On structural classification of elementary particles within vacuum medium mechanics

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Abstract In this paper one introduces structural classification of elementary particles which is based on vacuum medium mechanics. Two levels of description with respect to scale of averaging applied in modelling are discussed. Within larger scale electron, positron and neutrina are considered as the most elementary particles. All remaining particles are composed of the most elementary ones. Within smaller scale description having rather low status at this moment the most elementary particles are two opposite magnetic monopoles. They create internal structures of electron positron and neutrina.

I. INTRODUCTION

Classification of elementary particles based on quarks is not entirely satisfactory. First of all free quarks are not observed. Secondly, various problems with mass appear within corresponding classification. Furthermore, description of elementary particles by the Standard Model is based on rather poor system of fundamental notions. We have to do within corresponding models with point-like particles. This means that we are not able to consider interactions between various particles in more detail since we do not understand elementary particle as such by the model.

Recent discoveries of particles $Z_c(3900)$, $Z_c(4020)$ and $Y(4260)$ interpreted as composed of four quarks makes additionally classification by quarks more mysterious. Perhaps some other classifications would be useful for elementary particles which are based on more complex system of fundamental notions.

Vacuum medium mechanics is constructed just as theory based on more complex system of fundamental notions in order to see reality in more details. Within this paper we try to provide structural classification of elementary particles. Such a structural classification would be useful for introduction of more general full classification in case when vacuum medium mechanics attain sufficiently advanced stage of development.

Furthermore, we try to classify elementary particles also from more speculative point of view where still smaller scale of averaging is applied in modelling of vacuum medium properties. Then we are able to provide hypotheses on internal structure of electron, positron and neutrina. This point of view could be with time starting point for still more general and precise classification of elementary particles.

II. ASSUMPTIONS RELATED TO THE VACUUM MEDIUM STRUCTURE

A. General assumptions

We consider here structural classification of elementary particles which is based on vacuum medium mechanics discussed in several papers [1], [2], [3], [4], [5], [6], [7], [8]. In order to provide appropriate context for further considerations we discuss here main assumptions related to the vacuum medium.

Cosmological investigations indicate that the space of the Universe is flat. Furthermore, investigations of background radiation show existence of a reference configuration with respect to radiation in our space.

Having in mind above remarks we identify our medium with three-dimensional space E^3, where we introduce a Cartesian coordinate system $\mathbf{X} = \{X_i\},\ i = 1, 2, 3,\ \mathbf{X} \in E^3$. We assume furthermore, that behaviour of our medium does not induce any changes of introduced geometry at this stage of our considerations.

The vacuum medium is considered as a mixture of four components [1] joined within an elementary unit identified at this moment with a point of space. Motivations for assuming four components follows from observation that the Maxwell equations exhibit a symmetry with respect to electric and magnetic field. This induces considering at least two components. However, creation of electron-positron pair indicates that a separation of components is associated with electric field only. Therefore, two components are assigned to electric field. By analogy to observed symmetry between electric and magnetic fields two other components are also assigned to the magnetic field.

It is further assumed here that these components constitute four-component elementary units which create a stable medium for low energy states. In the continuum description applied here the elementary units correspond to points of space. However, in particular cases we can also assume that elementary units have a finite size which is more natural and convenient in our considerations.

We introduce densities which represent an amount of component related to a volume which can be discussed owing to the introduced coordinate system. Thus, we assume that ϱ_v, $\varrho_{\bar{v}}$, ϱ_w, $\varrho_{\bar{w}}$ and ϱ stand for densities of the components and the density of the united media, respectively. We have then

$$\varrho_v + \varrho_{\bar{v}} + \varrho_w + \varrho_{\bar{w}} = \varrho \ . \tag{1}$$

Symbols of these densities will be applied also as names for corresponding to them media.

State of each elementary unit is described by displacements or a kind of polarization of discussed components within units. They are represented by vectors $\mathbf{v}$, $\bar{\mathbf{v}}$, $\mathbf{w}$, $\bar{\mathbf{w}}$. We assume that two pairs of the components are discriminated by special interactions. Components within each pair are able to move with respect to each other. As a result, we can reduce in some cases the number of variables by introducing the new ones: $\mathbf{u} = \mathbf{v} - \bar{\mathbf{v}}$ and $\mathbf{q} = \mathbf{w} - \bar{\mathbf{w}}$. At this moment it is also assumed that $\bar{\mathbf{v}} = -\mathbf{v}$, $\bar{\mathbf{w}} = -\mathbf{w}$.

Considering state of the elementary unit we come to a natural question. To what degree such a polarization has a geometrical representation associated with classical displacements.

It seems reasonable that direction in space could be well defined within the elementary unit. Indeed, our intuition related to geometrical interpretation of space follows from straight propagation of light. In discussed model propagation of light is connected with transfer of interactions between elementary units. Therefore, it seems to be reasonable that such interactions determine direction within the elementary unit.

Interpretation of the polarization as displacements is perhaps not entirely convenient. Length of vector representing polarization should be in accordance with a size of the elementary unit what imposes constraints on degree of polarization. Therefore, we introduce a relation between degree of polarization and assigned to it displacements. We do this by functions

$$\mathbf{v}_G = \mathcal{G}_v(\mathbf{v}) \ , \quad \bar{\mathbf{v}}_G = \mathcal{G}_{\bar{v}}(\bar{\mathbf{v}}) \ , \tag{2}$$

and

$$\mathbf{w}_G = \mathcal{G}_w(\mathbf{w}) \ , \quad \bar{\mathbf{w}}_G = \mathcal{G}_{\bar{w}}(\bar{\mathbf{w}}) \ . \tag{3}$$

The functions $\mathcal{G}_v$, $\mathcal{G}_{\bar{v}}$, $\mathcal{G}_w$, $\mathcal{G}_{\bar{w}}$ assign geometrical displacements to vectors describing state of the elementary unit as vectors having the same directions.

Let $|\mathbf{v}|$ be length of the vector $\mathbf{v}$. Then, structure of the function $\mathcal{G}_v$ can be expressed as $\mathcal{G}_v(\mathbf{v}) = \tilde{\mathcal{G}}_v(|\mathbf{v}|)\mathbf{n}_v$, where $\mathbf{n}_v = \mathbf{v}/|\mathbf{v}|$.

Assignation of displacements to each kind of polarization enables incorporating of results of classical continuum mechanics to our methods of modelling. Consequently, we can introduce interpretation that each component deforms separately during interactions with the remaining ones. We are able to describe such a deformation by means of the deformation function which is considered in continuum mechanics [13]. This is formally possible since we have introduced the coordinate system.

Consequently, deformation of each component is described by deformation functions $\mathbf{x}_v = \chi_v(\mathbf{X})$, $\mathbf{x}_{\bar{v}} = \chi_{\bar{v}}(\mathbf{X})$, $\mathbf{x}_w = \chi_w(\mathbf{X})$, $\mathbf{x}_{\bar{w}} = \chi_{\bar{w}}(\mathbf{X})$, where $\mathbf{X}$ are points of a reference configuration. As a result we can consider displacements determined by means of (2) and (3) in connection with the deformation function by expressions

$$\mathbf{v}_G = \mathbf{x}_v - \mathbf{X}, \quad \bar{\mathbf{v}}_G = \mathbf{x}_{\bar{v}} - \mathbf{X}, \quad \mathbf{w}_G = \mathbf{x}_w - \mathbf{X}, \quad \bar{\mathbf{w}}_G = \mathbf{x}_{\bar{w}} - \mathbf{X} \,. \tag{4}$$

The reference configuration can be interpreted as describing nonexcited, equilibrium vacuum medium.

The variables $\mathbf{u}$ and $\mathbf{q}$ are identified with the vector of the electric field intensity $\mathbf{E}$ and the magnetic induction vector $\mathbf{B}$, respectively. Propagation of $\mathbf{u}$ and $\mathbf{q}$ through the vacuum medium is interpreted as electromagnetic wave.

We also introduce a displacement $\mathbf{h}_G$ in the elementary unit corresponding to gravitational field $\mathbf{h}$ by

$$\mathbf{h}_G = \mathcal{G}_h(\mathbf{h}) \,. \tag{5}$$

We do not interpret this displacement precisely. It represents an internal state of the elementary unit. Perhaps it is related to deformation of such a unit. Perhaps it represents a reorganization having vectorial character. We can also admit a fifth component into considerations. However, at this moment we have not sufficient premises for introduction of interpretations.

In the paper [1] we have assumed that the medium ϱ can be decomposed into the sum $\varrho = a + b$ for higher energy, where

$$a = \varrho_v + \frac{1}{2}(\varrho_w + \varrho_{\bar{w}}) \tag{6}$$

and

$$b = \varrho_{\bar{v}} + \frac{1}{2}(\varrho_w + \varrho_{\bar{w}}) \ . \tag{7}$$

This decomposition appears as a result of attaining by $\mathbf{u}$ a critical value $\mathbf{u}^*$ characteristic for the discussed medium.

Relations (6) and (7) can be understood as describing change of densities during separation of component process. However, they should be understood less formally rather as a balance of amount of corresponding components denoted also as densities. This is so since we do not analyze here any change of volumes. Furthermore we assume in what follows that volume corresponding to a and b is considerably smaller than that one corresponding to ϱ. Thereby, the relations (6) and (7) are devoted at this stage of considerations to accentuate that a change of structure within component organization happens. We do not understand of this change too precisely yet. However, by mentioning of the relations (6) and (7) we obtain a bridge-head for further analysis of mechanisms of separation of components.

Components a and b create medium of electron and positron respectively when they rotate. In such a case the components are separated from the remaining part of the medium by a discontinuity surface. Then, motion of this surface determines of motion of electron or positron.

We also admit rotation of a part of the ϱ-medium separated by a discontinuity surface from remaining part of stable ϱ-medium. Such a state is identified with neutrino and motion of the discontinuity surface describes motion of the neutrino. This motion is not associated with separation of components. Therefore motion of neutrino is not associated with any wave function.

We assume that each component $\varrho_v, \ \varrho_{\bar{v}}, \ \varrho_w, \ \varrho_{\bar{w}}$ considered separately attracts its own elements. Components a and b have the same property. Attraction between various kinds of components takes place for sufficiently small energy what leads to formation of the elementary units. Components a and b after separation also exhibit attraction which can lead, for some conditions, to recovering of the elementary units and thereby the four-component vacuum medium structure.

We could consider several energetic levels with different kinematics. The lowest energy is connected with displacements $\mathbf{u}$ and $\mathbf{q}$ only. Higher energy levels are associated with elementary particles. Consequently, electron and positron are viewed as rotating a and b-media separated from ϱ by a discontinuity surface [1]. This separation happens when a critical value $\mathbf{u} = \mathbf{u}^*$ is attained by the electric field. Interactions between particles and electromagnetic field are determined with the help of boundary conditions given on the discontinuity surface.

One also admits coexistence of components a, b and ϱ in the same point of space. Such a state is considered as a nonequilibrium state of the vacuum medium and has to relax to a lower energy level. In particular when electron moves then motion of the separation surface is associated with production of an excess of b before the particle and transferring of a into the particle as well as stopping part of a behind the electron. This induces just nonequilibrium distribution of components around the particle. Consequently $\{a,\ b,\ \varrho\}(\mathbf{X})$ associated with moving particle is interpreted as the wave function. Problem of evolution of such a nonequilibrium distribution of components was discussed in [4], [5].

Introduced above notions lead to a continuum description of the vacuum medium [1], [2], [3], [4], [5], [6], [7], [8] related to a scale considerably smaller than size of particles such as electron or neutrino. Therefore, the particles are seen by the model as extended particles.

However, in this paper we consider also model related to still smaller scale. Then, internal structure of electron by interpretation of component a can be discussed. Furthermore the structure of vacuum medium represented by ϱ can be suggested.

B. Some comments on fundamental assumptions and definition of the elementary particle

Presented in this work theory differs from traditional theories mainly by set of fundamental assumptions. In particular mass, charge and spin are not fundamental notions here.

We are able now to define elementary particle owing to larger context provided by vacuum medium mechanics instead of avoiding this as in quantum field theory. We define elementary particle within vacuum medium mechanics as follows:

Definition 1: Object within vacuum medium which contains at last one rotating part composed of component separated from resting vacuum medium by discontinuity surface is interpreted as elementary particle.

Thereby elementary particle is not defined by means of wave. In particular elementary particle can be associated with waving of components in neighbourhood of the particle when it moves. However, in general this is not the case. Neutrino for instance has no wave function. Photon is not elementary particle since it is associated with waving of well localized components only which are not entirely separated.

Mass is interpreted as resistance against change of velocity and depends on mechanisms of motion of particle. Therefore mass is understood as averaged parameter associated with properties of motion of particle. Thereby, we do not use the term "how particle gains its mass". Particle has resistance against change of velocity which depends on structure of particle and efficiency of transmission of external field for changing of its velocity. We do not accept any equivalence laws within vacuum medium including equivalence of mass and energy. Thereby, is as assumed also that Higgs particle does not exist within this theoretical context.

Matter and antimatter is entirely symmetric by assumption. This follows from symmetrical treatment of corresponding components. Charge is the consequence of existence of critical admissible value of length of electric intensity vector in the vacuum medium.

Spin of particle follows from internal dynamics of particle. This problem can be discussed in [7] where mechanism of rotation of electron is considered.

III. ARGUMENTS SUPPORTING MODEL OF THREE-POSITRON STRUCTURE OF THE PROTON

A. Introductory remarks

Decay of proton is not observed yet. However internal structure of proton is investigated for many years and three-parton structure is well established. However, what kind of particles is represented by partons is an open question. Decay modes predicted by the Standard Model undergo the charge conservation law [9]. Partons are usually identified with quarks having fractional charge and also with gluons responsible for interactions. However, free quarks are not observed yet.

Within vacuum medium mechanics three-positron structure of proton is considered. Justification for such a point of view is presented in [6]. The following arguments supporting three-positron structure of the proton are discussed in [6]:

1. The same external effect for positron and for proton represented by their electrostatic field which suggests the same component on the inside of both particles.
2. Generation of neutrino under high compression leading to considerable approaching of electron and proton. Then, joining of components of both particles can produce rotation of joined components interpreted just as neutrino.
3. Annihilation of proton and antiproton predominantly to three electrons and three positrons.
4. Annihilation of proton and antiproton through intermediate particle-antiparticle pairs instead of direct annihilation into electromagnetic waves. This is justified by fact that annihilation of close three electron-positron pairs considerably exceeds critical condition for creation of single electron-positron pair. Then, considerable instability of vacuum medium should appear and produce additional particles.

5. Presence of positrons near supermassive black hole in center of our galaxy as effect of annihilation of electrons on protons on the inside of black holes.
6. Presence of positrons in quasar jets.
7. Consistency of the Bing Bang theory based on annihilation of electrons on protons with corresponding explosion of space on the inside of giant black hole [3] with astrophysical observations.
8. Possible explanation of gamma ray bursts as collisional processes of black holes.
9. Interpretation of the three-positron structure of proton as three-particle chain state which can be considered as an asymptotic state for an attractor. Strength of proton provides then arguments for mechanisms of long lasting evolution and their persistence in molecular systems [5].

Above arguments are based on experimental investigations carried out in earth conditions and experiments provided by nature in cosmological scale. They are interpreted in context provided by multicomponent vacuum medium mechanics.

We introduce here also some additional arguments in comparison with [6] and based on interpretation of J/ψ meson decay.

B. Arguments based on J/ψ decay

Let us discuss an idealized case when three electrons are moving on a circle with a given radius R. Distances between neghbouring electrons are the same. Let us discuss forces acting on such a system of electrons.

We consider forces acting on a chosen electron in tangent to the circle direction and in radial direction. In radial direction we consider centrifugal inertial force f_C, component of resultant electrostatic repulsion force f_{REPn} and corresponding component of force f_{CHn} following from interactions within chain state of electrons on the circle. We assume that the chain state of electrons on a circle induces a radial force leading to shrinking of this circle when appropriate conditions happen [4], [5]. In other words electrons on the circle attract themselves.

When one electron composed of the component a moves then separation of components following from vacuum medium $\varrho = a + b$ happens on its surface. The component a is attracted into electron and the component b is produced in excessive form in front of this particle. Behind of the electron the component is stopped owing to forces in the medium [5]. Then, the wave function is associated with transfer of excessive component b into back of the particle where pure a is stopped in order to recover the vacuum medium. However when another electron is present before the first one then the component b of the first electron can be transferred back into of the second electron. Just this process induces attraction between electrons.

In tangent direction we consider component of force $f_{CH\tau}$ following from interactions within chain state of electrons on the circle and corresponding component of electrostatic repulsion force $f_{REP\tau}$.

We assume that the three electrons maintain the same distance between them. However we admit the situation when radius of the circle can undergo a change. Consequently, in case when

$$f_n = f_{CHn} + f_{REPn} + f_C < 0 \tag{8}$$

we have to do with dominance of the force f_{CHn} which has negative sign. Then, radius of the circle diminishes and velocity of particles increases since distances between them decreases. The last property follows from relation between velocity and distance for the chain state represented by decreasing function $D_{ab} = D_{ab}(v)$ in stationary case [5].

In this idealized case we can consider various situations with respect to behavior of electrons. We can find a critical value of $R = R_C$ when the force f_n changes its sign. Consequently, we assume that for $R > R_C$ we have that $f_n > 0$ and for $R < R_C$ there is $f_n < 0$.

In other words, after exceeding a critical value of the radius $R = R_C$, the three electrons will continue acceleration and shrinking of radius of the circle until they attain an uniform motion on the circle corresponding to antiproton with the radius $R = R_P$.

It is interesting to consider also a radius $R = R_{preP}$, $R_{preP} > R_C$ where attraction following from forces of the chain state becomes important and by this probability of finding of the three electrons close to $R = R_C$ is considerable. We understand in this case that perhaps not too big perturbation of conditions could approach the three electrons to the critical condition for transition to antiproton.

By above discussion we suggest that forces of the chain state increase rather slowly on larger distances in order to increase considerably near to $R = R_C$. Then, $R = R_{preP}$ characterizes region where discussed forces can lead to qualitative changes.

Let us admit some external perturbations of our system of electrons. We admit the case when three positrons with similar configuration on a circle as electrons approach to the electron system. We assume in particular that planes of the circles are parallel. Then, we can consider additionally electrostatic attraction between electrons and positrons. We have in general the following relations

$$R_C = R_C(f_{CHn},\ f_{REPn},\ f_{ATTn},\ f_C)\ , \quad R_{preP} = R_{preP}(f_{CHn},\ f_{REPn},\ f_{ATTn},\ f_C)\ , \tag{9}$$

where f_{ATTn} follows from electrostatic attraction between electrons and positrons.

The electrostatic attraction can considerably diminish effect of force f_{REPn} and by this make more easy action of the force f_{CHn}. In such a case R_C increases. Similarly R_{preP} also increases.

We can say that two similar rings of electrons and positrons placed on parallel planes make more easy exceeding the critical value of $R = R_C$ by system of electrons as well as by system of positrons.

We can consider also the case when a system of neutrina is placed between electrons and positrons. It is expected that rotating character of neutrina diminish effect of electrostatic interactions and by this act similarly as the force f_{ATTn}.

Let us consider a neutral meson which is composed, in accordance with vacuum medium mechanics, of several electron-positron pairs and a system of neutrina. We observe various ways of decay of neutral mesons. More light mesons of this kind decay into other mesons, neutrina and leptons. Decay into barions happens for more heavy neutral mesons. Let us mention here an important case of J/ψ meson. About one per cent of cases of decay of J/ψ contain proton-antiproton pair. The question is how proton could be produced within this meson.

Above discussed scenario could provide an answer to this question. The proton could be synthesized within internal structure of J/ψ meson, when three positrons find themselves approximately on the circle of radius $R = R_C$. Electrostatic repusion of positrons makes difficult to attain the critical condition since then R_C is small. However, the meson is neutral. Consequently it is imaginable that three positrons and three electrons present in the neutral meson could find themselves on parallel rings where between two each positrons the most close is one electron from the neighbouring ring placed at sufficiently small distance. Attaining of such a configuration can be supported by system of neutrina. Then, in accordance with our discussion R_C increases owing to screening of electrostatic repulsion. Consequently, probability of attaining discussed here critical conditions also increases.

Let us mention that neutron structure suggests that neutrino makes possible coexistence of proton and electron at small distances. Similar situation could happen on the inside of the meson J/ψ. Thereby, we assume that the meson J/ψ contain at least three electron-positron pairs in order to create three-positron ring and three-electron ring.

In general one assumes that the meson J/ψ is composed of three electron-positron pairs and a system of neutrina. Such a complex system of dynamically interacting particles is unstable and decays in various ways. In particular, part of such decays is continued by synthesis of stable barions.

Relatively long lifetime of the meson J/ψ suggests that the system of particles within this meson is in pre-proton state together with corresponding pre-antiproton state characterized by radius $R_C < R < R_{preP}$. Then, attraction of particles following from forces of the chain state increases which follows longer lifetime of this meson.

Summarizing, it seems that way of decay of the J/ψ meson especially to stable barions as well as its long lifetime considerably support the point of view that proton is composed of three positrons in the chain state. Consequently we can formulate two additional arguments supporting three-positron structure of proton as follows:

10. Decay of J/ψ meson into proton antiproton pair, resulting from conditions leading to creation of corresponding chain states of three-positrons and three electrons within the neutral meson.

11. Relatively long lifetime for the meson J/ψ perhaps induced by pre-proton and pre-antiproton chain states.

IV. ON INTERACTIONS OF NEUTRINO WITH CHARGED PARTICLES

A. On possibility of modelling of bounded state of neutrino with charged particle

Neutrino is rotating part of the component ϱ within stable vacuum medium also composed of ϱ. The rotating component is separated from resting one by a discontinuity surface. On this surface slip with a velocity happens.

In case when external electric field is applied and neutrino moves in this field we have to consider how the electric field is propagated. Both media: the resting one and rotating one have the same structure and by this similar mechanism for propagation of electric field. However, external field polarizes the medium on the surface of neutrino. Thereby the component a is partially bare and moves with respect to moving part of the ϱ-medium. In accordance with Maxwell equations for the vacuum medium [1] in this case we can consider a current of the component a which induces electric field. Consequently, we assume that a kind of current appears on the surface of neutrino. This current can be expressed by the formula

$$\mathbf{j}_S = C_j|\mathbf{u}|\mathbf{v}_S \; , \tag{10}$$

where C_j is a constant and $|\mathbf{u}|$ is length of the vector $\mathbf{u}$ representing electric intensity, $\mathbf{v}_S$ is velocity of slip on the surface of neutrino.

High velocity of neutrino, its rotating motion in presence of external, strong electric field induces electromagnetic field. This field can propagate within neutrino as well as on the outside of this particle. Therefore, it is possible to model observed change of motion of electron during neutrino-electron scattering process [10]. Such a change in motion can happen owing to pure electromagnetic field induced by neutrino. Evolution of this kind could also occur by means of the boson Z which has decay mode similar to particle-antipartice pair and therefore could happen in considered conditions. However high mass of the boson Z suggests that pure electromagnetic interactions happens in this place instead of interchange of the boson Z.

We can consider neutrino as cylinder with lateral surface $\mathcal{S}_L$ and base surfaces $\mathcal{S}_F$, $\mathcal{S}_B$ approximately. Free motion of neutrino is realized by surfaces $\mathcal{S}_F$, $\mathcal{S}_B$ which do not need be flat. However interaction with charged particle should be considered on the surface $\mathcal{S}_L$ where corresponding forces could maintain unstable motion around charged particle [2]. Then the neutrino can be modelled as in bounded state.

B. Interpretation of the new light boson E(38) considered within vacuum medium mechanics

Above discussed possibility of existence of bounded state of electron and neutrino introduces a new classification of elementary particles. We can admit internal structure of particles which considers electron and sequentially increasing number of neutrina in bounded state. Thereby we have to do with muon μ^- having two neutrina and mass $M_2 = 105MeV$ in accordance with its decay, meson π^- having mass $M_3 = 139MeV$ with three neutrina in its decay, lepton τ^- having four neutrina and mass $M_4 = 1776MeV$.

We see that increasing number of neutrina causes increasing of mass which is explained by mechanism of motion of charged particle. In above cases neutrina make more difficult acceleration of particles by screening of charged particle and preventing efficient action of external electric field on surface of this particle. This means just increasing of mass, considered as a resistance against acceleration, of whole system of electron and neutrina.

Let us also note that we have omitted in discussed above sequence of particles the case of electron with one neutrino. We do not observe such a particle what suggests that electron and one neutrino could have extremely short lifetime. On the other hand we have that masses increase gradually. Consequently we have that $M_2 < M_3 < M_4$. This suggests in turn that potential particle with one neutrino should have mass placed between mass of electron and mass M_2.

Let us note that in papers [11] and [12] physicists have reported discovery of a new boson $E(38)$ with mass $38MeV$. Such a mass fits to our classification of particles. Therefore we could suppose that it could be electron with one neutrino.

The boson is discovered by means of collision of heavier particles or their interactions. Let us note that proton, within vacuum medium mechanics is composed of three positrons. Mesons are bounded states of electrons, positrons and various neutrina. Neutron is viewed as bounded state of proton, electron and neutrino. Then, it is imaginable that interactions of heavier particles having appropriate components can force production of bounded state of electron and neutrino which emit electromagnetic waves when it decays.

Let us also remember that bounded state of electron and neutrino is caused by static electric field of electron and rotation of neutrino as part of the vacuum medium which disturbs dynamically the static electric field. Thereby this interaction has electromagnetic nature. Consequently, we can expect electromagnetic signal when the bounded state decays.

Summarizing, it is encouraging to interpret the boson $E(38)$ as lacking part of the sequence of particles with increasing number of neutrina and consider mass $38MeV$ as $M_1 = 38MeV$ corresponding to electron and neutrino in a bounded state.

V. ON STRUCTURAL CLASSIFICATION OF ELEMENTARY PARTICLES RELATED TO SCALE SC_1

We have elaborated point of view on structure of proton basing on theoretical concepts of the vacuum medium mechanics and also on interpretation of experimental observations. We have discussed eleven arguments following from rather independent experimental observations of various phenomena and interpreted within vacuum medium mechanics. Number of these arguments makes almost sure that proton has just three-positron structure.

On the other hand we have discussed interactions of neutrino with other particles. This particle can create bounded unstable states with charged particles. Thereby, we can propose models of heavy leptons and barions considering them as bounded states of the most elementary particles such as electron, positron and neutrino.

We could suggest classification of elementary particles which is based on their structure only, neglecting its internal states depending on energy and other dynamical characteristics. We do it for vacuum medium model related to scale denoted here by SC_1 where electron is composed of the component a without its particular interpretation. Multiscale considerations allow us to discuss in what follows also deeper structural interpretation of electron where scale of averaging applied during modelling is smaller and is denoted here by SC_2.

We distinguish three main systems $\{e^-\}$ which contains electron, $\{e^-,\ p\}$ which contains electron and proton, and $\{p\}$ containing proton. Additionally we distinguish the following systems: systems of neutrina of various kind $\{\nu_i\}$ $i = 1, 2, 3$ corresponding to electron neutrino, muon neutrino and tau neutrino, and the system $\{e_0\}$ containing electron and positron.

We introduce four numbers $n_{\nu i}$ and m_0. They characterize number of i-th kind of neutrina and number of electron-positron pairs in structure of elementary particle. We introduce furthermore the total number of neutrina of all kinds $n_\nu = \sum_i n_{\nu i}$.

The structure of elementary particles is represented by the following main systems $\{e^-\}$, $\{p\}$ and corresponding antiparticles by $\{e^+\}$, $\{\bar{p}\}$, where $\bar{p}$ is antiproton.

Then, structure of more complex elementary particles could be represented by notations

$$\{\{e^-\},\ \{n_{\nu i}\},\ m_0\}\ , \tag{11}$$

$$\{\{e^-,\ p\},\ \{n_{\nu i}\},\ m_0\}\ , \tag{12}$$

$$\{\{p\},\ \{n_{\nu i}\},\ m_0\}\ , \tag{13}$$

where (11) represents electron in bounded state with corresponding numbers $n_{\nu i}$ of neutrina of i-th type and number m_0 of systems $\{e_0\}$, (12) represents electron and proton in bounded state with corresponding numbers $n_{\nu i}$ of neutrina of i-th type and number m_0 of systems $\{e_0\}$ and (13) represents proton in bounded states with particles considered also in (11) or (12).

Corresponding antiparticles are then represented by analogous notations

$$\{\{e^+\},\ \{n_{\nu i}\},\ m_0\}\ , \tag{14}$$

$$\{\{e^+,\ \bar{p}\},\ \{n_{\nu i}\},\ m_0\}\ , \tag{15}$$

$$\{\{\bar{p}\},\ \{n_{\nu i}\},\ m_0\}\ . \tag{16}$$

We introduce also elementary particles represented by

$$\{\{n_{\nu i}\},\ m_0\}\ , \tag{17}$$

where the particular numbers $n_{\nu i} \geq 0$, $m_0 \geq 0$ and $n_\nu + m_0 > 0$. The last condition ensures that the set (17) is not empty.

We do not discriminate neutrina and antineutrina since within the vacuum mechanics they have the same structure and can differ by orientation related to dynamics only.

We do not discuss here dynamics of introduced above internal structure of elementary particles. Let us note that neutrino within vacuum medium mechanics discussed here is considered as a dynamical state of the vacuum medium. Therefore, it is not clear what kind of neutrino could be considered on the inside of particle. We know that we are able to distinguish three types of neutrina. However, they are considered in stationary state after decay of particle. Furthermore, even this fact is not sure. We could expect that neutrina are not entirely stable since they can change their type. Therefore, main systems are considered separately from the neutrina systems.

In other words considered here classification seems to be stable with respect electrons, positrons, protons and antiprotons. However, dynamics of the vacuum medium can introduce various additional aspects for such a classification. The question is for instance whether observed unstable particles, especially these ones which are more complex and heavy, have precisely defined internal structure. To what degree they can have various structures and with such various internal structures they could be identified experimentally as the same type of particle.

This problem is important especially when we discuss antiparticles of complex and heavy particles. Are we able to define antiparticles precisely in such a case?

Let us replace particular numbers of neutrina in our classification by one total number of neutrina n_ν. Within discussed here classification it is suggested that within category (11) with $m_0 = 0$ we have to do with particle E(38), for $n_v = 1$, with muon for $n_v = 2$, with pion for $n_v = 3$ and lepton tau for $n_v = 4$.

The category (12) contains neutron for $n_v = 1$, $m_0 = 0$ and neutral barions for larger numbers considered there.

The category (13) contains charged barions. The category (17) contains various types of neutrina when $n_v = 1$ and $m_0 = 0$. When $m_0 > 0$ we have to do with positronium or neutral mesons.

Let us mention also particularly interesting example of elementary particles associated with $m_0 = 3$. Then, we have to do with three electrons and three positrons on the inside of particle in unstable bounded state. Then, there is a chance that the three electrons and three positrons in convenient conditions synthesize proton and antiproton. We observe such a case when J/ψ decays. Part of these decays contain proton-antiproton pair. This suggests that within J/ψ chain state of three electrons as well as chain state of three positrons can appear. Strength of the chain states explains relatively long lifetime of the meson J/ψ.

We can suggest that when proton and antiproton appear in decay products then we have to do with particle with $m_0 \geq 3$.

Having in mind above conclusion we can suggest possible structural components of the $Z_c(3900)$ recently discovered and commented as four quark structure. The last point of view follows from possible decay of this particle into charged pion and J/ψ.

Pion is composed of electron or positron and three neutrina within our classification. On the other hand the J/ψ has $m_0 \geq 3$. Consequently we have to do in negative $Z_c(3900)$ with four electrons and three positrons and at least three neutrina. However precise determination of structural components can be difficult taking into account internal dynamics of such a particle. We can expect namely that within $Z_c(3900)$ internal dynamics can provide convenient conditions for creation of electron-positron pairs and additional neutrina.

In general structural classification of elementary particles can be difficult. We can have difficulties with precise determination of internal content of unstable elementary particles. This is so since we interpret them by decay products. It seems that such a classification should be supported by detailed mathematical models of their internal structure including dynamics. Vacuum medium mechanics gives chance for constructing corresponding models by development of model of electron and models of neutrina. Models of electron determine in turn description of proton. By means of such models description of heavier unstable particles is imaginable.

Within context provided by models of internal structure of elementary particles we can discuss more precisely what we understand by antiparticle for more complex particles. Then better interpretation of results of experimental investigations carried out in LHCb will be possible.

Let us also remark that photon is not elementary particle. Photon represents propagation of energy by mechanism of interactions of electric and magnetic field in form of waving. Photon is not associated with rotation of components separated by discontinuity surface.

Thereby, we can define elementary particle as system containing at least one element identified with rotating component separated from resting medium by discontinuity surface. Elementary particle can be associated with waving of component distribution. However, within this description the elementary particle is not identified with wave.

VI. AN ATTEMPT TO STRUCTURAL CLASSIFICATION OF ELEMENTARY PARTICLES RELATED TO SCALE SC_2

A. Introductory remarks

Within above presented classification of elementary particles electron is composed of component a which is not specified in details. Then applied averaging methods are related to scale SC_1.

The question is whether is it possible to distinguish any structure within electron. We discuss here theoretical speculations related to deeper structure of vacuum medium where we apply still smaller scale of averaging in modelling, denoted here by SC_2, than this is done in hitherto discussed vacuum medium models corresponding to scale SC_1.

B. Assumptions related to the model

We assume first that at the lowest scale discussed here the vacuum medium is considered as a stable background for other processes. This stable background is composed of three dominant components. The first one is associated with gravitational field $\mathbf{h}$ and next two components are associated with the fields $\mathbf{w}$ and $\bar{\mathbf{w}}$ which generate magnetic field $\mathbf{q}$. Then, no electric field is considered.

We assume furthermore that components $\varrho_{\mathbf{w}}$ and $\varrho_{\bar{\mathbf{w}}}$ can be separated. These components correspond with ϱ_w and $\varrho_{\bar{w}}$ related to scale SC_1. This separation leads to magnetic monopoles of two kinds. Such objects should be rather of finite size. Therefore we assume, similarly as for electron, that they have spherical form and rotate.

Introduced monopoles are considered as main components of a and b-media as well as ϱ_v and $\varrho_{\bar{v}}$ responsible for generation of electric field within SC_1 scale model.

Let us note that we do not observe magnetic monopoles in our world. Then, it would be justified that creation of them should be difficult and does not happen in conditions which we are able to create. Such conditions, perhaps would be attainable somewhere in Universe where our space can be produced.

Let us note that electron generates electric field since attraction within corresponding components leads to polarization of components ϱ_v and $\varrho_{\bar{v}}$ within stable ϱ-medium. Discussed above monopoles should not generate of magnetic field at larger distances in perpendicular to surface of monopole direction in similar way. This is so since we do not observe magnetic field in empty space. Within our concept electron is composed predominantly of magnetic monopoles with component

$\varrho_{\mathbf{w}}$ considering scale SC_2. In case when monopoles would have long range magnetic field in perpendicular direction then the resting electron also should generate static magnetic field in radial direction considered in relation to magnetic charge. Therefore, within this concept the magnetic field should be suppressed at least at larger distances in perpendicular direction.

Let us discuss some aspects of motion of our monopole in the background medium. Thus, we assume that our monopole is produced as a result of separation of components $\varrho_{\mathbf{w}}$ and $\varrho_{\bar{\mathbf{w}}}$ from

$$\varrho_{\mathbf{q}} = \varrho_{\mathbf{w}} + \varrho_{\bar{\mathbf{w}}} \tag{18}$$

considered as a part of the whole vacuum medium representing the background.

We assume that the monopole after separation of its component undergoes rotation and takes shape similar to a sphere. This happens owing to nonlocal attracting forces within each component of the medium and forces which act on the surface of particle. This happens in similar way as for electron [7] but forces considered here can have another character.

Consequently, we consider monopole particle composed of $\varrho_{\mathbf{w}}$ separated from $\varrho_{\mathbf{q}}$ by a discontinuity surface $\mathcal{S}_{\mathbf{w}}$ sometimes denoted also by $\mathcal{S}_{\mathbf{q}}$. Then, motion of this surface corresponds to motion of the monopole.

The surface $\mathcal{S}_{\mathbf{w}}$ is considered as a discontinuity surface for various fields describing state of the medium. In particular densities of components are changing on $\mathcal{S}_{\mathbf{w}}$ in a discontinuous way. Thereby, in order to analyze motion of our particle we should consider various balance equations taking into account discontinuity surface within assumed continuum description.

We should decide whether we accept energy as valid for this level of description together with its balance equation. Similarly, we should decide whether balance of amount of particular components can be accepted. Then, all balance equations together with corresponding constitutive equations should describe consistently motion of particle.

C. Description of magnetic monopoles and their interactions

We accept conservation of energy law in description of magnetic monopoles. Furthermore we admit balance of amount of corresponding components in this description.

We discuss here balance of the component $\varrho_{\mathbf{q}}$ for characterization of motion of the particle in the background medium.

We admit here that the medium $\varrho_{\mathbf{q}}$ can deform which is described by means of the deformation function $\mathbf{x}_q$. This deformation is related to displacements $\mathbf{w}_G = \mathcal{G}_w(\mathbf{w})$ and $\bar{\mathbf{w}}_G = \mathcal{G}_{\bar{w}}(\bar{\mathbf{w}})$ introduced by (3) assigned to magnetic field within SC_2 type of elementary units. Then, the corresponding balance equation is considered in the following form

$$\int_{\mathbf{x}_q(U)} \frac{\partial \varrho_{\mathbf{q}}}{\partial t} dV + \int_{\partial \mathbf{x}_q(U)} \varrho \dot{x}_{qi} m_i d(\partial V) + \int_{\mathcal{S}_{\mathbf{q}}} [[\varrho]] V_i n_i da +$$

$$+ \int_{\partial \mathbf{x}_q(U)} W_i^{\varrho} m_i d(\partial V) - \int_{\mathcal{S}_{\mathbf{q}}} r_S da = 0 \tag{19}$$

and is valid for each subset $\mathbf{x}_q(U)$ of E^3.

We have introduced in (19) the following notations: $\mathbf{m} = \{m_i\}$ stands for unit and normal vector to $\partial \mathbf{x}_q(U)$, $\mathbf{n} = \{n_i\}$ is such a vector related to $\mathcal{S}_{\mathbf{q}}$, $\mathcal{S}_{\mathbf{q}}$ is a discontinuity surface, W_i^{ϱ} are components of efflux of balanced quantity through $\partial \mathbf{x}_q(U)$, r_S is surface source of $\varrho_{\mathbf{q}}$, $[[\varrho_{\mathbf{q}}]] = \varrho_{\mathbf{q}}^- - \varrho_{\mathbf{q}}^+$, where $\varrho_{\mathbf{q}}^+$ is value of $\varrho_{\mathbf{q}}$ on +-side of $\mathcal{S}_{\mathbf{q}}$ determined by positive sense of the vector $\mathbf{n}$ and $\varrho_{\mathbf{q}}^-$ is value of ϱ on negative side of $\mathcal{S}_{\mathbf{q}}$.

Let us note that we have applied above continuum mechanics approach with discontinuity surface in classical sense [13], [14].

We assume here that $[[\varrho_{\mathbf{q}} \dot{x}_{qi}]] m_i = 0$ and $W_i^{\varrho_{\mathbf{q}}} = 0$ on the boundary of $\mathbf{x}_q(U)$, because the medium $\varrho_{\mathbf{q}}$ is stable and the surface $\partial \mathbf{x}_{\mathbf{q}}(U)$ deforms together with the medium. Furthermore, in this case we have $\varrho_{\mathbf{q}}^- = 0$, $\varrho_{\mathbf{q}}^+ = \varrho_{\mathbf{q}}$ and, finally, $[[\varrho]] = -\varrho_{\mathbf{q}}$.

The equation (19) is valid for all $\mathbf{x}_q(U)$. Thus let us consider a family of sets $\{P_k\}$ with property $P_{k+1} \subset P_k$, $\mathcal{S}_{\mathbf{q}} \subset P_k$ for each $k \in N$ and $\bigcap_k P_k = \mathcal{S}_{\mathbf{q}}$. When we apply this sequence of sets with condition $\mathbf{x}_q(U(k)) = P_k$, where $U(k)$ is corresponding sequence of sets, then all terms of (19) having $\mathbf{x}_q(U)$ tend to zero when $k \to \infty$. Finally we obtain local form of balance of amount of component $\varrho_{\mathbf{q}}$ on the surface $\mathcal{S}_{\mathbf{q}}$ as follows

$$U_n = -\frac{r_S}{\varrho_{\mathbf{q}}} , \tag{20}$$

where $U_n = V_i n_i$.

The equation (20) shows that the surface moves in positive sense of vector $\mathbf{n}$ when r_S is negative. It means also that such a motion is associated with decomposition of $\varrho_{\mathbf{q}}$ on the outside of particle near the surface.

Consequently, character of motion of our particle depends predominantly on form of constitutive equation imposed on r_S. In order to characterize corresponding constitutive equations we should assume what kind of properties of the vacuum medium should be modelled.

Explosion of space during annihilation of electron and positron seems to be important property of the vacuum medium since model of Big Bang constructed on this basis has good qualitative accordance with astrophysical observations [3].

We would like to introduce several conditions for modelling motion of $\varrho_{\mathbf{w}}$ and $\varrho_{\bar{\mathbf{w}}}$ particles in order to obtain property of explosion of space in the context which additionally creates an area for modelling of other properties of the vacuum medium.

Let us consider an energy formula

$$E = \int [C_{\mathbf{w}} e^2_{\mathbf{w}_N} + C_{\bar{\mathbf{w}}} e^2_{\bar{\mathbf{w}}_N} + C_\eta e^2_{\eta_N} + e_{LOC}(\mathbf{w},\ \bar{\mathbf{w}},\ \eta)] dV \ , \tag{21}$$

where $e_{\mathbf{w}_N} = div(\mathbf{w}_N)$, $e_{\bar{\mathbf{w}}_N} = div(\bar{\mathbf{w}}_N)$, $e_{\eta_N} = div(\eta_N)$, and index N is related temporarily to some additional fields related to $\mathbf{w}$, $\bar{\mathbf{w}}$, η and discussed further.

We have introduced an additional vector field η which is associated with generation of $\mathbf{q}$ for strong fields of this kind. Thus, η reflects an internal and postulated structure of background vacuum medium which is not detected at larger scale.

Introduction of the field η is aimed at modelling of particular near-to-surface processes associated with existence of discussed here particles. Conjugation between fields $\mathbf{q}$ and η are described predominantly by the term of energy denoted by e_{LOC}. Thereby, e_{LOC} is energy density assigned to each point of the medium $\varrho_{\mathbf{q}}$ or more precisely to each elementary unit corresponding to discussed scale. Graph of this function is spanned on space of variables $V_q = \{\mathbf{w},\ \bar{\mathbf{w}},\ \eta\}$.

The function e_{LOC} can be considered in the form

$$e_{LOC} = e_H(\mathbf{w},\ \bar{\mathbf{w}},\ \eta) + \Phi(\mathbf{w},\ \bar{\mathbf{w}}) \ , \tag{22}$$

where the function Φ for low energy field $\mathbf{q}$ takes the form

$$\Phi(\mathbf{w},\ \bar{\mathbf{w}}) = k_q(\mathbf{w} - \bar{\mathbf{w}}) = k_q \mathbf{q}^2 \tag{23}$$

representing part of energy for magnetic field [1]. It is assumed that for larger energy the function Φ can deviate from (23).

The term e_H can be expressed as $e_H = e_1 + e_2$ and characterized by its graph in the space $V_R = V_q \times R$, where R is the set of real numbers. To this end we can distinguish particular paths considered as one-dimensional manifolds in subspaces of V_q.

Let

$$p_1(\mathbf{w},\ \eta) = \{\{\mathbf{w},\ \eta)\} :\ \eta = \mathbf{0}\ for\ |\mathbf{w}| \leq |\mathbf{w}|_s,\ \eta \perp_s \mathbf{w}\ for\ |\mathbf{w}| > |\mathbf{w}|_s\} \tag{24}$$

and

$$p_2(\bar{\mathbf{w}},\ \eta) = \{\{\bar{\mathbf{w}},\ \eta)\} :\ \eta = \mathbf{0}\ for\ |\bar{\mathbf{w}}| \leq |\bar{\mathbf{w}}|_s,\ \eta \perp_s \bar{\mathbf{w}}\ for\ |\bar{\mathbf{w}}| > |\bar{\mathbf{w}}|_s\}\ . \tag{25}$$

We assume furthermore that $|\eta| = |\eta|(|\mathbf{w}|)$ is increasing function until the condition $\mathbf{w} = \mathbf{w}^*$ corresponding to separation of components is attained. It is assumed also that $\mathbf{w} = \mathbf{w}^*$ represents end of the path p_1. Similar property is assigned to $|\eta| = |\eta|(|\bar{\mathbf{w}}|)$. We do not discuss more precisely of the relation $\perp_s$ now. It means that direction of η will be interpreted on the perpendicular plane to considered vectors. This will be discussed later. Consequently we have defined two paths in subspaces $V_{\mathbf{w}} \times V_\eta$ and $V_{\bar{\mathbf{w}}} \times V_\eta$ of V_q correspondingly.

Domain of the function e_1 can be expressed as generalized Cartesian product

$$D_1 = p_1 \times_f d_1\ , \tag{26}$$

where p_1 is a basis and d_1 is a chosen fibre of the fibre bundle or equivalently as

$$D_1 = \bigcup_{p \in p_1} d_1(p)\ , \tag{27}$$

where $d_1(p)$ are considered as fibres and p_1 is considered as basis of the fibre bundle D_1. Similar consruction can be considered for the domain D_2.

Let us consider $f_1 : p_1 \to R$ and $f_{d1}(p) : d_1(p) \to R$. The functions $f_{d1}(p)$ are considered as having one minimum at the point p where p_1 intersects $d_1(p)$. Let $G(f_{d1}(p))$ stand for graphs of functions $f_{d1}(p)$. Then, the graph of the function e_1 can be expressed as the fibre bundle

$$G_1 = \bigcup_{p \in p_1} G(f_{d1}(p))\ , \tag{28}$$

and by analogy we obtain also graph of the function e_2 as

$$G_2 = \bigcup_{p \in p_2} G(f_{d2}(p)) \; . \tag{29}$$

Above considerations are related to a given point of space. Further considerations should be carried out taking into account character of space distribution of fields $\mathbf{w}$, $\bar{\mathbf{w}}$ and η. With the aid of (21) and some simplifications, introducing also that $\mathbf{w}_N = C_{\mathbf{w}}\mathbf{w}$, $\bar{\mathbf{w}}_N = C_{\bar{\mathbf{w}}}\bar{\mathbf{w}}$, $\eta_N = C_\eta \eta$ we postulate that fields are distributed in space by means of equations

$$div(C_{\mathbf{w}}\mathbf{w}) = 0 \; , \;\; \mathbf{w}(\mathbf{x}) = \mathbf{w}|_S(\mathbf{x}) \; , \;\; \mathbf{x} \in \mathcal{S}_{\mathbf{w}} \; , \tag{30}$$

$$div(C_{\bar{\mathbf{w}}}\bar{\mathbf{w}}) = 0 \; , \;\; \bar{\mathbf{w}}(\mathbf{x}) = \bar{\mathbf{w}}|_S(\mathbf{x}) \; , \;\; \mathbf{x} \in \mathcal{S}_{\bar{\mathbf{w}}} \; , \tag{31}$$

and

$$div(C_\eta \eta) = 0 \; , \;\; \eta(\mathbf{x}) = \eta|_S(\mathbf{x}) \; , \;\; \mathbf{x} \in \mathcal{S}_\eta \; , \tag{32}$$

with boundary conditions on some surfaces. In case of monopoles the surface $\mathcal{S}_\eta$ coincide with surface of corresponding particle. Constants become dependent on variables $C_{\mathbf{w}} = C_{\mathbf{w}}(\eta)$, $C_{\bar{\mathbf{w}}} = C_{\bar{\mathbf{w}}}(\eta)$ and $C_\eta = C_\eta(\mathbf{w}, \; \bar{\mathbf{w}})$ in what follows.

Form of introduced dependence of constants is aimed at ensuring of suppressing of static magnetic field generated by monopole at larger distances. Then, $C_{\mathbf{w}}(\eta)$ is large when $\mathbf{w}$ is perpendicular to η and smaller when $\mathbf{w}$ is parallel to η. This kind of anisotropy is aimed at suppressing magnetic field directed towards particle and transmitting more efficiently field tangent to surface of particle. The last case is related to generation of magnetic field by motion which has then just tangent character.

On the other hand dependence $C_\eta(\mathbf{w}, \; \bar{\mathbf{w}})$ is in general nonlinear and is aimed at describing propagation of η.

We have discussed in a general way generation of various fields in a neighbourhood of monopoles. The aim of these considerations is discussion of conditions which should be satisfied in order to obtain within the model considerable change of volume between media a and ϱ.

Let us note that velocity of whole particle V_P is an averaged velocity of velocities of all points of the surface of particle. Velocities corresponding to points of the surface are given by (20) where r_S is dominant factor. Consequently we can write

$$V_P = Av[U_n(r_S(\mathbf{x})),\ \mathbf{x} \in \mathcal{S}_{\mathbf{q}}] \ , \tag{33}$$

where Av is an averaging procedure.

Consequently, in order to discuss direction of motion of the particle we should impose constitutive equations on r_S. Such constitutive equations should have nonlocal form since ability to transfer appropriate component into particle depends on state of this component as well as its interactions with other components in some neighbourhood U of the point and the surface. Thereby, we assume that

$$r_S = r_S(\mathbf{w}(U),\ \bar{\mathbf{w}}(U),\ \eta(U)) \ . \tag{34}$$

Detailed form of the constitutive equation is rather complicated when we would like to take into account all effects responsible for motion of particle. It is assumed that motion of particle follows from competition of various forces. Some of them act from external with respect to particle part of the medium. However, discussed particle is a dynamical object. It should have its own stability at resting. Such a stability follows, by assumption, from competition of nonlocal forces acting within medium of the particle. They extract the component from external medium into particle and reduce the particle due to interaction between stable medium $\varrho_{\mathbf{q}}$ and medium of the particle $\varrho_{\mathbf{w}}$ on the surface of the particle during its rotation.

External forces which induce motion are imposed on such complex dynamical phenomenon. Thereby, at this moment we do not discuss form of the equation (34) precisely. However, we can characterize conditions which should be imposed on the equation (34) in order to describe assumed effects.

Let us consider two particles composed of the same component $\varrho_{\mathbf{w}}$. Then, in case of no presence of the field η we have to do with repulsion of such particles. This is so since the field $\mathbf{w}$ between particles is weaker than on their opposite sides. It means that the components can be separated and extracted from external medium more easily on opposite sides of particles. This means in turn that averaged velocities of both free particles should have opposite directions and have their senses on the outside of the system.

However, presence of the field η suppress the field $\mathbf{w}$ at larger distances. Thus repulsion is continued only for small distances. We assume furthermore that propagation of the field η leads to its presence sufficiently far beyond the field $\mathbf{w}$ in similar form as it takes on the surface of the first particle. Then, presence of η near the second particle can make more easily to attain critical values of $\mathbf{w} = \mathbf{w}^*$ for the second particle on the side placed closer to the first particle. This is so since the critical condition for the field $\mathbf{w}$ is attained in cooperation with the field η in accordance with (24).

In other words both fields are closer to the end of the path p_1 in presence of η what makes more easy separation of components in regions between particles. It means that at larger distances velocities should be directed to inside of the system which means that they attract themselves.

We come to the conclusion that there exists a distance between particles $\delta_{\mathbf{ww}}$ which corresponds to fading of force between particles in radial direction.

Let us consider now two particles: one composed of the components $\varrho_{\mathbf{w}}$ and the second one composed of $\varrho_{\bar{\mathbf{w}}}$. We neglect at the moment role of the field η. Then, the fields $\mathbf{w}$ and $\bar{\mathbf{w}}$ propagate between particles more easily than in the case of particles with the same components. It follows among others from the energy term $\Phi(\mathbf{w},\ \bar{\mathbf{w}})$. We see that both fields cooperate in order to separate components. Then, on zones of surfaces of both particles placed between them we have stronger fields necessary for exceeding critical condition for separation. It means that particles attract themselves. This can happen on considerably larger distances than $\delta_{\mathbf{ww}}$ just owing to cooperation of the fields $\mathbf{w}$ and $\bar{\mathbf{w}}$ in separation of components.

Let us introduce the field η. We assume that the field η near the surface of the first particle is opposite in some sense to the field η near surface of the second particle in places which lie on line joining centers of particles. Let us note that η are assumed to be tangent to the surfaces. We neglect at this moment more precise discussion on orientation of η on the tangent space which will be discussed in what follows.

Consequently, opposite character of the field η near particles follows that the field is approximately equal to zero between particles. This in turn means that in central region of particles it is difficult to obtain critical condition for separation of components. Form of paths p_1 and p_2 justify this point of view since the critical conditions for separation of components are associated with the field η characteristic for ends of the paths p_1 and p_2. In central region placed between particles we have that $\eta = 0$.

In other words, particles attract themselves at larger distances. However when they are closer then attractive motion becomes impossible since critical condition for separation of components cannot be attained by η. It means that at smaller distances particles undergo repulsion. Shape of the function of energy density e_{LOC} describes this. In case when η is placed far from paths p_1 or p_2 then energy increases considerably since minima are placed just on these paths. Consequently, there exists a distance $\delta_{\mathbf{w}\bar{\mathbf{w}}}$ where no force in radial direction between particles act.

Above discussion leads also to hypotheses on structure of vacuum medium ϱ considered in larger scale when components a and b are not separated. In low energy state particles $\varrho_{\mathbf{w}}$, $\varrho_{\bar{\mathbf{w}}}$ move approximately on spheres determined by interactions between the same and opposite monopoles. Electrical neutrality of the medium means that $\varrho_{\mathbf{w}}$ and $\varrho_{\bar{\mathbf{w}}}$ are on opposite sides of a sphere considering their averaged state and do not manifest any particular direction in this state. However, shifting of an averaged position of one monopole $\varrho_{\mathbf{w}}$ on the sphere can be attained owing to attractive force acting between the same monopoles. Thereby, when $\varrho_{\mathbf{w}}$ from another sphere is translated in an averaged way than a translation of similar monopole can happen also on our previous sphere. We assume that measure of this shifting considered as change of its averaged position is represented by a vector interpreted as electric intensity field vector assigned to region where the sphere is considered.

We have to assume that $\delta_{\mathbf{w}\bar{\mathbf{w}}}$ is considerably larger than $\delta_{\mathbf{w}\mathbf{w}}$ what means just that space ϱ recovered from joining of components a and b expands during annihilation of electron and positron. Such a property can be attained when we assume additionally that larger gradients of η lead to considerable increasing of energy. Opposite field on surface of particles $\varrho_{\mathbf{w}}$ and $\varrho_{\bar{\mathbf{w}}}$ leads to larger gradient than for two particles with $\varrho_{\mathbf{w}}$. Then, lowering this gradient we have to cause increasing just $\delta_{\mathbf{w}\bar{\mathbf{w}}}$ in comparison with $\delta_{\mathbf{w}\mathbf{w}}$.

D. Concept of the two-ring field

At this moment we can suggest interpretation of the variable η. One suggests that η is associated with the two-ring field. Two rings have coinciding centers and are placed on the same plane perpendicular to developing $\mathbf{w}$ and $\bar{\mathbf{w}}$ between particles. Then $\eta = R_{\bar{\mathbf{w}}} - R_{\mathbf{w}}$. In other words when $\mathbf{w}$ and $\bar{\mathbf{w}}$ increase along the paths p_1 and p_2 then increasing η means that two rings becomes separated.

When we consider particle composed of $\varrho_{\mathbf{w}}$ then corresponding ring with radius $R_{\mathbf{w}}$ diminishes with approaching to the particle. Then, separation of components into the particle is associated with separation of $\varrho_{\mathbf{w}}$ together with the ring component.

When we consider particle composed of $\varrho_{\bar{\mathbf{w}}}$ then corresponding ring with radius $R_{\bar{\mathbf{w}}}$ diminishes when we consider points closer to the particle. Therefore the variable η can have opposite sign.

Thereby, taking it more precisely the monopole particle is composed of $\bar{\varrho}_{\mathbf{w}} = \{\varrho_{\mathbf{w}}, c_{\mathbf{w}}\}$, where $c_{\mathbf{w}}$ is component associated with the ring $R_{\mathbf{w}}$. This means that we consider larger number of components in background vacuum medium. However, we do not specify them for simplicity and identify $\varrho_{\mathbf{w}}$ with $\bar{\varrho}_{\mathbf{w}}$ at this stage of considerations.

E. Discussion of status of gravitational field

We have introduced gravitational field within background vacuum medium by assumption. It means that we have not sufficient number of premises for postulating more details related to structure associated with the medium. We can postulate traditional behavior of this field by corresponding equations. Then, equations introduced for scales SC_1 have the same structure as for scale SC_2. It means that in the last case averaging is related to smaller volume.

Properties of the gravitational field in relation to scale SC_2 should be determined also by interactions with electromagnetic waves as well as by mechanisms of motion of particles induced by gravitational field. In the first case influence of this field on interactions between electric and magnetic field should be modelled within SC_2 scale model. In the second case way of making more difficult separation of components with increasing gravitational field should be described. This phenomenon is responsible just for gravitational attraction of massive particles.

However we can admit also another case which has more detailed interpretation. We have introduced the variable $\mathbf{h}_G$ as describing deformation of the vacuum medium in similar case as it was discussed in previous sections for SC_1 scale model. Then, this variable was interpreted as related to gravitation in case when it leads to deformation characterized predominantly by change of volume. When shear deformation is associated with this variable and is dominant phenomenon then this variable was applied to description of neutrino [2].

We can admit the situation when the variable $\mathbf{h}_G$ is associated with deformation of sphere where two monopoles interact within equilibrium vacuum medium. Having in mind that equilibrium vacuum medium is interpreted as uniformly distributed set of pairs of monopoles moving approximately on spheres we can also admit that such spheres could be deformed. Then, variable $\mathbf{h}_G$ would represent averaged deformation of corresponding spheres and would be related to scale SC_1 with deformation related predominantly to volume change.

In case when corresponding deformation of sphere would make more difficult separation of monopoles into a and b medium than gravitational attraction of massive particles can be described.

Similarly such a deformation could influence interactions of electric and magnetic field within propagating electromagnetic wave in accordance with observed interactions of gravitation and electromagnetism.

In discussed here can we should also indicate mechanism of propagation of such gravitational field having at our disposal some more fundamental properties. In other words equations of gravitational field could be derived when mechanisms of deformation of sphere would be elucidated in more details. Then we could interpret dynamical effects of gravitational field. The theory for instance would obtain possibility of its interpretation from smaller scale models.

The last considerations assign gravitational field again to SC_1 scale model as representing larger scale of averaging. Then, gravitation vanishes from background vacuum medium related to scale SC_2 where we would have magnetic field only conjugated with the two-ring field.

Summarizing, we have not sufficiently well determined premises for description of gravitational field. Therefore various type hypotheses have to be formulated. We have to do here with two different concepts manifested by the same equations on more averaged level. However, by construction of appropriate hypotheses we could discuss more fine properties of this field and discuss more deep structure of the vacuum medium.

F. On structural classification of elementary particles related to scale SC_2

We have discussed previously also deeper structure of the vacuum medium by application of scale SC_2 to modelling. Then, separated components a and b have obtained interpretation of their internal structure. They are considered as fluids composed of magnetic monopoles of the same kind for each component.

Our space is detected as structure composed of pairs of opposite magnetic monopoles bounded on spheres approximately. This detection is related mainly to separation of components observed during creation of electron-positron pair. However, status of corresponding description is low in comparison with SC_1 description. In order to accentuate it we discuss here classification related to scale SC_2 by hypotheses.

HYPOTHESIS 1: Magnetic monopoles are the most elementary particles. We consider two kinds of monopoles with opposite sign.

The component a is considered as component of electron. Let us note that experimental investigations do not reveal any internal structure of electron. Thereby we have obtained hypothesis corresponding to deeper structure of electron as follows:

HYPOTHESIS 2: Electron is composed of larger number of magnetic monopoles of the same kind considered as dense fluid which can move within electron during its motion and interactions.

Medium of electron is considered as fluid since electron induces external magnetic field when it moves. This happens when corresponding motion of component a takes place in accordance with Maxwell equations in vacuum medium [1]. Furthermore, transfer of component a takes place when it moves. All this suggests just that we have to do with fluid on the inside of electron.

Structure of vacuum medium is considered as network of bounded two opposite monopoles within SC_2 model which can move in background vacuum medium. This suggests that such a structure can also rotate within stable network of pairs of monopoles represented by ϱ-component on more averaged level. Then interactions of rotating structure through discontinuity surface related to averaged velocity are continued. This leads to the following hypothesis:

HYPOTHESIS 3: Neutrino is composed of rotating with respect to resting vacuum medium structure of pairs of opposite monopoles.

Having in mind that structural classification of elementary particles related to scale SC_1 is based on electrons, positrons and neutrina we obtain also role of magnetic monopoles in structure of more complex elementary particles than electron or positron.

We should also discuss status of this hypothesis. Introduced hypothesis is based on low status model related to scale SC_2. In other words we are not able at this moment to verify to what degree discussed SC_2-scale model corresponds to reality. On the other hand however this model is not constructed without any premises.

It seems that assumption that electric field is related to larger scale than remaining fields is justified by fact that creation of electron-positron pair has electric character. Thereby, components a and b are related to larger scale in modelling. However, electron composed of a creates also its own magnetic field during motion. Thereby, we can suppose that within component a magnetic properties can be hidden.

Within our model we have introduced the hidden magnetic properties by magnetic monopoles which have suppressed magnetic field in radial direction. This is in accordance with magnetic properties of electron. Thereby, both facts that a is related to larger scale than magnetic field and that a is not independent on magnetic properties indicate that there is reasonable probability that this kind of description can have connections with reality.

In discussed case the most elementary particles are two magnetic monopoles. They are still interpreted as rotating components. However still deeper structure of vacuum medium can introduce entirely new quality in discussion of what is elementary.

Let us also remark that we cannot go to smaller and smaller scale incessantly. The boundary for such steps is associated with three-dimensional interpretation of our space. Such an interpretation is in turn associated with character of motion of elementary particles hitherto considered as well as with character of propagation of electromagnetic waves.

We should put a question related to the smallest scale where we consider three-dimensional space interpreted by motion of particles and propagation of electromagnetic waves or perhaps other interactions. On the other hand we should use as far as possible just our three-dimensional space concept since we do not know mentioned above border. Perhaps we can still do it. Such an assumption is basis just for SC_2 model.

Let as also note that interpretation of components a and b in scale SC_2 should not be interpreted too formally by means of relations (6) and (7). Relations (6) and (7) have at this moment rather symbolic character in order to accentuate that the component a and b follows from decomposition of ϱ. However interpretation of this decomposition within scale SC_1 is not entirely clear. Corresponding relations should be modified when we will consider multiscale approach to modelling of the vacuum medium. Then models related to scale SC_1 should be obtained on formal way from SC_2 scale model.

G. Status of photon and graviton within smaller scale description

Photon is not considered as elementary particle in accordance with previous discussion on definition of elementary particle. Thereby, photon in the smaller scale description represents process of propagation of energy associated with dynamics of polarization of two-monopole unit and dynamics of corresponding magnetic field. This propagation has long range. Therefore, whole energy associated with this process cannot be lost. This should be taken into account in more detailed models of corresponding processes.

Graviton also is not considered as elementary particle. We expect propagation of gravitational interactions with finite velocity. However, modelling of corresponding process depends on interpretation of gravitational field within smaller scale model.

VII. FINAL REMARKS

Discovery of new particles such as $Z_c(3900)$ or $Y(4260)$ interpreted as composed of four quarks makes classification based on quark theory more difficult. Furthermore, poor system of fundamental notions applied to construction of the Standard Model makes difficult more precise interpretation of this fact. Therefore perhaps we should have at our disposal theory which is based on more complex system of fundamental notions. We consider in this paper vacuum medium mechanics for introduction of structural classification of elementary particles as theory constructed on considerably larger system of fundamental notions.

Full classification within vacuum medium mechanics is still impossible since dynamics of all processes is not described yet. This can be done after introduction of full description of electron and neutrino. However, structural classification is attainable. Therefore just such a classification is presented here.

The structural classification is first stage for considering full classification of elementary particles within vacuum medium mechanics. The full classification should take into account also dynamical effects in relation to internal structure of particles.

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