FINSLERIAN APPROACH TO THE ELECTROMAGNETIC INTERACTION IN THE PRESENCE OF ISOTOPIC FIELD-CHARGES AND A KINETIC FIELD

György Darvas
Symmetrion, Budapest, Hungary
darvasg@iif.hu

This paper deals with the application of the isotopic field-charge spin theory to the electromagnetic interaction. First there is derived a modified Dirac equation in the presence of a velocity dependent gauge field and isotopic field charges (namely Coulomb and Lorentz type electric charges, as well as gravitational and inertial masses). This equation is compared with the classical Dirac equation and there are discussed the consequences [6, 34, 35, 37].

There is shown that since the presence of isotopic field-charges would distort the Lorentz invariance of the equation, there is a transformation, which restores the invariance, in accordance with the conservation of the isotopic field-charge spin [8]. It is based on the determination of the $F^{\mu\nu}$ field tensor adapted to the above conditions.

The presence of the kinetic gauge field makes impossible to assume a flat electromagnetic interaction field. The connection field, which determines the curvature, is derived from the covariant derivative of the kinetic (velocity dependent) gauge field. In this case, there appears a velocity dependent metric, what involves a (velocity arrowed) direction-dependent, that means, Finsler geometry [11, 14]. The option of such a «theory of the electrons» (with the words of Dirac) was shown in the extension of his theory in [23]. This paper is an attempt to a further extension.

Key Words: field-charges, isotopic electric charges, isotopic masses, isotopic electric-charge spin, conservation, electromagnetic interaction, electroweak interaction, kinetic gauge field, extended Dirac equation, magneto-kinetic moment, electro-kinetic moment, coupling spin, accidental symmetry, conserved Noether currents.

Introduction

I presented the isotopic field-charge spin theory [10, 12] and its possible applications to the description of gravitational interaction at FERT 2011 [13]. It was shown that the presence of a kinetic field with a velocity dependent metric and isotopic field-charges (namely in that case distinguished gravitational and inertial masses) involve a (velocity arrowed) direction-dependent, that means, Finsler geometry [11, 14].

Electromagnetic field theories were related with Finsler geometries in, at least, two terms. First, the Dirac matrices, introduced in QED [19] follow the rules of hypercomplex numbers, as shown, among others, by Achiezer and Berestetskii [1, p. 90]. Later Dirac published two essential extensions to his QED theory. In [23], he introduced a curvilinear co-ordinate system. So, *at second*, he defined a second (auxiliary) co-ordinate system y^Λ, «which is kept fixed during the variation process and use the functions $y^\Lambda(x)$ to describe the x co-ordinate system in terms of the y co-ordinate system». He defines the y system «so that the metric for the x system» be $g_{\mu\nu} = \nu_{\Lambda\mu} y^\Lambda_\nu$. This metric, which then appears in the Hamiltonian of the electromagnetic interaction, is the first step to a Finsler extension.

Now, I will make three steps to a further extension of the field theoretic model of the electromagnetic interaction. First, I introduce the isotopic electric charges in the classical Maxwell EM theory [12]. Secondly, I introduce the isotopic electric charges in the classical Dirac equation. At third, I extend the Dirac equation with a kinetic field (see in more details in [15]. The main part of the paper discusses this extended equation.

1 Isotopic electric charges in classical EM

According to the isotopic field-charge theory [10], we can replace the charges appearing in our equations by two different (isotopic) charges, a Coulomb-type one, and a kinetic-type one. The Coulomb-type charge is associated with the potential part of the Hamiltonian (V), and the kinetic type with the kinetic part of the Hamiltonian (T), and they appear in the components of a current density respectively.

In classical electrodynamics, the A_μ four-potentials of the electromagnetic field were invariant under Lorentz transformation, and the four-current j_ν components transformed like a vector. We assumed, that the sources of the Coulomb force (q_V) are different type charges, than moving charges as sources of currents (q_T). The same charges play both roles (cf. covariance), we assume only, that in the two situations they behave as two isotopic states of the same physical property (i.e., field-charge). Provided, that the fourth component (in $+++-$ signature) of a j_ν current density, namely $j_4 = ic\rho$ contains a different kind of charge-density (ρ_V), than those moving (current-like, kinetic) charges (ρ_T) in j_i ($i=1,2,3$), the j current would lose its invariance under Lorentz transformation. We can demonstrate this through the transformation of the Lorentz force:

$$F^\mu = \frac{1}{c} F^{\mu\nu} j_\nu, \qquad (\text{where } j_\nu = \rho u_\nu \text{ and } u_\nu = \frac{dx_\nu}{d\tau}).$$

In the traditional picture this formulation applies the identical charge density for all components, F^μ and j_ν behave like vector components.

Provided, that current-like charges are associated with ρ_T charges, and the real- or Coulomb-charges are ρ_V-denoted charges, we should apply $j_i = \rho_T u_i$ ($i=1,2,3$), and $j_4 = ic\rho_V$ in the proposed isotopic electric charge picture. This latter j_ν does not transform like a vector, and the electromagnetic force should be written as:

$$F^\mu = F^{\mu\nu}\frac{1}{c} j_\nu = \begin{bmatrix} 0 & B_3 & -B_2 & -iE_1 \\ -B_3 & 0 & B_1 & -iE_2 \\ B_2 & -B_1 & 0 & -iE_3 \\ iE_1 & iE_2 & iE_3 & 0 \end{bmatrix} \begin{bmatrix} \rho_T \frac{u_1}{c} \\ \rho_T \frac{u_2}{c} \\ \rho_T \frac{u_3}{c} \\ i\rho_V \end{bmatrix} = \begin{bmatrix} B_3\rho_T\frac{u_2}{c} - B_2\rho_T\frac{u_3}{c} + E_1\rho_V \\ -B_3\rho_T\frac{u_1}{c} + B_1\rho_T\frac{u_3}{c} + E_2\rho_V \\ B_2\rho_T\frac{u_1}{c} - B_1\rho_T\frac{u_2}{c} + E_3\rho_V \\ iE_1\rho_T\frac{u_1}{c} + iE_2\rho_T\frac{u_2}{c} + iE_3\rho_T\frac{u_3}{c} \end{bmatrix} =$$

$$= \frac{1}{c}\begin{bmatrix} B_3u_2 - B_2u_3 & cE_1 \\ -B_3u_1 + B_1u_3 & cE_2 \\ B_2u_1 - B_1u_2 & cE_3 \\ iE_1u_1 + iE_2u_2 + iE_3u_3 & 0 \end{bmatrix} \begin{bmatrix} \rho_T \\ \rho_V \end{bmatrix} = \frac{1}{c} H^{\kappa l}\rho_l \tag{1}$$

where ($\kappa = 1,\ldots,4$), ($l=1,2$), $E_i = -\partial_i\varphi - \frac{1}{c}\frac{\partial A_i}{\partial t}$ and $B_i = \mathrm{rot}_i A$. It is easy to recognise, that the first column of the matrix $H^{\kappa l}$ represents components of the kinetic Lorentz force, wile the second column of the matrix represents components of the Coulomb force[1]. Here B_i are associated only with ρ_T, while E_i both with ρ_V and ρ_T, where $\varphi = \int \frac{\rho_V}{r} dV$ and $A = \int \frac{j(\rho_T)}{r} dV$

[1] This expression is very close to the approach applied by [21]. The roots are, however, much elder. To see the origins, I must mention a few other historical steps.

Following the *Symmetry Festival 2003*, when I first discussed the basic ideas — developed in detail in my book [12] — with Yuval Ne'eman, there appeared a few similar approach publications. Starting from the fundamental are the retarded scalar and vector potentials. It is obvious from the above matrix equation that this j_ν is *not* a four-vector, and for ρ_V and ρ_T are mixed during the multiplication by $F^{\mu\nu}$, the components F^μ do not transform as vector components either.

The result of this example is not in compliance with our experience! With the introduction of the isotopic electric charges, we lost certain symmetry[2]. As a consequence, to restore Lorentz invariance and compliance with experience, our program must include the requirement of the existence of an additional transformation that should counteract the loss of symmetry caused by the introduction of two isotopic states of the charges. This additional transformation was presented in [10, 12] by the proof of the conservation of the isotopic field-charge spin. The Lorentz transformation and the isotopic field-charge spin transformation combined restore the covariance of the theory. In the next sections, I specify it to the electromagnetic field.

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equation by Dirac [21] $\partial_{,,} J^\mu A^\nu$, de Haas E.P.J. [16, 17] in his PIRT paper, for example, derives similar (but not the same) conclusions like we, for QED and the SM, according to which physical real quantities can be derived by the distinction of the (spatially localised) electric potential and the Dirac velocity field. Although, in contrary to Dirac, our theory does not need to assume an ether, we can refer to Dirac's statement [22] where he defines the velocity field through the electromagnetic four-potential: «We have now the velocity at all points of space-time, playing a fundamental part in electrodynamics. It is natural to regard this as the velocity of some real physical thing». While Dirac identifies this «real physical thing» with an ether, our work is an attempt to identify these «things» with the quanta of a gauge-field, «localised» in that velocity field. For I received objections since I first communicated the essence of the theory presented later in detail in [10], which objections stated that the assumption of a velocity dependent gauge contradicts localisation, I advise to keep in mind the cited words by Dirac (in addition to my main argument, namely the original formulation of Noether's second theorem). De Haas assumes an analogy between Mie's [30] non-gauge invariant stress-energy tensor, and the stress-energy tensor in Dirac's 1951 theory in a four-velocity field. The analogy works only partially (in my opinion), but the acknowledgement of the role of the velocity field in defining the stress-energy tensor is worth attention, it partially confirms my approach, and leads to the same derivation of the Lorentz transformation of the electromagnetic field components, as I have interpreted it. As de Haas [18] refers to it, the stress-energy tensor by M. von Laue [38] can be written as $T_{\mu\nu} = J_\mu A_\nu$, where

$$A_\nu = \begin{bmatrix} \mathbf{A} \\ \frac{i}{c}\Phi \end{bmatrix} \quad \text{and} \quad J_\mu = \begin{bmatrix} \mathbf{J} \\ ic\rho \end{bmatrix}$$

so

$$T_{\mu\nu} = \begin{bmatrix} \mathbf{J} \\ ic\rho \end{bmatrix} \begin{bmatrix} \mathbf{A} \\ \frac{i}{c}\Phi \end{bmatrix} = \begin{bmatrix} \mathbf{J}\otimes\mathbf{A} & \frac{i}{c}\Phi\mathbf{J} \\ ic\rho\mathbf{A} & -\rho\Phi \end{bmatrix}$$

what demonstrates an analogy with our formula.

[2]For other forms of Lorentz violating phenomena see, e.g., [26] where he writes that «Effective field theories with explicit Lorentz violation are intimately linked to Riemann-Finsler geometry. The quadratic single-fermion restriction of the Standard-Model Extension provides a rich source of pseudo-Riemann-Finsler spacetimes and Riemann-Finsler spaces. An example is presented that is constructed from a 1-form coefficient and has Finsler structure complementary to the Randers structure.». In [27, 28] he writes that «Our basic premise is that minuscule apparent violations of Lorentz and CPT invariance might be observable in nature. The idea is that the violations would arise as suppressed effects from a more fundamental theory. We have shown in our publications that arbitrary Lorentz and CPT violations are quantitatively described by a theory called the Standard-Model Extension (SME), which is a modification of the usual Standard Model of particle physics and Einstein's theory of gravity, General Relativity.» Coleman and Glashow [7] proposed that «The existence of high-energy cosmic rays places strong constraints on Lorentz non-invariance. Furthermore, if the maximum attainable speed of a particle depends on its identity, then neutrinos, even if massless, may exhibit flavor oscillations. Velocity differences far smaller than any previously probed can produce characteristic effects at accelerators and solar neutrino experiments.»

2 Isotopic electric charges in QED

I presented the effect of the introduction of isotopic electric charges in the classical electrodynamics in the previous section. Now, as an example, I introduce isotopic field charges in the derivation of the Dirac equation [19].

Dirac considered in first (unperturbed) approximation a case of no field, when the wave equation reduces to

$$(-p_4^2 + p_i^2 + m^2c^2)\psi = 0 \tag{1a}$$

where $p_4 = \dfrac{\mathbf{W}}{c} = ih\dfrac{\partial}{c\partial t}$ and $p_i = -ih\dfrac{\partial}{\partial x_i}$ $(i=1,2,3)$ and the wave equation be in the form $(\mathbf{H} - \mathbf{W})\psi = 0$.

To maintain the required linearity of the Hamiltonian $\mathbf{H}$ in p_μ one introduces the dynamical variables α_i and β which are independent of p_μ, i.e., that they commute with t, x_i. Here Dirac considered particles moving in empty space, so that all points in space were equivalent, and one can expect the Hamiltonian not to involve t, and x_i. It follows that α_i and β are independent of t, x_i, i.e., that they commute with p_μ $(\mu = 1,2,3,4)$, although this latter held only until we did not distinguish gravitational and inertial masses. Dirac introduced his matrices in order to have other dynamical variables besides the co-ordinates and momentums of the electron, so that α_i and β may be functions of them, and that the relativistic Lorentz invariant wave function depended on these variables. So Dirac's wave equation took the form:

$$(p_4 + \alpha_1 p_1 + \alpha_2 p_2 + \alpha_3 p_3 + \beta)\psi = 0 \tag{2}$$

According to our assumptions, from here on we should modify the clue followed by Dirac. This equation must lead to a condition where we consider that the interacting two charges are carried by particles with masses in two isotopic field-charge (IFC) states, one of them in potential, the other in kinetic state. Since the masses of the carriers appear explicitly in β, we have to introduce two kinds of β, corresponding to the two states: β_V and β_T. We have to note that for the sake of relativistic invariance of the four-momentum's square the mass square in the equation (1a) must be equal with the rest mass. We will see, this is – at least numerically – equal with the potential (gravitational) mass: $m_V = m_0$. We make a qualitative distinction between the masses m_V and m_T, where the numerical value of the kinetic mass at relativistic velocities is

$$m_T = \frac{m_0}{\sqrt{1 - \dfrac{\nu^2}{c^2}}}$$

(here m_0 is the rest mass of the particle, and ν is the velocity of the particle in kinetic state relative to the interacting other particle in potential state). This qualitative distinction will obtain significance later. Thus the equation (2) leads to

$$(-p_4 + \alpha_1 p_1 + \alpha_2 p_2 + \alpha_3 p_3 + \beta_V) \cdot (p_4 + \alpha_1 p_1 + \alpha_2 p_2 + \alpha_3 p_3 + \beta_T)\psi = 0 \tag{3}$$

In order to agree with Eq. (1a) in the form $(-p_4^2 + p_i^2 + m_V m_T c^2)\psi = 0$ – considering, in accordance with [9, 10] that a particle in a kinetic state interacts always with another, which is in potential state — we must demand that the coefficients fulfil the conditions:

(d1) $\alpha_i^2 = 1$

(d2) $\alpha_i\alpha_j + \alpha_j\alpha_i = 0, \quad i \neq j$

(d3) $\beta_V\beta_T = m_V m_T c^2$

(d4) $\alpha_i p_i \beta_T + \beta_V \alpha_i p_i = 0$

(d5) $\beta_V p_4 - p_4\beta_T = 0$

(d1) and (d2) coincide with conditions established by Dirac. The conditions (d3) – (d5) do not follow from Dirac's original clue.

The results of the discussion of the extra conditions coincide with the conditions deduced by Dirac (the only difference is the qualitative replacement of m^2 by $m_V m_T$, taking into account the above notice on the relativistic invariance of the four-momentum's square), and they involve that the derived Dirac matrices will not take different forms in our treatment either. Replacing α_i and β with appropriate practical multiplets and notations, Dirac introduced the matrices named after him.

In the presence of an arbitrary electromagnetic field with a scalar potential $\Phi = A_4$ and vector potential $\mathbf{A}$, we substitute $p_4 + (e_T/c)A_4$ for p_4, and $p_i + (e_V/c)A_i$ for p_i in the Hamiltonian for no field, where e_V and e_T denote the potential (Coulomb) and kinetic (Lorentz) charges. Note, that according to the assumption introduced in the IFCS theory [12], there appear potential charges in the scalar field potential (A_4), which interacts solely with kinetic charges, and *vice versa*, there appear kinetic charges in the vector field potential ($\mathbf{A}$), which interacts solely with potential charges. Similar to m_T, e_T takes also three different values according to the spatial directions, like three components of a three-vector. However, I must mention, that e_T transforms with the velocity in a different way than m_T. In fact, it is not just the value of the charge of e_T, what changes at relativistic velocities, rather the charge density.

Introducing the above deduced conditions in the equation (3), the Dirac matrices, which follow from those conditions, and make the mentioned replacements to consider the effects of an electromagnetic field on our wave equation, we obtain:

$$\begin{aligned}\Big[-\Big(p_4 + \frac{e_T}{c}A_4\Big) - \gamma_5\Big(\boldsymbol{\sigma}, \mathbf{p} + \frac{e_V}{c}\mathbf{A}\Big) + \gamma_4 m_V c\Big] \cdot \\ \cdot \Big[\Big(p_4 + \frac{e_T}{c}A_4\Big) - \gamma_5\Big(\boldsymbol{\sigma}, \mathbf{p} + \frac{e_V}{c}\mathbf{A}\Big) + \gamma_4 m_T c\Big]\psi = 0.\end{aligned} \tag{4}$$

(According to the convention, we replaced the ρ matrices applied in Dirac's original [19] paper with the more widespread γ matrices, so that $\rho_1 = -\gamma_5$ and $\rho_3 = \gamma_4$, and also in accordance with the convention, we replace the original h in Dirac's equations with $\hbar$. To get a more easily comparable equation with the original, derived by Dirac — among other algebraic transformations — we make also the following replacement: $m_V m_T c^2 \equiv m_V^2 c^2 + m_V(m_T - m_V)c^2$. We use during the transformation of the wave equation that the differential operators are ineffective on the stationary m_V and e_V.) We derive:

$$\begin{aligned}\Big\{\Big[-\Big(p_4 + \frac{e_T}{c}A_4\Big)^2 + \Big(\mathbf{p} + \frac{e_V}{c}\mathbf{A}\Big)^2 + m_V^2 c^2 + \hbar\Big(\boldsymbol{\sigma},\ \mathrm{rot}\Big(\frac{e_V}{c}\mathbf{A}\Big)\Big) + \\ + i\hbar\gamma_5\Big(\boldsymbol{\sigma}, \mathrm{grad}\Big(\frac{e_T}{c}A_4\Big) + \frac{1}{c}\frac{\partial}{\partial t}\Big(\frac{e_V}{c}\mathbf{A}\Big)\Big)\Big] + \\ + \gamma_4\Big[-\Big(p_4 + \frac{e_T}{c}A_4\Big) + \gamma_5\Big(\boldsymbol{\sigma}, \mathbf{p} + \frac{e_V}{c}\mathbf{A}\Big) + \gamma_4 m_V c\Big](m_T - m_V)c\Big\}\psi = 0\end{aligned} \tag{5}$$

The first three terms in the first [ ] bracket coincide with those in the relativistic wave equation for electromagnetic fields derived by Dirac (with the assumption $m_V = m_0$) while making qualitative distinction between the potential (Coulomb) and kinetic (current-, or Lorentz) charges.

The fourth and fifth terms include rot $\left(\frac{e_V}{c}\mathbf{A}\right) = e_V\mathbf{H}$, where $\mathbf{H}$ is the *magnetic vector* of the field, as well as the *electric vector* of the field in a modified form, where the potential and the kinetic charges are taken into account: grad $\left(\frac{e_T}{c}A_4\right) + \frac{\partial}{\partial t}\left(\frac{e_V}{c}\right)\mathbf{A} = e'\mathbf{E}$, where e' is a quantum mixture of e_V and e_T. The charges appear under the derivation, because the value of e_T changes in relativistic covariant fields (for it is a function of its velocity in the given frame, cf., e.g., [1, §90], and we are free to write e_V also under the time derivative, because the derivative operator has no effect on the potential charge e_V. More precisely, it is rather the density of e_T, which changes with its velocity. So, in the following, I will replace the isotopic charges e_T with ρ_T and e_V with ρ_V in the formulas.

The expression in the first [ ] bracket in (5) — with the mentioned alteration in the charges – coincides with the quadratic form of the Dirac equation.

Equation (5) differs from Dirac's result essentially in the last, additional term:

$$-\gamma_4\left[-\left(p_4+\frac{e_T}{c}A_4\right)+\gamma_5\left(\boldsymbol{\sigma},\mathbf{p}+\frac{e_V}{c}\mathbf{A}\right)+\gamma_4 m_V c\right](m_T-m_V)c$$

This expression can be written by inserting the p_4 and $\mathbf{p}$ operators in the following

$$-\gamma_4\left[-\left(\frac{i\hbar}{c}\frac{\partial}{\partial t}+\frac{\rho_T}{c}A_4\right)-\gamma_5\left(\boldsymbol{\sigma},i\hbar\,\mathrm{grad}-\frac{\rho_V}{c}\mathbf{A}\right)+\gamma_4 m_V c\right](m_T-m_V)c$$

The components in this term can be regarded as the additional energy of *the interacting two massive, electrically charged particles due to their assumed additional degree of freedom* (arbitrary positions in the IFCS field). They *express the effect of the relativistic mass increase* — difference between the «dressed» and «bare» masses, i.e., the «dress» in itself – on the electromagnetic field. The expression in this last square bracket [ ] coincides again with the Dirac wave equation, in its Hamiltonian form.

This last part of the equation gives account on the *cross-interaction of the electromagnetic field and its two isotopic field charges with the two kinds of isotopic masses in QED*. The state function ψ in this equation, unlike in the original Dirac equation, depends not only on the space-time co-ordinates and the spin, but also on a two valued variable that makes distinction between the isotopic field charges.

In rest (when $m_T = m_V$, $\rho_T = \rho_V$), equation (5) coincides with the Dirac equation. However, in relativistic covariant fields the charges of both the gravitational and the electromagnetic fields will differ not only qualitatively, but also in their quantity, and we must take into account the last term. The appearance of this last term brings in the already acquainted (cf., [10, Secs. 3 and 3.2]) inconvenient, but not unexpected, asymmetry in our theory that should be counteracted by the presumed new symmetry transformation between the states of the isotopic field charges.

The effects of the operators in the two [ ] square brackets in (5) must be equal:

$$\left[-\left(p_4+\frac{\rho_T}{c}A_4\right)^2+\left(\mathbf{p}+\frac{\rho_V}{c}\mathbf{A}\right)^2+m_V^2c^2+\hbar\left(\boldsymbol{\sigma},\mathrm{rot}\left(\frac{\rho_V}{c}\mathbf{A}\right)\right)+\right.$$
$$\left.+i\hbar\gamma_5\left(\boldsymbol{\sigma},\mathrm{grad}\left(\frac{\rho_T}{c}A_4\right)+\frac{1}{c}\frac{\partial}{\partial t}\left(\frac{\rho_V}{c}\mathbf{A}\right)\right)\right]\psi= \tag{5a}$$
$$=\gamma_4\left[\left(p_4+\frac{\rho_T}{c}A_4\right)-\gamma_5\left(\boldsymbol{\sigma},\mathbf{p}+\frac{\rho_V}{c}\mathbf{A}\right)-\gamma_4 m_V c\right](m_T-m_V)c\psi$$

In the case of classical QED, the left side is equal to 0. The right side is 0, if $m_T = m_V$, that means, in a non-relativistic approximation. The effect of the operator in bracket { } on ψ in Eq. (5) will vanish as a result of the operators in the two square [ ] brackets together. If we demand that our mathematical derivations be in agreement with the time-proven Dirac equation, we must require that the effect of the operators in the first and the second square brackets on the wave function ψ be equal to 0 separately, according to the two sides of the Eq. (5a). Thus our equation (5) separates into two equations.

The *first* equation:

$$\left[-\left(p_4 + \frac{\rho_T}{c}A_4\right)^2 + \left(\mathbf{p} + \frac{\rho_V}{c}\mathbf{A}\right)^2 + m_V^2 c^2 + \hbar\left(\boldsymbol{\sigma}, \mathrm{rot}\left(\frac{\rho_V}{c}\mathbf{A}\right)\right) + \right.$$
$$\left. + \; i\hbar\gamma_5\left(\boldsymbol{\sigma}, \mathrm{grad}\left(\frac{\rho_T}{c}A_4\right) + \frac{1}{c}\frac{\partial}{\partial t}\left(\frac{\rho_V}{c}\mathbf{A}\right)\right)\right]\psi = 0 \qquad (6)$$

will provide the solutions of the Dirac equation in the presence of potential and kinetic charges in an electromagnetic field. Note, that there appears only the rest mass ($m_V = m_0$) of the particle. This equation differs from the original Dirac equation only in the presence of the two different isotopic electric charges.

The *second* equation:

$$-\gamma_4\left[-\left(p_4 + \frac{\rho_T}{c}A_4\right) + \gamma_5\left(\boldsymbol{\sigma}, \mathbf{p} + \frac{\rho_V}{c}\mathbf{A}\right) + \gamma_4 m_V c\right](m_T - m_V)c\psi = 0 \qquad (7)$$

holds either in rest when quantitatively $m_T = m_V$, or when the value in the square bracket is 0.

The form of equation (5) guarantees that in boundary conditions our result coincides with the traditional. In a state close to rest, the second part vanishes and we get back to the well known Dirac equation (6). In extreme relativistic situation, when $m_T \gg m_V = m_0$, (we can neglect the first component in (5), and) we get Eq. (7), and can divide the full modified Dirac equation by $(m_T - m_V)$. Eq. (7) can be written in a Schrödinger type form of a wave equation. The Dirac expression in the square bracket in Eq. (7) can be transformed in:

$$i\hbar\frac{\partial}{\partial t}\psi = \left[-\rho_T A_4 - \gamma_5\left(\boldsymbol{\sigma}, i\hbar\,\mathrm{grad} - \rho_V\mathbf{A}\right) + \gamma_4 m_V c^2\right]\psi \qquad (8)$$

where $-\rho_t A_4 - \gamma_5\left(\boldsymbol{\sigma}, i\hbar\,\mathrm{grad} - \rho_V\mathbf{A}\right) + \gamma_4 m_V c^2 = \mathbf{H}$ is the Hamiltonian of the system. There appears only the rest energy of the particles. However, due to the difference between ρ_T and ρ_V, this equation cannot be linearized in the four charge current components unless the isotopic field-charge spin invariance rotates the two isotopic electric charges of the electric field into each other in an IFCS gauge field (cf. [15]). This equation does not reflect the effect of that gauge field, because the Dirac equation expresses the interaction of the two electrons in the electromagnetic field, more precisely the scalar Coulomb field with the electromagnetic vector field. In this semi-classical approach[3], I have not taken into account the interaction with the

[3]Later, Dirac [21] considered that the classical theories of electromagnetic field are *approximate* and are valid only if the accelerations of the electrons are small. He stated that the earlier problems of QED resulted not in quantization, rather in the incompleteness of the classical theory of electrons, and one must try to improve on it. For this reason, he proposed to replace the application of the Lorentz condition with a gauge theory. He emphasised also the Hamiltonian approach instead of the Lagrangian one. He introduced a function λ (which was different from the quantity introduced by Feynman [24] and got a current $j_\mu = -\lambda(\partial S/\partial x^\mu + A_\mu^*)$ where S was a gauge function attributed to A, and λ could be chosen to be an arbitrary infinitesimal at one instant of time, while its value at other times was then fixed by the conservation law $\partial j_\mu/\partial x_\mu = 0$. This method resulted in the conclusion that the theory (as expected) involves only the ratio e/m, not e and m separately. This [21]

IFCS gauge field[4].

We can construct the Lagrangian of the interacting coupled two-electron system in the fields of each other from this Hamiltonian. Due to the two kinds of charges, this L differs from the usual form that appears in most textbooks. In principle, one can derive the non-linear charge–four-current from this L. The condition of linearization is that the gauge field, in which the charges ρ_T and ρ_V can substitute for each other, become invariant under an arbitrary gauge transformation. I will consider the interaction with a kinetic, concretely, IFCS gauge field in the next section.

3 Isotopic electric charges in the presence of a kinetic gauge field

Let's introduce a kinetic gauge field $\mathbf{D}$ similar to the general field-theoretical approach in [10]. As we saw in section 1 that the vierbein j_ν does not transform like a vector, we cannot expect this property of $\mathbf{D}$ either. This $\mathbf{D}$ kinetic gauge field is associated with the electromagnetic field. Therefore, I extend the Dirac equation, discussed in section 2, with the components of this $\mathbf{D}$ gauge field. For $\mathbf{D}$ is a kinetic field, all the four of its components interact with the potential electric (Coulomb) charge. Thus, I will start from the following, extended form of the equation:

$$\begin{aligned}&\left[-\left(p_4+\frac{\rho_T}{c}A_4+\frac{\rho_V}{c}D_4\right)-\gamma_5\left(\boldsymbol{\sigma},\mathbf{p}+\frac{\rho_V}{c}\mathbf{A}+\frac{\rho_V}{c}\mathbf{D}\right)+\gamma_4 m_V c\right]\cdot\\ &\cdot\left[\left(p_4+\frac{\rho_T}{c}A_4+\frac{\rho_V}{c}D_4\right)-\gamma_5\left(\boldsymbol{\sigma},\mathbf{p}+\frac{\rho_V}{c}\mathbf{A}+\frac{\rho_V}{c}\mathbf{D}\right)+\gamma_4 m_V c\right]\psi=0\end{aligned}\tag{9}$$

here D_4 is the fourth component of $\mathbf{D}$, and $\mathbf{D}$ depends on the velocity components $D_{\dot{\mu}}=D(\dot{x}^\mu)$. Note, that D_4, being a component of the kinetic gauge field interacts with the *potential* electric charge in contrast to the A_4 scalar potential of the electric field in the first ( ) brackets, and $\mathbf{D}$ in the second ( ) brackets is a three-component, vector-like quantity. Making the multiplication, applying the same transformations like in section 2, and considering that $p_4=i\frac{\hbar}{c}\frac{\partial}{\partial t}$ and

theory did not introduce the interaction of the electron with the electromagnetic field as a perturbation, like in the 1929–1932 Dirac–Fermi–Breit theories. The electron of that new theory could not be considered apart from its interaction with the electromagnetic field. As Dirac mentioned: «The theory of the present paper is put forward as a basis for a passage to a quantum theory of electrons. ... one can hope that its correct solution will lead to the quantization of electric charge ...» and «... questions of the interaction of the electron with itself no longer arise.» Then, a further model by Dirac [23, p. 64] provided a possible solution for eliminating the runaway motions of the electron.

Dirac's [21] paper was an attempt to exclude approximations by perturbation in either direction. It was in harmony with the aim of Bethe and Fermi (1932) [3] to show the equivalence of the perturbations applied by Breit (1929, 1932) [4, 5] and Møller (1931) [32]. In this respect Dirac's models were kin to the present attempt, in which, instead of a perturbation, we acknowledge the asymmetric roles of the interacting charged particles (as it can be read originally in [32] and apply a gauge theory that has led us to a quantised theory. The theory applied in this paper to QED and having been proposed in a general form in [10] eliminates the runaway motions of the electron too, although in an alternative way.

[4]At the end of their paper Bethe and Fermi [3, p. 306] showed that the formula introduced by Møller holds also when one of the interacting particles is in bound state. They consider also the option that the two interacting particles emit two quanta, but they reject it, because (for symmetry consideration for the momentums of the two quanta) they take into account only identical type quanta to be emitted and absorbed. (Although, the emission of one quantum painted another asymmetry in the picture, in which they aimed at eliminating the asymmetry caused by Møller's scattering matrix.) This conclusion by Bethe and Fermi is a result of their artificial symmetrisation of the potentials, and does not arise in the theory set forth, among others, in this paper.

$p_i = -i\hbar\frac{\partial}{\partial x^i}$, as well as commutation of the components, one gets:

$$\begin{aligned}
&\Big\{\Big[-\Big(p_4+\frac{\rho_T}{c}A_4+\frac{\rho_V}{c}D_4\Big)^2+\Big(\mathbf{p}+\frac{\rho_V}{c}\mathbf{A}+\frac{\rho_T}{c}\mathbf{D}\Big)^2+m_V^2c^2\Big]+\\
&+\hbar\Big(\boldsymbol{\sigma},\ \mathrm{rot}\Big(\frac{\rho_V}{c}\mathbf{A}\Big)\Big)+i\hbar\gamma_5\Big(\boldsymbol{\sigma},\ \mathrm{grad}\Big(\frac{\rho_T}{c}A_4\Big)+\frac{1}{c}\frac{\partial}{\partial t}\Big(\frac{\rho_V}{c}\mathbf{A}\Big)\Big)+\\
&+\hbar\Big(\boldsymbol{\sigma},\ \mathrm{rot}\Big(\frac{\rho_V}{c}\mathbf{D}\Big)\Big)+\hbar\Big(\boldsymbol{\sigma},\frac{\rho_V^2}{c^2}\left[D_jD_k-D_kD_j\right]+\\
&+i\hbar\gamma_5\Big(\boldsymbol{\sigma},\ \mathrm{grad}\Big(\frac{\rho_V}{c}D_4\Big)+\frac{1}{c}\frac{\partial}{\partial t}\Big(\frac{\rho_V}{c}\mathbf{D}\Big)\Big)+\gamma_5\frac{\rho_V^2}{c^2}\left(\boldsymbol{\sigma},D_4\mathbf{D}-\mathbf{D}D_4\right)+\\
&+\gamma_4\Big[-\Big(p_4+\frac{\rho_T}{c}A_4+\frac{\rho_V}{c}D_4\Big)+\gamma_5\Big(\boldsymbol{\sigma},\mathbf{p}+\frac{\rho_V}{c}\mathbf{A}+\frac{\rho_V}{c}\mathbf{D}\Big)+\gamma_4m_Vc\Big](m_T-m_V)c\Big\}\psi=0
\end{aligned}\tag{10}$$

Eq. (10) is the extended Dirac equation, in the presence of isotopic electric charges and a kinetic gauge field ***D***. There was considered that both the components of the EM vector potential $\mathbf{A}$, and the elements of $\mathbf{D}$ commute with $\boldsymbol{\sigma}$, the components of $\mathbf{A}$ commute with each other, but, for the elements of $\mathbf{D}$ do not compose a four-vector (in contrast to the components of $\mathbf{A}$), we have no reason to assume that the elements of $\mathbf{D}$ would commute with each other. Thus, in the multiplication in (9) we considered the following equalities:

$$\begin{aligned}
&\Big(\boldsymbol{\sigma},\mathbf{p}+\frac{\rho_V}{c}\mathbf{A}+\frac{\rho_V}{c}\mathbf{D}\Big)^2=\Big(\mathbf{p}+\frac{\rho_V}{c}\mathbf{A}+\frac{\rho_V}{c}\mathbf{D}\Big)^2+\hbar\Big(\boldsymbol{\sigma},\ \mathrm{rot}\Big(\frac{\rho_V}{c}\mathbf{A}\Big)\Big)+\\
&+\hbar\Big(\boldsymbol{\sigma},\ \mathrm{rot}\Big(\frac{\rho_V}{c}\mathbf{D}\Big)\Big)+\hbar\Big(\boldsymbol{\sigma},\frac{\rho_V^2}{c^2}(D_jD_k-D_kD_j)\Big)
\end{aligned}$$

and

$$\begin{aligned}
&\gamma_5\Big(p_4+\frac{\rho_T}{c}A_4+\frac{\rho_V}{c}D_4\Big)\Big(\boldsymbol{\sigma},\mathbf{p}+\frac{\rho_V}{c}\mathbf{A}+\frac{\rho_V}{c}\mathbf{D}\Big)-\\
&-\gamma_5\Big(\boldsymbol{\sigma},\mathbf{p}+\frac{\rho_V}{c}\mathbf{A}+\frac{\rho_V}{c}\mathbf{D}\Big)\Big(p_4+\frac{\rho_T}{c}A_4+\frac{\rho_V}{c}D_4\Big)=\\
&=i\hbar\gamma_5\Big(\boldsymbol{\sigma},\ \mathrm{grad}\Big(\frac{\rho_T}{c}A_4\Big)+\frac{1}{c}\frac{\partial}{\partial t}\Big(\frac{\rho_V}{c}\mathbf{A}\Big)\Big)+\\
&+i\hbar\gamma_5\Big(\boldsymbol{\sigma},\ \mathrm{grad}\Big(\frac{\rho_V}{c}D_4\Big)+\frac{1}{c}\frac{\partial}{\partial t}\Big(\frac{\rho_V}{c}\mathbf{D}\Big)\Big)+\gamma_5\frac{\rho_T^2}{c^2}\left(\boldsymbol{\sigma},D_4\mathbf{D}-\mathbf{D}D_4\right)
\end{aligned}$$

4 Discussion of the modified Dirac equation in the presence of isotopic electric charges and a kinetic gauge field

Equation (10) can be written in the following form: $\left[W+W^A+W^D-H(m_T-m_V)c\right]\psi=0$, where W refers to the first line of (10), W^A to the second line, W^D to the third and fourth lines, and $H(m_T-m_V)c$ to the fifth line of Eq. (10).

4.1 Coincidence with the classical Dirac equation in boundary case, when no kinetic field is present

The first line of the operator in Eq. (10), W expresses the first three elements of the classical Dirac equation, with the modifications that it contains (a) the isotopic electric charges, and

(b) the kinetic vector potential $\mathbf{D}$ of the considered kinetic field.

4.2 The magnetic and the electric moments

The two elements in W^A — considering the isotopic electric charges — coincide with the two elements of the classical Dirac equation as discussed in section 2, and yield the *magnetic* and the *electric* moments of the electron interacting with the electromagnetic field, respectively.

4.3 The magneto-kinetic and electro-kinetic moments

The essential difference, compared to the Eq. (5) of the semi-classical QED model discussed in section 2, is in W^D expressed in the lines 3 and 4 of the Eq. (10). The expression

$$\begin{aligned} &\hbar\left(\boldsymbol{\sigma},\ \mathrm{rot}\left(\frac{\rho_V}{c}\mathbf{D}\right)\right)+\hbar\left(\boldsymbol{\sigma},\frac{\rho_V^2}{c^2}(D_jD_k-D_kD_j)\right)+\\ &+i\hbar\gamma_5\left(\boldsymbol{\sigma},\ \mathrm{grad}\left(\frac{\rho_V}{c}D_4\right)+\frac{1}{c}\frac{\partial}{\partial t}\left(\frac{\rho_V}{c}\mathbf{D}\right)\right)+\gamma_5\frac{\rho_V^2}{c^2}\left(\boldsymbol{\sigma},D_4\mathbf{D}-\mathbf{D}D_4\right) \end{aligned}\tag{11}$$

provides a kinetic moment of the $\mathbf{D}$ field. Introducing the commutator of $\mathbf{D}$, one can write the following:

$$\begin{aligned} &\hbar\left(\boldsymbol{\sigma},\ \mathrm{rot}\left(\frac{\rho_V}{c}\mathbf{D}\right)\right)+ig\hbar\frac{\rho_V^2}{c^2}\left(\boldsymbol{\sigma},C^i_{jk}D_jD_k\right)+\\ &+i\hbar\gamma_5\left(\boldsymbol{\sigma},\ \mathrm{grad}\left(\frac{\rho_V}{c}D_4\right)+\frac{1}{c}\frac{\partial}{\partial t}\left(\frac{\rho_V}{c}\mathbf{D}\right)\right)+\gamma_5\frac{\rho_V^2}{c^2}\left(\boldsymbol{\sigma},D_4\mathbf{D}-\mathbf{D}D_4\right) \end{aligned}\tag{11a}$$

or

$$\begin{aligned} &\left(\frac{\hbar}{c}\boldsymbol{\sigma},\ \mathrm{rot}(\rho_V\mathbf{D})\right)+\left(\frac{\hbar}{c}\boldsymbol{\sigma},igC^i_{jk}\frac{\rho_V^2}{c}D_jD_k\right)+\\ &+i\gamma_5\left[\left(\frac{\hbar}{c}\boldsymbol{\sigma},\ \mathrm{grad}\,(\rho_VD_4)+\frac{1}{c}\frac{\partial}{\partial t}(\rho_V\mathbf{D})\right)+\left(\frac{\hbar}{c}\boldsymbol{\sigma},\frac{\rho_V^2}{\bar{c}}D_4\mathbf{D}-\mathbf{D}D_4\right)\right] \end{aligned}\tag{11b}$$

Here C^i_{jk} are the structure constants appearing with the multiplication of D_i-s, and g is the coupling constant for the electromagnetic interaction. C^i_{jk} are the coefficients in the commutation rule of the generators (transformation matrices) of the symmetry group of the kinetic (isotopic field-charge) field, as we saw in [10]. Since this field is subject of an SU(2) symmetry, there are three C^i_{jk} structure constants. This commutation term does not appear in W^A, because the $\mathbf{A}$ vector potential of the EM field composes a vector, and the derivatives of $\mathbf{A}$ commute with each other as vectors.

Since the derivatives of $D_{\dot\mu}=D(\dot x^\mu)$ appearing in (10) are derived by the space-time coordinates, and $D_{\dot\mu}$ depends on $\dot x^\mu$, all derivatives of $D_{\dot\mu}$ must be interpreted as $\dfrac{\partial D_{\dot\mu}}{\partial x^\nu}=\dfrac{\partial D_{\dot\mu}}{\partial \dot x^{\dot\rho}}\dfrac{\partial \dot x^{\dot\rho}}{\partial x^\nu}=D_{\dot\mu,\dot\rho}\lambda^{\dot\rho}_\nu=D_{\dot\mu,\dot\rho}\dot x^\rho_\mu$ (where $\mu,\nu,\rho=1,\dots,4$).

For simplicity, let us assume that $\mathbf{D}$ depends only on the linear combinations of the first derivatives and multiplications of the velocity, on the velocity itself, as well as on $\kappa = \dfrac{1}{\sqrt{1-\dfrac{\dot{x}_i^2}{c^2}}}$ and a constant. So

$$D(\dot{x}^\mu) = \alpha \frac{\partial \dot{x}^\mu}{\partial \dot{x}^\rho}\frac{\partial \dot{x}^\rho}{\partial x^\nu} + \beta \dot{x}_i \dot{x}_j + \gamma \dot{x}_i + \delta\kappa + \varepsilon$$

where $\alpha, \beta, \gamma, \delta$ and ε are coefficients, not depending on the actual relative velocity of the interacting charges. In this plausible, but quite not the most general case, the commutator of D_j and D_k is not identically 0. However, all the three elements of D_i $(i=1,2,3)$ commute with D_4. In this case the third term in N^D vanishes.

In the general case, (11b) can be written as $\left(\frac{\hbar}{c}\boldsymbol{\sigma}, \mathbf{M}^D\right) + i\gamma_5\left(\frac{\hbar}{c}\boldsymbol{\sigma}, \mathbf{N}^D\right)$, where

$$\begin{aligned} \mathbf{M}^D &= \text{rot}\rho_V\mathbf{D} + igC^i_{jk}\frac{\rho_V^2}{c}D_jD_k \qquad \text{and} \\ \mathbf{N}^D &= \text{grad}\rho_V D_4 + \frac{1}{c}\frac{\partial}{\partial t}\rho_V\mathbf{D} + \frac{\rho_V^2}{\hbar c}(\mathbf{D}D_4 - D_4\mathbf{D}) \end{aligned} \tag{11c}$$

Note, that in the expressions of $\mathbf{M}^D$ and $\mathbf{N}^D$, there appear only the potential (Coulomb) charge densities. This is natural, because the velocity dependence is considered in the kinetic gauge potential $\mathbf{D}$, which these charges interact with. Since ρ_V does not depend either on space-time co-ordinates, or on the actual velocity, it is not subject of derivation:

$$\mathbf{M}^D = \rho_V\text{rot}\mathbf{D} + igC^i_{jk}\frac{\rho_V^2}{c}D_jD_k \qquad \text{and}$$

$$\mathbf{N}^D = \rho_V\text{grad}D_4 + \frac{\rho_V}{c}\frac{\partial}{\partial t}\mathbf{D} + \frac{\rho_V^2}{\hbar c}(\mathbf{D}D_4 - D_4\mathbf{D})$$

The kinetic moment is an additional, new quantity in the isotopic electric charge theory compared to the classical Dirac theory. *The two kinetic moments determine the isotopic electric charge spin* Δ_{el}. According to [10] the isotopic field-charge spin (including also the isotopic electric charge spin) is a conserved quantity, so it must commute with the Hamiltonian.

4.3.1 The magneto-kinetic moment

The first term in (11), $\mathbf{M}^D$ (with an $(m_T - m_V)$ divider) can be considered as a «magneto-kinetic» additional energy of the electric charge due to its additional degree of freedom assigned to it by the interaction with the kinetic field. For $D_{\dot{\mu}}$ does not behave as a vector, its derivatives include an additional, gauge term, what the derivation of the extended Dirac equation (10) provided automatically in the form of the third term (W^D) in the expression (10). So, this second term of $\mathbf{M}^D$ forms part of the «magneto-kinetic» momentum of the field (cf., the first line of (11)).

The full magnetic moment of the interaction (with a mass-dimension divider), in the presence of the kinetic gauge field, will be:

$$\left(\frac{\hbar}{c}\boldsymbol{\sigma}, \mathbf{M}^{FULL}\right) = \left(\frac{\hbar}{c}\boldsymbol{\sigma}, \rho_V\text{rot}(\mathbf{A}+\mathbf{D}) + igC^i_{jk}\frac{\rho_V^2}{c}D_jD_k\right)$$

4.3.2 The electro-kinetic moment

The third term in (11) is similar to the expression got for the electric moment of the EM field in the line 2 (W^A) of (10), extended also with a gauge term. It can be considered in a similar way, like in Dirac's theory, as an «electro-kinetic» additional energy of the electron. Also, similar to $i\hbar\gamma_5\left(\boldsymbol{\sigma},\ \mathrm{grad}\left(\frac{\rho_T}{c}A_4\right)+\frac{1}{c}\frac{\partial}{\partial t}\left(\frac{\rho_V}{c}\mathbf{A}\right)\right)$, the «electro-kinetic»

$$i\gamma_5\left[\left(\frac{\hbar}{c}\boldsymbol{\sigma},\rho_V\mathrm{grad}D_4+\frac{\rho_V}{c}\frac{\partial}{\partial t}\left(\frac{\rho_V}{c}\mathbf{D}\right)\right)+\left(\frac{\hbar}{c}\boldsymbol{\sigma},\frac{\rho_V^2}{\hbar c}(\mathbf{D}D_4-D_4\mathbf{D})\right)\right]$$

is apparently imaginary too. Dirac observed the following: «It is doubtful whether the electric moment has any physical meaning» as a result that the multiplication due to which the imaginary term appeared, was an artificial involvement in the equation. In our case the multiplier of the three-vector $\boldsymbol{\sigma}$ (or $\gamma_5\boldsymbol{\sigma}$) is a sum, which includes the components of the velocity-dependent field. In the presence of that kinetic field, one can choose the co-ordinate system fitted to the electron's velocity arrow so that the multiplier of the imaginary σ_2 be non-zero. Then, the expression will yield a real component for the sum of the electric and the electro-kinetic energy, while there will be left two imaginary terms for the multiplication by σ_1 and σ_3, whose sum should be made equal to 0, and provide a constraint for the energy of the interaction. Note, that these two expressions are not fully imaginary, since D_4, depending on the fourth component of the velocity, is imaginary itself. On the other side, the multiplier of σ_2 contains an imaginary component, too ($\mathrm{grad}_2 D_4$). With these conditions, one can eliminate the imaginary terms in (10) and give physical meaning to the electric and the electro-kinetic moments.

$$i\hbar\gamma_5\left(\sigma_1,\mathrm{grad}_1\left(\frac{\rho_T}{c}A_4\right)+\frac{1}{c}\frac{\partial}{\partial t}\left(\frac{\rho_V}{c}A_1\right)\right)+i\hbar\gamma_5\left(\sigma_1,\mathrm{grad}_1\left(\frac{\rho_V}{c}D_4\right)+\frac{1}{c}\frac{\partial}{\partial t}\left(\frac{\rho_V}{c}D_1\right)\right)+$$
$$+\gamma_5\frac{\rho_V^2}{\hbar c^2}(\sigma_1,D_4D_1-D_1D_4)=0$$
$$i\hbar\gamma_5\left(\sigma_3,\mathrm{grad}_3\left(\frac{\rho_T}{c}A_4\right)+\frac{1}{c}\frac{\partial}{\partial t}\left(\frac{\rho_V}{c}A_3\right)\right)+i\hbar\gamma_5\left(\sigma_3,\mathrm{grad}_3\left(\frac{\rho_V}{c}D_4\right)+\frac{1}{c}\frac{\partial}{\partial t}\left(\frac{\rho_V}{c}D_3\right)\right)+$$
$$+\gamma_5\frac{\rho_V^2}{\hbar c^2}(\sigma_3,D_4D_3-D_3D_4)=0$$

The two conditions of the above equation can be satisfied, if both the imaginary and the real parts are equal to 0 separately.

$$i\hbar\left[\mathrm{grad}_1(\rho_TA_4)+\frac{\rho_V}{c}\frac{\partial}{\partial t}(A_1+D_1)\right]+\frac{\rho_V^2}{\hbar c}(D_4D_1-D_1D_4)=0$$
$$\mathrm{grad}_1 D_4=0$$

and

$$i\hbar\left[\mathrm{grad}_3(\rho_TA_4)+\frac{\rho_V}{c}\frac{\partial}{\partial t}(A_3+D_3)\right]+\frac{\rho_V^2}{\hbar c}(D_4D_3-D_3D_4)=0$$
$$\mathrm{grad}_3 D_4=0$$

We add from among the multipliers of σ_2:

$$\mathrm{grad}_2 D_4=0$$

Provided that the components of the $\mathbf{A}$ vector potential and the value of the interacting charges are known, this is a set of differential equations to determine the components D_1, D_2, D_3, D_4, and the actual value of the velocity arrowed parallel to σ_2, in each space-time point.

The reference frame, in which we calculated the constraints for $\mathbf{D}$, rotates together with the kinetic charge density ρ_T. This choice provided a restriction for the interacting system, while at the same time, it made us possible to calculate the exact forms of the four components of D_μ in the given reference frame.

Considering also the assumption formulated in section 4.3, the set of differential equations reduces to the following:

$$\begin{aligned}
&\mathrm{grad}_1(\rho_T A_4) + \frac{\rho_V}{c}\frac{\partial}{\partial t}(A_1 + D_1) = 0; \quad \mathrm{grad}_1 D_4 = 0\\
&\mathrm{grad}_2 D_4 = 0\\
&\mathrm{grad}_3(\rho_T A_4) + \frac{\rho_V}{c}\frac{\partial}{\partial t}(A_3 + D_3) = 0; \quad \mathrm{grad}_3 D_4 = 0
\end{aligned} \tag{11d}$$

This set of five differential equations can be solved and yield the four D_μ and — through ρ_T — the actual relative velocity of the two-charge system.

In this case the electro-kinetic moment (with a mass-dimension divider) will take the form where the first and third terms in the right side are equal to 0, so the electro-kinetic moment (with a mass-dimension divider) will reduce to:

$$i\gamma_5\left(\frac{\hbar}{c}\boldsymbol{\sigma}, \mathbf{N}^D\right) = i\gamma_5\rho_V\left(\frac{\hbar}{c}\boldsymbol{\sigma}, \frac{1}{c}\frac{\partial}{\partial t}\mathbf{D}\right).$$

The full electric moment (with an $(m_T - m_V)$ divider) can be written as:

$$i\gamma_5\left(\frac{\hbar}{c}\boldsymbol{\sigma}, \mathbf{N}^{\mathrm{FULL}}\right) = i\gamma_5\left(\frac{\hbar}{c}\boldsymbol{\sigma}, \mathrm{grad}\rho_T A_4 + \frac{\rho_V}{c}\frac{\partial}{\partial t}(\mathbf{A}+\mathbf{D})\right),$$

whose second component is real, first and third components are 0. The electric moment of the interacting particles is directed towards the real component of the spin, and this direction coincides with the direction of the velocity of one of the interacting particles, while the position of the other is fixed. We have not experienced such moment in the classical Dirac theory[5].

4.4 The Hamiltonian and the Lagrangian of the interaction

Line 5 of the Eq. (10) yields the Schrödinger wave equation $i\hbar\frac{\partial}{\partial t}\psi = \mathbf{H}\psi$, similar to the clue we followed in section 2:

$$i\hbar\frac{\partial}{\partial t}\psi = \left[-\rho_T A_4 - \rho_V D_4 - \gamma_5(\boldsymbol{\sigma}, i\hbar c\,\mathrm{grad} - \rho_V\mathbf{A} - \rho_V\mathbf{D}) + \gamma_4 m_V c^2\right]\psi \tag{12}$$

and hence the Hamiltonian

$$\mathbf{H} = -\rho_T A_4 - \rho_V D_4 - \gamma_5(\boldsymbol{\sigma}, i\hbar c\,\mathrm{grad} - \rho_V\mathbf{A} - \rho_V\mathbf{D}) + \gamma_4 m_V c^2$$

The Lagrangian of the interaction field can be constructed from the Hamiltonian. So

$$\mathbf{L} = \rho_T A_4 + \rho_V D_4 - \gamma_5(\boldsymbol{\sigma}, i\hbar c\,\mathrm{grad} - \rho_V\mathbf{A} - \rho_V\mathbf{D}) + \gamma_4 m_V c^2$$

Obviously, this expression differs from the classical one in the two terms, which include the three-component $\mathbf{D}$, and the fourth component of the vierbein, i.e., D_4, as well as in the two isotopic electric charges.

[5]The fact is, that Dirac [19, p. 619] could not do anything with the electric moment, and so did all but most textbooks following him. The appearance of the kinetic field D made possible to calculate the full electric moment.

As we showed in Sec. 2, the condition for getting the Schrödinger equation was, that $m_T \gg m_V$, that means, an extreme relativistic situation. If $m_T \neq m_V$, one can divide the full Eq. (10) by $(m_T - m_V)$. One could obtain Eq. (12) in this way. The division by $(m_T - m_V)$ may cause an increase in the energy of the system when the difference between $m_T - m_V$ approaches to 0, unless the increase in $\mathbf{D}$ does not counterbalance it. This means, first, that D must be a monotone function of the velocity, at second we can determine a limit of its monotone increase with the increase of the velocity.

Let we write again Eq. (10) in the form of

$$\left[W + W^A + W^D - H(m_T - m_V)c\right]\psi = 0 \tag{13}$$

Close to the rest, division of Eq. (10) or (13) by $(m_T - m_V)$ makes W and W_A high. This operation gets sense only at far relativistic velocities. Nevertheless, just in the case of low velocities, the role of $H(m_T - m_V)c$ can be neglected, since $(m_T - m_V) \to 0$. What is interesting for us, it is the role of W^D. Let's divide W^D (11) by $(m_T - m_V)$:

$$\left(\frac{\hbar}{c}\frac{\boldsymbol{\sigma}}{m_T - m_V}, \rho_V \,\mathrm{rot}\mathbf{D}\right) + \left(\frac{\hbar}{c}\frac{\boldsymbol{\sigma}}{m_T - m_V}, igC^i_{jk}\frac{\rho_V^2}{\hbar c}D_j D_k\right) +$$

$$+i\gamma_5\left[\left(\frac{\hbar}{c}\frac{\boldsymbol{\sigma}}{m_T - m_V}, \rho_V \,\mathrm{grad}D_4 + \frac{\rho_V}{c}\frac{\partial}{\partial t}\mathbf{D}\right) + \left(\frac{\hbar}{c}\frac{\boldsymbol{\sigma}}{m_T - m_V}, \frac{\rho_V^2}{\hbar c}(\mathbf{D}D_4 - D_4\mathbf{D})\right)\right].$$

As we saw, the last term can be disregarded, since according to our simplifying assumption D_i and D_4 commute with each other. So can one do with grad D_4 which is 0. We get:

$$\rho_V\left(\frac{\hbar}{c}\frac{\boldsymbol{\sigma}}{m_T - m_V}, \mathrm{rot}\mathbf{D} + igC^i_{jk}\frac{\rho_V}{c}D_j D_k\right) + i\gamma_5\rho_V\left(\frac{\hbar}{c}\frac{\boldsymbol{\sigma}}{m_T - m_V}, \frac{1}{c}\frac{\partial}{\partial t}\mathbf{D}\right) \tag{14}$$

Note, that in (14) there appear only the potential (Coulomb) charges, and the mass difference between the kinetic and potential states. (14) can be written also in the form:

$$\begin{aligned}&\left(\frac{\hbar}{c}\frac{\boldsymbol{\sigma}}{m_T - m_V}, \mathbf{M}^D\right) + i\gamma_5\left(\frac{\hbar}{c}\frac{\boldsymbol{\sigma}}{m_T - m_V}, \mathbf{N}^D\right) = \\ &= \rho_V\left(\frac{\hbar}{c}\frac{\boldsymbol{\sigma}}{m_T - m_V}, \mathrm{rot}\mathbf{D} + igC^i_{jk}\tfrac{\rho_V}{c}D_j D_k\right) + i\gamma_5\rho_V\left(\frac{\hbar}{c}\frac{\boldsymbol{\sigma}}{m_T - m_V}, \frac{1}{c}\frac{\partial}{\partial t}\mathbf{D}\right)\end{aligned} \tag{14a}$$

where $\mathbf{M}^D$ and $\mathbf{N}^D$ are the same, as defined in (11c), considering the mentioned neglecting. The two terms in the left side of (14a) are the additional *magneto-kinetic* and the *electro-kinetic* moments of the kinetic gauge field of the interaction. As we saw above, in contrast to the classical Dirac theory, in the presence of a kinetic gauge field the electro-kinetic momentum cannot be disregarded. Added to the components which are calculated from the electromagnetic field, it may have real components, and in a properly-chosen reference frame it obtained physical meaning. This latter option was not considered in the classical QED (cf. footnote 4).

The *full magnetic moment* of the interaction in the presence of the kinetic gauge field, will be:

$$\left(\frac{\hbar}{c}\frac{\boldsymbol{\sigma}}{m_T - m_V}, \mathbf{M}^{\mathrm{FULL}}\right) = \rho_V\left(\frac{\hbar}{c}\frac{\boldsymbol{\sigma}}{m_T - m_V}, \mathrm{rot}(\mathbf{A} + \mathbf{D}) + igC^i_{jk}\frac{\rho_V}{c}D_j D_k\right).$$

The full electric moment can be written as:

$$i\gamma_5\left(\frac{\hbar}{c}\frac{\boldsymbol{\sigma}}{m_T - m_V}, \mathbf{N}^{\mathrm{FULL}}\right) = i\gamma_5\left(\frac{\hbar}{c}\frac{\boldsymbol{\sigma}}{m_T - m_V}, \mathrm{rot}\rho_T A_4 + \frac{\rho_V}{c}\frac{\partial}{\partial t}(\mathbf{A} + \mathbf{D})\right).$$

Note, that in $\mathbf{N}^{\mathrm{FULL}}$, there appears also the kinetic charge density.

There are these $\mathbf{M}^{\mathrm{FULL}}$ and $\mathbf{N}^{\mathrm{FULL}}$ which should commute with the Hamiltonian operator of the interacting two charges (cf. Sec. 5).

5 The field tensors of the EM and the kinetic fields

5.1 The field tensor of the EM field

In accordance with [10] the obtained equations yield the classical QED fields in the absence of a kinetic D field. Thus the elements of the field tensor of the EM field, as well as the conserved current are of the same form, like we learned in our usual textbooks. They provide the same conserved quantities, that means, the electric charge, like we learned in the classical theory. This conclusion coincides with all said in connection with $J^{(1)}$ in [10].

5.2 The field tensor of the kinetic field

The field tensor of the kinetic field can be obtained as:

$$F^{(2)\mu\nu}(x) = \frac{\partial D_{\dot\rho}\lambda^{\rho}_{\mu}}{\partial x_\nu} - \frac{\partial D_{\dot\sigma}\lambda^{\sigma}_{\nu}}{\partial x_\mu} + D_{\dot\rho}\lambda^{\rho}_{\mu}D_{\dot\sigma}\lambda^{\sigma}_{\nu} + D_{\dot\sigma}\lambda^{\sigma}_{\nu}D_{\dot\rho}\lambda^{\rho}_{\mu}, \tag{15}$$

where $\lambda^{\rho}_{\mu} = \partial_\mu \dot x^\rho = \dfrac{\partial \dot x^\rho}{\partial x_\mu} = \dot x^{\rho}_{,\mu}$ (cf. Eq. (6) in [10]).

Like we obtained the elements of the field tensor for the EM field from the terms in the second line in (10), we can determine the elements of the kinetic field tensor from (11)-(11b). For this reason, we will use the expressions defined for $\mathbf{M}^D$ and $\mathbf{N}^D$, which denote the two components of the field strengths of the field's kinetic potential $\mathbf{D}$. From

$$\begin{aligned} \mathbf{M}^D &= \rho_V\,\mathrm{rot}\mathbf{D} + igC^i_{jk}\frac{\rho_V^2}{c}D_jD_k \qquad \text{and} \\ \mathbf{N}^D &= \rho_V\,\mathrm{grad}D_4 + \frac{\rho_V}{\hbar c}\frac{\partial}{\partial t}\mathbf{D} + \frac{\rho_V^2}{\hbar c}(\mathbf{D}D_4 - D_4\mathbf{D}) \end{aligned} \tag{16}$$

one can construct the following tensor:

$$\rho_V F^{\mu\nu} = \begin{bmatrix} 0 & M_3^D & -M_2^D & -i\gamma_5 N_1^D \\ -M_3^D & 0 & M_1^D & -i\gamma_5 N_2^D \\ M_2^D & -M_1^D & 0 & -i\gamma_5 N_3^D \\ i\gamma_5 N_1^D & i\gamma_5 N_2^D & i\gamma_5 N_3^D & 0 \end{bmatrix}$$

where

$$\begin{aligned} \mathbf{M}_i^D &= \partial_j\rho_V D_k - \partial_k\rho_V D_j + igC^i_{jk}\frac{\rho_V^2}{c}D_jD_k = \rho_V(\partial_jD_k - \partial_kD_j) + igC^i_{jk}\frac{\rho_V^2}{c}D_jD_k = \\ &= \rho_V\,\mathrm{rot}_i\mathbf{D}(\dot x) + igC^i_{jk}\frac{\rho_V^2}{c}D_jD_k = \rho_V\left[(\partial_{\dot\rho}D_k)\,\lambda^{\dot\rho}_j - (\partial_{\dot\rho}D_j)\,\lambda^{\dot\rho}_k\right] + igC^i_{jk}\frac{\rho_V^2}{c}D_jD_k \end{aligned} \tag{17}$$

and

$$\begin{aligned} \mathbf{N}_i^D &= \partial_i\rho_V D_4 + \frac{1}{\hbar c}\partial_t\rho_V D_i + \frac{\rho_V^2}{\hbar c}D_iD_4 - \frac{\rho_V^2}{\hbar c}D_4D_i = \\ &= \rho_V(\partial_jD_4 + \frac{1}{\hbar c}\partial_tD_i) + \frac{\rho_V^2}{\hbar c}(D_iD_4 - D_4D_i). \end{aligned} \tag{18}$$

Considering that grad $D_4 = 0$ and D_4 commutes with D_i:

$$\mathbf{M}_i^D = \rho_V\left(\mathrm{rot}_i\mathbf{D}(\dot x) + igC^i_{jk}\frac{\rho_V}{c}D_jD_k\right) = \rho_V\left[(\partial_{\dot\rho}D_k)\,\lambda^{\dot\rho}_j - (\partial_{\dot\rho}D_j)\,\lambda^{\dot\rho}_k\right] + igC^i_{jk}\frac{\rho_V^2}{c}D_jD_k \tag{17a}$$

and

$$\mathbf{N}_i^D = \frac{\rho_V}{\hbar c}\partial_tD_i. \tag{18a}$$

6 The curvature of the connection field

The curvature of the connection field can be read from the coefficient of the covariant extension of the matrix terms in $F^{\mu\nu}$ (16) – (18). $\mathbf{M}_i^D$ can be written also in the form (17a), where the last two terms define a covariant commutation of the elements D_i:

$$\mathbf{M}_i^D = \rho_V(\mathrm{rot}_i\mathbf{D}(\dot{x}) + ig\Gamma^i_{jk}D_jD_k).$$

Here $\Gamma^i_{jk} = C^i_{jk}\frac{\rho_V}{c}$ denotes that Γ depends only on constants, while D_i depend on the $\dot{x}^\mu$ four-velocity components. The latter $\dot{x}^\mu(x_\nu)$ corresponds to the functions[6] marked by Dirac [23] as y^λ_ν through which he defined the metric of the field. The metric of the field is much simpler than we expected, while the velocity dependence is transferred to the components of the **D** field.

$$F^\mu = F^{\mu\nu}\frac{1}{c}j_\nu = \frac{1}{\rho_V}\begin{bmatrix} 0 & M_3^D & -M_2^D & -i\gamma_5N_1^D \\ -M_3^D & 0 & M_1^D & -i\gamma_5N_2^D \\ M_2^D & -M_1^D & 0 & -i\gamma_5N_3^D \\ i\gamma_5N_1^D & i\gamma_5N_2^D & i\gamma_5N_3^D & 0 \end{bmatrix}\begin{bmatrix}\rho_T\frac{\dot{x}_1}{c} \\ \rho_T\frac{\dot{x}_2}{c} \\ \rho_T\frac{\dot{x}_3}{c} \\ i\rho_V\end{bmatrix} =$$

$$= \frac{1}{\rho_V}\begin{bmatrix} M_3^D\rho_T\frac{\dot{x}^2}{c} - M_2^D\rho_T\frac{\dot{x}^3}{c} + \gamma_5N_1^D\rho_V \\ -M_3^D\rho_T\frac{\dot{x}^1}{c} + M_1^D\rho_T\frac{\dot{x}^3}{c} + \gamma_5N_2^D\rho_V \\ M_2^D\rho_T\frac{\dot{x}^1}{c} - M_1^D\rho_T\frac{\dot{x}^2}{c} + \gamma_5N_3^D\rho_V \\ i\gamma_5N_1^D\rho_T\frac{\dot{x}^1}{c} + i\gamma_5N_2^D\rho_T\frac{\dot{x}^2}{c} + i\gamma_5N_3^D\rho_T\frac{\dot{x}^3}{c} \end{bmatrix} =$$

$$= \frac{1}{c\rho_V}\begin{bmatrix} M_3^D\dot{x}^2 - M_2^D\dot{x}^3 & c\gamma_5N_1^D \\ -M_3^D\dot{x}^1 + M_1^D\dot{x}^3 & c\gamma_5N_2^D \\ M_2^D\dot{x}^1 - M_3^D\dot{x}^2 & c\gamma_5N_3^D \\ i\gamma_5N_1^D\dot{x}^1 + i\gamma_5N_2^D\dot{x}^2 + i\gamma_5N_3^D\dot{x}^3 & 0 \end{bmatrix}\begin{bmatrix}\rho_T \\ \\ \rho_V\end{bmatrix} = \frac{1}{c}H^{D\kappa l}\rho_l$$

where $(\kappa = 1, \ldots, 4)$, $(l = 1, 2)$, or in the form

$$F^\mu = \frac{1}{c}\begin{bmatrix} M_3^D\dot{x}^2 - M_2^D\dot{x}^3 & c\gamma_5N_1^D \\ -M_3^D\dot{x}^1 + M_1^D\dot{x}^3 & c\gamma_5N_2^D \\ M_2^D\dot{x}^1 - M_3^D\dot{x}^2 & c\gamma_5N_3^D \\ i\gamma_5N_1^D\dot{x}^1 + i\gamma_5N_2^D\dot{x}^2 + i\gamma_5N_3^D\dot{x}^3 & 0 \end{bmatrix}\begin{bmatrix}\frac{\rho_T}{\rho_V} \\ \\ 1\end{bmatrix} \tag{19}$$

It is obvious in the latter form that the isotopic electric charges do not concern the electric moment, only their ratio is a coefficient to the magneto-kinetic moment. This ratio depends

[6]While the Dirac equation introduced and discussed first in his 1928 and 1929 papers is presented in almost all usual textbooks on QED and field theory, his extension published in 1962 is mentioned rarely (cf., [40]).

only on the Lorentz transformation, in which there appears the relative velocity of the two interacting charges to each other. This expression for the Lorentz force shows that our Γ curvature obtained for the kinetic field is in its form similar to the Γ curvature for the EM field as determined by Landau and Lifshitz [29, §85].

The kinetic addition to the Lorentz force can be defined with the use of the above $F^{\mu\nu}$:

$$F^{\mu} = \frac{1}{c\rho_V} \begin{bmatrix} [M_k^D \times \dot{x}^j] & c\gamma_5 N_i^D \\ i\gamma_5 N_i^D \dot{x}^i & 0 \end{bmatrix} \begin{bmatrix} \rho_T \\ \rho_V \end{bmatrix} = \frac{1}{c} H^{D\kappa l} \rho_l \tag{19a}$$

This expression for the Lorentz force indicates that the weak intermediate bosons can be derived from the tensor in the first square bracket [ ]: γ, with mass zero, is associated with H^{D22}, $W^{\pm}$ with H^{D12} and H^{D21}, while Z^0 with H^{D11}. Please, note the asymmetry between H^{D12} and H^{D21}, what confirms the assumption by C. Møller [32], and what was indicated by Weinberg [39] in another way. Note that we derived the unification of the electromagnetic and the weak interactions in a different way than Weinberg did. Nevertheless, this latter is the theme of another paper.

The kinetic addition to the Lorentz force expresses the velocity dependence (which was foreseen by Dirac), and through this, *the Finsler geometry* (like also in [26]) *to be applied for the extended electromagnetic field.*

References

[1] Achiezer A.I. Berestetskii V.B. Kvantovaya elektrodynamika. 3rd modified edition. Moskva, Nauka, 1969, 623 p.

[2] Belavin A., Polyakov A., Schwartz A., Tyupkin Y. // *Phys. Lett.* 59B, 1975, p. 85.

[3] Bethe H., Fermi E. Über die Wechselwirkung von zwei elektronen // *Zeitschrift für Physik*, 77, 5-6, 1932, pp. 296 – 306.

[4] Breit G. // *Phys. Rev.*, 34, 1929, p. 553.

[5] Breit G. // *Phys. Rev.*, 39. 1932, p. 616.

[6] Brinzei N., Siparov S. Equations of electromagnetism in some special anisotropic spaces. 2008, arXiv:0812.1513v1 [gr-qc] 15 p.

[7] Coleman S., Glashow Sh.L. Cosmic Ray and Neutrino Tests of Special Relativity // *Physics Letters B,* 405, 1997, pp. 249 – 252. http://arxiv.org/abs/hep-ph/9703240.

[8] Darvas G. Conserved Noether currents, Utiyama's theory of invariant variation, and velocity dependence in local gauge invariance // *Concepts of Physics*, VI, 1, 2009, pp. 3 – 16. http://arxiv.org/abs/0811.3189v1.

[9] Darvas G. GTR and the Isotopic Field Charge Spin Assumption. Presented to the «Physical Interpretations of Relativity Theory – 11» conference, held in Moscow, 4-7 July, 2011, 10 p.

[10] Darvas G. The Isotopic Field Charge Spin Assumption // *International Journal of Theoretical Physics*, 50, 10, 2011, pp. 2961 – 2991.

[11] Darvas G. Isotopic Field Charge Spin Conservation in General Relativity Theory, 2012, pp. 53 – 65, in: eds.: M.C. Duffy, V.O. Gladyshev, A.N. Morozov, P. Rowlands Physical Interpretations of Relativity Theory, Proceedings of the International Scientific Meeting PIRT-2011, Moscow, 4-7 July, Moscow, Liverpool, Sunderland: Bauman Moscow State Technical University, 347 p.

[12] Darvas G. Another Version of Facts. On Physical Interactions. 2012, coming.

[13] Darvas G. Finsler geometry in GTR in the presence of a velocity dependent gauge field // *Bulletin of the Transilvania University of Brasov, Series III: Mathematics, Informatics, Physics*, 5 (54), 1, 2012, pp. 85 – 96.

[14] Darvas G. Finsler geometry in the presence of isotopic field charges applied for gravity, pp. 17 – 42 In: Proceedings of the Vth Petrov International Symposium, "High Energy Physics, cosmology and Gravity, Ed. S. Moskaliuk, Kiev: TIMPANI, 299 p., 2012.

[15] Darvas G. The Isotopic Field-Charge Assumption Applied to the Electromagnetic Interaction, 32 p. (2012, under review).

[16] de Haas E.P.J. The combination of de Broglie's harmony of the phases and Mie's theory of gravity results in a principle of equivalence for quantum gravity // *Ann. Fond. L. de Brioglie*, 29, 4, 2004, pp. 707 – 726.

[17] de Haas E.P.J. A renewed theory of electrodynamics in the framework of a Dirac ether. *Proc. P.I.R.T.-IX*, London, 2004, PD Publications, Liverpool, 2004, pp. 95 – 123.

[18] de Haas E.P.J. From Laue's stress-energy tensor to Maxwell's Equations and the implications for Einstein's GTR // *Proceedings of the Int. Conference* «Physical Interpretation of Relativity Theory (PIRT-05)», eds. M.C.Duffy et al., Moscow, Bauman Univ. Press, 2005.

[19] Dirac P.A.M. The quantum gravity of the electron // *Proceedings of the Royal Society A: Mathematical, Physical and Engineering Sciences*, 117 (778), 1928, pp. 610 – 624.

[20] Dirac P.A.M. A theory of electrons and protons // *Proceedings of the Royal Society of London*, 126, 801, 1929, pp. 360 – 365.

[21] Dirac P.A.M. A new classical theory of electrons //*Proc. Roy. Soc. A*, 209, 1951, pp. 291 – 296.

[22] Dirac P.A.M. // *Nature*, 168, 1951, pp. 906 – 907.

[23] Dirac P.A.M. An extensible model of the electron // *Proc. Roy. Soc. A*, 268, 1962, pp. 57 – 67.

[24] Feynman R.P. Space-time approach to quantum electrodynamics // *Phys. Rev.*, 76, 6, 1949, pp. 769 – 789.

[25] Jackiw R., Rebbi C. Conformal properties of Yang-Mills pseudoparticle // *Phys. Rev. D*, 14, 2, 1976, pp. 517 – 523.

[26] Kostelecky A. Riemann-Finsler geometry and Lorentz-violating kinematics // *Phys.Lett.B*, 2011.

[27] Kostelecky A. Background information on Lorentz and CPT violation, 2012. http://physics.indiana.edu/∼kostelec/faq.html

[28] Kostelecky A. Articles on Lorentz and CPT violation, 2012. http://physics.indiana.edu/∼kostelec/faq.html#20

[29] Landau L.D., Lifshitz E.M. Teoriya Polya [in Russian], 1967, Moskva, Nauka, 458 p.

[30] Mie G. Grundlagen einer Theorie der Materie // *Ann. Phys.*, 37, 1912, pp. 511 – 534.

[31] Mills R. Gauge fields // *American Journal of Physics*, 57 (6), 1989, pp. 493 – 507.

[32] Møller C. Über den Stoβ zweier Teilchen unter Berücksichtigung der Retardation der Kräfte, *Zeitschrift für Physik*, 70, 11-12, 1931, pp. 786 – 795.

[33] Noether E.A. Invariante Variationsprobleme. *Nachrichten von der Königlichen Gesellschaft der Wissenschaften zu Göttingen: Mathematisch-physikalische Klasse*, pp. 235 – 257.

[34] Pons J.M., Salisbury D.C., Shepley L.C. Gauge transformations in Einstein-Yang-Mills theories. 1999, arXiv:gr-qc/9912086 v1. (Submitted to J. Math. Phys).

[35] Siparov S. Introduction to the Anisotropic Geometrodynamics. Singapore, World Scientific, 2012, 303 p.

[36] van't Hooft G. Introduction to General Relativity. Princeton, Rinton Press Inc., 2002.

[37] Voicu N. Equations of electromagnetism in some special anisotropic spaces. Part 2 // *Hypercomplex Numbers in Geometry and Physics*, 7, 2 (14), 2010, pp. 61 – 72.

[38] von Laue M. // *Ann. Phys.*, 35, 1911, pp. 524 – 542.

[39] Weinberg S. A model of leptons // *Phys. Rev. Lett.*, 19, 21, 1967, pp. 1264 – 1266.

[40] Weinberg S. Changing Attitudes and the Standard Model, p. 38, in Hoddeson L., L. Brown, M. Riordan and M. Dresden: The Rise of the Standard Model. Cambridge University Press, Cambridge., 1997, pp. 36 – 44.

ФИНСЛЕРОВ ПОДХОД К ЭЛЕКТРОМАГНИТНОМУ ВЗАИМОДЕЙСТВИЮ В ПРИСУТСТВИИ ИЗОТОПИЧЕСКИХ ЗАРЯДОВЫХ И КИНЕТИЧЕСКИХ ПОЛЕЙ

Юрий Дарваш

Симметрион, Будапешт, Венгрия

darvasg@iif.hu

Предмет настоящей статьи – применение теории изотопических зарядовых спиновых полей к электромагнитному взаимодействию. Получены модифицированные уравнения Дирака в присутствии зависящих от скорости калибровочных и изотопических зарядовых полей (электрических зарядов Кулоновского и Лоренцевского типа, а также гравитационной и инертной масс), которые сравниваются с классическим уравнением Дирака [6, 34, 35, 37].

Показано, что присутствие изотопических зарядовых полей будет возмущать лоренцеву инвариантность этого уравнения. Существует преобразование, которое восстанавливает эту инвариантность в соответствии с сохранением изотопического зарядового спинового поля [8]. Оно основывается на определении тензора поля, который адаптирован к вышеприведенным условиям.

Присутствие кинетических калибровочных полей делает невозможным предположение о взаимодействии плоских электромагнитных полей. Поле связности, которое определяет кривизну, выводится из ковариантной производной кинетического (зависящего от скорости) калибровочного поля. В этом случае возникает зависящая от скорости метрика, которая приводит к зависящей от направления, т.е. финслеровой геометрии [11, 14]. Выбор такой «теории электрона» (по словам Дирака) был показан в расширении его теории в [23]. Настоящая работа представляет собой попытку дальнейшего расширения.

Ключевые слова: изотопические электрические заряды, изотопические массы, изотопический спин электрического заряда, сохранение, электромагнитное взаимодействие, электрослабое взаимодействие, кинетические калибровочные поля, расширенное уравнение Дирака, магнито-кинетический момент, электро-кинетический момент, взаимодействующий спин, случайная симметрия, сохраняющиеся нетеровы токи.