reality world at this level. There is no substance of what we think of as very small particles. A different possibility for reality only when the wave is observed, the wave collapses into the outcome of one perspective, and ends up seeing it as a physical part, then we see the material world as we see it is not the true nature of reality, but rather possibilities. An interaction between the observer and the "physical" thing causes uncontrolled changes in the observed system, causes the discontinuous changes characteristic of atomic and subatomic processes, and the result is that in each experiment takes place to assign some numerical quantities the conversion of the other's knowledge into an illusion.

This research reviews neutrino, and the role that these particles play, and how its mass is central to life and the universe, Evidence indicates that neutrino from non-terrestrial forms of matter do not naturally exist on Earth, It is virtually the most impenetrable particle, penetrating almost everything, and is not affected by any of the forces acting within the dense substance.

The principle of uncertainties is also evident in the neutrino mass, This is what we are studying in our research. This is a comparison between the probability of the two outcomes and the accuracy that can be measured.

KEYWORDS

Introduction:-

A study of the neutrino mass from aquantitative perspective and the heisenberg principle, where he says, the more diligence in obtaining more accurate information about the neutrino mass, the greater our need for accuracy, as it is impossible for any experiment to defeat the principle of suspicion or to reinforce additional information that enables more knowledge than quantum mechanics allows [1].

This natural fact is subject to the equation written below, which is controlled by planck's constant, and the error is indetermining the product of the variances ,and not only in one of them.

$$\Delta X . \Delta P \geq \frac{\hbar}{2} \quad (1)$$

And from the result of multiplying the previous asymmetry, positive effects of this principle appeared in some important issues, including proving that the electron is unlikely to exist in the nucleus [2].

Neutrinos are the most common froms of matter in the universe, and they are also the most mysterious. It is not electrically charged, little or no mass, as it moves at a speed close to the speed of light. Scientists believe that neutrinos play a major role in the formation of the universe and are now considered one of the true primary particles of matter. In the late twenties, physicists faced a problem during their study of beta decay emitted from the nucleus of the atom during beta decay and by the change of a neutron to a proton. But experiments have proven otherwise, it has come out with a beta that carries a large amount of energy and is a better beta to measure than its slow-moving colleague Aulberton, and violated the basic law in building energy. Austrian physicist pauli took a bold step by suggesting that there is a particle responsible for this reaction and the theory was simple [3]. If three particles ware involved in the energy released from the dissolution in many ways. For purely theoretical reasons, this particle proposed by pauli is not clear-cut , and Erco Fermi (Neutrino) called him and included in his theory the dissolution of beta. The neutrino entered practical life with Clydekuan- and Fred Daines at the Los Alamos National laboratory.

Theory Of Beta Decay :

Radiations β are released as a result of the transformation of both protons and neutrons inside the nucleus according to the formula:

$$n \rightarrow \mathrm{p} + \beta^{-} + \nu$$

$$\mathrm{p} \rightarrow n + \beta + \bar{\nu}$$

As for the electronic families, it is done according to the formula;

$${}^{\mathrm{A}}_{\mathrm{Z}}\mathrm{X}(\text{His mother}) + \mathrm{e}^{-} \rightarrow {}_{z-1}^{\;A}Y(\text{His son}) + \bar{\nu}$$

Based on these transformations, Fermi was able in 1954 to devise the complete theory to describe the beta transformation and the interpretation of the spectra of beta rays and the half –lives of both of them. Likewise, I dealt with the problem using relative quantum mechanics and Fermi theory was developed according to the following assumptions :

1-Fermi hypothesized that an analysis result from a type of interaction between nucleons,electrons, and neutrinos. This reaction is of a new type, as it differs from electrical, gravitational, or nuclear reactions. Then it was called Weak Interaction.

Weak strength is one of the fundamental forces of nature that is responsible for the dissolution of radioactive materials for neutrinos and other particles.

The interaction of neutrinos or their antiparticles in the bubble chamber of Gurgameli in cern are called neutral current reaction because it occurs through the neutral particle and not a charged particle.

Also, this reaction has a very small range and is located within the limits of nuclear power. It also depends on the amount of spin motion of its angular or linear motion [4]

2 - Since the electron and neutrino cannot both exist within the nucleus, therefore these particles must be produced during the transformation.

According to Fermi's theory, the causes of a nucleon's transformation into a particle β and neutrinos is the presence of an interaction between these three particles [5].

Thus, the transformation of β is an interaction between three particles and not an interaction between two particles. As the masses of these particles are small, then it is appropriate to use the laws of Relativistic Mechanics, because the speeds of these particles will be close to the speed of light.

We will tackle the problem using quantum mechanics

Where the transition from one nuclear level to another can be expressed by the probability of transfer in a unit of time (p) where:

$P = \frac{2\pi}{\Psi} |\Psi_f^* \mathrm{Hop}\ \Psi_i d\upsilon|^2 \frac{dN}{dE}$ (2)

Where Ψ_f and Ψ_i are the wave functions for both the final and primary levels, respectively.

Hop ≡ a hamton effect, which is the special reaction card that caused the transition.

$d\upsilon$ ≡ a small size item

$\frac{dm}{dE}$ ≡ The number of levels per unit of energy or is the energy density

For finish levels / volume unit.

The amount ($\int \Psi_f^* \mathrm{Hop} \Psi_i d\upsilon$) is known as the expected value of $H_{if}$where

$H_{if} = \int \Psi_f^* \mathrm{Hop} \Psi_i d\upsilon$ (3) From equation (2), the probability of N (p) dp can be expressed as a particle β release at the time unit, so that it carries a quantity of movement between p and p + dp in the following relationship:

$N(P)dp = \frac{2\pi}{\hbar} |H_{if}|^2 \frac{dN}{dE_B}$ (4)

Now we have to determine the amount, of $\frac{dN}{dE_B}$ using statistical mechanics[6].

The total number of levels that can be tolerated by a particle that releases with the quantum motions, p and d + d, is proportional to the size of a spherical shell in the space of the volume of motion. So that the diameter of p is the thickness of dp, that is, at levels proportional to $4\pi p^2 dp$

According to the principle of non-determination, we find that

$\Delta x \Delta p \cong \hbar$ (5)

Therefore,

$\Delta x \Delta y \Delta z \Delta p_x \Delta p_y \Delta p_z = \hbar^3$ (6)

Wave functions are independent of time

$\phi_\upsilon = e^{i p_B \cdot \frac{r}{\hbar}}$ (7)

As we note from the previous equation, this is astrong confirmation of what is known as the great principle of precision in the field of quantum physics [7].

The principle of uncertainties is also evident in the neutrino mass

Neutrino mass

The question about the hidden mass of the neutrino is closely related to the hypothesis of the vibrations of the neutrino. Some scientists have made a distinguished experiment in this field that shows that the electron-neutrino spends a lifetime of its life in the form of a neutrino-muon and even a neutrino-tau, which prompted the scientists to conduct principles of new science that is the appropriate mechanics. To this square this experience which resulted in the existence of a mass of a neutrino This very small mass does not exceed one in ten million parts of the proton mass. What we studied in this research is to compare the probability of the two outcomes and the accuracy available to measure them [8].

It is a quantum phenomenon referred to by Ponticorvo, which says that a neutrino that originates from a lepton with a flavor like an electron, a muon or a tau may appear upon a measure that has different quantum flavors and the possibility of measuring a specific flavor of a neutrino changes periodically during the spread of the neutrino. The Neutrino fluctuation is of importance in both theoretical and experimental physics, as viewing this characteristic confirms that the neutrino has a mass greater than zero, and this contradicts the standard model of particle physics.

Neutrino Oscillation is a dilemma that emerged due to the difference between measuring the amount of neutrinos generated from electrons in space coming from the sun and their measurement on the ground, as those measurements differed from the measurements coming from the Stanfrod accelerator. Or Tao, and since the difference in mass between the origin of the original neutrino, when moving in space, it changes its flavor periodically and fluctuates successively due to the quantitative laws of the Schrödinger function

$|\upsilon_e\rangle = U_{e1}|\upsilon_1\rangle + U_{e2}|\upsilon_2\rangle + U_{e3}|\upsilon_3\rangle$ (8)

Neutrino reaction

Neutrino interacts with matter by interacting with weak current because the neutrino originally interact with all particles, including the neutrino itself, through the weak nuclear force,i.e. interacts weakly with the material.

It represented a weak reactive current J^μ which is about:

$J^\mu = \sum_e \alpha_\iota^t \tilde{\sigma}^\mu \nu_{e\iota}$ (9)

Where they represent α_l leptons charged $\tilde{\sigma}\tilde{\mu}$ ($\alpha = e, \mu, \tau$) Matrix represents pauli $\boldsymbol{\nu}_\iota$ Neutrino represents

(the neutrino function)

$J^\mu = \sum_{\mathbf{e}} (\nu_{e\iota})^\dagger \tilde{\sigma}^\mu \nu_{e\iota}$ (10)

These currents can be represented by Feynman diagrams. The state of the charged current is the beta dissolution of the neutrino interaction with leptons.

$\pi^- \rightarrow e^- + \nu_e^-$

$\pi^- + \nu_e^- \rightarrow e^-$ (11)

For neutral current reactions, the interaction of a neutrino with a neutrino with a neutrino

$\nu_{\iota 1} + \nu_{\iota 2} = \nu_{\iota 1}^- + \nu_{\iota 2}^-$ (12)

The Impact of Mikhailov Smirnov Molkenstein MSW

The effect of neutrino interaction and diffusion within material was discovered by these scientists, so it became known as the effect of

MSW. Because of the oscillation of the neutrino in a vacuum, it is the wave function of a neutrino in a vacuum that changes if the neutrino enters a physical medium (Lagrange function)

$L = -2\sqrt{2}G_f g_{\mu\upsilon} J^{\mu} J^{\upsilon t}$ (13)

Where G_f the Fermi constant of the weak reaction

Lagrange function can be rewritten to inrteract with (12)and (13)

$\square = -2\sqrt{2}\, G_f g_{\mu\upsilon}(e^t_\iota \tilde{\sigma}\upsilon_{e\iota})(\upsilon^t_{e\iota}\tilde{\sigma}^{\upsilon} e\iota) = -2\sqrt{2} G_f g_{\mu\upsilon}(e^t_\iota \tilde{\sigma} e\iota)(\upsilon^t_{e\iota}\tilde{\sigma}^{\upsilon}\upsilon_{e\iota})$ (14)

And the full formula is

$\square = -\frac{1}{4}W_{\mu\upsilon}W^{\mu\upsilon} - \frac{1}{4}B_{\mu\upsilon}B^{\mu\upsilon} - \frac{1}{4}G_{\mu\upsilon}G^{\mu\upsilon} + \bar{L}\upsilon^{\mu}\left(i\,\partial_\mu - g\frac{1}{4}\tau W_\mu - \acute{g}\frac{y}{4}B_\mu\right)L + \bar{R}\upsilon^{\mu}\left(i\,\partial_\mu - \acute{g}\frac{y}{2}B_\mu\right)R + \left|\left(i\,\partial_\mu - g\frac{1}{4}\tau W_\mu - \acute{g}\frac{Y}{2}B_\mu\right)\phi\right|^2 - V(\phi) + (Y_d \bar{q}_L \phi d_R + Y_u \bar{q}_L \phi^* U_R + Y_e \bar{\iota}_L \phi e_R + \text{h.c.}$ (15)

Where $\mathcal{L}$ denotes left fermion, lepton and quark, $\mathcal{R}$ right fermion.

neutrino mass in grand unified models :

Here we will study the mass of the neutrino in the theory of grand unified, especially in the theories of mechanisms See saw mechanism and has three types and SU (5) L-R Symmetric under and SO (10) Symmetric outer other that lead to the mass of neutrino majorana and this is what is achieved in the theory of symmetry [9].

The see saw mechanism :

The see saw mechanism is a general model used to understand the relative sizes of the observed neutrino, lighter than an electron volt, compared to those quarks and leptons, which are millions of times heavier. There are several types of see saw mechanism. We will take the first type of see saw mechanism as an example of the neutrino mass. Evidence has been obtained from many nuclear interactions with the presence of a neutrino mass and each scenario requires a certain range of mass differences, which does not allow to measure the mass accurately, resulting from an inaccuracy in the amount. Some other experiments also prove that a neutrino does not have a mass, as there is no physical particle that moves at the speed of light, meaning that any particle that has a mass has no ability to move at the speed of light and since the neutrino has a mass if it cannot move at the speed of light, and in the case of movement at the speed of light, the mass They are non-existent or constant, but in the case of the neutrino, we find the neutrino travels between three flavors, and each flavor has a mass that differs from the other, that is, there is a change in mass over time, and this is what is called the Oscillation of the neutrino [10]ز

THE I see saw mechanism

Right neutrino that allows an additional term to be inserted into the Yukawa reaction

$\mathcal{L}^{\nu}_{y} = Y_D \bar{\ell}_L \sigma_2 \Phi^* \nu_R + \frac{M_R}{2}\nu^T_R C\nu_R + \text{h.c.}$ (16)

The Yukawa reaction is known as the quantum numbers of the right neutrino that the term major lepton mass number carries, and it allows the Yemeni neutrinos in accordance with the consistency of the theory scale. The interaction between Yukawa, which results in couples with the left and right neutrinos after breaking the automatic symmetry, as usual, the matrix of the mass (Dirak) deuteric neutrino so that the full comprehensive range is given[11].

$m_D = Y_D \nu$ (17)

$\mathcal{L}^{\nu}_{M} = m_D \bar{\nu}_L \nu_R + \frac{1}{2}M_R \nu^T_R\, C\nu_R + \text{h.c.}$ (18)

We can rewrite the equation in the range of two components forming spindles

$\nu \equiv \nu_L + C\bar{\nu}^T_L$ (19)

$N \equiv \nu_R + C\bar{\nu}^T_R$ (20)

Using the properties of the responsible conjugation matrix which can be found in any quantity books.

$C^T \nu^{\mu} C = -\nu^T_{\mu}\, , C^T = -C$ (21)

We get the following relationship

$\bar{\nu}N = \bar{\nu}_L \nu_R + \bar{\nu}_R \nu_L = \bar{N}_\nu$ (22)

$\bar{N}N = \nu^T_R C\nu_R + \text{h.c.}$ (23)

Type I see saw mechanism	Type Ⅱ see saw mechanism	Type Ⅲ see saw mechanism
$\boldsymbol{m^{light}_{\nu} = -m_D \frac{1}{M_R} m^T_D}$	$m_\nu = Y_\Delta \frac{\mu v^2}{M\Delta^2}$	$\mathbf{M_\nu = -Y^T_T \frac{1}{M_T} Y_T v^2}$

$\nu\bar{\nu} = \nu^T_R C\nu_L + \text{h.c.}$ (24)

So that Lagrange complete with kinematic terms would be:

$\mathcal{L} = \frac{1}{2}\left[i\bar{\nu}\gamma^{\mu}\,\partial_\mu \nu + i\bar{N}\gamma^{\mu}\,\partial_\mu N - M_L\bar{\nu}\nu - M_R\bar{N}N - m_D\bar{\nu}N - m_D\bar{N}\nu\right]$ (25)

We now summarize the mass in the above equation as the matrix of mass

$$\mathcal{L}^{(\nu)}_{m} = \frac{1}{2}(\bar{\nu},\bar{N})\begin{pmatrix} 0 & m_D \\ m^T_D & M_R \end{pmatrix}\begin{pmatrix} \nu \\ N \end{pmatrix} + h.c, \qquad (26)$$

ass matrix of neutrino fields ν and N

$$\begin{pmatrix} 0 & m_D \\ m^T_D & M_R \end{pmatrix}$$

Where $m_D = Y_D \nu$ is the diameter of this matrix by converting the similarity using the orthogonal matrix

$$\begin{pmatrix} 1 & \epsilon \\ -\varepsilon^T & 1 \end{pmatrix}$$

Where $\epsilon = \frac{m_D}{M_R}$ is this correct enumeration with conditions smaller than the order ϵ^2 , it gets The mass matrix of the light neutrino to be

$m^{light}_{\nu} = -m_D \frac{1}{M_R} m^T_D$ (27)

This is the original swinging formula called Type One

THE II see saw mechanism

$\mathcal{L}_\Delta = Y^{-1}_\Delta \ell^T C\sigma_2 \Delta_L \ell + h.c.$ (28)

Neutrino mass

$m_\nu = Y_\Delta \frac{\mu v^2}{M\Delta^2}$ (29)

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THE III see saw mechanism

The exact same way as before in the first type and the second type gets a swing mechanism

$$\Delta\mathcal{L}(\mathrm{T_F}) = \mathrm{Y_T}\ell^{\mathrm{T}} C\sigma_2\vec{\sigma}.\vec{T}_F\Phi + M_T\vec{T}_F^T C\vec{T}_F \quad (30)$$

$$\mathrm{M}_\nu = -\mathrm{Y}_\mathrm{T}^\mathrm{T}\frac{1}{\mathrm{M_T}}\mathrm{Y_T}\nu^2 \quad (31)$$

Table (1.1) shows the weighting mechanism

Table (1.1) The see saw mechanism

his classification according to mass (which is still largely unknown!) However, quantum mechanics prohibits us from this classification of neutrinos, in fact, the neutrino of a specific block type is a mixture, or superposition of the three weak interaction neutrinos. Each block type neutrino is a specific mixture. And so it is, a mass type neutrino is a mixture of weak reaction type neutrinos, and a weak reaction type neutrino is likewise a mixture of mass type neutrons. (The place where this analogy is disturbed is that you cannot use a more accurate classification and this inability to classify a neutrino as a specific block type and a specific weak interaction type at the same time, for example an "Uncertainty Principl" similar to the strangeness That leads to the impossibility of knowing the exact location of a particle and knowing its exact velocity simultaneously, because you knew one of these quantities specifically, you will not have a clear knowledge of the other quantity[12].

This issue is not specific to neutrinos. It occurs with some other particles as well. But it is especially important for the behavior of neutrinos. Neutrino spreads through space but from the inside, it is three different mass types that travel at different speeds very very little, and all are speeds very close to the speed of light. The reason for this is that the speed of the body depends on both its energy and its mass.

Discussion:

We do not know anything of specific accuracy. Heisenberg described that brilliant result of the principle of indeterminacy, and the meaning of this principle is that whatever the tightness and the development of our methods of measurement, we will not be able to reach a complete knowledge of the nature around us, if the basic laws of physics prevent any world whatever it may be Ideal conditions for obtaining completely confirmed information, what does a policy naturally contains a degree of inaccuracy that cannot be overlooked, because it is a natural law. This is the operative of the principle of indeterminacy and this is the theory that Heisenberg guided to and which made clear to man an important characteristic of the properties of this universe.

As quantum mechanics requires that neutrinos live longer or less than this age, the fact that the mass of the neutrino does not reach zero is the main reason behind the great strangeness of the neutrino and the world of quantum mechanics where neutrinos particles take near-wave oscillations while traveling through space, and hence are It is a wave with variable probability.

Conclusion :

Quantum mechanics is a new field where old methods no longer work. Therefore, new methods were developed, by searching directly for something entirely new and not persisting in research within the limits of known physics, because it would not achieve success, which led to the emergence of new principles and the most important of which is the principle of distrust and stipulates that it is not possible to study the material without changing its nature and this It is Heisenberg's distinctive vision.

The neutrino is this ghostly particle that is still the focus of study until today's history because there are many facts that have not been reached, such as the actual mass of this particle, as it is not possible to obtain an accurate determination of the mass, but rather a minimum for the accuracy with which this amount of "mass" can be known. Determining the values of neutrino masses is one of the major challenges that particle physicists face in our current channel, and this leads us naturally to a larger question: What is the nature of the mass itself ?

Recommendations:

We must start in the broad practical study in a highly accurate and expanded manner in studying the neutrino mass and trying to make the mass formulas accurate enough, to be able to define error measurements in the form of a representation or a graph.

If we can support this study, it will seriously change and influence our understanding of the subatomic world. The applications of the principle of distrust are truly formidable and the mass of a neutrino is an example of this. Similarly, neutrino applications, including obtaining high energies, are used in many fields such as medicine and energy saving in a modern way.

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