Mechanical scenario for the reaction:
neutron → proton + electron + antineutrino

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Small perturbations of averaged ideal turbulence reproduce the electromagnetic field. The luminiferous medium has the relatively low pressure and high energy. A vapor bubble in the fluid models the neutron. The bubble stabilized via creating in the fluid a field of the positive perturbation of the turbulence energy serves as a model of the proton. An isle of the fluid that produces the respective field of the negative perturbation of the turbulence energy models the electron. The antineutrino corresponds to a local positive disturbance of the turbulence energy needed in order to compensate the difference in perturbations of the energy produced by the electron and proton.

1. SUBSTRATUM FOR PHYSICS

The properties of physical space known as fields and particles can be modelled in terms of continuum mechanics[1,2]. The concept of substratum for physics is used to this end. The substratum serves as a medium to carry over the electromagnetic wave and to transmit interactions. On a large scale the substratum can be approximated by a turbulent medium.

2. PERTURBATIONS OF TURBULENCE

We consider the averaged turbulence of an ideal fluid. The system is governed by linearized Reynolds equations[3,4,5]:

$$\partial_i \langle u_i \rangle = 0, \tag{1}$$

$$\varsigma \partial_t \langle u_i \rangle + \varsigma \partial_k \langle u_i' u_k' \rangle + \partial_i \langle p \rangle = 0 \tag{2}$$

where ς is the medium density, $\langle \mathbf{u} \rangle$ the averaged velocity of the fluid flow, $\langle p \rangle$ the averaged pressure and $\mathbf{u}'$ the turbulent fluctuation of the velocity, so that

$$\mathbf{u} = \langle \mathbf{u} \rangle + \mathbf{u}'. \tag{3}$$

Here and further on we use denotations $\partial_t = \partial/\partial t$, $\partial_k = \partial/\partial x_k$. Summation over recurrent index is implied throughout.

We assume that in the unperturbed state the turbulence is homogeneous and isotropic, i.e.

$$\langle \mathbf{u} \rangle^{(0)} = 0, \tag{4}$$

$$\langle p \rangle^{(0)} = p_0, \tag{5}$$

$$\langle u_i' u_k' \rangle^{(0)} = c^2 \delta_{ik} \tag{6}$$

where $p_0, c = \text{const}$ and c is the speed of the turbulence perturbation wave in the medium. Integrating equation (2) for an isotropic turbulence

$$\langle u_i' u_k' \rangle = \langle u_1' u_1' \rangle \delta_{ik} \tag{7}$$

and $\langle \mathbf{u} \rangle = 0$, we get a kind of Bernoulli equation

$$\varsigma \langle u_1' u_1' \rangle + \langle p \rangle = \varsigma c^2 + p_0. \tag{8}$$

Formally, by (8), any distribution of the turbulence energy density

$$\frac{1}{2} \varsigma \langle u_i' u_i' \rangle \tag{9}$$

may occur.

The next linearized term in the chain of Reynolds equations looks as follows

$$\partial_t \langle u_i' u_k' \rangle + c^2 \left(\partial_i \langle u_k \rangle + \partial_k \langle u_i \rangle \right) + h_{ik} = 0 \tag{10}$$

where

$$\varsigma h_{ik} = \langle u_i' \partial_k p' \rangle + \langle u_k' \partial_i p' \rangle + \varsigma \partial_j \left\langle u_i' u_j' u_k' \right\rangle . \tag{11}$$

The density (9) of the turbulence energy is in a way similar to distribution of the heat energy. However, the aether fluid is a true continuum, i.e. it does not consist of corpuscles and hence does not imply the dissipation of the mechanical energy. It can be shown[4] that in the absence of diffusion

$$h_{ii} = 0. \tag{12}$$

Taking in (10) $i = k$ and summing over the recurrent index we get with the account of (1) and (12)

$$\partial_t \langle u_i' u_k' \rangle = 0. \tag{13}$$

By (13) the profile of linear perturbations is conserved in the nondissipative incompressible medium.

For uniformity with (2), it is expedient to differentiate equation (10) with respect to x_k:

$$\partial_t \partial_k \langle u_i' u_k' \rangle + c^2 \nabla^2 \langle u_i \rangle + \partial_k h_{ik} = 0 \tag{14}$$

where the incompressibility condition (1) was used.

3.   MAXWELL'S EQUATIONS

With the definitions

$$A_i = \kappa c \left(\langle u_i \rangle - \langle u_i \rangle^{(0)} \right), \tag{15}$$

$$\varsigma \varphi = \kappa \left(\langle p \rangle - \langle p \rangle^{(0)} \right), \tag{16}$$

$$E_i = \kappa \partial_k \left(\langle u_i' u_k' \rangle - \langle u_i' u_k' \rangle^{(0)} \right), \tag{17}$$

$$j_i = \frac{\kappa}{4\pi} \partial_k h_{ik} \tag{18}$$

where κ is an arbitrary constant, (2), (14) and (1) take the form of Maxwell's equations

$$\frac{1}{c} \partial_t \mathbf{A} + \mathbf{E} + \boldsymbol{\nabla}\varphi = 0, \tag{19}$$

$$\frac{1}{c} \frac{\partial \mathbf{E}}{\partial t} - \boldsymbol{\nabla} \times (\boldsymbol{\nabla} \times \mathbf{A}) + \frac{4\pi}{c}\mathbf{j} = 0 \tag{20}$$

with the Coulomb gauge

$$\boldsymbol{\nabla} \cdot \mathbf{A} = 0 \tag{21}$$

respectively, where in (20) the general vector relation

$$\nabla^2 \mathbf{A} = \boldsymbol{\nabla}(\boldsymbol{\nabla} \cdot \mathbf{A}) - \boldsymbol{\nabla} \times (\boldsymbol{\nabla} \times \mathbf{A}) \tag{22}$$

and incompressibility condition (21) were used.

So, small perturbations of an ideal turbulence reproduce the electromagnetic field[3].

4.   THE NEUTRON AS A VAPOR BUBBLE

Discontinuities, or defects, of the medium model particles. Typically, a spherical cavity included into the medium represents a point-like discontinuity. A bubble filled with the vapor of the fluid can be taken as a model of the neutron.

Let V^* be the volume of the turbulent fluid evaporated into the bubble. The kinetic energy K^* transferred with the fluid into the gas phase can be found from (9). We get with the account of (6) for the unperturbed medium

$$K^* = V^* \frac{3}{2} \varrho \langle u_1' u_1' \rangle^{(0)} = \frac{3}{2} \varrho V^* c^2. \tag{23}$$

The vapor will be assumed to behave as an ideal gas. The equation of state of the ideal gas can be written in the form

$$pV = \frac{2}{3} K. \tag{24}$$

In the mechanical equilibrium the gas pressure p must be equal to the fluid pressure $\langle p \rangle$. If V is the volume of the bubble then using (23) in (24) we get for a bubble in the unperturbed medium

$$p_0 V = \varrho V^* c^2 \tag{25}$$

where p_0 is the background pressure (5). Insofar as $V^* \ll V$ we see from (25) that the occurrence in the fluid of ideal vapor bubbles implies the turbulence of the high energy and low pressure:

$$p_0 \ll \varsigma c^2. \tag{26}$$

5.   THE MASS AND SELF-ENERGY OF A PARTICLE

The mass of the bubble can be determined from the mass of the gas contained in it

$$m = \varrho V^*. \tag{27}$$

Substituting (27) into (25) we get

$$p_0 V = mc^2. \tag{28}$$

The self-energy of a bubble can be defined as the work needed in order to create the bubble in the unperturbed medium

$$E = p_0 V. \tag{29}$$

Using (29) in (28) gives

$$E = mc^2. \tag{30}$$

In the phenomenological theory (see e.g. the textbook[6]) we can deduce for the increment of the kinetic energy of a particle

$$dE = c^2 dm. \tag{31}$$

In order to obtain from (31) the expression for the self-energy we must postulate that all the internal energy of the particle concerned with the mass has the kinetic origin. As you see from the microscopic theory considered the self-energy (30) of a particle is indeed immediately reduced to a part of the turbulence energy of the luminiferous medium.

6.   CONVERSION TO THE PROTON

A turbulent fluid may adjust itself to boundary conditions via the perturbation of the turbulence energy (Fig.1, left). A new stable configuration is thus formed. The conversion of the neutron to the proton can be seen in the

following way. A microscopic restructuring takes place in the core of the particle. The gas in the bubble cools down and the pressure on the wall drops to some value $p_0 - \Delta p$, where $\Delta p > 0$.

The field of the turbulence perturbation produced by the point discontinuity was shown in[5] to take the form $1/r$. We have for the stable bubble of the radius R_p located at $\mathbf{x}'$:

$$\langle p \rangle = p_0 - \frac{a}{|\mathbf{x} - \mathbf{x}'|}, \tag{32}$$

$$a = R_p \Delta p. \tag{33}$$

The respective field of the turbulence energy can be found using (32) in (8):

$$\varsigma \langle u_1' u_1' \rangle = \varsigma c^2 + \frac{a}{|\mathbf{x} - \mathbf{x}'|}. \tag{34}$$

The bubble inclusion that produces in the turbulent fluid the field of the positive perturbation of the turbulence energy models the proton (Fig.1, left).
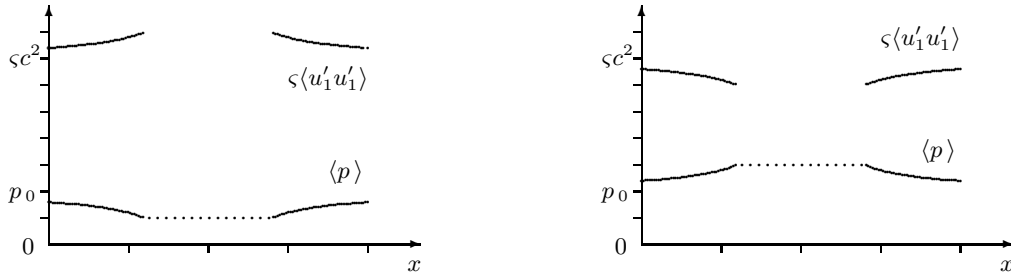

FIG. 1: The proton (left) and antiproton (right). Dots on the pressure graph indicate the vapor in the bubble.

7. THE ELECTRON

The form (34) implies an infinite quantity of the total energy perturbation

$$\frac{1}{2} \int_\Omega \varsigma \left(\langle u_i' u_i' \rangle - \langle u_i' u_i' \rangle^{(0)} \right) d^3 x \tag{35}$$

where the medium volume $\Omega \to \infty$. So, the positive deviation (34) from the background (6) should be compensated by a negative deviation of the turbulence energy of the same form, yet with the opposite sign of the coefficient (33):

$$a = -R_p \Delta p. \tag{36}$$

Supposing that the energy attains a reduced value $\varsigma \langle u_1' u_1' \rangle = \varsigma c^2 - \Delta \varepsilon$ at the core $|\mathbf{x} - \mathbf{x}'| = r_e$ of the negative disturbance center, we find from (34):

$$a = -r_e \Delta \varepsilon. \tag{37}$$

The center of the negative perturbation of the turbulence energy serves as a model of the electron (Fig.2, right).

8. THE ANTINEUTRINO

Comparing energy configurations of the proton (Fig.1, left, top) and the electron (Fig.2, right, top) we see that the negative perturbation of the turbulence energy in the core of the electron should be compensated by a respective positive perturbation of the background energy (6). This surplus of the turbulence energy corresponds to the emission of a new particle. Assuming in (36) and (37) $r_e \simeq R_p$ we get $\Delta p \simeq \Delta \varepsilon$. An isle of the fluid with increased turbulence energy may serve as a model of the antineutrino (Fig.3, left).

Thus, we constructed a linear mesoscopic mechanical scenario of the reaction

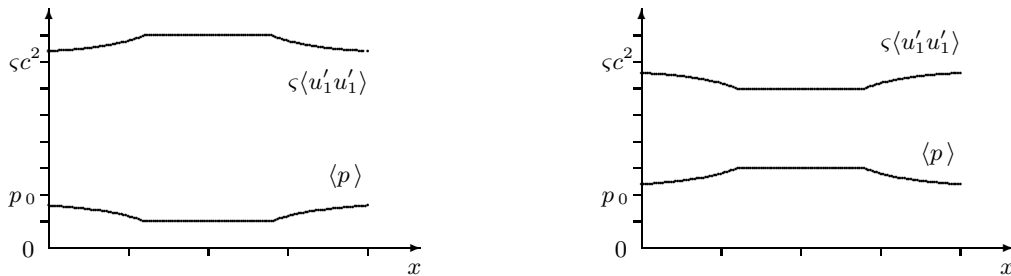$$n \to p^+ + e^- + \tilde{\nu}. \tag{38}$$

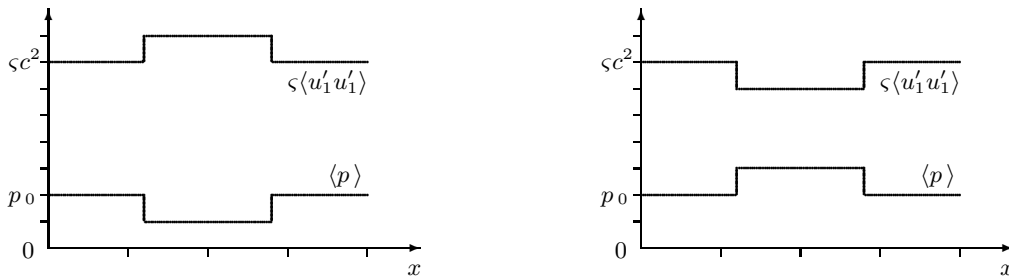FIG. 2: The positron (left) and electron (right).

FIG. 3: The antineutrino (left) and neutrino (right).

9. PARTICLES AND WAVES

Regions of the turbulent fluid such as in the models of the neutrino and inner part of the electron are referred to in hydrodynamics as the turbulence core. In the turbulence core the simple closure $h_{ik} = 0$ of the chain of governing equations (1), (2) and (10) is not valid. Using appropriate closure schemes for (10), perturbations of the energy in the turbulence core was shown[4] to be in general nonstationary. So, the neutrino as well as the electron should be properly considered as waves of the turbulence energy.

The neutron and proton are associated with the inclusions into the medium of the empty space. This is the reason why respective perturbations of the turbulence energy are stationary, and the baryon number is conserved.

On the other hand, in the model of the electromagnetic wave there was shown[5] to be no perturbation of the turbulence energy. Nondiagonal terms of correlations $\langle u'_i u'_k \rangle$ of turbulent fluctuations are only perturbed.

Thus we come to the conclusion that a particle is concerned with the perturbation of the turbulence energy while the pure wave does not accompanied by a perturbation of the turbulence energy.

10. QUANTUM MECHANICS

There is considered a special kind of nonstationarity of the wave-particles. The core of the electron is an isle of the fluid. So, the electron can be additively decomposed into the collection of fractions. Each fraction has an isle of the fluid in the core. The size of the core is the same as in the whole particle. The turbulence energy in the core is decreased relative to the background level (6). Yet it is greater than in the core of the original localized electron. Each fraction generates in the fluid the turbulence perturbation field that corresponds to a part of the electric charge. The decomposition of the electron may proceed under the action of turbulent fluctuations. This process underlies what is known as quantum phenomena.

The proton can not be decomposed into fractions in the same manner. It is a true particle.

11. ANTIPARTICLES

Models of antiparticles can be obtained mirroring graphs of respective particles in relation to the background levels of the pressure (5) and energy (6). Thus we come to a model of the positron as the center of the positive perturbation of the turbulence energy (Fig.2, left). The neutrino is the isle of the fluid with the reduced turbulence energy (Fig.3, right).

In the present approach the proton was modelled by the bubble with vapor in it cooled as compared with the vapor in the neutron core. Then the bubble with the vapor heated in comparison with the vapor in the neutron core models the antiproton (Fig.1, right).

12. CONCLUSION

In the mesoscopic approach the luminiferous medium can be modelled by the averaged turbulence of an ideal fluid. Particles of matter are concerned with inclusions into the medium of empty space. The neutron is modelled by the vapor bubble. The cooling of the vapor in the bubble forms the center of the positive perturbation of the turbulence energy that serves as a model of the proton. The center of the negative perturbation of the turbulence energy models the electron. The antineutrino is concerned with a local positive perturbation of the turbulence energy necessary in order to compensate the difference in perturbations of the turbulence energy between the proton and the electron.

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