

## Alternative To ‘Great Unification’

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**Annotation:** Vain attempts to unite gravitation with electromagnetism based on the relativity theory and quantum mechanics stimulates to search for alternative ways of their synthesis. It is shown that such an alternative may be realized if physics is constructed on the basis of energodynamics excluding hypotheses, postulates and model concepts to be used in the foundations of the theory. In such a case gravitation and electromagnetism are construed as different manifestations of the same interaction caused by the heterogeneous distribution of matter in space and the wave nature of matter and radiation. Experimental confirmations of the concept set forth are also made available in this article.

**Key Words:** methodological principles, relativity theory, quantum mechanics, gravitation, electromagnetism, radiation, field theory, modified laws

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### I. Introduction

Search for a unified method to describe explicitly distinguishable phenomena in the nature and engineering is one of the strategical directions in the development of theoretical physics. The most prominent breakthroughs of the past were steps toward this aim. Those were the unification of terrestrial and celestial mechanics by Newton in the XVIII century, electromagnetism and optics by Maxwell in the XIX century. In the XX century striving for the synthesis of scientific disciplines was embodied in appearing hydro-aeromechanics, physical chemistry and chemical physics, biophysics and biochemistry, geophysics and astrophysics, etc.

However, the ‘Great Unification’ as a unified description of the gravitational and electromagnetic interactions has not been achieved hitherto though A. Einstein dedicated to that problem as many as 30 years of his life [1]. In W. Heisenberg’s opinion [2] that occurred because Einstein had taken the general relativity theory (GRT) for starting point and searched for such a generalization of the space curvature metric tensor which would result, at least, in the laws of electromagnetism. As for the description of material bodies, A. Einstein evidently expected that at the next stage of the theory development the elementary particles could be considered as singularities of some universal field. However, quantum mechanics also failed to advance far in that direction. The standard model of elementary particles allowed formal unification of electromagnetism with weak interactions only. The problem to unite the electromagnetic and gravitational interactions appeared to be much more complicated since the gravitation is ‘unaware’ of not only the particles responsible for its existence, but also the principles which could bring together the GRT with quantum mechanics (QM).

In this context undoubtedly interesting is an alternative approach to solve this problem using neither GRT nor QM. It is based on the synthesis of equilibrium [3] and nonequilibrium thermodynamics [4, 5], which allowed creating a unified theory of real processes for transfer and conversion of any forms of energy [6] and synthesizing foundations for technical disciplines [7]. This article is aimed at showing that such an approach makes us reconsider many provisions of the fundamental theories and results in a conclusion that a unified long-range interaction ‘mechanism’ exists.

### II. Energodynamic Description Of Real Processes

Energodynamics has extended the classical (deductive) method of equilibrium thermodynamics to irreversible processes and nonequilibrium systems providing conversion of nonthermal forms of energy [6]. Unlike principle disciplines A. Einstein assigned to category of ‘constructive’ ones, energodynamics is closer to the ‘theory of principles’ more preferable from his viewpoint. It is caused by the fact that energodynamics is based on the principle of general physics. Besides the deductive method of research (general-to-specific) supplemented with the system approach (whole-to-part) advantages of energodynamics may include the refusal of hypotheses and postulated in theory foundations and the explicit consideration of irreversibility of real processes not only in thermodynamics, but in constructing other disciplines, too [7]. Instead of this, it is therein based on an *axiom of process identifiability* which, on the basis of the centuries-old experience, is governed by the possibility to identify (with the help of the whole stockpile of experimental facilities) independent processes in terms of not

only their reasons, but specific state changes not reducible to others, they cause. This axiom allows proving the theorem defining *thenecessary and sufficient* number of arguments for intrinsic (internal) energy of an isolated system  $U$  as the most general function of its state. According to this theorem the *number of the independent arguments defining the energy of some system is equal to the number of the independent processes running therein*. In other words, for any independent process there exists and can be found the single independent state coordinate as a parameter whose change is *the necessary and sufficient* characteristic of this process to be run. In particular, as known, to describe the state of an equilibrium thermodynamic system that participates in the processes of heat and mass exchange with the external medium, diffusion, bulk expansion and electrostatic charging, it is necessary to know such  $\Theta_i$  parameters as entropy  $S$ , mass  $M$ , number of moles of the  $k$ th matter  $N_k$ , volume  $V$  and electric charge  $\Theta_e$ . However, to describe the internally nonequilibrium (heterogeneous) systems with internal processes of the *redistribution* of the above parameters over the volume of the system, it is necessary, according to this theorem, to introduce the same number of the missing parameters of their spatial heterogeneity<sup>1)</sup>. To find these parameters, let us pay attention to the position of the radius vector  $\mathbf{R}_i$  for center of some extensive value  $\Theta_i$  (Fig. 1). As follows from the figure, distribution  $\Theta_i$  being deviated from the uniform one with the density  $\bar{\rho}_i(t)$ , some amount  $\Theta_i^*$  of this value is transferred from one part of the system to other in the arrowed-line direction. Such a 'redistribution' of the  $i$ th energy form carrier  $\Theta_i$  is accompanied by shifting the center of its value  $\Theta_i$  ( $i = 1, 2, \dots, n$ ) from the initial position  $\mathbf{R}_{i0}$  to the current one  $\mathbf{R}_i$ . This position is defined by the known way:

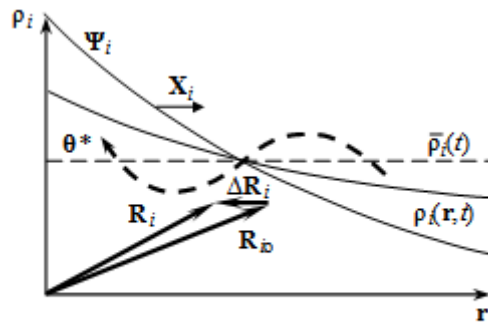


Fig.1. Forming moment of distribution

$$\mathbf{R}_i = \Theta_i^{-1} \int \rho_i \mathbf{r} dV; \mathbf{R}_{i0} = \Theta_i^{-1} \int \bar{\rho} \mathbf{r} dV \quad (1)$$

where  $\rho_i = \partial \Theta_i / \partial V$  is the density of the  $\Theta_i$  value in the field point  $\mathbf{r}$  at the moment of time  $t$ ,  $\bar{\rho} = \Theta_i / V$  is its average.

From (1) it directly follows that the system being withdrawing from the homogeneous (internally equilibrium) state, some 'moment of distribution'  $\mathbf{Z}_i$  for the parameter  $\Theta_i$  appears [6, 7]:

$$\mathbf{Z}_i = \Theta_i (\mathbf{R}_i - \mathbf{R}_{i0}). \quad (2)$$

<sup>1)</sup> Contrary to the hypothesis of local equilibrium considering it is possible to describe the elements of nonequilibrium continuum by the same number of variables as at equilibrium [6]

The arm  $(\mathbf{R}_i - \mathbf{R}_{i0})$  of this moment at  $\mathbf{R}_{i0} = 0$  defines  $\mathbf{R}_i$  as the 'displacement vector' of the  $\Theta_i$  value center from its equilibrium position. Thus, the moment  $\mathbf{Z}_i$  becomes an extensive parameter of the system spatial heterogeneity characterizing the deviation of the system in whole from its internally equilibrium state. The number of such 'parameters of nonequilibrium'  $\mathbf{Z}_i$  is in general equal to the number of the equilibrium coordinates  $\Theta_i$  and, therefore, finite. This allows extending the thermodynamic method for describing the state of systems as a whole to nonequilibrium (including continual) media up to isolated systems. In this case the necessity is eliminated to break down these systems into infinite number of conventionally equilibrium elements of volume all the known continual theories resort to.

Thus, the internal (intrinsic) energy of a heterogeneous system  $U = \sum_i U(\Theta_i, \mathbf{R}_i)$ , i.e. is generally a function of the double number of the state coordinates  $i = 1, 2, \dots, n$ , where  $n$  is the number of independent forms for system 'partial' energy  $U_i(\Theta_i, \mathbf{R}_i)$ . In such a case the total differential of the system energy  $U$  may be represented in the form of an identity [6,8] as:

$$dU \equiv \sum_i \Psi_i d\Theta_i - \sum_i \mathbf{F}_i \cdot d\mathbf{R}_i, \quad (i = 1, 2, \dots, n) \quad (3)$$

where  $\Psi_i \equiv (\partial U / \partial \Theta_i)$  is the system volume averaged values of the absolute temperature  $T$ , pressure  $p$ , electrical  $\phi$ , gravitational  $\psi_g$  and chemical potential of the  $k$ th matter;  $\mu_k$  are Cartesian components of their

relative translational and rotational speed  $w_k$  and  $\omega_k$ , respectively;  $\mathbf{F}_i \equiv -(\partial U / \partial \mathbf{R}_i)$  are relaxation forces as construed from general physics.

Identity (3) generalizes the main equation of the first and second laws of classical [3] and locally equilibrium thermodynamics of polyvariant systems [5] represented by its first sum to nonequilibrium systems doing 'anti-equilibrium' work (its second sum). This allows energodynamics to give a unified description of any real processes starting from microcosmic objects and up to the Universe in whole.

In isolated systems wherein  $dU = 0$  the forces  $\mathbf{F}_i$  may be found as partial derivative of the so-called 'partial' energy  $U_i$  with respect to corresponding displacement vector  $\mathbf{R}_i$ . Since in definition of the force  $\mathbf{F}_i$  all other variables  $\Theta_i$  and  $\mathbf{R}_j (j \neq i)$  remain unchanged,  $dU = dU_i$  and  $d\mathbf{R}_i = d\mathbf{r}$ , so that the force  $\mathbf{F}_i$  takes the unified meaning as a gradient of the corresponding form for system energy (with reverse sign)<sup>1)</sup>:

$$\mathbf{F}_i \equiv -(\partial U / \partial \mathbf{R}_i) = -(\partial U_i / \partial \mathbf{r}). \quad (4)$$

<sup>1)</sup> Sign '-' is dictated by the rule of signs as adopted in mechanics and thermodynamics: work is positive if done by system (due to its energy)

Since any component  $U_i$  of the system internal energy  $U$  may be represented as product of the extensive  $\Theta_i$  and intensive  $\psi_i$  parameters  $U_i = \psi_i \Theta_i$  [8], then at  $\Theta_i = \text{const}$  it can be written instead of (4):

$$\mathbf{F}_i = -(\partial U_i / \partial \mathbf{r}) = -\Theta_i \nabla \psi_i = \mathbf{X}_i \Theta_i. \quad (5)$$

Thus, energodynamics allows unifying the notion of force assigning to forces of different nature  $\mathbf{F}_i$  the unique meaning of the corresponding energy form gradient and to their specific values ('energodynamic forces')  $\mathbf{X}_i = \mathbf{F}_i / \Theta_i$  – the unified meaning of the corresponding potential gradient (with reverse sign). Thereby, forces of different nature acquire a *unified meaning, unified dimensions and unified determination method*. Thus, energodynamics opens the door for replacing the vain search of a unified field theory by a more realistic task of developing a unified method of finding explicitly distinguishable forces [9].

It also follows therefrom that, contrary to the wide-spread belief, any force fields (including gravitational, electrical and magnetic ones) *are caused by not masses, charges or currents as themselves, but by their non-uniform distribution in space*. This excludes the possibility to interpret field as some substance able, like the Maxwell's electromagnetic field, 'to break away from sources' and 'to transfer energy in space' [10].

It is characteristic that the above consequences have been obtained without resort to whatever hypotheses, postulates and model concepts regarding the subject of research. This is what allows assigning energodynamics to the theory-of-principles category. It is even more justified because further application of energodynamics to particular systems would not require knowing the 'mechanism' of system processes and structural details. It will be enough to know only the equations of their state and motion. To experimentally find these equations, it is possible to use hypotheses, postulates and model concepts since their validity is subject to experimental control irrespective of the theory abovementioned. Thanks to such a distinct separation of the theory and its applications, its consequences gain the status of indisputable truth.

### III. Energodynamic Description Of Gravitation

Let us apply energodynamics to that part of the intergalactic medium that is free of baryonic (visible, structured) matter. That part of matter, wherefrom all forms of the matter in the Universe have been formed, was earlier called 'ether' and now – 'physical vacuum', 'dark mass', 'nonbaryonic matter', etc. In order to avoid the identification with any of the above, we will call it 'cosmic vacuum'. The share of this invisible (unobservable) part of the Universe matter is, according to the up-to-date data, at least 95% of the whole Universe mass [11,12]. Therefore, it should be considered as that 'prime matter', wherefrom in the course of the evolution all forms of the Universe visible matter and all celestial bodies have been formed. This matter, as proved, does not participate in the electromagnetic interaction and possesses only the gravitational form of energy  $U_g$ . The density  $\rho(\mathbf{r}, t) = dM/dV$  of this matter is distributed in extremely non-uniform manner in space and varies from  $\max 10^{-29} \text{ g cm}^{-3}$  up to the value enough to start its 'condensation' into conventional (baryonic) matter (whose density reaches in the white dwarfs a value of at least  $\sim 10^{18} \text{ g cm}^{-3}$ ).

Some additional information of this medium may be obtained from energodynamics [13]. According to identity (3) the gravitational potential of the cosmic vacuum

$$\Psi_g = (\partial U_g / \partial M), \quad (4)$$

which, according to the principle of mass  $M$  and energy  $U_g$  equivalence, is equal to squared velocity of light in vacuum  $c^2$ , J/kg. Comparing this value with the Newtonian gravitational potential on the Sun surface wherein it is maximum and equal to  $\psi_c = 1.906 \cdot 10^{11} \text{ J/kg}$  we can find that it is the  $\sim 0.512 \cdot 10^{-7}$ th part of the cosmic vacuum potential. Thus, the intergalactic medium features the so-called 'strong gravitation' not conceding (considering density and nucleus radius) the so-called 'strong' interaction. [14]. It makes the gravitational energy to be a basis for the Universe energy resource and drastically changes the concept of the

gravitational interaction that has been considered to be most weak of the four its types known. It becomes clear that the unobservable accretion of the nonbaryonic matter accompanied by its condensation and releasing energy not comparable with the energy of the following thermonuclear synthesis is the actual 'star fuel'. Besides, this synthesis as itself (both 'cold' and 'hot') takes the character of a forced (stimulated) process caused by the work done on the densification of the system [15].

The fact there are no 'field forming' and 'trial' bodies in the cosmic vacuum as continuum necessitates finding for it a gravitational law equivalent to the Newton law for celestial bodies. With this purpose let us resort again to the principle of mass and energy equivalence, wherefrom it follows that the density of gravitational energy  $u_g$  is expressed as

$$u_g = c^2 \rho, \text{ J/m}^3. \tag{5}$$

Applying the operator  $\nabla$  to both parts of this expression gives:

$$\nabla u_g = c^2 \nabla \rho. \tag{6}$$

Since  $\nabla u_g$  defines the density of the energodynamic gravitational force  $\rho \mathbf{X}_g = -\nabla u_g$  as a value reverse to the gravitational acceleration  $\mathbf{g} = -\mathbf{X}_g$ , it directly follows from (6) the law of gravitation [15] as alternative to the Newton law:

$$\mathbf{X}_g = -\psi_g \nabla \rho / \rho. \tag{7}$$

According to this expression the value of gravitational force is proportional to the relative gradient  $\nabla \rho / \rho$  of density for the matter filling space. In this case the active gravitation  $\mathbf{g}$  that causes the process of cosmic vacuum density redistribution is always directed along the matter density gradient  $\nabla \rho$  and, therefore, may have in different domains of the Universe different value and sign depending on the value and sign of the above gradient. In other words, the gravitational forces being the forces of the same nature may be both attraction and repulsion depending on the character of mass distribution in space. This fact explains the observable local expansion of the visible part in the Universe due to the heterogeneous distribution of the celestial bodies therein without any resort to an exotic 'dark energy'.

The bipolar character of the gravitation by no means ensued from the Newton law based on existence of exclusively attraction forces. Nevertheless, as shown in [15], its modified form (7) does not conflict with the Newton law providing the potential  $\psi_g$  therein is also represented as a function of the local density  $\rho$  for the medium in some 'trial' (unit) volume at its invariable radius  $R$ . Then it becomes clear that should the 'trial' volume be removing in space with different density, the potential on the surface of the trial volume will be also changing in complete accordance with the Newton law.

Another, not less important consequence from this law, is the forecast there exists a gravitational equilibrium meeting the condition

$$\mathbf{X}_g = -\nabla \psi = 0. \tag{8}$$

The fact the stable equilibrium in the gravitational field is possible is confirmed by the libration phenomenon due to which a celestial body may be at rest or oscillate being in between more massive bodies. The same is also validated after discovery of multiple spherical galaxies on the 3D chart of the Universe, which in their section look like concentric rings considerably distant from the central cluster [16]. Vast 'empty' zones available in these structures may be explained by only the fact there are no conditions therein necessary to form celestial bodies.

#### IV. Energodynamic Description Of Structure Formation Processes

The bipolar law of gravitation (7) explains many specific features in the formation of celestial bodies. As ensues from it, the density gradient having spontaneously appeared in whatever domain of the Universe causes gravitations therein and results in accretion of cosmic vacuum nonbaryonic matter into this domain. Due to isotropy of this medium a spherical zone with increased density appears, wherein a solitary 'elevation wave' occurs. An increase of density  $\rho'$  in such a wave as compared with its average level  $\bar{\rho} = M/V$  is considerably above the decrease of the density level in the ambient space  $\bar{\rho} - \rho''$ . The condition of this wave formation can be easily found if proceeding from the Universe mass conservation law. Let us choose in some volume  $V$  subsystems with volumes  $V'$  и  $V''$  wherein the densities  $\rho'$  and  $\rho''$  are superior or inferior to the average value  $\bar{\rho}$ . Then, due to the obvious equality  $\int \rho dV = \int \bar{\rho} dV = M$ , we have:

$$\int (\rho' - \bar{\rho}) dV' + \int (\rho'' - \bar{\rho}) dV'' = 0. \tag{9}$$

It follows therefrom that  $\rho' - \bar{\rho}$  и  $\rho'' - \bar{\rho}$  are opposite in sign, but equal in value  $V' = V''$  when the wave is symmetrical (sinusoidal). However, at  $V'' \gg V'$ , when accretion occupies a part of space considerably prevailing over the densification zone, it is the 'elevation wave' that appears. It is these waves that form the 'nuclei' of baryonic (structured) matter at any hierarchical level – from atoms to clusters of galaxies. Such waves retain their form a rather durable time depending on the duration of the oscillation semi-period. The

duration of this semi-period may be evaluated by the proton lifetime, whose lower limit is now evaluated as  $10^{29} - 10^{33}$  years.

The density gradients at the 'slopes' of such waves are negative and cause, according to (5), the gravitational forces  $F_g$ . Thanks to these forces such waves become similar to electrically charged particles (i.e. 'particle-like'). These solitary, structurally stable and particle-like 'elevation' waves are similar to the solitons in liquid. At the same time they differ from the Russell's solitons in that the wave running in liquid is stable in only nonlinear media with velocity dispersion and viscosity, when the increase in the wave edge 'steepness', due to the velocity dispersion, is compensated by wave 'flattening' due to the energy dissipation [15]. In the cosmic vacuum with no viscosity such waves may also be standing retaining its structural stability for a long time. Generally speaking, such are all celestial bodies starting from meta-galaxies and down to atoms. These are what should be assigned to solitons considering waves and liquids as their particular case and calling them 'soliton-like' structures. However, respecting tradition, we will apply the term 'waveton' to 'standing' solitons otherwise using scare quotes around 'particle'.

The dimensions of such structural formations may vary a in wide range – from gigantic spherical clusters of galaxies with a diameter of 500 million light years [16] down to microscopic waves leaving point-like trace on photo-film or in the Wilson chamber and, therefore, taken for particles. E. Schrödinger stuck to that view to the end of his life. He believed that the 'matter that had earlier been considered as consisting of particles we should imagine as consisting of waves' [17].

It is quite natural that along with such stable structures there are conventional harmonic density waves of even higher frequencies also appearing in the cosmic vacuum [18]. According to (9) it occurs under the  $V' \approx V''$  conditions dominating throughout the space of the Universe. In the central gravitational fields of the nucleus such waves form spherical 'shells' around the nucleus. These shells are located at such a distance from the nucleus where the radial gravity forces  $\mathbf{g}$  are compensated by resulting repulsion forces caused due to the difference between gradients of density and forces at the 'slopes' of such shells. Since the density in such shells is maximum in their crests, the latter are located at distances from the nucleus multiple of the wavelength of their oscillation. In this case the shell in whole appears to be within the zone of libration, wherein gravity forces are balanced by repulsion forces. This is what ensures the stability of such structures. The number of the shells, their 'width', character of their oscillations, etc. may be different, which caused the variety of matters [19]. This is the way whereby the 'shell' structure of atom (see Fig.2) is formed. It consists of a central massive nucleus and a certain number of 'shells' which in quantum mechanics are called 'orbitals' and represented in the form of electron clouds.



Fig.2. Shell Model of Atom

The reality of such structures are to date confirmed by both astronomical observations [19] and recent experiments on electrons [20], which have revealed that the latter behave as if consisting of a number of elastic spherical shells. As indirectly support of the shell structure of atom may also serve the spherical character of the waves atom radiates, as well as the photos of atoms obtained with the tunnel scanning microscopes, which have nothing to do with the planetary model of atom by Rutherford.

It is fundamentally important that the wave structure of atom described here does not demand a balance of whatever forces pertaining to different types of interaction. It provides an absolutely new explanation for the stability of structures (from atoms up to meta-galaxies) not demanding a subtle balance between different-type forces and existence of gluons with their mysterious ability to 'stick' particles together.

However, much more important is the fact that the wave concept of matter structure allows a validation of the Planck radiation law, the law of spectral series formation and the Schrödinger stationary equation with no resort to whatever considerations of quantum-mechanical character [21]. The gravitation theory set forth enables, as a consequence, a new explanation of the Universe evolution processes starting from the formation of atoms, molecules, gases, dust clouds and further to small and large celestial bodies, stars, galaxies and their clusters [22]. In the chain of events involving the accretion of nonbaryonic and baryonic matter to celestial bodies and their gradual heating there is also a place found for 'black holes' as 'seed' regions of increased

matter density. They are where the process of cosmic vacuum condensation starts accompanied by matter structuring and acquiring new forms of energy. The difference in the optical characteristics of the structured matter results in appearing 'jets' – powerful flows of particles and radiation 'discarding' into the cosmic vacuum the surplus energy of its condensation. This process continues until the internal pressure in the forming celestial bodies exceeds the gravity forces of their compression. This is the moment when the period of the local involution of the Universe starts – from the supernova outburst and to return of the Universe matter to the initial state. This process of changing evolution and involution of the Universe in its particular domains being incessant for the Universe as a whole allows both the formation of local 'singularities and such phenomena as 'big bang' and 'expansion' of the visible part of the Universe due to 'recession' of galaxies therein [25].

## V. Energodynamic Description Of Electromagnetism

Some bodies are known to either attract or repulse different materials when interacting with them. This property has resulted in the idea of electrical charges of opposite signs. These ideas strengthened after invention of electroscope as a device capable of revealing that property and studying the behavior of charges in various bodies. The notion of positive and negative charge first introduced B. Franklin (1749). According to him attraction and repulsion forces depend not on the kind of some 'electrical liquid' that, as assumed at first, is contained in some bodies, but on its distribution between various bodies (according to the more-less principle). The idea of existing charges of two signs prevailed and strengthened especially after the Faraday's experiments with separation of electrolytes into electrons and ions [24]. Later (in 1933) free particles with charges of opposite signs (electrons and positrons) and in different amounts were discovered in cosmic rays [25]. At the same time the phenomenon of generation of electron-positron pairs [26] were also discovered, which provided evidence of a possible polarization of the same medium in physical vacuum.

To this idea favorably testifies the modified form of the Coulomb law found [27] in application to continuums (where it is impossible to identify point charges of different signs):

$$\mathbf{E} = -\varphi_0 \nabla \rho_e / \rho_e. \quad (10)$$

where  $\mathbf{E}$  is electric field intensity,  $\rho_e$  is charge density,  $\varphi_0 = \rho V_0 / 4\pi \epsilon_0 R_0$  is 'trial' potential on the surface of sphere of unit volume  $V_0$  with radius  $R_0$  and dielectric constant  $\epsilon_0$ .

This expression is absolutely similar to the modified Newton law and obtained from the Coulomb law under the same prerequisites. The main of them is the notion of 'trial volume' introduced, the potential on whose surface depends on only the local density of the energy carrier in the unit volume of question. In such a case the trial volume being removed to electrical field, its intensity will change depending on the density of the energy carrier  $\rho_e$ , but not on the distance to the 'field-forming' charge.

Expression (10) reveals the existence of attraction and repulsion forces for charges  $\rho_e$  of the same sign thus confirming the Franklin's viewpoint. Hence, it's not a matter of a difference in type of charge, but the distribution of material carrier throughout the space as it was in the case of gravitation. However, unlike the gravitation, this kind of interaction involves not the whole mass of the body, but its certain part  $\rho_e/\rho$  capable of this kind of interaction. This fact being comprehended, the necessity is excluded to consider the existing attraction and repulsion forces as two special kinds of interaction. In such a case it becomes actually to reveal the specific features of that part of the 'baryonic' matter structure that causes the ability of the body to participate in the 'electrical' interaction. Then it will become almost obvious that those structures are identified with those 'shells' which are formed around the nucleus. Whereas the atomic nuclei have the lifetime not exceeding the semi-period of their density oscillation, the shells oscillate at higher frequencies. Therefore, the 'mechanism' of their interaction differs from the same for nuclei. On the other hand, the density of the baryonic matter reaches maximum in the crests of such waves, which causes the density gradients  $\nabla \rho_e$  and forces of opposite signs at their leading and trailing edges. The sum of these forces is what defines the value and direction of the electrical field  $\mathbf{E}$  in some point of space. Such an idea is quite close to the quantum-mechanical atomic model wherein the said shells are represented as 'orbitals', i.e. electron clouds located at different distances from nucleus. Thus, the charge  $Q = \int \rho_e dV$  appears as the part of the body mass  $M = \int \rho dV$  involved in the oscillatory motion of the atomic electron shells. It ensues therefrom the constancy of the  $\rho_e/\rho$  relation in the processes not involving the atomic restructuring.

Let us consider now the fundamental nature of magnetism and the specific features of magnetic field from the position of energodynamics. This field is also characterized by available forces of both attraction and repulsion. The magnetic material is known to retain this bipolarity at its splitting into any parts providing this splitting has been accomplished with no structural damage to atom. Hence, magnetic properties are inherent in also elementary volumes of a magnetic material, i.e. contingent on structures of atoms. The existing viewpoint on permanent magnetism associates it with the molecular current loops appearing at rotary motion of electrons in atoms when the sum of the angular momenta of their rotation takes the directional character. This idea is

extended to also electromagnetism caused by the macroscopic flow of charges along closed current-carrying loops.

The connection between magnetism and flow of charges directly ensues from energodynamics. According to identity (5) the charge displacement at the distance  $\Delta\mathbf{R}_e$  occurs with an average velocity of  $\mathbf{v}_e = d\mathbf{R}_e/dt$ . This velocity may be generally resolved into translational  $\mathbf{w}_e$  and rotational  $\boldsymbol{\omega}_e$  components:

$$\mathbf{v}_e = \mathbf{w}_e + \boldsymbol{\omega}_e \times \mathbf{R}_e. \quad (11)$$

Correspondingly the momentum  $\mathbf{J}_e = Q\mathbf{v}_e$  of the system charge  $Q$  is resolved into the translational component  $\mathbf{I} = Q\mathbf{w}_e$  with a density of  $\mathbf{j}_e = \rho_e\mathbf{w}_e$  named current and the rotational component  $\mathbf{L} = Y\boldsymbol{\omega}_e$  with the moment of inertia  $Y$ . This translational and rotational motion results in that the current-carrying system has now not one, as commonly cited, but two new degrees of freedom with the vector-nature potentials  $\mathbf{w}_e$  and  $\boldsymbol{\omega}_e$ . The independent scalar components of these potentials are defined in the same manner as the potentials  $\Psi_i$ . In this case it may be shown that magnetism is nothing else than the electrokinetic form of motion. Here the angular speed  $\boldsymbol{\omega}_e$  of the current-carrying system with the magnetic permeability  $\mu_0$  and the current density  $\mathbf{j}_e$  is the vector magnetic potential  $\mathbf{A} = (\mu_0/4\pi)(\mathbf{j}_e/R_e)dV$  assigned to the above system charge  $Q$  [28]:

$$\boldsymbol{\omega}_e = \mathbf{A}/Q. \quad (12)$$

The magnetic eddy field intensity  $\mathbf{B} = \text{rot}\mathbf{A}$  will also be in this case a vector function of angular speed  $\mathbf{B} = \text{rot}\boldsymbol{\omega}_e$  with a somewhat revised dimension. Since the angular speed  $\boldsymbol{\omega}_e$  does not depend on body sizes, the magnetic properties pertain to elementary magnets, too. Not less important is also the prediction there is the rotational interaction not only for charged, but also for electrically neutral bodies. It is caused by the fact that the angular speed of both coincides in solid de-energized bodies. Such interaction existing is experimentally validated [29].

At the same time energodynamics predicts also existing scalar (the so-called 'longitudinal') field  $\mathbf{H}_0 = \text{div}\mathbf{w}_e$  whose reality has also been confirmed experimentally [30]. Thus, with the energodynamic approach the magnetic potential acquires a sense unified with other potentials, a unified analytical expression and unified functionality. This reveals the physical meaning of this potential, which has remained obscure for a long time and caused variety of opinions regarding both the fact of its existence as itself and the practicability of its introduction in the toolkit of energodynamics.

As follows from energodynamics, each independent process requires a potential (scalar or vector) to be introduced. That is why the fact as itself of existing translational and rotational motion of charge requires two independent potentials to be introduced featuring the vector nature in this case. Based on this fact, energodynamics predicts the existence of a numerous interactions not reducible to the four kinds known. Such is, in particular, the interaction between rotating bodies electrically neutral (including the spin-spin interaction between elementary particles) [29]. Some of these interactions feature short-range character inherent in the thermal, chemical, baric, etc. interaction. These interactions do not differ in principle from the so-called 'strong' and 'weak' interactions assigned to the short-range nuclear forces. Therefore, their consideration is the same necessary as for the nuclear forces. However, this even more complicates the problem of searching for the unified theory of field. In this context the energodynamic approach alternative to this theory becomes an actual one as a unified method of searching for explicitly distinguishable forces.

## VI. Energodynamic Description Of Radiation

The abovementioned puts physics before the problem of searching for the radiation potential as a special radiant heat exchange not reducible to others. Following the H. Hertz's experiments (1887) discovered the transfer of electromagnetic oscillations in space [31] the concept has predominated of the electromagnetic nature of this process. Meanwhile, the Hertz's experiments by no means excluded the possibility the electrical oscillations in the Hertz radiator could convert into the oscillatory energy of luminiferous medium followed by the partial or total restoration of energy initial form in the receiver. Hertz, following Maxwell, considered that such a medium is the electromagnetic field (EMF)[10]. That meant that the electromagnetic and whatever else oscillations in a matter are continuing in the ether as well which transfers the energy of the source in the same form.

Meanwhile in the next century the ether was expelled from physics, while experiments and analysis of the Maxwell's equations revealed their imperfection and some inadequacy to the root of the matter. First of all, it was unreasonable to assume that the electrical and magnetic components of the EMF would convert into each other<sup>1)</sup> once M. Faraday yet in 1831 discovered their phase coincidence [32]. It was a mistake to consider the EMF being 'out of touch' with their sources and, nevertheless, capable of energy transfer, since it violated the energy conservation law [32, 33]. There were no grounds to claim the displacement currents closed the conduction current once they were opposing. It is same erroneous to consider the electromagnetic energy flow to be something uniform, since the electrical and magnetic components of the Poynting vector are directed counter each other [33, 34]. There are no grounds to take for electromagnetic the field wherein the magnetic component of the same power as the electrical one has not yet been discovered. It is unacceptable to assign to

electromagnetic radiation the numerous ones which easily penetrate through the EM screens, but are attenuated by polymeric film. It is also incorrectly to assign electromagnetic properties to light if its carrier possesses neither electrical, nor magnetic properties [34, 35].

Finally, there are absolutely no grounds to materialize the EMF or some other field if, in accordance with [12], there is no place for it remaining in the domains of the Universe free of the baryonic matter.

All the above has stimulated us to develop the non-electromagnetic theory of light based on the recent discoveries. The wave concept of baryonic and nonbaryonic matter structure is most compliant with the 'gravity-acoustical'<sup>2)</sup> theory of light, according to which light means the running waves of density modulated in the cosmic vacuum by the atoms of baryonic matters at radial oscillations of the abovementioned atomic shells [35]. This concept directly ensues from the consideration of the wave-formation process in the cosmic vacuum, which also involves the displacement of each half-wave mass by a value of  $\mathbf{r}_B - \mathbf{r}_{B0}$  (Fig.4) at the deviation of density  $\rho$  from the average value  $\bar{\rho}$ . This displacement occurs for the period of oscillation reciprocal to its frequency  $\nu$  and, therefore, runs with the average velocity  $\mathbf{c}_B = \nu(\mathbf{r}_B - \mathbf{r}_{B0})$ . The kinetic energy of oscillations corresponding to this velocity has the density  $\rho_B \equiv \rho c_B^2/2$ .

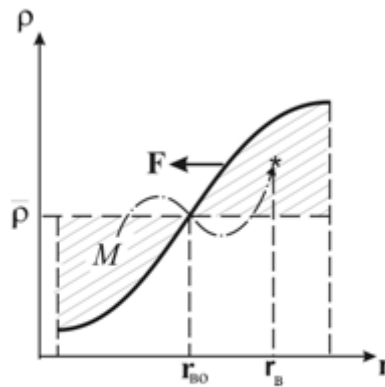


Fig. 4. Mass Displacement at Wave-Formation

Taking the displacement modulus  $|\mathbf{r}_B - \mathbf{r}_{B0}|$  for amplitude  $A$  of the longitudinal wave thus appearing we can drive at the expression known for the wave energy density [36]:

$$\rho_B = \rho A^2 \nu^2 / 2, \quad (\text{J/m}^3), \quad (13)$$

The total derivative of the wave energy  $\rho_B = \rho_B(\mathbf{r}, t)$  as a function of spatial coordinates  $\mathbf{r}$  and time  $t$  is known to be expressed by the sum of its local  $(\partial \rho_B / \partial t)$  and spatial  $(\mathbf{c}_B \cdot \nabla) \rho_B$  components. This derivative may be formed up as the wave equation in its so-called 'single-wave' approximation:

$$\partial \rho_B / \partial t + \mathbf{c}_B \cdot (\partial \rho_B / \partial \mathbf{r}) = d\rho_B / dt. \quad (14)$$

Such an equation is sometimes called 'kinematic'. Unlike the so-called 'dynamic' second-order equation ensuing from the Maxwell equations this one describes the decaying unidirectional (from the source) wave of energy density. In this case the role of the term responsible for the wave decay plays the expression itself of time total derivative of wave density. Thus, equation (1) also contains the wave solution confirming thereby the inevitability of the running density waves appearing in the cosmic vacuum and its capability of the energy transfer.

This process of the radiant energy transfer obeys the same laws as the processes of transfer of other energy-carriers. In order to make sure of this, let us express the component  $(\mathbf{c}_B \cdot \nabla) \rho_B$  in the form of the product between the radiant flux density  $\mathbf{j}_B$  and its motive ('thermodynamic') force  $\mathbf{X}_B$  as adopted in thermodynamics of irreversible processes [6]. Based on the expression of wave energy density (10) we can get:

$$(\mathbf{c}_B \cdot \nabla) \rho_B = \rho A_B \nu \mathbf{c}_B \cdot \nabla (A_B \nu) = -\mathbf{j}_B \cdot \mathbf{X}_B \quad (\text{W/m}^3), \quad (15)$$

<sup>1)</sup> What is usually illustrated by the 'Brag chain'

<sup>2)</sup> The name 'gravity-acoustical' is caused by the fact that the density oscillations of a medium, in its nature, relate to acoustics, whereas the waves as themselves in the medium featuring only the gravitational form of energy are gravitational

where  $\mathbf{j}_B = \rho A_B \nu \mathbf{c}_B$  is a value known as the spectral density of radiation ( $\text{J/m}^3$ );  $\mathbf{X}_B = -\nabla(A_B \nu)$  is the motive force of the radiant energy transfer process expressed by the negative gradient of wave potential  $\psi_B = A_B \nu$  (m/s) and named by us as the amplitude-frequency potential [37].



There is the same relation between the radiant flux  $\mathbf{j}_b$  and its motive force  $\mathbf{X}_b$  as in the equations of thermal conductivity, electrical conductivity, diffusion, etc.

The radiant energy transfer is also connected with the energy dissipation and, therefore, requires some force to be applied. In this case this force  $\mathbf{X}_b$  is connected with the radiant energy dissipation due to its absorption by the baryonic part of the intergalactic medium. As a result of the absorption the wave potential  $\psi_B$  (its amplitude  $A_b$  and frequency  $\nu$ ) decreases, which results in the reduction of light intensity and the 'red shift'. At the same time it is this transfer that makes the baryonic matter 'visible'.

Thus, the cosmic vacuum as a medium with density other than zero is quite capable of fulfilling all functions of ether not possessing at the same time, like the ether, electrical and magnetic properties. This makes the electromagnetic field as a luminiferous medium replacing the ether a superfluous entity. The only gravitational field remains responsible for all kinds of interaction and caused by non-uniform distribution of matter in space [38]. This is what serves an alternative to the fruitless attempts to compare incompatible.

## VII. Conclusion

1. The vain attempts to unite gravitation with electromagnetism based on the relativity theory and quantum mechanics forces searching for alternative ways of their synthesis. Such an alternative may be realized if we give up searching for the theory of unified field and change over to energodynamics as a unified method to find the explicitly distinguishable forces.
2. The offered energodynamic approach to the synthesis of interactions is based on the unity of forces as vector functions of scalar fields and on their mutual nature ensuing from the non-uniform distribution of matter in the cosmic vacuum space. This approach allows revealing the specific character of the gravitational, electrical and magnetic interaction and predicting the existence of a whole number of its newtypes.
3. The comprehension of the interaction processes between baryonic and nonbaryonic matter is substantially facilitated from the position of the wave concept of matter structure. The dipole character of the wave structures imparts the particle-like properties to them, while the difference in their wave characteristics explains the multiplicity of matters. Due to this fact the wave concept of the matter nature is preferable as compared with the corpuscular one that admits existence of a plurality of 'virtual' particles.
4. The forces of gravitational interaction are caused by non-uniform distribution of matter in space and are defined by the value and direction of the relative gradient of its density. They are inherent in all forms of matter and are the only reason of the tension in the cosmic vacuum as the non-structured part of the matter in the Universe.
5. The electrostatic and electrodynamic (magnetic) forces are caused by the non-uniform distribution of the density and pulse of charges as a part of the baryonic matter mass participating in the oscillatory motion. In this case the sign and value of the electrical forces are defined by the gradients of the charge density, while the magnetic forces – by the gradient of the charge pulse (current).
6. Despite the diversity of the interaction forces between different structural elements of the baryonic matter all of them have a unified gravitational nature and differ only formally (conventionally) in the type of their material carrier. The physical ground for this difference involves the specific structural features of the energy carrier and the character of its oscillatory motion predetermining the properties of the waves it radiates.
7. The transfer of energy in space between bodies or 'particles' of the bodies is conducted by generation of oscillations in the cosmic vacuum, which are transferred by the waves running therein. This process named as radiation does not have any other material basis than the cosmic vacuum as a luminiferous medium. Therefore, there is absolutely no necessity to 'unify' gravitation as the only form of interaction in this medium with something else.

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