Gravitation described by Maxwell equations.

The Maxwell electromagnetism as the theory of almost everything

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Abstract. In the past papers by the author, the Maxwell theory of electromagnetism, as the theory unifying the manifestations of fundamental interaction in the nature and, at the same time, comprehending the quantum phenomena, was presented. Since the papers were rather extended and further progress in the representation of several ideas has occurred meanwhile, we give, in this article, a relatively brief, compact, sometimes popular description of the already presented theory. Few new ideas are also presented.

1 Motivation

Why two particles electrically charged with the charges of opposite polarity attract each other and those charged with the charges of the same polarity are mutually repelent? Why is the gravity only attractive force? Why there is inertia of mass, but no inertia of electric charge? What is an intrinsic relationship between the electric and gravitational interaction? How can the structure of the atom be described within the theories of macroscosm as Maxwell theory of electromagnetism and/or general relativity? This five and several further fundamental questions are attempted to be answered by the authors of the most advanced physical theories. Here, we present an extract of the main results of our earlier work (Neslušan, 2010; 2014), which addresses and answers these and several further questions in the case of the interaction between two stable (or accelerating from the rest), electrically charged, point-like particles or multi-particle objects. The particular answers (relevant parts of the text) are written in italics to highlight them.

The work does not bring any principially new theory. It is a new, unitary representation of the well-known Maxwell (1873) theory of electromagnetism, completed with some formulas of general relativity (Einstein, 1915; 1916). Bacause of the latter, it is assumed that the electromagnetic wave is the evanescent wave, in its proper nature. Besides this one, there is done, in addition, only a single another modification: an alternative gauging of one integration constant.

The reader likely asks, why he or she should preferably devote his or her attention just to this work being one of tens, maybe hundreds, other works published every year, which also address the above mentioned questions? We mean that our theory is exceptional because of the following reasons. After the Dirac's quantum theory, our

unitary representation of electric interaction is only the second theory, ever, providing, in an independent way, the exact theoretical determination of the energy states in the spectrum of hydrogen atom (with the same precision as Dirac's theory provides). In addition, one can hardly find another theory which would answer all the asked questions at the same time, within a single framework. The new representation remarkably applies the Occam's razor: to answer the questions, one can forget, in principle, the whole physics developed after Maxwell and Einstein, a major part of quantum physics including. The representation is, in fact, a continuation of the main-stream physics of the beginning of 20-th century. Of course, the value of the knowledge achieved in the post-Maxwell and post-Einstein era is not lost, because a lot of mathematical procedures and partial concepts from the post eras is utilized also within the new approach.

2 Electric field in a vicinity of elementary electrically charged particles and concept of the elementary particle

Let us consider two elementary electrically charged particles (e.g. proton and electron), which are both in rest. The basic task we aim to solve is a description of the field in their vicinity, whereby we are interested in solving of this problem by using the well-known Maxwell equations (MEs, hereinafter). These fundamental equations should be, in principle, applicable to any problem that occurs in the framework of Maxwell electromagnetism.

The electromagnetic field is completely described when the vector of its electric intensity, $\vec{E}$, and magnetic induction, $\vec{B}$, are found. In general, both these vectors are the function of position, characterized with vector $\vec{r}$, and time, t.

To solve the MEs, it is reasonable to eliminate the time from them. As far as we know, there is not known any other way of time elimination than to assume the solution in the form

$$\vec{E}(\vec{r},t) = \vec{E}(\vec{r})\exp(\pm i\omega t), \tag{1}$$

where i is the unit of imaginary number and ω is the angular frequency of wave associated with the particle because of reason described below. Numerically, it is related to the particle's mass, m, according to de Broglie's (1925a; 1925b) theory as

$$\hbar\omega = mc^2 \tag{2}$$

($\hbar$ is the Planck constant, h, divided by 2π and c is the speed of light). The time function of this solution can be expressed as

$$\exp(\pm i\omega t) = \cos(\omega t) \pm i\,\sin(\omega t) \tag{3}$$

and this form implies:

(1) Every elementary particle or a small group of particles generates the variable field. The particle must be the source of the waving and this is possible only if the existence of the particle itself is, correspondingly, variable. In more detail, we can see from the form (3) than the elementary particle is not any constant entity, but it must oscillate between the real-valued and imaginary-valued sub-spaces.

Q1. What is the origin of uncertainity principle?

Since *the phase of the oscillations of various particles in the universe is, obviously, not synchronized and we do not know the phase of particular particle, there is the uncertainity* in the intensity determination. The maximum uncertainity can be estimated considering the maximum phase shift, which is 2π. In other words, the phase ωt can be shifted about this factor. So, the maximum uncerainity can be estimated as $\omega t \approx 2\pi$ or (after multiplying this inequality with $\hbar$)

$$Wt \approx h, \tag{4}$$

where

$$W = \hbar\omega \tag{5}$$

is the energy of the particle according to the de Broglie's (1925a; 1925b) theory. Inequality (4) is one of the forms of the Heisenberg uncertainity principle (but here within the Maxwell electromagnetism).

(2) Since we observe things in real-valued sub-space of universe, real-valued component of the intensity, $\vec{E}(\vec{r})\cos(\omega t)$, changes periodically its sign and no permanent action in a given direction of one particle onto another is possible. If we assumed the concept of the force, in which the "acting particle" (AP) emits a signal ("wave") spreading toward the other, "test particle" (TP) to mediate the force action, then we would obtain a varying force, which would cause some oscillations of the TP around its mean position, only. There would not be any single-direction electric force, which is observed in the case of macroscopic electrically charged objects.

The single-direction force is, however, an observed reality. To explain it, we have to adopt the following concept of the force action. The time-variable intensity (and, similarly, induction; because of simplicity of our explanation, we speak only about the intensity, but analogous considerations can be done also for the induction) implies an existence of an environment around the oscillating source/particle and this environment obviously occurs due to the fact that each particle emits a (spherical) wave carrying an impulse (electromagnetic wave must be evanescent wave, therefore this assumption is reasonable; a reason is discussed below). If the particle is in the rest and isolated, then the impulse of this wave in the positiom of its source is mutually perfectly compensated because of the spherical symmetry. There are two possibilities (I. and II.) of the symmetry break and occurrence of force.

Q2. What is the mechanism of force action?

I. There is another particle (which was referred above as the AP) in the vicinity of the given particle (referred as the TP) and, thus, *the AP absorbs a part of the wave/impulse.* After the wave from the opposite direction returns onto the TP (after time r/c), *there is an inbalance of impulse and the TP is accelerated. Since the part of absorbed wave is* $(\pi R_I^2)/(4\pi r^2)$ *fraction of whole spherical wave, factor* $1/r^2$ *occurs in the force law.* (Quantity R_I is a constant effective radius of absorption or a formal "physical" radius of every elementary particle; it is more specified below.) However, the proper delivery of impulse happens in a fixed distance from the TP, which equals R_I in fact, therefore

we have to consider the amplitude of the intensity in $r = R_I$.

Q3. What is the nature of inertia force?

II. If the TP is forced (because of a whatever reason) to accelerate, the emited wave is blue-shifted in the direction of acceleration and red-shifted in the opposite direction. The impulse depends of the wave frequency, therefore *the symmetry of impulse carried by the TP's wave is broken because of the blue and red shift. This is the nature of inertia force.*

3 Unified interaction implied by the appropriate solution of the Maxwell equations

Let us still consider the two elementary electrically charged particles. Since there is no charge in the space between them, the charge density, ρ, is zero and the MEs can be re-written to the form of wave equations,

$$\Delta\vec{E} + k^2\vec{E} = \vec{0}, \tag{6}$$

$$\Delta\vec{B} + k^2\vec{B} = \vec{0}, \tag{7}$$

where Δ stands for the Laplace operator and k is the amplitude of wave vector. It is possible to find such the solution of MEs (6) and (7) (Neslušan, 2010) that the orientation of $\vec{E}$ is parallel with the line connecting the particles and $\vec{B}$ is perpendicular to $\vec{E}$, but in the same sense as real-valued component of a complex number is perpendicular to the imaginary-valued component of this number. (If a given component of $\vec{E}$ of the solution is real-valued, then the corresponding component of $\vec{B}$ is imaginary-valued and vice versa.)

The radial component of the intensity amplitude is then proportional to

$$E_r \propto \mp iK_E \exp(\pm ikr), \tag{8}$$

where $\mp iK_E$ is an imaginary-valued integration constant. In the region of radial distances comparable to R_I, size of the wave vector k can be approximated by the formula for a harmonical wave, $k = \omega R_I/c$. Further, it appeared that R_I can be identified with an effective distance in which the interaction takes place ("interaction radius") and can appropriately be calibrated to equal

$$R_I = \frac{\hbar}{2\pi M_o c}, \tag{9}$$

where

$$M_o = \frac{q_o}{\sqrt{4\pi\varepsilon_o G}} \tag{10}$$

is so-called elementary electromass (established on the basis of formal equation of the Newton law, GM_o^2/r^2, and Coulomb law for two elementary charges, $q_o^2/(4\pi\varepsilon_o r^2)$, to unify the quantities figuring in both these laws; q_o is the elementary electric charge, ε_o is the permittivity of vacuum, and G is the gravitational constant). It can also be given with the help of fime structure constant, α, and Planck mass, M_P, as $M_o = \sqrt{\alpha}M_P$.

Considering de Broglie's relation (2), we find

$$\frac{\omega R_I}{c} = \frac{m}{M_o}. \tag{11}$$

If m equals the mass of a common elementary particle, it is valid $m/M_o \ll 1$ and we can approximate the form giving the proportionality of the radial component of electric intensity as

$$-iK_E \exp(ikR_I) = -iK_E \cos(kR_I) + K_E \sin(kR_I) = K_E \left(-i + \frac{m_-}{M_o} - ...\right) \tag{12}$$

for negatively charged particle with mass m_- and, considering the complex conjugate,

$$iK_E \exp(-ikR_I) = +iK_E \cos(kR_I) + K_E \sin(kR_I) = K_E \left(+i + \frac{m_+}{M_o} + ...\right) \tag{13}$$

for the positively charged particle with mass m_+.

Q4. Why is the magnitude of elementary electric charge of all charged elementary particles the same?

The first term in the series (12) and (13), $-i$ and $+i$, corresponds to the electric charge. The fact that it is the constant, which has the same size for every electrically charged elementary particle, answers the question of why the size of the charge of elementary particle is the same.

The absorption of the wave, emited by the TP, by the AP can be assumed to be proportional to the intensity amplitude, $AK_E(\pm i + m_A/M_o)$, where A is a constant of proportionality and sufix "A" indicates the AP. (Below, sufix "T" will analogously indicate the TP.) Of signs $\pm$, the actual sign is that of the AP. Complex mass/charge can be established calibrating $AK_E = 1$. So, we obtain $\pm iM_o + m_A$.

The radial force between two particles is

$$F_r = \frac{K_E}{M_o r^2}(\pm iM_o + m_T)(\pm iM_o + m_A) = \pm\frac{K_E}{M_o r^2}M_o^2 + \frac{K_E}{M_o r^2}m_T m_A + \\ + \textit{imaginary component}. \tag{14}$$

(The signs $\pm$ depends on the signs of charges of the TP and AP and are explained below.)

Q5. How does the gravity occur in the solution of the MEs?

We observe only the phenomena in the real-valued sub-space and we can see that the force in this sub-space consists of two parts. The ratio of their size is $M_o^2/(m_T m_A)$ and equals $\sim 10^{36}$ if $m_T \sim m_A \sim 10^{-27}$ kg. While the first part can be as negative as positive, the second part can be only positive. Clearly, *these circumstances support the identification of the first part of the force in Eq.(14), gained on the basis of the power series of one function, to the (primary) electrostatic force and the second part is the gravitational force.*

Q6. Why the orientation of gravitatioal force is the same as the orientation of electric force between the charges of opposite polarities?

If we consider an interaction between the particles with the same polarity of their charge, then the first part of the force (14) is proportional to $(+iM_o)(+iM_o) = (-iM_o)(-iM_o) = -M_o^2$. *If the polarities are opposite, then the force is proportional to* $(+iM_o)(-iM_o) = (-iM_o)(+iM_o) = +M_o^2$. *Since* $-M_o^2 < 0$ *and* $+M_o^2 > 0$, *the orientation of the force in the second case must be opposite than that in the first case. The second part is always proportional to* $m_T m_A > 0$. *Therefore, the orientation of this force must be the same as that between the charges of opposite polarities. In other words, this answers the question of why the orientation of gravity is the same as the orientation of electric force between the charges of opposite polarity.*

Q7. Why there is inertia of mass, but not inertia of electric charge?

As mentioned above, the electric intensity is proportional to $\pm i + m/M$, which is an alternative *form of* $\pm i + \omega R_I/c$. It is now clear that the first term is related to electric charge and the second term to mass. Notice that *while the second term contains the angular frequency* ω, *which can be blue-shifted and red-shifted, the first term,* $\pm i$, *is the constant, which cannot be influenced by any blue or red shift. It explains why there is an inertia related to the mass, but no inertia related to the electric charge.*

4 Interaction of "neutral" objects in macrocosm

Q8. The electric force between two objects consisting of the same numbers of positive and negative charge carriers appears to be non-zero, when it is derived from the MEs. Why? In other words, why does the secondary electric force − gravity − always occur at the material objects?

If we consider an object consisting of the exactly the same number, N, of positively and negatively charged particles, it can be expected to generate the field with the electric intensity, which is the sum $N(K_E/r^2)(+i+m_+/M_o)+N(K_E/r^2(-i+m_-/M_o) = N(K_E/r^2)(m_+ + m_-)/M_o$. *Because the second terms in the second parentheses are only positive, they cannot eliminate each other (as the first terms) and, thus, their sum can never be zero.* (The difference of functions $\exp(x) - \exp(-x)$ for a very small, but still non-zero x, does not equal to zero.) *Hence, the total sum of the partial intensities cannot be zero. In other words, the electric intensity generated by the same number of both positively and negatively charged elementary particles can never be zero. The secondary term of the intensity is always present, manifestating itself as the gravity.*

The analogous conclusion can be drawn concerning the mass/charge of the object. It equals $N(iM_o + m_+) + N(-iM_o + m_-) = N(m_+ + m_-)$. Although the first terms in the parentheses eliminate each other and, thus, the object is electrically neutral (the primary electric force), the result is not zero because the second terms provide a finite mass. The product of the intensity, generated by a test object (TO) with mass (or "secondary electric charge") $m_{TO} = N_T(m_+ + m_-)$, and mass of an acting object (AO) $m_{AO} = N_A(m_+ + m_-)$ is, here, proportional to $m_{TO}m_{AO}$ (for a simplicity, we consider

the objects consisting of only a single kind of positive-charge carriers and of a single kind of negative-charge carriers). The last proportionality indicates that the magnitude of the secondary electric force is consistent with that of gravity. We emphasize that this secondary electric force/gravity was derived as the solution of MEs (without any additional principial assumption).

5 Dominant interaction in microcosm

According to relations (12) and (13), the electric intensity is proportional to $\sin(kr)$. Hence, the part of the wave generated by the TP, which is absorbed by the AP, is also proportional to $\sin(kr)$ (the wave is absorbed in distance r from the TP, where the AP is situated). It was demonstrated (Neslušan, 2010; 2014) that this proportionality can be used to describe the atom.

In this description, the evanescent character of the electromagnetic wave cannot be longer approximated by the harmonical wave. Therefore, we have to consider the size of the propwer wave vector of evanescent wave, which is

$$k = \frac{\sqrt{\omega^2 - \omega_o^2}}{c}, \tag{15}$$

where ω_o is the "rest" angular frequency corresponding to the rest mass, m_o, of particle (according to the de Broglie's formula (2), again). The last equation is valid for the evanescent wave in a free space, without any external force field. However, the electron in atom is always situated in a vicinity of atom nucleus, i.e. in the nucleus' force field. To generalize formula (15) for this case, we use its correspondence with the formula for the energy of particle in general relativity, which is

$$W = \sqrt{p^2c^2 + m_o^2c^4} \tag{16}$$

where p is the magnitude of the impulse of particle. Eq.(15) can be squared and, then, multipled by c^2. After a further simple algebraic handling, the equation changes to

$$\omega^2 = k^2c^2 + \omega_o^2. \tag{17}$$

If we now multiply this equation by $\hbar^2$, use relation (5), and another de Broglie's relation,

$$\vec{p} = \hbar\vec{k}; \qquad \text{also} \quad p = \hbar k, \tag{18}$$

then Eq.(17) becomes the quadrate of (16).

The energy of particle in the force field, in which its potential energy is W_p, is given by relation (static case)

$$W = \sqrt{p^2c^2 + m_o^2c^4} + W_p = \sqrt{\hbar^2k^2c^2 + m_o^2c^4} + W_p. \tag{19}$$

We can use this equation for the reverse task to derive k from ω (or m), ω_o (or m_o), and W_p. The result is

$$k = \frac{1}{\hbar c}\sqrt{(W - W_p)^2 - m_o^2c^4}. \tag{20}$$

Q9. Why can we expect that the Maxwell electromagnetism also comprehend the quantum phenomena? What is the specific relationship between these branches of physics?

If one considers the Coulombian potential energy of electron in the force field of proton in hydrogen atom, $W_p = -q_o^2/(4\pi\varepsilon_o r)$, as the explicit function of r (the other functions are the implicit functions of r) and supplies k given by the last relation to the MEs (6), then *the radial equation (for component of the intensity E_r) of the latter becomes mathematically similar to the Klein-Gordon equation (relativistic analugue of Schrödinger equation) in quantum physics. Both equations become identical, if relation $E_r = \psi/r$ between the radial component of intensity, E_r, and wave function ψ in the Klein-Gordon equation is established. Here, we can see how the fundamental equation of quantum physics is incorporated in the MEs and, hence, how the quantum physics is incorporated in the Maxwell electromagnetism.*

Let us, further, to use the general relativity, its outer Schwarzschild (1916) solution, to derive the dependence of angular frequency ω related to a given particle on the particle's potential energy W_p. It is well known that $\omega = \omega_o/\sqrt{g_{tt}}$, when the wave is spherical and we calculate ω in the distance r from its center, where the potential energy is W_p. g_{tt} is the time component of metric tensor, which equals $g_{tt} = 1 + C_1/r$, where C_1 is an integration constant occurring when the appropriate field equations are solved. This constant is calibrated using the fact that the relevant formulas of general relativity are approximable by the corresponding formulas of Newtonian physics in the limit of weak gravitational field. It was found that if Ψ is the gravitational potential, then g_{tt} can be given as $g_{tt} = 1 + \Psi/c^2$.

At this point, we suggest a different calibration of C_1 and this is only modification in the Maxwell traditional theory in course to create the model of (hydrogen) atom in the framework of this theory. Specifically, we multiply both nominator and denominator of fraction Ψ/c^2 with rest mass m_o. In the case of a static particle in a weak gravitational field, mass m is approximately equal to rest mass m_o and, thus, product $m_o\Psi$ is the nominator can be identified to the gravitational potential energy of the particle. The product $m_o c^2$ is the denominator is the particle's rest energy, W_o. So, we obtain $g_{tt} = 1 + W_p/W_o$.[1]

Since we interpret gravity as the secondary electric force, the general relativity would be a theory of nothing if it was not applicable to the electric interaction in the same way as it was for the gravity when the latter was represented as an independent force. We assume that the application is possible and, consequently, we postulate that potential energy W_p figuring in the new relation for g_{tt} is the potential energy related to the unified (electrical) integraction derived from the MEs. This is the fundamental feature of the new calibration of C_1.

After new calibration, the angular frequency equals

$$\omega = \frac{\omega_o}{\sqrt{1 + W_p/W_o}}. \tag{21}$$

[1]Replacing the potential with potential energy causes that the equivalence principle is not longer valid. We just abandoned the theory of relativity, in principle. However, we practically changed nothing because the difference due to the violating of the equivalence principle can be measured in the experiments on the Earth's surface on 42th decimal digit, for example.

Subseuqently, the energy of particle can, alternatively to Eq.(19), be also given with the help of the de Broglie's formula (5) generalized for a non-zero force field as

$$W = \hbar\omega + W_p = \frac{W_o}{\sqrt{1 + W_p/W_o}} + W_p. \tag{22}$$

Comparing formulas (19) and (22), the size of wave vector is

$$k = \frac{2\pi\omega_o}{c}\sqrt{\frac{-\frac{W_p}{W_o}}{1+\frac{W_p}{W_o}}}. \tag{23}$$

Q10. Does the solution of the MEs yield an analogue of the quantum condition for atom?

Considering the real-valued part of proportionality (8), *the condition for stable, bound position of electron in a vicinity of proton (positive ion) is* $\sin(kr) = 0$ or

$$kr = 2\pi n, \tag{24}$$

where n is a natural number. The condition (24) is, in fact, the quadratic equation for distance r (see Neslušan, 2010 or 2014) and its *first solution gives the stable-equilibrium positions of electron in hydrogem atom*, series characterized with the quantum numbers in the Dirac thery $l = n - 1$ and $j = l + 1/2$. The corresponding energy levels can be calculated with the same precision as by the Dirac theory. (The complete set of energy levels can probably be calculated with the help of solution for the transversal components of $\vec{E}$. An attempt in this sense was published in our earlier paper (Neslušan, 2014).)

Q11. Why do only two regions of stable structures exist in the universe (that in the atom nucleus and that in the atom shell and molecules)?

Q12. Is there a possibility to include also the strong interaction into the unified description derived from the MEs?

The second solution of the quadratic equation (24) implies the second region of a bound structure: in the distances typical for the atom nuclei. The solution implies that the magnitude of elecrostatic force in this region is about the factor of n/α larger that the corresponding Coulombian behavior. It provides a possibility to include also the "strong" interaction within the framework of the MEs.

Relation (23) giving the complete, full-precision size of the wave vector can explain, in which regions of radial distance k is real-valued and in which imaginary-valued. It is an important aspect. In Sect. 3, we presented a simple solution of the MEs (the direct solution of Eq.(6)). Below, we consider a more sofisticated solution based on the Diracian decomposition of Eqs.(6) and (7), which was found in the earlier works (Neslušan, 2010; 2014).

If k is real-valued, functions $\cos(kr)$ and $\sin(kr)$ remain unchaged and the electric intensity alternates its orientation with r. There are the intervals of attractive intensity

alternating with those of repulsive intensity. In the borders of these intervals, the intensity is zero and bound structures can occur. On contrary, if k is imaginary-valued, then the functions $\cos(kr)$ and $\sin(kr)$ change to $\cosh(|k|r)$ and $i\sinh(|k|r)$, therefore the intensity is monotonous function of r. Such the behavior is characteristic for the macroscopic fields.

In relation (23), we can see that k is real-valued, if $0 > W_p/W_o > -1$. For a certain interval of r, it is also the case of proton-electron pair, where the Coulombian potential energy of electron is $W_p = -q_o^2/(4\pi\varepsilon_o r)$ and its rest energy equals $W_o = m_e c^2$ (m_e is the rest mass of electron). Therefore, the electron and proton can constitute a bound structure. If we consider two particles charged with the charges of the same polarity, then $W_p/W_o > 0$, k is imaginary valued and no bound structure can form. It is the reason of why we do not observe, e.g., any bound proton-proton pairs.

Ratio W_p/W_o can be given as $W_p/W_o = -q_o^2/(4\pi\varepsilon_o m_e c^2 r) = -R_e/r$, where $R_e = q_o^2/(4\pi\varepsilon_o m_e c^2)$ is so-called classical radius of electron. Since the Schwarzschild gravitational radius figures in the R_e-correspoding position in the case of gravity, radius R_e can be regarded as an electric analogue of the gravitational radius. (In this case, there is no event horizon.) With the help of R_e, which can also be negative in the case of electric interaction, the condition for the real-valued k can be written as $0 < R_e/r < 1$.

Q13. What is the criterion separating the macroscopic and microscopic regimes of the force field according to the MEs?

The way to calculate R_e for the macroscopic neutral objects was given in our earlier papers (Neslušan, 2010 and, especially, Neslušan, 2014). In macroscopic regime, it appears that there is always valid $R_e/r > 1$, therefore k is imaginary valued and the electric intensity is monotounous function of r. So far, the inequality $R_e/r \gg 1$ is mostly satisfied and the intensity can be approximetd, with a high precision, by its Coulombian/Newtonian behavior. The fact that while *the miscroscopic regime of unified intensity is characterized with inequality* $R_e/r < 1$ *implying* $r > R_e$ *and its macroscopic regime with* $R_e/r > 1$ *(most often with* $R_e/r \gg 1$*) implying* $r < R_e$ *(most often* $r \ll R_e$*)* seems to be a paradox.

The last inequalities are, however, crucial for the unification of micro and macroscopic phenomena into a single theory. The paradox can be easily understood when we realize that $R_e \sim 10^{-15}$ m for the proton-electron pair. Since an electron in atom shell is in distance $r \sim 10^{-10}$ m from the atom nucleus, inequality $r > R_e$ is satisfied. But it was estimated (Neslušan, 2010) that $R_e \sim 10^{30}$ m for the system Sun and 10-kilogram spacecraft. If the latter is situated in 1 astronomical unit (1.5×10^{11} m) from the Sun, then it is actually valid that $r \ll R_e$. Term "macroscopic" appears to be primarily related to a *huge number* of elementary particles.

6 On the reaction particle+antiparticle $\leftrightarrow$ two photons

General relativity passed several tests of its correctness. We should therefore attempt to "read" what this theory "wants to say" us. In this section, we deal with the structure of line element in the context of the above established concept of complex space consisting of both real-valued and imaginary valued sub-spaces.

For a sake of simplicity, let us consider the relation giving the quadrate of line element, ds^2, in the case of spherical symmetry. (We have considered the spherical wave.) It equals

$$ds^2 = g_{11}dx^2 + g_{22}dy^2 + g_{33}dz^2 + g_{44}(\pm ic\,dt)^2 \tag{25}$$

when the cartesian space coordinates x, y, and z are considered. While the first three terms are obviously related to the position of a TP in the real-valued sub-space, the fourth term, with the coordinate element $\pm ic\,dt$, is related to the position of this particle in the imaginary space. (The fact that the position in this sub-space is described with a single term in relation (25) does not necessarily mean that the sub-space in one-dimensional. $|g_{44}(c\,dt)^2|$ can be an integrated characteristics. In the real-valued sub-space, we can also establish the single quantity $|g_{ss}dr^2|$ which equals $|g_{11}dx^2 + g_{22}dy^2 + g_{33}dz^2|$ and is, thus, alternative, single-term expression of the latter.)

In general relativity, time is regarded as the fourth dimension. Representing $\pm ic\,dt$ as the spatial dimension in the imaginary-valued sub-space, we abandom the relativistic representation of time. In accord with Fiscaletti and Sorli (Sorli et al., 2011; Fiscaletti and Sorli, 2013; 2015), we represent time as the "sequential numerical order of change". In other word, it is a universal parameter to characterize any change in the dynamic universe.

Q14. How is the position of a particle characterized in the imaginary-valued sub-space?

The form $\pm ic\,dt$ implies that the "sub-existence" of every particle in the imaginary sub-space is in the position, which changes with time with the speed of light. In other words, the particle moves, in this sub-space, permanently with the speed equal to c. This concept offers us a natural explanation of what happens in the interaction when a pair of particle and its antiparticle anihilates and two photons occur or, vice versa, when two photons having a suitable energy recombine to a Fermionic pair of particle and antiparticle, i.e. in the interaction

$$particle + antiparticle \leftrightarrow 2\gamma, \tag{26}$$

where γ stands for photon.

Q15. What does in the anihilation of particle and antiparticle happen?

In the first process,

$$particle + antiparticle \rightarrow 2\gamma, \tag{27}$$

i.e. *in the anihilation, the sub-existences of the particle and antiparticle in both real-valued and imaginary-valued sub-spaces mutually interchange.* Before the process, we could not see the sub-existences in the imaginary-valued sub-space moving with speed of light, but after the process these sub-existences occurred in the real-valued and, therefore, observable sub-space.

Q16. What there happen in the recombination of two energetic photons?

In the second process,

$$2\gamma \rightarrow particle + antiparticle, \tag{28}$$

i.e. *in the recombination*, the opposite exchanges happen: *the sub-existences of two photons in both imaginary-valued and real-valued sub-spaces mutually interchange*. Otherwise, it is hard *to explain the disappearance and appearance of electric charges or masses of the Fermionic particles*. As well, it is hard *to explain the sudden motion of newly occurring photons with the speed of light*.

Q17. Why does every particle, also that with zero impulse, have the non-zero rest energy?

The permanent motion of every particle in the imaginary-valued sub-space with the speed of light can also explain the existence of its rest energy, which does not disappear even if the impulse of the particle is zero (see Eq.(16)). The impulse can be zero only in the real-valued sub-space, but its size is always equal to $m_o c$ in the imaginary-valued sub-space.

7 Geometric theory and meaning of physical constants

Albert Einstein originally created the theory of relativity as the pure geometrical theory. Besides energy and energy related quantities, only the geometric structures were expected to figure in this theory according to his meaning. Another well-known goal, which Einstein attempted to achieve during a long period of his scientific career, was the theory of everything. In s more detail, he wanted to unify all four fundamental interactions in the nature and explain the quantum phenomena within a common framework of the universal theory.

Q18. Can the pure geometrical theory be derived on the basis of Maxwell electromagnetism?

It appears that these Einstein's goals can be achieved within the Maxwellian electromagnetism with the improvements described above. *If both universal electro-gravitational force law and law of inertia are derived from a unique principle, mentioned in Sect. 2, then the equation of motion, consisting of these laws, can be given in the dimensionless form*, which contains only the ratios of lengths or derivatives of lengths in respect to length. (Or, these derivations can be expressed with the help of time as the universal variable for a characterizing of any change.) Such the dimensionless equation of motion was derived and published in our earlier paper (Neslušan, 2010; see also a simplified derivation in Neslušan, 2012). And, *the Einstein field equations for the spherically symmetric static problem were also re-written to the dimensionless form* in (Neslušan, 2015). Most probably, every equation of motion and every field equations can be given in this form.

In an analysis done in course to re-write an equation of motion or field equations from the traditional to the dimensionless form, there appear the physical quantities of two kinds: (i) the artificial quantities as, e.g., mass or electric charge, which were

established by man during the human history for some practical purposes of everyday life, mostly, and (ii) the natural quantities as, e.g., the numbers of periodic phenomena or lengths. *The dimensionless form appears after all artificial quantities are eliminated (replaced by the natural quantities). Then, also all physical constants disappear* (except of the dimensionless fine structure constant, which can, however, be represented as a geometrical constant (Neslušan, 2010)).

Q19. What is the meaning (interpretation) of the fundamental physical constants within the unified theory?

The disappearance means that *the physical constants, as gravitational constant, permittivity of vacuum, or Planck constant, are simply the transformation constants between the artificial and natural physical quantities.*

8 An example of the heuristic power of new theory

As we could see, the Maxwell electromagnetism can unify several parts of the current physics and this unification relates some facts, which were regarded as mutually independent, before. The new relations can imply some new physics. Below, we predict a special kind of elementary particles, with the properties which can account for the dark matter in the universe.

In our earlier paper (Neslušan, 2015), we demonstrated the Diracian decomposition of the radial equation from the set (6) (the same can be done with that of set (7)). From the mathematical point of view, the equation is the differential equation of the second order. In the way suggested and used by Dirac in the case of Klein-Gordon equation, this equation can be decomposed to two differentual equations of the first order (but the matrices 2×2, instead of 4×4, are used because the latter do not provide us with any new information, in fact). At this decomposition, we can use, in total, the 2×2 unit matrix and three Pauli matrices. In a given specific case, we however need only three of the four matrices. Hence, there are several combinations to choose three matrices from the set of four. Each specific choice is related to a specific kind of the interaction described by the MEs. Each kind of interaction is obviously related to the corresponding specific kind of elementary particles.

Instead of the "standard" combination, considered in papers (Neslušan, 2010 and 2014) to describe the common, electro-gravitational interaction (we dealt with in the previous parts of this paper), one can consider another combinations, of which the following one is interesting. It results in the mass/charge in the form $\pm M_o + m$, i.e. also the term corresponding to charge is real-valued. If the coresponding hypothetical particle possessing this charge, or rather "pseudo-charge", interacts with a particle of "normal" matter (as proton or electron), it means that this pseudo-charge does not interact with the charge of the normal particle, but it interacts with its mass.

Q20. Can the Maxwell theory predict some further properties of neutrinos (other exotic particles)?

Consequently, it was demonstrated that *the collisional cross-section in such a "mixed" interaction is many orders of magnitude smaller than its counterpart in the collision*

of two electrically charged particles of normal matter. Because of this circumstance, it seems to reasonable *to identify the hypthetical particles possessing the pseudo-charge with neutrinos.*

In the experiments with neutrinos performed until now, the pseudo-charge could remain hidden. Namely, we study the properties of neutrinos on the basis of effects, when the latter interact with the observable particles of normal matter. And these effects depends on the (inertial) mass of neutrinos and, therefore, are the same (and extremely small) regardless the neutrino possesses or does not possess the pseudo-charge.

The pseudo-charge of neutrinos, if exists, is predicted to be discovered in the mutual interactions − collisions − between these particles. In the collisions, the pseudo-charge of one neutrino is predicted to interact with that of other neutrino. Consequently, the collisional cross-section is essentially the same as that in, e.g., electron-electron collisions, if we assume the equal energy of both kinds of incident particles. So, a beam of neutrinos should be significantly (detectably) dispersed by another beam of neutrinos, crossing the first one.

It would be premature to deal with the neutrinic dark matter before the pseudo-charge is confirmed. It is however clear that the objects constituted of a neutrinic "pseudo-plasma" would play an importatnt role in the explanation of dark matter and, possibly, dark energy, in such a case.

9 Concluding remarks

We have not deal with the interference phenomena of a radiation or particles passing through the slits. Because of the described waving nature of the particles and, of course, radiation, the success with a quantitative explanation of these phenomena within the presented and advocated theory can be expected.

Only fundamental branch of physics, which has not been concerned by the new theory, is the "standard model" (or, maybe, other model) of elementary particles. Here, their discrete rest masses were not even attempted to be predicted. This is likely the last serious problem of the Maxwell electromagnetism to become the theory of everything. However, there is still the question if this problem is fundamental or appears only due to the fact that the new representation of the theory has been developed, until now, only by a single researcher...

We let the reader alone to evaluate the potential of the Maxwell electromagnetism, its fundamental equations, to explain a large part of physics within a single framework. We would like to emphasize that only the **single** presented solution was enough for this job, in fact. This is remarkable aspect of the suggested unique theory. We wonder, if other theory with such a large or, perhaps, even a larger unifying potential is known or will ever be known?

The theory of everything is usually expected to be a completely new, multi-dimensional, quantum-logic, etc., i.e. an ultra-complicated theory. However, as it was possible to see, the presented explanation of the basic fundametal properties of unique interaction as well as of the relationship between the macro and microcosm is, on contrary, unbelievably simple. So, why should we make the things difficult and hard, if we can have them simple?

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