J.G. Klyushin

Some Fundamental Problems of Electro- and Gravidynamics

S.T.Petersburg, Russia
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To the memory of my father
Professor Grigory Klyushin
who gave me everything

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Foreword to English Edition

This book presents a new approach to the Relativity Theory (RT) and Quantum Mechanics (QM). Besides the main motivation for the new approach – that RT and QM appear to be incompatible with one another – we note that a number of physically important cases and well documented experiments cannot be explained in the framework of the two theories. This approach has been presented at several conferences and symposia organized by International Scientists Club (ISC) in Russia and Natural Philosophy Alliance (NPA) in USA since 1990's.

Several historical remarks are relevant in this context.

In 1980's, B.G.Wallace analyzed the results on Venus location obtained by US spacecrafts and came to the conclusion that the classic mechanics rule for simply summing the velocities describes the observed results much better than the relativistic one. His work was ostracized, and journals refused to publish it. Presently, the same problem is encountered in connection with Global Positions Systems. In 2006, one of the participants of NPA conference (held in Tulsa, OK) delivered a report on experimental data on summing the light velocity from Jupiter satellites and Earth' velocity. The result was $c \pm v$. He told me that he was not allowed to deliver this report anywhere else.

I find it puzzling that mainstream journals are closed for alternative views. It is high time to openly discuss the problem.

As discussed in the present work, all the known, properly verified, experimental data that can be explained in the framework of traditional Electrodynamics, RT and QM can be explained in the framework of the proposed theory as well. But, in addition, many other data (obtained in USA, Russia and other countries) that cannot be explained in the traditional framework find their explanation in the theory proposed here.

The book is a collection of this author publication's devoted to analyses of the connections between electricity and gravity. Paper [36] is the foundation of the whole work. It is essentially supplemented . Some examples are investigated in greater details. The role of ether, a media filling the space and all bodies, is formulated more accurately and understandable. In particular etherian explanation of dielectric drawing into capacitor is proposed.

The concept of diamagnetics and paramagnetics is linked with ether compressibility in bodies. An example of a magnetic field from which paramagnetics are pushed out and diamagnetics are pulled in is considered. An example when a curve does not envelope current but there is a magnetic field inside it is considered. The cause of such an effect are additional items which appear in generalized electrodynamics proposed by the author and are absent in traditional considerations. The problem of the third Newton law validness in generalized electrodynamics is considered in greater details. Traditional Lorentz force formula does not satisfy this demand as it is well known.

Links with gravity is formulated in several appendixes. Each appendix is a logic step from generalized electrodynamics to gravidynamics which is described by Maxwell type equations in which the first time derivatives are changed for the second ones. Appendix 1 is devoted to the problem of dimensions of electrodynamic quantities, which are expressed in mechanical terms at last. One can immediately see that electric field is a field of velocities and gravidynamics is a field of accelerations. There is no problem with gravidynamic field : it was described in mechanic terms by Newton from the very beginning.

Appendix 2 is devoted mainly to historic causes which determined General Relativity Theory victory in its struggle with other ones. A description of the new approach linking electricity and gravity is given.

The author’s propositions for gravidynamic field description is given in Appendix 3. The corresponding equations and force formula between two moving masses is found. In addition to static gravity law this formula includes a dynamic part somehow in the same way in which Lorentz force formula does this in electrodynamics. This force depends on velocities, accelerations and the third and the fourth radius-vector time derivatives. Appearance of the dynamic part of the formula is connected with existence of a gravimagnetic field.

Appendix 4 may be considered as a work done in anticipation. Accurate analogies of conservation laws in electrodynamics are valid for gravidynamic field. Conservation laws in electrodynamics just as in hydro- and thermodynamics are mathematically formulated in continuity equation depending on fluid velocity flowing through a surface. But it is not sufficient in processes of accelerated flowing. But just such processes are observed in gravidynamics. Appendex 4 is called “The Second Continuity Equation”. It enables us to describe accelerated processes.

This author plans to go on with considerations of different applications and first of all cosmic manifestations of gravidynamics in particular the effect of “dark mass” in galaxies.

I hope that the book will stimulate discussions, and I would be quite interested in hearing objections.

Help of my students (in particular, of Alexey Bogdanov) is gratefully acknowledged.

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Foreword to the Second Russian Edition.

During the last six years which have passed since the first edition of the book new physics which deserted mysticism of relativity and quantum mechanics have made some essential steps forward. Profound connection between electricity and gravity has been realized. This connection in the first edition was manifested only in the fact that electric charge is just a rotating mass. Quantitative models of electron proton and neutron, non-Bohr model of hydrogen atom coordinated to the whole set of experimental facts have been proposed. The role of ether, i.e. media filling the space and matter has become evident in all physical phenomena. But quite new book with essentially bigger volume is necessary in order to include all these papers. The author has not lost hope to write such a book yet. This is the deed of perhaps not near future. But the approaches proposed in the book are claimed. Meantime the first edition of not many copies has been completely exhausted. Therefore it was decided to republish the first version of the book without essential changes. Noted misprints are just corrected.

I feel sad that many participants of the St.Petersburg Physical Society seminar who so helped me to write this book in 1999 by their criticism and non-reconciliation have already passed away. Especially acute I feel absence of V.A.Fogel. On the 15th of September my wife who had been helping me to go through this life for forty years had also passed away. What can we do ? Such is apparenty the will of the Lord.
Many thanks to my students Svetlana Myshenko and Olga Zshbanova who took on their shoulders not easy work of this book type-setting.

February 2006. J.G.Klyushin.

From the Author.

This book is conceived as a challenge to the crestfallen conformism in the science. And any challenge is addressed first of all to the youth cognizing the laws of nature for the first time and therefore potentially more inclined to perceive non-standard ideas.

My words are to you, student and postgraduate. Your life will not be devoted to specification of the hundredth sign of a well known constant. Modern physics foundation has collapsed and its building is tumbling down. Nature unity about which ancient wisdom told us is founding felt form. You will have space to develop and subject to think over. To realize and formulate time linkagies... What can be more worthy ? And what can give greater joy of life ? I have lived my life and I can say : neither money nor power even nor love I do not say about wine and drugs can give you the wonderful non-bluntingly keen feeling which embrace the person when the heap of discrepant and looking non-linked facts suddenly find just proportion, simplicity and you begin feeling universe harmony. I believe that something like this is felt by a woman who keeps healthy and crying baby against her brest after a long and difficult pregnancy and not easy childbirth. Creative work is the only way for a man to experience this feeling.

But my words are also for venerable scientists of my generation. You are knowledge curators. It is impossible without you to create hierarchy, canon so important for the science of the coming millennium, so necessary to construct “Beads game” on the place where today we observe a mixture of strange fantasies called physical concepts. So let us not become like politicians who put their personal ambitions higher than the interests of our common pursuit. In the great evolution movement the Lord prescribed us the role of the humanity brain. So let us be worthy of our destination.

I take chance to express my gratitude to everybody who directly or indirectly helped in my difficult journey to modern physics. And first of my thanks are addressed to I.V.Prohorzev. This book could not appear at all without his attention and support. I am very grateful to all my collegues in St.Petersburg physical society seminar and first of all to the seminar curator A.P.Smirnov and to the “first between equal”

V.A.Fogel who attracted my attention to electrodynamics and persistently revived the interest sometimes even despite my resistance.
As always professional was Svetlana Begacheva who type-setted this book. As always forbearant and benevolent was my wife Alena about my love to whom I would like to say here because I seldom pronounce this in everyday life. My thanks to my teachers – professors of Leningrad State University who has grafted habit for quantitative investigations and perhaps naive believe in the final victory of truth to me, also to all my friends and first of all to A.N.Proszenko who always found strength to support me in my foolhardy initiatives. Also many thanks to you my reader who had enough endurance to come to these words.

February 1999. J.G.Klyushin.

Introduction.

All the sciences could be devided into two classes : sciences “long” and sciences “wide”. Mathematics could be an example of a long science : it constructs long chains of conclusions from initial axioms-assumptions. An example of a wide science could be history or economy. In these sciences there is a lot of different not clearly how linked between each other facts from which “pig tailes” of conclusions stick out.

In accord with widely spread opinion physics is a long science : see how many facts follow from it. But more attentive analyses shows that modern physics is much closer to economy than to mathematics in this aspect.

Multiplicity and semantic diffusion of looking to be main terms, usage of mathematics not to clear up but to obscure essence of the problems, authority citation as a proof all these birth-marks of wide sciences are also characteristics of physics nowadays. The author is sure that modern physics is in crisis. Crisis more profound than hundred years ago. One can call it “lengthening crisis”. This means that it is useful to look how other sciences and first of all pattern for other sciences – mathematics passed such crisises.

One can say that the last crisis of mathematics began from realization of the Euiclidis fifth postulate problem at the second half of the 19^{th} century and ended in the beginning of 20^{th} century by formulation of “axiomatic method” in mathematics. And what was realized in this crisis process ?

First of all it was realized that it was impossible to define everything with the help of everything. Some notions should be given to the scientist’s intuition. For instance the notion of set is not defined in mathematics but there is a set theory. But there should not be too many such non-defined notions. Otherwise the same assertion may be understood differently by different persons. Further on, new theory construction must begin with axioms formulations. These axioms are not compelled to be “evident truth”. The set of axioms certainly must satisfy some demands of non-contradiction and completeness etc. But these assumptions can be absolutely voluntary in other senses.

What can physics of new millennium take from these mathematical tradition ? I believe that first of all this is necessity to essentially decrease the number of non-defined notions. Nowadays there are tens if not hundreds of such notions in physics. Conservation energy principle is enunciated. But nobody knows what energy is. They write text-books on the field theory but nobody knows field's definition. They call equation everything where equality sign appears although half of these "equations" are really identities and definitions.

One example. Apparently the first one who said about this was Lagrange. Kirchhoff was the first one who put the question point-blank. H.Poincare reasoning in his "Lectures on Mechanics" [1] is reproduced below in a slightly voluntary manner perhaps. Poincare writes approximately the following. In what case correlation $\mathbf{F} = m\mathbf{a}$ may be called a law ? Only if we have three independent definitions : force $\mathbf{F}$, mass m and acceleration $\mathbf{a}$. Only after this a clever man after sitting under apple or plane tree can come to us and say : "All of you old chaps thinks that these things are not connected with each other and I tell you there is the equality here, let us come to experiments".

But the situation is quite another actually. At a pinch we can say that we understand what $\mathbf{a}$ is if we understand what space and time is and are able to calculate derivatives. Then Poincare shows that all mass definitions he knows are flawy in this or that aspect. And already completely, - Poincare goes on, - we do not understand what force is. The conclusion : the assertion we call the second law of Newton is definition at best : if mass velocity changes as a result of external causes and the mass is accelerated we assert that a force acts on the mass.

But let us turn the pages of physical text books further. We see the very mass in gravitational field with potential $\mathbf{\Phi}$. New definition appears : force $\mathbf{F} = m \cdot grad\,\mathbf{\Phi}$. Technically these definitions are completely different. Are the definitions equivalent or they differ in some aspects ? We shall consider Lorentz and Weber forces in electrodynamics below. How these concepts are linked with the mentioned above ? I have not found answer at the text-books I know.

Therefore the following passages are typical for modern text-books. A long talk takes place concerning electromagnetic forces acting on electron. Then they remember : ah, but the force is the impulse time derivative, let us equalize these concepts. And why the force is not potential gradient ? And who has given us right to equalize things of different origin ? And who said to us that electrically charged body reaction to the force is the same as of electrically neutral ? As a minimum validity such assertions must be being grounded for a long time. Any consequence follows false premise. Therefore they come to valid conclusions sometimes.

But let us return to physics crisis. What seems to be the first and the most important step ? To enumerate and minimize the number of non-defined notions. Perhaps we should limit ourselves with the intuitively clear concepts of space, time, mass…Perhaps 3 or 4 notions in addition. I am afraid that many spades will be broken in this battle. Because one of the greatest losses Relativity Theory inflicted physics is the habit to behave in a familiar way with notions of space and time to mix them up with corresponding concepts in mathematics. Metric, topology for a mathematician is just a convenient way for him to build his logic construction. He attaches no physical meaning to them. Although physical space and time in which we live may be supplied with some qualities of mathematical metric actually it is linked with no logic definitions. This is something given to us by the Lord who also supplied us with the capability to orientate ourselves in it. And this capability says to us that time and space coordinates cannot have equal rights. The time is rather a rod on which space coordinates' flesh is stringed. Therefore we often consider space coordinates as time functions and never vice-versa. Mathematically this means that when we use Euler coordinates we must calculate total time derivative. Its convective part describes link between time and space. And such link is usually the very essence of problems.

Apparently just in this point to-day official physics has stumbled. See if a non lazy person was found who would reproduce electrodynamics in Lagrange coordinates artificial four dimensionality by Minskovsky would immediately fall to pieces and relativistic monster would vanish with this cock's cry. Meanwhile there are amateures proposing to consider physical space as general topological and even fiber space.

Thus the first task is to select and reach common understanding of fundamental notions in physics. The second step would be formulation of main postulates. Certainly desires for mathematical axioms are not sufficient for physical postulates. We must demand that the axioms' corollaries were corroborated by experiences. The problem what experience is correct and above all what is its interpretation certainly will need long discussions.

Here we only note that capability for a theory to explain an experiment can not be ground to proclaim the theory correct yet. Almost two millennium Ptolemaus astronomy and Aristotel belief that movement with constant speed must be maintained by external force were confirmed by experiments. But nowadays we do not believe in it. Almost a centruary some experiments were considered as Special Relativity Theory confirmation. Nowadays they found explanation in the framework of other theories which explain dozens of other facts which can not be explained in the framework of SRT and up till recently were explained either ad hoc or were not explainted at all. Meanwhile we often observe that asymmetric theories explaining a dozen of experimental facts are declared to be eternal truth and suppress alternative approaches. Thus the main problem of to-day theoretical physics is not the quantity of experiments, their number is often sufficient, but the problem is their natural and distinct explanation.

It seems that English root in modern physics proclaiming primacy of experiments too prevailes in the today science and suppresses French root demanding transparent logic and elegant theory construction. Future physics apparently is in prospect of somehow harmonizing these principles.

And how the physical axioms should look like ? Apparently equations of fundamental fields must become such axioms. There have already being been such a tradition in physics. But today the theorems, i.e. the corollaries, the consequences from the equations are constructed completely unsatisfactorily using vague and previously non-defined notions. Therefore its seems that physics development during the nearest years must look as follows. Fundamental fileds' equations are written, for instance equations of electrodynamic, gravidynamic or thermodynamic fields. All the consequences from these equations are looked over. It is ascertained why some facts can not be understood as consequences from the equations. After that either initial equations are generalized or new postulates are introduced.

1. Historical Review of Electrodynamic Theories.

Electrodynamics is considered to be truly a fine sample for the other branches of physics, as far as its logical aspects, as well as its experimental proof are concerned. Houses are lighted by the bulbs, electric power-stations work, we can communicate by means of INTERNET. What can be more ?

However, if we make a more detailed examination, we will find out, that all is all right, only in some special cases, like parallel wires with electric current. And yet, the present explanation of induction wakes a number of objections, which we shall only mention here. The more detailed consideration can be found in the article by Doctorovich [2].

A great many, or even all problems in electrodynamics arise from the fact, that in modern terms the theory was formulated as a result of sometimes very different approaches to the description of phenomena.

Those approaches, consequently were being matched to each other with a loss of train of a thought. The logical flaws were being complemented by artificial, sometimes apparently non symmetric definitions.

Let us mention here the basic stages of formation of electrodynamics, which are usually rendered in university courses nowadays.

The attraction of the electrified objects, experimentally known since the ancient times, was formulated in terms of rigid mathematical definition, known as Coulomb's law : the force of interaction of two electric charges q_1 and q_2

$$\mathbf{F}_{21} = \frac{q_1 q_2}{4\pi\varepsilon_0 r^3}\mathbf{r}_{21} \tag{1.1}$$

Let us investigate this formula. What does it say ? First of all, the force $\mathbf{F}_{21}$ is a vector and (1.1) points out the direction of this force : the force is radial and directed along the radius going from charge 2 to charge 1. Its proportionality to the radius-vector $\mathbf{r}_{21}$, going from charge 2 to charge 1 accounts for it. Value r, the modulus of radius-vector $\mathbf{r}_{21}$, is the denominator of the fraction.

We'll use further the Descartes' three-dimentional rectangular system of coordinates, points of which will be denoted as $\mathbf{x} = (x_1, x_2, x_3)$, x_i , i =1,2,3 – are projections of this point to the coordinate axes. So, we have the following (in Descartes' rectangular three-dimentional coordinate system) :

$$\mathbf{r}_{21} = ((x_1^1 - x_1^2), (x_2^1 - x_2^2), (x_3^1 - x_3^2)) \qquad (1.2)$$

$$r = \sqrt{(x_1^1 - x_1^2)^2 + (x_2^1 - x_2^2)^2 + (x_3^1 - x_3^2)^2} \qquad (1.3)$$

The upper indices denote numbers of the charges. So, $\left(x_1^1 - x_1^2\right)$, means, for example, the distance between the charge 1 and charge 2 along the axis x_1. It is supposed here, that the size of charges is negligible, if it is compared with *r*. If it is not mentioned the opposite, we'll suppose it true, below. The formula (1.1) has a radius-vector, which stands in the numerator, and the third power of its value which stands in the denominator.

It means that the value of a force decreases as the square of a distance. Some more values, except for the distance, appear in (1.1).

First of all, these are charges - q_1, q_2 . The modern manuals consider the conception of any electric charge as some primary essence. We'll return to the question of the physical sense of the charge, below in Appendix 1, and here we'll follow this traditional point of view, mentioning only the fact, that the unit of the charge is Coulomb, in SI-system, which we'll apply. And, even now, we encounter with some problem of a correct definition.

The next approach would be natural. Of course, we do not understand the exact sense of the conception "charge", but we are sure, that there are particles, carrying minimum quantity of this quality. So, one can assume the charge of electron, proton, or some quantity of these charges to be equal to a unit charge, for example $6{,}25 \cdot 10^{18} e$, where e means a charge of electron. One proceed this way usually. But at the same time, one does not determine the unit of a charge, which is equal to the previously written number of elementary charges, and called “Coulomb” (in SI-system). Instead at the beginning the speed of changing of the charge – “coulomb per second” is defined.

This value is called “Ampere”, and it is defined as a force of constant current, if it goes through a pair of parallel straight forward conductors of the infinite length and infinitesimaly small cross-section, provided the distance between the conductors placed in vacuum equals 1m, so the current induces the force between these conductors, which is equal to $2 \cdot 10^{-7}$ Newtons per metre.

What is interesting here for our discussion ? One wants to determine the unit of a charge and the force of current in terms of force, but not vice versa : such-and-such force corresponds to such-and-such quantity of resting or moving charges. Such inconsistent determinations seem to be natural from the historical point of view.

As a matter of fact, even now, all the electric devices, which measure electrodynamic characteristics, measure the force, or angular momentum of the force. We’ll mention, before coming to the discussion of the main stages of the development of electrodynamics, that there is one more value - ε_0, which is present in (1.1). This constant is usually called “electric constant” or permittivity of free space.

It characterizes interaction of charges in vacuum. It can be experimentally measured :

$$\varepsilon_0 = \frac{1}{4\pi 9 \cdot 10^9} \frac{C^2}{N} \frac{}{\text{м}^2} \qquad (1.4)$$

This constant indicates, that the force of interacting charges is not equal, and only proportional to the product of charges, as well as inversely proportional to the square of distance.

This constant arises only in SI-system. If one changes the value and dimention of an electric charge, it can be equal to unit, what happens in CGSE-system. Although, it is convenient sometimes for calculation process, we’ll see that it obscures very much the physical sense of electrodynamic expressions, whereas ε_0 has a fundamental mechanical sense of free ether mass density (see Appendix 1).

So, in the middle of the 40^{th} of XIX century physics knew two foundamental laws : the law of gravitation and the Coulomb’s law. Both laws predicted the existence of radial force of interaction between two charges, the force, which magnitude decreases as the square of distance.

In 1846, Wilhelm Weber offered the generalization of the Coulomb's law for the case of moving charges, when the passive charge equals unit. The value of the passive charge was taken by Weber equal to unit, probably, just as a matter of convenience. Never the less, as we'll see further, this inconspicuous simplification stemmed up a certain ideology, which is natural for modern manuals on physics. As a matter of fact, it brought to simplistic understanding of the notion of "electric field", as a force, which acts on the test charge. Let us start from the very beginning.

The Weber's formula for the case of two charges is :

$$\mathbf{F}_{21} = \frac{q_1 q_2 \mathbf{r}_{21}}{4\pi\varepsilon_0 r^3} - \frac{q_1 q_2 \mathbf{r}_{21}}{8\pi\varepsilon_0 r^3 c^2}\left(\frac{dr}{dt}\right)^2 + \frac{q_1 q_2 \mathbf{r}_{21}}{4\pi\varepsilon_0 r^2 c^2}\left(\frac{d^2 r}{dt^2}\right) \qquad (1.5)$$

$$r = \sqrt{(x_1^1 - x_1^2)^2 + (x_2^1 - x_2^2)^2 + (x_3^1 - x_3^2)^2} \qquad (1.6)$$

Already in the second part of the 20th century a new force formula called New Gaussian one was proposed by Moon, Spencer, Mirchandaney, Shama and Mann.

$$\mathbf{F}_G = \frac{q_1 q_2}{4\pi\varepsilon_0}\left\{\frac{1}{r_{III}^3}\left[\mathbf{r}_{21} - \frac{(\mathbf{v}_2(\tau_{III}) - \mathbf{v}_1) \times ((\mathbf{v}_2(\tau_{III}) - \mathbf{v}_1) \times \mathbf{r}_{21})}{2c^2}\right] - \right.$$

$$\left. - \frac{1}{c^2 r_{III}^2}\left[\frac{d\mathbf{v}_2(\tau_{III})}{d\tau_{III}} + \frac{\mathbf{v}_2(\tau_{III}) - \mathbf{v}_1}{2c} \times \left(\frac{d\mathbf{v}_2(\tau_{III})}{d\tau_{III} \cdot r} \times \mathbf{r}_{21}\right)\right]\right\} \qquad (1.7)$$

Here τ_{III} is the time defined by *universal time postulate* proposed by the authors.

Just as (1.5) formula it depends on relative velocities of the charges but is based on another postulate on light velocity.

Let us summarise the said above.

1. The force (1.5) is radial. It is clear psychologically because all the fundamental forces, known at that time, were radial.
2. The force, which was added to the Coulomb's force, depends on the relative velocities and accelerations of the charges, that is the formulas (1.5) and (1.7) predict the

presence of additional, to the Coulomb's force, even if one of the charges (for example the test one) is at rest.

3. Formula (1.5) satisfies the third Newton's law : the force, with which charge 2 interacts with the test charge, is equal and directed oppositely towards the force, with which the charge 1 interacts with the charge 2.
4. Formula (1.5) accounts for interaction of charges, saying nothing about the mechanism of propagation of such interaction in space.

The last statement made physicists of the middle of the former century feel rather ambivalent, because interaction had "contact character" in mechanics – the queen of that day science. This statement is a matter of discussion for the nowadays scientists though.

In 1782 in order to overcome difficulties of long-range interaction Laplace suggested to replace gravitation law for the differential equation for some parameter, named the "field". One can consider under such an approach, that the differential equation describes the short distance interaction between the neighbouring elements of the field.

The introduction of this field substitutes the problem of "long-range interaction" between the real charges by the problem of "short-range" interaction between the neighbouring regions of space, filled in with some artificially invented field. We are obliged to Laplace by the idea of introducing the equations of the field, equations, which act everywhere outside the points, in which the charges are placed.

Maxwell suggested his famous system of equations for electromagnetic field, having used the idea of field for the problems of electrodynamics and generalizing the results of experiments, accomplished first of all by Faraday in terms of the field.

These equations are :

$$\mathrm{div}\mathbf{E} = \rho/\varepsilon \tag{1.8}$$

$$rot\mathbf{E} = -\partial\mathbf{B}/\partial t \tag{1.9}$$

$$\mathrm{div}\mathbf{B} = 0 \tag{1.10}$$

$$c^2 rot\mathbf{B} = \mathbf{j}/\varepsilon_0 + \partial\mathbf{E}/\partial t \qquad (1.11)$$

Here **E** and **B** are fields called electric and magnetic ones, ρ is electric charges' density, $\mathbf{j} = \rho\mathbf{v}$ is electric current density, i.e. the charges' density propagation with velocity **v,** ε_0 is already mentioned electric constant. It will be shown that ε_0 means free ether density. But what is the physical sense of the **E** and **B** fields ?

Partial answer is obtained when (1.8) is integrated under condition

$$\mathrm{rot}\,\mathbf{E} = 0 \qquad (1.9a)$$

One obtains having integrated (1.8)

$$\mathbf{E} = \frac{q_2}{4\pi\varepsilon_0 r^3}\mathbf{r} \qquad (1.12)$$

where q_2 is the charge quantity in the integration volume and **r** is radius-vector from charge 2 to the observation point.

This correlation is very symilar to Coulomb law (1.1). It is just supposed in Coulomb law that charge q_1 is situated in the observation point. We shall obtain force from (1.12) if multiply it by charge q_1 , i.e. $\mathbf{E}q_1$ is the force with which static charge q_2 acts on static charge q_1.

But equations (1.8)-(1.11) in addition contain magnetic field **B** which must also somehow influence on the test charge q_1. Apparently Heaviside was the first one who proposed the formula later called Lorentz force one. Here it is

$$\mathbf{F}_{21} = q_1\mathbf{E}_2 + q_1\mathbf{v}_1 \times \mathbf{B}_2 \qquad (1.13)$$

It is believed that moving charge q_2 acts on moving charge q_1 with this force. Here test charge q_1 appears explicitely. The charge q_2 action is concealed in the fields $\mathbf{E}_2$ and $\mathbf{B}_2$ which it creates.

How do these fields look ? In order to answer this question we must solve equations (1.8)-(1.11) for q_2 and substitute these solutions into (1.13). But we do not know Maxwell's system solution for separate charges. We can find them in some special partial cases.

One of such cases is the case of long beam of moving electrons. In this case

$$\mathbf{B}_2 = \frac{\mathbf{I}_2 \times \mathbf{r}_{21}}{2\pi\varepsilon_0 c^2 r^2} \tag{1.14}$$

where $\mathbf{I}_2$ is current, i.e. the charge quantity intersecting the beam transverse section per second, *c* is light velocity. (1.14) may be transformed if the charges' velocity in the beam $\mathbf{v}_2$ is written explicitely.

$$\mathbf{B}_2 = \frac{\lambda_2(\mathbf{v}_2 \times \mathbf{r}_{21})}{2\pi\varepsilon_0 c^2 r^2} \tag{1.15}$$

Here λ_2 is linear charge density in the beam. (1.13) for the case looks as follows

$$\mathbf{F}_{21} = \frac{q_1\lambda_2\mathbf{r}_{21}}{2\pi\varepsilon_0 r^2} + \frac{q_1\lambda_2}{2\pi\varepsilon_0 r^2 c^2}[\mathbf{v}_1 \times (\mathbf{v}_2 \times \mathbf{r}_{21})] =$$

$$\frac{q_1\lambda_2\mathbf{r}_{21}}{2\pi\varepsilon_0 r^2} + \frac{q_1\lambda_2}{2\pi\varepsilon_0 c^2 r^2}[\mathbf{v}_2(\mathbf{r}_{21}\cdot\mathbf{v}_1) - \mathbf{r}_{21}(\mathbf{v}_1\cdot\mathbf{v}_2)] \tag{1.16}$$

Let us compare this formula with the Weber's (1.5).

1. Force (1.16) has not only radial but directed along velocity force $\mathbf{v}_2(\mathbf{r}_{21}\cdot\mathbf{v}_1)$.
2. Additional to Coulomb force depends on the velocities' product. Therefore it is zero if at least one charge is at rest. This conclusion compels to-day physics which limits itself with this formula to assert that only Coulomb force acts between moving charge and charge at rest although simple experiment shows invalidness of such an assertion.
3. (1.16) does not satisfy the third Newton law. If for instance $\mathbf{r}_{21} \parallel \mathbf{v}_1, \mathbf{r}_{21} \perp \mathbf{v}_2, \mathbf{v}_1 \perp \mathbf{v}_2$, i.e. $\mathbf{v}_2(\mathbf{r}_{21}\cdot\mathbf{v}_1) \neq 0$, $\mathbf{r}_{21}(\mathbf{v}_1\cdot\mathbf{v}_2) = 0$, then changing indexes we obtain expression for the counteraction force : $\mathbf{v}_1(\mathbf{r}_{12}\cdot\mathbf{v}_2) = 0$, $\mathbf{r}_{12}(\mathbf{v}_1\cdot\mathbf{v}_2) = 0$, i.e. action force in the case is non zero and counteraction force is zero.

4. Interaction mechanism between charges in (1.13) is explained by the fields $\mathbf{E}_2$ and $\mathbf{B}_2$ which charge q_2 creates in the surrounding space. For all this $\mathbf{E}_2$ acts on the "static part" of the test charge and $\mathbf{B}_2$ acts on the component depending on the test charge velocity. Let us note that this means that the test charge as if does not have fields of its own. The external fields act directly on it. But this short-range action disappears in (1.16) formula which is equivalent to (1.13). In other terms a question appears : isn't it our wrong intuition which leads us to the problem of long and short range action problem ?
5. (1.16) does not predict a force induced by the charges' acceleration, but (1.5) force depends on it.

Let us repeat once more that the very idea of the (1.16) formula is to find interaction force knowing the fields created by charge q_2 and characteristics of the charge q_1.

But the problems with finding Maxwell system solution led to nesessity to reverse the situation. Here is a characteristic example. Professor Purcell in his text-book ([4]p.182, Russian version) writes the following. Having written our equation (1.13) he writes : "…we accept it (formula 1.13) as a definition of Electric and Magnetic field in this space point."

In other terms we are proposed not interaction force to define with the help of the fields (the idea initially incorporated into the formula), but having adopted the formula universe and exhaustive to define fields with the help of measured force. But such an attempt meets many problems. Let us pin point some of them.

Generally speaking 4 unknown variables appear in (1.13) formula :

1. First two are value and velocity of the test charge. Usually (but not always) the way out is found accepting that test charge is unit and the velocity is known.
2. The second two are fields $\mathbf{E}_2$ and $\mathbf{B}_2$ created by charge q_2 .

Purcell writes further : "We have proved that the force acting on the test charge is completely independent with respect to its velocity if the other charges are at rest. This means that equation (1.13) is valid everywhere when $\mathbf{B}_2=0$".

But even if we accept the proof which is very nonevident because it incorporates many unnatural assuptions the problem is that eq.(1.13) must be valid also in the case when $\mathbf{B}_2 \neq 0$, because $\mathbf{E}_2$ changes as well when $\mathbf{B}_2$ changes. But in accord with the idea of Purcell himself immobility of the charge q_2, i.e. condition $\mathbf{B}_2=0$ is nesessary condition for the validity of the first item.

But perhaps the greatest problem is that formula (1.13) is not universal. Therefore we loose many very important partial cases incorporated into Maxwell equations if we define field with the help of it.

In practice this means that $\mathbf{E}_2$ is understood as charge q_2 static field ($\mathbf{E}_2$ dynamic part is lost), i.e. special case (1.9a) but not general case (1.9) is considered.

Thus Lorentz force formula can not replace Maxwell equations and asymmetic definitions proposed in text-books can not describe Electric and Magnetic fields which we must obtain as solutions of the Maxwell system. Therefore they often strive to obtain force manipulating with (1.8)-(1.11) equations in particular integrating them over volumes or surfaces.

But let us try to understand mathematical sense of (1.8)-(1.11) system.

If this is equations then with respect to what ? It is assumed usually that charge and current densities are known. The answer looks evident : this is equation system in which **E** and **B** are unknown. But in order to find two vector-functions we need two vector equations ((1.9) and (1.11)) not more and not less. But system (1.8)-(1.11) incorporates two scalar equations in addition. Does it mean that system (1.8)-(1.11) is overdetermined ?

It is strange but the only book in which I met certain perplexity inspired by this fact is the magnificent monography by L.I.Sedov [5] on continuous media mechanics. In all other books I read including books written by mathematicians such a strange fact astonishes nobody. Rushing a little bit forward one can say that when system (1.8)-(1.11) is generalized it becomes clear that the equations, i.e. equities valid only with some values of the unknown variables are vector correlations (1.9) and (1.11). Equalities (1.8) and (1.10) define initial conditions, i.e. they are definitions or identities.

Let us note that accurate following this understanding meets a certain problem : the right hand part of the divergent correlations must describe the process of "charge generating" by ether particles. Mathematically this means that angular velocity of the ether particles must appear there.

The author tried to construct such a theory in paper [20]. This led to necessity to describe fields in terms of complex functions. The field energy turned to be equally distributed between real and imaginary parts of the field. In particular just because of this elementary particles energy is equal mc^2 and not $\frac{1}{2}mc^2$. Some other useful results were obtained and I am sure can be obtained in addition. But this needs quite a new theory.

Here we limit ourselves with only real functions. Therefore the following interpretation of (1.8)-(1.11) is possible here. In accordance with well known theorem by Helmholtz any field consists of divergent and curl parts. Thus scalar correlations (1.8), (1.10) define divergent part and (1.9), (1.11) its curl component. But purely mathematical problem appears here : how to find vector function with the help of scalar equation.

Actually we have got vector function (1.12) from scalar correlation (1.8) with the help of mathematical forgery. We cannot do this strictly logically. Physical text-books obtain this result "repeating some physical words". We are not going to devote too much space here to this problem. But dear reader, try to calculate divergence of the vector function (1.12) in order to evaluate reliability of such "physical words" in general. Have you got zero ? But let us return to our narration.

Hystorically many formulas for interaction force between charges were proposed as generalizations of some experimental facts without any concept of field. One of them, the Weber one, was mentioned above. Weber's formula (1.5) just as New Gaussian formula (1.7) proposed by Spencer and her collegues depends on relative velocities and accelerations of the charges. Formulas depending on the product of absolute velocities of the charges were also proposed. All of them were based on experiments with currents in neutral conductors and formulated in terms of current differentials. We reproduce them below for references in terms of separate charges and their velocities which will be used in section 2.

Neumann formula [10]

$$\mathbf{F}_{21} = +\frac{q_1 q_2}{4\pi\varepsilon_0 c^2 r^3}\mathbf{r}_{21}(\mathbf{v}_1 \cdot \mathbf{v}_2) \tag{1.16a}$$

Grassman formula [11]

$$\mathbf{F}_{21} = -\frac{q_1 q_2}{4\pi\varepsilon_0 c^2 r^3}[\mathbf{v}_2(\mathbf{r}_{21} \cdot \mathbf{v}_1) - \mathbf{r}_{21}(\mathbf{v}_1 \cdot \mathbf{v}_2)] \tag{1.16b}$$

Ampere formula [12]

$$\mathbf{F}_{21} = \frac{q_1 q_2}{4\pi\varepsilon_0 c^2 r^5}\left[3(\mathbf{r}_{21} \cdot \mathbf{v}_1)\cdot(\mathbf{r}_{21} \cdot \mathbf{v}_2) - 2(\mathbf{v}_1 \cdot \mathbf{v}_2)r^2\right]\mathbf{r}_{21} \tag{1.16c}$$

Whittaker formula [13]

$$\mathbf{F}_{21} = \frac{q_1 q_2}{4\pi\varepsilon_0 c^2 r^3}[\mathbf{v}_1(\mathbf{r}_{21} \cdot \mathbf{v}_2) + \mathbf{v}_2(\mathbf{r}_{21} \cdot \mathbf{v}_1) - \mathbf{r}_{21}(\mathbf{v}_1 \cdot \mathbf{v}_2)] \tag{1.16d}$$

But let us return to the problem by what way and for explanation of what phenomena system (1.8)-(1.11) is used. Eq.(1.9) usually used to explain induction. Its integral form is often used

$$\int_L \mathbf{E}dl = -\frac{\partial}{\partial t}\iint_S \mathbf{B}ds \tag{1.9б}$$

Here L is a certain contour, S is voluntary surface drawn on L.

To my regret we are compelled to concentrate on mathematical side of integral transformations. In order not to burdn our conversation with distracting details we shall not consider formulas for spatial integrals, they can be found in any text-book on mathematical analyses and physics. But we must pay attention to some peculiarities of differential and integral transformation. We must remember that we have no right to differentiate or integrate equations under equivalent transformations.

For instance equation 2x+1=0 is derivative of the equation x^2+x+5=0. But not any physicists dare say that they are equivalent.

We have right to differentiate and integrate such equations only when we substituted solutions in them, i.e. converted them in identities. Therefore we do not need any additional suppositions in order to come from (1.8) to (1.12). But in order to come from (1.9) to (1.9b) we are compelled to suppose that already solutions of the system (1.8)-(1.11) figure in (1.9b). For better understanding **E** and **B** in (1.9b) should be stressed somehow to emphasise that they are already known functions in contrast to (1.9) where **E** and **B** are unknown and we must find them.

This is said in order to stress that **E** and **B** in (1.9b) are certain functions determined by charge density ρ and current density **j**. The problem how other charges react on such fields must be solved by additional axiom for instance by Lorentz force formula. We shall see that this formula is not universal enough and it must be generalized but in principle it plays role of such an axiom which defines the rule of interaction between the fields induced by two different charges. But Lorentz force formula does not envelop some important cases. Therefore an idea appeared to describe interaction between two charges with the help of so called flow rule.

The very rule is described in every text-book. We shall not spare time for it. It appeared as an attempt to describe the case when a loop moves in constant magnetic field or is at rest in alternating one.

The left hand part of equity (1.9b) is believed to be determined by the charges in the loop and the right hand part – by the external charges, creating external magnetic field.

Let us repeat once more : *such a partition of the fields contradicts the essence of equity (1.9b). which actually just inform us about identity of the electric field circulation and time derivative of the magnetic field flow, created by the same charge distribution.*

Lorentz force formula (1.13) works OK when current loop moves in constant magnetic field. But it fails to describe the effect observed when current loop is at rest in an alternative magnetic field.

To explain just this case equity (1.9b) was used. It helped to obtain nesessary result and logical jumps on this way were not noticed. But not by all, some felt certain discomfort here. Let us cite the corresponding discourse by R.Feynman [6,p.53]:

"The two possibilities – "circuit moves" or "field changes" are not distinguisted in the statement of the rules. Yet in our explanation of the rule we have used two completely distinct laws for the two cases - $\mathbf{v}\times\mathbf{B}$ for "circuit moves" and rot$\,\mathbf{E}=-\partial\mathbf{B}/\partial\mathbf{t}$ for "field changes". "We know of no other place in physics where such a simple and accurate general principle requires for its real understanding an analysis in terms of two different phenomena. Usually such a beautiful generalization is found to stem from a single deep underlying principle. Nevertheless, in this case there does not appear to be any profound implication. We have to understand the rules as the combined effects of two quite separate phenomena".

No, mr.Feynman, we should not combine two separate phenomena, we'd better use generalized Lorentz force formula which will appear in this book section 2, because the phenomena are really different.

But why does correlation (1.9b) in to-day interpretation so luckily bridge the gaps in Lorentz force formula (1.13) ? We shall see below that generalized Lorentz force formula in the case of changing fields comes to very similar correlation but for two different charge distributions, i.e. **E** in the left hand part of (1.9b) is determined by one distribution and **B** in the right hand part by another one.

Not aiming to investigate the problem of Poynting vector let us mention it as an example of a symmetric logical mistake. Lorentz force formula is used to deduce Poynting formula [6,p.289]. We have already said that this formula describes interaction of the fields originated by two different charges distribution. But these fields are identified when Poynting formula is obtained, therefore using Poynting vector leads us sometimes to a very strange conclusions.

Poynting vector was introduced to describe energy density flow in electromagnetic wave. And it works there quite satisfactorily because it links electric and magnetic fields of photons. Certainly it is applicable to fields created by a separate charge or set of charges. But its application to interaction of the fields created by different charges is wrong. Such interaction will be defined in Section 2 and we shall need special axioms for that.

Therefore grieves that Poynting vector does not describe for instance static case seem strange. It would be surprising if Poynting vector described static case : see, magnetic field of static charge is zero, and only a devoted relativist can create it running around with tremendous speed.

Therefore Feynman is not right when he comes to conclusion [6,p.289] that Poynting vector is directed from outside to conductor with current and predicts energy influx through lateral area into it. The mistake is that he calculates Poynting vector substituting the external electric field into it which is directed along the conductor and pushes electron in it. The electrons' electric field should be substituted into corresponding product. This is electrons' Coulomb force directed along radius in this case. And such a flow is directed along conductor just as Feynman's intuition tells him.

One more strange conclusion is made when it is asserted that (1.9b) predicts "energy pumping in light wave from electric field to magnetic one and vice versa" and that this allegedly sustains fields' vectors rotation in light wave. We are compelled to declare that (1.9b) cannot predict such a pumping because this is an identity in any space-time point, i.e. this is just different names for the same physical reality. This assertion certainly does not mean that we object that energy is pumped from one field to another one in light wave. We just declare that it cannot be consequence of (1.9b) identity.

Another mathematical mistake became foundation for the theory of retarded potentials. Accurate analysis of the all problems would take too much time for our introductory part. Therefore we pinpoint the very mistake and leave the problem for specialists.

Retarded potentials theory strives to take into account the very fact that light signal needs some time to pass from source to receiver. And sometimes it is really essential. But already at first glance it becomes clear that this is important only for some very quickly changing processes or for very far situated objects. But the theory declares essential result for all the cases. Therefore the question appears : isn't there any mistake ?

Such a mistake is really found. Let us demonstrate this citing an abstract from Feynman text-book [6,eq.21.20 and 21.22].

He considers the velocity of dipole moment p changing not in the current time t but in the previous moment (t-r/c), where r is the distance from the source, $r = \sqrt{x^2 + y^2 + z^2}$, and c is light velocity. He calculates derivative of $\dot{p}$(t-r/c) with respect to spatial coordinate y and does this in the following way

$$\frac{\partial \dot{p}}{\partial y}(t - r/c) = -\frac{y}{cr}\ddot{p}(t - r/c) \tag{1.17}$$

where $\ddot{p}$ is time derivative of $\dot{p}$.

But this is wrong. And the mistake is seen immediately : the author calculates partial derivative with respect to spatial coordinate but obtains time derivative. This could be if time was a function of spatial coordinates and total derivative was calculated. The correct result is

$$\frac{\partial}{\partial y}\dot{p}(t\text{-}r/c) = -\frac{y}{r}\frac{\partial p(t\text{-}r/c)}{\partial r} \tag{1.18}$$

See when partial derivative is calculated the other parameters should be fixed. This becomes especially clear if initial definition is used : let us fix time t_0, spatial coordinates x_0 and z_0, then partial derivative of $\dot{p}$ with respect to y is the limit

$$\lim_{\Delta y \to 0} \frac{\dot{p}(t_0 - \sqrt{x_0^2 + (y+\Delta y)^2 + z_0^2}\,/\,c) - \dot{p}(t_0 - \sqrt{x_0^2 + y^2 + z_0^2}\,/\,c)}{\Delta y} \tag{1.19}$$

It is clear that time derivative here can appear from nowhere.

Nevertheless why does the retarded potentials theory works in many cases ? We can answer : because (1.17) actually calculates certain substitute for total time derivative, and such a derivative as we shall see below is essential for correct and universal description of electrodynamics. They get the desired result just because the functions are continuous and time derivative of the retarded coordinate not essentially differs from convectional part in total time derivative.

To the point some words about partial time derivative in (1.9b). Partial time derivative in (1.9b) is written because to-day orthodox theory demands this and we reproduce it here. But when we are really drawing the conclusion we are compelled to write total time derivative. Wise Feynman finds very good and simple way out : somewhere he writes total and somewhere partial time derivative leading the problem to the reader : either this is type-setter misprint or the author's mistake. The authors of other text-books are more straight forward. We cite Pursell's text-book here just only because it is under hand. One can find similar assertions in many others.

In his text-book [4] Purcell comes to his formula 29 (Section 7.5) which coincides with (1.9b) but total time derivative. Then he writes word for word : "Because B may depend on position and time we write $\partial B/\partial t$ instead of dB/dt". And that's all, no explanation in addition. And this is for all that some lines earlier he writes down different combinations of partial derivatives with respect to spatial coordinates. And here he proposes to exclude these coordinates and limit with only time which even was not mentioned explicitely before just because such dependence exists. It is typical : the nesessity to get the desired answer compels to constrain logic.

Coming to the end of this hystoric part let us say some words about Relativity Theory because it dominates to-day physics and our results will be compared with its predictions. I shall not reproduce all indistinct and paradoxal considerations on which it is based, but only dare declare my deep belief that the "king is nude" and note that many serious scientists in USA, Russia and other countries pinpoints multiple logical contradictions in it. Let us also note that direct experiments to verify the main its assumptions : time dilation and space contraction showed negative results [7,8].

But certainly RT could not exist so long if did not predict correct results at least in some cases. One could note here that Ptolemaus astronomy based on the idea of 7 crystal spheres had being existed for almost two millenium certainly because correctly predicted many observable facts. Really Copernicus and Galileo had already said their words, three Kepler laws had already been well known but the majority of astronomers were going on calculating in accord with Ptolemaus. And got better results by the way. I believe no comments are needed here.

Let us finish the section with some deductions :

1. Different not coinciding formulas were proposed to describe electrodynamic forces and all of them were based on the experiments. Does not this mean that general formula incorporating all these force laws exist ?
2. Force interpretation of Maxwell system is invalid. Therefore field explanation of induction, “flow rule”, the very concept of field turn to be suspended. Apparently fields must be understood just as Maxwell equations’ solutions. There should be proposed additional axiom (formula) which constructs interaction force from such solutions.
3. Theories of Poynting vector, retarded potentials are based on logical mistakes, non correct calculations or as in the case of Relativity Theory on indistinct initial definitions of fundamental notions of space and time. But all of them successfully explain some experimental facts. The theory having a claim on their substituting must explain all these experiments and propose explanation of many others which to-day are explained *ad hoc* or are not explained at all.

2. WHAT CAN BE DONE ?

A certain approach which as the author believes could overcome the drawbacks of to-day electrodynamics mentioned in the previous part is proposed in this chapter.

Let a rectangular right hand coordinate triple be defined in threedimensional Euclidian space. Let $\mathbf{x} = (x_1, x_2, x_3)$ be a point in this space, t be time and ***i, j, k*** be unit vectors. Let q_1, q_2 be electric charges 1 and 2, $\mathbf{v}_1, \mathbf{v}_2$ and $\mathbf{a}_1, \mathbf{a}_2$ be their velocities and accelerations. For simplicity the charges are assumed to be evenly distributed in a ball of radius r_0. Let $\mathbf{E}_1, \mathbf{E}_2$, $\mathbf{B}_1, \mathbf{B}_2$ be electric and magnetic field intensities generated by the charges in space (ether). In the development below, a double index means field intensity created by the charge whose index goes first evaluated at the point where the charge whose index goes second is situated. For instance $\mathbf{E}_{21}$ means the electric field intensity created by the second charge at the point where the first charge is situated. Let $\mathbf{r}_{21}$ be radius-vector from charge 2 to charge 1, r be its modulus, $r \gg r_0$ and ε_0 be dielectric constant.

Generalized formula for Lorentz force

Charge 2 produces the following force on charge 1

$$\mathbf{F}_{21} = -grad[4\pi\varepsilon_0 c r^3 (\mathbf{B}_{12} \cdot \mathbf{E}_{21})] + \frac{d}{dt}[4\pi\varepsilon_0 c r^3 (\mathbf{B}_{12} \times \mathbf{B}_{21})] \qquad (2.1)$$

Here and everywhere below $c = c_0(\boldsymbol{i} \times \boldsymbol{j}) \cdot \boldsymbol{k}$, where c_0 is light velocity. This quantity is called pseudo-scalar light velocity.

Two notions of force are used in modern physics : the idea inherited from Newton and Descartes as an impulse derivative with respect to time, and the idea inherited from Huygens and Leibnitz as energy gradient. It is believed that these definitions are equivalent. And this is really so if we mean a separate body of constant mass as it was in the discussed above force definition in the second Newton law. We came to the conclusion there that it was not a law but force definition. We are compelled to assert now that such definition is not satisfactory on some reasons. One of them is the following : the very notion of force means interaction at least between two objects. We can not describe collision force between two cars limiting ourselves with the characteristics of only one of them. Therefore force definition in the static law of gravity where two masses participate or Coulomb law where two charges are used we must acknowledge natural and understandable. On the same reason the force definition with the help of the second Newton law must be admitted nonsatisfactory. Apparently Newton himself felt this and therefore supplemented it with the third law which includes the second object.

The sense of the (2.1) formula is the following : each of the charges moves creating fields in the surrounding space (ether). Any of these fields depends on the charge value, its velocity and radius-vector. The fields may be found as solutions of some equations (for instance Maxwell system). We construct interaction energy and interaction impulse as a certain combination of these fields. Such combination depends already on two charges' values, their velocities and distance between them. Interaction energy gradient supplies us with Huygens interaction force and total time derivative of the interaction impulse with Newton dynamic force already including the third Newton law in explicit form : the force with which the charge 1 acts on the charge 2 is modulo equal and oppositely directed to the force with which the charge 2 acts on the charge 1. Perhaps it is useful to note that those forces are directed not only along radius-vector but along charges' velocities as well. More details are investigated in Section 10. So constructed forces are not equivalent but are two items in a generalized understanding of force. Formula (2.1) unites these two concepts. Scalar product of the passive charge 1 magnetic field and the active charge 2 electric field describes their interaction energy density which is written under gradient symbol. Vector product of the passive charge 1 magnetic field and the active charge 2 magnetic field describes their interaction impulse which is written under total time derivative symbol.

To realize this approach we need certain system of equations. Maxwell system is used in traditional theory to describe fields. We are compelled to modify Maxwell system in order to coordinate it to formula (2.1)

Generalized Maxwell equations

Electric charge q distributed in the space with density ρ, originates electric and magnetic fields which are solutions of the following system

$$\mathrm{div}\mathbf{E} = \rho/\varepsilon_0 \tag{2.2}$$

$$\mathrm{rot}\mathbf{E} = -\mathrm{d}\mathbf{B}/\mathrm{dt} \tag{2.3}$$

$$\mathrm{div}\mathbf{B} = -\rho/\mathrm{c}\varepsilon_0 \tag{2.4}$$

$$\mathrm{c}^2\mathrm{rot}\mathbf{B} = \mathrm{d}\mathbf{E}/\mathrm{dt} \tag{2.5}$$

Let us begin our explanations with the equation (2.5)

$$\frac{d\mathbf{E}}{dt} = (\mathbf{v}\cdot grad)\mathbf{E} + \frac{\partial \mathbf{E}}{\partial t}, \tag{2.6}$$

where $\mathbf{v}$ is the charge velocity and $\frac{d}{dt}$ is total time derivative. The first item in the right hand part of (2.6) generalizes the idea of a current in classical theory and comes to it if $\mathbf{E}$ satisfies some additional conditions

$$(\mathbf{v}\cdot \mathrm{grad})\mathbf{E} = \mathbf{v}\mathrm{div}\mathbf{E} + \mathrm{rot}(\mathbf{E}\times\mathbf{v}) = \frac{\mathbf{j}}{\varepsilon_0} + \mathrm{rot}(\mathbf{E}\times\mathbf{v}) \tag{2.6 a}$$

where $\mathbf{j}$ is current density, $\mathbf{j} = \rho\mathbf{v}$. So the right hand part of (2.5) contains a curl component in addition to the classical one. This item is manifested for instance in a light wave. It also predicts magnetic field appearance in some cases where force lines do not envelope current (see Section 9).

Equation (2.4) means that equations (2.3)-(2.5) generalize the idea of magnetic field. A magnetic field $\mathbf{B}$ that is the solution of (2.3)-(2.5) possesses not only a curl but also a divergence component as well. The divergence component of $\mathbf{B}$ is defined by pseudo-scalar electric charge (defined as usual electric charge devided by a mixed product of unit vectors and light velocity). The $\mathbf{B}$ appears to be a pseudo-vector just as in classical theory.

The right hand part of (2.4) may be considered as “another incarnation” for electric charge, because the existence of electric charge is both necessary and sufficient for its existance.

One may consider it as a “magnetic charge” as well. But it is necessary to emphasize that such a “magnetic charge” does not coincide with Dirac’s monopole. Let us pin-point some of the differences.

1. Such a magnetic charge is a pseudo-scalar, i.e. its sign changes when a right handed coordinate triple is changed for a left handed one.
2. It is c times less than electric charge; correspondingly its dimension differs from the electric charge dimension.
3. And last but not least, (2.1) implies that two static “magnetic charges” do not interact, because the second term in (2.1) responsible for magnetic interaction is zero in this case. I ask the reader to pay attention to this fact because “ordinary physical mentality” usually identifies field and force, two charges and their inevitable static interaction. We shall see that Newtonian (second) part in (2.1) does not contain static item.

Equality (2.2) coincides with the classical equation, but (2.3) expands as

$$\frac{d\mathbf{B}}{dt} = (\mathbf{v} \cdot grad)\mathbf{B} + \frac{\partial \mathbf{B}}{\partial t} \tag{2.7}$$

So it includes a convective derivative of $\mathbf{B}$ originated by electric charge (and correspondingly “magnetic charge”) movement with velocity $\mathbf{v}$. Classical theory associates the appearance of magnetic field just with the movement of electric charges but do not include the originating movement into (2.3) equation.

The $\mathbf{E}$ and $\mathbf{B}$ in (2.2)-(2.3) may be defined by means of potentials.

Let $\mathbf{A}$ be vector and φ be scalar potentials of electric field and let them satisfy the following equations

$$\mathrm{divgrad}\mathbf{A} - \frac{1}{c^2}\frac{d^2\mathbf{A}}{dt^2} = 0 \qquad (2.8)$$

$$divgrad\varphi = -\frac{\rho}{\varepsilon_0} \qquad (2.9)$$

Let us assume the following gauge conditions

$$\mathrm{div}\mathbf{A} = -\frac{1}{c^2}\frac{d\varphi}{dt} = 0 \qquad (2.10)$$

Equations (2.10) means that $\mathbf{A}$ is the curl of a certain vector function. If φ is imagined as a density of a certain "electric liquid" and $\mathbf{A}$ determines the velocity of such a liquid, then the first part of (2.10) is revealed to be a continuity equation for φ and the second part of (2.10) becomes a condition of incompressibility for φ.

If we define

$$\mathbf{B} = +grad\varphi / c + rot\mathbf{A} \qquad (2.11)$$

$$\mathbf{E} = -grad\varphi - d\mathbf{A} / dt \qquad (2.12)$$

then (2.8)-(2.10) comes to (2.3)-(2.5).

Now we are compelled to concentrate on the point to which modern physics prescribes great importance. This is Maxwell equations invariance with respect to Galilean and Lorentz transformation.

Equations (1.8)-(1.11) are non-invariant under the Galilean transformation. The letter asserts that

$$\mathbf{r}' = \mathbf{r} - \mathbf{u}t\,,\; t' = t \qquad (2.13)$$

for inertial transformation between unprimed and primed system which moves with constant velocity **u** with respect to the unprimed one.

What is the physical meaning of this velocity **u** ? The most typical case in hydrodynamics is media movement : previously we observed water particle in a lake (and partial time derivative was enough for us) and we now strive to obtain the same picture in a river where water moves with velocity **u**. Certainly we can observe not only water movement but for instance sand particles which water carries. In the last case **u** will be sand particles velocity in the water with respect to the bank and not water velocity.

How does hydrodynamics take this problem into account ? When the process is described in Euler coordinates (as it is in Electrodynamics) total time derivative (2.6) is calculated instead of the partial one. We interpreted **v** in (2.6) as charge velocity in stationary ether. And what to do if the ether moves as well ? Then we assume that the charge will move with velocity **v** + **u** .

About 10 years before Lorentz used his transformation in electrodynamics Voigt [14] proposed the same transformation in hydrodynamics.

Let us return to water movement in a river. Voigt proposes not to calculate total time derivative but to come to new reference frame linked not with the bank but with the water in the river. Really if we produce our experiments on a raft moving with velocity of river water we can limit ourselves with only partial derivatives. It is clear that everything said above are applicable to the sand particles movement : their velocity in the lake is **v** with respect to as water as bank, and their velocity in the river is **v** + **u** with respect to bank and **v** with respect to water.

But what will observer on the bank see ? He will see the picture so scrupulously described in physical text-books when Lorentz transformation is commented : he will see that bodies on the raft are contracted in the movement direction and time is dilated. Of course, no a sober hydrodynamist believes that persons on the raft have lost their flesh and their dying day has been put off. Any sane person understands that this is just a “mathematical mirage”.

But for relativity theory believers such an idea not only does not seem insane but they declare insane everybody who does not agree with it God save their mentality.

Therefore let us return to electrodynamics. System (1.8)-(1.11) is not invariant with respect to Halilean transformation (2.13). All the text-books known to the author declair but do not explain this fact, Therefore let us say some explaining words. In the time of Maxwell magnetic field was believed to be connected only with electric charges movement. Maxwell introduced electric field partial time derivative into the right handed part of equation (1.11) apparently only on mathematical reasoning. The charges movement was introduced “by hands” on experimental reasoning. The connection of the charges movement with convective part of total time derivative was not understood. No kind of current was introduced into equation (1.9) because nothing which could be interpreted as magnetic charge was observed in that time experiments. Therefore appearance of magnetic field was linked with electric charges movement one. The existence of magnetic charges was negated. This negation was manifested in correlations (1.9) and (1.10). Dirac's failure to introduce such charges finally buried the idea. One can say summing that Maxwell formulated his equations for the case of stable ether and electric current was introduced into it as an axiom based on experiment.

Therefore when experiments which could be interpreted as ether movement were produced a problem of generalizing Maxwell system appeared. Hertz was apparently the first one who thought about it. He solved the problem introducing total time derivative into Maxwell system. Velocity **v** in its convective part was interpreted by him as ether movement velocity [12]/ Therefore he had to assume some ether qualities in his model. In particular he supposed that any ether movement must induce electric phenomena. The ether at that time was believed to be hardly connected with electrodynamics and even called "lightcarrying" : the media in which light propagates. Only to-day we begin understanding that ether determines gravi- and thermodynamical phenomena as well.

But this Hertz idea was not lucky. Soon after his early death Eichenwald [15] produced an experiment with rotating capacitors which he interpreted as a proof of Lorentz theory of stable ether and correspondingly refutation of Hertz concept of moving ether and correspondingly uselessness of total time derivatives in Maxwell system.

We shall return to Eichenwald's experiments and their interpretation in Section 8. Here we just only repeat the assertion formulated above : total time derivatives are useful not only for description of moving ether but in the case of stable ether as well. With their help we not only naturally introduce conductivity current but obtain curl current in addition. We shall see that this current is very essential for explanation of many electrodynamic phenomena.

But this or that way the fact is that concept of total time derivatives was buried and relativistic approach triumphed. Hydrodynamically this meant that media and particles in this media movement were taken into account not with the help of convective derivative but with the Voigt method : coming to moving reference frame.

Everything said above helps us to go to mathematical side of the problem. System (1.8)-(1.11) is not Halileo invariant because partial time derivative in (2.13) does not conserve $\mathbf{r}$ and $\mathbf{r}'$ but conserves velocity $\mathbf{u}$. Therefore it is impossible to obtain equality in (1.9) and (1.11) for moving media and it is necessary to use Voigt-Lorentz method which gives us the desired result "scratching left ear with right hand".

Let us show that system (2.2)-(2.5) is Halileo invariant (and certainly Lorentz non-invariant). Not to forget let us mention that system (2.2)-(2.5) is non-linear and generally speaking it does not satisfy superposition principle. But we shall not go too far with this question and postpone it for a separate talk. Let us come to mathematics. We shall do this following Phipps Jr. [13]

Electric and Magnetic fields

$$\mathbf{E} = \mathbf{E}(x_1, x_2, x_3, t) \tag{2.14}$$

$$\mathbf{B} = \mathbf{B}(x_1, x_2, x_3, t) \tag{2.15}$$

How derivatives in primed and unprimed system are connected if (2.13) is valid ? We are going to show, that

$$grad' = grad\ , \ \frac{d}{dt'} = \frac{d}{dt} + (\mathbf{u} \cdot grad) \tag{2.16}$$

Really one obtains using the chain rule :

$$\frac{d}{dx_1} = \frac{dx_1'}{dx_1}\frac{d}{dx_1'} + \frac{dx_2'}{dx_1}\frac{d}{dx_2'} + \frac{dx_3'}{dx_1}\frac{d}{dx_3'} + \frac{dt'}{dx_1}\frac{d}{dt'} = \frac{d}{dx_1'} \tag{2.16a}$$

One obtains after repeating the procedure for other coordinates

$$grad' = grad\ , \tag{2.17}$$

if (2.13) is valid.

Similarly, since $x_1' = x_1 - u_{x_1} t$, $\dfrac{\partial x_1'}{\partial t} = -\mathbf{u}_{x_1}$ etc, we have

$$\frac{\partial}{\partial t} = \frac{\partial}{\partial t'} - (\mathbf{u} \cdot grad') = \frac{\partial}{\partial t'} - (\mathbf{u} \cdot grad) \qquad (2.18)$$

One can see that traditional Maxwell system (1.8)-(1.11) is not invariant under Galilean transformation. For instance, additional item $\mathbf{u} \cdot grad$ appears in the right hand part of (1.9) when we have come to another inertial system moving with constant velocity $\mathbf{u}$ and this item is not compensated in the left hand part of (1.9). In today physics the problem was solved by Lorentz transformation usage. Identity (2.6) shows that this problem disappears if total time derivative is used : additional items are annihilated.

Vector $\mathbf{v}$ in (2.6) is interpretated by us as charge velocity. It appears even in immovable media, i.e. in the fixed frame reference. And it remains invariant if we come to another inertial frame moving with constant velocity $\mathbf{u}$. It this case (2.6) will look as follows

$$\frac{d\mathbf{E}}{dt} = ((\mathbf{u} + \mathbf{v}) \cdot grad)\mathbf{E} - (\mathbf{u} \cdot grad)E + \frac{\partial \mathbf{E}}{\partial t} = (\mathbf{v} \cdot grad)\mathbf{E} + \frac{\partial \mathbf{E}}{\partial t} \quad (2.19)$$

But we cannot agree with the mr. Phipps' idea that field equations must include sink or detector velocity. Another charge plays role of sink or detector. How this sinking and detection takes place must de defined by special additional postulate and can not be obtained from the equations describing fields originated by one charge. Therefore we can not obtain charges' interaction formulas (either Lorentz or any other) from Maxwell equations. Formula (2.1) is just such an axiom which describes "source" and "sink" interaction. The following paragraphs will be devoted to its revealing.

The right hand part of (2.4) must be pseudoscalar just on purely mathematical reasoning. But what is physical essence of this demand ?

It will be shown in Appendix 1 that dielectric constant ε_0 means free ether mass density and magnetic constant μ_0 means free ether compressibility. Therefore it is more natural to say not only about light velocity but about the whole coefficient $\frac{1}{\varepsilon_0 c}$, i.e about free ether impedance.

Equality $c^2 = \frac{1}{\varepsilon_0 \mu_0}$ means that we can write $\sqrt{\frac{\mu_0}{\varepsilon_0}}$ instead of $\frac{1}{\varepsilon_0 c}$. Thus magnetic field divergence is free ether impedance proportional in contrast to electric field divergence which is ε_0 inverse and does not depend on μ_0. Pseudoscalar character of $\sqrt{\frac{\mu_0}{\varepsilon_0}}$ coefficient means that we must take radical sign minus in the right hand part of (2.4) if we use right hand coordinate triple and plus in the opposite case. The only explanation of this fact which I can imagine is that ether polarization is manifested when magnetic field extends. And this polarization makes left hand and right hand rotations non-equivalent. This non-equivalence does not influence electric field divergence. The situation is vise versa for rotational parts of the fields : ether polarization influence electric field and does not influence magnetic field.

3. Field Formula.

Equations (2.2)-(2.5) define in differential form the fields $\mathbf{E}$ and $\mathbf{B}$ originated by moving charges. They are just the fields one needs in order to use formula (2.1).

Mathematically, the system (2.2)-(2.5) dissociates into two groups. Equations (2.3) and (2.5) define the $\mathbf{E}$ and $\mathbf{B}$ which are their solutions. And this is enough : in order to find two vector-functions $\mathbf{E}$ and $\mathbf{B}$ we need only two vector equations, not more, and not less. But system (2.2)-(2.5) contains two scalar (divergent) equations in addition. Does this mean that system (2.2)-(2.5) is overdetermined ? Accurate analyses shows that correlations (2.2) and (2.4) are actually initial conditions for $\mathbf{E}$ and $\mathbf{B}$, i.e. (2.2) and (2.4) may be rewritten :

$$\mathbf{E}(0,\mathbf{r}) = \frac{\rho}{3\varepsilon_0}\mathbf{r} \tag{3.1}$$

$$\mathbf{B}(0,\mathbf{r}) = -\frac{\rho}{3\varepsilon_0 c}\mathbf{r} \tag{3.2}$$

$$div\mathbf{E}(0,\mathbf{r}) = \frac{\rho}{\varepsilon_0} + \frac{1}{3\varepsilon_0} grad\rho \cdot \mathbf{r} \tag{3.3}$$

$$div\mathbf{B}(0,\mathbf{r}) = -\frac{\rho}{\varepsilon_0 c} - \frac{1}{3\varepsilon_0 c} grad\rho \cdot \mathbf{r} \tag{3.4}$$

We assumed above that charge q was evenly distributed in a ball of radius r_0, i.e.

$$\mathrm{grad}\,\rho = 0 \tag{3.4a}$$

We has come to (2.2) and (2.4). One can verify that (2.2) and (2.5) imply that

$$\frac{\mathrm{d}\rho}{\mathrm{dt}} = \frac{\partial\rho}{\partial \mathrm{t}} + \mathbf{v}\cdot\mathrm{grad}\rho = 0 \tag{3.5}$$

In other terms our assumption concerning ρ yields in addition that partial time derivative

$$\frac{\partial\rho}{\partial t} = 0 \tag{3.6}$$

We also assume that $\mathbf{v}$ is independent with respect to spatial coordinates, i.e.

$$\mathbf{v} = \mathbf{v}(t) \tag{3.7}$$

Under conditions (3.4a)-(3.7) one can find a partial solution of (2.2)-(2.5). This is

$$\mathbf{E} = \frac{\rho}{3\varepsilon_0}\left[-\frac{(\mathbf{r}\times\mathbf{v})}{c}+\mathbf{r}\right] \tag{3.8}$$

$$\mathbf{B} = -\frac{\rho}{3\varepsilon_0 c}\left[\frac{(\mathbf{r}\times\mathbf{v})}{c}+\mathbf{r}\right] \tag{3.9}$$

where $\mathbf{r}$ is radius-vector from the charge into the observation point. Let us verify (3.8) and (3.9) by direct substitution and show that they are really solutions of the modified Maxwell's equations (2.2)-(2.5)

$$\mathrm{div}\mathbf{E} = \frac{\mathrm{grad}\rho}{3\varepsilon_0}\left[-\frac{(\mathbf{r}\times\mathbf{v})}{c}+\mathbf{r}\right]+\frac{\rho}{3\varepsilon_0}\mathrm{div}\left[-\frac{(\mathbf{r}\times\mathbf{v})}{c}+\mathbf{r}\right]=\frac{\rho}{\varepsilon_0} \tag{3.10}$$

Just in the same way

$$\mathrm{div}\mathbf{B} = -\frac{\rho}{\varepsilon_0 c} \tag{3.11}$$

Let us calculate left and right handed parts of (2.3)

$$\varepsilon_0\frac{d}{dt}\mathbf{B} = -\frac{1}{3}\frac{d\rho}{dt}\left[\frac{\mathbf{r}\times\mathbf{v}}{c^2}+\frac{\mathbf{r}}{c}\right]-\frac{\rho}{3c}\left[\frac{\mathbf{v}\times\mathbf{v}}{c}+\frac{\mathbf{r}\times\mathbf{a}}{c}+\mathbf{v}\right]=$$

$$= -\frac{\rho}{3c}\left[\frac{\mathbf{r}\times\mathbf{a}}{c}+\mathbf{v}\right] \tag{3.12}$$

In the text below we assume that the first item in the last expression here is zero, i.e. we assume that either radius-vector is perpendicular to acceleration **a** or the very **a** is zero, i.e. the velocity is constant. One obtains finally

$$\frac{d}{dt}\mathbf{B} = -\frac{\rho\mathbf{v}}{3c\varepsilon_0} \tag{3.13}$$

On the other hand

$$\varepsilon_0 \operatorname{rot}\mathbf{E} = \frac{1}{2}\left\{ \operatorname{grad}\frac{\rho}{3} \times \left[-\frac{\mathbf{r}\times\mathbf{v}}{c} + \mathbf{r} \right] + \right.$$
$$\left. + \frac{\rho}{3c}\left[-(\mathbf{v}\cdot\operatorname{grad})\mathbf{r} + (\mathbf{r}\cdot\operatorname{grad})\mathbf{v} - (\operatorname{div}\mathbf{v})\mathbf{r} + (\operatorname{div}\mathbf{r})\mathbf{v} \right] \right\} = +\frac{\rho\mathbf{v}}{3c} \tag{3.14}$$

Here we assumed definition of *rot* as one half of the corresponding derivatives adopted in Russian Mathematical Encyclopedia [27]. If *rot* is defined without this "one half" denominator 2 appears in vector product items in (3.8) and (3.9). Equations (2.5) is verified in the same way.

4. The Final Correlation.

Let us write down the items appering in the formula (2.1) in explicit form

1. $\mathbf{B}_{12}=-\dfrac{q_1}{4\pi\varepsilon_0 r^3 c}\Big[\dfrac{\mathbf{r}_{12}\times\mathbf{v}_1}{c}+\mathbf{r}_{12}\Big]=\dfrac{q_1}{4\pi\varepsilon_0 r^3 c}\Big[\dfrac{\mathbf{r}_{21}\times\mathbf{v}_1}{c}+\mathbf{r}_{21}\Big]$

2. $\mathbf{E}_{21}=\dfrac{q_2}{4\pi\varepsilon_0 r^3}\Big[-\dfrac{\mathbf{r}_{21}\times\mathbf{v}_2}{c}+\mathbf{r}_{21}\Big]$

Let us find these fields' scalar product gradient

3. $-\mathbf{B}_{12}\cdot\mathbf{E}_{21}=\dfrac{q_1 q_2}{16\pi^2\varepsilon_0^2 r^6 c}\Big[\dfrac{(\mathbf{r}_{21}\times\mathbf{v}_1)\cdot(\mathbf{r}_{21}\times\mathbf{v}_2)}{c^2}-r^2\Big]$

$$-\,grad[4\pi\varepsilon_0 r^3 c(\mathbf{B}_{12}\cdot\mathbf{E}_{21})]=$$

4. $=\dfrac{q_1 q_2}{4\pi\varepsilon_0 r^3}\Big[\mathbf{r}_{21}-\dfrac{3\mathbf{r}_{21}((\mathbf{r}_{21}\times\mathbf{v}_1)\cdot(\mathbf{r}_{21}\times\mathbf{v}_2))}{r^2c^2}+$

$$+\frac{\mathbf{v}_1\times(\mathbf{r}_{21}\times\mathbf{v}_2)+\mathbf{v}_2\times(\mathbf{r}_{21}\times\mathbf{v}_1)}{c^2}\Big]$$

Now the second item in (1.1) is found

5. $\mathbf{B}_{21}=-\dfrac{q_2}{4\pi\varepsilon_0 r^3 c}[\dfrac{\mathbf{r}_{21}\times\mathbf{v}_2}{c}+\mathbf{r}_{21}]$

6. $\mathbf{B}_{12}=\dfrac{q_1}{4\pi\varepsilon_0 r^3 c}\Big[\dfrac{\mathbf{r}_{21}\times\mathbf{v}_1}{c}+\mathbf{r}_{21}\Big]$

7. $4\pi\varepsilon_0 r^3 c(\mathbf{B}_{12}\times\mathbf{B}_{21})=$

$$=\frac{q_1 q_2}{4\pi\varepsilon_0 r^3 c}\Big[\frac{(\mathbf{r}_{21}\times\mathbf{v}_2)\times(\mathbf{r}_{21}\times\mathbf{v}_1)}{c^2}+\mathbf{r}_{21}\times\frac{\mathbf{r}_{21}\times(\mathbf{v}_1-\mathbf{v}_2)}{c}\Big]$$

Radius-vector time derivatives

$$\frac{d\mathbf{r}_{21}}{dt}=\mathbf{v}_1-\mathbf{v}_2,\qquad\qquad \frac{d^2\mathbf{r}_{21}}{dt^2}=\mathbf{a}_1-\mathbf{a}_2.$$

If the problem conditions not essentially depend on the signal retardation the derivatives are calculated at the time t. If this is essential the derivatives are calculated at the previous time $\tau = t - \frac{r}{c_0}$.

The second term in (1.1) looks as follows

8. $$\frac{d}{dt}[4\pi\varepsilon_0 r^3 c(\mathbf{B}_{12} \times \mathbf{B}_{21})] =$$
$$= \frac{q_1 q_2}{4\pi\varepsilon_0 r^3 c^2}\Big\{-[(\mathbf{v}_1 - \mathbf{v}_2) \times (\mathbf{r}_{21} \times (\mathbf{v}_1 - \mathbf{v}_2))] -$$
$$- \frac{3\mathbf{r}_{21} \cdot (\mathbf{v}_1 - \mathbf{v}_2)}{\mathbf{r}^2}[\mathbf{r}_{21} \times (\mathbf{r}_{21} \times (\mathbf{v}_1 - \mathbf{v}_2))] +$$
$$+ \mathbf{r}_{21} \times [\mathbf{r}_{21} \times (\mathbf{a}_1 - \mathbf{a}_2)] + \frac{(\mathbf{v}_1 \times \mathbf{v}_2) \times [(\mathbf{r}_{21} \times \mathbf{v}_1) - (\mathbf{r}_{21} \times \mathbf{v}_2)]}{c} +$$
$$+ \frac{[(\mathbf{r}_{21} \times \mathbf{v}_2) \times (\mathbf{r}_{21} \times \mathbf{a}_1) - (\mathbf{r}_{21} \times \mathbf{v}_1) \times (\mathbf{r}_{21} \times \mathbf{a}_2)]}{c} -$$
$$- \frac{3\mathbf{r}_{21} \cdot (\mathbf{v}_1 - \mathbf{v}_2) \cdot [(\mathbf{r}_{21} \times \mathbf{v}_2) \times (\mathbf{r}_{21} \times \mathbf{v}_1)]}{r^2 c}\Big\}$$

Finally one obtaines : the force with which the second charge acts on the first one is

$$\begin{aligned}
\mathbf{F}_{21} &= \frac{q_1 q_2}{4\pi\varepsilon_0 r^3}\mathbf{r}_{21} + \\
&+ \frac{q_1 q_2}{4\pi\varepsilon_0 r^3 c^2}\Big\{[\mathbf{v}_1 \times (\mathbf{r}_{21} \times \mathbf{v}_2) + \mathbf{v}_2 \times (\mathbf{r}_{21} \times \mathbf{v}_1) - \\
&- \frac{3\mathbf{r}_{21}}{r^2}((\mathbf{r}_{21} \times \mathbf{v}_1) \cdot (\mathbf{r}_{21} \times \mathbf{v}_2))] + [(\mathbf{v}_1 - \mathbf{v}_2) \times (\mathbf{r}_{21} \times (\mathbf{v}_1 - \mathbf{v}_2)] - \\
&- \frac{3\mathbf{r}_{21} \cdot (\mathbf{v}_1 - \mathbf{v}_2)}{r^2} \cdot [\mathbf{r}_{21} \times (\mathbf{r}_{21} \times (\mathbf{v}_1 - \mathbf{v}_2))] + [\mathbf{r}_{21} \times (\mathbf{r}_{21} \times (\mathbf{a}_1 - \mathbf{a}_2))] + \\
&+ \frac{(\mathbf{v}_1 \times \mathbf{v}_2) \times [(\mathbf{r}_{21} \times \mathbf{v}_1) - (\mathbf{r}_{21} \times \mathbf{v}_2)]}{c} + \\
&+ \frac{[(\mathbf{r}_{21} \times \mathbf{v}_2) \times (\mathbf{r}_{21} \times \mathbf{a}_1) - (\mathbf{r}_{21} \times \mathbf{v}_1) \times (\mathbf{r}_{21} \times \mathbf{a}_2)]}{c} - \\
&- \frac{3\mathbf{r}_{21} \cdot (\mathbf{v}_1 - \mathbf{v}_2) \cdot [(\mathbf{r}_{21} \times \mathbf{v}_1) \times (\mathbf{r}_{21} \times \mathbf{v}_2)]}{r^2 c}\Big\}
\end{aligned} \qquad (4.1)$$

Revealing triple vector products one obtains another expression for the same force

$$\mathbf{F}_{21} = \frac{q_1 q_2}{4\pi\varepsilon_0 r^3}\mathbf{r}_{21} + \frac{q_1 q_2}{4\pi\varepsilon_0 r^3 c^2}\cdot$$
$$\cdot\{[\mathbf{r}_{21}(\mathbf{v}_1\cdot\mathbf{v}_2) - \mathbf{v}_1(\mathbf{r}_{21}\cdot\mathbf{v}_2) - \mathbf{v}_2(\mathbf{r}_{21}\cdot\mathbf{v}_1) +$$
$$+\frac{3\mathbf{r}_{21}}{r^2}\cdot((\mathbf{r}_{21}\cdot\mathbf{v}_1)\cdot(\mathbf{r}_{21}\cdot\mathbf{v}_2))] +$$
$$+[\mathbf{r}_{21}(\mathbf{v}_1-\mathbf{v}_2)^2 - (\mathbf{v}_1-\mathbf{v}_2)\cdot(\mathbf{r}_{21}\cdot(\mathbf{v}_1-\mathbf{v}_2))] - \tag{4.2}$$
$$-\frac{3\mathbf{r}_{21}(\mathbf{v}_1-\mathbf{v}_2)}{r^2}[\mathbf{r}_{21}(\mathbf{r}_{21}\cdot(\mathbf{v}_1-\mathbf{v}_2)) - (\mathbf{v}_1-\mathbf{v}_2)r^2] +$$
$$+[\mathbf{r}_{21}(\mathbf{r}_{21}\cdot(\mathbf{a}_1-\mathbf{a}_2)) - (\mathbf{a}_1-\mathbf{a}_2)r^2] +$$
$$+\frac{(\mathbf{v}_2-\mathbf{v}_1)\cdot(\mathbf{r}_{21}\cdot(\mathbf{v}_1\times\mathbf{v}_2))}{c} + \frac{\mathbf{r}_{21}[(\mathbf{r}_{21}\times\mathbf{v}_2)\cdot\mathbf{a}_1 - (\mathbf{r}_{21}\times\mathbf{v}_1)\cdot\mathbf{a}_2]}{c} +$$
$$+\frac{3\mathbf{r}_{21}[\mathbf{r}_{21}\cdot(\mathbf{v}_1-\mathbf{v}_2)]\cdot[\mathbf{r}_{21}\cdot(\mathbf{v}_1\times\mathbf{v}_2)]}{r^2 c}\}$$

Let us find another form of the force (4.2) explicitely introducing the angles between the vectors.

Let

θ_1 be the angle between $\mathbf{r}_{21}$ and $\mathbf{v}_1$

θ_2 be the angle between $\mathbf{r}_{21}$ and $\mathbf{v}_2$

θ_3 be the angle between $\mathbf{r}_{21}$ and $\mathbf{v}_3$

θ_4 be the angle between $\mathbf{r}_{21}$ and $(\mathbf{v}_1 - \mathbf{v}_2)$

θ_5 be the angle between $\mathbf{r}_{21}$ and $(\mathbf{a}_1 - \mathbf{a}_2)$

θ_6 be the angle between $\mathbf{r}_{21}$ and $(\mathbf{v}_1 \times \mathbf{v}_2)$

θ_7 be the angle between $(\mathbf{r}_{21}\times\mathbf{v}_2)$ and $\mathbf{a}_1$

θ_8 be the angle between $(\mathbf{r}_{21}\times\mathbf{v}_1)$ and $\mathbf{a}_2$

The (4.2) looks as follows

$$
\begin{aligned}
&\mathbf{F_{21}} = \frac{q_1 q_2}{4\pi\varepsilon_0 r^3}\mathbf{r}_{21} + \frac{q_1 q_2}{4\pi\varepsilon_0 r^3 c^2}\cdot \\
&\cdot\{-[\mathbf{v}_2 v_1 r Cos\theta_1 + \mathbf{v}_1 v_2 r Cos\theta_2 + \\
&+\mathbf{r}_{21} v_1 v_2 (Cos\theta_3 + 3Cos\theta_1 Cos\theta_2)] + \\
&+[\mathbf{r}_{21}(\mathbf{v}_1 - \mathbf{v}_2)^2(1 - 3Cos^2\theta_4) + \\
&+2(\mathbf{v}_1 - \mathbf{v}_2) r \,|\, \mathbf{v}_1 - \mathbf{v}_2 \,|\, Cos\theta_4] + \qquad\qquad (4.3) \\
&+[\mathbf{r}_{21} r \,|\, \mathbf{a}_1 - \mathbf{a}_2 \,|\, Cos\theta_5 - (\mathbf{a}_1 - \mathbf{a}_2) r^{\mathbf{2}}] + \\
&+\frac{(\mathbf{v}_1 - \mathbf{v}_2) r v_1 v_2 Cos\theta_6 Sin\theta_3}{c} + \\
&+\frac{\mathbf{r}_{21}[r a_1 v_2 Sin\theta_2 Cos\theta_7 - r a_2 v_1 Sin\theta_1 Cos\theta_8]}{c} + \\
&+\frac{3\mathbf{r_{21}}\cdot((\mathbf{v}_1 - \mathbf{v}_1)\cdot(\mathbf{v}_1 \times \mathbf{v}_1)) Cos\theta_4 Cos\theta_6}{c}\}
\end{aligned}
$$

One can see that Neumann, Grassman, Ampere and Whittaker formulas mentioned in paragraph 1 are special cases of the formula (4.2) gradiental part. All they are terms in the first square brackets. Really (1.16a) is just the first item there, (1.16b) is the first and the third items, (1.16c) is the doubled first and the forth ones, (1.16d) is the first, the second and the third items. It is worth while to note that Grassman formula (1.16b) accurately coincides with Lorentz formula (1.16) when being integrated over current contour. It is understandable why all the above mentioned authors proposed terms from the first square bracket in (4.2) : they all experimented with current loops, i.e. with neutral currents for which as we shall see the second, third and forth square brackets in (4.2) are zero.

But Weber [27] somehow managed to come to the items in the second, the third and the forth brackets in (4.2). Perhaps he experimented just with charged currents but he came to the radial items in the brackets. The first square bracket coincides with New Gaussian formula (1.7) if time is calculated in accord with *universal time postulate*. In contrast to Weber formula it contains not only radial but directed along velocities' difference items.

Let us try to clarify the physical essence of the obtained formula. All the derivatives here are calculated with respect to the laboratory frame of reference.

Let us return to functions (3.8) and (3.9). The second terms in their right hand sides define static components that are manifested only for "nude charges". The first terms define dynamic components and they are manifested not only for charged currents but for neutral ones as well. This quality is inherited when these components are multiplied and when derivatives are calculated in formula (2.1). For instance the first item in (4.1)-(4.3) is obtained as a gradient of the static components' product. Therefore it is valid only for "nude charges" (Coulomb law). On the contrary the first square bracket is a result of dynamic components' product. So it is valid for neutral currents' as well. One can easily see that this square bracket is a symmetrization of the classical Lorentz force in such a way that it begins satisfying the third Newtonian law plus Ampere force.

The second square bracket in (4.1)-(4.3) is a product of dynamic and static components. So it is equal to zero between two neutral currents. It is valid if at least one of the currents is charged. This square bracket depends on the difference between charges velocities, and predicts all experimentally verified effects of Relativity Theory without "time dilation" and "space contraction". It also predicts a force produced on a "nude charge" at rest near current.

The third square bracket depends on the charges accelerations and describes field radiation. It is valid for all kinds of currents because the radiated field should be considered as a "nude" one. It often predicts the same result as classical theory but Example 2 in section 5 shows that it predicts no radiation for an electron rotating around positive charge.

The last three terms in braces are c^3 inverse. They are apparently essential in electro-weak interactions.

5. Examples.

Example 1. Let test charge q_1 be evenly distributed along the circumference of a circle of radius R_0 situated in the (x_1 x_2) plane with the center in the coordinate system origin. The charge q_2 is at rest in the center of the circle. The classical Lorentz formula and the formula (4.3) predict only a Coulomb force directed along the radius. Let q_2 move with constant velocity **v** along the x_1 axis. Today theory predicts that relativistic effects exist in this case. They are believed to change the Coulomb force magnitude but to preserve its radial character. This force is considered to be

$$F_{\mathbf{e}} = \frac{q_1 q_2}{4\pi\varepsilon_0 R_0^2} \cdot \frac{(1-\beta^2)}{(1-\beta^2 Sin^2\theta)^{3/2}}, \tag{5.1}$$

where $\beta = v/c$, θ is angel between **v**and radius-vector to q_1.

When β is small enough and it is possible to expand (5.1) in a series, one gets

$$F_{\mathbf{e}} = \frac{q_1 q_2}{4\pi\varepsilon_0 R_0^2} + \frac{q_1 q_2}{4\pi\varepsilon_0 R_0^2} \cdot \frac{\beta^2}{2}(1-3Cos^2\theta). \tag{5.1a}$$

When $\theta=0$, (5.1a) predicts Coulomb force multiplication by a factor $(1-\beta^2)$, i. e. force decrease. When $(1\text{-}3\cos^2\theta)=0$ (about 55^0 and 125^0) the second term in (5.1) is zero. Coulomb force acts on the points where additional force changes its sign. When $\theta=90^0$ (5.1a) predicts force factor $(1+\beta^2/2)$, i. e. common force increase. When β increases other terms in the series become essential expantion (5.1a) becomes incorrect and we must use (5.1).

Let us see predictions of the (4.3) formula. Only the second square bracket is nonzero in (4.3) for the case. Two forces are predicted by the bracket: radial force F_r and directed along velocity force $F_{v.}$

One obtains for the radial force:

$$F_r = \frac{q_1 q_2}{4\pi\varepsilon_0 R_0^2} + \frac{q_1 q_2}{4\pi\varepsilon_0 R_0^2} \cdot \beta^2 (1 - 3Cos^2\theta) \qquad (5.2)$$

One can see that (5.2) predicts qualitatively the same but twice greater result for small β in comparison with (5.1a). The difference with (5.1) in transverse direction ($\theta = 90^0$) decreases with β increase. When $\beta^2 = 3/4$ (5.1) is already bigger than (5.2). And when $\beta \to 1$, $F_e \to \infty$ and F_r approaches double the Coulomb force in the direction perpendicular to **v** ($\theta = 90^0$). Let us note that (5.2) is also valid when one of the currents is neutral (for instance q_1 is distributed in a neutral conductor).

The velocity force is

$$F_v = \frac{q_1 q_2}{4\pi\varepsilon_0 R_0^2} \cdot \beta^2 Cos\theta \qquad (5.3)$$

The force is maximum when θ=0 (longitudinal direction). When $\theta \in (0^0, 90^0)$, it decreases from $\beta^2 q^1 q^2 / 4\pi\varepsilon_0 R_0^2$ to zero and when $\theta \in (90^0, 180^0)$ it goes on decreasing from zero to $-\beta^2 q^1 q^2 / 4\pi\varepsilon_0 R_0^2$. The overall force produced on a charged circumference is the sum

$$\mathbf{F_k} = \mathbf{F_{v+}} \mathbf{F_r} \qquad (5.4)$$

$\mathbf{F_v}$ originates tangential to the circumferential force. If q_2 is a negative charge and the circumference is a neutral conductor free electrons gather in the region where the circumference crosses x_1 axis. Correspondingly the x_3 and the circumference intersection is charged positevly. This charging goes on until the mechanical moment due to the Coulomb force equilibrates the moment transferred to the system by the external forces that give velocity **v** to the charge (see details in section 10). If velocity of charge q_2 is not constant, i. e. q_2 moves with acceleration **a**, an additional force (the third square bracket in (4.3)) is produced on circumferential charges. Its magnitude is

$$F_a = \frac{q_1 q_2 a}{4\pi\varepsilon_0 c^2 R_0^2} \cdot Sin\theta \qquad (5.4a)$$

If velocity and acceleration direction coincide, then this force is maximal on the intersection of the circumference and the x_3 axis ($\theta = 90^0$). It decreases not changing its sign on the intervals $(90^0,0^0)$, $(90^0,180^0)$. One can compare it with $\mathbf{F_v}$ force which decreases on the $(0^0,180^0)$ interval and has different signs on the mentioned intervals.

Some deductions :

1. Formula (4.3) predicts two (or in the case of accelerated movement - three) forces produced on a test charge.

2. The acceleration force coincides with the classical one. The radical force is close to relativity theory predictions in a wide range of velocities. But the velocity force is not predicted by to-day electrodynamics and may be used for experimental verification of the proposed scheme.

Example 2. Let positive charge q_2 be at rest, i.e. $\mathbf{v}_2$=0, $\mathbf{a}_2$=0. A negative charge q_1 rotates around q_2 with constant velocity $\mathbf{v}_1$ and correspondingly with constant centripetal acceleration $\mathbf{a}_1$. What effects does (4.3) predict?

The first square bracket in (4.3) is zero because $\mathbf{v}_2 = 0$. The third square bracket is zero because $\mathbf{a}_1$ is parallel to $\mathbf{r}_{21}$ (One can see this especially clearly in (4.1)), $\theta_4 = 90^0$, i.e. $\cos\theta_4 = 0$.

One gets finally

$$\mathbf{F}_{21} = \frac{q_1 q_2}{4\pi\varepsilon_0 r^3}\mathbf{r}_{21} + \frac{q_1 q_2 \mathbf{v}_1^2}{4\pi\varepsilon_0 r^3 c^2}\mathbf{r}_{21} \qquad (5.5)$$

Formula (5.5) predicts no force produced on q_1 because of centripetal acceleration, hence q_1 does not radiate. Such radiation takes place only if q_1 is tangentially accelerated .

(5.5) predicts radial force that "helps" the Coulomb one. This force leads to orbit rotation as a unit (pericenter shift) in the case of elliptic orbit. It is just an accurate analogue to the case of the planets orbits periceter shift in gravity.

Example 3. Let charge q_1 and q_2 of the same sign move along parallel straight lines with equal constant velocities, i.e. $\mathbf{v}_1 = \mathbf{v}_2 = \mathbf{v}$, $\theta_1 = \theta_2 = \theta_1$, $\cos\theta_3=1$ and only the first bracket is nonzero

$$\mathbf{F}_{21} = \frac{q_1 q_2}{4\pi\varepsilon_0 r^3}\mathbf{r}_{21} - \frac{q_1 q_2 v^2 (1-3Cos^2\theta)}{4\pi\varepsilon_0 r^3 c^2}\mathbf{r}_{21} - \frac{2q_1 q_2 v Cos\theta}{4\pi\varepsilon_0 r^2 c^2}\mathbf{v} \tag{5.6}$$

Force (5.6) implies that in addition to the Coulomb force (the first term) the radial force $\mathbf{F_r}$ directed along radius $\mathbf{r}$ and the force $\mathbf{F_v}$ directed along velocity (the third term) are produced on charge 1.

When $(1-3\cos^2\theta)=0$ (approximately 55^0 and 125^0), the radial force $\mathbf{F_r}$ is zero. When $\theta\in[0,55^0)$ and $\theta\in(125^0,180^0]$ $\mathbf{F_v}$ is positive and "helps" the Coulomb force. When $\theta\in(55^0,125^0)$ it is negative and "weakens" the Coulomb force. The velocity force is equal to zero when $\theta=90^0$, i.e. charges fly "side by side". When $\theta\in(180^0,90^0)$ (the first charge is behind the second one), $\mathbf{F_v}$ is directed along the first charge velocity and accelerates it (the second charge "helps" its partner to fly). When $\theta\in(90^0,0^0)$ (the first charge is before the second one) $\mathbf{F_v}$ is directed against the first charge velocity (the second charge brakes the first one movement). An equal and oppositely directed force is produced on the second charge. So the equilibrium point for the charge is going "side by side".

If there are two beams instead of two separate charges velocity force $\mathbf{F_v}$ separates the beams into clusters which strive to move “side by side”. We observe “cluster effect”. Force $\mathbf{F_r}$ weakens Coulomb force between such clusters.

6. Charge 2 is Evenly Distributed along an Infinite Straight Line.

Let q_2 be distributed with constant density λ along the x_3 axis. This means that boundary conditions (2.2) and (2.4) must be changed. We assume that initial condition (2.2) is

$$div\mathbf{E_2} = +\frac{\lambda}{2\pi\varepsilon_0 r^2}, r > r_0 \tag{6.1}$$

where $r = \sqrt{x_1^2 + x_2^2}$, r_0- is wire radius, $r > r_0$.

$$E_2 = -\frac{\lambda}{2\pi\varepsilon_0 r}$$

Instead of the item 2 of Section 4 one obtains

$$\mathbf{E}_{21} = \frac{\lambda}{2\pi\varepsilon_0 r^2}\left[\frac{\mathbf{r}_{21} \times \mathbf{v}_2}{c} - \mathbf{r}_{21}\right]$$

In the same way

$$\mathbf{B}_{21} = -\frac{\lambda}{2\pi\varepsilon_0 r^2 c}\left[\frac{\mathbf{r}_{21} \times \mathbf{v}_2}{c} + \mathbf{r}_{21}\right]$$

If the calculations of Section 4 are repeated for the charge q_1 one gets

$$\begin{aligned}
\mathbf{F_{21}} &= \frac{q_1\lambda}{2\pi\varepsilon_0 r^2}\mathbf{r_{21}} - \frac{q_1\lambda}{2\pi\varepsilon_0 r^2 c^2}\cdot \\
&\cdot\{[((\mathbf{v}_1 \cdot \mathbf{v}_2) + \frac{2(\mathbf{r_{21}} \cdot \mathbf{v}_1)(\mathbf{r_{21}} \cdot \mathbf{v}_2) - (\mathbf{r_{21}} \cdot \mathbf{v}_1)(\mathbf{r_{21}} \cdot \mathbf{v}_2)}{r^2})\mathbf{r_{21}} - \\
&- \mathbf{v}_1(\mathbf{r_{21}} \cdot \mathbf{v}_2) - \mathbf{v}_2(\mathbf{r_{21}} \cdot \mathbf{v}_1)] + [(\mathbf{v}_1 - \mathbf{v}_2) \times (\mathbf{r_{21}} \times (\mathbf{v}_1 - \mathbf{v}_2))] - \\
&- \frac{2\mathbf{r_{21}} \cdot (\mathbf{v}_1 - \mathbf{v}_2)}{r^2}[\mathbf{r_{21}} \times (\mathbf{r_{21}} \times (\mathbf{v}_1 - \mathbf{v}_2))] + \\
&+ [\mathbf{r_{21}} \times (\mathbf{r_{21}} \times (\mathbf{a_1} - \mathbf{a}_2))]\}
\end{aligned} \tag{6.2}$$

Let us assume that the charged straight wire (axis x_3) does not move as a unit, i.e. $\mathbf{v}_2 = 0$, $\mathbf{a}_2 = 0$, so $\mathbf{r}_{21} \cdot \mathbf{v}_2 = 0$, $\mathbf{r}_{21} \cdot \mathbf{a}_2 = 0$. And let us reveal the triple vector product in (6.2) taking this condition into account

$$\mathbf{F_{21}} = \frac{q_1 \lambda}{2\pi\varepsilon_0 r^2}\mathbf{r}_{21} -$$

$$- \frac{q_1 \lambda}{2\pi\varepsilon_0 r^2 c^2}\left\{\left[v_1 v_2 \cos\theta_3 \mathbf{r}_{21} - \mathbf{v}_2 r v_1 \cos\theta_1 \mathbf{v}_2\right] + \right. \tag{6.3}$$

$$+[(\mathbf{v}_1 - \mathbf{v}_2)^2 \cdot (1 - 2\cos^2\theta_4)]\mathbf{r}_{21} - [2r|\mathbf{v}_1 - \mathbf{v}_2|\cos\theta_4](\mathbf{v}_1 - \mathbf{v}_2) +$$

$$\left. + [r a_1 \cos\theta_5 \mathbf{r}_{21} - (\mathbf{a}_1 - \mathbf{a}_2) r^2]\right\}$$

Let us note that the first square bracket in (6.3) coincides with dynamic part of traditional Lorentz force if magnetic field of a charged straight line (charged wire) is revealed with respect to charges' velocities creating it.

7. More Examples.

Example 1. Let charge q_1 move parallel to x_3 with the same velocity as charge q_2 along x_3, i.e. $\mathbf{v}_1 = \mathbf{v}_2 = \mathbf{v}$.

All the square brackets in (6.4) are equal to zero except the first one in which $\cos\theta_1 = 0, \cos\theta_3 = 1$. One obtains finally

$$\mathbf{F}_{21} = \frac{q_1\lambda}{2\pi\varepsilon_0 r^2}\mathbf{r}_{21} - \frac{q_1\lambda v^2}{2\pi\varepsilon_0 r^2 c^2}\mathbf{r}_{21} \tag{7.1}$$

This formula coincides with Lorentz formula predictions.

Example 2. In the previous Example 1, let $\mathbf{v}_1 = -\mathbf{v}_2 = \mathbf{v}$, i.e. q_1 moves antiparallel to the charges in the wire. The first and the second square brackets in (6.3) are nonzero for the case, $\cos\theta_1 = 0, \cos\theta_3 = -1$

$$\mathbf{F_{21}} = \frac{q_1\lambda}{2\pi\varepsilon_0 r^2}\mathbf{r}_{21} + \frac{q_1\lambda v^2}{2\pi\varepsilon_0 r c^2} \tag{7.2}$$

again we have got coincidence with classic case.

Example 3. Let the first charge moves perpendicular to the x_3 axis from it along radius-vector. The first two square brackets are nonzero in (6.3), $\cos\theta_1 = 1, \cos\theta_3 = 0, \cos\theta_4 = \cos\theta_1 = 1$. The force produced on q_1 is

$$\begin{aligned}\mathbf{F_{21}} &= \frac{q_1\lambda}{2\pi\varepsilon_0 r^2}\mathbf{r}_{21} - \frac{q_1\lambda(\mathbf{v}_1 - \mathbf{v}_2)^2}{2\pi\varepsilon_0 r^2 c^2}\mathbf{r}_{21} - \\ &- \frac{2q_1\lambda|\mathbf{v}_1 - \mathbf{v}_2|}{2\pi\varepsilon_0 c^2 r}(\mathbf{v}_1 - \mathbf{v}_2) + \frac{q_1\lambda v_1}{2\pi\varepsilon_0 r c^2}\mathbf{v}_2\end{aligned} \tag{7.3}$$

The last two items here are not predicted by the Lorentz formula. Let us investigate the physical sense of them more accurately for the case when charges' velocity in the beam $\mathbf{v}_2$ is much less than the velocity of the separate charge $\mathbf{v}_1$, i.e $\mathbf{v}_1 >> \mathbf{v}_2$.

Then the force

$$\mathbf{F_k} = -\frac{q_1\lambda}{2\pi\varepsilon_0 r^2}\{\mathbf{r}_{21} - \frac{q_1\lambda\mathbf{v}_1^2}{2\pi\varepsilon_0 r^2 c^2}\mathbf{r}_{21} - \frac{q_1\lambda v_1}{\pi\varepsilon_0 r c^2}\mathbf{v}_1\} \quad (7.3a)$$

But $\mathbf{r}_{21}$ and $\mathbf{v}_1$ are parallel. Therefore one obtains in the case : if $\mathbf{v}_1 >> \mathbf{v}_2$ the force (7.3a) is directed along radius and

$$\mathbf{F}_{21} = \frac{q_1\lambda(1-3\beta^2)}{2\pi\varepsilon_0 r^2}\mathbf{r}_{21} \quad (7.3b)$$

where $\beta^2 = \mathbf{v}_1^2/c^2$. Let us note that when $\mathbf{v}_1^2 = c^2/3$ force (7.3b) changes its sign, i.e. when velocity $\mathbf{v}_1$ is big enough repulsion of the charges of the same sign changes for attraction.

Example 4. Let $\lambda\mathbf{v}_2$ be a steady neutral current and “nude” charge q_1 be at rest, i.e. $\mathbf{v}_1 = \mathbf{a}_1 = 0$ in laboratory reference frame. Traditional theory predicts no force produced on q_1 but the second square bracket in (6.3) is nonzero, and it predicts

$$\mathbf{F}_{21} = -\frac{3q_1\lambda v_2}{2\pi\varepsilon_0 r^2 c^2}\mathbf{r}_{21} \quad (7.4)$$

(7.3) and (7.4) may be used for experimental verification of the proposed theory. Electrons’ velocity in conductors are small. Therefore in order to verify (7.4) it is more convenient to use a beam of rapid charges and to observe electrons’ behaviour in a conductor.

8. Charged Plane.

Let plane (x_1, x_2) is charged with density σ. Generally speaking these charges can move with velocity $\mathbf{v_2}$ and acceleration $\mathbf{a_2}$. Static part of the electric field satisfying the initial condition

$$div\mathbf{E_2}\,|_{x_3=0} = 0 \tag{8.1}$$

looks as follows

$$E_2 = \frac{\sigma}{2\varepsilon}, \tag{8.2}$$

and electric field created by the charged plane in the vicinity of the charge q_1 is

$$\mathbf{E_{21}} = \frac{\sigma}{2\varepsilon r}[-\frac{\mathbf{r_{21}} \times \mathbf{v}_2}{c} + \mathbf{r_{21}}] \tag{8.3}$$

where $\mathbf{v}_2$ is the charges velocity on the plane.
$\mathbf{r_{21}}$ here is radius-vector from plane (x_1, x_2) to the charge q_1.

Just in the same way

$$\mathbf{B_{21}} = \frac{-\sigma}{2\varepsilon rc}[\frac{\mathbf{r_{21}} \times \mathbf{v_2}}{c} + \mathbf{r_{21}}] \tag{8.4}$$

The formula for the magnetic field of the passive charge q_1 is preserved:

$$\mathbf{B_{12}} = \frac{q_1}{4\pi\varepsilon r^3 c}[\frac{\mathbf{r_{21}} \times \mathbf{v_1}}{c} + \mathbf{r_{21}}] \tag{8.5}$$

Function $\varepsilon(x_1, x_2, x_3, t)$ that appears in (8.1)-(8.5) is assumed to be function of space and time coordinates here and not constant ε_0. It is shown in **Appendix 1** that ε_0 characterizes density of free ether. It is natural in our case to understand ε as ether density in substance. We are interested here in the analyses of the $\varepsilon(x_1, x_2, x_3, t)$ behaviour on borders between two substances and especially in the transition space between substance and free ether or to be more accurate in ε gradient function near static or moving bodies. Using $\varepsilon(x_1, x_2, x_3, t)$ instead of ε_0 we aim for taking into account the case when dielectric is introduced between the charged plane and q_1 or other charged plane. Thus we strive to investigate the cases, which are explained by the dielectrics polarization in to-day physics. The proposed theory links it with different ether density in different substances thus overcoming many problems of to-day theory of electric fields in medias.

We must take into account in addition that magnetic constant μ_0 which has meaning of free ether compressibility [Appendix 1] also becomes function of spatial and time coordinates $\mu(x_1, x_2, x_3, t)$. Light velocity in the matter $c^2 = \dfrac{1}{\varepsilon\mu}$ also turns to be function of spatial coordinates.

Taking into account that $\mu = \dfrac{1}{\varepsilon c^2}$ one obtains

$$
\begin{aligned}
&-grad[4\pi\varepsilon r^2 c(\mathbf{B}_{12}\cdot\mathbf{E}_{21})] = \\
&\frac{q_1\sigma}{2\varepsilon r}[\mathbf{r}_{12} + \frac{r^2 grad\varepsilon}{\varepsilon}] + \frac{\mu q_1\sigma}{2r}\cdot \\
&\cdot\left\{\left[\mathbf{2r}_{21}(\mathbf{v}_1\cdot\mathbf{v}_2) - \frac{(\mathbf{r}_{21}\times\mathbf{v}_1)\cdot(\mathbf{r}_{21}\times\mathbf{v}_2)}{r}\right] - \right. \\
&\left. -\mathbf{v}_1(\mathbf{r}_{21}\cdot\mathbf{v}_2) - \mathbf{v}_2(\mathbf{r}_{21}\cdot\mathbf{v}_1)\right\} + \\
&\frac{q_1\sigma}{2r} grad\mu[(\mathbf{r}_{21}\times\mathbf{v}_1)\cdot(\mathbf{r}_{21}\times\mathbf{v}_2)]
\end{aligned}
\tag{8.6}
$$

Peculiarity of (8.6) formula is that the second item in the first square bracket and the last item depend on the ether mass density and compressibility distribution in space. The gradiental item in the first bracket predicts appearance of force directed along ether density gradient. Therefore dielectric is drawn into capacitors: ether density ε_0 in hollow capacitor is lesser than ε in dielectric and charges has opposite signs on plates of the capacitor. This force grows with *r*: distance of q_1 from the charged plane. In the case of capacitor this means that force is bigger when the dielectric plate is thicker.

These effects are observed only when the charges are nude. It is well known that when dielectric is brought between capacitor's plates its capacity is enlarged or, this is the same, attraction strength between plates is lowered. What is this effect cause ?

To-day this effect is explained by “dielectrics’ polarization”. It is believed that molecular dipoles are shifted as a reaction to the external field action. Such a shift partly neutrolises the plates’ charge and weakens Coulomb force.

Let us investigate this problem in greater detailes, return to the views of the physicists in the 19 century and discuss Eichenwald’s experiments. They are believed to disprove Hertz electrodynamics including total time derivatives as it was mentioned in Section 2. At that time physicists believed in ether polarization between capacitor’s plates which led to the observed effects as they thought. They often say about one Eichenwald’s experiment although he set up a lot of experiments and many conclusions were deduced from his experiments. We shall consider some of them referring to our discussion.

Round capacitors’ plates were rotated in the first experiment. Induced magnetic field was measured. The experiment showed that such electrons’ movement creates the same magnetic field as their movement in conductor.

In the second experiment the same conductor with dielectric between plates was rotated. Such rotation created the same magnetic field as in the first experiment, i.e without dielectric.

In the third experiment capacitor’s plates were immovable but dielectric was rotated. Such rotation also induced magnetic field. Its direction did not change when the rotation direction changed but it changed when the plates were charged oppositely.

Let us consider the conclusions which were made from these experiments. These conclusions were incorporated into the base of modern physics.

It was concluded from the first experiment that any charge’s movement induces magnetic field. The second item in (2.6a) predicts this assertion. It is difficult not to agree with this assertion.

There was another question which excited physicists at that time. This was the problem of physical sense of bias current introduced by Maxwell into his equations in addition to conductivity current. Bias current was mathematically realized as electric field partial time derivative. Bias current was used to explain the fact that magnetic field does not end on one of the capacitor's plate but overcome the space between plates although electrons do not come from one plate to another.

The following explanation was proposed. Ether particles between the plates are polarized by the electric field and biased. This biasation creates conductivity in the ether which is manifested as electric field partial time derivative.

It is interesting that to-day physics denying ether actually preserved this explanation just as the very name of the current. And to-day it becomes completely ununderstandable why electric field changes independently of space coordinates and dependence on time manifests only between capacitor's plates and does not manifest along conductors and in substance.

But let us return to the first Eichenwald's experiment. If such a biasation of the ether particles takes place it must lessen the charge on the plates and correspondingly magnetic field created by rotating capacitor should be less than the magnetic field created by conductivity current. But the experiment showed complete coincidence.

Eichenwald himself [15] and some other scientists interpreted this fact as stability of ether and its polarized particles : capacitor's rotation does not carry along them.

It is impossible to understand nowadays how Eichenwald could come to such conclusion. Certainly it is difficult to come to any conclusion about behaviour of such a nonhabitual substance as ether on the base of only one experiment and Eichenwald's second experiment shows that ether containing in dielectric is carried along but the effect remains.

This way or another Eichenwald supported Lorentz theory of stable ether and declared that his experiment refutes Hertz's idea of moving ether. To-day one can hear very different interpretation as the very experiment as its interpretation by Eichenwald. Many educated persons assert that Eichenwald shows that it is prohibited to use total time derivatives in electrodynamics. Some very educated persons, for instance [13], believe that Eichenwald proves ether nonexistence but total time derivatives in electrodynamics are necessary.

Let us consider Phipps' monography [13] in greater details. I recommend the reader to read this book if possible. This is sum total of many years meditation on electrodynamics problems written by a very clever man with very keen insight. Therefore his even erroneous, as we believe, ideas characterize scatter coefficient in interpretation of Eichenwald's experiments.

Dr. Phipps is a supporter of the idea to introduce total time derivatives into Maxwell equations. He scropolously investigates how Hertz did this [13, p.24] : "He (Hertz) conceived of his theory…as describing an electrodynamics of "moving media," and interpreted his new velocity parameter (appearing in total time derivative) as ether velocity. This was a serious mistake, a false interpretation. He compounded that error by postulating a Stokesian ether 100% convected by pondarable matter. This made his theory testable, because it reified the ether-giving it "hooks" to observable matter…Soon after Hertz death an experimentalist, Eichenwald went into his laboratory and disconfirmed Hertz's predictions. The invariant theory was thus discredited and relegated to history's trash bin."

Such understanding of Eichenwald's experiments leads Dr.Phipps to negation of ether at all and to his semirelativistic theory although, we repeat, he insists on total time derivatives in electrodynamics.

We cite Dr.Phipps here only to illustrate that Eichenwald's experiments can be interpreted very differently and to propose our own interpretation. First of all let me express my deep conviction that the main problem of experimental physics during this millenium will be ascertaining of ether qualities. Therefore we cannot be completely sure declaring its qualities nowadays. Nevertheless we have certain foundation for conclusions.

We can not say for sure if ether is carried along in the first experiment. But we are sure that ether in dielectric is carried along with it because dielectric's ether density ρ and compressibility μ are not changed. And this urge us on the conclusion that ether is carried along in the first experiment as well.

But the most interesting point for us here is that we need total time derivatives in electrodynamics in contrast to Mr.Phipps interpretation not only to describe ether movement but also to describe conductivity current not introducing it axiomatically. And the main result of their usage is introduction of the curl current (second item in 2.6a). This current moves in conductor as well and not with electrons' velocity but with light velocity. Therefore knife-switch switched on in Europe lights lamp in America immediately and not in some years when electron come there over cable.

Just this curl current overcomes space between capacitor's plates and extends moving along the conductor carrying electrons along and creating magnetic field. Just this curl current is responsible for all the effects attributed to current nowadays. Just curl current induces ether rotation in dielectric meanwhile electrons cannot penetrate dielectric. And electrons' movement in conductor is rather consequence of curl current in the same way in which sand's movement in river is a consequence of water movement in it.

Let us note that partial time derivative cannot be a cause for current to overcome space between capacitor's plates just because there is no depending on time changes of the fields between capacitor's plates in comparison with the fields in conductor. These changes depend just in space coordinates.

But let us return to the second Eichenwald's experiment when capacitor rotates together with dielectric and correspondingly ether filling the dielectric also rotates. We need more accurate consideration of this experiment because modern physics in this case not hindered by disbelief in ether accurately reproduces for dielectric the ideas of the 19th century concerning ether.

They already do not say about ether particles polarization but attribute this idea to molecules. They believe that charges in dielectric are shifted, the shift enlarges capacity and partly neutralizes charges on capacitor's plates, lessening attraction between them.

But why does dielectric influence the capacity ? And what is the essence of capacity ? And is capacity linked with dielectrics' polarization ? And why does not this shift neutralize all the charges on the capacitor's plates ?

They usually answer that there is not enough dipoles in dielectric. But if so when there is small amount of charges on the plates for which there is enough dipoles in dielectric all such charges should be neutralized. But experience does not show such an effect. Coulomb's force is just lessened in $\frac{\varepsilon}{\varepsilon_0}$ times either for small or for big amount of charges. And let us note that direct measurements to determine dipoles' shift in dielectrics were not produced to the best of my knowledge.

What an explanation of the corresponding experiments can be proposed ? Let us begin with capacity. It was mentioned that physical sense of free ether dielectric permeability ε_0 is free ether mass density. Correspondingly we interpret absolute dielectric permeability ε as ether density in dielectric. This means that dielectric's introduction between capacitor's plates just changes ether density between them. Correspondingly Coulomb force is lessened : it depends not only on charges' value but also on the quality of the substance filling the space separating them. Therefore dielectric between plates does not influence on the magnetic field of the rotating capacitor : its introduction conserves charges on the plates. Thus we could predict the result of the second Eichenwald's experiment.

And what is the physical sense of the capacity ? If C is capacity, d is distance between plates and A is plates' square then

$$C = \frac{\varepsilon A}{d},$$

i.e capacity is average surface mass density of the ether in dielectric.

What other effects detected in Eichenwald's experiments does formula (8.6) predict ? Ether density between the capacitors' plates does not change. This means that Coulomb force is ε_0 inverse in the first experiment and ε inverse in the second one, although charges on the plates are concerved. Ether densities ε_0 and ε are constant therefore the second item in the first square bracket in (8.6) is zero, because grad ε =0.

The charges' velocities on the plates are parallel. These velocities are perpendicular to radius-vector. This means that only radial force remaines in braces. This force is μ proportional, i.e it is $\frac{v^2}{c^2}$ weaker than Coulomb force but is codirected with it and enlarges it. Eichenwald did not measure it but it would be interesting to produce corresponding experiment and verify : "Is it correct that attraction force between rotating plates of capacitor is greater than between stable ones ?"

We have analized the effects predicted by the first item in (8.6).

Physical meaning of the third, gradiental item in (8.6) (the second square brackets in braces is analogous to physical meaning of the gradiental item in static part. But it is linked with another ether characterictics : with its compressibility. We observe its action paramagnetics are pulled in and diamagnetics pushed out of solenoid. The force is directed along ether compressibility μ gradient which increases from solenoid's ends to its midpoint. Static gradiental part is also directed along ε gradient. This force always pushes out dielectric from free ether because ε_0 is always less than ether density in substance. But in the case of capacitor charges of opposite sign are induced on its plates. Therefore gradε is directed into capacitor.

Current in solenoid's circles are induced by charges of the same sign. And ether compressibility in different substances can be as bigger than in free ether (paramagnetics) as lesser (diamagnetics). Therefore paramagnetics are pulled in and diamagnetics are pushed out of solenoid.

What does the first Eichenwald's experiment shows us in this aspect. Let us note that square brackets in the third item in (8.6) is always positive because $\mathbf{v_1}$ and $\mathbf{v_2}$ (tangential velocities of the charges on the rotating plates) are codirected. Opposite sign charges are induced on the plates. Therefore the third item products force directed against gradμ, i.e in the direction of magnetic field decrease.

Charges' velocities increase along radius of the plates but magnetic fields may overcross each other. Therefore we cannot assert that magnetic field also increase along radius. This should be determined by experiment. But we can assert that paramagnetics will be pulled in capacitor and diamagnetics pushed out of it if the magnetic field inside capacitor increases along radius. The sign of the assertion is opposite in the opposite case. It is also opposite if the charges on the plates are of the same sign. In the last case picture similar to that of solenoid is predicted.

We observe here just an accurate analogue to electric field. Rotation of two plates charged with the charges of the same sign will induce traditional effect : diamagnetics well be pushed out and paramagnetics pushed in.

Let us formulate the main result of our consideration of (8.6) formula. Although certain polarization of dielectrics in capacitors apparently takes place the main effects are determined by the fall of ether mass density ε and ether compressibility μ on the border between different matters' or free space ether and ether in substance.

If the charged plane is immovable then the following correlations are valid

$\mathbf{r}_{21} \perp \mathbf{v}_2, \mathbf{r}_{21} \perp \mathbf{a}_2$, т.е. $(\mathbf{r}_{21} \cdot \mathbf{v}_2)=0$, $(\mathbf{r}_{21} \cdot \mathbf{a}_2)=0$

In this case (8.6) grows simpler

$$-grad[4\pi\varepsilon r^3 c(\mathbf{B}_{12} \cdot \mathbf{E}_{21})] = \frac{q_1\sigma}{2\varepsilon r}[\mathbf{r}_{12} + \frac{r^2 grad\varepsilon}{\varepsilon}] + \frac{\mu q_1 \sigma}{2r}[2\mathbf{r}_{21}(\mathbf{v}_1 \cdot \mathbf{v}_2) - \mathbf{v}_2(\mathbf{r}_{21} \cdot \mathbf{v}_1)] \quad (8.7)$$

We have calculated Huygens part of the force. The Newton's one looks as follows

$$\frac{d}{dt}[4\pi\varepsilon\ r^3 c(\mathbf{B}_{12}\times\mathbf{B}_{21})]=$$
$$=\frac{q_1\sigma\mu}{2r}[-\mathbf{r}_{21}(\mathbf{v}_1-\mathbf{v}_2)^2+(\mathbf{v}_1-\mathbf{v}_2)(\mathbf{r}_{21}\cdot(\mathbf{v}_1-\mathbf{v}_2))-$$
$$-\mathbf{r}_{21}(\mathbf{r}_{21}\cdot(\mathbf{a}_1-\mathbf{a}_2))-(\mathbf{a}_1-\mathbf{a}_2)r^2]+$$
$$+\frac{q_1\sigma(\mathbf{r}_{21}\cdot(\mathbf{v}_1-\mathbf{v}_2))\varepsilon^{\frac{1}{2}}\mu^{\frac{3}{2}}}{2r}[(\mathbf{v}_2-\mathbf{v}_1)(\mathbf{r}_{21}\cdot(\mathbf{r}_{21}\cdot(\mathbf{v}_1\times\mathbf{v}_2))]+ \tag{8.8}$$
$$+\frac{q_1\sigma\frac{d\mu}{dt}}{2r}[\mathbf{r}_{21}(\mathbf{r}_{21}(\mathbf{v}_1-\mathbf{v}_2)-(\mathbf{v}_1-\mathbf{v}_2)r^2]+$$
$$+\frac{q_1\sigma}{2r}d(\frac{\varepsilon^{\frac{1}{2}}\mu^{\frac{3}{2}}}{dt})[(\mathbf{r}_{21}\times\mathbf{v}_2)\times(\mathbf{r}_{21}\times\mathbf{v}_1)]$$

Static part is absent in this formula and consequently force depending on ε gradient is absent as well. The whole part depends not on velocities' product but on their difference product. Therefore it is null in the first and the second Eichenwald experiments : the plates' velocities are modulo equal and codirected. Let us suppose the following modification of the second Eichenwald experiment : capacitor's plates uniformly rotate in opposite directions around dielectric. Radius-vector in such experiment is perpendicular to velocities. Therefore all the items containing ($\mathbf{r}_{21}\cdot(\mathbf{v}_1-\mathbf{v}_2)$), all the item containing accelerations and the last item in (8.8) will be zero. Only radial force is preserved in (8.8). Thus Newton's part of force density

$$\mathbf{F}_N=-\frac{4\sigma^2\mu v^2}{2r}\mathbf{r}_{21} \tag{8.9}$$

The velocities in the experiment are oppositely directed. Therefore the braces in (8.6) will look for the case as following

$$\mathbf{F}_H=-\frac{\sigma^2\mu v^2}{2r}\mathbf{r}_{21} \tag{8.10}$$

i.e as Huygens' as Newtons' surface force density for the case are directed against Coulomb surface force density and the sum surface force density looks as follows

$$\mathbf{F}_N + \mathbf{F}_H = -\frac{5\sigma^2 \mu v^2}{2r}\mathbf{r}_{21} \tag{8.11}$$

below we shall use term force instead of surface force density to simplify the narration.

The forces defined by the second and the forth square brackets are c times less than the other forces here. They could be essential in the processes combined by the idea of electroweak interaction. They need special investigation which we postpone. Let us investigate the force defined by the third square bracket. Its coefficient depends on time derivative of μ, i.e ether compressibility in dielectric. We can detect this force if for instance we put a substance with periodically changing ether compressibility among oppositely rotating plates of capacitor. Let

$$\mu = \mu_0 \cos \omega t \tag{8.12}$$

i.e

$$\frac{d\mu}{dt} = -\omega\mu_0 \sin \omega t \tag{8.13}$$

Here μ_0 is average ether compressibility in the substance, ω is frequency.

Then the force between capacitor's plates appearing because of μ changing in time and acting from plate 2 on plate 1

$$\mathbf{F}_{21} = \sigma^2 \omega\mu_0 r \sin \omega t \mathbf{v}_1 \tag{8.14}$$

This force is proportional to square surface charges density σ^2 on the plates and linear on ω, μ_0, r, i.e it increases with these parameters' increase. It periodically untwists and brakes plate 1 in sinus law accordance. The force with which plate 1 acts on plate 2

$$\mathbf{F}_{12} = -\mathbf{F}_{21} \tag{8.15}$$

plate 1 acts on plate 2 in the same way.

Let us consider an additional modification of this experiment : dielectric does not rest between oppositely rotating plates but rotates with one of them. In this case μ does not depend on time explicitely, but convective part of the total time derivative $(\mathbf{v}_1 \cdot \mathrm{grad})\,\mu$ generally speaking is not null. Under what conditions ? Apparently when tangential velocity $\mathbf{v}_1$ and $\mathrm{grad}\,\mu$ are not perpendicular. Is this condition valid for the case ? Perhaps not. See grad μ in static case is apparently directed perpendicular to the dielectric surface. We know too small about ether qualities in order to assert something with sure. But we can adop the following *Assumption : grad* μ *near surface of a rotating dielectric is directed along tangential velocity, i.e* μ *increases in this direction.*

The adopted assumption means that total time derivative convective part ($\mathbf{v_1} \cdot \text{grad}) \mu$ is always positive and does not depend on the direction of the dielectric rotation. The force with which the plates act on each other

$$\mathbf{F}_{21} = \frac{1}{2}\sigma^2 r(\mathbf{v_1} \cdot grad)\mu\mathbf{v_1} \tag{8.16}$$

$$\mathbf{F}_{12} = -\mathbf{F}_{21} = \frac{1}{2}\sigma^2 r(\mathbf{v}_2 \cdot grad)\mu\mathbf{v}_2 \tag{8.17}$$

Let us return to the third Eichenwald experiment. In this experiment capacitor's plates were in rest and only ebonite disc rotated. Sudden for Eichenwald and expected for us was that magnetic field direction did not depend on rotation direction. Eichenwald himself explained this by ebonite qualities. We are sure that this is the ether qualities : when ether jumps from its more dense state in dielectric into more rarefied state in free space it is drifted by the rotation movement.

Therefore its compressibility gradient is directed along tangential velocity and their scalar product is always positive.

The last two items here are non zero if μ and ε depend on time. The previous items are consequences of general formulas (4.1)-(4.3). The general formula is the sum of the Huygens and Newton forces

$$\mathbf{F_{21}} = \mathbf{F_H} + \mathbf{F_N} \tag{8.18}$$

9. Charged Sphere.

Our aim here is to find force which acts on charge q_1 inside sphere of radius R_0 charged with density σ. Initial condition

$$div\mathbf{E}_2 = \frac{4\sigma r}{\varepsilon_0 R_0^2}, r \le R_0 \tag{9.1}$$

supplies us with static part of the field inside the sphere

$$\mathbf{E_2} = \frac{\sigma r}{\varepsilon_0 R_0^2}\mathbf{r}_{21}, r \le R_0 \tag{9.2}$$

One can see that the field (9.2) is proportional to r^2, i.e. it decreases up to zero when r decreases to zero. This means that the field is not constant and not zero as it is believed nowadays because electric field is defined as a force acting on a charge. It had been already said that such definition was not satisfactory. Does it mean that our conclusion contradicts well know experimental facts ? We shall see below that there is really no force acting an charge inside charged sphere in static case, but not because there is no field inside the sphere but because interaction energy inside such sphere is constant and therefore its gradient is zero.

If the charges on the sphere move with velocity $\mathbf{v_2}$ they create the following field in the point where charge q_1 is situated

$$\mathbf{E_{21}} = \frac{\sigma r}{\varepsilon_0 R_0^2}[-\frac{\mathbf{r_{21}} \times \mathbf{v_2}}{c} + \mathbf{r_{21}}], r \le R_0 \tag{9.3}$$

Just in the same way

$$\mathbf{B}_{21} = -\frac{\sigma r}{\varepsilon_0 R_0^2 c^1}\left[\frac{\mathbf{r}_{21} \times \mathbf{v}_2}{c} + \mathbf{r}_{21}\right], r \le R_0 \tag{9.4}$$

The magnetic field created by moving q_1 charge is traditional :

$$\mathbf{B_{12}} = \frac{q_1}{4\pi\varepsilon_0 r^3 c}[\frac{\mathbf{r_{21}} \times \mathbf{v_1}}{c} + \mathbf{r_{21}}], r \le R_0 \tag{9.5}$$

The Huygens force acting on q_1 inside the sphere is

$$-grad[4\pi\varepsilon_0 R_0^3 c(\mathbf{B_{12}}\cdot\mathbf{E}_{21})=$$
$$=\frac{q_1\sigma R_0}{\varepsilon_0 rc^2}[\mathbf{r_{21}}v_1v_2(\cos\theta_3+\cos\theta_1\cdot\cos\theta_2)-\mathbf{v_1}v_2r\cos\theta_2- \quad (9.6)$$
$$-\mathbf{v}_2v_1r\cos\theta_1],r\le R_0$$

Here θ_1 is the angle between radius-vector $\mathbf{r_{21}}$ and velocity $\mathbf{v_1}$, θ_2 is the angle between $\mathbf{r_{21}}$ and $\mathbf{v}_2$, θ_3 is the angle between $\mathbf{v_1}$ and $\mathbf{v}_2$.

This force acts on q_1 from every point of the charged sphere. Let us note that Coulomb force is absent : its interaction energy with the charge is constant, and such energy gradient is zero.

This example shows the problems of to-day understanding electric field as a force acting on a charge. Such definition compels us to believe that the field inside the sphere is zero. Such a field must be discontinuous on the sphere because it exists outside. And what is going on the sphere ? And will any force act on a charge moving inside static charged sphere ?

Let us show that we can obtain reasonable answers on all these questions in the framework of the proposed approach. Charge density on the sphere $\sigma=\frac{q_2}{4\pi R_0^2}$ where q_2 is sum charge of the sphere. Having integrated over sphere we obtain from (9.2)

$$E_2\Big|_{r=R_0}=\frac{q_2}{4\pi\varepsilon_0 R_0^2} \quad (9.7)$$

And without any discontinuity

$$E_2=\frac{q_2}{4\pi\varepsilon_0 r^2},r\ge R_0, \quad (9.8)$$

Let us return to (9.6). It does not exhaust the forces acting on charge inside the sphere. In addition we must find Newtonian part of the force, i.e. time derivative of the magnetic fields' vector product.

Coefficient before square bracket can create an impression that force (9.6) is proportional c sphere radius R_0. But charge density σ is R_0^2 inverse, therefore force (9.6) is R_0 inverse. All the items in square bracket depend on product of the charges' velocity on sphere and velocity of the charge inside the sphere. Therefore the whole force is zero if at least one of the charges is at rest. Radius-vector in the square bracket links any charge on the sphere with the charge q_1 inside. This bracket coefficient radius-vector modulo inverse, i.e the whole force does not depend on the distance between q_1 and charges on the sphere. But it essentially depends on the angles between radius-vector and the charges' velocities and on the angle between velocities of the charges on the sphere and q_1.

Usually we are interested not in the interaction force between q_1 and any point on the sphere. We usually want to understand how the whole sphere influences q_1. In this case we must integrate (9.6) over the whole sphere.

Let us find Newton's force in our case

$$\begin{aligned}
&\frac{d}{dt}[4\pi\varepsilon_0 R_0^3 c(\mathbf{B}_{12}\times\mathbf{B}_{21})]= \\
&=\frac{q_1\sigma R_0}{\varepsilon_0 rc^2}\{\mathbf{r}_{21}[(\mathbf{v}_1-\mathbf{v}_2)^2\cdot(1-\cos\theta_4)]+ \qquad (9.9)\\
&+[\mathbf{r}_{21}r(\mathbf{a}_1-\mathbf{a}_2)\cos\theta_5-(\mathbf{a}_1-\mathbf{a}_2)r^2]\}, r\le R_0
\end{aligned}$$

Here θ_4 is the angle between $\mathbf{r}_{21}$ and $(\mathbf{v}_1-\mathbf{v}_2)$, θ_5 is the angle between $\mathbf{r}_{21}$ and $(\mathbf{a}_1-\mathbf{a}_2)$. One can see that speedy part of the formula does not depend on the distance from q_1 to the points on the sphere but acceleration part increases with this distance. This force is not zero if charges on the sphere or q_1 are at rest. Let us consider the case of stable current on the sphere and constant velocity of q_1, i.e we put zero the second square bracket in (9.9).

The angle between $\mathbf{r}_{21}$ and $(\mathbf{v}_1-\mathbf{v}_2)$ is never null for any movement of q_1, i.e $\cos\theta_4$ is never equal to 1. This means that radial force directed from sphere must be observed because $(\mathbf{v}_1-\mathbf{v}_2)^2$ and $(1-\cos\theta_4)$ are always positive. In other terms there is a magnetic field inside the charged sphere. This contradicts well known theorem that magnetic field circulation over curve not enveloping current is zero. The cause is that to-day electrodynamics does not take into account curle current (eq.2.6a) and radial part of magnetic field (eq.9.4). Formula (9.4) shows that charged sphere magnetic field decreases as r^2 to the sphere center and is directed from this center to the sphere along radius. Concentric spheres are level surfaces of the field. This field exists even if the charges on the sphere are at rest : static part of (9.4) and magnetic field of moving charge q_1 interact and create observable effects contradicting to-day theory. General formula of force acting on q_1 inside charged sphere looks as follows

$$\mathbf{F_{21}} = \frac{q_1\sigma R_0}{\varepsilon_0 rc}\{\mathbf{r}_{21}[(\mathbf{v}_1 - \mathbf{v}_2)^2(1-\cos\theta_4) + v_1 v_2 \cos\theta_1 \cos\theta_2] - \quad (9.10)$$

$$-\mathbf{v}_1 r v_2 \cos\theta_2 - \mathbf{v}_2 r v_1 \cos\theta_1 + [\mathbf{r}_{21} r(\mathbf{a}_1 - \mathbf{a}_2)\cos\theta_5 - (\mathbf{a}_1 - \mathbf{a}_2)r^2]\}$$

In particular when the charge q_1 inside the sphere is at rest, i.e. $\mathbf{v_1}= 0, \mathbf{a_1} = 0$

$$\mathbf{F_{21}} = \frac{q_1\sigma R_0}{\varepsilon_0 rc^2}\{[\mathbf{r_{21}}(\mathbf{v_2^2}(1-\cos\theta_2)) - \mathbf{a_2}r^2 - \mathbf{r_{21}} r a_2 \cos\theta_5\} \qquad (9.11)$$

If the charges in and on the sphere are immovable (9.10) is zero. There is an electric field inside the sphere but there is no force acting on the charge.

Let us illustrate (9.10) by the example when direct current is brought to a diameter end of the sphere and drawn aside from the other end of the diameter. The current flows over the sphere between these points. How will force lines look ?

To-day physics asserts that circulation of magnetic field over curve which does not envelop the current is zero. But formula (9.10) predicts force which acts on a charge in our case, i.e. it predicts magnetic field inside the sphere. Not going into mathematical details I just pinpoint the cause of this contradiction. The cause is that eq.(1.11) contains only conductivity current and does not contain curl item $rot(\mathbf{E}\times\mathbf{v})$ which appears in eq.(2.6a). Just this item creates magnetic field and corresponding force (9.11) inside the sphere.

Magnetic field (9.4) is proportional r^2. It is minimal and equal to zero when $\mathbf{r_{21}} \perp \mathbf{v}_2$, i.e. it is minimal in the sphere center.

It increases along radius. Small concentric spheres are level curves for magnetic field created by current over the big sphere. The magnetic field comes to maximum on the big sphere, i.e. it enlarges with the distance from the big circumference center.

The situation with the force is different. Formula (9.10) shows that it does not depend on the distance from the sphere but essentially depends on the angle between radius-vector and velocities (we assume acceleration equal to zero). But in our case this angle is 90^0, i.e. $\cos\theta_2 = 0$ in (9.10). Finally we obtain : the force acting on a static charge inside the current sphere is constant, directed along radius and proportional to square velocity of the charges on the square.

10. Energy, Impulse, Force Momentum.

Let us clear up mechanical qualities of the two charges' system in consideration. Let us emphasize that (4.1)-(4.3) suppose that external forces which induce charges' velocities and accelerations act on the system. Formulas for $\mathbf{F_{12}}$ and $\mathbf{F_{21}}$ contain non central terms, and therefore classical mechanical theorems cannot be transferred directly on the system under our consideration.

The principle force vector

$$\mathbf{F_{int}} = \mathbf{F_{12}} + \mathbf{F_{21}} \equiv 0 \tag{10.1}$$

Integrating this identity with respect to time and along one arbitrary trajectory in space, on obtains

$$\int_A \mathbf{F_{int}} dt = const \tag{10.2}$$

$$\int_B \mathbf{F_{int}} dx = 0 \tag{10.3}$$

Equalities (10.2) and (10.3) imply the validity of two theorems.

Theorem 1. *Internal forces do not change the system impulse.*
Theorem 2. *Internal forces do not produce work.*

Let us find the moment of internal forces. Let O be an arbitrary point in space, $\mathbf{r_1}$ be radius –vector from O to q_1 and $\mathbf{r_2}$ be radius-vector from O to q_2. The internal forces' principal moment with respect to O is

$$\begin{aligned}\mathbf{M_{int}} &= \mathbf{r_1} \times \mathbf{F_{21}} + \mathbf{r_2} \times \mathbf{F_{12}} = (\mathbf{r_1} - \mathbf{r_2}) \times \mathbf{F_{21}} = (\mathbf{r_2} - \mathbf{r_1}) \times \mathbf{F_{12}} = \\ &= \mathbf{r_{21}} \times \mathbf{F_{21}} = \mathbf{r_{12}} \times \mathbf{F_{12}}\end{aligned} \tag{10.4}$$

Eq. (10.4) implies the validity of

Theorem 3. *A moment of force transferred to the system by external forces does not depend on the point of its application and creates two moments of force acting on the charges. These moments are modulo equal and codirected. They can be considered as force couple applied to radius-vector.*

Force couple notion is used in mechanics to describe solid body movement. It determines solid body rotation if the couple arm is not zero, i.e the forces in the couple are directed along not parallel but the same line. Such a couple does not influence solid body movement. We can interpret **Theorem 3** as application of the force couple idea to radius-vector, or to be more accurate to its ends. This force couple not only rotate radius-vector but also deforms it : expands or compress when the forces are directed along the same straight line. Just this case corresponds radial forces. This means that in our case force couple with zero arm also has understandable physical sense.

Charges are situated on the ends of radius-vector. Thus we come to connection of **Theorem 3** with the third Newton law in mechanics.

It is widely accepted that the assertion that action and counteraction forces are directed oppositely means that they are directed along the same straight line. The author heard such assertions from mechanic professors. Therefore they believe that all nonradial forces cannot satisfy the third Newton law. They assert that, for instance, Lorentz force formula cannot satisfy the third Newton law already because it contains nonradial item (look for instance [13]). Certainly when we say about pointwise masses we have no other selection. But the situation essentially changes when we say about real physical bodies.

It was mentioned in Section 1 that all the forces in 18-19 century physics were radial. This tradition comes to us as we see. But it is difficult to agree with such understanding of the third Newton law. If that were so the billiard game could not exist for instance. The passive ball would just continue trajectory of the active one not changing it. In other terms such understanding leaves only head-on collision and excludes oblique one for mechanical bodies' interaction. First I thought that **Theorem 3** generalized the third Newton law for general electrodynamics. But recently I read its formulation in the text-book [28]. The author Putilov just stresses that action and counteraction forces in the third Newton law are directed along parallel straight lines in general. As an example he proposes interaction of "magnetic poles". Thus we can assert now that **theorem 3** just corroborates validity of the third Newton law in general electrodynamics.

But the very law should be formulated as follows : in real mechanic bodies collision action and counteraction moments of force are modulo equal and codirected.

Example 1. Let us find the force moment produced on the charge in **Example 3** of **Section 5**. The force $\mathbf{F_{21}}$ is defined by (4.6)

$$\mathbf{r}_{21} \times \mathbf{F}_{21} = \frac{-2q_1q_2vCos\theta}{2\pi\varepsilon_0 r^2c^2}(\mathbf{r}_{21} \times \mathbf{v}) = \mathbf{r}_{12} \times \mathbf{F}_{12} \qquad (10.5)$$

Eq. (10.5) means that both arms work the same.

Example 2. Let us find force moment produced on the charges in Example 3 of Section 7. The force $\mathbf{F_{21}}$ is defined by (7.3).

$$\mathbf{r}_{21} \times \mathbf{F}_{21} = \frac{q_1\lambda}{2\pi\varepsilon_0 rc^2}[(\mathbf{r}_{21} \times \mathbf{v}_2) - (\mathbf{r}_{21} \times (\mathbf{v}_1 - \mathbf{v}_2))] =$$

$$= \mathbf{r}_{12} \times \mathbf{F}_{12} \qquad (10.6)$$

Only the first equality here is valid in accordance to Lorentz force, i.e. only one arm works if we limit ourselves with to-day electrodynamics.

Lorentz force predicts appearance of not only radial but directed along velocity force as well, i.e. mechanically it describes oblique impact but predicts rotation of only one of the interacting body and not of the second one.

11. Conclusion.

Let us briefly repeat the main points to which we has come above:

1. Certain generalization of the traditional Maxwell equations was proposed. New aspects of such generalizations are :

a) divergence of Magnetic field is assumed to be non zero, i.e. existence of magnetic charge is accepted. But such charge does not coincide with Dirac monopole in many aspects. It is closely connected with magnetic moment of the electrically charged particles and in this sense it may be considered as another incarnation of the electric charge. But in contrast to electric charges a force similar to Coulomb one does not appear between two magnetic charges. They begin interact only in movement;

b) total time derivatives are used instead of the partial ones in the equations. Physically this means that we can take into account the ether, i.e. media in which electric wave propagates. For this direct current which is introduced into traditional Maxwell equations "by hands" turns to be one of the two items forming convective part of the total time derivative. The second part of it is a curl expression which appears when electric wave is described and which was not a subject of investigation in the Maxwell system explicitely.

Mathematically this means that generalized Maxwell system is Galileo invariant and we do not need to use Lorentz transformation : total time derivative takes it into consideration automatically. Generalized Maxwell equations have a good mathematical peculiarity in addition : they have solution in the case of separate charge in contrast to traditional equations.

2. The last mathematical peculiarity of the Generalized Maxwell equations enables us to propose some new approaches to the concepts of the fields and their interaction.

a) Fields are defined not as a force acting on a charge but just as a solution of the Generalized system. It is shown in appendix one that electric field has mechanic dimension of velocity and magnetic field is non dimentional one and means rotation angle.

b) Thus we turn to be able to describe interaction between charges with the help of interaction between fields induced by these charges. Interaction energy and interact ion impulse are constructed with the help of the fields. Interaction energy gradient supplies us with the Huygens part of the force and the time derivative of the interaction impulse gives us Newton part of it. The obtained formula describes all the experimental results known to the author.

3. Some examples are investigated.

a) A case nowadays investigated usually in the framework of Relativity theory examined. An alternative formula is proposed.

b) Peculiarity of interaction between two electrically charged beams is investigated. Existance of cluster effect is predicted.

c) It is shown in appendix 1 that electric constant ε_0 means free ether mass density and magnetic constant μ_0 means free ether compressibility. They are different in different substances. Examples are proposed to show that many qualities of capacitors, solenoids, diamagnetics and paramagnetics are determined by ε and μ in these bodies.

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On Mechanic Dimensionalities of Electro- and Gravidynamic Fields.

Static law of gravity means that mass M at distance r creates static gravitational field:

$$G = \frac{\gamma \cdot M}{r^2}$$

Taking into account that gravitational constant γ has mechanical dimensionality $m^3/kg\ s^2$, one obtains that gravitational field has dimensionality of acceleration m/s^2.

Electric charge at distance r creates static gravitational field:

$$E = \frac{q}{4 \cdot \pi \cdot \varepsilon_0 \cdot r^2}$$

Where ε_0 is electric constant.

But we can say nothing about its mechanic dimensionality until mechanic dimensionality of electric charge q is defined. If we could do this we would obtain clear formal dependence with mechanics and between gravity and electricity.

In this author papers [2] and [6] it is shown that electric charge has dimensionality kg/s and electric field has dimensionality of velocity, i.e. m/s. Electric constant ε_0 has dimensionality of mass density, i.e. kg/m^3. Its physical meaning is free ether mass density. The aim of the article is to extend these results on electrodynamic and gravidynamic fields.

In papers [1] and [2] it was proposed to describe field of gravity with the help of Maxwell type equations in which the first time derivatives are changed for the second ones. This means in particular, that gravitation is understood as a field of accelerations in contrast to electricity, which is a field of velocities. Respectively these fields are characterized with constants, which has dimensionality of acceleration for gravity and dimensionality of velocity (light speed *c*) for electricity.

Gravity preserves its natural mechanical dimensionality. It has dimensionality of acceleration and its charge is mass.

Several dimensionality systems are used in electrodynamics. To my knowledge scientists who use a certain system are its devoted supporters of the system they use and do not see any problems.

One can agree with this point. Really physics in general and electricity in particular may be studied in any language: in English, Chinese and even Russian. But there is a unique, preferred language among all of them. Our intuition works better, we better understand other persons and interdependence of different phenomena, we better express our ideas in this language. This is our native language.

Do physicists have such a language? I am sure they have. This language is the language of mechanics. Therefore method of gravity description mentioned above should be considered natural and understandable and all dimensionality systems used in modern electrodynamics artificial and nonconvinient. If electric field has dimensionality of velocity then all electrodynamic values obtain mechanic dimensionalities. In particular electric charge has dimensionality kg/s, i.e. mass time derivative.

In different times different authors came to this conclusion although starting from different concepts.

Papers by Aszukovsky [3] and Prussov [4] must be mentioned in this connection. But it is not enough for us to know dimensionalities of the described objects. We must translate electrodynamic values used in today terms into terms of mechanics.

That is what V.A. Aszukovsky writes in his paper [3] (page 49) discussing this problem. He comes to conclusion that electric constant ε_0 means ether mass density ρ and that dimensionality farada corresponds mechanic dimensionality kg/m^2. He concludes from here that ether mass density must be equal to 8.85 10^{-12}kg/m^3 because $\varepsilon_0 = 8.85*10^{-12}$F/m. But this conclusion is wrong because it contains logic flaw. The fact that capacity is measured in Farad and kg/m^2 does not mean yet that 1F = 1kg/m^2. And just correlation between units we must find in order to transform one dimensionality into another one. One easily sees that assertion that mass may be measured in grams and kilograms does not mean that 1g = 1kg. Therefore other quantitative evaluations in Aszukovsky book [3] seem to be unnatural.

Experiment in which electric and gravitational forces are compared must answer our question. The most well known such experiment is experiment in which gravitational attraction and electric repulsion between two electrons is compared.

$$\frac{F_e}{F_q} = \frac{q^2}{\gamma \cdot \varepsilon_0 \cdot m^2} = 4.17 \cdot 10^{42} \qquad (1)$$

This number is taken from Feynman lectures [9].

Here q is electric charge, m – electron mass, ε_0 and γ are electric and gravitational constants. In order to use this equality we must adopt a certain model of elementary particle in general and electron in particular. Some authors (in addition to above-mentioned Aszukovsky and Prussov, F.M. Kanarev [5] should be mentioned) proposed models of elementary particles as follows. Ether particles draw torus performing two curling movements: in equatorial and meridional planes. Similarity between models of the author and the above-mentioned ones stop here: these rotations are prescribed different physical meaning. The author believes that equatorial rotation determines electric charge and meridional rotation determines spin of the particle.

Electron's charge is:

$$q = m \cdot \omega, \qquad (2)$$

where m is its mass and ω is equatorial rotation angular velocity.

Such description of the charge is natural consequence of the translational movement idea in kinematics. As my reader remember translational movement velocity of a massive point is linked with rotation and described there with the help of the radius-vector and angular velocity vector product. Just this idea was used by the author in paper [6].

One obtains substituting (2) into (1):

$$\frac{\omega^2}{4\pi\,\gamma\cdot\varepsilon_0} = 4.17\cdot 10^{42} \tag{3}$$

We are compelled now to adopt some suppositions linking gravitational constant γ and electric constant ε_0. Paper [2] yields that electric field is a special case of gravitational one. This means that ε_0 and $1/\gamma$ must be numerically equal (perhaps with the accuracy of 2π). The difference in dimensionalities is consequence of the dimensionality difference between electric charge and mass. The difference in static gravitational and electric forces is determined by the angular velocity value ω in (2). $1/\gamma$ has dimension kg/m^3s^2 and mechanic dimension of ε_0 is kg/m^3.

Assumption:

$$8\pi^2\gamma\varepsilon_0=1\,rad^2/s^2 \tag{4}$$

Angular velocity square unit is in the right hand part here.

In other terms we suppose that $1/4\pi\gamma$ and ε_0 are numerically equal with the accuracy of 2π.

One obtains taking (4) and (3) into account

$$\omega = 8{,}1\ 10^{20}\ rad/s \tag{5}$$

This number is close to Compton electron angular velocity

$$\omega_s = 7{,}8\ 10^{20}\ rad/s \tag{6}$$

We can take (6) as accurate equatorial angular velocity for electron taking experimental errors into account. This number is in accord with the spectral analyses data in the framework of ethereal (non Bohr) model of elementary particles ([7], [8]). The author does not know any experimental facts contradicting evaluation (6).

Equality (6) enables us to express all electrodynamic units in mechanical terms. Some of them are reproduced below.

Electric charge:

$$e = 7{,}1\ 10^{-10}\ kg/s \tag{7}$$

Correspondingly:

$$1Kl=4,44\ 10^{9}kg/s \quad (8)$$

Electric constant:

$$\varepsilon_0 = 1,9\ 10^{8}\ kg/m^{3} \quad (9)$$

Magnetic constant:

$$\mu_0 = 5,84\ 10^{-26}\ ms^{2}/kg \quad (10)$$

Electric constant means free ether mass density and magnetic constant means its compressibility.

Free ether impedance:

$$\frac{1}{\varepsilon_0 c} = 1,75\ 10^{-17}\ m^{2}s/kg \quad (11)$$

It is known that it is equal to 377Ohm. Thus:

$$1Om = 4,6510^{-20}m^{2}s/kg \quad (12)$$

$$1A=4,44\ 10^{9}kg/s^{2} \quad (13)$$

$$1V = 1Om\ 1A = 2,07\ 10^{-10}m^{2}/s \quad (14)$$

Aszukovsky [3] was right: capacity mechanic dimensionality is kg/m^2. But

$$1F= 1Kl/1V = 2,14\ 10^{19}kg/m^{2} \quad (15)$$

One can express other electrodynamic values in mechanic terms in the same way.

There is no dimensionality problem for gravidynamic field. Just as in static case gravidynamic field has dimension of acceleration and is characterized with certain acceleration constant a which plays the same role for it that light velocity c plays for electrodynamic field.

Let us note that static gravitational force m**G** and static electric force q**E** may be considered as two items in Newtonian definition of the force as impulse time derivative.

$$\mathrm{d/dt}\,(m\mathbf{V}) = m\mathbf{G} + q\mathbf{E}\,, \tag{16}$$

Here $\mathbf{G} = d\mathbf{V}/dt$, $q = dm/dt$, $\mathbf{E} = \mathbf{V}$

Links between electricity and gravity are investigated in greater details in paper [2].

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On Connection between Electricity and Gravity.

When Einstein came to analyses of Gravity from Electricity as a first postulate he adopted the concept of equivalence of gravitational field and acceleration. This means that he considered Gravity as a field of acceleration, in contrast to Electricity which is the field of velocities. The next natural step would have been to introduce a new constant with the dimension of acceleration which had to characterize Gravity somehow in the same sense as the speed of light characterizes Electricity.

Einstein did not go this way. We know the result : General Relativity Theoty (GRT) has very limited applications.

In 1993 the author proposed to describe Gravity by equations of Maxwell type in which first time derivatives are replaced by second ones. This approach leads to predictions of planets' perihelia shifts, differential rotation of the Sun and gasoliquid planets, the proximity of natural satellites' orbits to equatorial plane of their central body, the Earth's continental drift, the observed type of atmosphere and ocean currents, etc.

1. Historic Review.

When Gauss and his assistant Weber proposed their generalization of Coulomb law for the case of moving charges many investigators immediately tried to apply Gauss and Weber laws to gravity. Such approach looks quite natural because ststic law of Gravity and Coulomb formula look so resembling.

Dynamic part of Gauss and Weber laws depend on electric charges' velocities' difference. The calculations were first aimed to explain Mercury orbit displacement. This problem was very acute at that time. Observations showed that Mercury perihelium shifts approximately 43" per century. And all the attempts to explain this effect in the framework of Newtonian gravitational law had no success. But new attemps were also unsuccessful. Weber's formula predicted 14” per century and Gauss’ formula gave 28” per century. These attempts renewed recently in connection with the new wave of interest to Gauss and Weber works ([1],[2]). Historically the first one who obtained desired 43” was Gerber ([3]). His paper was recollected ([4]) when Einstein also obtained 43” in the framework of GRT. Fierce discussion followed this publication. Unfortunately interests of different nations, financial and scientific circles essentially influenced final scientific outcome of the dispute. However we observe something like this nowadays as well.

At last it was decided that Gerber’s formula was just an adjustment to a preliminary known fact. There were two additional arguments on GRT side. It predicted “gravitational red shift” and double deviation of star photon in the sun field. It became clear soon that “red shift” was actually predicted in the framework of Newtonian mechanics. But double deviation was confirmed by experiment. Only nowadays certain doubt appears. The problem is that it is impossible, even today, to clearly identify this effect against the background of noncalm Sun. The question is how Eddington and others were lucky to do this at the beginning of the 20th century. But the main problem of GRT today is lack of any application.

When new Maxwell field theory eclipsed Gauss approach attempts to apply the electromagnetic approach to gravity renewed.

The first one who made an attempt was Maxwell himself. But soon he came to the conclusion that direct analogy contradicts energy conservation law. He concluded this mainly because opposite signs appear in Newton and Coulomb laws : two electric charges of the same sign are repulsed and two masses are attracted.

Despite this such attemps continued in different countries : England, France, Russia and others. The best was Heaviside one [5]. It was unsuccessful just as others, including recent ones. There are many causes of this. We mention the one that is related to Maxwell objections.

Field equations describe neither charges’ nor fields’ interaction. Therefore modern electrodynamics consist of two parts :

Maxwell equations, which describe fields and Lorentz formula, which describes interaction. Formulas of Gauss and Weber ([1],[2]) as well as the ones of Grassman [6], Ampere [7] and Whittaker [8] describe current differentials' interaction. They do not need fields. It would be natural if field theory supplied us with a formula describing fields' interaction. But Lorentz force formula takes an intermediate position. It takes one charge called "test charge" whose field is ignored and defines interaction of test charge with fields induced by other ordinary charges in acordance with Maxwell equations.

Such approach has many drawbacks. One of them is as follows : Lorentz force formula is asymmetric. It predicts situations when charge №1 affects charge №2 but not vice-versa, i.e. the third Newton law is violated.

One can express Lorentz force formula idea differently. If in accordance with Maxwell equations, we express fields by means of charges and put them into Lorentz force formula we obtain Grassman formula [6]. This means that if we limit ourselves to Lorentz force formula the entire Maxwell system becomes unneccessary and one can always use Grassman's formula instead of modern electrodynamics. But Grassman's formula covers very specific cases of charges interaction. Other cases are described by other formulas , the above mentioned ones in particular.

But why formula describing fields' interaction was not proposed ? I believe there were historic causes. I would mention one frequently used argument in support of Lorentz formula. It is alleged that two fields do not interact. Example : two light beams freely intersect each other. And photons are believed to be fields' transmitters. One objection to this assertion was mentioned above : any field induced by a charge can be expresses by means of this charge in accordance with Maxwell equations. We shall come to the second objection below.

Thus we can assert that we must re-examine electrodynamics problems before we try to apply this approach to gravity.

2. Generalized Electrodynamics.

The author proposed a certain generalization of Maxwell equations whose solutions were found for the case of charges and photons ([9],[10]). It turned out that photons were described with functions of complex variables with the part of photon energy defined by the imaginary part. Solutions for charges and photons correspond to different initial conditions. Thus the fields generated by photons and charges are partial solutions of generalized Maxwell equations. Therefore interaction formula for photons differ from that for charges.

A formula describing fields' interaction was proposed in the framework of Generalized Electrodynamics. It covered Lorentz and other above mentioned force formulas. It also contained additional items, which predicted new effects, the cluster effect in particular. Two concepts of force is used when generalized interaction formula is constructed.

The first one is Huygens' idea that force is energy gradient. The second one is Newtonian understanding of force as impulse time derivative. Modern mechanics uses both approaches to analyze movement of isolated bodies although the very idea of force implies interaction. These approaches are believed to be equivalent. And this is indeed so provided bodies' masses are constant.

The picture essentially changes if fields' interaction is taken into account. Electrodynamics' fields generated by two charges depend on the charges' value, their velocities and distances between them. We obtain the interaction energy by taking scalar product of electric fields and interaction impulse by taking vector product of magnetic fields. But we come to different expressions when calculate corresponding derivatives.

Energy gradient incorporates Coulomb, Lorentz (Grassman), Ampere and Whittaker forces.

The dynamic part of this force depends on velocities' product and is zero if at least one of the above discussed charges does not move. Uncritical use of Lorentz force formula in modern physics resulted in a strange assertion that interaction force between two charges at rest and one moving charge and other one at rest is equal. This is certainly wrong and a simple experiment shows that an extra force additional to Coulomb's force appears in the latter case. In particular this additional force is predicted by the second, Newtonian, part of the generalized force.

This part of generalized force depends on difference between velocities and accelerations. It covers Gauss and Weber formulas and adds new terms to them, which symmetrize them in the same sense as the gradient part symmetrizes Lorentz force formula. The Newtonian part of generalized force does not contain static terms analogous to Coulomb force, i.e. it does not predict interaction between "static magnetic fields".

3. On Gravidynamic Field and Force.

In the early 1980's the author proposed a variational "Logarithm Principle" which fields, in particular, gravitational field describes by Maxwell type equations in which first time derivatives are replaced by second ones and constant acceleration *a* plays the role of light velocity *c* in electrodynamics. In the first version, certain analogue of Lorentz force formula was adopted [11] but, instead of electric charges and their velocities, masses and their accelerations appeared. This scheme was presented at St.Petersburg Physical Society meeting in 1993 [11].

Already at this stage, it became possible to explain many gravity phenomena. They were well known but no attempts to explain them had been made to the best of our knowledge.

Most of the proposed explanations were essentially related to gravimagnetic field that appears in the equations.

For instance, planets' movement in the Sun gravimagnetic field leads to emergence of several forces. One force is radial and defines planets orbits displacement. The second one is directed towards Sun equator's plane and creates orbit forcing into this plane. That's why most of the orbits of natural satellites are close to central body equator plane. Orbits behave like a current loop in electromagnetic field. The difference is that the forces are small and process is slow.

The third force is directed tangentially and either enhances or counteracts the planet movement. This very force increases or decreases angular velocity of the planets' own rotation depending of the sign of gravimagnetic field. Apparently these forces produce effects in galaxies today prescribed to "dark mass" and explain the following observed fact : young stars in our Galaxy rotate slowly, grown up stars rotate fast enough and old stars again rotate slowly. Gravimagnetic field distribution in the Earth controls atmospheric and ocean currents and continental drift. The same force leads to differential rotation of Sun and gasoliquid planets : equatorial regions rotate faster than polar ones.

It was clear from the very beginning that gravimagnetic field is closely related to the electromagnetic one. To-day, we understand that magnetic and electric fields are just special cases of gravity. Thus we can discuss the magnetic field only in all the cases.

It is known that Earth's magnetic field oscillates and even changes sign. To-day we do not know the cause of such behaviour but we can state that the rate of Earth's rotation, continental drift and ocean currents are closely linked to the behaviour of Earth's magnetic field.

Generalization of gravimagnetics in the way electrodynamics was generalized shows that masses' interaction depends on not only accelerations but on the third and forth time derivatives as well. Newtonian attraction appears in such generalization with correct sign and predicts attraction of two masses.

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On Gravidynamic Forces.

Certain generalization of Maxwell equations was proposed in paper [1]. It implies total time derivatives instead of the partial ones. Partial solution of this system was found for the case of the fields induced by electric charges.

Scalar product of electric fields created by different charges determines their interaction energy and vector product of their magnetic fields determines their interaction impulse. Having calculated interaction energy gradient we obtain interaction force as Huygens understood it and having calculated impulse total time derivative we obtain Newton's interaction force.

It turns out that these forces physical sense and their mathematical description essentially differ.

Gradiental part depends on charges velocities product and is equal to zero if at least one of the charges is in rest. This part incorporates force formulas earlier proposed by Ampere, Whittaker and Lorentz. The last one is usually defined by interaction of a certain charge called test charge and fields induced by other charge. Actually it coincides with force formula proposed by Grassman earlier. Proposed formula in contrast to Lorentz one satisfies the third Newtonial law.

The second Newtonian part of the force formula depends on differences product of the charges velocities and accelerations. Therefore it predicts interaction in particular between moving and standing charges in addition to Coulomb one. It contains items earlier proposed for force description by Gauss and Weber. As in the case of Lorentz force formula it adds items which make Gauss and Weber force symmetric. Certain part of this force is light velocity c^2 inverse and a part of it is c^3 inverse. Apparently these items are essential for electroweak interaction.

This paper is devoted to similar investigation of gravitational forces created by moving masses. Corresponding fields are described by Maxwell type equations in which first time derivatives are changed for the second ones. One can say that Electricity is a field of velocities and gravity is a field of accelerations. Solutions of such a system are used to construct interaction energy and interaction impulse. Gradient of scalar product of corresponding gravitational fields and second time derivative of vector product of gravimagnetic fields turn to be accurate analogues of electrodynamic interaction. But here forces depend not only on velocities and accelerations but on third and fourth derivatives as well.

Equations of Gravidynamic field

Let **G** be gravidynamic and **D** be gravimagnetic fields, which are induced by moving mass m, which is distributed in the space with density ρ. We assume that functions describing these fields satisfy the following equations :

$$div\mathbf{G} = \gamma\rho \tag{1.1}$$

$$div\mathbf{D} = -\frac{\gamma\rho}{a} \tag{1.2}$$

$$rot\mathbf{G} = -\frac{d^2\mathbf{D}}{dt^2} \tag{1.3}$$

$$a^2 rot\mathbf{D} = \frac{d^2 G}{dt^2} \tag{1.4}$$

where γ is gravitational constant, and *a* is constant acceleration playing in gravidynamics the same role which light velocity c plays in electrodynamics. Thus we consider gravity as a field of accelerations in contrast to Electricity which is a field of velocities.

System (1.1)-(1.4) is similar to generalized Maxwell equations [1]. It originates the same questions as traditional Maxwell system. They are : in order to find two vector-functions **G** and **D** which are unknown in system (1.1)-(1.4) we need two vector equations not more and not less. But system (1.1)-(1.4) contains two divergent equations in addition. Accurate analyses shows that divergent correlations as in Maxwell system as in (1.1)-(1.4) are actually not equations but initial conditions for **G** and **D** written in divergent form. Therefore instead of (1.1) and (1.2) we shall write

$$\mathbf{G}(0,r)=\frac{\gamma\rho}{3}\mathbf{r} \qquad (1.5)$$

$$\mathbf{D}(0,r)=-\frac{\gamma\rho}{3a}\mathbf{r} \qquad (1.6)$$

We come to (1.1) and (1.2) having calculated (1.5) and (1.6) divergence. If we want to obtain system (1.3)-(1.4) partial solution we must determine initial conditions for their time derivatives in addition to initial conditions to the very fields (1.5) and (1.6). They are determined by the physical essence of the problem. We accept here zero initial conditions for them, i.e.

$$\mathbf{G}'(0,\mathbf{r})=0 \qquad (1.7)$$

$$\mathbf{D}'(0,\mathbf{r})=0 \qquad (1.8)$$

In other terms we assume that initial impulse of the investigated mass is null. Mathematically this means that its initial velocity $\frac{d\mathbf{r}}{dt}$ and initial velocity of its density changing $\frac{d\rho}{dt}$ are zero.

Let $\mathbf{r}_0$ be radius of the minimal sphere containing the mass $\mathbf{m}$. We assume the following border conditions for this sphere

$$\mathbf{G}(t,\mathbf{r}_0)=-\frac{\gamma m}{4\pi r_0^{\,3}}\left[\frac{\mathbf{r}_0\times\mathbf{w}}{a}-\mathbf{r}_0\right] \qquad (1.9)$$

$$\mathbf{D}(t,\mathbf{r}_0)=-\frac{\gamma m}{4\pi r_0^{\,3}a}\left[\frac{\mathbf{r}_0\times\mathbf{w}}{a}+\mathbf{r}_0\right] \qquad (1.10)$$

$$t\in[0,\infty]$$

w here is acceleration of the mass **m** which is obtained by ρ integration over ball of the radius $\mathbf{r}_0$ which containes it.

Conditions (1.9)-(1.10) fix the fields translational and rotational movement on the minimal sphere containing **m**.

$\mathbf{G}(t,\mathbf{r})$ and $\mathbf{D}(t,\mathbf{r})$ are functions of time and space coordinates (x_1,x_2,x_3) which we express with the help of radius-vector **r**. Thus we search for system (1.3)-(1.4) solution with initial conditions (1.5)-(1.6), (1.7)-(1.8) and boundary conditions (1.9)-(1.10).

Let mass **m** which we obtain integrating density ρ over the volume inside which this mass is distributed moves with velocity **v** and acceleration **w**. Time derivatives will be designated by dot over the corresponding letter. Thus $\dot{\mathbf{w}}$ and $\ddot{\mathbf{w}}$ are the third and the forth radius-vector **r** time derivatives. We assume the following limitation on the character of mass **m** movement

$$2(\mathbf{v} \times \dot{\mathbf{w}}) + \mathbf{r} \times \ddot{\mathbf{w}} = 0 \tag{1.11}$$

This condition holds for instant in the case of moving with constant acceleration **w** or when vector **v** is collinear to $\dot{\mathbf{w}}$ and **r** is collinear to $\ddot{\mathbf{w}}$. Condition (1.11) holds in particular when two masses oscillate along parallel straight lines. When condition (1.11) holds system (1.3)-(1.10) has the following solution

$$\mathbf{G} = \frac{\gamma m}{4\pi r^3}\left[-\frac{\mathbf{r} \times \mathbf{w}}{a} + \mathbf{r}\right] \tag{1.12}$$

$$\mathbf{D} = -\frac{\gamma m}{4\pi r^3 a}\left[\frac{\mathbf{r} \times \mathbf{w}}{a} + \mathbf{r}\right] \tag{1.13}$$

(1.12) and (1.13) show that gravidynamic field consists of not only static part (the second part in square brackets) but of the dynamic curl part (the first item in square brackets).

Let two masses m_1 and m_2 move inducing fields $\mathbf{G}_1, \mathbf{D}_1$ and $\mathbf{G}_2, \mathbf{D}_2$ and their accelerations are $\mathbf{w}_1$ and $\mathbf{w}_2$. Let $\mathbf{r}_{21} = \mathbf{r}_1 - \mathbf{r}_2$ be radius-vector from mass m_2 to mass m_1, $\mathbf{r}_1$ and $\mathbf{r}_2$ are radius-vectors to masses m_1 and m_2, and $r = |\mathbf{r}_{21}|$.

We assume the following formula which describes forces with which fields $\mathbf{G}_2, \mathbf{D}_2$ act on fields $\mathbf{G}_1, \mathbf{D}_1$:

$$\mathbf{F}_{21} = -grad\left[\frac{4\pi a r^3}{\gamma}(\mathbf{G}_1 \cdot \mathbf{G}_2)\right] + \frac{d^2}{dt^2}\left[\frac{4\pi a r^3}{\gamma}(\mathbf{D}_1 \times \mathbf{D}_2)\right] \quad (1.14)$$

When (1.12)-(1.13) are substituted into (1.14) one obtains for the gradiental part

$$\mathbf{F}_{21}^1 = -\frac{\gamma m_1 m_2}{4\pi r^3}\mathbf{r}_{21} + \frac{\gamma m_1 m_2}{4\pi r^3 a^2}[\ \mathbf{w}_1 \times (\mathbf{r}_{21} \times \mathbf{w}_2) + \mathbf{w}_2 \times$$

$$\times (\mathbf{r}_{21} \times \mathbf{w}_1) + \frac{3(\mathbf{r}_{21} \times \mathbf{w}_1) \cdot (\mathbf{r}_{21} \times \mathbf{w}_2)}{r^2}\mathbf{r}_{21}] = -\frac{\gamma m_1 m_2}{4\pi r^3}\mathbf{r}_{21} + \quad (1.15)$$

$$+\frac{\gamma m_1 m_2}{4\pi r^3 a^2}[\mathbf{w}_1(\mathbf{r}_{21} \cdot \mathbf{w}_2) + \mathbf{w}_2(\mathbf{r}_{21} \cdot \mathbf{w}_1) + \mathbf{r}_{21}(\mathbf{w}_1 \cdot \mathbf{w}_2) -$$

$$-\frac{3(\mathbf{r}_{21} \cdot \mathbf{w}_1)(\mathbf{r}_{21} \cdot \mathbf{w}_2)}{r^2}\mathbf{r}_{21}]$$

The expression after the second equality sign is obtained by revealing the triple vector products in the previous one.

The first item here determines Newtonian static force of gravity. We have obtained it not as a generalization of experimental information but as an implication of fundamental correlation between energy and force. We obtained Coulomb force in [1] just in the same way but in contrast to Coulomb force Newtonian force in (1.15) has opposite sign, i.e. two masses are attracted and not repulsed. Items in square brackets describe forces which appear because of masses movement. The first two summonds predict forces directed along masses accelerations, the second two ones predict appearance of forces additional to Newtonian force. They are directed along radius-vector. All these forces are zero if at least one of the masses is in rest or moves with constant velocity. Actually this is another formulation of the first Newtonian law. One can name $\mathbf{F}_{21}^{1}$ Huygens force. We have obtained it following his concept of force as energy gradient. The difference is that he applied it to analysis of movement of a separate massive body. Formula (1.14) uses this idea to describe interaction of massive bodies with the help of interaction of the fields induced by these bodies.

One can say the same words about the second, Newtonian part of the force (1.14). The first time derivative of the second square brackets in (1.14) supplies us with the fields interaction impulse and the second time derivative furnishes us the force formula. One obtaines after corresponding calculations : first part of Newtonian gravidynamic force

$$\begin{aligned}\mathbf{F}_{21}^{2} = \frac{\gamma m_1 m_2}{4\pi a^2 r^3}[(\mathbf{w}_1 - \mathbf{w}_2)\times(\mathbf{r}_{21}\times(\mathbf{w}_1 - \mathbf{w}_2)) + 2(\mathbf{v}_1 - \mathbf{v}_2)\times \\ \times((\mathbf{v}_1 - \mathbf{v}_2)\times(\mathbf{w}_1 - \mathbf{w}_2)) + 2(\mathbf{v}_1 - \mathbf{v}_2)\times(\mathbf{r}_{21}\times(\dot{\mathbf{w}}_1 - \dot{\mathbf{w}}_2)) + \\ + 2\mathbf{r}_{21}\times((\mathbf{v}_1 - \mathbf{v}_2)\times(\dot{\mathbf{w}}_1 - \dot{\mathbf{w}}_2)) + \mathbf{r}_{21}\times(\mathbf{r}_{21}\times(\ddot{\mathbf{w}}_1 - \ddot{\mathbf{w}}_2))]\end{aligned} \tag{1.16}$$

This part of the Newton's dynamic force is a^2 inverse.

The second part of it is a^3 inverse and looks as follows

$$\begin{aligned}\mathbf{F}_{21}^{3} = \frac{\gamma m_1 m_2}{4\pi a^3 r^3}[(\mathbf{r}_{21}\times\ddot{\mathbf{w}}_2)\times(\mathbf{r}_{21}\times\mathbf{w}_1) + (\mathbf{r}_{21}\times\mathbf{w}_2)\times(\mathbf{r}_{21}\times\ddot{\mathbf{w}}_1) + \\ + (\mathbf{w}_1\times\mathbf{w}_2)\times((\mathbf{r}_{21}\times\mathbf{w}_1) - \mathbf{r}_{21}\times\mathbf{w}_2)) + 2((\mathbf{v}_1 - \mathbf{v}_2)\times\dot{\mathbf{w}}_2)\times \\ \times(\mathbf{r}_{21}\times\mathbf{w}_1) + 2((\mathbf{v}_1 - \mathbf{v}_2)\times\mathbf{w}_2)\times((\mathbf{v}_1 - \mathbf{v}_2)\times\mathbf{w}_1) + 2((\mathbf{v}_1 - \\ -\mathbf{v}_2)\times\mathbf{w}_2)\times(\mathbf{r}_{21}\times\dot{\mathbf{w}}_1) + 2((\mathbf{r}_{21}\times\dot{\mathbf{w}}_2)\times((\mathbf{v}_1 - \mathbf{v}_2)\times\mathbf{w}_1) + 2\cdot \\ (\mathbf{r}_{21}\times\mathbf{w}_1)\times(\mathbf{r}_{21}\times\dot{\mathbf{w}}_2) + 2(\mathbf{r}_{21}\times\mathbf{w}_2)\times((\mathbf{v}_1 - \mathbf{v}_2)\times\dot{\mathbf{w}}_1)]\end{aligned} \tag{1.17}$$

As it was said above permanent acceleration *a* plays the same part in gravidynamics which constant light velocity *c* plays in electrodynamics. There are certain reasons to believe that numerically *a* is not less than *c* and perhaps is equal to it with 2π accuracy.

One obtains revealing triple vector products in (1.16)

$$\mathbf{F}_{21}^2 = \frac{\gamma m_1 m_2}{4\pi a^2 r^3}\{\mathbf{r}_{21}[(\mathbf{w}_1 - \mathbf{w}_2)^2 + 2(\mathbf{v}_1 - \mathbf{v}_2)\cdot(\dot{\mathbf{w}}_1 - \dot{\mathbf{w}}_2) +$$
$$+ \mathbf{r}_{21}\cdot(\ddot{\mathbf{w}}_1 - \ddot{\mathbf{w}}_2)] + 2(\mathbf{v}_1 - \mathbf{v}_2)[(\mathbf{v}_1 - \mathbf{v}_2)\cdot(\mathbf{w}_1 - \mathbf{w}_2) + \tag{1.18}$$
$$+ \mathbf{r}_{21}\cdot(\dot{\mathbf{w}}_1 - \dot{\mathbf{w}}_2)] - (\mathbf{w}_1 - \mathbf{w}_2)[\mathbf{r}_{21}\cdot(\mathbf{w}_1 - \mathbf{w}_2) + 2\cdot$$
$$(\mathbf{v}_1 - \mathbf{v}_2)^2] - 4(\dot{\mathbf{w}}_1 - \dot{\mathbf{w}}_2)[\mathbf{r}_{21}\cdot(\mathbf{v}_1 - \mathbf{v}_2)] - (\ddot{\mathbf{w}}_1 - \ddot{\mathbf{w}}_2)\mathbf{r}^2\}$$

Coefficient before braces is equal to corresponding coefficient before dynamic gradient force, i.e. they have the same multiplicity. But this force depends on the first, second, third and fourth time derivatives differences. Square brackets contain scalar products of such derivatives. Vectors pointing direction of the corresponding forces stay before square brackets. They are radius-vector derivatives of the zero, first, second, third and fourth multiplicity. All the summonds except one containing the fourth derivative decrease as r^2. The term containing fourth derivative decreases as *r*. Just as the gradient part this part contains terms directed along radius and "deforming" static force of gravity.

One obtains revealing triple vector products in (1.17):

$$\mathbf{F}_{21}^3 = \frac{\gamma m_1 m_2}{4\pi a^3 r^3}\{\mathbf{r}_{21}[\mathbf{r}_{21}\cdot((\ddot{\mathbf{w}}_1 \times \mathbf{w}_2) - 2(\dot{\mathbf{w}}_2 \times \dot{\mathbf{w}}_1) + (\mathbf{w}_2 \times$$
$$\times \ddot{\mathbf{w}}_1)) + 2\cdot(\mathbf{v}_1 - \mathbf{v}_2)\cdot((\dot{\mathbf{w}}_2 \times \mathbf{w}_1) + (\mathbf{w}_2 \times \dot{\mathbf{w}}_1))] + 2(\mathbf{v}_1 - \tag{1.19}$$
$$-\mathbf{v}_2)[\mathbf{r}_{21}\cdot(\dot{\mathbf{w}}_2 \times \mathbf{w}_1) + (\mathbf{v}_1 - \mathbf{v}_2)\cdot(\mathbf{w}_2 \times \mathbf{w}_1) + \mathbf{r}_{21}\cdot(\mathbf{w}_2 \times$$
$$\times \dot{\mathbf{w}}_1)] + (\mathbf{w}_2 - \mathbf{w}_1)[\mathbf{r}_{21}\cdot(\mathbf{w}_1 \times \mathbf{w}_2)]\}$$

This force is a^3 inverse in contrast to (1.18) force. If permanent acceleration *a* with which gravity moves is big enough this means that this force is modulo less as (1.18) (the first part of Newtonian gravidynamic force) as dynamic part of the gradient force (1.15) (Huygens force). Just as in (1.18) vectors pointing force direction stay before square brackets in (1.19). They are radius-vector and velocities and accelerations differences Scalar values constructed from different radius-vector time derivatives from zero up to the fourth order stay in square brackets. They determine values of the corresponding force. (1.19) contains items directed along radius and predicting force deforming static force just as in the case of forces (1.15) and (1.18).

In contrast to Huygens force (1.15) forces (1.18) and (1.19) are not zero if one of the masses is in rest or moves with constant velocity. This means that the first Newton law is not universal and a certain although small additional force appears between masses moving with constant velocities. Forces (1.18) and (1.19) does not contain static item in contrast to Huygens force (1.15), i.e. they are zero if both masses are in rest. If masses m_1 and m_2 move with equal velocities, accelerations, the third and the fourth time derivatives force (1.18) is zero but in general force directed along radius is not zero in (1.19) expression. One obtains finally : gravidynamic force acting on mass m_1 from moving mass m_2 is

$$\begin{aligned}
&\mathbf{F}_{21} = \mathbf{F}_{21}{}^{1} + \mathbf{F}_{21}{}^{2} + \mathbf{F}_{21}{}^{3} = -\frac{\gamma m_1 m_2}{4\pi r^3}\mathbf{r}_{21} + \frac{\gamma m_1 m_2}{4\pi r^3 a^2}[\mathbf{w}_1 \times (\mathbf{r}_{21} \times \\
&\times \mathbf{w}_2) + \mathbf{w}_2 \times (\mathbf{r}_{21} \times \mathbf{w}_1) + \frac{3(\mathbf{r}_{21} \times \mathbf{w}_1)\cdot(\mathbf{r}_{21} \times \mathbf{w}_2)}{r^2}\mathbf{r}_{21}] + \\
&+ \frac{\gamma m_1 m_2}{4\pi r^3 a^2}[(\mathbf{w}_1 - \mathbf{w}_2) \times (\mathbf{r}_{21} \times (\mathbf{w}_1 - \mathbf{w}_2)) + 2(\mathbf{v}_1 - \mathbf{v}_2) \times ((\mathbf{v}_1 - \\
&- \mathbf{v}_2) \times (\mathbf{w}_1 \times \mathbf{w}_2)) + 2(\mathbf{v}_1 - \mathbf{v}_2) \times (\mathbf{r}_{21} \times (\dot{\mathbf{w}}_1 - \dot{\mathbf{w}}_2)) + 2\mathbf{r}_{21} \times \\
&\times ((\mathbf{v}_1 - \mathbf{v}_2) \times (\dot{\mathbf{w}}_1 - \dot{\mathbf{w}}_2)) + \mathbf{r}_{21} \times (\mathbf{r}_{21} \times (\ddot{\mathbf{w}}_1 - \ddot{\mathbf{w}}_2))] + \frac{\gamma m_1 m_2}{4\pi r^3 a^3}\cdot \qquad (1.20) \\
&\cdot[(\mathbf{r}_{21} \times \ddot{\mathbf{w}}_2) \times (\mathbf{r}_{21} \times \mathbf{w}_1) + (\mathbf{r}_{21} \times \mathbf{w}_2) \times (\mathbf{r}_{21} \times \ddot{\mathbf{w}}_1) + \\
&+ (\mathbf{w}_1 \times \mathbf{w}_2) \times ((\mathbf{r}_{21} \times \mathbf{w}_1) - (\mathbf{r}_{21} \times \mathbf{w}_2)) + 2((\mathbf{v}_1 - \mathbf{v}_2) \times \dot{\mathbf{w}}_2) \times \\
&\times (\mathbf{r}_{21} \times \mathbf{w}_1) + 2((\mathbf{v}_1 - \mathbf{v}_2) \times \mathbf{w}_2) \times ((\mathbf{v}_1 - \mathbf{v}_2) \times \mathbf{w}_1) + \\
&+ 2\cdot((\mathbf{v}_1 - \mathbf{v}_2) \times \mathbf{w}_2) \times (\mathbf{r}_{21} \times \dot{\mathbf{w}}_1) + 2(\mathbf{r}_{21} \times \dot{\mathbf{w}}_2) \times ((\mathbf{v}_1 - {}_2) \times \mathbf{w}_1) + \\
&+ 2(\mathbf{r}_{21} \times \dot{\mathbf{w}}_1) \times (\mathbf{r}_{21} \times \dot{\mathbf{w}}_2) + 2(\mathbf{r}_{21} \times \mathbf{w}_2) \times ((\mathbf{v}_1 - \mathbf{v}_2) \times \dot{\mathbf{w}}_1)]
\end{aligned}$$

We obtain the following formula revealing triple vector products here

$$
\begin{aligned}
\mathbf{F}_{21} &= -\frac{\gamma m_1 m_2}{4\pi r^3}\mathbf{r}_{21} + \frac{\gamma m_1 m_2}{4\pi r^3 a^2}[\mathbf{w}_1(\mathbf{r}_{21}\cdot\mathbf{w}_2) + \mathbf{w}_2(\mathbf{r}_{21}\cdot\mathbf{w}_1) + \\
&+ \mathbf{r}_{21}(\mathbf{w}_1\cdot\mathbf{w}_2) - \frac{3(\mathbf{r}_{21}\cdot\mathbf{w}_1)(\mathbf{r}_{21}\cdot w_2)}{r^2}\mathbf{r}_{21}] + \frac{\gamma m_1 m_2}{4\pi r^3 a^2}\{\mathbf{r}_{21}[(\mathbf{w}_1 - \\
&- \mathbf{w}_2)^2 + 2\cdot(\mathbf{v}_1 - \mathbf{v}_2)\cdot(\dot{\mathbf{w}}_1 - \dot{\mathbf{w}}_2) + \mathbf{r}_{21}\cdot(\ddot{\mathbf{w}}_1 - \ddot{\mathbf{w}}_2)] + 2\cdot \\
&\cdot(\mathbf{v}_1 - \mathbf{v}_2)[(\mathbf{v}_1 - \mathbf{v}_2)\cdot(\mathbf{w}_1 - \mathbf{w}_2) + \mathbf{r}_{21}\cdot(\dot{\mathbf{w}}_1 - \dot{\mathbf{w}}_2)] - (\mathbf{w}_1 - \mathbf{w}_2)[\mathbf{r}_{21}\cdot \\
&\cdot(\mathbf{w}_1 - \mathbf{w}_2) + 2(\mathbf{v}_1 - \mathbf{v}_2)^2] - 4(\dot{\mathbf{w}}_1 - \dot{\mathbf{w}}_2)[\mathbf{r}_{21}\cdot(\mathbf{v}_1 - \mathbf{v}_2)] - \\
&- (\ddot{\mathbf{w}}_1 - \ddot{\mathbf{w}}_2)\,\mathbf{r}^2\} + \frac{\gamma m_1 m_2}{4\pi r^3 a^3}\{\mathbf{r}_{21}[\mathbf{r}_{21}\cdot((\ddot{\mathbf{w}}_2\times\mathbf{w}_1) - 2(\dot{\mathbf{w}}_2\times \\
&\times\dot{\mathbf{w}}_1) + (\mathbf{w}_2\times\ddot{\mathbf{w}}_1)) + 2(\mathbf{v}_1 - \mathbf{v}_2)\cdot((\dot{\mathbf{w}}_2\times\mathbf{w}_1) + (\mathbf{w}_2\times\dot{\mathbf{w}}_1))] + \\
&+ 2(\mathbf{v}_1 - \mathbf{v}_2)[\mathbf{r}_{21}\cdot(\dot{\mathbf{w}}_2\times\mathbf{w}_1) + (\mathbf{v}_1 - \mathbf{v}_2)\cdot(\mathbf{w}_2\times\mathbf{w}_1) + \mathbf{r}_{21}\cdot(\mathbf{w}_2\times \\
&\times\dot{\mathbf{w}}_1)] + (\mathbf{w}_2 - \mathbf{w}_1)[\mathbf{r}_{21}\cdot(\mathbf{w}_2\times\mathbf{w}_1)]\}
\end{aligned}
\tag{1.21}
$$

Examples

Example 1. Let two masses m_1 and m_2 move with equal accelerations $\mathbf{w}_1 = \mathbf{w}_2 = \mathbf{w}$ along parallel straight lines, i.e.

$$\mathbf{w}_1 \cdot \mathbf{w}_2 = w^2 \tag{2.1}$$

Let angle between $\mathbf{r}_{21}$ and $\mathbf{w}_1$ be θ.It is equal to angle between $\mathbf{r}_{21}$ and $\mathbf{w}_2$. Dynamic part of Newton force is zero for such masses and gradiental part looks as follows

$$\mathbf{F}_{21} = -\frac{\gamma m_1 m_2}{4\pi r^3}\mathbf{r}_{21} + \frac{\gamma m_1 m_2}{4\pi r^3 a^2}[2\mathbf{w} rw\cos\theta + \mathbf{r}_{21} w^2 (1 - 3\cos^2\theta)] \tag{2.2}$$

Dynamic force directed along radius and deforming static one (second item in square brackets) depends on θ, i.e. depends on the masses location with respect to each other.

When $(1 - 3\cos^2\theta) = 0$ (i.e. about 55° and 125°) dynamic radial force is zero. When $\theta \in [0,55] \cup (125^0, 180^0]$ the force is negative and reinforce the static part. When $\theta \in [55^0, 125^0]$ it is positive and weaken static force. The force directed along acceleration (the first item in square brackets) is zero when $\theta = 90^0$, i.e. if masses fly "side by side". When $\theta \in (180^0, 90^0)$ (the first mass is behind) this force is directed along acceleration and increase acceleration of the first one (the second mass "helps" the first one). When $\theta \in (90^0, 0^0)$ (the first mass is ahead) this force is directed against the first mass acceleration (the second mass brakes the first mass movement). Modulo equal and oppositely directed force is applied to the second mass. This means that masses strive for moving "side by side". We observe such an effect in planets movement. It is just strict analogue for corresponding effect in generalized electrodynamics [1] where it displays in cluster effect in particular: when chargers velocities are high they gather together in clusters instead of scattering because of Coulomb force.

Example 2. Let under conditions of the previous example accelerations are not constant but masses oscillate along parallel straight lines with amplitude A and angular velocity ω, i.e.

$$\mathbf{w}_1 = \mathbf{w}_2 = -A^2 w^2 \cos \omega t \mathbf{d}\,, \tag{2.3}$$

here $\mathbf{d}$ is unit vector determining direction of the straight lines along which oscillations take place. Newtonian dynamic force here is again zero and gradiental one looks as follows

$$\mathbf{F}_{21} = -\frac{\gamma m_1 m_2}{4\pi r^3}\mathbf{r}_{21} + \frac{\gamma m_1 m_2 A^2 w^4 \cos^2 \omega t}{4\pi r^3 a^2}[-2r\cos\theta \cdot \mathbf{d} + (1-3\cos^2\theta)\mathbf{r}_{21}] \tag{2.4}$$

Here θ again is angle between $\mathbf{r}_{21}$ and $\mathbf{d}$ just as in the previous example.

We have obtained formula very similar to (2.2). It is interesting because show constructive way to “antigravitation”. The masses should oscillate “side by side”. Static gravitational force will be overcome when

$$A^2 w^4 \cos^2 \omega t \ge a^2 \tag{2.5}$$

Example 3. Let mass m_1 rotates around static mass m_2 with constant tangential velocity $\mathbf{v}_1$, i.e. with constant centripetal acceleration $\mathbf{w}_1$. Gradiental force is zero for the case because one of the masses is static. The greater part of the items in Newtonian dynamic force which contain third and fourth derivatives are also zero. We obtain

$$\mathbf{F}_{21} = -\frac{\gamma m_1 m_2}{4\pi r^3}\mathbf{r}_{21} + \frac{\gamma m_1 m_2}{4\pi r^3 a^2}[w_1{}^2\mathbf{r}_{21} + (2v_1{}^2 - rw_1)\mathbf{w}_1] \qquad (2.6)$$

Taking into account that

$$\mathbf{w}_1 = -\frac{v_1{}^2}{r^2}\mathbf{r}_{21} \qquad (2.7)$$

i.e. that centripetal force is antiparallel to radius-vector we obtain that items in square bracket in (2.6) are mutually annihilated and only static part remains (the first item in 2.6). We could predict this result if we gazed more attentively at formula (1.13) which determines gravimagnetic field. The first item in it for mass m_2 is zero because it is static ($\mathbf{w}_2 = 0$), and it is also zero for m_1 because $\mathbf{w}_1$ is antiparallel to radius-vector. Vector product of radius-vector to radius-vector is zero in contrast to scalar product which participate in gradiental part of the formula where it determines static part (static Newton force).

Let us repeat the idea already mentioned above : formula for magnetic fields interaction does not contain static part in contrast to interaction formula for electric and gravitational fields.
Astronomic observations show that additional forces appear between moving planets and Sun. This means that planets and Sun are “gravitational ferromagnetics”, i.e they are stable gravimagnets. Special investigation will be devoted to this case.

References

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The Second Continuity Eqiation.

An equation generalizing the classical continuity equation for the case of accelerated movement is proposed. It turns to be useful in Gravity description.

Let **v** be fluid velocity and ρ be its density and Q be the total fluid inside the surface S. The time rate of change of Q or, this is the same, the velocity of the fluid leaking through a surface S

$$\frac{dQ}{dt} = \iint_S \rho \, \mathrm{v}_n ds \tag{1}$$

where v_n is **v** projection on external normal **n**, to S. On the other hand the rate of change fluid in the volume υ

$$-\iiint_\upsilon \rho_t d\upsilon \tag{2}$$

Here and below the lower index t means partial derivative with respect to t. With the help of Gauss theorem one finds for any volume υ

$$\iiint_\upsilon \left[\rho_t + \mathrm{div}(\rho\mathbf{v})\right] d\upsilon = 0$$

This is satisfied if

$$\rho_t + \mathrm{div}(\rho\mathbf{v}) = 0 \tag{3}$$

which is the classical continuity equation. If the flow is accelerated then the second total derivative with respect to t in (1) will be also non zero. One obtains:

$$\frac{d^2Q}{dt^2} = \iint_S \left[(\rho v_n)_t + v_n \, div\,(\rho\mathbf{v})\right] ds =$$

$$\iiint_\upsilon \mathrm{div}\left[(\rho\mathbf{v})_t + \mathbf{v}\,\mathrm{div}(\rho\mathbf{v})\right] d\upsilon \tag{4}$$

On the other hand acceleration with which density ρ changes in volume υ is

$$-\iiint_{\upsilon} \rho_{tt} d\upsilon \tag{5}$$

i.e

$$\iiint_{\upsilon} \left[\rho_{tt} + \operatorname{div}\left[(\rho\mathbf{v})_t + \mathrm{v}\operatorname{div}(\rho\mathbf{v})\right]\right] d\upsilon = 0 \tag{6}$$

for any υ.

$$\rho_{tt} + \operatorname{div}\left[(\rho\mathbf{v})_t + \mathrm{v}\operatorname{div}(\rho\mathbf{v})\right] = 0 \tag{7}$$

If the flow is steady, i.e $\rho_{tt} = 0$, $v_t = 0$, one can easily verify that (7) comes to (3). On the whole both equations should be valid simultaneously and (3) can be used to simplify (7).

One gets finally

$$\rho_{tt} + \operatorname{div}(\rho \mathrm{v}_t) = 0 \tag{8}$$

(3) and (8) must be valid simultaneously for accelerated processes. (8) becomes identify for nonaccelerated processess. Both (3) and (8) are kynematic facts and are independent with respect to any assumptions except assumption that there is no sources of fluid inside the volume under consideration. Just analogous conclusions could be drawn for higher rank derivatives if necessary.

Continuity equation (3) is widely used in physics and understood as mathematical expression of conservation laws. The said above means that this assumption is correct only for steady processes. In particular it is OK when electric charge conservation law is obtained from Maxwell equations.

But (3) becomes only nesessary condition when accelerated processes or processes depending on the third and forth time derivatives are investigated. In particular we need equation (8) when mass conservation law is obtained from gravidynamic equations.

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