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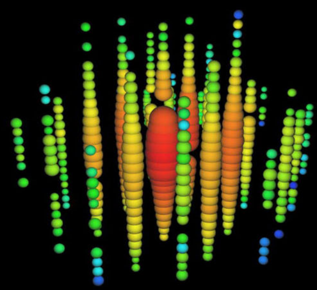

About Quantum-Mechanicall Nature of Nuclear Forces and Electromagnetic Nature of Neurinos

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and

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Neutrinos

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Part I

Introduction

Chapter 1

The main principle of natural sciences

1.1 The Gilbert principle

It may seem to our contemporaries, the level of education of which corresponds to the development of science in the XXI century, that medieval science was generally concentrated in theology, astrology and alchemy. But this is not the case. The Middle Ages was a time of the development of the foundations of modern science.

Outstanding medieval scientist William Gilbert (1544-1603) introduced into scientific use the notion of electric and magnetic fields, taking the first step to understanding the nature of electromagnetism. He was first who tried to explain the nature of Earth's magnetic field.

But it seems that the most important of his contribution to science is the creation of postulate, which became the main principle of modern natural science studies [1].[1]

Gilbert principle is stated simply: all theoretical constructs that claim to be science must be verified and confirmed experimentally.

What reasons causes the necessity to devote so much attention to this historical issue?

It seems that among our contemporary scholars there is no one who would have objected to Gilbert's principle.

However, in the twentieth century a number of scientific constructs was created that have been accepted by the scientific community and still are dominant in their fields of knowledge, but at that they do not satisfy this principle.

It should be emphasized that the vast majority of modern theoretical models adequately and accurately reflect the properties of matter and the laws of nature,

[1]It is possible to assume that the idea of this principle, as they say, was in the air among the educated people of that time. But this principle was worded and came to us thanks to W. Gilbert.

their creation are conducted in full compliance with the Gilbert's postulate.

But in some cases, models developed by theorists at XX century were wrong [2].

Let us consider some problems of physics of elementary particles and their compliance with the Gilbert postulate.

1.2 Substitution of the Gilbert principle

How can one replace the Gilbert principle in order to the speculative theoretical model look as if it having scientific proof?

Drawing up tables as a method for classifying objects of research

A typical example of this is the Gell-Mann quark model, which is generally considered as a basis of modern elementary particle physics.

The formation of this model in the chain of the structure of matter science seems quite consistent: all substances consist of atoms and molecules. Nuclei are central elements of atoms. They are composed of protons and neutrons, which in turn are composed of quarks.

The quark model implies that all elementary particles consist of quarks (except lightest particles). Accordingly to the Gell-Mann's quark model, to describe all of particle diversity, the quarks must have fractional electric charge (1/3 or 2/3 e) and other discrete properties, referred to as flavor, color, and others.

In the 60 years after the formulation of the foundations of the quark model, many experimenters have tried to find particles with fractional charge. But unsuccessfully.

An existence of fractional charges in a free state did not found of the experimental verification. To explain this, it was suggested that a confinement is characteristic for quarks, ie, property, prohibiting them in any way to express themselves in a free state. The confinement was introduced to reconcile the model with the observed data (or rather with data of unobservation), but at the same time it withdraws quarks from subordination of the Gilbert principle.

As such, the quark model with fractional charges claim on scientific validity without the confirmation of the measurement data.

The quark model of Gell-Mann has become widespread due to the fact that it can be used to systematize the whole world of elementary particles. It seems that the very possibility of such a classification can be considered as a some experimental confirmation of the Gell-Mann theory.

But this would be really so, provided that the properties of classified particles was determined experimentally.

If the properties of particles are invented, then their systematization of scientific significance has no.

It will be shown below that the Gell-Mann quark model uses incorrect definitions of the neutron and meson properties [4], [5], so all this construction, not based on the Gilbert principle, is speculative and has no scientific meaning.

Everyone thinks this is a scientific theory.

Another thesis replacing the experimental test is the conviction that everyone thinks that this theoretical construction is scientific.

It should be noted that the quark model successfully describes some experiments on the scattering of particles at high energies, for example, the formation of jets or feature of the scattering of high-energy particles without destroying. However, this is not enough to recognize the existence of quarks with a fractional charge.

Now the Gell-Mann quark model is generally accepted and gives the impression that all scientists have recognized its scientific significance, not taking into account its inconsistency with the Gilbert principle.

The award of the Nobel Prize as proof of the correctness of the theory.

Another argument proving the high scientific significance of the theory may be the awarding of the Nobel Prize to it. In most cases, the Nobel Committee approaches with great attention and thoroughness to its work. However, in any case, the award of the Nobel Prize can not replace the experimental verification of the theoretical construction.

Chapter 2

Is it possible to construct a proton from quarks with an integer charge [4]

Gell-Mann, when creating his theory, proceeded from the assumption that both - proton and neutron - are elementary particles with different quark sets.

Because of this, the main purpose of his model was to explain the process of conversion of neutron into proton on the quark level.

The solution of this problem required the introduction of quarks with fractional charges that are not experimentally observed and are not intended for predicting of nucleons properties.

However, if we take into account the electromagnetic nature of neutron [3], it turns out that a explanation of the conversion of neutron into proton is unnecessary and it is quite possible to model basic properties of proton using a set of quarks with integer charges.

To calculate the basic properties of proton let's construct it out of quarks with integer charge (+e, -e). We assume that, as in Gell-Mann's model, the proton consists of three quarks. We also assume that own spin of the quarks is absent, and their quantum motion is expressed in their rotation around a common center of circle of radius R (Fig.(2.1)).

Let the value of the radius R is determined by the fact that the length of the circumference $2\pi R$ is equal to length of de Broglie waves of quark λ_D:

$$2\pi R = \lambda_D = \frac{2\pi\hbar}{p_q}, \tag{2.1}$$

where p_q is quark momentum.

For simplicity, we will assume that quarks have the same momentums p_q and rotate in a single circle, so that equality (2.1) reduces to equation

$$p_q R = \hbar. \tag{2.2}$$

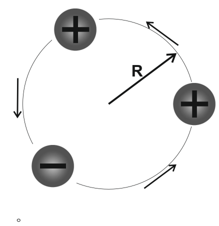


Figure 2.1: Proton consisting of quarks with integer charge

Generalized moment of rotation (spin) of the system is made up of two components: mechanical torque is created by all three quarks $3\mathbf{p_q} \times \mathbf{R}$, but magnetic field pulse is generated by one positively charged quark only $-\frac{e}{c}\mathbf{A}$:

$$\mathbf{s} = \mathbf{R}\left[3\mathbf{p}_q - \frac{e}{c}\mathbf{A}\right]. \tag{2.3}$$

Given that the magnetic vector potential is generated by the rotating charge

$$\mathbf{A} = \frac{[\overrightarrow{\mu} \times \mathbf{R}]}{R^3} \tag{2.4}$$

and the magnetic moment of a circular current

$$\overrightarrow{\mu} = \frac{e}{2c}[\mathbf{R} \times \mathbf{v}] \tag{2.5}$$

we obtain invariant angular momentum (spin)

$$s = \frac{\hbar}{2}\left(6 - \frac{e^2}{\hbar c}\frac{1}{\sqrt{1-\beta^2}}\right), \tag{2.6}$$

where $\beta = \frac{v}{c}$.

Based on the fact that the value of the proton spin is known, we obtain

$$\frac{\hbar}{2} = \frac{\hbar}{2}\left(6 - \frac{\alpha}{\sqrt{1-\beta^2}}\right), \tag{2.7}$$

where $\alpha = \frac{e^2}{\hbar c}$ is the fine structure constant.

This equation gives possibility to suggest that the charged quark in a free state is positron with mass m_e, while the mass of this quark-positron in the bounded state

$$m_q = \frac{m_e}{\sqrt{1-\beta^2}} = \frac{5}{\alpha}m_e \simeq 685.2\ m_e. \tag{2.8}$$

For all quarks we have

$$3m_q \simeq 2055\ m_e, \tag{2.9}$$

that in satisfactory agreement with the measured value of the proton mass:

$$\frac{3m_q}{M_p} \simeq 1.12. \tag{2.10}$$

Given the value of mass of charged quark (Eq.(2.8)), the magnetic moment produced by this quark is found to be

$$\mu_q = \frac{e\hbar}{2m_q c} = \frac{M_p}{m_q}\frac{e\hbar}{2M_p c} \approx 2.68\mu_N \tag{2.11}$$

(where $\mu_N = \frac{e\hbar}{2M_p c}$ is the Borh's nuclear magnetic moment),

which is close to the experimentally measured value of the magnetic moment of proton

$$\mu_p = 2.79\mu_N. \tag{2.12}$$

Part II

The electromagnetic model of neutron

Basic properties of proton and neutron The main physical properties of proton and neutron was scrutinized. There are measuring of their mass, charge, spin, etc. Since the measured values of the masses of the proton and neutron are:

$$\begin{aligned} M_p &= 1.6726231 \cdot 10^{-24}\ g \cong 1836.2\ m_e \\ M_n &= 1.6749286 \cdot 10^{-24}\ g \cong 1838.7\ m_e \end{aligned} \tag{2.13}$$

Their magnetic moments are measured with very high accuracy too. In units of the nuclear magneton they are [7]

$$\begin{aligned} \xi_p &= 2.792847337 \\ \xi_n &= -1.91304272 \end{aligned} \tag{2.14}$$

Chapter 3

Is neutron an elementary particle?

The basic Gell-Mann's quarks of the first generation (u and d) are introduced in such a way that their combinations could explain the charge parameters of protons and neutrons. Naturally, the neutron is considered at that as an elementary particle in the sense that it consists of a different set of quark than a proton. In the 30s of the XX-th century, theoretical physicists have come to the conclusion that a neutron must be an elementary particle without relying on the measurement data, which was not at that time.

Later the neutron mass, its magnetic moment and the energy of its beta-decay were precisely measured. The quark model does not allow to calculate these parameters, but they can be calculated in the electromagnetic model of neutron [3]-[5].

Suppose that the neutron is not an elementary particle, and as well as Bohr's hydrogen atom consists of proton and electron which rotates round proton on a very small distance. Near proton the electron motion must be relativistic.

For the first time after the discovery of the neutron, physicists was discussing whether or not to consider it as an elementary particle. Experimental data, which could help to solve this problem, was not exist then. And soon the opinion was formed that the neutron is an elementary particle alike proton [8]. However, the fact that the neutron is unstable and decays into proton and electron (+ antineutrino) gives a reason to consider it as a nonelementary composite particle.

Is it possible to now on the basis of experimentally studied properties of the neutron to conclude that it is elementary particle or it is not?

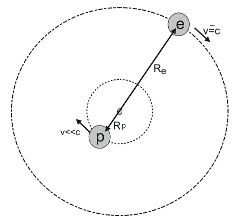


Figure 3.1: Composite particle consisting of proton and heavy (relativistic) electron orbiting around a common center of mass.

3.1 Equilibrium in the system of relativistic electron + proton

Let's consider the composite corpuscle, in which electron with the rest mass m_e and charge $-e$ is spinning on a circle of radius R_e with speed $v \to c$ around proton.

(The presence of the intrinsic magnetic moment of the rotating particle does not matter because of the particularities of the resulting solutions Eq.(3.22).)

Since we initially assume that the motion of electron can be relativistic, it is necessary to take into account the relativistic effect of the growth of its mass:

$$m_e^* = \gamma m_e, \tag{3.1}$$

where

$$\gamma = \frac{1}{\sqrt{1-\beta^2}} \tag{3.2}$$

is the relativistic factor and $\beta = \frac{v}{c}$.

The rotation of heavy electron m_e^* does not allow simplistically consider proton as resting. Proton will also move, revolving around a common center of mass (Fig.(3.1)).

Let's introduce the parameter characterizing the ratio of mass of relativistic electron to proton mass:

$$\vartheta = \frac{\gamma m_e}{M_p/\sqrt{1-\beta_p^2}}. \tag{3.3}$$

From the condition of equality of pulses, it follows that $\beta_p = \vartheta$ and therefore the radii of the orbits of the electron and proton can be written in the form:

$$R_e = \frac{R}{1+\vartheta}, \qquad R_p = \frac{R\vartheta}{1+\vartheta}. \tag{3.4}$$

The relativistic factor of electron is then equal to

$$\gamma = \frac{\vartheta}{\sqrt{1-\vartheta^2}} \frac{M_p}{m_e}. \tag{3.5}$$

The Larmor theorem.

To describe the characteristic feature of the proton rotation, we can use the Larmor theorem [9]. According to this theorem, in a reference frame which rotates together with proton with frequency Ω, a magnetic field is applied to it. This magnetic field is determinated by the gyromagnetic ratio of the particle

$$H_L = \frac{\Omega}{\xi_p \frac{e}{M_p c}}. \tag{3.6}$$

As a result of the action of this field, the magnetic moment of the proton turns out to be oriented perpendicular to the plane of rotation. In other words, we can say that due to interaction with this field, the electron rotation must occur in the plane of the proton's "equator".

The energy of interaction of proton and Larmor's field is equal to:

$$\mathcal{E}_L = -\mu_p H_L = -\frac{\hbar\Omega}{2} = -\frac{1}{2} \cdot \gamma m_e c^2. \tag{3.7}$$

The magnetic energy of rotating electron.

The magnetic field created by rotation of electron has energy

$$\mathcal{E}_\Phi = \frac{\Phi I_e}{2c}, \tag{3.8}$$

Because this field tends to break current e-ring, the energy of this field has the positive sign.

Due to the fact that the motion of electron in orbit must be quantized, also the magnetic flux penetrating e-ring of radius R_e needs to be quantized too, and we have the magnetic flux in e-ring equals to quantum of magnetic flux Φ_0

$$\Phi = \Phi_0 \equiv \frac{2\pi\hbar c}{e} \tag{3.9}$$

The main part of electron current is equal to $\frac{ec}{2\pi R_e}$. Beside it we need to consider a small addition due to the Coulomb and magnetic effects of protons on the electronic orbit.

So energy

$$\mathcal{E}_\Phi = \frac{\Phi_0 I_e}{2c} \approx \frac{1}{2c}\frac{2\pi e}{\alpha}\frac{ec}{2\pi R_e}\left(1 - \frac{\alpha}{1+\vartheta}\right) \approx \frac{1}{2}\left(1 - \frac{\alpha}{1+\vartheta}\right)\gamma m_e c^2. \tag{3.10}$$

Where $\alpha = \frac{e^2}{\hbar c}$ is the fine structure constant.

Thus, we obtain that the energy associated with magnetic flux is almost exactly compensates the spin-orbit interaction described by the Larmor field:

$$\delta \equiv \frac{\mathcal{E}_\Phi + \mathcal{E}_L}{\gamma m_e c^2} = -\frac{\alpha}{2(1+\vartheta)}. \tag{3.11}$$

The balance of forces in the proton-electron system.

In a stable bound state, the Coulomb attraction between electron and proton and the Lorentz force acting from the proton magnetic moment on moving electron should be differently oriented that the total energy of their interaction was less.

In equilibrium state, these forces are compensated by the centrifugal force:

$$\frac{\gamma m_e c^2}{R_e} - \gamma\frac{e^2}{R^2} + \gamma\frac{e\mu_p}{R^3} + \frac{\delta \cdot \gamma m_e c^2}{R} = 0. \tag{3.12}$$

After simple transformations we obtain the equation

$$(1+\vartheta) - X + \xi_p \frac{m_e}{\alpha M_p} X^2 + \delta = 0. \tag{3.13}$$

Where $r_c = \frac{\hbar}{m_e c}$ is the Compton radius and

$$X = \frac{\alpha r_c}{R} = \frac{\alpha M_p}{m_e}\frac{\vartheta}{(1+\vartheta)\sqrt{1-\vartheta^2}}. \tag{3.14}$$

From these equations we obtain the solution

$$\vartheta \cong 0.2 \tag{3.15}$$

and

$$R = \frac{\alpha r_c}{X} \cong 1.235 \cdot 10^{-13}\ cm \tag{3.16}$$

3.2 Main properties of neutron

3.2.1 Spin of neutron

The spin of neutron is the sum of spin of proton, the generalized moment of momentum of the e-current ring and the generalized moment of momentum of proton.

Moment of the generalized electron momentum can be written as

$$S_{0e} = \left[R_e \times \gamma \left\{ m_e c - \frac{e}{c}\left(\frac{e}{R} - \frac{\mu_p}{R_e^2} - \frac{\delta \cdot m_e c^2}{e}\right)\right\}\right]. \tag{3.17}$$

Where $\mu_p, \mu_{0e}, \mu_{0p}$ are magnetic moment of proton, magnetic moment of e-current ring and magnetic moment of current ring of proton.

Or

$$S_{0e} = \frac{\gamma m_e c R}{(1+\vartheta)} \left\{ 1 - X + \xi_p \frac{m_e}{\alpha M_p} X^2 + \delta \right\}. \tag{3.18}$$

The generalized moment of current ring of proton is equal to

$$S_{0p} = \left[R_p \times \left\{ \frac{M_p \vartheta c}{\sqrt{1-\vartheta^2}} \right\} \right] \tag{3.19}$$

or

$$S_{0p} = \frac{\gamma m_e c R}{(1+\vartheta)} \cdot \vartheta \tag{3.20}$$

The total angular momentum of current rings

$$S_0 = S_{0e} + S_{0p} = \frac{\gamma m_e c R}{(1+\vartheta)} \left\{ 1 - X + \xi_p \frac{m_e}{\alpha M_p} X^2 + \delta + \vartheta \right\}. \tag{3.21}$$

Due to the fact that the expression in brackets of this equation coincides with the left part of Eq.(3.13), we obtain

$$S_0 = 0. \tag{3.22}$$

Thus, spin of neutron is equal to spin of proton.

3.2.2 The magnetic moment of neutron

The magnetic moment of neutron is composed of proton magnetic moment and the magnetic moments of currents of electron and proton.

The total magnetic moment generated by circulating currents

$$\mu_0 = -\frac{e\beta_e R_e}{2} + \frac{e\beta_p R_p}{2} = \frac{eR}{2}\frac{(1-\vartheta^2)}{(1+\vartheta)} = \frac{eR}{2}(1-\vartheta). \tag{3.23}$$

If to express this moment in Bohr magnetons μ_B, we get

$$\xi_0 = \frac{\mu_0}{\mu_B} = -\frac{(1-\vartheta^2)\sqrt{1-\vartheta^2}}{\vartheta}. \tag{3.24}$$

Given the values of ϑ (3.15) we have

$$\xi_0 = -4.6974. \tag{3.25}$$

The summation of this quantity with the magnetic moment of the proton (Eq.(2.14)) gives

$$\xi_N = \xi_0 + \xi_p \approx -1.9046. \tag{3.26}$$

This value is in good agreement with the measured value of the magnetic moment of neutron (Eq.(2.14)):

$$\frac{\xi_n - \xi_N}{\xi_n} \approx 4 \cdot 10^{-3}. \tag{3.27}$$

3.2.3 The neutron mass

It is important that the measured value of the neutron mass

$$m_n > M_p + m_e. \tag{3.28}$$

At first glance it seems that this fact creates an obstacle for the electromagnetic model of neutron with a binding energy between proton and electron.

It should lead to the opposite inequality: the mass of a neutron, it would seem, must be less than the combined mass of proton and electron on energy of their connection (there must exists a defect of mass).

For this reason, it is necessary to conduct a detailed examination of these energies.

The electron energy.

To clarify this question, first let us write the energy of electron. It consists of kinetic energy and potential energy of interaction with the proton. In addition we need to consider the energy of the magnetic field of a current ring, which creates a rotating electron $\mathcal{E}_\Phi$:

$$\mathcal{E}^e = (\gamma - 1)m_e c^2 - \left(\gamma\frac{e^2}{R} - \gamma\frac{e\mu_p}{R^2} - \delta \cdot \gamma m_e c^2\right). \tag{3.29}$$

or

$$\mathcal{E}^e \approx \left(1 - \frac{1}{\gamma} - X + \xi_p \frac{m_e}{\alpha M_p} X^2 + \delta\right)\gamma m_e c^2. \tag{3.30}$$

Taking into account Eq.(3.13), we obtain

$$\mathcal{E}^e \approx -\left(\vartheta + \frac{1}{\gamma}\right)\gamma m_e c^2. \tag{3.31}$$

Since the total energy of electron is negative, that indicates on the existence of a stable bound state of electron in the field of proton.

The kinetic energy of proton.

The positive contribution to neutron mass give kinetic and magnetic energies of the proton, which carries out the movement on a circle of radius R_p (Fig.(3.1)).

The kinetic energy of the proton, taking into account the relativistic supplements

$$T^p = \left(\frac{1}{\sqrt{1-\vartheta^2}} - 1\right) M_p c^2 \approx \left(\frac{\vartheta}{2} + \frac{\vartheta^3}{8}\right)\gamma m_e c^2. \tag{3.32}$$

Additionally, due to its rotation in a circle with radius R_p, proton generates a magnetic field with energy $\vartheta \cdot \mathcal{E}^{e0}$ and has energy of spin-orbital interaction

$$\mathcal{E}^{p0} = \vartheta \cdot \mathcal{E}^{e0} - \delta = \left(\frac{\vartheta}{2} - \delta\right) \cdot \gamma m_e c^2. \tag{3.33}$$

It is equal to the Larmor energy $\mathcal{E}_L$.

Summing up these additional contributions to the energy of proton and electron we obtained

$$\begin{aligned}\mathcal{E}^{e+p} &= \left\{-\left(\vartheta+\tfrac{1}{\gamma}\right)+\left(\tfrac{\vartheta}{2}+\tfrac{\vartheta^3}{8}\right)+\tfrac{\vartheta}{2}-\delta\right\}\cdot\gamma m_e c^2 = \\ &= \left\{-1+\tfrac{\vartheta^3}{8}\cdot\gamma+\tfrac{\alpha\gamma}{2\cdot 1.2}\right\} m_e c^2 \approx 0.51\ m_e c^2.\end{aligned} \tag{3.34}$$

Thus the mass of neutron is equal to

$$M_n = M_p + m_e + \frac{\mathcal{E}^{e+p}}{c^2} = (1836.2 + 1 + 0.51)\ m_e \simeq 1837.7 m_e. \tag{3.35}$$

This is in qualitative agreement with the measured value of the mass of the neutron Eq.(2.13).

This excess energy needs to limit the spectrum of β-electrons produced by the neutron decay and it also agrees qualitatively with the measured data.

Thus the electron energy in fields of proton is negative Eq.(3.31). It means that the bound state exists between proton and electron. However, the additional contribution to neutron mass makes the energy of proton movement. The kinetic energy of proton slightly overlaps the negative binding energy of electron. As a result of addition of these energies, the neutron mass becames slightly greater than the sum of the masses of free proton and electron what explains the existence of inequality (3.28).

Chapter 4

Discussion

The consent of estimates and measured data indicates that the neutron is not an elementary particle [5]. At that neutron is unique object of microcosm. Its main peculiarity lies in the fact that the proton and electron that compose it are related to each other by a (negative) binding energy. But the neutron mass is greater than the sum of the rest masses of proton and electron despite the presence of a mass defect. This is because proton and electron, forming neutron, are relativistic and their masses are much higher than their rest masses. In result the bound state of neutron disintegrates with the energy releasing.

This structure of neutron must change our approach to the problem of nucleon-nucleon scattering. The nuclear part of an amplitude of the nucleon-nucleon scattering should be the same at all cases, because in fact it is always proton-proton scattering (the only difference is the presence or absence of the Coulomb scattering). It creates the justification for hypothesis of charge independence of the nucleon-nucleon interaction.

The above considered electromagnetic model of neuron is the only theory that predicts the basic properties of the neutron. According to Gilbert's postulate, all other models (and in particular the quark model of neutron) that can not describe properties of neutron can be regarded as speculative and erroneous. The measurement confirmation for the discussed above electromagnetic model of neutron is the most important, required and completely sufficient argument of its credibility.
Nevertheless, it is important for the understanding of the model to use the standard theoretical apparatus at its construction. It should be noted that for the scientists who are accustomed to the language of relativistic quantum physics, the methodology used for the above estimates does not contribute to the perception of the results at a superficial glance. It is commonly thought that for the reliability, a consideration of an affection of relativism on the electron behavior in the Coulomb field should be carried out within the Dirac theory. However that is not necessary in the case of calculating of the magnetic moment of the

neutron and its decay energy. In this case, all relativistic effects described by the terms with coefficients $\left(1-\frac{v^2}{c^2}\right)^{-1/2}$ compensate each other and completely fall out. The neutron considered in our model is the quantum object. Its radius R_0 is proportional to the Planck constant $\hbar$. But it can not be considered as relativistic particle, because coefficient $\left(1-\frac{v^2}{c^2}\right)^{-1/2}$ is not included in the definition of R_0. In the particular case of the calculation of the magnetic moment of the neutron and the energy of its decay, it allows to find an equilibrium of the system from the balance of forces, as it can be made in the case of non-relativistic objects. The another situation arises on the way of an evaluation of the neutron lifetime. A correct estimation of this time even in order of its value do not obtained at that.

For the above proton model (Fig.2.1), there is no question about what are quarks in a free state.

However, it remains unclear what interactions joins these quarks together in completely stable particle - proton, which decays in nature is not observed. It is not clear why positron-quark and electron-quark are not annihilate.

But antiproton with the same structure is unstable.

Part III

Nature of nuclear forces

Chapter 5

The one-electron bond between two protons

Let us consider a quantum system consisting of two protons and one electron. If protons are separated by a large distance, this system consists of a hydrogen atom and the proton. If the hydrogen atom is at the origin, then the operator of energy and wave function of the ground state have the form:

$$H_0^{(1)} = -\frac{\hbar^2}{2m}\nabla_r^2 - \frac{e^2}{r}, \qquad \varphi_1 = \frac{1}{\sqrt{\pi a^3}} e^{-\frac{r}{a}} \tag{5.1}$$

If hydrogen is at point R, then respectively

$$H_0^{(2)} = -\frac{\hbar^2}{2m}\nabla_r^2 - \frac{e^2}{|\overrightarrow{R} - \overrightarrow{r}|}, \qquad \varphi_2 = \frac{1}{\sqrt{\pi a^3}} e^{-\frac{|\overrightarrow{R} - \overrightarrow{r}|}{a}} \tag{5.2}$$

In the assumption of fixed protons, the Hamiltonian of the total system has the form:

$$H = -\frac{\hbar^2}{2m}\nabla_r^2 - \frac{e^2}{r} - \frac{e^2}{|\overrightarrow{R} - \overrightarrow{r}|} + \frac{e^2}{R} \tag{5.3}$$

At that if one proton removed on infinity, then the energy of the system is equal to the energy of the ground state E_0, and the wave function satisfies the stationary Schrodinger equation:

$$H_0^{(1,2)}\varphi_{1,2} = E_0\varphi_{1,2} \tag{5.4}$$

We seek a zero-approximation solution in the form of a linear combination of basis functions:

$$\psi = a_1(t)\varphi_1 + a_2(t)\varphi_2 \tag{5.5}$$

where coefficients $a_1(t)$ and $a_2(t)$ are functions of time, and the desired function satisfies to the energy-dependent Schrodinger equation:

$$i\hbar\frac{d\psi}{dt} = (H_0^{(1,2)} + V_{1,2})\psi, \tag{5.6}$$

where $V_{1,2}$ is the Coulomb energy of the system in one of two cases.

Hence, using the standard procedure of transformation, we obtain the system of equations

$$\begin{aligned} i\hbar\dot{a}_1 + i\hbar S\dot{a}_2 &= E_0\Big\{(1+Y_{11})a_1 + (S+Y_{12})a_2\Big\} \\ i\hbar S\dot{a}_1 + i\hbar\dot{a}_2 &= E_0\Big\{(S+Y_{21})a_1 + (1+Y_{22})a_2\Big\}, \end{aligned} \tag{5.7}$$

where we have introduced the notation of the overlap integral of the wave functions

$$S = \int \phi_1^*\phi_2 dv = \int \phi_2^*\phi_1 dv \tag{5.8}$$

and notations of matrix elements

$$\begin{aligned} Y_{11} &= \frac{1}{E_0}\int \phi_1^* V_1 \phi_1 dv \\ Y_{12} &= \frac{1}{E_0}\int \phi_1^* V_2 \phi_2 dv \\ Y_{21} &= \frac{1}{E_0}\int \phi_2^* V_1 \phi_1 dv \\ Y_{22} &= \frac{1}{E_0}\int \phi_2^* V_2 \phi_2 dv \end{aligned} \tag{5.9}$$

Given the symmetry

$$Y_{11} = Y_{22} \qquad Y_{12} = Y_{21}, \tag{5.10}$$

after the adding and the subtracting of equations of the system (5.7), we obtain the system of equations

$$\begin{aligned} i\hbar(1+S)(\dot{a}_1+\dot{a}_2) &= \alpha(a_1+a_2) \\ i\hbar(1-S)(\dot{a}_1-\dot{a}_2) &= \beta(a_1-a_2) \end{aligned} \tag{5.11}$$

Where

$$\begin{aligned} \alpha &= E_0\Big\{(1+S) + Y_{11} + Y_{12}\Big\} \\ \beta &= E_0\Big\{(1-S) + Y_{11} - Y_{12}\Big\} \end{aligned} \tag{5.12}$$

As a result, we get two solutions

$$\begin{aligned} a_1 + a_2 &= C_1 exp\left(-i\frac{E_0}{\hbar}t\right) exp\left(-i\frac{\epsilon_1}{\hbar}t\right) \\ a_1 - a_2 &= C_2 exp\left(-i\frac{E_0}{\hbar}t\right) exp\left(-i\frac{\epsilon_2}{\hbar}t\right) \end{aligned} \tag{5.13}$$

where

$$\begin{aligned}\epsilon_1 &= E_0\frac{Y_{11}+Y_{12}}{(1+S)}\\ \epsilon_2 &= E_0\frac{Y_{11}-Y_{12}}{(1-S)}.\end{aligned} \tag{5.14}$$

From here

$$\begin{aligned}a_1 &= \frac{1}{2}e^{-i\omega t}\cdot(e^{-i\frac{\epsilon_1}{\hbar}t}+e^{-i\frac{\epsilon_2}{\hbar}t})\\ a_2 &= \frac{1}{2}e^{-i\omega t}\cdot(e^{-i\frac{\epsilon_1}{\hbar}t}-e^{-i\frac{\epsilon_2}{\hbar}t})\end{aligned} \tag{5.15}$$

and

$$\begin{aligned}|a_1|^2 &= \frac{1}{2}\left(1+cos(\frac{\epsilon_1-\epsilon_2}{\hbar})t\right)\\ |a_2|^2 &= \frac{1}{2}\left(1-cos(\frac{\epsilon_1-\epsilon_2}{\hbar})t\right)\end{aligned} \tag{5.16}$$

As

$$\epsilon_1-\epsilon_2 = 2E_0\frac{Y_{12}-SY_{11}}{1-S^2} \tag{5.17}$$

with the initial conditions

$$a_1(0)=1 \qquad a_2(0)=0 \tag{5.18}$$

and

$$C_1=C_2=1 \tag{5.19}$$

or

$$C_1=-C_2=1 \tag{5.20}$$

we obtain the oscillating probability of placing of electron near one or other proton:

$$\begin{aligned}|a_1|^2 &= \frac{1}{2}\,(1+cos\omega t)\\ |a_2|^2 &= \frac{1}{2}\,(1-cos\omega t)\end{aligned} \tag{5.21}$$

Thus, electron jumps into degenerate system (hydrogen + proton) with frequency ω from one proton to another.

In terms of energy, the frequency ω corresponds to the energy of the tunnel splitting arising due to electron jumping (Fig.5.1).

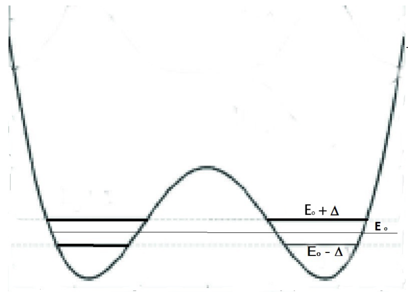


Figure 5.1: The schematic representation of the potential well with two symmetric states. In the ground state, electron can be either in the right or in the left hole. In the unperturbed state, its wave functions are either φ_1 or φ_2 with the energy E_0. The quantum tunneling transition from one state to another leads to the splitting of energy level and to the lowering of the sublevel on Δ.

As a result, due to the electron exchange , the mutual attraction arises between protons. It decreases their energy on

$$\Delta = \frac{\hbar\omega}{2} \tag{5.22}$$

The arising attraction between protons is a purely quantum effect, it does not exist in classical physics.

The tunnel splitting (and the energy of mutual attraction between protons) depends on two parameters:

$$\Delta = |E_0| \cdot \Lambda, \tag{5.23}$$

where E_0 is energy of the unperturbed state of the system (ie, the electron energy at its association with one of proton, when the second proton removed on infinity),
and function of the mutual distance between the protons Λ.

This dependence according to Eq.(5.17) has the form:

$$\Lambda = \frac{Y_{12} - SY_{11}}{(1 - S^2)} \tag{5.24}$$

The graphic estimation of the exchange splitting $\Delta\mathcal{E}$ indicates that this effect decreases exponentially with increasing a distance between the protons in full compliance with the laws of the particles passing through the tunnel barrier.

Chapter 6

The molecular hydrogen ion

The quantum-mechanical model of simplest molecule - the molecular hydrogen ion - was first formulated and solved by Walter Heitler and Fritz London in 1927 [10].

At that, they calculate the Coulomb integral:

$$Y_{11} = \left[1 - (1+x)e^{-2x}\right], \tag{6.1}$$

the integral of exchange

$$Y_{12} = \left[x(1+x)e^{-x}\right] \tag{6.2}$$

and the overlap integral

$$S = \left(1 + x + \frac{x^2}{3}\right) e^{-x}. \tag{6.3}$$

Where $x = \frac{R}{a_B}$ is the dimensionless distance between the protons.
The potential energy of hydrogen atom

$$\mathcal{E}_0 = -\frac{e^2}{a_B} \tag{6.4}$$

and with taking into account Eq.(6.1)-Eq.(6.3)

$$\Lambda(x) = e^{-x} \frac{x(1+x) - \left(1 + x + \frac{x^2}{3}\right)\left(1 - (1+x)e^{-2x}\right)}{1 - \left(1 + x + \frac{x^2}{3}\right)^2 e^{-2x}} \tag{6.5}$$

At varying the function $\Lambda(x)$ we find that the energy of the system has a minimum at $x \simeq 1.3$ where $\Lambda_{x=1.3} \simeq 0.43$. As a result of permutations of these values we find that in this minimum energy the mutual attraction of protons reaches a maximum value

$$\Delta_{max} \simeq 9.3 \cdot 10^{-12} erg. \tag{6.6}$$

This result agrees with measurements of only the order of magnitude. The measurements indicate that the equilibrium distance between the protons in the molecular hydrogen ion $x \simeq 2$ and its breaking energy on proton and hydrogen atom is close to $4.3 \cdot 10^{-12} erg$.

The remarkable manifestation of an attraction arising between the nuclei at electron exchange is showing himself in the molecular ion of helium. The molecule He_2 does not exist. But a neutral helium atom together with a singly ionized atom can form a stable structure - the molecular ion. The above obtained computational evaluation is in accordance with measurement as for both - hydrogen atom and helium atom - the radius of s-shells is equal to a_B, the distance between the nuclei in the molecular ion of helium, as in case of the hydrogen molecular ion, must be near $x \simeq 2$ and its breaking energy near $4.1 \cdot 10^{-12} erg$.

In order to achieve a better agreement between calculated results with measured data, researchers usually produce variation of the Schrodinger equation in the additional parameter- the charge of the electron cloud. At that, one can obtain the quite well consent of the calculations with experiment. But that is beyond the scope of our interest as we was needing the simple consideration of the effect.

Chapter 7

Deutron and other light nuclei

7.0.1 Deutron

The electromagnetic model of a neutron, discussed above, gives possibility on a new look on the mechanism of the proton-neutron interaction [5]. According to this model a neutron is a proton surrounded by a relativistic electron cloud. Therefore a deuteron consists of the same particles as the molecular ion of hydrogen. There is a difference. In the case of a deuteron, the relativistic electron cloud has the linear dimension $R_0 \approx 10^{-13}$cm (Eq.(3.16)). One might think that a feature occurs at such a small size of the electron cloud. When an electron jumps from one proton to another, a spatial overlap of the wave functions will not arise and therefore the overlap integral S (Eq.(6.3)) can be set equal to zero.

In accordance with the virial theorem, the potential energy of this system at the unperturbed state is

$$\mathcal{E}_0 = -\frac{e^2}{R_0}. \tag{7.1}$$

The function $\Lambda(x)$ (Eq.(5.24)) at $S = 0$ and taking into account Eq.(6.2) obtains the form

$$\Lambda(x) = x(1 + x)e^{-x} \tag{7.2}$$

(where $x = \frac{R}{R_0}$ is a dimensionless distance between the protons.)

When varying this expression we find its maximum value $\Lambda_{max} = 0.8399$ at $x = 1.618$.

After substituting these values, we find that at the minimum energy of the system due to exchange of relativistic electron, two protons reduce their energy on

$$\Delta_0 \simeq \Lambda_{max} \cdot \frac{e^2}{R_0} \simeq 2.130 \cdot 10^{-6} erg. \tag{7.3}$$

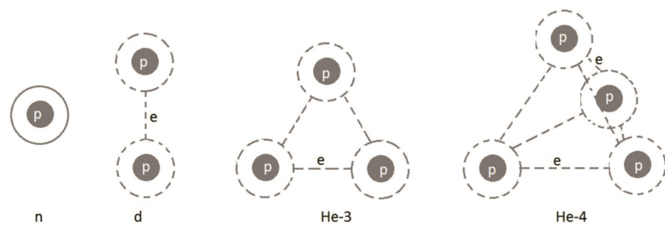


Figure 7.1: Schematic representation of the structure of light nuclei. Dotted lines schematically indicate the possibility of a relativistic electron hopping between protons.

To compare this binding energy with the measurement data, let us calculate the mass defect of the three particles forming the deuteron

$$\Delta M_3 = 2M_p + m_{e*} - M_d \approx 3.9685 \cdot 10^{-27} g, \tag{7.4}$$

where M_d is mass of deuteron.

This mass defect corresponds to the binding energy

$$\mathcal{E}_d = \delta M_d \cdot c^2 \approx 3.567 \cdot 10^{-6} erg. \tag{7.5}$$

Using the relativistic electron mass in Eq.(7.4) does not seem obvious. However, this is confirmed by the fact that at the fusion reaction proton and neutron to form a deuteron

$$p + n \to D + \gamma \tag{7.6}$$

γ-quantum takes energy equal to $3.563 \cdot 10^{-6}$ erg [11]-[12].

Thus the quantum mechanical estimation of the bonding energy of deuteron Eq.(7.3), as in the case of the hydrogen molecular ion, consistent with the experimentally measured value Eq.(7.5), but their match is not very accurate.

7.0.2 Nucleus ^3_2He

As can be seen from the schematic structure of this nucleus (Fig.7.1), its binding energy is composed by three pairwise interacting protons. Therefore it can be assumed that it equals to the tripled energy of deuteron:

$$\mathcal{E}_{He3} = 3 \cdot \mathcal{E}_d \approx 10.70 \cdot 10^{-6} erg. \tag{7.7}$$

The mass defect of this nucleus

$$\Delta M(He3) = 3M_p + m_{e*} - M_{He3} = 1.19369 \cdot 10^{-26} g. \tag{7.8}$$

Thus mass defect corresponds to the binding energy

$$\mathcal{E}_{\Delta M(He3)} = \Delta M(He3) \cdot c^2 \approx 10.73 \cdot 10^{-6} erg. \tag{7.9}$$

Consent energies $\mathcal{E}_{He3}$ and $\mathcal{E}_{\Delta M(He3)}$ can be considered as very good.

7.0.3 Nucleus ${}^4_2He$

As can be seen from the schematic structure of this nucleus (Fig.7.1), its binding energy is composed by six pairwise interacting protons which are realised by two electrons. On this reason its binding energy can be considered as:

$$\mathcal{E}_{He4} = 2 \cdot 6 \cdot \mathcal{E}_d \approx 42.80 \cdot 10^{-6} erg. \tag{7.10}$$

The mass defect of this nucleus

$$\Delta M(He4) = 4M_p + 2m_{e*} - M_{He4} = 48.62 \cdot 10^{-26} g. \tag{7.11}$$

Thus mass defect corresponds to the binding energy

$$\mathcal{E}_{\Delta M(He4)} = \Delta M(He4) \cdot c^2 \approx 43.70 \cdot 10^{-6} erg. \tag{7.12}$$

Consent of these energies can be considered as alright.

7.0.4 Nucleus ${}^6_3Li$

The binding energy of $Li-6$ can be represented by the sum of binding energy of $He-4$ and deuteron. The last placed on next shell and has a weak bounding with $He-4$:

$$\mathcal{E}_{Li6} \approx \mathcal{E}_{He4} + \mathcal{E}_d \approx 47.26 \cdot 10^{-6} erg. \tag{7.13}$$

The mass defect of this nucleus

$$\Delta M(Li6) = 6M_p + 3m_{e*} - M_{Li6} = 54.30 \cdot 10^{-26} g, \tag{7.14}$$

and corresponding binding energy

$$\mathcal{E}_{\Delta M(Li6)} = \Delta M(Li6) \cdot c^2 \approx 48.80 \cdot 10^{-6} erg, \tag{7.15}$$

That really confirms the weak link between the protons in different shells.
It should be noted that the situation with the other light nuclei are not so simple.
The nucleus ${}^3_1T$ consists of three protons and two communicating electrons between them. Jumps of two electrons in this system should obey to the Pauli exclusion principle. Apparently this is the reason that the binding energy of tritium is not very much greater than the binding energy of He-3.
Nuclear binding energy of $Li-7$ can be represented as $\mathcal{E}_{Li7} \approx \mathcal{E}_{He4} + \mathcal{E}_T$. But it is quite a rough estimate. At that the binding energy of unstable nucleus Be-8 very precisely equal to twice binding energy of He-4.

Chapter 8

Discussion

The good agreement between the calculated binding energy of some light nuclei with measured data suggests that nuclear forces (at least in the case of these nuclei) have the above-described exchange character. These forces arise as a result of a purely quantum effect of exchange relativistic electrons.

For the first time the attention on the possibility of explaining the nuclear forces based on the effect of electron exchange apparently drew I.E.Tamm [13] back in the 30s of the last century. However, later the model of the π-meson and gluon exchange becomes the dominant in nuclear physics. The reason for that is clear. To explain the magnitude and range of the nuclear forces need particle with a small wavelength. Non-relativistic electrons does not fit it. However, on the other hand, models π-meson or gluon exchange was not productive: it gives not possibility to calculate the binding energy of even light nuclei.

Therefore, the simple assessment of the binding energy given above and consistent with measurements is the clear proof that the so-called strong interaction (in the case of light nuclei) is a manifestation of the quantum-mechanical effect of attraction between protons produced by the relativistic electron exchange.

Part IV

Neutrinos

Chapter 9

Introduction

W.Pauli was the first who thought of the existence of neutrinos. He suggested the possibility of their existence in an effort to save the law of conservation of energy in the β-decay.

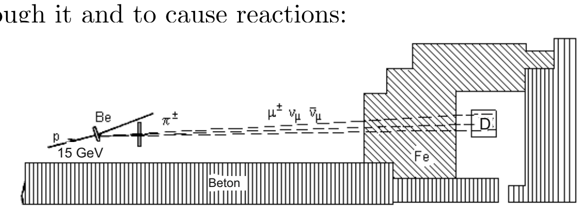
Further detailed study of β-decays gave the first experimental evidence of its possible existence. However, in order to speak with confidence about the existence of neutrinos, it was necessary to detect neutrinos in a free state at some distance from the place of their birth.

For the first time it was made by F. Reines and C. Cowan in the experiment, where the nuclear reactor was the source of neutrinos. At that values of the cross section of capture antineutrino by proton were first experimentally determined.

Further studies of nuclear reactions that take place with the participation of neutrinos have shown that neutrinos exist in two different modifications - neutrino and antineutrino.

The conclusion about the existence of muon neutrinos and electron neutrinos was made by L.Ledermanom and his colleagues on the basis of the results of their experiment (Fig.(9.1)). In this experiment a beam of protons with an energy of 15 GeV, was aimed at a target of beryllium, which was a source of π-mesons.

The decay of π-mesons gave a beam of μ-mesons and neutrinos. Detectors were protected from all particles by a powerful iron shield. Only neutrinos could pass through it and to cause reactions:



(9.1)

Figure 9.1: Schematic representation of the Lederman's experimental setup.

At that reactions with a birth of electrons and positrons were not detected:

$$\begin{aligned} \overline{\nu} + p = n + e^{+} \\ \nu + n = p + e^{-} \end{aligned} \tag{9.2}$$

On the basis of this experiment it was concluded that neutrinos, if they are formed at birth of muons, carry a some muon "charge" and they can in the future to participate in reactions with the birth of muons only.

Chapter 10

Electromagnetic radiation

The radiation and propagation of electromagnetic waves in vacuum is considered in detail in a number of monographs and textbooks. Taking as the basis for the consideration of these mechanisms the description given by the course of the Landau-Lifshitz [9], let us consider the mechanism of excitation and propagation of waves in vacuum in the absence of electric charges, electric dipoles and currents [5]. A time variable magnetic dipole moment **m** will be the only source of electromagnetic fields in the following consideration.

10.1 The vector potential generated by a magnetic dipole

In general, the potentials of the electromagnetic fields generated by electric charge distribution ρ and the current j at the point R with allowance for retardation, are written in the form:

$$\varphi(R,t) = \frac{1}{R}\int \rho_{t-\frac{R}{c}+\mathbf{rn}/c} dV \tag{10.1}$$

and

$$\mathbf{A}(R,t) = \frac{1}{cR}\int \mathbf{j}_{t-\frac{R}{c}+\mathbf{rn}/c} dV \tag{10.2}$$

Where $\mathbf{r}$ is the radius-vector within the system of charges and currents, $\mathbf{n} = \frac{\mathbf{R}}{R}$ is the unit vector.

Introducing the delayed time $t^* = t - \frac{R}{c}$, we write down the first two terms of the expansion of the vector potential expression (10.2) in powers of $\mathbf{rn}/c$:

$$\mathbf{A}(R,t) = \frac{1}{cR}\int \mathbf{j}_{t^*} dV + \frac{1}{c^2R}\frac{\partial}{\partial t^*}\int (\mathbf{rn})\mathbf{j}_{t^*} dV. \tag{10.3}$$

Using the definition $\mathbf{j} = \rho\mathbf{v}$ and passing to the point charges, we obtain:

$$\mathbf{A}(R,t) = \frac{1}{cR}\sum e\mathbf{v} + \frac{1}{c^2R}\frac{\partial}{\partial t^*}\sum e\mathbf{v}(\mathbf{rn}). \tag{10.4}$$

Due to the fact that the expression of the second term can be transformed to

$$\mathbf{v}(\mathbf{rn}) = \frac{1}{2}\left(\frac{\partial}{\partial t^*}\mathbf{r}(\mathbf{rn}) + \mathbf{v}(\mathbf{rn}) - \mathbf{r}(\mathbf{nv})\right) = \frac{1}{2}\frac{\partial}{\partial t^*}\mathbf{r}(\mathbf{rn}) + \frac{1}{2}[[\mathbf{r}\times\mathbf{v}]\times\mathbf{n}], \quad (10.5)$$

and using the definitions of the electric dipole $\mathbf{d}$, the electric quadrupole moment $\mathbf{Q}$ and the magnetic dipole moment

$$\mathbf{m} = \frac{1}{2}\sum e[\mathbf{r}\times\mathbf{v}] \quad (10.6)$$

we obtain([9]Eq.71.3)

$$\mathbf{A}(R,t) = \frac{\dot{\mathbf{d}}(t^*)}{cR} + \frac{\ddot{\mathbf{Q}}(\mathbf{t}^*)}{6c^2R} + \frac{[\dot{\mathbf{m}}(\mathbf{t}^*)\times\mathbf{n}]}{cR}. \quad (10.7)$$

Here the first two terms describe the electric dipole and electric quadrupole radiation. In our case, they are equal to zero, since there are no appropriate moments in the beginning condition of statement of the problem.

So finally for our case we have

$$\mathbf{A}(R,t) = \frac{[\dot{\mathbf{m}}(\mathbf{t}^*)\times\mathbf{n}]}{cR}. \quad (10.8)$$

10.2 The electric field generated by a magnetic dipole

By definition, at $\varphi = 0$ ([9],Eq.46.4)

$$\mathbf{E}(R,t) = -\frac{1}{c}\frac{d\mathbf{A}(R,t)}{dt^*} \quad (10.9)$$

If to denote

$$\frac{d\dot{\mathbf{m}}(t^*)}{dt^*} \equiv \ddot{\mathbf{m}}(t^*) \quad (10.10)$$

we obtain

$$\mathbf{E}(R,t) = -\frac{1}{c^2R}[\ddot{\mathbf{m}}(\mathbf{t}^*)\times\mathbf{n}]. \quad (10.11)$$

10.3 The magnetic field generated by a magnetic dipole

By definition, at $\varphi = 0$ ([9],Eq.46.4)

$$\mathbf{H}(R,t) = rot\mathbf{A}(R,t) = \left[\nabla\times\frac{[\dot{\mathbf{m}}(\mathbf{t}^*)\times\mathbf{n}]}{cR}\right] = \frac{1}{c}\left[\nabla\times[\dot{\mathbf{m}}(t^*)\times\mathbf{n}]\cdot\frac{1}{R}\right] \quad (10.12)$$

In general case, the rotor of the function F, depending on the parameter ξ, can be written as:

$$[\nabla \times \mathbf{F}(\xi)] = \left[grad\ \xi \times \frac{d\mathbf{F}}{d\xi}\right]. \tag{10.13}$$

Therefore, since the $grad\ t^* = \nabla(t - R/c) = -\mathbf{n}/c$, we obtain

$$rot\ \dot{\mathbf{m}}(t^*) = \left[grad\ t^* \times \frac{d\dot{\mathbf{m}}(t^*)}{dt^*}\right] = -\frac{1}{c}[\mathbf{n} \times \ddot{\mathbf{m}}(t^*)]. \tag{10.14}$$

The differentiation of the second term of Eq.(10.12) gives

$$\frac{1}{c}\left[\nabla\frac{1}{R} \times [\dot{\mathbf{m}}(t^*) \times \mathbf{n}]\right] = \frac{1}{cR^2}\left[\mathbf{n} \times [\dot{\mathbf{m}}(t^*) \times \mathbf{n}]\right]. \tag{10.15}$$

So the result is

$$\mathbf{H}(R,t) = -\frac{1}{c^2R}\left[\mathbf{n} \times [\ddot{\mathbf{m}}(t^*) \times \mathbf{n}]\right] + \frac{1}{cR^2}\left[\mathbf{n} \times [\dot{\mathbf{m}}(t^*) \times \mathbf{n}]\right] \tag{10.16}$$

Chapter 11

Photons and Neutrinos

At consideration of neutrinos, we must understand that there is another particle in nature - the photon, which has some common features with the neutrino. Neutrinos and photons are stable particles and they move in space with the speed of light. Neutrinos, the same as photons have no electrical charge and mass.

We can consider photons at the electromagnetic wave forming.

Plane polarized electromagnetic waves in vacuum have two orthogonal components. Electric field oscillates in a plane perpendicular to the propagation vector. If the source of the electromagnetic wave is a magnetic dipole $\mathbf{m}$, then the oscillation amplitude of the electric field away from it is described by Eq.(10.11) and depends on the second time derivative of the function describing the oscillating dipole only.

The magnetic field oscillates in plane perpendicular to the electric field and the direction of propagation is described by Eq.(10.16).

The oscillation amplitude of the magnetic field depends as on the second time derivative $\ddot{\mathbf{m}}$ and also on the first time derivative $\dot{\mathbf{m}}$ too.

When harmonically oscillating dipole, the contribution of the first time derivative is in λ/R times less than the contribution from the second derivative and it can be ignored.

For this reason, the term with $\dot{\mathbf{m}}$ in Eq.(10.16) usually do not write. Usually these formulas are interpreted as evidence that values of electric and magnetic fields in an electromagnetic wave are exactly equal to each other.

So the periodically oscillating magnetic dipole (as electric dipole too) always excites an electromagnetic wave with both components - with electric and magnetic fields.

Therefore, an oscillating dipole can not radiate a purely magnetic photon.

However from courses of mathematics, it is known that there are functions that have no derivative. In this respect, we are interested in such a dependence of $\mathbf{m}$ on the time at which $\dot{\mathbf{m}} \neq 0$ and $\ddot{\mathbf{m}} = 0$.

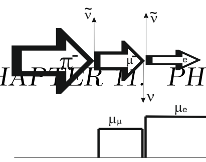


Figure 11.1: Schematic representation of the transformations chain of π-meson in μ-meson and finally into electron. Below: the resulting magnetic moments are shown schematically.

In this case, the wave will be deprived from the electric component. Only magnetic wave with the intensity proportional to $\dot{\mathbf{m}}$, will propagate in space.

An unusual feature which a magnetic photon should have arises from the absence of magnetic monopoles in nature.

Conventional photons with an electrical component dispersed and absorbed in substances mainly due to the presence of electrons.

In the absence of magnetic monopoles a magnetic photon must interact extremely faintly with matter and the length of its free path in the medium should be about two dozen orders of magnitude greater than that for conventional photon [5].

If photon with both magnetic and electric components is circularly polarized, its spin equals to $\hbar$. It seems natural to assume that a circularly polarized magnetic photon devoid of electric component should have spin equal to $\hbar/2$.

11.1 The Heaviside's function and its derivatives

Alternatively, a quickly emerging magnetic moment must excite oscillations in the ether.

This phenomenon occurs, for example, in the chain of successive transformations of π^--meson $\rightarrow$ μ^--meson $\rightarrow$ electron (Fig.(11.1)).

π-meson has no magnetic moment, but μ-meson has it.

The transformation of π-meson into μ-meson occurs in a very short time. The evaluation of this time can be obtained using the uncertainty relation:

$$\tau_{\pi\rightarrow\mu} \approx \frac{\hbar}{(m_\pi - m_\mu)c^2} \approx 10^{-23} sec \tag{11.1}$$

A little less time required for the conversion of μ-meson into electron.

The sudden appearance of the magnetic moment at these conversions can be described by the Heaviside function.

The Heaviside's stair function equals to zero for negative argument and 1 for positive one. At zero, this function requires further definition. Usually, it considered to be convenient, at zero to set it equal to 1/2:

$$He(t) = \begin{cases} 0 \;\; if \;\; t < 0 \\ 1/2 \;\; if \;\; t = 0 \\ 1 \;\; if \;\; t > 0 \end{cases} \tag{11.2}$$

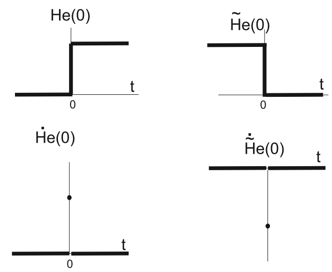


Figure 11.2: Two Heaviside's stairs function and its first derivative. The second derivative of this function is absent.

The first derivative of the Heaviside's function $\frac{d}{dt}He(t) \equiv \dot{H}e(t)$ is the Dirac δ-function:

$$\dot{H}e(t) = \delta(0) = \begin{cases} 0 \;\; if \;\; t < 0 \\ \to \infty \;\; if \;\; t = 0 \\ 0 \;\; if \;\; t > 0 \end{cases} \tag{11.3}$$

Wherein, the second derivative of Heaviside's function is absent (Fig.(11.2)).

11.2 Neutrinos and antineutrinos

The magnetic dipole moment occurs very quickly at the β-decay.

In accordance with the electromagnetic model of neutron, the generalized momentum (spin) of relativistic electron is equal to zero if it forms a neutron [3]. Thus the magnetic moment of electron becomes unobservable. At the β-decay of a neutron, an electron acquires freedom, and with it a spin and magnetic moment. For the emitted electron with a speed close to the speed of light, this process should take place as leap.

Experiments show that the β-decay of neutron is accompanied by the emission of antineutrino:

$$n \to p^+ + e^- + \tilde{\nu}. \tag{11.4}$$

Thus, δ-shaped surge magnetic field arising after a sudden onset of magnetic moment of electron can be identified as an antineutrino.

Another implementation of magnetic γ-quantum should arise at the reverse process that is at the K-capture. In this process, electron initially forms an atom shell and has its own magnetic moment and spin. At a certain moment it is captured by nucleus and forms neutron together with proton.

This process can be described by the inverse Heaviside function. This function is equal to 1 at negative times and reset at $t = 0$:

$$\widetilde{H}e(t) = \begin{cases} 1 \quad if \quad t < 0 \\ 1/2 \quad if \quad t = 0 \\ 0 \quad if \quad t > 0 \end{cases} \tag{11.5}$$

In this process should occur magnetic γ-quantum with reverse orientation of the field relative to its propagation vector $\mathbf{R}$ (Fig. (11.2)).

Such "reverse" surge corresponds to the neutrino in the K-capture reaction:

$$p^{+} + e^{-} \rightarrow n + \nu. \tag{11.6}$$

11.3 Mesons as excited states of electron

The chain of transformations of π^{-}-meson$\rightarrow$ μ^{-}-meson$\rightarrow$ electron gives birth to three neutrinos (Fig.(11.1)).

No other products besides neutrino and antineutrino do occur in these reactions. That leads us to an assumption that the pion and muon should be the excited states of electron.

These mesons have masses

$$\begin{array}{l} M_{\pi}^{\pm} = 273.13 m_e \\ M_{\mu}^{\pm} = 206.77 m_e \end{array} \tag{11.7}$$

Let us assume that the excited state of the electron is formed from a particle with mass $M = \frac{m_e}{\sqrt{1-\beta^2}}$ (where $\beta = v/c$) and charge e rotating in a circle of radius R with the velocity $v \rightarrow c$.

We assume that the excited states are stable if their de Broglie wavelengths are integer times of their circumferences

$$\frac{2\pi R}{\lambda_D} = n, \tag{11.8}$$

where $\lambda_D = \frac{2\pi\hbar}{p}$ is length of de-Broglie wave,
$n = 1, 2, 3...$ is integer.

Invariant angular momentum (spin) of such particles

$$\mathbf{S} = n \left[\mathbf{R} \times (\mathbf{p} - \frac{e}{c}\mathbf{A})\right], \tag{11.9}$$

where $\mathbf{A} = \frac{[\mathbf{m} \times \mathbf{R}]}{R^3\sqrt{1-\beta^2}}$ is vector potential of the magnetic field generated by the rotating charge.

The rotating charge e creates magnetic moment

$$\mathbf{m} = \frac{e}{2c}[\mathbf{R} \times \mathbf{v}] \tag{11.10}$$

and we get

$$S = n\hbar \left(1 - \frac{\alpha}{2\sqrt{1-\beta^2}}\right). \qquad (11.11)$$

Where $\alpha = \frac{e^2}{\hbar c}$ is the fine structure constant.

According to Eq.(11.11) at the condition $S = 0$, the relativistic factor $\frac{1}{\sqrt{1-\beta^2}}$ is equal to $2/\alpha$. Wherein, the mass of the particle is

$$M_0 = \frac{2}{\alpha} m_e = 274.08\ m_e. \qquad (11.12)$$

This value of mass is very close to the mass of π-meson (11.7), which has a spin equal to zero:

$$\frac{M_0}{M_{\pi^\pm}} \simeq 1.003 \qquad (11.13)$$

At spin $S = \hbar/2$, the relativistic coefficient $\frac{1}{\sqrt{1-\beta^2}}$ equal to $3/2\alpha$ (at n=2) and mass of particle

$$M_{1/2} = \frac{3}{2\alpha} m_e = 205.56\ m_e. \qquad (11.14)$$

This value of mass is very close to the mass of μ meson (11.7) which has spin $= \hbar/2$:

$$\frac{M_{1/2}}{M_{\mu^\pm}} \simeq 0.9941 \qquad (11.15)$$

Chapter 12

About muonic neutrino

The reactions of antineutrino and neutrino with nucleons have muonic and electronic modes:

$$\tilde{\nu} + p \begin{array}{l} \nearrow \; \mu^+ + n \\ \\ \searrow \; e^+ + n \end{array} \tag{12.1}$$

$$\nu + n \begin{array}{l} \nearrow \; \mu^- + p \\ \\ \searrow \; e^- + p \end{array} \tag{12.2}$$

The Lederman's experiment has shown that those neutrinos that were born in the transformation pion→muon can participate only in muonic modes of reactions in the future.

While electronic modes are not implemented at all.

This result is surprising.

All neutrinos - muonic and electronic - are born with the abrupt appearance of magnetic moments. The Heaviside's functions describing this process have only one variable. The stair has two meanings only - up or down. This is in according with existence of neutrinos or antineutrinos (Fig.(11.2)). Heaviside's stairs can not have any other parameters. It is impossible to put any label for them. Magnetic gamma-quanta can not bear any specific muonic and electronic "charges".

This seems quite unnecessary to assume that the birth of a free electron in the ground state and the birth of it in the excited state (as muon) must be described in different Heaviside's stairs.

Differences may be in the magnitude of these stairs. But because of a wide range of energies characteristic for neutrinos at β-decay, this parameter can not distinguish the types of neutrinos.

12.1 The Lederman's experiment

The primary beam of protons with energy of 15 GeV was used in the L.Lederman's experiment [14]. As a result of their interaction with the target, a beam of highly energetic charged π-mesons was formed. In turn at their decay, highly energetic charged μ-mesons and neutrinos were created.

In future, the muonic reaction mode was observed only and e-mode reaction was not registered.

On this basis, it was concluded on the existence of specific muon-type neutrinos. This conclusion would be true if these reactions would be equally probable. However, this is not the case, since products of these reactions have different phase volumes.

For example, let's turn our attention on the reaction of the charged π-meson decay. This decay has two modes:

$$\pi^{\pm} \begin{array}{l} \nearrow \; \mu^{\pm} + \nu^{\simeq} \\ \\ \searrow \; e^{\pm} + \nu^{\simeq} \end{array} \tag{12.3}$$

Measurements show that the muonic mode of this reaction is more probable for 10^4 times.

The reason of the electronic channel suppression is that these reactions generate relativistic electrons.

Because of the kinetic energy of electrons in this decay much more of their mass and their helicity is preserved with good accuracy, this mode of decay must be suppressed relatively to the muon mode on the factor [15]

$$R_\pi = \frac{m_e^2}{m_\mu^2 \left(1 - \frac{m_\mu}{m_\pi}\right)} \approx 1.3 \cdot 10^{-4}. \tag{12.4}$$

In the reaction of interaction of neutrinos with nucleons Eq.(12.1) - Eq.(12.2), we should expect the same phenomenon, because there are muonic and electronic modes of reaction also, and electronic mode must be suppressed because of its relativism.

At time when L.Lederman with his colleagues made their measurements, this was not known and this factor can not be taken into account.

For this reason we can assume, that L.Lederman and his colleagues found no electrons and positrons not because neutrinos had a specific muon "charge" but due to the strong suppression of the electron channel of reaction.

12.2 How to clarify the Lederman's experiment?

The primary proton beam used Lederman had very high energy. This helped him to form a large beam of neutrinos flying forward. However, this advantage led to the suppression of the electronic mode of reaction.

To avoid this one needs to repeat the Lederman's experiment at lower energy of primary protons.

Born π-mesons will have lower kinetic energy if energy of protons in the primary beam is only slightly above the threshold of their birth in the pp reaction (290 MeV). Neutrinos, born as a result of π-meson decay will have energy of about 30 MeV. The interaction of these neutrinos with nucleons of the target can not give the muonic branch of reaction because the threshold of muon birth is about 105 MeV. Whereas the electron branch of reaction should go with a standard cross section.

However, it should be noted that the registration of the electron mode in this case is complicated by the fact that the decay of π-meson will take place in 4π-angle.

To improve the geometry of this experiment one can raise energy of primary protons to about 360 MeV. At that the threshold of muon birth would not yet been achieved, but the registration of the electron mode should increase by several times due to more favorable flux of neutrinos.

It is important that if we increase the energy of the proton primary beam just about only 10 MeV , produced neutrinos will be able to induce muon-branch reactions and e-branch of the reaction in this case must be suppressed.

Part V

Conclusion

Thus, the concept of magnetic γ-quanta allows us to understand all main features of neutrinos [6]:
- neutrinos almost never interact with matter because magnetic monopoles do not exist,
- spin of neutrino is equal to $\hbar/2$ as they have no the electrical component,
- neutrinos arise in β-decay as the magnetic moment occurs at the same,
- there are two types of neutrinos because there are two types of stairs
- also that allows us to consider π-meson and μ-meson as excited states of electron and to predict their masses with good accuracy.

Therefore, the assumption that the neutrino is the magnetic gamma-quantum is confirmed by all available experimental data.

The Gilbert's postulate is the main tool to distinguish between theoretical models that reliably describe the object under study, from speculative quasi-theories that seek to do the same, but use the wrong approach.

In physics of the 20th century, some of these far-fetched theory became commonly accepted [2].

The reason for this is probably that a theory can not be constructed on arbitrary reasonings and fantasies.

In particle physics, much attention was paid to their systematization by means of tables based on quark structure.

The formation of a table representing the quark structure of elementary particles illustrates the ability to some systematization but it is not proof of an existence of fractional charged quarks.

The above computations of the properties of the neutron and mesons reveal the falsity of the quark model with fractional charges. This model demonstrates the successful possibility of classifying particles, some of which have invented properties.

The main attribute of a quasi-theories is that they can not give an explanation of the individual primary characteristics of the objects and try to explain the general characteristics of the phenomenon as a whole.

The fact that the electromagnetic model allows us to predict most important characteristics of neutron forces us recognize that an use of presentation of structure of elementary particles based on quarks with fractional charge appears to be erroneous.

The force of attraction between the protons arising at the relativistic electron exchange allow us to explain the mechanism of occurrence of nuclear forces (in the case of light nuclei). This gives possibility do not use gluons for it and to simplify this theory at excluding from consideration of the strong interaction.

Indeed, the relativistic electron exchange between the protons in the deuteron (as well as the exchange of non-relativistic electron in a molecular hydrogen ion) is the quantum mechanical phenomenon. There is no reason to ascribe this exchange effect in the case of deuteron the role of specific fundamental interactions of Nature.

But it is obvious that for the calculation of nuclear forces in heavy nuclei it is necessary to use other effects, for example associated with the existence of nuclear shells.

β-decay does not require introducing any new fundamental special natural interaction too.

β-decay has a significant feature: at it for a very short time occurs (or disappears when K-capture) the magnetic moment of a free electron. This produces a magnetic effect on ether and causes the emission of a magnetic γ-quantum, i.e. neutrinos. This phenomenon has a purely electromagnetic nature and its description do not need to enter in a special weak or electro-weak interaction.

The possibility of electromagnetic descriptions of some of particles makes it relevant to question the correctness of the existing descriptions of many other, more complex objects of microcosm.

Obviously, in accordance with the Gilbert's main postulate of natural Sciences, the validating of such descriptions should be based on experimental data of the underlying properties of the objects.

A successful method of systematization of particles in a certain table should not be considered exhaustive proof of correctness and uniqueness of this approach, if there is no confidence in the correct definition of properties of classified particles.

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