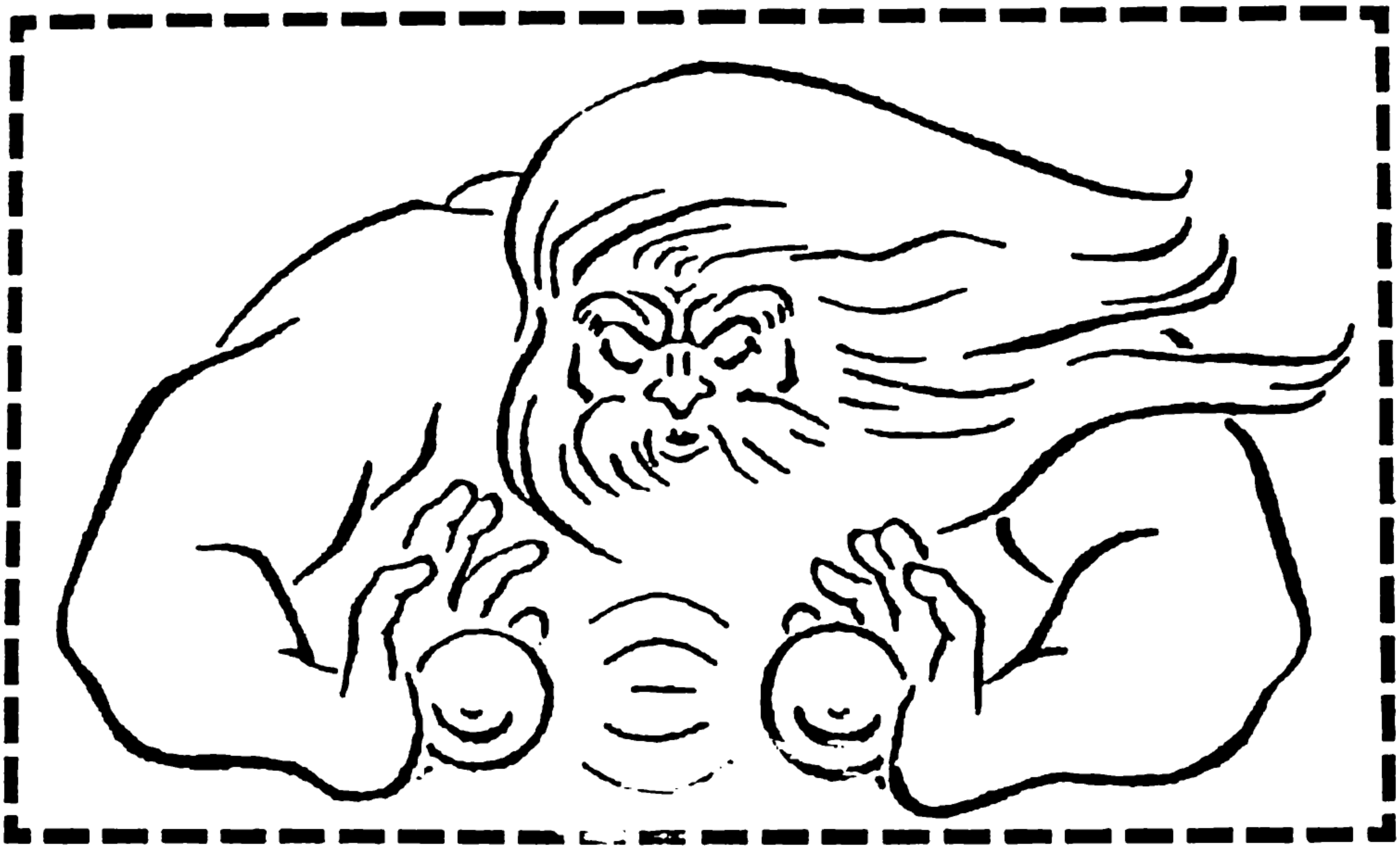
Stefan Marinov

DIVINE



ELECTRO-MAGNETISM

EAST - WEST
International Publishers

Published in Austria
by
International Publishers »East-West«

First published in 1993

Adresses of the International Publishers »East-West« Affiliates:
AUSTRIA — Morellenfeldgasse 16, 8010 Graz, Tel. (0316) 37 70 93
BULGARIA — ul. Elin Pelin 22, 1164 Sofia, Tel. (02) 66 73 78

Суди спокойней, беспристрастней -
и ты поймешь в конце концов:
просчеты мудрецов опасней,
чем заблуждения глупцов.

Вадим Шефнер (НЕВА, 3/1991, стр. 3)

Reading the old papers of Poincaré and
Lorntz one comes to the conclusion:
Einstein was not only wrong, but had no
originality in being wrong.

Desmond Cumberland

Фальшивой теорией вести за нос мало людей
долгое время можно, фальшивой теорией вести
много людей недолгое время тоже можно, но
фальшивой теорией вести за нос много людей
долгое время, пока свет стоит, не удалось
никому.

Плиний средний

Отыщи всему начало и ты многое поймешь.

Козьма Прутков

Relativity has vanished through the window...

John Maddox, Nature, **346**, 103.

The drawing on the cover is by Prof. J. P. Wesley

P R E F A C E

Electromagnetism is a science which is to be learned by everybody who knows some mathematics in ten days. Eleven days are too many.

Why then the students in the universities study it for years and nevertheless all of them, as well as the professors who teach it in the class-rooms, look with desperation at the electromagnetic phenomena, without being able to explain what is really going on there and why? A clear example for the "puzzleness" of the electromagnetic phenomena are the numerous papers in the AMERICAN and EUROPEAN JOURNAL OF PHYSICS. Such a paper is also that of John Maddox cited quite the whole in Sect. 21.

When reading this book the reader will give the answer readily: Official electromagnetism is simply wrong. The theory of relativity is wrong, the "closed current lines", "flux" and "propagation of interaction" Faraday-Maxwell concepts are wrong.

In electromagnetism there are only a couple of simple and clear formulas (as a matter of fact, there is only one fundamental formula, the Newton-Lorentz equation), deduced logically from a couple of simple axioms (see them is Sect. 2), and any electromagnetic phenomenon is then to be calculated by the help of these simple formulas if one knows differential, integral and vector calculus.

And the fundamental Newton-Lorentz equation leads logically to the violation of the laws of angular momentum and energy conservation, i.e., to the construction of machines which rotate under the action of internal forces and which produce energy from nothing.

Official physics works with a wrong fundamental formula, namely with the Lorentz equation, consequently without the scalar magnetic field and assumes that the electromagnetic effects depend only on the relative velocities of the bodies.

One may wonder: how was it possible that until the end of the XXth century humanity has not noticed the scalar magnetic intensity and the existence of the motional-transformer induction. I point out at the reasons for this "blindness": 1) the scalar magnetic intensity is equal to zero (with some very rare exceptions) when it is generated by a closed current, and 2) the induced motional and motional-transformer electric tensions in a closed loop are equal. And in low-acceleration electromagnetism official physics works predominantly with closed currents and closed loops.

But why to narrate in the preface in a hurry that what is written calmly and in all detail in the book?!

DIVINE ELECTROMAGNETISM can be read, grasped and mastered in ten days. At this reading the reader has to jump over some complicated calculations. One will lose nothing if one will not verify all steps of the mathematical speculations. All other "theoretical" deductions are of the most simple kind which every sophomore student can follow with easiness.

If the reader would have under hand the first part of my encyclopaedic book CLASSICAL PHYSICS, entitled MATHEMATICAL APPARATUS, the reading of this book can proceed more quickly and calmly, as there can be found all relevant formulas from algebra, trigonometry, analytical geometry, differential calculus, integral calculus, infinite series, differential equations, vector and tensor analysis. For this reason I do not attach to the present book a part dedicated to the mathematical apparatus used in it.

I wish to note only the following.

Every student in a technical university knows what are the differential operators grad, div, rot, however few of them know the fourth differential operator (**v**.grad), called "vector-gradient". I won from a friend of me 1000 AS by asserting that if we take five university textbooks on electromagnetism, then with surety in four of them we will not find the operator (**v**.grad). In case that in more than in one of the five books the operator would be found, I had to pay to the friend 5000 AS. We ordered the books on the library computer. The operator (**v**.grad) couldnot be found even a single time in all of them. (A similar bet can be won with Grassmann's formula, namely I shall pay to everyone 5000 AS if by choosing arbitrarily five university text-books on electromagnetism, Grassmann's formula would be found written explicitly in more than in one.)

Thus if one wonders why the motional-transformer induction was not revealed by humanity, I always retort: And if some student occasionally has observed it, how would he write it, if the professor has not told him that besides grad, div and rot there is also (**v**.grad).

It is very useful to have under hand the formulas for grad, div, rot and (**v**.grad) of a product of two functions, as to deduce the relevant formula any time when one needs it is tedious. As I use some of these formulas often in the book, I give them here:

If Φ, Φ_1, Φ_2, are scalar funcions and $\mathbf{A}$, $\mathbf{A}_1$, $\mathbf{A}_2$ are vector functions of the coordinates of the reference point, then

$$\mathrm{grad}(\Phi_1\Phi_2) = \Phi_1\mathrm{grad}\Phi_2 + \Phi_2\mathrm{grad}\Phi_1,$$

$$\mathrm{grad}(\mathbf{A}_1.\mathbf{A}_2) = (\mathbf{A}_1.\mathrm{grad})\mathbf{A}_2 + (\mathbf{A}_2.\mathrm{grad})\mathbf{A}_1 + \mathbf{A}_1\times\mathrm{rot}\mathbf{A}_2 + \mathbf{A}_2\times\mathrm{rot}\mathbf{A}_1,$$

$$\mathrm{div}(\Phi\mathbf{A}) = \Phi\mathrm{div}\mathbf{A} + \mathbf{A}.\mathrm{grad}\Phi,$$

$$\mathrm{div}(\mathbf{A}_1\times\mathbf{A}_2) = \mathbf{A}_2.\mathrm{rot}\mathbf{A}_1 - \mathbf{A}_1.\mathrm{rot}\mathbf{A}_2,$$

$$\mathrm{rot}(\Phi\mathbf{A}) = \Phi\mathrm{rot}\mathbf{A} - \mathbf{A}\times\mathrm{grad}\Phi,$$

$$\mathrm{rot}(\mathbf{A}_1\times\mathbf{A}_2) = (\mathbf{A}_2.\mathrm{grad})\mathbf{A}_1 - (\mathbf{A}_1.\mathrm{grad})\mathbf{A}_2 + \mathbf{A}_1\mathrm{div}\mathbf{A}_2 - \mathbf{A}_2\mathrm{div}\mathbf{A}_1,$$

$$(\mathbf{v}.\mathrm{grad})(\Phi\mathbf{A}) = \mathbf{A}(\mathbf{v}.\mathrm{grad}\Phi) + \Phi(\mathbf{v}.\mathrm{grad})\mathbf{A},$$

$$(\mathbf{v}.\mathrm{grad})(\mathbf{A}_1\times\mathbf{A}_2) = \mathbf{A}_1\times(\mathbf{v}.\mathrm{grad})\mathbf{A}_2 - \mathbf{A}_2\times(\mathbf{v}.\mathrm{grad})\mathbf{A}_1.$$

The book is dedicated primarily to low-acceleration electromagnetism. Only Chapter IV is dedicated to high-acceleration electromagnetism (radiation of electromagnetic waves). This Chapter can be simply omitted by the persons who are not interested to learn how I solve the problems about the radiation of energy.

Well. Now read the book. Without fear - you are in paradise under the shadow of a beautiful cherry-tree. When opening your mouth, the cherries fall exactly in and the Divinity combs his long white beard on the medow next to yours solving the cross-words in the last day English press.

And after ten days you will know electromagnetism much better than any other professor in the world.

Let me make at the end an important remark concerning the nasty and disgusting problem about the measuring systems. In my address "Marinov to the world's scientific conscience"[(45)] I wrote: "In the damned system SI B and H are, my God!, two quantities with different dimensions, so that even the grandchildren of our grandchildren will curse and swear at us when studying electromagnetism." One of the most important reasons that electromagnetism cannot be understood by the students is the damned measuring system SI. If the electromagnetic units of measurement (ampere, volt, etc.) had been introduced on the basis of the Gauss system, the mental disorders between the students (and the professors!) of the high technical schools would be with 35% less.

But we have this damned system SI and cursing and swearing we must live with it, as every European who comes to the Island with his own car has to drive on the left and curse and swear...

I dedicated a whole Chapter (Chapter V) to the measuring systems to save my readers from mental disorders, as such a chapter cannot be found in the current text-books (I can make the same bet as above!). Read this chapter attentively, and then have always under hand Table 43.2 jumping from the Gauss system to the SI system (and vice versa) without thinking too much. Think then theoretically in the Gauss system, as I do in Chapters I-IV, and make the numerical calculations for the experiments in the SI system, as I do in Chapter VI.

Italians say: *Guadagna a Milano e spendi a Napoli.*

Graz, July 1993

Stefan MARINOV

Hoferfinder,

Oberstallknecht von Niederschöckl

Il Signor GENIO TEORICO e la Signorina ESPERIMENTALINA

CONTENTS:

V. SYSTEMS OF UNITS

VI. EXPERIMENTAL VERIFICATIONS

I. AXIOMATICS

1. INTRODUCTION

As a result of my experimental and theoretical work in the last twenty years, I firmly established that space and time are absolute categories, such as defined by Newton and conceived intuitively by everybody during one's childhood and student life. The crucial experiments supporting this viewpoint are my "rotating axle" experiments(1-6), by means of which for the first time in history I succeeded in measuring the Earth's absolute velocity in a laboratory.

Proceeding from the absolute space-time concepts, I tried to build all of CLASSICAL (i.e., non-quantum and non-statistical) PHYSICS on a firm and clearly defined axiomatical basis. I established that this axiomatical basis can by chosen in a very simple, intuitively comprehensible manner, and that all fundamental equations in classical physics can be then obtained by plain and rigorous mathematical speculations.

The internal logic of the theory impelled me to introduce axiomatically, by analogy with the magnetic energy, a companion to the gravitational energy which I called MAGRETIC ENERGY (Heaviside first has done this). Until now human experience has not established the existence of such a type of energy, but neither has it shown whether such an energy should not exist. Thus the magretic energy is a hypothetical notion. Nevertheless, I hope that in future, when experimental techniques will offer the necessary possibilities, the existence of magretic energy might be revealed.

I propose an aether-type model for light propagation, i.e., I assume that light propagates with a constant velocity along any direction only in absolute space. However, the "aether" is not some medium at rest in absolute space in which light propagates like sound in air. I firmly defend the corpuscular (Newton) model of light propagation, rejecting the wave (Huyghens-Fresnel) model, so that I call my model for light propagation NEWTON-AETHER MODEL.

Within effects of first order in V/c (V is the absolute velocity of the reference frame considered, c is the velocity of light in absolute space or the to-and-fro velocity in any inertial frame), all physical and light propagation phenomena can be rightly described by the traditional "Newtonian" mathematical apparatus, and thus within this accuracy the Galilean transformation is adequate to physical reality. I call this the low-velocity mathematical approach (LOW-VELOCITY PHYSICS).

The low-velocity mathematical apparatus wrongly describes the effects of second (and higher) order in V/c. For a correct explanation of these effects, the Newton-aether model of light propagation must be replaced by the MARINOV-AETHER MODEL.

The high-velocity mathematical approach (HIGH-VELOCITY PHYSICS) based on the Lorentz transformation and on its companion the Marinov transformation (both of which can be considered as mathematical presentation of the Marinov-aether character of light propagation), as well as on the 4-dimensional mathematical formalism of Minkowski, rightly describes the effects of any order in V/c.[3,5,7] However, the Lorentz transformation and the 4-dimensional mathematical apparatus must be treated from an absolute point of view, as is done in my absolute space-time thepry.[5] If they are treated and manipulated from a "relativistic" point of view, as is done in the Einstein approach to the theory of relativity, results inadequate in regard to physical reality are obtained. The errors to which the theory of relativity leads are within effects of first order in V/c.

In my approach I assume axiomatically (see the second axiom in Sect. 2) that the velocity of light, propagating along the direction **n** in absolute space and along the direction **n**' in a frame moving with a velocity **V** is absolute space, is equal not to

$$c' = c\{1 - (\mathbf{n}'\times\mathbf{V}/c)^2\}^{1/2} - \mathbf{n}'.\mathbf{V} = c(1 - 2\mathrm{n}.\mathbf{V}/c + V^2/c^2)^{1/2}, \qquad (1.1)$$

as it must be according to the traditional Newtonian concepts but to

$$c' = \frac{c(1 - V^2/c^2)^{1/2}}{1 + \mathbf{n}'.\mathrm{V}/c} = \frac{c(1 - \mathrm{n}.\mathrm{V}/c)}{(1 - V^2/c^2)^{1/2}}. \qquad (1.2)$$

These formulas differ one from another only within terms of second order in V/c. In this book I shall not present motivations for the substitution of formulas (1.1) by the formulas (1.2) and the reader can find such motivations in Refs. 3,5,7,8. Accepting axiomatically the validity of formulas (1.2), I remove from the way to the scientific truth a terribly heavy stone which has for about a century tormented humanity. I showed[3,5,7,8] that either one has to introduce the peculiar Marinov-aether character of light propagation into the theory, or one should be unable to bring all effects observed in space-time physics under one hat.

Formula (1.1) shows that the time which a light pulse needs to cover a distance d in the moving frame is equal to $\Delta t_{\parallel} = 2d/(1 - V^2/c^2)$ when this distance is parallel to the frame's motion and to $\Delta t_{\perp} = 2d/(1 - V^2/c^2)^{1/2}$ when it is perpendicular t the frame's motion. Formula (1.2) shows that in both these cases the time should be the same $\Delta t_{\parallel} = \Delta t_{\perp} = 2d/(1 - V^2/c^2)^{1/2}$ and with the factor $(1 - V^2/c^2)^{-1/2}$ larger than the time needed to cover the same distance d when it is at rest in absolute space. (Take into account that when d is parallel to the frame's motion $\mathbf{n}'.\mathbf{V} = \mathbf{n}.\mathbf{V} = V$, $(\mathbf{n}'\times\mathbf{V})^2 = 0$, and when d is perpendicular to the frame's motion $\mathbf{n}'.\mathbf{V} = 0$, $\mathbf{n}.\mathbf{V} = V^2/c$, $(\mathbf{n}'\times\mathbf{V})^2 = V^2$. A LIGHT CLOCK sends successively light pulses to and fro.

If we define the time unit in the ABSOLUTE (attached to absolute space) FRAME and in the RELATIVE (moving) FRAME by the time which light needs to cover a certain distance d to and fro, we obtain that the time unit in the moving frame (which I call PROPER TIME UNIT) is larger by the factor $(1 - V^2/c^2)^{-1/2}$ than the time unit in the rest frame (which I call UNIVERSAL TIME UNIT). Thus the Marinov-aether character of light propagation automatically introduces the CLOCK RETARDATION which I consider (and I show this[3,5]) to be a physical effect; thus I do not use the notion "TIME

One may add that formulas (1.2) can be considered as introducing also automatically the "LENGTH CONTRACTION", but I firmly defend the opinion that the "length contraction" is not a physical effect and appears in the mathematical apparatus only because of the peculiar Marinov-aether character of light propagation.

I showed[3,5,7,8] that if the isotropy of the to-and-fro light velocity in the moving frame will be coupled with the principle of relativity, the Lorentz transformation should be obtained, while if it will be coupled with the existence of absolute space, the Marinov transformation formulas should be obtained. My experiments[1-6] demonstrated that the Marinov transformation is adequate to physical reality and I showed[3,5,7,8] how the Lorentz transformation is to be reconciled with physical reality, i.e., with the space-time absoluteness. I showed also[3,5,7,8] the fundamental difference between the LORENTZ and MARINOV INVARIANCES which can be briefly delineated as follows:

If there is an isolated material system of several interacting particles, the most natural and simple approach is to consider the motion of these particles in a frame attached to absolute space. Then we can make the following two transformations:

1) To move the whole system with a velocity **V** in absolute space and to consider the appearing in the system physical phenomena further in absolute space.

2) To leave the system untouched and to consider the appearing in the system phenomena in another (relative) frame which moves with a velocity **V** in absolute space.

According to the principle of relativity, these two transformations must lead to identical results for all phenomena which can be observed in the system, as according to this principle an absolute space does not exist and if there is a system and observer, it is immaterial whether the observer moves with respect to the system or the system moves with respect to the observer.

According to my absolute space-time theory, the two mentioned transformations do not lead to identical results, although many of the observed phenomena remain identical, first of all the low-velocity mechanical phenomena, but not the electromagnetic and high-velocity mechanical phenomena.

When we wish to obtain results adequate to physical reality, we have to use the Lorentz transformation only when making the first of the above transformations. In such a case the "moving frame" K' in which we first consider the material system (usually if the system represents a single particle, it is at rest in K', and if the system has many particles, its center of mass is at rest in K') and the "rest frame" K in which we then consider the system (and in which the single particle or the center of mass of the system move with a velocity **V**) is one and the same physical frame attached to absolute space. Thus it is not the observer who has changed his velocity with respect to absolute space, but the system has changed its velocity from zero to **V** with respect to absolute space. As the velocity of light in absolute space is c along any direction, then in the "moving frame" K' and in the "rest frame" K it will preserve its constant value along all directions because, I repeat, K and K' are, as a matter of fact, one and the same physical frame. When making such a kind of transformation we must always replace the 4-dimensional scalars observed in K' by their 4-dimensional analogues in K, i.e., we have to work with the Lorentz invariant quantities.

When making the second of the above transformations, we have to use the Marinov transformation. In such a case the frame K is attached to absolute space and the moving frame K' moves with a velocity **V** in absolute space, i.e., those are <u>two different physical frames</u>, whilst the observed system has always the same character of motion with respect to absolute space. Now the velocity of light will be c in the rest frame K, but it will be direction dependent in the moving frame K'. When making such a kind of transformation we have to replace the 3-dimensional scalars observed in K by their 3-dimensional analogues in K', keeping in mind that the Marinov invariant quantities as the space and time energies have the <u>same</u> values in K and K'.

When K and K' are two inertial frames, it is not easy to find experiments revealing the difference between the above two transformations and I was the first man constructing such experiments (such <u>successful</u> experiments!). However when K' is a rotating frame, then it is of cardinal importance whether the observed system rotates with respect to the observer or the observer rotates with respect to the system. Being unable to understand the difference between the first and second transformations for inertial frames, the relativists were unable to understand many substantial differences for the case where K and K' rotate one with respect to the other. Moreover ideal inertial frames do not exist because for any frame moving with an enough constant velocity in absolute space always a far enough center can be found, so that the motion of the frame can be considered as rotation about this center. This theorem is similar to Archimedes' theorem that for any big enough number always a number which is bigger can be found.

2. THE AXIOMS OF CLASSICAL PHYSICS

The fundamental undefinable notions (concepts) in physics are:

a) space,

b) time,

c) energy (matter).

I consider the notions "MATTER" and "MATERIAL SYSTEM" as synonyms of the notions ENERGY and ENERGY SYSTEM.

An IMAGE (MODEL) OF A MATERIAL SYSTEM is any totality of imprints (symbols) with the help of which, if corresponding possibilities and abilities are at our disposal, we can construct another system IDENTICAL with the given one. We call two material systems identical if their influence on our sense-organs (directly, or by means of other material systems) is the same. We call two images of a given material system EQUIVALENT if with their help identical systems can be constructed. An image is ADEQUATE TO PHYSICAL REALITY if the impact of the considered system on our sense-organs, as predicted from this image, is the same as the actual impact.

A material system is called ISOLATED if it can be represented by a model independent of other material systems.

We imagine space as a continuous, limitless, three-dimensional totality of space points. The different Cartesian frames of reference (these are geometrical, i.e., mathematical concepts) with which we represent space may have various relations with respect to each other. Depending on their relationship to each other, any pair of Cartesian frames of reference will belong to one or more of the following three classes:

1. Frames with different origins.
2. Frames whose axes are mutually rotated.
3. Frames with differently oriented (or reflected) axes (right or left orientation).

The fundamental properties of space may be defined as:

1. HOMOGENEITY. Space is called homogeneous if considering any material system in any pair of space frames of the first class, we always obtain equivalent images.

2. ISOTROPY. Space is called isotropic if considering any material system in any pair of space frames of the second class, we always obtain equivalent images.

3. REFLECTIVITY. Space is called reflective if considering any material system in any pair of space frames of the third class, we always obtain equivalent images.

We imagine time as continuous, limitless, one-dimensional totality of moments (time points). Here frames of reference for time of the first and third class only can be constructed, i.e., time frames with different origins and oppositely directed axes. The fundamental properties of time may be defined as:

1. HOMOGENEITY. Time is called homogeneous if considering any material system in any pair of time frames of the first class, we always obtain equivalent images.

2. REVERSIBILITY. Time is called reversible if considering any material system in any pair of time frames of the third class, we always obtain equivalent images.

The assertions of my first (for space), second (for time), third (for energy), fourth (for the first type of space energy), fifth (for the second type of space energy), sixth (for time energy), seventh (for the first type of space-time energy), eighth (for the second type of space-time energy) and ninth (for conservation of energy) axioms are the following:

AXIOM I. SPACE is homogeneous, isotropic and reflective. The unit of measurement L for distances (i.e., space intervals along one of the three dimensions in space) has the property of length and may be chosen arbitrarily. ABSOLUTE SPACE is the reference frame in which the world as a whole is at rest.

AXIOM II. TIME is homogeneous. The unit of measurement T for time intervals has the property of time and is to be established from the following symbolical relation

$$L/T = c, \qquad (2.1)$$

where c is a universal constant which has the property of velocity (length divided by time). Light propagates in absolute space with this velocity which is called UNIVERSAL LIGHT VELOCITY. In a frame moving with a velocity $\mathbf{V}$ in absolute space the two-way light velocity along any arbitrary direction, called PROPER LIGHT VELOCITY, is

$$c_0 = c/(1 - V^2/c^2)^{1/2}, \tag{2.2}$$

while the one-way light velocity along a direction concluding an angle θ' with $\mathbf{V}$, called PROPER RELATIVE LIGHT VELOCITY, is

$$c_0' = c/(1 + V\cos\theta'/c). \tag{2.3}$$

Thus $c' = c_0'(1 - V^2/c^2)^{1/2}$ must be called UNIVERSAL RELATIVE LIGHT VELOCITY. The time unit in any frame is defined by the period for which light covers a half-length unit to and fro. Hence the universal time intervals are measured on light clocks which are at rest in absolute space, while the proper time intervals are measured on light clocks which are at rest in the moving frame.

AXIOM III. All individually different material systems can be characterized by a uniform (i.e., having the same qualitative character) quantity which is called ENERGY and which can only have different numerical value for different material systems. The unit of measurement E for energy has the property of energy and is to be established from the following symbolical relation

$$ET = h, \tag{2.4}$$

where h is a universal constant which has the property of ACTION (energy multiplied by time) and is called PLANCK CONSTANT. If we assume the numerical values of c and h to be unity, then the corresponding units for length, time and energy are called NATURAL UNITS OF MEASUREMENT. MATERIAL POINTS (or PARTICLES) are those points in space whose energy is different from zero. Every particle is characterized by a parameter m, called UNIVERSAL MASS, whose dimensions and numerical value are to be established from the relation

$$e = mc^2, \tag{2.5}$$

where e is the energy of the material point when it is at rest in absolute space and is called UNIVERSAL (TIME) ENERGY. When a particle moves in absolute space its energy is called PROPER (TIME) ENERGY and has two forms: the MARINOV TIME ENERGY (or SECOND PROPER TIME ENERGY) and the HAMILTON TIME ENERGY (or FIRST PROPER TIME ENERGY)

$$e_{00} = mc_0^2/2 = mc^2/2(1 - v^2/c^2), \quad e_0 = mcc_0 = mc^2/(1 - v^2/c^2)^{1/2} = m_0c^2, \tag{2.6}$$

where the quantity m_0 is called PROPER MASS. Other important characteristics of a material point are the quantities

$$\mathbf{p} = m\mathbf{v} \quad (\mathbf{p}_0 = m_0\mathbf{v}) \qquad \text{and} \qquad \bar{p} = mc \quad (\bar{p}_0 = m_0c), \tag{2.7}$$

called, respectively, the UNIVERSAL (PROPER) SPACE MOMENTUM and the UNIVERSAL (PROPER) TIME MOMENTUM. Furthermore every particle is also characterized by the quantities

$k = p/h = mv/h$ $(k_0 = p_0/h = m_0v/h)$ and $\bar{k} = \bar{p}/h = mc/h$ $(\bar{k}_0 = \bar{p}_0/h = m_0c/h)$, (2.8)

called, respectively, the UNIVERSAL (PROPER) WAVE VECTOR and the UNIVERSAL (PROPER) WAVE SCALAR. Two material points can be discerned one from another if the space distance between them (at a given moment) is more than their PROPER WAVE LENGTH $\lambda_0 = 1/\bar{k}_0$, or the time interval between their passages through a given space point is more than their PROPER PERIOD $\tau_0 = 1/c\bar{k}_0$. If these conditions are not fulfilled, the particles interfere (the phenomenon "interference" will be not considered in this book).*

AXIOM IV (NEWTON'S LAW). The individual image of a material system in space is given by the value of its PROPER GRAVITATIONAL ENERGY U_g. The energy U_g of two particles is proportional to their proper time momenta $\bar{p}_{01}$, $\bar{p}_{02}$ divided by c and inversely proportional to the distance r between them

$$U_g = - \gamma\bar{p}_{01}\bar{p}_{02}/c^2r = - \gamma m_{01}m_{02}/r. \tag{2.9}$$

The coupling constant γ, called the GRAVITATIONAL CONSTANT, shows what part of the energy unit represents the gravitational energy of two unit masses separated by a unit distance. The mass m_e of an important class of elementary (non-divisible) particles, called electrons, is a universal constant called the MASS OF ELECTRON. If one works with natural units and assumes the numerical value of the electron mass to be unity, i.e., $m_e = 1\ E\ L^{-2}T^4$, then the gravitational constant has the value $\gamma = 2.78\times10^{-46}\ E^{-1}L^5T^{-4}$. If taking in (2.9) not the proper but the universal masses, U_g is called UNIVERSAL GRAVITATIONAL ENERGY.

AXIOM V (COULOMB'S LAW). In addition to the mass parameter, every particle is characterized by a parameter q, called the ELECTRIC CHARGE. The quantities

$$j = qv, \qquad \bar{j} = qc \tag{2.10}$$

are called, respectively, the SPACE CURRENT and the TIME CURRENT. The individual image of a material system in space, in addition to its gravitational energy U_g, is also given by the value of its ELECTRIC ENERGY U_e. The energy U_e of two particles is proportional to their time currents $\bar{j}_1$, $\bar{j}_2$ divided by c and inversely proportional to the distance r between them

$$U_e = \bar{j}_1\bar{j}_2/\varepsilon_0c^2r = q_1q_2/\varepsilon_0r. \tag{2.11}$$

The coupling constant $1/\varepsilon_0$ is called the INVERSE ELECTRIC CONSTANT and ε_0 - the ELECTRIC CONSTANT; the inverse electric constant shows what part of the energy unit represents the electric energy of two unit charges separated by a unit distance. The

---

* The recent experiments of F. Louradour et al. (Am. J. Phys., **61**, 242 (1993)) have shown that two extremely short light waves, practically photons concentrated in a single space-time point, can interfere when these photons are radiated from different sources and have different frequencies, i.e., periods, the only condition being that at a given moment they cross the same space point. Thus the conclusion of certain physicists that a photon can interfere with itself is an absurdity. Any particle interferes with any other particle, but only at certain conditions this interference can be observed.

dimensions of the electric charge q and of the electric constant ε_0 are to be established from (2.11), thus the dimensions of one of them are to be chosen arbitrarily. The electric charge of every elementary particle is equal to q_e, $-q_e$, or 0, where q_e is a universal constant called THE CHARGE OF ELECTRON. If we work with natural units and assume the numerical value of the electron charge to be unity, i.e., q_e^2 = 1 EL, then the electric constant is dimensionless and has the numerical value ε_0 = 861.

AXIOM VI. The individual image of a material system in time is given by the value of its proper time energy E_0. The proper time energy of one particle e_0 depends on its absolute velocity **v**, i.e., on its velocity with respect to absolute space; the change (the differential) of the proper time energy is proportional to the scalar product of the velocity and the differential of the velocity, the mass of the particle being the coupling constant,

$$de_0 = m\mathbf{v}.d\mathbf{v}. \qquad (2.12)$$

AXIOM VII (MARINOV'S LAW). The individual image of a material system in space and time is given by the value of its PROPER MAGRETIC ENERGY W_g. The energy W_g of two particles is proportional to the scalar product of their proper space momenta $\mathbf{p}_{01}$, $\mathbf{p}_{02}$ divided by c and inversely proportional to the distance r between them

$$W_g = \gamma\mathbf{p}_{01}\cdot\mathbf{p}_{02}/c^2r = \gamma m_{01}m_{02}\mathbf{v}_1\cdot\mathbf{v}_2/c^2r. \qquad (2.13)$$

The coupling constant γ, called the MAGRETIC CONSTANT, is equal to the gravitational constant. If taking in (2.13) not the proper but the universal masses, W_g is called UNIVERSAL MAGRETIC ENERGY.

AXIOM VIII (NEUMANN'S LAW). The individual image of a material system in space and time, in addition to its magretic energy W_g, is also given by the value of its MAGNETIC ENERGY W_e. The energy W_e of two particles is proportional to the scalar product of their space currents $\mathbf{j}_1$, $\mathbf{j}_2$ divided by c and inversely proportional to the distance r between them

$$W_e = -\mu_0\mathbf{j}_1\cdot\mathbf{j}_2/c^2r = -\mu_0q_1q_2\mathbf{v}_1\cdot\mathbf{v}_2/c^2r. \qquad (2.14)$$

The coupling constant μ_0, called the MAGNETIC CONSTANT, is equal to the inverse electric constant.

AXIOM IX. FULL ENERGY H of a material system is called the sum of the time energy E_0 and the space energy U. TOTAL ENERGY $\tilde{H}$ is the full energy minus the space-time energy W. The numerical value of the total energy of an isolated material system remains constant in time, that is

$$d\tilde{H} = 0, \quad \text{i.e.,} \quad dE_0 + dU - dW = 0. \qquad (2.15)$$

NOTE. If we take a general look at equations (2.9), (2.11), (2.13) and (2.14), we see that it is more reasonable to choose as parameters of the space and space-time energies in gravimagretism and electromagnetism not the masses and the electric charges of the particles but their MARINOV MASSES and MARINOV ELECTRIC CHARGES

$$m^* = m/c, \qquad q^* = q/c. \qquad (2.16)$$

With the Marinov masses and charges the space and space-time energies of two particles will be written

$$U_g = -\gamma m^*_{o1} m^*_{o2} c^2/r, \qquad W_g = \gamma m^*_{o1} m^*_{o2} \mathbf{v}_1 \cdot \mathbf{v}_2/r, \qquad (2.17)$$

$$U_e = q^*_1 q^*_2 c^2/\varepsilon_o r, \qquad W_e = -\mu_o q^*_1 q^*_2 \mathbf{v}_1 \cdot \mathbf{v}_2/r. \qquad (2.18).$$

In the CGS-system of units - see Chapter V - we take $\varepsilon_o = 1/\mu_o = 1$.

3. TRANSFORMATION OF COORDINATES

For the sake of simplicity, the space geometry in this section will be one-dimensional.

If in the frame K', moving with the velocity V with respect to frame K, the radius vector of a certain point, which is at rest in K', is x', then its radius vector with respect to frame K will be

$$x = x' + Vt, \qquad (3.1)$$

where t is the (absolute) time interval between the initial moment when the origins of both frames have coincided and the moment of observation. This is the DIRECT GALILEAN TRANSFORMATION. The INVERSE GALILEAN TRANSFORMATION will be

$$x' = x - Vt. \qquad (3.2)$$

The Galilean transformation seems to be in conformity with the PRINCIPLE OF RELATIVITY as by considering either frame K or frame K' attached to absolute space nothing changes in the transformation formulas. I shall, however, add that since the time of Copernicus humanity does not make the error, when considering an object moving with respect to the fixed stars, to consider the object at rest and the stars moving. The Galilean transformation under this Copernican insight is, obviously, in conformity with the Newton-aether character of light propagation.

The Marinov-aether character of light propagation introduces changes into the Galilean transformation formulas. Taking into account the Marinov-aether character of light propagation, I showed(3,5,7) that:

1) By assuming the principle of relativity as valid, one obtains the Lorentz transformation formulas.

2) By assuming the principle of relativity as not valid, one obtains the Marinov transformation formulas.

As these demonstrations are time and space consuming, I shall not give them here (see Refs. 3, 5 or 7), and I shall only give the formulas for the:

1. DIRECT AND INVERSE LORENTZ TRANSFORMATIONS

$$x' = (x - Vt)/(1 - V^2/c^2)^{1/2}, \qquad t' = (t - xV/c^2)/(1 - V^2/c^2)^{1/2}, \qquad (3.3)$$

$$x = (x' + Vt')/(1 - V^2/c^2)^{1/2}, \qquad t = (t' + x'V/c^2)/(1 - V^2/c^2)^{1/2}. \qquad (3.4)$$

2. DIRECT AND INVERSE MARINOV TRANSFORMATIONS

$$x' = (x - Vt)/(1 - V^2/c^2)^{1/2}, \qquad t_0 = t(1 - V^2/c^2)^{1/2}, \qquad (3.5)$$

$$x = x'(1 - V^2/c^2)^{1/2} + Vt_0/(1 - V^2/c^2)^{1/2}, \qquad t = t_0/(1 - V^2/c^2)^{1/2}. \qquad (3.6)$$

One sees that the Lorentz transformation formulas are entirely symmetric and thus one can attach either frame K to absolute space (in this case light velocity will be isotropic in K and anisotropic in K') or frame K' (in this case light velocity will be isotropic in K' and anisotropic in K), while the Marinov transformation formulas are not symmetric, so that frame K is to be considered attached to absolute space and the velocity of light is isotropic in K and anisotropic in K'.

The time "coordinates" in the Lorentz transformation do not present real physical time, as in their transformation formulas space coordinates do appear. I call such time RELATIVE (or LORENTZ TIME). The time in the Marinov transformation is real measurable physical time. There is only the stipulation that the time units used in frames moving with different velocities with respect to absolute space are different, as in my second axiom I chose the time unit in any frame to be equal to the duration which a light pulse takes to cover a half-unit distance to and fro. I showed[3,5] that, as in any periodic phenomenon, independent of its character, light velocity plays an important role, the clock retardation appears not only in "light clocks" but in any other "clock".

The Marinov transformation is adequate to physical reality. The Lorentz transformation can be kept adequate to physical reality only if it will be considered from an absolute point of view, thus if the relative time will be considered not adequate to real time and the relative (or Lorentz) velocity[3,5] appearing in the Lorentz transformation formulas for velocities will be considered not as real velocity. In Refs. 3 and 5 I show the way in which the Lorentz transformation can be saved from the pernicious Einstein's relativistic claws. In Einstein's claws the Lorentz transformation contradicts physical reality and the errors to which it leads are of first order in V/c. Let me remember that the errors to which the Galilean transformation formulas lead are of second order in V/c. Thus the Lorentz transformation in Einstein's claws is a worse mathematical apparatus than the Galilean transformation.

In the Lorentz transformation, it is assumed that the velocity of light has an absolute constant value in any inertial frame; however, as the space coordinates enter into the transformation formulas for time, time is assumed "relative". In the Marinov transformation, time is assumed absolute (consequently the space coordinates are not present in the transformation formulas for time) and the velocity of light appears to be relative, i.e., direction dependent in any moving frame. My approach is straightforwardly adequate to physical reality, while in the Lorentz transformation the absoluteness of time is transferred to light velocity and the relativity of light velocity is transferred to time. Nevertheless the Lorentz transformation is very useful in theretical physics because it allows the introduction of the powerful mathematical apparatus of the 4-dimensional formalism which gives extreme simplicity and elegance to electromagnetism and, according to my concepts, to gravimagretism, too. In my absolute space-time theory[5] I work intensively with the 4-dimensional mathematical formalism and I introduced the following very convenient notations:

$$\overset{\mapsto}{a} = (\vec{a},\ i\bar{a}) = (\mathbf{a},\ i\bar{a}) \qquad (3.7)$$

is a 4-VECTOR where $\vec{a} = \mathbf{a}$ is its space part and $\bar{a}$ is its time part,

$$\overset{\leftrightarrow\leftrightarrow}{a} = \begin{vmatrix} \overset{\leftrightarrow}{a} & i\vec{a} \\ i\tilde{\vec{a}} & -\bar{a} \end{vmatrix} \qquad (3.8)$$

is a 4-TENSOR where $\overset{\leftrightarrow}{a}$ is its space-space part, $\vec{a} = \mathbf{a}$ is its space-time part, $\tilde{\vec{a}} = \tilde{\mathbf{a}}$ is its time-space part and $\bar{a}$ is its time-time part,

$$\bigtriangledown = (\partial/\partial x,\ \partial/\partial y,\ \partial/\partial z,\ -i\partial/c\partial t) = (\partial/\partial x)\hat{\mathbf{x}} + (\partial/\partial y)\hat{\mathbf{y}} + (\partial/\partial z)\hat{\mathbf{z}} - (i\partial/c\partial t)\hat{\tau}, \qquad (3.9)$$

where $\hat{\mathbf{x}}$, $\hat{\mathbf{y}}$, $\hat{\mathbf{z}}$ are the unit vectors along the three space axes and $\hat{\tau}$ is the unit vector along the time axis, is a symbolical 4-vector calle by me the ERMA OPERATOR (in honour of my girl-friend, the Bulgarian physicist Erma Gerova), the square of which is the symbolical 4-dimensional scalar, called the d'ALEMBERT OPERATOR (the symbol is proposed by me)

$$\bigtriangleup = \bigtriangledown . \bigtriangledown = \partial^2/\partial x^2 + \partial^2/\partial y^2 + \partial^2/\partial z^2 - \partial^2/c^2\partial t^2. \qquad (3.10)$$

The four-dimensional Erma and d'Alembert operators correspond to the three-dimensional HAMILTON OPERATOR and LAPLACE OPERATOR

$$\nabla = (\partial/\partial x,\ \partial/\partial y,\ \partial/\partial z) = (\partial/\partial x)\hat{\mathbf{x}} + (\partial/\partial y)\hat{\mathbf{y}} + (\partial/\partial z)\hat{\mathbf{z}}, \qquad (3.11)$$

$$\Delta = \partial^2/\partial x^2 + \partial^2/\partial y^2 + \partial^2/\partial z^2.$$

4. VELOCITY, ACCELERATION, SUPER-ACCELERATION

I introduce two kinds of velocity of a particle (by analogy with the universal and proper light velocities):

The UNIVERSAL VELOCITY

$$\mathbf{v} = d\mathbf{r}/dt, \qquad (4.1)$$

where dr is the distance covered by the particle (which is absolute and does not depend on the frame in which we are working) for a time interval dt registered on a UNIVERSAL CLOCK (i.e., a clock attached to absolute space).

The PROPER VELOCITY

$$\mathbf{v}_o = d\mathbf{r}/dt_o = d\mathbf{r}/dt(1 - v^2/c^2)^{1/2} = \mathbf{v}/(1 - v^2/c^2)^{1/2}, \qquad (4.2)$$

where the time interval dt_o is read on a PROPER CLOCK (i.e., a clock attached to the particle).

It is logical to introduce three kinds of acceleration:

The UNIVERSAL ACCELERATION

$$\mathbf{u} = d\mathbf{v}/dt = d^2\mathbf{r}/dt^2. \tag{4.3}$$

The FIRST PROPER ACCELERATION

$$\mathbf{u}_0 = \frac{d\mathbf{v}_0}{dt} = \frac{d}{dt}\left(\frac{d\mathbf{r}}{dt_0}\right) = \frac{\mathbf{u}}{(1 - v^2/c^2)^{1/2}} + \frac{\mathbf{v}}{c^2}\frac{\mathbf{v}.\mathbf{u}}{(1 - v^2/c^2)^{3/2}}. \tag{4.4}$$

The SECOND PROPER ACCELERATION

$$\mathbf{u}_{00} = \frac{d\mathbf{v}_0}{dt_0} = \frac{d}{dt_0}\left(\frac{d\mathbf{r}}{dt_0}\right) = \frac{\mathbf{u}}{1 - v^2/c^2} + \frac{\mathbf{v}}{c^2}\frac{\mathbf{v}.\mathbf{u}}{(1 - v^2/c^2)^2}. \tag{4.5}$$

Further it is logical to introduce four kinds of super-acceleration:

The UNIVERSAL SUPER-ACCELERATION: $\mathbf{w} = d\mathbf{u}/dt$.

The FIRST PROPER SUPER-ACCELERATION: $\mathbf{w}_0 = d\mathbf{u}_0/dt$.

The SECOND PROPER SUPER-ACCELERATION: $\mathbf{w}_{00} = d\mathbf{u}_{00}/dt$.

The THIRD PROPER SUPER-ACCELERATION: $\mathbf{w}_{000} = d\mathbf{u}_{00}/dt_0$.

5. TIME ENERGY

5.1. THE LOW-VELOCITY CONSIDERATION.

From the axiomatical relation (2.12), immediately after integration, the form of the TIME ENERGY of a particle with mass m in low-velocity physics can be obtained

$$e_0 = mv^2/2 + \text{Const}. \tag{5.1}$$

If we assume Const = 0, we obtain the form of the KINETIC ENERGY

$$e_k = mv^2/2. \tag{5.2}$$

If we assume Const = mc^2 (see the third axiom), we obtain the form of the time energy in low-velocity physics, called LOW-VELOCITY TIME ENERGY

$$e_1 = mc^2 + mv^2/2. \tag{5.3}$$

5.2. THE HIGH-VELOCITY CONSIDERATION.

To obtain the TIME ENERGY of a particle in high-velocity physics, we have to put in the axiomatical relation (2.12) the proper velocity $\mathbf{v}_0$ instead of the universal velocity $\mathbf{v}$. There are three possibilities

$$de^0 = m\mathbf{v}_0.d\mathbf{v}, \qquad de_0 = m\mathbf{v}.d\mathbf{v}_0, \qquad de_{00} = m\mathbf{v}_0.d\mathbf{v}_0, \tag{5.4}$$

and after integration we obtain three different expressions for the time energy in high-velocity physics

$$e^0 = - mc^2(1 - v^2/c^2)^{1/2} = - mc^2 + mv^2/2 = - e + e_k, \tag{5.5}$$

$$e_0 = mc^2/(1 - v^2/c^2)^{1/2} = mc^2 + mv^2/2 = e + e_k, \tag{5.6}$$

$$e_{00} = mc^2/2(1 - v^2/c^2) = mc^2/2 + mv^2/2 = e/2 + e_k, \tag{5.7}$$

where all constants of integration are taken equal to zero. I call these three forms, respectively, LAGRANGE TIME ENERGY, HAMILTON TIME ENERGY and MARINOV TIME ENERGY. All these three forms of time energy are used in theoretical physics, however the Hamilton energy is the most convenient as the proper time momentum, $\bar{p}_0$, is proportional to it

$$\bar{p}_0 = e_0/c = m_0 c = mc/(1 - v^2/c^2)^{1/2}. \qquad (5.8)$$

From here again (see the second formula (2.6)) we obtain the relation between proper mass and universal mass

$$m_0 = m/(1 - v^2/c^2)^{1/2} = m^* c_0, \qquad (5.9)$$

where $c_0 = c/(1 - v^2/c^2)^{1/2}$ is the proper light velocity in a frame attached to the particle, which I call PROPER TIME VELOCITY <u>of the particle</u>. According to my concepts one has to work <u>always</u> with the universal mass and its velocity dependence is to be transferred to the time velocity of the particle. Thus I use the notion "proper mass" only for certain convenience and the reader has never to forget that in the Newton's gravitational law (see the fourth axiom) the mass appears coupled with light velocity. Or to say even more clear: the notion "mass" does not exist; only the notion "energy" ("time momentum") does exist.

The product of the mass of the particle by its acceleration is called KINETIC FORCE. Thus

$$\mathbf{f} = m\mathbf{u}, \qquad f_0 = mu_0, \qquad f_{00} = mu_{00} \qquad (5.10)$$

are, respectively, the UNIVERSAL KINETIC FORCE, the FIRST PROPER KINETIC FORCE and the SECOND PROPER KINETIC FORCE of the particle. I denote always the kinetic force <u>of</u> the particle (of the system of particles) by small letter "f" and the potential force (see later) acting <u>on</u> the particle (on the system of particles) by capital letter "F". As we shall see in the next chapter, the kinetic force of a particle is always equal to the potential force acting on the particle. This equality is the fundamental equation in physics.

II. THE FUNDAMENTAL EQUATIONS OF CLASSICAL PHYSICS

6. THE LAGRANGE EQUATIONS

6.1. THE LOW-VELOCITY CONSIDERATION.

The space energy U and the space-time energy W are called by the common name POTENTIAL ENERGIES. As can be seen easily, the space-time energy is to be considered only in high-velocity physics as its presence leads to effects of the order v/c; in low-velocity physics, when speaking about potential energy, we take into account only the space energy. In low-velocity physics I write time energy E without the subscript "o" and I usually mean only the kinetic energy.

Let us assume that in a time dt the space (potential) energy U and the time (i.e., kinetic) energy E of an isolated system of n particles have changed their values by dU and dE. Denote by $\mathbf{r}_i$, $\mathbf{v}_i$, $\mathbf{u}_i$, e_i, respectively, the radius vector, velocity, acceleration and energy (i.e., kinetic energy) of the i-th particle. As space energy depends only on the distances between the particles (I repeat, the velocity dependence of the gravitational space energy is a high-velocity phenomenon), we shall have

$$dU = \sum_{i=1}^{n} \frac{\partial U}{\partial \mathbf{r}_i} . d\mathbf{r}_i . \qquad (6.1)$$

The kinetic energy depends only on the velocities of the particles, and thus

$$dE = \sum_{i=1}^{n} \frac{\partial E}{\partial \mathbf{v}_i} . d\mathbf{v}_i = \sum_{i=1}^{n} \frac{\partial e_i}{\partial \mathbf{v}_i} . d\mathbf{v}_i = \sum_{i=1}^{n} \frac{d}{dt}\left(\frac{\partial e_i}{\partial \mathbf{v}_i}\right) . d\mathbf{r}_i , \qquad (6.2)$$

where we have taken into account (5.2) and the relation

$$\mathbf{u}_i . d\mathbf{r}_i = \mathbf{v}_i . d\mathbf{v}_i , \qquad (6.3)$$

which can be proved right by dividing both sides by dt.

Substituting (6.1) and (6.2) into the fundamental axiomatical equation (2.15), and dividing by dt, we obtain

$$\sum_{i=1}^{n} \left\{\frac{d}{dt}\left(\frac{\partial e_i}{\partial \mathbf{v}_i}\right) + \frac{\partial U}{\partial \mathbf{r}_i}\right\} . \mathbf{v}_i = 0. \qquad (6.4)$$

In this equation all n (as a matter of fact, 3n) expressions in the brackets must be identically equal to zero because otherwise a dependence would exist between the components of the velocities of the different particles, and this would contradict our sixth axiom that the time energy of a particle of a system of particles depends only on its own velocity. Thus from (6.4) we obtain the following system of n vector equations

$$\frac{d}{dt}\left(\frac{\partial e_i}{\partial \mathbf{v}_i}\right) = - \frac{\partial U}{\partial \mathbf{r}_i}, \qquad i = 1, 2, \ldots, n, \qquad (6.5)$$

which are called the LAGRANGE EQUATIONS and represent the fundamental equations in low-velocity physics.

Taking into account (5.2), (4.3) and the first relation (5.10), we see that the left side of (6.5) represents the kinetic force f_i of the i-th particle. Introducing the notation

$$F_i = - \partial U/\partial r_i \tag{6.6}$$

and calling F_i the POTENTIAL FORCE which all n-1 particles exert on the i-th particle, we can write equations (6.5) in the form

$$f_i = F_i, \qquad i = 1,2,\ldots\ldots,n, \tag{6.7}$$

in which form they are called the NEWTON EQUATIONS (or NEWTON'S SECOND LAW).

The potential force with which the j-th particle acts on the i-th particle is $F_i^j = - \partial U_{ij}/\partial r_i$, and the potential force with which the i-th particle acts on the j-th particle is $F_j^i = - \partial U_{ij}/\partial r_j$, where U_{ij} is the space energy of these two particles. Since U_{ij} depends on the distance between the particles, we shall have

$$\partial U_{ij}/\partial r_i = - \partial U_{ij}/\partial r_j, \quad \text{i.e.,} \quad F_i^j = - F_j^i. \tag{6.8}$$

Thus the potential forces with which two particles of a system of particles (in general, two parts of the system) act on each other are always equal and oppositely directed along the line connecting them. Consequently also the kinetic forces of two interacting particles will be equal and oppositely directed along the line connecting them. This result is called NEWTON'S THIRD LAW.

6.2. THE HIGH-VELOCITY CONSIDERATION.

As the high-velocity forms of the space and space-time energies in gravimagretism and electromagnetism are different, the Lagrange equations in these two physical domains will be slightly different. I shall deduce the more complicated equations in gravimagretism, from which the equations in electromagnetism can immediately be obtained.

A. Gravimagretism.

In high-velocity gravimagretism the space energy U depends also on the velocities of the particles and equation (6.1) is to be replaced by the following one (see formulas (2.9), (5.9) and (4.4))

$$dU = \sum_{i=1}^{n} \left(\frac{\partial U}{\partial r_i}.dr_i + \frac{\partial U}{\partial v_i}.dv_i\right) = \sum_{i=1}^{n} \left\{\frac{\partial U}{\partial r_i}.dr_i + \frac{U_i v_i .dv_i}{c^2(1 - v^2/c^2)^{3/2}}\right\} = \sum_{i=1}^{n} \left(\frac{\partial U}{\partial r_i}.dr_i + \frac{U_i}{c^2} v_i .dv_{0i}\right), \tag{6.9}$$

where U_i is the part of the space energy in which the i-th particle takes part which is universal with respect to m_i.

In high-velocity physics equation (6.2) is to be replaced by the following one (see formulas (5.6), (5.5) and (4.4))

$$dE_o = \sum_{i=1}^{n} \frac{\partial E_o}{\partial \mathbf{v}_i}.d\mathbf{v}_i = \sum_{i=1}^{n} \frac{\partial e_{oi}}{\partial \mathbf{v}_i}.d\mathbf{v}_i = \sum_{i=1}^{n} \frac{d}{dt}\{(1 - \frac{v_i^2}{c^2})\frac{\partial e_{oi}}{\partial \mathbf{v}_i}\}.d\mathbf{r}_i = \sum_{i=1}^{n} \frac{d}{dt}(\frac{\partial e_i^o}{\partial \mathbf{v}_i}).d\mathbf{r}_i =$$

$$\sum_{i=1}^{n} m\mathbf{u}_{oi}.d\mathbf{r}_i, \qquad (6.10)$$

where e_{oi} and e_i^o are the Hamilton and Lagrange time energy of the i-th particle.

In high-velocity gravimagretism we have to take into account also the space-time energy W. However, taking into account that the magretic energy of two particles moving with velocities $\mathbf{v}_1$ and $\mathbf{v}_2$ is $\mathbf{v}_1.\mathbf{v}_2/c^2$ times less than their gravitational energy, we have to work <u>not</u> with the proper magretic energy of the system of masses but with its <u>universal</u> magretic energy.

In Ref. 5 when deducing the Lagrange equations in gravimagretism, I worked with the proper magretic energy of the system. This more complicated calculation was <u>needless</u>. Indeed, to discuss the problem whether we have to work with the proper or universal magretic energy is senseless, as we do not know whether a magretic energy does exist at all. Thus we shall consider W as the universal magretic energy

$$dW = \sum_{i=1}^{n} (\frac{\partial W}{\partial \mathbf{r}_i}.d\mathbf{r}_i + \frac{\partial W}{\partial \mathbf{v}_i}.d\mathbf{v}_i) = \sum_{i=1}^{n} \{\frac{\partial W}{\partial \mathbf{r}_i}.d\mathbf{r}_i + d(\frac{\partial W}{\partial \mathbf{v}_i}.\mathbf{v}_i) - d(\frac{\partial W}{\partial \mathbf{v}_i}).\mathbf{v}_i\}, \qquad (6.11)$$

We have

$$\sum_{i=1}^{n} d(\frac{\partial W}{\partial \mathbf{v}_i}.\mathbf{v}_i) = \sum_{i=1}^{n} dW_i = d\sum_{i=1}^{n} W_i = 2dW, \qquad (6.12)$$

where W_i is the part of the space-time energy in which the i-th particle takes part and there is

$$W = (1/2)\sum_{i=1}^{n} W_i, \qquad (6.13)$$

so that formula (6.11) can be written as follows

$$dW = \sum_{i=1}^{n} \{- \frac{\partial W}{\partial \mathbf{r}_i}.d\mathbf{r}_i + d(\frac{\partial W}{\partial \mathbf{v}_i}).\mathbf{v}_i\}. \qquad (6.14)$$

Substituting equations (6.9), (6.10) and (6.14) into the fundamental equation (2.15) and dividing by dt, we obtain by the same reasoning as in Sect. 6.1 the fundamental equations of motion in high-velocity gravimagretism

$$\frac{d}{dt}\{\frac{\partial(E^o - W)}{\partial \mathbf{v}_i}\} + (U_i/c^2)\mathbf{u}_{oi} = - \frac{\partial(U + W)}{\partial \mathbf{r}_i}, \qquad i = 1,2,\ldots\ldots,n, \qquad (6.15)$$

which I call the FULL LAGRANGE EQUATIONS IN GRAVIMAGRETISM. If there is no magretic energy, we have to put W = 0. But if the gravitational energy will depend on the proper masses of the particles, there still will be a difference between the low-velocity equations (6.5) and the high-velocity equations (6.15).

The quantity

$$\tilde{\mathbf{F}}_i = - \partial(U + W)/\partial \mathbf{r}_i \qquad (6.16)$$

is called FULL POTENTIAL FORCE. The quantity (6.6), as already said, is called potential force and if more precision is needed NEWTONIAN POTENTIAL FORCE.

The quantity

$$\tilde{f}_{oi} = (m + U_i/c^2)\, u_{oi} - \frac{d}{dt}\left(\frac{\partial W}{\partial v_i}\right) = \tilde{m}u_{oi} - \frac{d}{dt}\left(\frac{\partial W}{\partial v_i}\right) = f_{oi} - \frac{d}{dt}\left(\frac{\partial W}{\partial v_i}\right) \qquad (6.17)$$

is called PROPER FULL KINETIC FORCE. The quantity f_{oi} is called PROPER KINETIC FORCE and if more precision is needed PROPER NEWTONIAN KINETIC FORCE.

The quantity

$$\tilde{m} = m + U_i/c^2 \qquad (6.18)$$

is called FULL MASS and the mass m can be called with more precision NEWTONIAN MASS. As however $mc^2 \gg |U_i|$, a distinction between m and $\tilde{m}$ will be not made further.

The FULL NEWTON EQUATIONS are

$$\tilde{f}_{oi} = \tilde{F}_i, \qquad i = 1,2,\ldots\ldots,n. \qquad (6.19)$$

The FULL NEWTON'S THIRD LAW for the full potential forces with which two particles act one on another

$$\partial(U_{ij} + W_{ij})/\partial r_i = - \partial(U_{ij} + W_{ij})/\partial r_j, \quad \text{i.e.,} \quad \tilde{F}_i^j = - \tilde{F}_j^i, \qquad (6.20)$$

shows that these forces are equal and oppositely directed along the line joining them.

The FULL NEWTON'S THIRD LAW for the full kinetic forces of two interacting particles

$$f_{oi} - (d/dt)(\partial W_{ij}/\partial v_i) = - \{f_{oj} - (d/dt)(\partial W_{ij}/\partial v_j\}, \quad \text{i.e.,} \quad \tilde{f}_{oi} = - \tilde{f}_{oj} \qquad (6.21)$$

shows that these forces are also equal and oppositely directed. However it may be

$$f_{oi} \neq - f_{oj}, \qquad (6.22)$$

i.e., the Newtonian kinetic forces of two interacting particles in high-velocity physics may be not equal and oppositely directed. Hence at the availability of space-time energy the "Newtonian" Newton's third law might be violated.

B. Electromagnetism.

In electrimagnetism the space energy is not velocity dependent and the space-time energy has not "velocity dependent denominators". Thus, it is easy to see that the the FULL LAGRANGE EQUATIONS IN ELECTROMAGNETISM will have the form

$$\frac{d}{dt}\frac{\partial(E^o - W)}{\partial v_i} = - \frac{\partial(U + W)}{\partial r_i}, \qquad i = 1,2,\ldots\ldots,n. \qquad (6.23)$$

Correspondingly the PROPER FULL KINETIC FORCE will have the form

$$\tilde{f}_{oi} = mu_{oi} - \frac{d}{dt}\frac{\partial W}{\partial v_i} = f_{oi} - \frac{d}{dt}\frac{\partial W}{\partial v_i}, \qquad (6.24)$$

and here the notion "full mass" cannot be introduced, i.e., only the gravitational energy leads to a change of the Newtonian mass to a full mass but the electric energy does not. Pay attention in making the distinction: If there are two particles with masses m_1, m_2 and electric charges q_1, q_2 (let them be at rest), whose gravitational and electric energies are U_g and U_e, there will be a difference in the masses of the particles when they will be separated and when they will stay near one to another: the decreased mass of every particle will be given by formula (6.18), where U_i (< 0) is their gravitational energy. However, if we consider the two particles as a single particle, the mass of the composed particle will be, neglecting their mutual gravitationla energy as small with respect to their mutual electric energy,

$$m_{system} = 2m + U_e/c^2. \qquad (6.25)$$

There is nothing strange in this effect, as mass and energy are two names of the same thing and to pass from the masses to the energies we have only to multiply (6.25) by c^2.

As also in electromagnetism only the full kinetic forces are equal, oppositely directed and acting along the line joining the interacting particles, but the Newtonian kinetic forces are not, the "Newtonian" Newton's thid law in electromagnetism might become violated and only the full Newton's third law holds good (see Sect. 63). In electromagnetism also the energy conservation law may become violated (see Chapter VI).

One will perhaps pose the question: How have I come to a violation of the energy conservation law when this law is a fundamental axiom in my electromagnetic theory (axiom IX)? The answer is the following: My axiomatics concerns only the physics of particles. As in the physics of particles I assume the energy conservation law as a fundamental axiom, one can, of course, not violate this law for a system of single particles. But my experiments are done with solid bodies (pieces of metal), i.e., media, in which currents flow. Here the kinetic forces of the particles are "transferred" to the whole body (it can be also liquid) and this is the reason that leads to a violation of the energy conservation law in such experiments.

Of course, we are at the beginning of a new chapter in physics (the physics of the violation of the laws of conservation) and the mathematical and logical analysis of the appearing phenomena needs a much more profound experimental and theoretical research.

7. THE NEWTON-MARINOV EQUATION

Now I shall give another form of the full Lagrange equations in gravimagretism, called in this form also the Newton-Marinov equations.

Let us have a system of n masses m_i moving with velocities $\mathbf{v}_i$, whose distances from a given REFERENCE POINT are r_i. The quantities

$$\Phi = -\gamma \sum_{i=1}^{n} m_{0i}/r_i, \qquad A = -\gamma \sum_{i=1}^{n} m_{0i}\mathbf{v}_i/cr_i \qquad (7.1)$$

are called GRAVITATIONAL POTENTIAL and MAGRETIC POTENTIAL generated by the system of masses at this reference point.

If a material point (a particle) with mass m, called TEST MASS, crosses the reference point with a velocity **v**, the gravitational and magretic energies of the whole system of n+1 masses in which mass m takes part will be

$$U = m_0\Phi, \qquad W = - m_0\mathbf{v}.\mathbf{A}/c = - m\mathbf{v}.\mathbf{A}/c \tag{7.2}$$

In equations (6.15) we can write U_i instead of U and e_i^0 instead of E^0. Choosing then our test mass as the i-th particle of the system of n+1 particles, we can suppress the index "i" and so we obtain the equation of motion of our test particle in the form

$$\frac{m}{c^2}(c^2 + \Phi)\mathbf{u}_0 + \frac{m}{c}\frac{d\mathbf{A}}{dt} = - m_0\mathrm{grad}(\Phi - \mathbf{v}.\mathbf{A}/c). \tag{7.3}$$

This equation can be written also in the form

$$(1 + \Phi/c^2)\mathbf{u}_0 + (1/c)d\mathbf{A}/dt = - \mathrm{grad}(\Phi - \mathbf{v}.\mathbf{A}/c)/(1 - v^2/c^2)^{1/2}, \tag{7.4}$$

which is the equation of motion of a particle surrounded by a gravimagretic system of particles in which the mass of the particle does not take place at all.

Equation (7.3) represents the full Newton (Lagrange) equation in gravimagretism written with the help of the potentials and I call it the NEWTON-MARINOV EQUATION.

When deducing the Newton-Marinov equation I have supposed that the considered material system is isolated. But it is impossible to construct a gravitationally isolated system, as one cannot suppress the gravitational action of the celestial bodies. Looking at formula (7.3), it is logically to assume that the term c^2 in the brackets on the left side represents the gravitational potential generated by all celestial bodies at the reference point taken with a negative sign, i.e.,

$$c^2 = - \Phi_w = \gamma \sum_{i=1}^{n} m_i/r_i, \tag{7.5}$$

where n is the number of the particles in the world, or the number of the celestial bodies (in the last case m_i is the mass of the i-th celestial body). From this point of view the mystery of time energy disappears, as time energy represents nothing else than the negative gravitational energy of the particle with the mass of the whole world

$$m_0c^2 = - m_0\Phi_w. \tag{7.6}$$

So we reduce the energy forms to two kinds - space energy and space-time energy, and it becomes clear that never the "volume" and the "materiality" of the particles can be established, as such "material points", i.e., drops of energy, <u>do not exist</u>. The time energy of any particle is its gravitational energy <u>dispersed</u> in the whole world. Thus, accepting the undefinable notions "space" and "time" as intuitively clear, the only enigmatic notion in physics remains the notion "space energy". (N.B. May be in this link of every particle with the whole universe is to be searched for the explanation of the paraphysical phenomena.)

Embracing this point of view, we can cancel the notion "time energy" in our axiomatics and operate only with the notions "space energy" and "space-time energy" (let me again emphasize that in the same manner we can cancel the notion "mass" and operate only with the notion "energy").

The notion "time energy" can be canceled from the axiomatics if we replace the sixth and ninth axioms by the follwoing ones:

AXIOM VI. The energy e_0 of any particle is its gravitational energy with the mass of the whole world, which we call WORLD ENERGY and denote by U_w, taken with a negative sign. The world energy of a unit mass which rests in absolute space is equal to $- c^2$ energy units. Thus the world energy of a mass m moving in absolute space is

$$U_w = - m_0c^2. \tag{7.7}$$

AXIOM IX. The change in time of the difference of the space and space-time energies of an isolated material system is equal to the change in time of its world energy, that is

$$dU - dW = dU_w. \tag{7.8}$$

So we see that the discussion of the problem about the equality of "inertial" and "gravitational" masses loses its sense, as "inertial mass" does not exist. The mass is only gravitational. Thus all costly experiments with which one searches to establish whether there is a difference between the "inertial" and "gravitational" masses have been and continue to be a waste of time, efforts and money.

In the light of these conclusions the PRINCIPLE OF EQUIVALENCE in the formulation that the gravitational field in a small space domain can be replaced by a suitable non-inertially moving frame of reference also loses its flavour. Let me note, however, that the principle of equivalence in its "relativistic" formulation, according to which a gravitational acceleration cannot be experimentally distinguished from a kinematic acceleration is not true, as I have demonstrated by the help of my accelerated "coupled mirrors" experiment.[3,5,9]

Let us now present the Newton-Marinov equation in another more convenient for calculations form.

The full time change of **A** can be presented as a sum of its partial time change (direct dependence of **A** on time, because the n charges generating **A** change their positions and velocities) and the time change of **A** caused by the change of the radius vector of the particle, because of its motion with velocity **v**. Thus we can write

$$\frac{d\mathbf{A}}{dt} = \frac{\partial \mathbf{A}}{\partial t} + \frac{\partial \mathbf{A}}{\partial \mathbf{r}}\frac{d\mathbf{r}}{\partial t} + \frac{\partial \mathbf{A}}{\partial r}\frac{\partial r}{\partial x}\frac{dx}{dt} + \frac{\partial \mathbf{A}}{\partial \mathbf{r}}\frac{\partial r}{\partial y}\frac{dy}{dt} + \frac{\partial \mathbf{A}}{\partial \mathbf{r}}\frac{\partial r}{\partial z}\frac{dz}{dt} = \frac{\partial \mathbf{A}}{\partial t} + v\frac{\partial \mathbf{A}}{\partial \mathbf{r}} + v_x\frac{\partial \mathbf{A}}{\partial x} + v_y\frac{\partial \mathbf{A}}{\partial y} + v_z\frac{\partial \mathbf{A}}{\partial z} =$$

$$\frac{\partial \mathbf{A}}{\partial t} + \mathrm{v\,div}\mathbf{A} + (\mathbf{v}.\mathrm{grad})\mathbf{A}. \tag{7.9}$$

Note that I consider the time change of **A** due to the time change of the radius vector of the test particle, first, because of a direct change in time of the radius vector of the test particle, $\mathbf{v}\mathrm{div}\mathbf{A}$, and then because of a direct change in time of its components, $(\mathbf{v}.\mathrm{grad})\mathbf{A}$. My critics of the above interpretation of the full time derivative of $\mathbf{A}$ raise the objection that I take twice the same "partial" derivative. They do not take into account that in physics there is only one independent variable, the time t, and thus we are not at all allowed, from a rigorous mathematical point of view, to introduce partial time derivatives (there are always people who assert that the Maxwell-Lorentz equations are to be written not with partial but with full derivatives). Indeed, the partial derivatives in physics have another aspect which is rather physical and not mathematical: We look first at the change of the potential when the particles generating it change velocities and positions for a time dt and second when the test particle changes its position for a time dt. In the second case we have to take both $\mathbf{v}\mathrm{div}\mathbf{A}$ and $(\mathbf{v}.\mathrm{grad})\mathbf{A}$, otherwise (i.e., by taking only $(\mathbf{v}.\mathrm{grad})\mathbf{A}$) we shall obtain a wrong physical equation. The mathematical reliability of equation (7.9) is proven by the fact that the obtained equation of motion is physically right.

However, we shall later see (Sect. 24) that in electromagnetism the term $(\partial\mathbf{A}/\partial\mathbf{r})(d\dot{\mathbf{r}}/dt)$ is to be slightly changed, as the experiment impels us to introduce this change. Thus if we shall not write now in (7.9) the term $(\partial\mathbf{A}/\partial\mathbf{r})(d\mathbf{r}/dt)$, nevertheless we have to introduce it later in a slightly changed form, as otherwise our equation will enter into a conflict with the experiments. Thus there is no need now to discuss at great length the problem whether equation (7.9) is to be written with or without this term. I repeat, we are impelled to introduce *ad hoc* such a term (in a slightly modified form) to be able to obtain an equation which will be adequate to physical reality. Thus the conclusion is to be drawn that the fundamental equation in electromagnetism can be not deduced only by a rigorous mathematical logic from the Coulomb and Neumann laws. Nevertless the simplicity with which I obtain from these two laws almost the right fundamental equation is amazing.

Taking now into account the mathematical relation (see p. 6)

$$\mathrm{grad}(\mathbf{v}.\mathbf{A}) = (\mathbf{v}.\mathrm{grad})\mathbf{A} + (\mathbf{A}.\mathrm{grad})\mathbf{v} + \mathbf{v}\times\mathrm{rot}\mathbf{A} + \mathbf{A}\times\mathrm{rot}\mathbf{v}, \qquad (7.10)$$

which, in our case, must be written at the condition $\mathbf{v}$ = Const, and putting (7.9) and (7.10) into (7.3), making no difference between full and Newtonian mass, we obtain the Newton-Marinov equation in its most convenient form

$$\mathbf{f}_0 \equiv d\mathbf{p}_0/dt = - m_0(\mathrm{grad}\Phi + \partial\mathbf{A}/c\partial t) + (m_0/c)\mathbf{v}\times\mathrm{rot}\mathbf{A} - (m_0/c)\mathbf{v}\mathrm{div}\mathbf{A}. \qquad (7.11)$$

To this equation we always attach its scalar supplement which can be obtained after the multiplication of both its sides by the velocity of the test mass

$$\mathbf{v}.\mathbf{f}_0 \equiv de_0/dt = - m_0\mathbf{v}.(\mathrm{grad}\Phi + \partial\mathbf{A}/c\partial t + \mathbf{v}\mathrm{div}\mathbf{A}/c). \qquad (7.12)$$

Introducing the quantities

$$\mathbf{G} = - \mathrm{grad}\Phi - \partial\mathbf{A}/c\partial t, \qquad \mathbf{B} = \mathrm{rot}\mathbf{A}, \qquad S = - \mathrm{div}\mathbf{A}, \qquad (7.13)$$

called GRAVITATIONAL INTENSITY, (VECTOR) MAGRETIC INTENSITY and SCALAR MAGRETIC IN-

TENSITY, we can write the Newton-Marinov equation in the form

$$d\mathbf{p}_0/dt = m_0\mathbf{G} + (m_0/c)\mathbf{v}\cdot\mathbf{B} + (m_0/c)\mathbf{v}S. \quad (7.14)$$

Denoting $(1/m_0)d\mathbf{p}_0/dt = \mathbf{G}_{glob}$ and calling it GLOBAL GRAVITATIONAL INTENSITY, we can write (7.11) and (7.14) in the form

$$\mathbf{G}_{glob} = -\,\mathrm{grad}\Phi - \partial\mathbf{A}/c\partial t + (\mathbf{v}/c)\times\mathrm{rot}\mathbf{A} - (\mathbf{v}/c)\mathrm{div}\mathbf{A} = \mathbf{G} + (\mathbf{v}/c)\times\mathbf{B} + (\mathbf{v}/c)S. \quad (7.15)$$

When clarity needs it, G is to be called RESTRICTED GRAVITATIONAL INTENSITY.

Taking partial derivative with respect to time from the gravitational potential Φ (consider the distances r_i in the first expression (7.1) as functions of time) and divergence from the magretic potential **A** (see the second expression (7.1)), we obtain the EQUATION OF POTENTIAL CONNECTION

$$\mathrm{div}\mathbf{A} = -\,\partial\Phi/c\partial t, \quad (7.16)$$

which in official electromagnetism is wrongly called the "LORENTZ GAUGE CONDITION". Equation (7.16) is a lawful physical equation and not a "condition" which one can impose at will.

8. THE NEWTON-LORENTZ EQUATION

In electromagnetism the formulas analogical to formulas (7.1) and (7.2) for the ELECTRIC and MAGNATIC POTENTIALS are

$$\Phi = \sum_{i=1}^{n} q_i/r_i, \qquad \mathbf{A} = \sum_{i=1}^{n} q_i\mathbf{v}_i/cr_i, \quad (8.1)$$

$$U = q\Phi, \qquad W = -\,q\mathbf{v}.\mathbf{A}/c. \quad (8.2)$$

The equation analogical to the Newton-Marinov equation is called in electromagnetism the NEWTON-LORENTZ EQUATION and I shall write it in a form analogical to (7.3)

$$m\mathbf{u}_0 + (q/c)d\mathbf{A}/dt = -\,q\,\mathrm{grad}(\Phi - \mathbf{v}.\mathbf{A}/c), \quad (8.3)$$

in a form analogical to (7.11)

$$\mathbf{f}_0 \equiv d\mathbf{p}_0/dt = -\,q(\mathrm{grad}\Phi + \partial\mathbf{A}/c\partial t) + (q/c)\mathbf{v}\times\mathrm{rot}\mathbf{A} - (q/c)\mathbf{v}\mathrm{div}\mathbf{A}, \quad (8.4)$$

and in a form analogical to (7.15), calling $\mathbf{E}_{glob} = (1/q)d\mathbf{p}_0/dt$ GLOBAL ELECTRIC INTENSITY,

$$\mathbf{E}_{glob} = -\,\mathrm{grad}\Phi - \partial\mathbf{A}/c\partial t + (\mathbf{v}/c)\times\mathrm{rot}\mathbf{A} - (\mathbf{v}/c)\mathrm{div}\mathbf{A} = \mathbf{E} + (\mathbf{v}/c)\times\mathbf{B} + (\mathbf{v}/c)S, \quad (8.5)$$

where

$$\mathbf{E} = -\,\mathrm{grad}\Phi - \partial\mathbf{A}/c\partial t, \qquad \mathbf{B} = \mathrm{rot}\mathbf{A}, \qquad S = -\,\mathrm{div}\mathbf{A} \quad (8.6)$$

are the (RESTRICTED) ELECTRIC INTENSITY, the (VECTOR) MAGNETIC INTENSITY and the SCALAR MAGNETIC INTENSITY, q is the electric charge of a test mass m moving with velocity **v** and Φ, **A** are the electric and magnetic potentials of the surrounding system at the reference point crossed by the test mass.

The scalar supplement to the Newton-Lorentz equation is (see (7.12))

$$\mathbf{v}.\mathbf{f}_0 \equiv de_0/dt = - q\mathbf{v}.(\mathrm{grad}\Phi + \partial\mathbf{A}/c\partial t + \mathbf{v}\mathrm{div}\mathbf{A}/c). \qquad (8.7)$$

The EQUATION OF POTENTIAL CONNECTION in electromagnetism will have exactly the same form as in gravimagretism (see (7.16))

$$\mathrm{div}\mathbf{A} = - \partial\Phi/c\partial t. \qquad (8.8)$$

Substituting (8.8) into (8.5), we obtain the Newton-Lorentz equation in a very symmetric form showing that $\mathbf{E}_{glob}$ is determined by the time and space derivatives of Φ and $\mathbf{A}$

$$\mathbf{E}_{glob} = (\mathbf{v}/c^2)\partial\Phi/\partial t - \mathrm{grad}\Phi - (1/c)\partial\mathbf{A}/\partial t + (\mathbf{v}/c)\times\mathrm{rot}\mathbf{A}. \qquad (8.9)$$

Thus the scalar magnetic intensity can be calculated either by the third formula (8.6) or by the formula

$$S = (1/c)\partial\Phi/\partial t. \qquad (8.10)$$

If we have a system of two particles with masses m_1, m_2 and charges q_1, q_2 moving with velocities $\mathbf{v}_1$, $\mathbf{v}_2$, we can write

$$U + W = q_1\Phi_1 - q_1\mathbf{v}_1.\mathbf{A}_1/c = q_2\Phi_2 - q_2\mathbf{v}_2.\mathbf{A}_2/c. \qquad (8.11)$$

Thus the following equality must be valid

$$m_1\mathbf{u}_{o1} + (q_1/c)d\mathbf{A}_1/dt = - \{m_2\mathbf{u}_{o2} + (q_2/c)d\mathbf{A}_2/dt\}, \qquad (8.12)$$

as grad(U + W) in equation (8.3) can be taken once for the reference point where m_1 is placed and once for the reference point where m_2 is placed.

Equation (8.12) can be written in the form

$$\sum_{i=1}^{2}\{m_i\mathbf{u}_{oi} + (q_i/c)d\mathbf{A}_i/dt\} = 0, \qquad (8.13)$$

or

$$\sum_{i=1}^{2}(\mathbf{p}_{oi} + q_i\mathbf{A}_i/c) = \mathrm{Const}. \qquad (8.14)$$

The quantity in the bracket called FULL MOMENTUM of the particle m is denoted by $\tilde{\mathbf{p}}_0$ and (8.14) is called LAW OF THE CONSERVATION OF THE FULL MOMENTUM.

If W = 0, we obtain

$$\sum_{i=1}^{2}\mathbf{p}_{oi} = \mathbf{P}_0 = \mathrm{Const}. \qquad (8.15)$$

This is called LAW OF CONSERVATION OF THE (SPACE) MOMENTUM and $\mathbf{P}_0$ is called proper momentum of the whole system.

The law (8.14) can be easily generalized for a system of n particles, as any two particles of the system interact <u>independently</u> of the existence of the other particles.

If $\mathbf{r}$ is the radius vector of a particle m, the quantity

$$\mathbf{l}_0 = \mathbf{r}\times\mathbf{p}_0 \qquad (8.16)$$

is called PROPER ANGULAR MOMENTUM of the particle m with respect to the frame's origin.

If

$$\sum_{i=1}^{n} l_{oi} = L_o = \mathbf{Const}, \tag{8.17}$$

we say that the angular momentum of the system of n particles with respect to the frame's origin is conserved. Equation (8.17) is called LAW OF CONSERVATION OF THE ANGULAR MOMENTUM and L_0 is called proper angular momentum of the system. The deduction of this law in gravitation and electricity is straightforward but there are problems in gravimagretism and electromagnetism. As I have shown above, one can deduce logically only the law of conservation of the full momentum.

If **r** is the radius vector of a particle with a kinetic force **f**, i.e., on which a potential force F acts, then

$$\mathbf{M} = r \times F \tag{8.18}$$

is called MOMENT OF FORCE (or TORQUE) of this potential force with respect to the frame's origin. The vector distance **r** in (8.18), as well as in (8.16), can be taken with respect to any point of space.

In this book the four-dimensional aspects of electromagnetism are not considered (my electromagnetism in 4-dimensional interpretation is considered in Ref. 5). I should like only to note that the axiomatical assertion (see equations (2.11) and (2.14)) that the electric and magnetic energies of two positive charges moving with parallel velocities have opposite signs finds its more profound explanation when considering the sum of the electric and magnetic energies of two charges (see equation (8.11)) as a scalar product (taken with a negative sign) of the 4-current of the one particle

$$\overset{\mapsto}{J}_1 = q_1\overset{\mapsto}{v}_1 = (q_1\mathbf{v}_1,\ iq_1c) \tag{8.19}$$

with the 4-potential generated by the other particle

$$\overset{\mapsto}{A}_1 = (\mathbf{A}_1,\ i\Phi_1) = (\mathbf{j}_2/cr,\ i\bar{j}_2/cr) = (q_2\mathbf{v}_2/cr,\ iq_2/r). \tag{8.20}$$

Calling this product electromagnetic energy of the two particles and denoting it by W + U, we shall have

$$W + U = -\overset{\mapsto}{j}_1.\overset{\mapsto}{A}_1 = -\mathbf{j}_1.\mathbf{A}_1 + \bar{j}_1\bar{A}_1 = -q_1q_2\mathbf{v}_1.\mathbf{v}_2/c^2r + q_1q_2/r. \tag{8.21}$$

9. DIFFERENTIAL RELATIONS BETWEEN DENSITIES AND POTENTIALS

A STATIC SYSTEM of particles is this one in which the particles do not move. The QUASI-STATIC SYSTEM is this one in which the particles can move but at any moment at any differentially small volume the same number of particles moving with the same velocity can be found. A DYNAMIC SYSTEM of particles is this one in which the particles can have arbitrary velocities.

The MASS and MOMENTUM DENSITIES of a system of particles at a reference point with radius vector $\mathbf{r}$ are the following quantities (these are the so-called δ-DENSITIES)

$$\mu(\mathbf{r}) = \sum_{i=1}^{n} m_i \delta(\mathbf{r} - \mathbf{r}_i), \qquad \boldsymbol{\pi}(\mathbf{r}) = \sum_{i=1}^{n} \mathbf{p}_i \delta(\mathbf{r} - \mathbf{r}_i), \tag{9.1}$$

where $\mathbf{r}_i$ are the radius vectors of the single masses m_i, $\mathbf{p}_i$ are their momenta and $\delta(\mathbf{r}) = \delta(x)\delta(y)\delta(z)$ is the three-dimensional δ-function of Dirac.

9.1. THE STATIC AND QUASI-STATIC CASES.

First I shall prove the validity of the following mathematical relation

$$\Delta(1/r) = -4\pi\delta(\mathbf{r}), \tag{9.2}$$

where Δ is the Laplace operator and r is the distance between the origin of the frame and the reference point.

Indeed, putting into (9.2)

$$r = |\mathbf{r} - 0| = (x^2 + y^2 + z^2)^{1/2}, \tag{9.3}$$

we obtain an identity. Only for r = 0 the left-hand side gives the uncertainty 0/0 and the right-hand side gives the uncertainty δ(0).

To establish whether relation (9.2) is valid also for r = 0, let us integrate (9.2) over an arbitrary sphere with radius R which has its center at the frame's origin. Using the Gauss theorem, we shall obtain for the integral on the left-hand side

$$\int_V \Delta(1/r)dV = \int_V \mathrm{div}\{\mathrm{grad}(1/r)\}dV = \oint_S \mathrm{grad}(1/r).d\mathbf{S} = -\oint_S (1/r^2)dS = -(1/R^2)\oint_S dS = -4\pi, \tag{9.4}$$

where S is the surface of the sphere of integration whose volume is V and dS is the elementary area (taken as a vector) of the integration surface with a direction pointing outside of the volume enclosed. The integral of the right of (9.2) taken over the same arbitrary surface, on the grounds of the fundamental property of the δ-function, gives the same result. Since the integrals of both sides of (9.2) are equal and the domains of integration represent spheres with arbitrary radii, both integrands must be also equal. Thus the relation (9.2) is valid also for r = 0.

In the same way, or on the grounds of the first axiom for homogeneity and isotropy of space, we can prove the validity of the following relations

$$\Delta(1/|\mathbf{r} - \mathbf{r}_i|) = -4\pi\delta(\mathbf{r} - \mathbf{r}_i), \qquad i = 1, 2, \ldots\ldots, n, \tag{9.5}$$

where $\mathbf{r}_i$ are the radius vectors of n different space points.

Let us assume that $\mathbf{r}_i$ is the radius vector of a space point where a mass m_i is placed (static case) or where at any moment a mass m_i moving with a velocity $\mathbf{v}_i$ can be found (quasi-static case). Multiplying every of the equalities (9.5) by the corresponding mass m_i or momentum divided by c, $\mathbf{p}_i/c$, and summing, we obtain, after having taken into account (7.1) and (9.1), the following differential equations for the potentials in terms of the mass and momentum densities

$$\Delta\Phi = 4\pi\gamma\mu, \qquad \Delta\mathbf{A} = (4\pi/c)\gamma\boldsymbol{\pi}. \tag{9.6}$$

9.2 THE DYNAMIC CASE.

Let us consider a point (calling it i-point) which moves with a velocity v along the x-axis of a rest frame K and at the initial zero moment crosses the origin of the frame. Let a moving frame K' be attached to this i-point, and let the transformation between K and K' be a special one (as are the transformations considered in Sect. 3). In such a case the radius vector of the i-point in K' will be $\mathbf{r}'_i = (0,0,0)$. If the radius vector of the reference point in frame K is $\mathbf{r} = (x,y,z)$, according to the Marinov transformation (3.5), the radius vector $\mathbf{r}'$ of the same reference point in the moving frame K' is given by

$$\mathbf{r}' = (x',y',z') = \left(\frac{x - vt}{(1 - v^2/c^2)^{1/2}}, y, z\right). \qquad (9.7)$$

The distance between the i-point and the reference point considered in frame K' but expressed by the coordinates in frame K will be

$$r_o = |\mathbf{r}' - \mathbf{r}'_i| = |\mathbf{r} - \mathbf{r}_i|_o = \left\{\frac{(x - vt)^2 + (1 - v^2/c^2)(y^2 + z^2)}{1 - v^2/c^2}\right\}^{1/2}. \qquad (9.8)$$

This distance considered in frame K and expressed by the coordinates in frame K will be

$$r = |\mathbf{r} - \mathbf{r}_i| = \{(x - vt)^2 + y^2 + z^2\}^{1/2}. \qquad (9.9)$$

I call r the UNIVERSAL DISTANCE and r_o the PROPER DISTANCE.(3,5,8) The difference between these two distances is due to the Marinov-aether character of light propagation. I repeat, this has nothing to do with a physical "length contraction" ("Lorentz length contraction"). As a matter of fact, here we are considering the distance between two points moving with respect to one another which cannot be connected by a rigid rod, and thus it is meaningless to speak about a contraction of such a "rod". On the other hand, the situation in the frames K and K' is entirely symmetric: in frame K the i-point is moving and the reference point is at rest, while in frame K' the i-point is at rest and the reference point is moving. I wish that the reader understands once and for ever that the Marinov transformation (as well as the Lorentz transformation) serve only for the introduction of the Marinov-aether character of light propagation into the mathematical apparatus of high-velocity physics. The Marinov-aether character of light propagation is incompatible with the classical conceptions for motion of a particle which, I repeat, lead to the Newton-aether character of light propagation (cf. formulas (1.1) and (1.2) once more!). The Marinov-aether "abnormality" in the motion of the photons (this "abnormality" exists also at the motion of the particles with non-zero rest mass(5)) leads to the mathematically contradicting equations (9.8) and (9.9) which describe the same physical distance.

Now easily can be established the validity of the following mathematical relation

$$\Delta(1/r_{oo}) = -4\pi\delta(r - r_i), \qquad (9.10)$$

where $\square$ is the d'Alembert operator and

$$r_{00} = r_0(1 - v^2/c^2)^{1/2} = \{(x - vt)^2 + (1 - v^2/c^2)(y^2 + z^2)\}^{1/2} \quad (9.11)$$

is called the SECOND PROPER DISTANCE.

Indeed, using in (9.10) the expression (9.11), we obtain an identity. Only for $r_{00} = 0$, i.e., for $x - vt = y = z = 0$, the left-hand side gives the uncertainty 0/0 and the right-hand side gives the uncertainty $\delta(0)$.

To establish whether relation (9.10) is valid also for $r_{00} = 0$, let us integrate (9.10) over an arbitrary sphere with radius R which has its center at the i-point (thus this sphere is moving along the x-axis of frame K with the velocity v)

$$\int_V \square(1/r_{00})dV = - 4\pi\int_V \delta(r - \mathbf{r}_i)dV. \quad (9.12)$$

For all points of volume V the integrand on the left-hand side is equal to zero. Thus we can spread the integral over a small domain around the point with coordinates given by $x - vt = y = z = 0$, i.e., about the i-point which is also the origin of frame K'. But as $r_{00} \to 0$, we obtain $1/r_{00} \to \infty$, and the derivatives with respect to x,y,z will increase much faster than the derivative with respect to t. Hence the latter can be neglected with respect to the former. So we reduce the integral on the left-hand side of (9.12) to the integral (9.4). The integral on the right-hand side of (9.12), on the grounds of the fundamental property of the δ-function, gives the same result, and, as in Sect. 9.1, we conclude that the integrands must be equal. Thus relation (9.10) is valid also for the i-point.

In the same manner as in Sect. 9.1, we can obtain from (9.10) the following relations between potentials and densities for the most general dynamic case

$$\square \Phi = 4\pi\gamma\mu(t), \qquad \square \mathbf{A} = (4\pi/c)\gamma\boldsymbol{\pi}(t), \quad (9.13)$$

where the mass and momentum densities can be functions of time.

In electromagnetism the δ-DENSITIES of the CHARGE and the CURRENT are defined by the following formulas similar to formulas (9.1)

$$Q(\mathbf{r}) = \sum_{i=1}^{n} q_i\delta(\mathbf{r} - \mathbf{r}_i), \qquad \mathbf{J}(\mathbf{r}) = \sum_{i=1}^{n} \mathbf{j}_i\delta(r - \mathbf{r}_i). \quad (9.14)$$

In electromagnetism the formulas analogical to (9.6) and (9.14) will be

$$\Delta\Phi = - 4\pi Q, \qquad \Delta\mathbf{A} = - (4\pi/c)\mathbf{J}, \quad (9.15)$$

$$\square\Phi = - 4\pi Q(t), \qquad \square \mathbf{A} = - (4\pi/c)\mathbf{J}(t). \quad (9.16)$$

10. INTEGRAL RELATIONS BETWEEN DENSITIES AND POTENTIALS

10.1. THE STATIC AND QUASI-STATIC CASES.

Substitiing formulas (9.1) into the definition equalities for the potentials (7.1), we obtain the integral relation between the gravitational and magretic potentials and the mass and momentum densities for a static and quasi-static system of particles

$$\Phi = -\gamma\int_V(\mu/r)dV, \qquad \mathbf{A} = -\gamma\int_V(\pi/cr)dV, \qquad (10.1)$$

where μ and π are the mass and momentum densities in the volume dV which are equal to the sums of the δ-densities in dV divided by dV. These equations are to be considered also as solutions of the differential equations (9.6).

10.2. THE DYNAMIC CASE.

The integral relations between densities and potentials for the general dynamic system are to be obtained by solving equations (9.13). I showed[5] that the solution of equations (9.13) leads to the following integral relations between densities and potentials

$$\Phi(\mathbf{r}_0,t) = -\frac{\gamma}{2}\int_V \frac{1}{r}\{\mu(\mathbf{r},t-\frac{r}{c}) + \mu(\mathbf{r},t+\frac{r}{c})\}dV,$$

$$\mathbf{A}(\mathbf{r}_0,t) = -\frac{\gamma}{2}\int_V \frac{1}{r}\{\pi(\mathbf{r},t-\frac{r}{c}) + \pi(\mathbf{r},t+\frac{r}{c})\}dV, \qquad (10.2)$$

where $\Phi(\mathbf{r}_0,t)$ and $\mathbf{A}(\mathbf{r}_0,t)$ are the potentials at the reference point with radius vector $\mathbf{r}_0$ at the moment t and the integral is spread over the whole space or over the volume V in which there are particles of the system.

I call the potentials (giving for brevity only the formulas for the gravitational potential)

$$\Phi' = -\gamma\int_V\frac{\mu(t-r/c)}{r}\,dV, \qquad \Phi'' = -\gamma\int_V\frac{\mu(t+r/c)}{r}\,dV, \qquad (10.3)$$

respectively, ADVANCED and RETARDED POTENTIALS. Official physics calls <u>wrongly</u> Φ' "retarded" and Φ'' "advanced" potential. Indeed Φ' is the potential at the moment $t' = t - r/c$ which is <u>before</u> the OBSERVATION MOMENT t and thus it is an ADVANCED MOMENT, while Φ'' is the potential at the moment $t'' = t + r/c$ which follows <u>after</u> the observation moment t and thus it is a RETARDED MOMENT. Conventional physics mixes up the notions as it supposes that the "interaction" propagates with the velocity c and it assumes that Φ' is the potential <u>at the moment of observation</u> t, i.e., that the potential "appears" with a certain "retardation" at the reference point and leaves absolutely without attention the other solution Φ'' of the equations (9.13).

The potentials must be given as half-sums of their advanced and retarded values as an observer at the reference point can obtain information only about the advanced and retarded values in the following two ways: 1) either messengers will start from any volune dV_i at the respective advanced moments $t_i' = t - r_i/c$ and, moving with the highest possible velocity c, will bring the information about the mass and momentum densities in dV_i to the observer at the reference point, or 2) messengers will start from the reference point at the observation moment t and moving with velocity c will reach every of the volumes dV_i at the respective retarded moments $t_i'' = t + r_i/c$ to see which are there the mass and momentum densities. Obviously the densities at the moment of observation will be the half-sums of the advanced and retarded densities.

If in the volume dV_i the charges move with accelerations, they will radiate energy in the form of gravimagretic waves which will propagate in space with the velocity of light. In Chapter IV I show that a mass moving with acceleration generates, besides the "momentary" gravitational and magretic intensities, two other intensities: the one propagates with the velocity c away from the mass carrying with itself momentum and energy and the other acts directly on the radiating mass. I call the "momentary" intensity due to the masses and their velocities the POTENTIAL INTENSITY, the intensity field due to the masses and their accelerations which carry away energy and momentum the RADIATION INTENSITY, and the intensity acting on the radiating mass braking its motion, so that the lost kinetic energy should compensate the radiated energy the RADIATION REACTION INTENSITY. The mathematical logic leads to all these three substantially different intensities. And all these three intensities have been observed in electromagnetism ex as the. mathematics applied to the Newton-Lorentz equation predicts them.

If we wish to know what gravimagretic energy reaches the reference point at the moment of observation t in the form of gravimagretic waves, we have to use for the calculation not the observation potential (with whose help the potential intensity can be calculated) but the advanced potential because the radiated energy needs the time r_i/c to come from the volume dV_i to the reference point.

Official physics, or, better to say, the majority of the conventional physicists think that not only the radiated energy propagates with the velocity c but also the potentials "propagate" with the same velocity and introduce the notion "propagation of interaction". Following this trend, they calculate also the potential intensities by the help of the advanced (in their language, retarded) potentials. This is wrong, as one is able to observe only the propagation of energy, i.e., the transfer of mass. An immaterial "interaction" cannot be observed and it is senseless to narrate that such an "interaction", like a ghost, can propagate.

The potentials are not really existing physical quantities, they exist only in our heads. Also the intensities exist only in our heads. The only physical quantity which really does exist is the energy (the mass). And only energy can be transferred from one space domain to another.

The wrong treatment of the potentials of dynamic systems leads to the result that the official physicists are unable to calculate the radiation reaction intensity proceeding directly from the potentials. Their wrong calculations lead to the phantasmagoric self-accelerating solutions.[5] In Chapter IV I give my theoretical solution of the problem about the radiation of electromagnetic waves. And I propose two very simple experiments (see Sect. 37) with whose help one can see whether the potential electric intensity appears momentarily in whole space, as I assert, and that only the radiation electric intensity has a wave character of propagation with a velocity equal to c.

11. LIENARD-WIECHERT FORMS OF THE POTENTIALS

Let us consider (fig. 1) a system consisting of only one electric charge q which moves in absolute space with the constant velocity **v**. Let us take the reference point at the origin, P, of the rest frame K.

Let us assume that at the advanced moment t' the charge q sends a photon from its advanced position Q' which, covering for the time $\Delta t' = r'/c$ the ADVANCED DISTANCE r' arrives at the observation moment $t = t' + r'/c$ at the reference point when the distance to q is the OBSERVATION DISTANCE r. Then this photon is sent back to q along the RETARDED DISTANCE r" and after time $\Delta t'' = r''/c$ it reaches the charge q at the retarded moment $t'' = t + r''/c$ when it is at its retarded position Q".

If the photon has a Newton-aether character of propagation, taking into account that $Q'Q = v(r'/c)$ and $QQ'' = v(r''/c)$, we can easily find the relation between the observation distance, on one side, and the advanced and retarded distances, on the other side,

$$r = r'(1 - 2\mathbf{n}'.\mathbf{v}/c + v^2/c^2)^{1/2}, \quad r = r''(1 + 2\mathbf{n}''.\mathbf{v}/c + v^2/c^2)^{1/2}. \quad (11.1)$$

These formulas can be obtained also if putting into the second formula (1.1) $c' = r/\Delta t'$, $c = r'/\Delta t'$, $\mathbf{n}.\mathbf{V} = \mathbf{n}'\mathbf{v}$, for the first case, and $c' = r/\Delta t''$, $c = r''/\Delta t''$, $\mathbf{n}.\mathbf{V} = -\mathbf{n}''.\mathbf{v}$, for the second case.

However when the photon has a Marinov-aether character of propagation, we have to find the relation between observation, advanced and retarded distances by putting into the second formula (1.2), in which the factor $(1 - V^2/c^2)^{1/2}$ related to the clock retardation is to be omitted, $c' = r/\Delta t'$, $c = r'/\Delta t'$, $\mathbf{n}.\mathbf{V} = \mathbf{n}'.\mathbf{v}$, for the first case, and $c' = r/\Delta t''$, $c = r''/\Delta t''$, $\mathbf{n}.\mathbf{V} = -\mathbf{n}''.\mathbf{v}$, for the second case, thus ob-

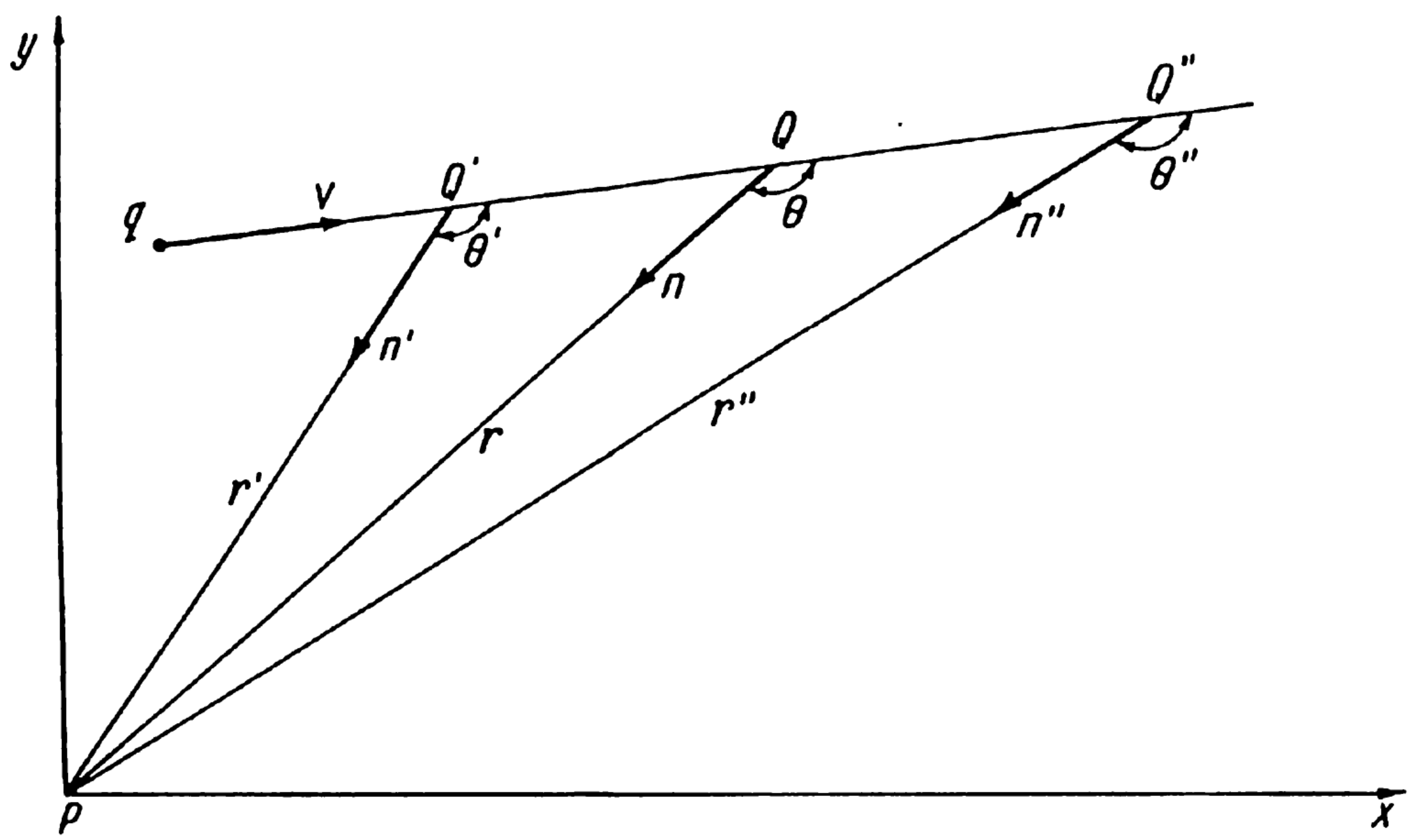


Fig. 1. Advanced, observation and retarded distance.

taining

$$r = r'(1 - \mathbf{n}'.\mathbf{v}/c), \qquad r = r''(1 + \mathbf{n}''.\mathbf{v}/c), \qquad (11.2)$$

and here (as well as in formulas (11.1)) **n**' and **n**" are the unit vectors pointing, respectively, from the advanced and retarded position of q to the reference point.

As the Newton-aether and Marinov-aether characters of light propagation are mathematically contradicting, it is senseless to try to reconcile formulas (11.1) and (11.2).

By putting the expressions (11.2) into formulas (8.1), we obtain the so-called LIENARD-WIECHERT POTENTIALS in electromagnetism

$$\Phi = \frac{q}{r'(1 - \mathbf{n}'\mathbf{v}/c)} = \frac{q}{r''(1 + \mathbf{n}''.\mathbf{v}/c)}, \qquad \mathbf{A} = \frac{q\mathbf{v}}{cr'(1 - \mathbf{n}'.\mathbf{v}/c)} = \frac{q\mathbf{v}}{cr''(1 + \mathbf{n}''.\mathbf{v})}. \qquad (11.3)$$

It is extremely important to note that **v**, especially in the nominators of **A**, is the observation velocity of the charge q and not its advanced velocity **v**', as conventional physics assumes (for the case when **v** is not constant), considering only the left parts of these equations and calling them wrongly "retarded" potentials. It must be absolutely clear that Φ and **A** in formulas (11.3) are the observation potentials, as the distances in (11.3) are the observation distances.

Let me note that by considering in the nominators of **A** the observation velocity in the forms $\mathbf{v} = \mathbf{v}' + \mathbf{u}'(t - t') = \mathbf{v}'' - \mathbf{u}''(t'' - t)$, where **v**', **v**" and **u**', **u**" are the advanced and retarded velocities and accelerations, I could deduce the radiation reaction intensity directly from the potentials working with the most simple and rigorous mathematical logic (see Sect. 34).

12. THE MAXWELL-MARINOV EQUATIONS

Taking rotation from both sides of the first equation (7.13) and making use of the mathematical identities

$$\mathrm{rot}(\mathrm{grad}\Phi) = 0, \qquad \mathrm{div}(\mathrm{rot}\mathbf{A}) = 0, \qquad (12.1)$$

we obtain the FIRST PAIR OF THE MAXWELL-MARINOV EQUATIONS

$$\mathrm{rot}\mathbf{G} = -\,\partial\mathbf{B}/c\partial t, \qquad \mathrm{div}\mathbf{B} = 0. \qquad (12.2)$$

Let us now take partial derivatives with respect to time from both sides of the first equation (7.13), dividing it by c,

$$\partial\mathbf{G}/c\partial t = -\,(1/c)\mathrm{grad}(\partial\Phi/\partial t) - (1/c^2)\partial^2\mathbf{A}/\partial t^2. \qquad (12.3)$$

Write the second equation (9.13) in the form

$$-\,(1/c^2)\partial^2\mathbf{A}/\partial t^2 = -\,\Delta\mathbf{A} + (4\pi/c)\gamma\mathbf{m} \qquad (12.4)$$

and put here the mathematical identity

$$\Delta\mathbf{A} = \mathrm{grad}(\mathrm{div}\mathbf{A}) - \mathrm{rot}(\mathrm{rot}\mathbf{A}). \qquad (12.5)$$

Substituting (12.4) into (12.3) and taking into account (7.16), we obtain

$$\mathrm{rot}\mathbf{B} = (1/c)\partial\mathbf{G}/\partial t - (4\pi/c)\gamma\pi. \quad (12.6)$$

Let us finally take divergence from both sides of the first equation (7.13)

$$\mathrm{div}\mathbf{G} = -\Delta\Phi - (1/c)\partial(\mathrm{div}\mathbf{A})/\partial t. \quad (12.7)$$

Write the first equation (9.13) in the form

$$\Delta\Phi = (1/c^2)\partial^2\Phi/\partial t^2 + 4\pi\gamma\mu. \quad (12.8)$$

Putting (12.8) into (12.7) and taking into account (7.16), we obtain

$$\mathrm{div}\mathbf{G} = -4\pi\gamma\mu. \quad (12.9)$$

Equations (12.6) and (12.9) are the SECOND PAIR OF THE MAXWELL-MARINOV EQUATIONS.

13. THE MAXWELL-LORENTZ EQUATIONS

The analogues to the Maxwell-Marinov equations in electromagnetism are the famous Maxwell-Lorentz equations. Here are the FIRST and SECOND PAIR OF THE MAXWELL-LORENTZ EQUATIONS (see formulas (12.2), (12.6) and (12.9))

$$\mathrm{rot}\mathbf{E} = -(1/c)\partial\mathbf{B}/\partial t, \qquad \mathrm{div}\mathbf{B} = 0, \quad (13.1)$$

$$\mathrm{rot}\mathbf{B} = (1/c)\partial\mathbf{E}/\partial t + (4\pi/c)\mathbf{J}, \qquad \mathrm{div}\mathbf{E} = 4\pi Q. \quad (13.2)$$

Now I shall present the Maxwell-Lorentz equations in an integral form.

According to Gauss theorem we have

$$\oint_S \mathbf{B}.d\mathbf{S} = \int_V \mathrm{div}\mathbf{B}\, dV, \quad (13.3)$$

where the integral on the left side is taken over the closed surface S bounding the volume V, over which we take the integral on the right side. Using here the second equation (13.1), we obtain

$$\oint \mathbf{B}.d\mathbf{S} = 0. \quad (13.4)$$

This integral equation, which corresponds to the differential equation (13.1), asserts that the scalar flux of the magnetic intensity through any closed surface is equal to zero.

According to Stokes theorem we have

$$\oint_L \mathbf{E}.d\mathbf{r} = \int_S \mathrm{rot}\mathbf{E}.d\mathbf{S}, \quad (13.5)$$

where the integral on the left side is taken along the closed line L bounding the surface S, over which we take the surface integral on the right side. Using here the first equation (13.1), we obtain

$$\oint_L \mathbf{E}.d\mathbf{r} = -(1/c)(\partial/\partial t)\int_S \mathbf{B}.d\mathbf{S}. \quad (13.6)$$

This integral equation, which corresponds to the first differential equation (13.1), asserts that the circulation of the electric intensity along any closed line L is equal to the time derivative, taken with an opposite sign, from the scalar flux of the magnetic intensity through any surface bounded by this line.

The circulation of the electric intensity is also called ELECTRIC TENSION along the respective line and is denoted by U (do not confound this symbol with the symbol for the electric energy). For the differential part **dr** of the line L we shall have

$$dU = \mathbf{E}.d\mathbf{r}. \qquad (13.7)$$

Let us turn now our attention to the second pair of the Maxwell-Lorentz equations.

According to Gauss theorem we have

$$\oint_S \mathbf{E}.d\mathbf{S} = \int_V \mathrm{div}\mathbf{E}\, dV. \qquad (13.8)$$

Using here the second equation (13.2), we obtain

$$\oint_S \mathbf{E}.d\mathbf{S} = 4\pi \int_V Q dV. \qquad (13.9)$$

This integral equation which corresponds to the second differential equation (13.2), asserts that the scalar flux of the electric intensity through any closed surface S is equal to the sum of the charges in the volume V bounded by this surface and multiplied by 4π.

According to Stokes theorem we have

$$\oint_L \mathbf{B}.d\mathbf{r} = \int_S \mathrm{rot}\mathbf{B}.d\mathbf{S}. \qquad (13.10)$$

Using here the first equation (13.2), we obtain

$$\oint_L \mathbf{B}.d\mathbf{r} = (1/c)(\partial/\partial t)\int_S \mathbf{E}.d\mathbf{S} + (4\pi/c)\int_S \mathbf{J}.d\mathbf{S}. \qquad (13.11)$$

The quantity

$$\mathbf{J}_{dis} = (1/4\pi)\, \partial\mathbf{E}/\partial t \qquad (13.12)$$

is called DISPLACEMENT CURRENT DENSITY. Using this quantity (whose physical essence will be explained in Sect. 30), we can write (13.11) in the form

$$\oint_L \mathbf{B}.d\mathbf{r} = (4\pi/c)\int_S (\mathbf{J} + \mathbf{J}_{dis}).d\mathbf{S}. \qquad (13.13)$$

This integral equation, which corresponds to the first differential equation (13.2), asserts that the circulation of the magnetic intensity along any closed line L is equal to the scalar flux of the current and displacement current through any surface S bounded by this line.

14. ENERGY DENSITY AND ENERGY FLUX DENSITY

Let us multiply the first equation (13.1) by **B**, the first equation (13.2) by **E**, and then subtract the first from the second

$$\frac{\mathbf{E}}{c}.\frac{\partial\mathbf{E}}{\partial t} + \frac{\mathbf{B}}{c}.\frac{\partial\mathbf{B}}{\partial t} + \frac{4\pi}{c}\mathbf{J}.\mathbf{E} + \mathbf{B}.\mathrm{rot}\mathbf{E} - \mathbf{E}.\mathrm{rot}\mathbf{B} = 0. \qquad (14.1)$$

Using the mathematical relation (see p. 6)