A Model of Electric Field in the Vicinity of Charged Particle

Jarosław Kaczmarek

Institute of Fluid-Flow Machinery
Polish Academy of Sciences
80-952 Gdańsk, ul. J.Fiszera 14, Poland

Abstract

In this paper a method of modelling electric field near charged particles is introduced. Main assumption considered states that the field takes a constant value on surfaces of particles. This value is maximal admissible value of the electric field in the vacuum medium. Such an assumption induces immediately the problem how to model constant value of charge for particles with various sizes. It is shown that modelling of such a situation is possible when we assume electric field which is considerably more flat near the particle as compared with Coulomb field introduced on larger distances from the particle. Equations which describe behaviour of the electric field in the vicinity of the charged particles are discussed. They are derived with the help of assumptions introduced for four-component vacuum medium. Dominant assumption related to interactions within components states that elements of the medium responsible for generation of electric field attract themselves. Derived equations are of second order with respect to space variables and describe also the Coulomb law at larger distances from the particle. Such a possibility is attained by introduction displacements associated with intensity of electric field. This step also makes possible to adopt methods of continuum mechanics in description of the vacuum medium behaviour. Possibility of breaking the charge conservation law is discussed within this method of modelling.
1 Introduction

Charge conservation law has very high status in physics [1], [2]. As a result theoretical predictions are usually carried out in accordance with this law. However, fractional charge of quarks [2] necessitates more detailed discussion of the problem whether total charge is really conserved in all elementary particle processes.

In the paper [3] and also in [4], [5], [6] a concept of braking of charge conservation law has been discussed in the context of the proton disintegration. Considerations carried out in [3] are based on four component vacuum medium where the charge is not introduced directly as a fundamental notion.

In the paper [3] a four-component vacuum medium structure is postulated. Discussed there approach suggests modelling vacuum medium processes by postulating, in a speculative manner, their laws of evolution directly related to the vacuum medium structure. Such laws are difficult to direct experimental verification since they are associated with very small scale. Therefore, their role is designed to derivation of more complex descriptions which then would be confronted with experiments. Status of assumptions introduced could be verified on this way.

The electron and positron appear, within this kind of modelling, as a result of separation of a pair of components $a$ and $b$ from the four component vacuum medium $\varrho$. The electron is then considered as an extended particle composed of rotating medium $a$ separated from the vacuum medium $\varrho$ by a separation surface. It is assumed that a critical, maximal value of the electric field $u^*$ is attained on this surface. Therefore the fundamental notion for our considerations is a strength of the medium $\varrho$ against separation of components $a$ and $b$, expressed just by value $u^*$. Then, the charge of particle is connected with electric field induced by $u^*$ on the surface of this particle and viewed as a boundary condition.

Constant value of the electric field on the surface follows various charges of particles when they have different sizes. In particular, it is expected, that proton and electron have various sizes. The question is then why they have the same absolute value of charge. In the paper [3] solution of this problem is suggested by assuming the same profile $\bar{u}(r)$ of the electric field directly near the particle in the domain with radius considerably larger then sizes of both particles. As a result, effect of change of diameters of particles has a small effect on their electric field induced in the domain where the Coulomb law is assumed to be valid.

Introduction of constant value of maximal electric field admits possibility of discussion of charge conservation law breaking. Surface of the particle $S_a$ is defined as a surface on which such a maximal value is attained. Then, we can admit various internal stages of particles.
The particle can be composed of homogeneous component \( a \) on the whole area bounded by the surface \( S_a \) as in electron for instance. However, we can admit also the situation when several tightly bounded particles composed of the \( a \)-medium are present within area closed by the surface \( S_a \). Such a concept is assumed for antiproton. Neglecting at this moment mechanism which is responsible for so tightly bounded state [4], we see that at small distances electric field cannot be additive since the critical value \( u = u^* \) could be exceeded.

Summarizing, by introduction of condition on maximal value of electric field as a measure of strength of the vacuum medium against separation of components we obtain also a possibility of considering the charge conservation law breaking.

In the paper [3] we do not discuss why the profile \( \bar{u}(r) \) with finite maximal value \( u^* \) on the surface appears and what equations govern distribution of electric field which is not in accordance with the Coulomb law.

The aim of this paper is to discuss methods of modelling which lead to explanation why electric field with distribution different then the Coulomb law can happen directly near the particle. Discussed methods of modelling are also designed to describe situation when particles of various sizes can have the same charge.

2 Assumptions related to the vacuum medium structure

The four-component vacuum medium is identified with three-dimensional space \( E^3 \). In this space we introduce a Cartesian coordinate system \( X = \{X_i\}, i = 1, 2, 3, X \in E^3 \). We assume furthermore, that behaviour of our medium does not influence geometry introduced by the coordinate system.

The vacuum medium is considered as a mixture of four components [3]. 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.

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 \( \varrho_v, \varrho_\bar{v}, \varrho_w, \varrho_\bar{w} \) and \( \varrho \) stand for densities of the
components and a density of the united media, respectively. We have then
\[ \rho_v + \rho_{\bar{v}} + \rho_w + \rho_{\bar{w}} = \rho. \] (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 contained within them. They are represen-
ted by vectors \( v, \bar{v}, w, \bar{w} \). 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: \( u = v - \bar{v} \) and
\( q = w - \bar{w} \). At this moment it is also assumed that \( \bar{v} = -v \), \( \bar{w} = -w \).
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. This question is also associated with status of
classical geometry for such a small scale.
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 propa-
gation 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 a limitation on degree of
polarization. Therefore, we introduce a relation between degree of polarization
and assigned to it displacements. We do this by functions
\[ v_G = G_v(v) , \quad \bar{v}_G = G_{\bar{v}}(\bar{v}) , \] (2)
\[ w_G = G_w(w) , \quad \bar{w}_G = G_{\bar{w}}(\bar{w}) . \] (3)
The functions \( G_v, G_{\bar{v}}, G_w, G_{\bar{w}} \) assign geometrical displacements to vectors de-
scribing state of the elementary unit as vectors having the same directions.
Let \( v_L \) be length of the vector \( v \). Then, structure of the function \( G_v \) can
be expressed as \( G_v(v) = \tilde{G}_v(v_L) n_v \), where \( n_v = \frac{v}{v_L} \). We assume that the
function \( \tilde{G}_v(v_L) \) is monotone and increasing.
Assignation of displacements to each kind of polarization enables incorpo-
rating 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 [7]. All this is formally possible since we have introduced previously the coordinate system.

Consequently, deformation of each component is described by deformation functions \( p = \chi_P(X) \), \( \bar{p} = \chi_{\bar{P}}(X) \), \( s = \chi_S(X) \), \( \bar{s} = \chi_{\bar{S}}(X) \), where \( X \) are points of a reference configuration. As a result we can consider displacements given by (2) and (3) in connection with the deformation function by expressions

\[
\begin{align*}
v_G &= p - X, & v_{\bar{G}} &= \bar{p} - X, & w_G &= s - X, & w_{\bar{G}} &= \bar{s} - X.
\end{align*}
\]

In the paper [3] we have assumed that the medium \( \varrho \) can be decomposed into the sum \( \varrho = a + b \) for higher energy, where

\[
a = \varrho_v + \frac{1}{2}(\varrho_w + \varrho_{\bar{w}}) \quad \text{and} \quad b = \varrho_v + \frac{1}{2}(\varrho_w + \varrho_{\bar{w}}).
\]

This decomposition appears as a result of attaining by \( u \) the critical value \( u^* \) characteristic for discussed medium. Rotating, separate components \( a \) and \( b \) create medium of electron and positron respectively.

The variables \( u \) and \( q \) are identified with the vector of the electric field intensity \( E \) and the magnetic induction vector \( B \), respectively.

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 vacuum medium structure.

We could consider several energetic levels with different kinematics. The lowest energy is connected with displacements \( u \) and \( q \) only, which are considered as small. Higher energy levels are associated with elementary particles. Consequently, electron and positron are viewed as rotating \( a \) and \( b \)-media separated from \( \varrho \) by a discontinuity surface [3]. Interactions between particles and electromagnetic field are determined with the help of boundary conditions considered on the discontinuity surface.

### 3 Description of electromagnetic field in multicomponent vacuum medium

We have assumed that the electric field takes value \( u = u^* \) on the surface of the particle. Let us assume temporarily that the Coulomb law is valid in the whole region of space, on the outside of the particle.

Let us consider two particles with radii \( r_1 \) and \( r_2 \) correspondingly. Then, validity of the Coulomb law follows that the condition \( \frac{Q_1}{r_1^2} = \frac{Q_2}{r_2^2} = u^* \) is fulfilled on the surface. As a result charges of these particles strongly depend on their sizes which is illustrated by the relation \( \frac{Q_1}{Q_2} = \frac{r_1^2}{r_2^2} \).
In order to avoid such a difficulty we could assume that the electric field is distributed near the particles by the same profile $\bar{u}(r)$, where $r \in [r_1, r_1 + \bar{r}]$ and $r \in [r_2, r_2 + \bar{r}]$ for the first and the second particle correspondingly. It is also assumed that $\bar{r} >> r_1, r_2$ and $\bar{u}(r_1 + \bar{r}) = \bar{u}(r_2 + \bar{r}) = u^{**}$ and furthermore the Coulomb law is valid for $r \geq r_1 + \bar{r}$ and $r \geq r_2 + \bar{r}$ only.

Above introduced properties follows that the condition $Q_1(r_1 + \bar{r})^2 = Q_2(r_2 + \bar{r})^2 = u^{**}$ is satisfied, which leads to the relation

$$\frac{Q_1}{Q_2} = \frac{(r_1 + \bar{r})^2}{(r_2 + \bar{r})^2}.$$  \hspace{1cm} (5)

If $\bar{r}$ increases considerably then $\frac{Q_1}{Q_2}$ tends to 1, which is interpreted as the fact that both particles have the same charge. We infer also that the profile $\bar{u}$ is relatively flat near the surface of the particle. Otherwise, we could have the case similar to that one when the Coulomb law is valid in the whole domain what in turn contradicts taking the same values of charges by particles considered.

Summarizing, by this discussion we come to the conclusion that a possible way of avoiding difficulty with various charges of particles is to introduce flat electric field in comparison with the Coulomb field, directly near charged elementary particles.

If we accept this point of view then we should explain, starting from properties of the medium, why distribution of the electric field given by $\bar{u}$ appears near the particle. To this end we discuss here a method of modelling of electromagnetic field based on properties of the four-component vacuum medium.

We have introduced kinematical assumptions connected with state of elementary units creating the vacuum medium. They have a geometrical interpretation introduced by displacements within units as well as they are also associated with intensity of polarization. Discussed here geometrical aspect enables application of results of continuum mechanics for our aims. In particular, we can consider the Green strain tensor as a measure of deformation owing to the deformation function introduced.

The energy conservation law is considered here as the highest rank law. Thereby, we have to express postulated properties of the medium by corresponding energy terms. These properties are connected with interactions within each component separately as well as with interactions between components.

We postulate that the effect of generation of the profile $\bar{u}$ is a consequence of attraction within separate components.

Modelling the vacuum medium by means of the deformation function needs distinguishing a reference configuration. However, in the case of the multicomponent medium we have to do with several possible reference configurations related to each component.

Let us consider the case when a part of the medium $a$ is separated from
Then, we encounter two possible situations. First, equilibrium state of $\varrho$ determines a reference configuration for the component $a_\varrho$ joined with $b_\varrho$ within the $\varrho$-medium. On the other hand separated $a$ exhibits its own properties. In particular, equilibrium state of $a$ can differ with respect to geometrical properties from $a_\varrho$ within $\varrho$. As a result of this, we assign another reference configuration to the separated component $a$.

It is postulated that attraction within $a$-medium is induced by attraction within $\varrho_v$-medium as dominant component of $a$. Therefore we will consider $\varrho_v$-medium interchangeably with $a$, especially in the case when we discuss in fact the medium $a_\varrho$ as $a$ joined with $b$ within the medium $\varrho$.

Attraction within the component $a$ suggests that equilibrium state of the separated component should have smaller volume then that one corresponding to $a_\varrho$ placed within $\varrho$. In other words we assume that a screening of attraction within $\varrho_v$ takes place when it is joined with $\varrho$ in $\varrho$. Therefore separation of components leads to decreasing of the screening and admit stronger attraction in $a$ which in turn leads to considerable decreasing of its elementary volume.

However, in this case we have to decide what configuration should be valid for the whole medium $a$ and whether such a configuration could be changed continuously between various regions.

Let us consider property of attraction within $\varrho_v$. We have introduced position of an element of the $\varrho_v$-medium determined by $p = \chi_p(X)$ and associated with this function displacement $v_G = p - X$.

Such a displacement is interpreted as occurring within the elementary unit. Therefore, the reference configuration coincides with the whole space in the case corresponding to stable $\varrho$-medium. However, when degree of polarization increases, what is expressed by length $v_L$ of the vector $v$, we can expect that intensity of attraction within the medium $\varrho_v$ increases. In extreme case we obtain an area of separated component $a$ which has, by assumption, considerably smaller volume than corresponding to it part of the medium $\varrho$. Accordingly, increasing value of $v$ leads to behaviour of $\varrho_v$, to increasing degree, as independent from the medium $\varrho$.

We express this fact by gradual appearing of a new reference configuration for emerging $\varrho_v$ with increasing $v$. Problem of precise determination of such a configuration is open in general. However, when electric field is induced by presence of a spherical, extended elementary particle, we assume that such a new configuration takes the form

$$X_a = \alpha_v(v)(X - X_C) + X_C, \quad X \in \mathbb{E}^3,$$

(6)

where $X_C$ is a center of particle and $\alpha_v(v) \in (\alpha_m, 1]$, $\alpha_m > 0$. $\alpha_v(v) = 1$ for $v = 0$ and the function $\alpha_v$ is decreasing from value 1 to value $\alpha_m$ when $v_L$ increases. Consequently, the configuration $X_a$ coincides with $X$ for $v = 0$. 

Taking into account new configuration we have also to consider new displacements. We assume them in the following form

\[ \mathbf{v}_{Ga} = \mathbf{p}(\mathbf{X}) - \mathbf{X}_a(\mathbf{X}). \] (7)

Since \( \mathbf{p}(\mathbf{X}) = \mathbf{v}_G + \mathbf{X} \), we obtain from (6) and (7)

\[ \mathbf{v}_{Ga} = \mathbf{v}_G + (1 - \alpha_v)(\mathbf{X} - \mathbf{X}_C) \] (8)

which expresses relation between \( \mathbf{v}_{Ga} \) and \( \mathbf{v}_G \). We need such a relation since we would like to have possibility of using the variable \( \mathbf{v} \) only in final equations.

Considering particular case when \( \mathbf{X}_C \) is a center of particle we assume that \( \mathbf{X}_C = \mathbf{0} \). Then, we obtain

\[ \frac{\partial \mathbf{v}_{Gai}}{\partial X_j} = \frac{\partial \mathbf{v}_{Gi}}{\partial X_j} + (1 - \alpha_v)\delta_{ij} - \frac{\partial \alpha_v}{\partial X_j} X_i. \] (9)

Let \( P \) and \( Q \) be points in the reference configuration. Let us apply a deformation function \( \chi = \{\chi_l\}, l = 1, 2, 3 \). The Green strain tensor is defined by \( \varepsilon_{jk} = \frac{1}{2}(\chi_l,j\chi_l,k - \delta_{jk}) \). Let \( ds_0 \) and \( ds \) stand for lengths of the segment \( PQ \) before and after the deformation. Then, unit elongation of the segment \( PQ \) is defined by \( \lambda_{PQ} = (ds - ds_0)/ds_0 \) and satisfies the equation

\[ \lambda_{PQ}(1 + \frac{1}{2}\lambda_{PQ}) = \varepsilon_{jk}\nu_j\nu_k, \] (10)

where \( \nu_j \) are direction cosines of the segment \( PQ \).

In the case when \( P \) and \( Q \) are situated on the straight line parallel to the axis \( X_1 \), we obtain from (10) that

\[ \lambda_{11} = \sqrt{1 + 2\varepsilon_{11}} - 1 \approx \varepsilon_{11}, \] (11)

where approximation for small strain is also expressed. Similarly we define \( \lambda_{22} \) and \( \lambda_{33} \) with respect to the remaining coordinate axes.

We assume that attraction between elements of the \( \varrho_v \)-medium means that if this medium is stretched then elastic stress appears. We express this stretching by fact that \( \lambda_{ii} \geq 0, \ i = 1, 2, 3 \), where \( \lambda_{ii} \) is defined with respect to the reference configuration \( \mathbf{X}_a \). Positiveness of \( \lambda_{ii} \) means that no repulsion forces act between elements of the medium \( \varrho_v \) at this stage of discussion. Corresponding energy term is postulated by

\[ E_v = C_{av}\lambda_{ii}^2, \] (12)

where summation convention is applied. However, we need such a term for arbitrary \( \lambda_{ii} \). Taking into account that \( \lambda_{ii} \approx \varepsilon_{ii} \), we introduce the energy term \( E_v \) in the following form
\[ E_v = \begin{cases} 
C_{av}(e_{11}^2 + e_{22}^2 + e_{33}^2), & e_{11}, e_{22}, e_{33} \geq 0 \\
C_{av}(e_{ii}^2 + e_{jj}^2), & e_{ii}, e_{jj} \geq 0, e_{kk} < 0, \ i \neq j \neq k \\
C_{av}e_{ii}^2, & e_{ii} \geq 0, e_{jj}, e_{kk} < 0, \ i \neq j \neq k \\
0, & e_{11}, e_{22}, e_{33} < 0 \end{cases} \quad (13) \]

The strain tensor is defined in general as
\[ e_{ij} = \frac{1}{2}(\frac{\partial v_Gai}{\partial x_j} + \frac{\partial v_Gaj}{\partial x_i} + \frac{\partial v_Gak}{\partial x_i} \frac{\partial v_Gak}{\partial x_j}). \]

We apply here the linear case only when \( e_{ij} = e_{Gaij} \) and \( e_{Gaii} = \frac{\partial v_{Gai}}{\partial x_{ai}} \) is calculated with respect to the new configuration \( X_a \).

The constant \( C_{av} \) which appears in (13) is responsible for stiffness of the attraction. It is natural to admit that this quantity depends on intensity of polarization represented by \( v \). Consequently we assume that \( C_{av} = C_{av}(v) \) and is increasing function of \( v_L \). This is justified by fact that with increasing \( v_L \) we obtain gradually emerging \( \varrho_v \) from \( \varrho \)-medium, as an independent component. This leads in turn to increasing role of the new reference configuration \( X_a \) for description of attraction within \( \varrho_v \).

We consider also interactions between components \( \varrho_v \) and \( \varrho_{\bar{v}} \) within the elementary units. Such interactions are expressed by property \( v = -\bar{v} \). However, we could admit a small violation of this relation what can be postulated by the following energy term
\[ \Phi_{v\bar{v}} = C_{v\bar{v}}(v + \bar{v})^2. \quad (14) \]

Assuming that \( C_{v\bar{v}} \) is very high we obtain that \( v = -\bar{v} \) approximately, what means that directions of polarization of discussed complementary components has to be the same.

Undoubtedly intensity of polarization has to be associated with energy. This is expressed by well known formula for energy of static electric field \([1]\). We express this fact by the following energy term
\[ K_{v\bar{v}} = k(v - \bar{v})^2. \quad (15) \]

In this case we assume that \( k \ll C_{v\bar{v}} \), \( C_{av} \) what means that the term \( K_{v\bar{v}} \) as the most soft, collects predominant amount of total energy of the field in form connected with length of the vector \( v \) only, without any derivatives.

Summarizing, we have obtained energy density related to pair of components \( \varrho_v \) and \( \varrho_{\bar{v}} \) in the form
\[ \mathcal{E}_{v\bar{v}} = E_v + E_{\bar{v}} + \Phi_{v\bar{v}} + K_{v\bar{v}}, \quad (16) \]
where \( E_{\bar{v}} \) is defined in the same manner as \( E_v \) but for the displacements \( \bar{v}_G \).

By analogy we define also energy density associated with the remaining two components \( \varrho_w \) and \( \varrho_{\bar{w}} \) as
\[ \mathcal{E}_{w\bar{w}} = E_w + E_{\bar{w}} + \Phi_{w\bar{w}} + K_{w\bar{w}}, \]

where energy terms \( E_w \) and \( E_{\bar{w}} \) are defined in the same way as in (13) taking displacements \( w_G \) and \( \bar{w}_G \) for determination of the strain tensor.

Distinguished groups of components \( \{ \varrho_v, \varrho_{\bar{v}} \} \) and \( \{ \varrho_w, \varrho_{\bar{w}} \} \) also interact in this model. Form of these interactions is postulated by the following formulas

\[ \varepsilon_{ijk} \frac{\partial u_{fj}}{\partial X_k} = m_i, \quad \varepsilon_{ijk} \frac{\partial q_{fj}}{\partial X_k} = n_i, \]

where \( u_f \) and \( q_f \) are some forces in the media \( \{ \varrho_v, \varrho_{\bar{v}} \} \) and \( \{ \varrho_w, \varrho_{\bar{w}} \} \) correspondingly. Furthermore, \( m = \{ m_i \} \) and \( n = \{ n_i \} \) are postulated in the form

\[ m = A \frac{\partial q}{\partial t}, \quad n = B \frac{\partial u}{\partial t}. \]

We have obtained expressions which describe how \( m \) and \( n \) generate forces in direct neighbourhood of the elementary unit. Such a form of interactions should be incorporated into (16) and (17) in order to enable description of effects which they induce in the whole medium.

Taking into account well known properties of the operation \( \text{rot} \) we obtain from the relations (18) the expression for \( u_f \)

\[ u_f = \frac{1}{4\pi} \text{rot} \int \frac{m}{r} dV. \]

Finally, the expression which determines force in the medium \( \{ \varrho_v, \varrho_{\bar{v}} \} \), induced by processes in \( \{ \varrho_w, \varrho_{\bar{w}} \} \), is postulated by the formula

\[ f_{v\bar{v}} = C_m u_f \left( \frac{\partial q}{\partial t} \right). \]

Forces acting within group of components \( \{ \varrho_w, \varrho_{\bar{w}} \} \) as resulting from interactions with \( \{ \varrho_v, \varrho_{\bar{v}} \} \) are defined in similar way by the expression

\[ f_{w\bar{w}} = C_n \frac{1}{4\pi} \text{rot} \int \frac{n}{r} dV = C_n q_f \left( \frac{\partial u}{\partial t} \right). \]

We postulate furthermore that \( u_f = v_f - \bar{v}_f \) and \( q_f = w_f - \bar{w}_f \) by analogy to properties of \( u \) and \( q \). Then, we postulate also forces acting in separate components by \( f_v = C_m v_f, \quad f_{\bar{v}} = C_m \bar{v}_f, \quad f_w = C_m w_f, \quad f_{\bar{w}} = C_m \bar{w}_f \) which have properties \( f_{v\bar{v}} = f_v - f_{\bar{v}}, \quad f_{w\bar{w}} = f_w - f_{\bar{w}} \).

Let us assume that displacements \( v_G, \bar{v}_G, w_G, \bar{w}_G \) are small. Let \( W \subset E^3 \) be subset of our three-dimensional space for which the electromagnetic field is discussed. The subset \( W \) does not coincide with the whole space when we consider field of an extended particle. In such a case boundary conditions
imposed on $\partial W$, considered as surface of particle, has additionally to be discussed. Furthermore, we admit deformation functions which transform the set $W$ into new sets $\chi_P(W)$, $\chi_P(W)$, $\chi_S(W)$, $\chi_S(W)$. Consequently, dominant variables which govern form of the balance energy equation are $v_G$, $\dot{v}_G$, $\dot{w}_G$, $\ddot{w}_G$ as related to the deformation functions instead of $\dot{v}$, $\dot{v}$, $\ddot{w}$, $\dddot{w}$.

We postulate the following general form of balance energy equation

$$
\int_W [\dot{\mathcal{E}}_{\dot{v}} + \dot{\mathcal{E}}_{\ddot{w}} - f_v \dot{v} - f_\dot{v} \ddot{v} - f_\ddot{w} \dot{w} - f_\dot{w} \dddot{w}]dV - \int_{\partial W} (L\dot{v} + L\ddot{v} + N\dot{w} + N\dddot{w})da = 0 ,
$$

(23)

where we have introduced formally some additional forces on the surface $\partial W$ for more general considerations.

Let us note that we should consider four sets $\chi_P(W)$, $\chi_P(W)$, $\chi_S(W)$, $\chi_S(W)$ instead one set $W$ in the integral discussed in (23). Furthermore, we should also introduce their boundaries replaced by $\partial W$ in (23). We simplify our considerations by assumption about small displacements. This is not too formal way which allows us to avoid more complex calculations connected with four deformation functions in the sequel.

Let us consider the term $\int_W \dot{\mathcal{E}}_{\dot{v}}dV$ in more detail. Taking into account (9), (13), (16) and the relations $v_G = G_v(v)$, $\ddot{v}_G = G_\ddot{v}(v)$, we obtain

$$
\int_W \dot{\mathcal{E}}_{\dot{v}}dV = \int_W \left[ \frac{\partial E_v}{\partial v_{G,i}} \dot{v}_{G,i} + (2C_{v\dot{v}}(v_i + \dot{v}_i) + 2k(v_i - \ddot{v}_i)) \frac{\partial G_{\ddot{v}}^{-1}}{\partial v_{G,i}} \dot{v}_{G,i} + \frac{\partial E_\ddot{v}}{\partial v_{G,j}} \dot{v}_{G,j} + (2C_{\dot{v}\ddot{v}}(v_j + \dot{v}_j) - 2k(v_j - \ddot{v}_j)) \frac{\partial G_{\ddot{v}}^{-1}}{\partial v_{G,j}} \dot{v}_{G,j} \right]dV .
$$

(24)

Balance of energy equation (23) can be considered separately for groups of components $\{\mathcal{G}_v, \mathcal{G}_\ddot{v}\}$ and $\{\mathcal{G}_w, \mathcal{G}_\dddot{w}\}$ owing to independence of time processes $\dot{v}$, $\ddot{v}$, $\dot{w}$, $\dddot{w}$.

Using (16), (24) and (23), part of balance of energy equation related to $\mathcal{G}_v$ and $\mathcal{G}_\ddot{v}$ can be expressed in the form

$$
\int_W \left\{ -(\frac{\partial E_v}{\partial v_{G,i}})_{,i} + (2C_{v\dot{v}}(v_i + \dot{v}_i) + 2k(v_i - \ddot{v}_i) - f_{vi}) \frac{\partial G_{\ddot{v}}^{-1}}{\partial v_{G,i}} \right\} \dot{v}_{G,i} + \left\{ -\frac{\partial E_\ddot{v}}{\partial v_{G,j}} \right\} J + (2C_{\dot{v}\ddot{v}}(v_j + \dot{v}_j) - 2k(v_j - \ddot{v}_j) - f_{vj}) \frac{\partial G_{\ddot{v}}^{-1}}{\partial v_{G,j}} \right\} \dot{v}_{G,j} \right\}dV + \int_{\partial W} \left\{ [(\frac{\partial E_v}{\partial v_{G,i}})_{,i} - L_i \frac{\partial G_{\ddot{v}}^{-1}}{\partial v_{G,i}}] \dot{v}_{G,i} + (\frac{\partial E_\ddot{v}}{\partial v_{G,j}})_{,j} - L_j \frac{\partial G_{\ddot{v}}^{-1}}{\partial v_{G,j}} \right\} \dot{v}_{G,j} \right\}d(\partial W) = 0 .
$$

(25)
Similar derivation can be carried out with the help of the term $f_W \dot{E}_{\bar{w}\bar{w}} dV$ and part of the balance of energy equation (23) related to $\varrho_w$ and $\varrho_{\bar{w}}$. Assuming that processes $\dot{v}_G, \bar{v}_G, \dot{w}_G, \bar{w}_G$ are independent we obtain from (25) the following equations

$$-(\frac{\partial E_v}{\partial v_{Gi,i}})_i + (2C_{\bar{w}v}(v_i + \bar{v}_i) + 2k(v_i - \bar{v}_i) - f_{wi}) \frac{\partial G_{vi}^{-1}}{\partial v_{Gi}} = 0, \quad (26)$$

$$-(\frac{\partial E_{\bar{w}}}{\partial \bar{v}_{Gj,j}})_j + (2C_{\bar{w}v}(v_j + \bar{v}_j) - 2k(v_j - \bar{v}_j) - f_{\bar{w}j}) \frac{\partial G_{\bar{w}j}^{-1}}{\partial \bar{v}_{Gj}} = 0 \quad (27)$$

for the components $\{\varrho_v, \varrho_{\bar{w}}\}$ and by analogy we obtain also equations

$$-(\frac{\partial E_w}{\partial w_{Gi,i}})_i + (2C_{\bar{w}w}(w_i + \bar{w}_i) + 2k(w_i - \bar{w}_i) - f_{wi}) \frac{\partial G_{wi}^{-1}}{\partial w_{Gi}} = 0, \quad (28)$$

$$-(\frac{\partial E_{\bar{w}}}{\partial \bar{w}_{Gj,j}})_j + (2C_{\bar{w}w}(w_j + \bar{w}_j) - 2k(w_j - \bar{w}_j) - f_{\bar{w}j}) \frac{\partial G_{\bar{w}j}^{-1}}{\partial \bar{w}_{Gj}} = 0 \quad (29)$$

for the components $\{\varrho_w, \varrho_{\bar{w}}\}$.

We admit two forms of boundary conditions determined on $\partial W$ for equations related to components $\{\varrho_v, \varrho_{\bar{v}}\}$. The first form is

$$\left(\frac{\partial E_v}{\partial v_{Gi,i}}\right)_i = L_i \frac{\partial G_{vi}^{-1}}{\partial v_{Gi}}, \quad \left(\frac{\partial E_{\bar{v}}}{\partial \bar{v}_{Gj,j}}\right)_j = L_j \frac{\partial G_{\bar{v}j}^{-1}}{\partial \bar{v}_{Gj}} \quad (30)$$

and the second one is given by formulas

$$\mathbf{v} = \mathbf{v}_{BC}, \quad \bar{\mathbf{v}} = \bar{\mathbf{v}}_{BC}, \quad (31)$$

where $L_i, L_j$ and $\mathbf{v}_{BC}, \bar{\mathbf{v}}_{BC}$ are given values of these fields on the surface $\partial W$.

By analogy we also admit two forms of boundary conditions determined on $\partial W$ for equations related to components $\{\varrho_w, \varrho_{\bar{w}}\}$ as

$$\left(\frac{\partial E_w}{\partial w_{Gi,i}}\right)_i = N_i \frac{\partial G_{wi}^{-1}}{\partial w_{Gi}}, \quad \left(\frac{\partial E_{\bar{w}}}{\partial \bar{w}_{Gj,j}}\right)_j = \bar{N}_j \frac{\partial G_{\bar{w}j}^{-1}}{\partial \bar{w}_{Gj}} \quad (32)$$

and

$$\mathbf{w} = \mathbf{w}_{BC}, \quad \bar{\mathbf{w}} = \bar{\mathbf{w}}_{BC}, \quad (33)$$

where $N_j, \bar{N}_j$ and $\mathbf{w}_{BC}, \bar{\mathbf{w}}_{BC}$ are given values of these fields on $\partial W$.

Let us note that $E_v$ depends directly on $v_{Ga,i}$ by virtue of definition of this function given by (13), and also on $v_{Gi,i}$ intermediately by the relation (8) between $v_{Ga}$ and $v_G$. As a result we obtain the expression
\[
\dot{E}_v = \frac{\partial E_v}{\partial e_{Gamn}} \frac{\partial e_{Gamn}}{\partial v_{Gai,j}} \dot{v}_{Gai,j}
\]  

(34)

what leads to the term under the integral considered in (26)

\[- \frac{\partial}{\partial X_j} (\frac{\partial E_v}{\partial e_{Gamn}} \frac{\partial e_{Gamn}}{\partial v_{Gai,j}}) \dot{v}_{Gai} = - \frac{\partial}{\partial X_k} (\frac{\partial E_v}{\partial e_{Gamn}} \frac{\partial e_{Gamn}}{\partial v_{Gai,j}}) \frac{\partial X_k}{\partial X_j} S_{ai} \dot{v}_{Gi} .
\]  

(35)

The term \(S_{ai}\) is obtained with the aid of differentiation of \(v_{Gai}\) with respect to time. We obtain then

\[\dot{v}_{Gai} = (1 - \frac{\partial a_v}{\partial v_j} (X_i - X_{Ci})) \dot{v}_{Gi} = S_{ai} \dot{v}_{Gi} ,
\]  

(36)

where summation is considered for the index \(j\) only.

We prefer using the term on the right side of the relation (35) in the balance of energy equation. Both displacements \(v_G\) and \(v_{Ga}\) have geometrical interpretation. However \(v_G\) has additionally direct connection with \(v\) which is our final independent variable. The geometrical interpretation is valid in the context of using description analogous to continuum mechanics. Above discussed intention is expressed in (24) by differentiation of \(E_v\) with respect to \(v_{Gi,j}\) directly.

4 Modelling electric field near the electron

In this paper we confine our discussion to static electric field only. Furthermore, we assume that particles considered are perfectly spherical. This assumption allows one to discuss our equations in spherical coordinates.

Interactions of electric field with a charged particle, in static case, are determined by boundary conditions imposed on the surface of the particle. We have assumed in the paper [3] that a critical value \(u = u^*\) is attained on such a surface. The surface of electron is considered approximately as a sphere. Then, in order to obtain static field around this particle, equations (26), (27) should be solved with spherically symmetric boundary conditions of type (31).

Let \(\partial W\) be a sphere with unit and normal vector \(n_r = \{n_{r1}, n_{r2}, n_{r3}\}\). The surface \(\partial W\) is viewed as boundary of particle containing the component \(a\). Then, \(v|_{\partial W} = v_{BC} n_r\), where \(v_{BC}\) is a given negative value which reflects attraction of the separated component \(a\) acting on the medium \(\rho_v\) in \(v\).

Owing to the boundary conditions discussed above we also assume that solutions of equations (26), (27) are spherically symmetric and take the form \(v_i = v(r)n_{ri}, i = 1, 2, 3\). Distance of a given point of space from the center of the particle considered is denoted by \(r\).
We discuss the equation (26) only in what follows. This is possible owing to the relation \( \mathbf{v} = -\bar{\mathbf{v}} \) induced by the term of energy (14).

Let us note that definition of energy terms \( E_v \) given by (13) depends on parts of domain to which values of strain tensors belong. We consider strain tensors \( e_{av} \) which is defined with the help of displacements \( \mathbf{v}_{Ga} \). The displacements are determined with respect to the reference configuration \( \mathbf{X}_a \) corresponding to the medium \( \varrho_v \).

In order to decide what form of \( E_v \) should be applied in the case of using spherical coordinates and spherically symmetric field, let us discuss strains which appear around a point lying on a chosen ray.

Let us consider a point \( A(r, 0, 0) \) on the axis \( X_1 \) viewed as the chosen ray. Then, the spherically symmetric boundary conditions induce elongation of a neighbourhood of the point \( A \) in direction \( X_1 \) what means that \( e_{av11}(A) > 0 \). Furthermore, each sphere with radius \( r \) is transformed by deformation function into a larger sphere when we consider the reference configuration \( \mathbf{X}_a \) induced by the particle. Thereby, we also have \( e_{av22}(A) > 0 \) and \( e_{av33}(A) > 0 \). As a result we obtain from (13) that 
\[
\frac{\partial E_v}{\partial e_{av11}} = 2C_{av}e_{av11},
\]
\[
\frac{\partial E_v}{\partial e_{av22}} = 2C_{av}e_{av22},
\]
\[
\frac{\partial E_v}{\partial e_{av33}} = 2C_{av}e_{av33}.
\]

We discuss a static case. Then, \( f_{vi} \) representing dynamical interactions, is equal to zero in (26). We temporarily neglect the term with \( k \) in this equation. Then, the equation (26) takes the form for the discussed point \( A \)
\[
-\frac{\partial}{\partial X_{ai}} (2C_{av}e_{avii}) S_\alpha = 0, \quad i = 1, 2, 3,
\]
(37)

where \( S_\alpha = 1 - \frac{\partial e_{av}}{\partial v} \frac{\partial v}{\partial r} \). The term \( 2C_{av} \) will be replaced by \( C_{av} \) in what follows.

Taking into account that \( v_{Ga}(r) = v_{Ga}(r)n_i \) and the term \( k \) in (26), discussion connected with derivation of (37), we transform equations (26) into the form
\[
-\frac{1}{r^2} \frac{\partial}{\partial r_a} (r^2 C_{av} \frac{\partial v_{Ga}}{\partial r}) S_\alpha + kv \frac{\partial G^{-1}}{\partial v} = 0.
\]
(38)

We would like to use differentiation with respect to \( r \) instead of \( r_a \). Let us note that the relation \( r_a = \alpha_v r \) is satisfied. This relation is useful for calculation \( \frac{\partial X_k}{\partial x_{aj}} \) which appears in (35). Now we discuss it in the form \( \frac{\partial r}{\partial r_a} \) for all differentiations in (38). The function \( \alpha_v \) depends on \( v \) and also by this on \( r \). However we introduce at this moment a simplification and effect of changing of \( r_a \) into \( r \) is assumed approximately as
\[
-\frac{1}{r^2} \frac{\partial}{\partial r} (r^2 C_{av} \frac{\partial v_{Ga}}{\partial r}) \frac{S_\alpha}{\alpha_v^2} + kv \frac{\partial G^{-1}}{\partial v} = 0.
\]
(39)

This equation is the starting point for our further considerations. We would like to show that it is possible to model the situation when size of particles
changes and their charge remains the same. Furthermore, we expect that such a discussion is based on consistency related to assumed properties of the medium.

We have postulated that there is an attraction between elements of the $a$-medium. Then, new reference configuration $X_a$ determined by $\alpha_v < 1$ induces an extension of the $a$-medium which is joined with $b$ within $\varrho$. Intensity of this attraction can be expressed by form of the function $C_{av} = C_{av}(v)$. Since with increasing length of $v$ the medium $a_\varrho$ becomes gradually more and more separated, we expect that intensity of the attraction also increases. This should be manifested within the model by $C_{av}(v)$ as an increasing function of length of the vector $v$.

We assume that the electric field generated around the particle is governed by the Coulomb law at larger distances from the particle, and takes the form $v = -Q/r^2$, $Q > 0$. Near the particle the field is more flat and takes value $v = v^*$ on the surface of the particle.

We should show that for given, expected solution $v(r)$ of the equation (39), we can obtain the function $C_{av}(v)$ with discussed above properties. To this end we derive equation for $C_{av}$ for given $v(r)$.

We would like to express the equation (39) as dependent on the variable $v$ only. To this end we introduce $v_{Ga} = v_Ga(r)n_{ri}$, $v_G = v_G(r)n_{ri}$, $X_i = r n_{ri}$ for spherically symmetric field. Taking into account introduced above relations, we obtain from (8) that

$$v_{Ga} = v_G + (1 - \alpha_v)r.$$ (40)

We have furthermore that $\frac{\partial v_{Ga}}{\partial r} = \frac{\partial v_G}{\partial r}n_{ri}$, $\frac{\partial v_G}{\partial r} = \frac{\partial v_G}{\partial r}n_{ri}$ and $\frac{\partial X_i}{\partial r} = n_{ri}$. With the help of these expressions and the function $v_G = G_v(v)$ the derivative of $v_{Ga}$ with respect to $r$ is expressed in the form

$$\frac{\partial v_{Ga}}{\partial r} = \frac{\partial G_v}{\partial v} \frac{\partial v}{\partial r} + 1 - \alpha_v - \frac{\partial \alpha_v}{\partial r} r.$$ (41)

We substitute the relation (41) into (39) and obtain finally the equation equivalent to (39), and having the variable $v$

$$\frac{1}{r^2} \frac{\partial}{\partial r} \left( r^2 C_{av} \left( \frac{\partial G_v}{\partial v} \frac{\partial v}{\partial r} + 1 - \alpha_v - \frac{\partial \alpha_v}{\partial r} r \right) \right) = \frac{\alpha_v^2 k v \frac{\partial \varrho_v^{-1}}{\partial \varrho}}{S_\alpha}.$$ (42)

Let us introduce notations

$$M_v = \frac{\partial v}{\partial r} \frac{\partial v_{Ga}}{\partial r},$$ (43)

$$N_v = \frac{2}{r} \frac{\partial v_{Ga}}{\partial r} + \frac{\partial^2 v_{Ga}}{\partial r^2},$$ (44)
\[
\frac{\partial^2 v_{Ga}}{\partial r^2} = \frac{\partial^2 G_v}{\partial v^2} \left( \frac{\partial v}{\partial r} \right)^2 + \frac{\partial G_v}{\partial r} \frac{\partial^2 v}{\partial r^2} - \frac{\partial^2 \alpha_v}{\partial v^2} \left( \frac{\partial v}{\partial r} \right)^2 - \frac{\partial \alpha_v}{\partial v} \frac{\partial^2 v}{\partial r^2} - 2 \frac{\partial \alpha_v}{\partial v} \frac{\partial v}{\partial r}. \tag{45}
\]

Quantities \( M_v \) and \( N_v \) can be calculated with the help of (41) and (45).

Finally, we transform the equation (42) to the form expressing condition which should be satisfied by function \( C_{av} \)

\[
\frac{\partial C_{av}}{\partial v} + \frac{N_v}{M_v} C_{av} = \frac{\alpha_v^2 k v \partial G^{-1}}{M_v S_{\alpha}}. \tag{46}
\]

In order to solve the equation (46) we have to calculate \( v_{Ga} \) and their derivatives. Thereby, we should postulate functions \( G_v \) and \( \alpha_v \).

Let us notice that we suggest second order equation (42) for description of the Coulomb law. We know that in such a case the field is proportional to \( 1/r \). However, our equation is of second order but is not directly related to the field \( v \) in the form (39). Instead of this we have introduced the field \( v_G \) which has better geometrical interpretation and by this enables application of methods of continuum mechanics. We can postulate temporarily that \( v_G = -\frac{H}{r}, H > 0 \) is a solution of the equation (39). Then, taking into account that the field described by the Coulomb law as \( v = -\frac{Q}{r^2}, Q > 0 \) should also be a solution, we obtain the following form of the function \( G_v \)

\[
v_G = -\frac{H}{\sqrt{Q}} \sqrt{-v} \equiv G_v(v). \tag{47}
\]

This form of \( G_v \) introduces a geometrical interpretation associated with separation of components. For small \( v \) geometrical distance of separation expressed by \( v_G \) increases rapidly in comparison with \( v \). Next increasing of \( v_G \) is slower than \( v \).

The function \( \alpha_v \) is postulated in form shown in Fig.1 and has assumed properties \( \alpha_v > 0 \) and \( \alpha_v < 1 \) which enable transformation of the reference configuration.

The function \( v(r) \) considered as solution of the equation (46) is given in Fig.2 by continuous line. We assume there that \( v = -\frac{Q}{r^2}, Q = 1 \) for \( r < 1.5 \) and \( v \) takes more flat form for \( r \in [0.26, 1.5] \), and then \( r_1 = 0.26 \).

We have applied units \( H_r = 10^{-17} m \) for the radius of the particle and \( H_Q = e \) for charge of the particle. Thereby, we have assumed validity of the Coulomb law for distances larger then \( r^{**} = 1.5 \cdot 10^{-17} m \).

Taking into account postulated \( \alpha_v \) and \( G_v \), we have obtained the function \( C_{av} \) as solution of the equation (46). Form of this function is shown in Fig.3. This function increases with increasing length of the vector \( v \) what is expected property reflecting attraction within the \( a \)-medium.
We introduce a new particle with smaller radius $r_2 = 0.1$ and modified field $v(r)$ around this particle as compared with the field of particle having radius $r_1 = 0.26$.

We tend finally to show that we are able to model the same charge for particles of various sizes. To this end we assume for our further considerations that obtained hitherto $C_{av}(v)$ represents a law in the vacuum medium considered and does not undergo any change.

Furthermore, we introduce condition that we have $v(r^{**}) = v^{**}$ for given $r^{**}$, the same for both particles of various sizes. This condition is stronger than the condition $Q_1/Q_2 = (r_2 + r)^2/(r_1 + r)^2 \approx 1$ since we postulate directly the same $Q$ for both particles by the introduced relation on border of validity of the Coulomb law.

Modified profile of the electric field is shown in Fig.2 by dotted line. The modification is carried out directly near the particle, in region where $r < r^{**}$. As a result of this modification we expect a change of $\alpha_v$ for the given law determined by obtained previously $C_{av}$.

In order to calculate modified $\alpha_v$, we derive equation for the variable $\alpha_v$ using (46). Thus we have

$$S_1 \frac{\partial^2 \alpha_v}{\partial v^2} + S_2 \frac{\partial \alpha_v}{\partial v} + S_3 \alpha_v + S_4 = \frac{S_6 \alpha_v^2}{1 - \frac{\partial \alpha_v}{\partial v} S_5},$$

(48)

where the coefficients $S_1$, $S_2$, $S_3$, $S_4$, $S_5$, $S_6$ are determined by means of the equation (46) for given $C_{av}$, and take the form
Figure 2: Initial and modified intensity of electric field around particles.
Figure 3: Function $C_{av}$ obtained as solution of corresponding equation.
\begin{align*}
S_1 &= -r\left(\frac{\partial v}{\partial r}\right)^2 C_{av}, \\
S_2 &= -\left(\frac{\partial v}{\partial r}\right)^2 r \frac{\partial C_{av}}{\partial v} + \left(-4\frac{\partial v}{\partial r} - r \frac{\partial^2 v}{\partial r^2}\right) C_{av}, \\
S_3 &= -\frac{\partial v}{\partial r} \frac{\partial C_{av}}{\partial v} - \frac{2}{r} C_{av}, \\
S_4 &= \frac{\partial v}{\partial r} \left(\frac{\partial G_v}{\partial v} \frac{\partial v}{\partial v} + 1\right) \frac{\partial C_{av}}{\partial v} + \\
&\quad + \frac{\partial^2 G_v}{\partial v^2} \left(\frac{\partial v}{\partial r}\right)^2 + \frac{\partial G_v}{\partial v} \frac{\partial^2 v}{\partial v \partial r} + 2 \left(\frac{\partial G_v}{\partial v} \frac{\partial v}{\partial r} + 1\right) C_{av}, \\
\text{and} \\
S_5 &= \frac{\partial G_v^{-1}}{\partial v G} r, \\
S_6 &= k v \frac{\partial G_v^{-1}}{\partial v G}.
\end{align*}

Solution of the equation (48) with given $C_{av}$ and modified $v(r)$ provides new $\bar{\alpha}_v = \alpha_v + \Delta \alpha_v$. The difference $\Delta \alpha_v$ which characterizes obtained change of $\alpha_v$ is shown in Fig.4.

The function $\bar{\alpha}_v$ satisfy the condition $0 < \bar{\alpha}_v < 0$ and has the same monotone character as $\alpha_v$. Such a property indicates that modelling of the same charge for particles of various sizes is possible on way discussed in this paper.

5 Final remarks

The aim of this paper is to introduce a method of modelling of electric field in the vicinity of charged particles. Several requirements are imposed on methods of modelling discussed.

Firstly, we introduce the fundamental condition that $u = u^*$ on the surface of the particle. As a result of this the charge of elementary particles is viewed as a consequence of the introduced condition. Then, we have to obtain property that it is possible to model particles of various sizes with the same charge. To this end electric field which differs from that which is described by the Coulomb law is discussed in the vicinity of the particle. Then the question what equations govern such a field appears. Therefore, introduced methods of modelling discuss just such a problem.
Figure 4: Change of the function $\alpha_v$ for modified distribution of electric field.
Secondly, we would like to introduce equations which describe both, the field near the particle and the field described by the Coulomb law at larger distances from the particle in order to be in accordance with known experimental facts. This task is realized mainly by introduction of displacements $v_G$ related to electric field and form of the function $G$.

Thirdly, energy of electrostatic field should follow from discussed equations in the well known form [1]. To this end the term $kvv$ is introduced into the balance of energy equations. Assumption that $k$ is considerably smaller than the remaining constants induces gathering energy in the most soft mode of deformation associated just with the term $kvv$.

Furthermore, we would like to have a consistency between the most elementary assumptions related to the four-component medium and obtained model. It means that assumptions introduced into the model cannot contradict those ones introduced previously for the medium. Such a consistency gives possibility for generalization of the model in order to describe larger variety of phenomena.

Discussed above property is maintained by development of methods of modelling corresponding to multicomponent medium, especially by introduction various reference configurations as well as by interpretation of equations with respect to assumed interactions within components.

We accept validity the Coulomb law in the paper. However, we have postulated mapping $v_G = G(v)$ which introduce a geometrical interpretation of the process of separation of components within elementary units. Dependence of $v_G$ on $\sqrt{\nu_L}$ suggests discussion on validity of the Coulomb law for very weak fields where $\frac{\partial G^{-1}}{\partial v_G}$ takes very high values.

Considerations carried out in this paper show that three-positron chain state interpreted as proton [4] can have the same charge as one free positron. Mechanism of bonding of the three positrons is described in [4] and rests on interpretation of waving of nonequilibrium distribution of components in the vacuum medium. Consequently, this paper together with the paper [4] provide foundations for considering mechanism of breaking of charge conservation law.

References


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