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Polarization Model of the Inhomogeneous Physical Vacuum

The book sets forth and substantiates a polarization model for the inhomogeneous physical vacuum. According to the model which is developed, the physical vacuum is a heterogeneous polarization medium which is present everywhere and consists of a homogeneous – absolute – physical vacuum and two modified – matter and antimatter – physical vacuums. The local formations of a modified vacuum, which the author calls vacuum domains, float within the unbounded absolute physical vacuum medium.

The properties of the absolute physical vacuum are described by nonconjugate systems of Maxwell electrodynamics and Heaviside gravidynamic equations. The Heaviside equations are reduced to the standard form of Maxwell equations; i.e., by the introduction of two inductions, gravity and spin.

The properties of the matter and antimatter physical vacuums are also described by conjugate Maxwell and Heaviside vacuum equations. These equations are linked due to the linear dependence of electrical and magnetic inductions not only on like electric and magnetic fields but also by gravity and spin fields, as well as the dependence of gravity and spin inductions not only on like fields but also on their interactions with electrical and magnetic fields.

Matter is represented in the model by equations from the electronic theory of matter and the theory of continuum mechanics. In the analysis of the model developed, the physical properties of vacuum domains are compared to anomalous phenomena, such as ball lighting, UFOs, tornadoes, poltergeists, etc. The satisfactory coincidence of the physical properties of vacuum domains and the manifestations of the phenomena in question make it possible to confirm the viability of the model.

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Author's Foreword

At the end of 1988, Academy of Sciences Member Mikhail Mikhailovich Lavrentyev suggested that I work on the problem of anomalous phenomena, the experiments of A. N. Kozyrev in particular. At that time, my scientific interests were, to all practical appearances, very remote from such phenomena. Before M. M. Lavrentyev's suggestion, for a long time I had been creating physical and mathematical models of new computer hardware, microelectronics and micromechanics components based on the use of magnetic and dielectric materials (ferrites, Permalloys, dielectrics, ferrielectrics). It is convenient to identify such substances by a single term: polarization media.

The study of the literature in the field of anomalous phenomena was stunning in terms of the abundance, variety and frequently low scientific quality of available publications. I developed the firm conviction, however, that such physical phenomena simply did not fit within the framework of modern physics. Later on, I came to the realization that many of the paranormal phenomena which are outwardly different nevertheless have the same scientific and physical basis.

In delving deeper into the study of anomalous phenomena literature, I was trying to accomplish two things. This was first to find satisfactory and sufficient ideas in the field of physical and mathematical models and second, to find a group phenomena with a sufficiently comprehensive and systematic description of their physical properties. Not only could a model of certain anomalous phenomena be created in this way but an experimental basis would be compiled that would substantiate and allow the further development of such a model.

The ideas of A. Ye. Akimov and G. I. Shipov, who introduced a fundamentally new concept into physical vacuum theory, proved extremely similar with respect to anomalous phenomena. A phrase from Akimov – "physical vacuum polarization states" – made a particularly effective impression upon me and seemed familiar from a long time ago. And then memories from the years of post-graduate study in the late fifties at the department of theoretical bases of electrical engineering (TBE department) of the Moscow Power Engineering Institute started to come back to me.

During those years, the TBE department was headed by Konstantin Mikhaylovich Polivanov, a successor to Karl Adolfovich Krug, the founder of the Soviet school of theoretical electrical engineering. Professor K. M. Polivanov made a great contribution to the electromagnetic theory of polarization media. He became my Teacher and Mentor in the true sense of the word. I was recommended to the TBE at MPI by Professor Valentin Yevgenyevich Bogolyubov, who knew and deeply respected "Father Pavel" – Pavel Aleksandrovich Florenskiy, the great electrical engineer and theorist and a great philosopher. I might mention that later, in his old age, V. Ye. Bogolyubov became a monk at the Zagorsk Monastery.

In the department, where the theory of polarization media was known and understood in depth, many of the professors and instructors understood the physical vacuum in just this way: as a polarization medium. However, they talked about this matter only within their own narrow circle. The ether and everything associated with it fell under an extremely strict official ban at that time.

I once asked Polivanov the question: "Why do we take the member $\mu_0\mathbf{H}$ into consideration in the induction expression $\mathbf{B} = \mu_0\mathbf{H} + \mu_0\mathbf{M}$ inside a ferromagnetic substance? This, after all, is a direct acknowledgement of the ether as a ubiquitous polarization medium." K. M. (as Professor Polivanov was known in the department) gave me a strange look and answered: "Think about it yourself." I understood that K. M. approved of my question.

Florenskiy went considerably further. In his books *Mnimosti v geometrii. Raswhireniye oblasti dvukhmernykh obrazov v geometrii [Virtual Images in Geometry. Expanding the Field of Two-Dimensional Images in Geometry]*, 1922 [1], and *Dielektriki i ikh tekhnicheskoye primeneniye [Dielectrics and Their Technical Uses]*, 1924, he wrote about the large role of boundary surfaces in space-time, i.e., in the physical vacuum. We shall note that the polarization media on the whole are neutral, but when they are represented in the form of enclosed bodies, they provide an example of the major role not only of the volumes but of the surfaces of bodies in physics. So-called bound charges can appear on the surfaces of bodies of polarized matter, sometimes causing strong fields. Something else entirely different should be noted in connection with Florenskiy's books mentioned above – it was just these books that brought Pavel Aleksandrovich to an untimely end in 1937.

After reading Akimov's article [2], I borrowed the idea from him of an electro-gravity connection in a physical vacuum and, after expressing it in the language of mathematics, soon had written an article about it which was published in 1995 [2. 4]. I shall note here that articles with similar titles and results were rejected twice by the journal *Doklady Akademii Nauk*, despite recommendations from Academy member M. M. Lavrentyev. The system of equations of electrogravidynamics in this model has only two parameters characterizing the electro-gravity relationships in the physical vacuum medium, which makes it possible to represent it as a heterogeneous, varied polarized medium.

The most important result of my article was the description of the mechanism – strange at first glance – of cold self-luminescence of some empty volume of space, which is characteristic of many anomalous phenomena. Such self-luminescence is explained in this article by the transformation of the energy of gravity waves in the physical vacuum into the energy of electromagnetic waves.

Doctor of geological and mineralogical sciences Aleskey Nikolayevich Dmitriyev has described the physical properties and special features of a large group of anomalous phenomena quite comprehensively and systematically [5]. For many years he conducted field instrument measurements and studies in the Altai mountains on objects he called natural glowing formations. The characteristic feature of such formations is that they are observed in the form of transparent glowing bodies of various sizes and shapes but, as a rule, have an ellipsoid form. Dmitriyev devoted attention to the fact that the very same kind of translucent glowing bodies are present in ball lightning, tornadoes, poltergeists and even UFOs. A common property of this kind made it possible to hypothesize that all these phenomena are varieties of the same physical phenomenon, which has a great variety of manifestations.

After becoming acquainted with the results of Dmitriyev's studies and thanks to numerous personal conversations with him, I began to understand that one can construct physical and mathematical models of natural glowing formations based on the macroscopic equations of electrogravidynamics [6]. It rarely happens, by the way, that the results of independent theoretical and phenomenological research coincide so closely. In this situation, it was sufficiently clear to define the parameters of the electro-gravity relationship in the equations of combined electrogravidynamics, after isolating some enclosed region in an unbounded space. Here, the equations of electrogravidynamics in the outer region of the space break down into independent equations of electrodynamics and gravidynamics, in order to create the model. This meant that the parameters of the electrogravity relationship had to be set equal to zero for the outer region and not equal to zero for the inner region of the space.

In this problem in question, the isolation of a closed region was equivalent to the formation of some local body located in an unbounded space. Parameters of the electrogravity relationship equal and not equal to zero actually characterized two different vacuum polarization media. A body with parameters not equal to zero, hence, was called a vacuum domain. Such vacuum domains were identical to the translucent glowing bodies of the anomalous phenomena indicated above.

Physical and mathematical models of natural glowing formations have combined and are referred to as a polarization model of a non-homogeneous physical vacuum. It was assumed that the model is also applicable to situations of weak self-luminescence of vacuum domains. In this connection, once again, one must recall Florenskiy's surface in a physical vacuum. In introducing the concept of the vacuum domain, we also automatically introduce the concept of the domain surface, i.e., a surface in a physical vacuum which separates two different polarized media. The basic physical properties of vacuum domains, which coincide with the physical properties of the bodies of natural glowing formations, have proved to be related to just these vacuum domain surfaces, which can be called Florenskiy surfaces.

The physical analysis of the polarization model of a non-homogenous physical vacuum required intensive work, the results of which are presented in part in this book. The author did not have sufficient versatility and scientific competence in all of these cases for the complete analysis and development of the model; this problem is the result of the possible extensions of the model itself. These possibilities later attracted the attention of great specialists from various fields of scientific and technical knowledge.

Professor V. I. Merkulov, doctor of physical and mathematical sciences, has demonstrated [7] the possibility of explaining various previously incomprehensible phenomena based upon equations of continuum mechanics and the equations used in this model: UFOs of the complex type and beaded ball lightning, many of the properties of tornadoes and tropical hurricanes, electromagnetic waves accompanying acoustic waves in the Earth, etc. He also explained how it is necessary to understand the Einstein-de Haas effect in the theory of continuum mechanics which was developed by Academy member L. I. Sedov.

Professor Yu. G. Kosarev, doctor of technical sciences, provided major methodological assistance and in particular, demonstrated the philosophical significance of the model, on the example of Florenskiy's ideas.

Professor V. R. Kireytov, doctor of physical and mathematical sciences, established the relativistic nature of the equations of the model and confirmed the reversible transformation of gravity waves into electromagnetic waves in vacuum domains.

And now for my greatest pleasure. In the understanding that this book would have been impossible without the support of Academy member M. M. Lavrentyev, I wish to express the very greatest appreciation to him.

I am a confirmed advocate of physical and mathematical models based on experimental studies of specific physical objects. Doctor of geological and mineralogical sciences A. N. Dmitriyev pointed out such an object to me in the non-homogeneous physical vacuum model, hence I wish to express my deep gratitude to him for this and for his exceptionally interesting collaboration. I am sincerely grateful to Professor V. I. Merkulov, Professor Yu. G. Kosarev, Professor V. R. Kireytov, Professor O. D. Dzhefimenko (Jefimenko, USA), Candidate of physical and mathematical sciences E. G. Kostsov, Candidate of physical and mathematical sciences G. A. Kirpichnikov, and many other physicists, geophysicists and mathematicians of the Siberian Branch of the Russian Academy of Sciences, Novosibirsk, Moscow and St. Petersburg, as well as to

1. The Problem of the Non-Homogeneous Physical Vacuum

1.1. Anomalous phenomena and the non-homogeneous physical vacuum

Throughout the many centuries of the history of civilization, mankind has continually encountered unexplanable or anomalous phenomenon. These include unidentified flying objects (UFOs), ball lightning, tornadoes, poltergeists, explosions in the atmosphere as well as on the Earth's surface that are not of manmade origin. Three basic approaches have been developed to perceive and study such phenomena. We shall provisionally refer to them as mythological, laboratory, and phenomenological events.

Since ancient times the mythological approach has served as an aid explain folklore and legends. The idea that UFOs are alien spacecraft has become widespread in our own time. In the presence of this mindset, other such phenomena also seems to be the creations developed by alien civilizations.

The laboratory or traditional approach is based on the idea that all phenomena emerge as natural processes that are consequences of known physical laws of nature. Such an approach assumes that for detailed description and explanation of any new physical phenomenon, it must be recreated under laboratory or specifically controlled conditions. The laboratory approach has proven itself in a multitude of cases and is considered fundamental in modern physics. It is not surprising, therefore, that it has also been used for the explanation of the phenomena of ball lightning, tornadoes, etc. However, this tested method did not work in the cases under investigation. There are already more than 100 known physical models for predicting ball lightning phenomena [8] and a plethora of tornado models [9], but none of these are generally accepted. Analogs of ball lightning have been obtained in high-frequency discharges in the presence of combustible or dispersed materials [10-12], but they possess only a small fraction of the physical properties of natural ball lightning. The lack of success in physical modeling of the anomalous phenomena in question serves as the main argument for the self-affirmation of the advocates of the mythological approach.

The phenomenological approach to the study of anomalous phenomena also has emerged due to the lack of success of the traditional physical approach. Many scientists have tried to understand that mankind is encountering some kind of new and unknown physical reality in the form of UFOs, ball lightning, tornadoes, poltergeists, etc. Objective, painstaking description of the entire combination of physical properties and features of these phenomena, without prejudice, could, of course serve as the first step in comprehending this new reality. However, there is a major obstacle in this path: all the phenomena listed above occur rarely and randomly. So it

seems, in any case, to the first researchers working on the phenomena about the randomness and rarity of these events in question.

At first a solution to the problem of describing the physical properties and features of anomalous phenomena was seen in statistical processing of the extensive information on sightings of such phenomena which had been published in many periodicals. It was assumed that various subjective statistical event moments in the respective publications could be gathered during the processing of this information. Thus appeared the first physical descriptions of the physical properties and features of UFOs [13-15], ball lightning [11], tornadoes [9, 21], poltergeists [22, 23], etc.

The characteristics of the physical properties and features of the anomalous phenomena in question which were obtained in this way reflected only those properties which could be obtained as a result of observation with the naked eye; i.e., they were known to be incomplete. These descriptions, however, reflected such strange physical characteristics of the anomalous phenomena as levitation and penetration of solid matter, not to mention intense rotation of a gas media within the active region not only of tornadoes but of ball lightning as well [5, 17-20].

Meanwhile, the less than serious attitude of scientists toward these first description of the physical properties of this anomalous phenomena led to negative results. The advocates of the traditional approach to physical phenomena did not take into consideration the properties of these phenomena which they considered questionable, but they also avoided those properties which were not in doubt among the advocates of the phenomenological approach, such as rotation of the objects under investigation. Thus, there appeared unsound physical models of ball lightning, etc., which were published in the most prestigious journals [10, 12]. Hence the solution of an extremely important and interesting problem of physics was delayed for many years. The scientific authority of a particular scientist or journal in this case stood in the way of scientific progress.

The situation in the field of the phenomenological study of anomalous phenomena changed fundamentally from the time (the seventies) when the military recognized that UFOs are a strong factor in the destruction of military hardware which included primarily aircraft, missiles and satellites, that came into contact with the UFOs; and the creation of radar interference in the form of false targets and the disruption of radio communications [13]. Geologists and geophysicists were recruited to study UFOs, which made possible several important discoveries [5]. The frequency of UFO sightings shows a strong dependence on the geological and geophysical features of the Earth (UFOs and ball lightning appear mainly at the locations of fractures in the Earth's crust) and the physical state of the Sun (the frequency of UFOs, ball lightning and tornadoes increases substantially during years of high Solar activity). Locations on the Earth's surface with a significant increase in the frequency of UFOs, which at first were called plasmoids [5], were identified, and geophysical expeditions to these sites were organized. The UFOs and rocks of the Earth's surface at the points of contact of UFOs with the Earth were subjected to direct physical study with instruments [5, 24-29]. Thus, the phenomenological instrumental investigations of the anomalous phenomena listed above were started which made it possible to deepen and broaden substantially the description of the physical properties of the glowing objects of these phenomena.

Of the physical properties of anomalous phenomena, one property was attracting more and more attention from researchers: a translucent, glowing body with a spherical, ellipsoid, cylindrical or conical shape was always present in the active regions of UFOs, ball lightning, tornadoes, poltergeists and non-manmade explosions. At night this body in many cases (UFOs, poltergeists, ball lightning, tornadoes) was clearly visible with the naked eye. The body showed up considerably more clearly, however, on videotapes and sensitive photographic film. It was this

glowing body that prompted Dmitriyev [5] to call objects of the anomalous phenomena in question natural glowing formations (NGF). It was established that these bodies can penetrate into solid matter and pass through it (UFOs, ball lightning, poltergeists).

Sightings of the luminescence of bodies of UFOs, ball lightning, tornadoes, poltergeists, etc., led to an understanding that all of these effects, which seemed different at first glance, are varieties of the same phenomenon, which has a number of distinguishing features in its appearance and development in the form of the anomalies indicated above. Attention was also devoted [5] to other coinciding physical properties in the phenomena in question, especially penetration of solid matter and levitation.

These features of anomalous phenomena cannot be explained by modern physics. However, we do know of many ideas in the history of physics that are rejected even by modern physics. Some of these ideas should be reexamined on the basis of new physical knowledge. Such ideas include the idea of the ether – the ubiquitous medium which fills space. In the nineteenth century, the ether was understood to be a mechanical medium, and this representation of the ether proved to be unsound. Hence at the beginning of the twentieth century, the concept of the ether was generally excluded from physics.

In the middle of the twentieth century, research on material polarization media – ferromagnetics and ferrielectrics, in particular – underwent extensive development. The work of Polivanov and his students [30-34] has a significant contribution to the study of polarized media. These works formed the basis for the physical and mathematical macroscopic polarization model developed in this book for the non-homogeneous physical vacuum understood as a ubiquitous non-homogeneous polarization medium, but not a mechanical medium, which fills space [3, 4, 6].

According to the polarization model of the non-homogeneous physical vacuum, the translucent, self-luminescent body in the anomalous phenomena considered is some kind of modified physical vacuum in the medium of the absolute physical vacuum. Due to the features of the polarization properties of the vacuums outside and inside the glowing body, such a formation is called a vacuum domain. Vacuum domains supplement the range of known objects in the universe such as galaxies, nebulae, stars, planets, moons, comets, meteors and meteorites, etc. They play their own special role within the universe, which will be examined in this book.

1.2. Basic physical properties of vacuum domains and a comparison of the domains to the physical properties of anomalous phenomena

Vacuum domains, which are local formations of a non-homogeneous physical vacuum, are transformers of gravitational energy into electromagnetic energy and the reverse and of both these types of energy into mechanical and thermal energy.

Vacuum domains, as a kind of confined bodies, have volume and a corresponding boundary surface. The equations of the non-homogeneous physical vacuum model together with the equations of the electronic theory of matter and continuum mechanics, as well as the conditions on the surfaces of the vacuum domains and at infinity, make it possible to formulate typical boundary-value problems of mathematical physics. The solution of such problems can help us obtain theoretical physical properties of the vacuum domains in any media and fields, such as those of the Earth. This book presents some solutions of those problems which, I submit, give the basic properties of vacuum domains on Earth. These properties are as follows:

1. Penetration into matter or passage through matter in any of its phase states: plasma, gas, liquid and solid.
2. Self-luminescence, emission of electromagnetic waves in a broad frequency spectrum, and absorption of electromagnetic waves.
3. The presence of their own electrical, magnetic and gravity fields inside and outside the vacuum domains.
4. Intense rotation of the gas inside the vacuum domains with a change in the magnetic and spin fields of the Earth.
5. Two types of explosions with the preservation of the vacuum domains: explosions as a result of an electrical discharge inside the vacuum domains, and contact explosions as the vacuum domains penetrate from the gas of the atmosphere into the electrically conductive rock of the Earth, as well as in passage through the Earth's ionosphere.

The polarization model of vacuum domains which is presented below makes it possible to establish the laws of movement of the domains, especially as point bodies in the Earth's fields. It is demonstrated, in particular that the mechanical equilibrium of the vacuum domains is disrupted after the explosions indicated above, hence an abrupt change in their movement must occur without fail.

It follows from the model that a third type of explosion is possible, associated with the annihilation of two types of vacuum domains. These very powerful explosions cause an intense release of high-energy photons. They can be called photon explosions. A characteristic example of such cataclysms is the Tunguska "meteorite" explosion [13, 35].

It follows naturally from the model that vacuum domains can move deep in the Earth, causing mechanical stresses and injecting photons into the Earth's rock. The mechanical stresses can cause earthquakes and volcanic eruptions, while the photons can cause chemical reactions which would normally be impossible inside the Earth without the vacuum domains.

Many of the natural anomalous physical phenomena which are being observed and studied with instruments at present are characterized, at least partially, by the external manifestations listed above. Among them we can distinguish ten phenomena: ball lightning; natural glowing formations or cold plasmoids; poltergeists; tornadoes; angels; cosmic ice; ionospheric and atmospheric explosions; lithosphere explosion pipes; sprites; elves; jets; luminescence in earthquakes and volcanic eruptions.

Table 1 presents the physical properties of the anomalous phenomena listed above and the characteristic physical properties of vacuum domains indicated above. Crosses are placed in the respective columns of the table only where the anomalous phenomenon in question is conclusively known to possess the respective physical property according to published data or communications of specialists.

A brief examination of the physical properties of each of the anomalous phenomena listed above follows.

Table 1

Phenomena \ Properties	Passage through matter	Shape: sphere, ellipsoid. etc.	Self-luminescence.	Electromagnetic radiation	Electrical field	Magnetic field	Levitation	Rotation of air, dust. etc.	Explosions	Relationship to solar activity
Vacuum domains	+	+	+	+	+	+	+	+	+	+
Ball lighting	+	+	+	+	+	+		+	+	+
Natural glowing formations	+	+	+	+	+	+	+	+	+	+
Poltergeists	+	+	+			+			+	
Tornadoes	+	+	+	+	+	+	+	+	+	+
Angels	+	+	+	+						+
Cosmic ice	+	+	+	+					+	
Ionospheric and atmospheric explosions	+	+	+						+	
Lithosphere explosion pipes	+	+	+	+					+	
Sprites, elves and jets	+	+	+		+				+	
Luminescence in earthquakes and volcanic eruptions	+	+	+	+	+				+	+

1. Ball lightning is the most familiar anomalous phenomenon of the group considered [10, 16-20]. Exceptionally extensive information on the observed physical properties of ball lightning has been presented at three levels: individual communications (such as that of Pudovkin [36]); collections of observed cases (Arago, Brandt, Khemfreis, McNally, Reyl, Dmitriyev, Arabadzhi, Grigoryev-Dmitriyev, Cherman, Stakhanov, Keul, Grigoryev-Grigoryeva, Otsuki-Ofuruton, Egeli [10], etc.); and analysis of data of collections (such as Smirnov [10], Dmitriyev [5]).

In particular, Smirnov [10] presented the averaged physical properties of lightning which are used in this book. There is confusion, however, even in his fundamental study of ball lightning. I had occasion to read hundreds of communications of random individuals about their encounters with ball lightning. It was interesting at first to read "this Satan" or "this devil," etc., but after a hundred-odd files, you begin to mentally see what the unread files are going to say. Intense rotation of dust inside the ball lightning is mentioned in many of the communications. Smirnov does not include rotation among the physical properties of ball lightning. Apparently the senses simply do not accept the abundance and variety of the physical properties possessed by ball lightning. For example, in response to the question of one specialists about this problem, "Why didn't you describe the effect of ball lightning on the televisions in the house in the journal *Uspekhi fizicheskikh nauk*, in particular the switching of the television sets to different programs after the ball lightning had departed?" He replied: "I don't know why I didn't describe it. Other neighbors' televisions were just switched, but a microcircuit burned out in mine – my son fixed it."

Passage through matter, glowing, strong electromagnetic radiation, electrical and magnetic fields and explosions are typical physical properties of ball lightning. To these we shall add rotation of air and dust inside the ball lightning. Publications do not include the property of gravitational field distortion, i.e., levitation. For objects as small as ball lightning, however, with a typical ball lightning diameter of 20-35 cm, it is difficult to observe such a property, especially as extremely varied movements of small objects under the effects of aerodynamic, magnetic and electrical forces are associated with ball lightning. An increase in the frequency of ball lightning during years of high solar activity was already noted by Barri [17].

2. **Natural glowing formations or plasmoids** are large-scale ball lightning [5]. This exceptionally important conclusion was drawn by Dmitriyev based upon a study of the materials of numerous multipurpose scientific expeditions. These were under his supervision to the area of the Terektin Range of Gorno-Altai, where sites of frequent appearance of such natural glowing formations had been discovered [29]. The basic physical properties of natural glowing formations and ball lighting coincide: passage through matter, glowing, electrical and magnetic fields, rotation, explosions. In addition, previously unknown physical properties were discovered: levitation, and a substantial increase, by a factor of about four, in the frequency of the appearance of natural glowing formations during years of high solar activity.

Olkhovatov [37] presents a brilliant description of the property of levitation of natural glowing formations in his study of the Sasovo explosions. Kolchin [13] describes many of the physical properties listed above for natural glowing formations, which he defines as UFOs of natural origin, and indicates that they are a major danger for every living thing.

3. **Poltergeists** are inexplicable sounds and movements and damage to furniture and equipment – phenomena with features of ball lightning. In the words of Yklichkin [23] (paper by V. P. Kaznacheyev, Fall 1997), the poltergeist phenomenon is associated with a spherical, weakly glowing body the size of average ball lightning with its own magnetic and electrical [22] fields. This formation, like ball lightning, passes freely through the walls of rooms. It can kill people, strangely enough, by unexpectedly forcing blood from one part of the body to another.

4. **Tornadoes** are destructive movements of the air well known from television and the press media which are clearly related to natural glowing formations and clusters of ball lightning. Nalivkin [9] describes tornadoes this way: "Faye (1897) describes several cases in which tornadoes were accompanied by ball lightning. Short and wide sheet lightning sometimes encircles the funnel. Sometimes the entire surface glows with a strange yellowish luminescence. Sometimes spherical bluish formations of the ball lightning type but of much larger dimensions can be seen in the tornado cloud. Sometimes slow-moving columns of fire are formed (Lane, 1966; Lowe and McKay, 1962; Vonnegut and Meyer, 1961). A study by Jones (1965) describes a unique pulsed electrical activity generator and a center visibly in a tornado cloud in the form of a rounded light blue spot that appears 30-90 minutes before the funnel develops. Vonnegut's study (Vonnegut and Meyer, 1966) cites night photography of glowing columns accompanying funnels."

The terms "tornado cloud" and "funnel" require explanation. For this purpose, we shall refer to Merkulov's professional description of the tornado phenomenon [21]: "The tornado is generated from a mother or tornado cloud and touches down in the form of a long trunk, inside which the air rotates rapidly, at a speed which sometimes reaches the speed of sound. The mother cloud, which is a small tropical hurricane, has a so-called eye like a real hurricane, in which there

is a dead calm, and has a spiral structure. . . . The average dimensions of a tornado cloud are not large: 5-10 km across, with a height of 4-5 km. The distance from the ground to the bottom edge of the cloud is of the order of a few hundred meters – or more rarely more. A horizontal vortex cloud with an inclined or vertical column of the cyclone-tornado itself is observed, as a rule, in the tornado cloud. A farmer from the state of Kansas has given a detailed description of the void inside a tornado. Standing in the entrance to a storm shelter, he observed a tornado approaching over the plain. Near the shelter, the tip of the tornado funnel rose from the ground and passed above the farmer. "The big, ragged end of the funnel was hanging right over my head. Everything around was still. There was a squeaking, hissing sound coming from the end of the funnel. I looked up and, to my surprise, saw the heart of the tornado itself. In the middle of it was a void with a diameter of 30-70 m that went up for a distance of about a kilometer. The walls of the cavity were formed by rotating clouds, and the cavity itself was illuminated by the steady flashing of lightning jumping in zigzags from one side to the other. The cavity was completely empty, and there were only misty formations moving up and down. The tornado moved slowly, and I had time to get a good look at everything, inside and out." The internal void of a tornado, as numerous observations and measurements have demonstrated, has substantially reduced pressure.

Hence the glowing formations exist both in the relatively large-scale tornado cloud and in the relatively small tornado funnel. The radiation of tornadoes in the light range of electromagnetic waves has been previously pointed out. It is also known that a tornado emits electromagnetic waves in the radio range in the form of high-intensity white noise. Ordinary lightning attests to the presence of an electrical field in tornadoes. It has been discovered that the trunk of the tornado has a magnetic field corresponding to an electric current of hundreds of amperes [38]. A tornado can carry living people and animals for a good distance; it also carries a multitude of various objects, such as a cache of coins [21], without scattering them. Doesn't it follow that a tornado possesses the property of levitation?

The improbably intense rotation in a tornado can be caused only by the distributed moment of forces. Hence we can see in the tornado phenomenon all the physical properties which indicate the presence of vacuum domains.

5. Angels are a form of typical radar noise [39]. Radar operators learned long ago to distinguish such angels from their targets: aircraft and missiles. It should be mentioned that the angles are observed at the points of fractures in the Earth's crust. As it turns out, the angels are observed kilometers above the fractures, while below, directly above the fractures, natural glowing formations are visually observed.

6. Cosmic ice is the name for bodies moving toward Earth from nearby space which absorb ultraviolet radiation. These objects were detected in 1982 as a result of the analysis of photographs of open sectors of outer space transmitted to Earth by two American satellites. It was hypothesized initially that these bodies were made of water, specifically ice. "Judging from the data of the new Polar satellite, these ice chunks fly into our atmosphere with a frequency of 5 to 20 times a minute. Their size is often approximately that of a house in the suburbs" [40].

The hypothesis that ice falls on the Earth, and consequently on the Moon, has been met with sharp objections. If cosmic ice were actually made of ice, its falling on the Moon would have been recorded by seismographs from the Apollo spacecraft. "However, seismographs record much fewer strikes than must be made by ice comets" [40, 41].

According to the model examined in this book, vacuum domains, like ice, must absorb ultraviolet radiation. At the same time, vacuum domains must release much less energy than ice comets in contact with the Moon.

Hence natural glowing formations are encountered in direct proximity to the Earth's surface, angels are seen higher up, and still higher there is cosmic ice; i.e., all three types of objects are visible traces of the same phenomenon.

7. Ionospheric and atmospheric explosions are explosions not of manmade origin in the region of the Earth's ionosphere. These explosions cause conflicts of military and civilian authorities in the United States, Australia, etc. [35]. The military has proven that they are not involved with these explosions.

According to the model examined in this book, vacuum domains must explode while preserving their form in entering the highly electrically conductive plasma medium of the ionosphere. Hence we can see another trace in the ionosphere from the effect of vacuum domains in their movement from space to the Earth.

8. Lithosphere explosion pipes are the visible consequences of concentrated explosions in the lithosphere of the Earth, in which thermodynamic conditions for the formation of diamonds are established. The mechanism of these explosions remains completely incomprehensible within the limits of current physical concepts. On the other hand, Yakut legends make it possible to link the lithosphere explosion pipes to explosions of natural glowing formations [42].

The problem of contact explosions of vacuum domains, i.e., the problem in which a vacuum domain in a gravitational field comes into rapid contact with the electrically conductive medium of the Earth's lithosphere, is one of the simplest problems in the vacuum domain model. The cause of a contact explosion is associated with pulsed electric current which appears as a result of the neutralization of the electrical monocharge of a vacuum domain in Earth rock. It turns out that the energy density of such an explosion will be high only in the presence of large dimensions of the vacuum domain, such as a spherical domain diameter greater than 1-10 km.

Hence one can suggest that the lithosphere explosion pipes are a trace in the rock of the Earth of large vacuum domains in their movement from space to the Earth.

9. Sprites, elves and jets are types of luminescence in the upper part of a storm cloud in the presence of flashes of lightning in the lower part. Sprites are a red luminescence in the central part of the cloud in the form of a rocket taking off. Elves are a blue side luminescence that accompanies the sprites. Jets are a luminescence along the ionosphere accompanying sprites that appears when the sprites reach the appropriate altitude.

On the initiative of Eberhard Vonnegut, a well-known tornado researcher and brother of Kurt Vonnegut, the famous German author, sprites, elves and jets were investigated in 1996-1997 under the Space Shuttle program [43].

The impression is that there is something in the storm cloud, as in the tornado cloud (in the case of tornadoes). This impression was reflected in the Feynmann lectures on physics [44]: "Now we want to turn to a discussion of the aspect of the matter that is most important to us – the development of electrical charges [author's note: in a storm cloud] . . . . The apex of the thunderstorm is positively charged, while the bottom is negatively charged, with the exception of a small section of positive charges in the lower part of the cloud, which has caused quite a bit of trouble for researchers. No one knows why it shows up there or how important it is, whether it is

just a secondary effect of positive rain, or whether it is a substantial part of the overall mechanism. . . . The charge of the bottom part of the cloud suffices to create a potential different of 20, 30 or even 100 million V between the cloud and the ground – incomparably greater than the 0.4-million-volt differential between the sky and the ground in clear weather. These enormous voltages go through the air and create a gigantic storm discharge. The negative charge from the bottom of the cloud in breakdown is carried in lightning zigzags to the ground . . . . The flashes follow, one after another, in an irregular way, but essentially in such a way that the return to the initial conditions always occurs in approximately five seconds. Consequently, there is a current of approximately 4 A in the storm dynamo. And this means that any model conceived to explain how a storm vortex generates electricity must be very powerful – this must be an enormous, high-speed scheme."

It seems that the vacuum domain plays the role of such an enormous, high-speed scheme – the electrical machine of the thundercloud. There are many cases in the descriptions of anomalous phenomena in which the assumption of shape changing and even dividing of vacuum domains is made. Such dividing of vacuum domains apparently also occurs in the case of thunderstorms, with the development of luminescence in the form of sprites, elves and jets.

10. Luminescence in earthquakes and volcanic eruptions are a widespread phenomenon which has been described by many eyewitnesses and researchers [45]. Dmitriyev writes [5] in connection with this phenomenon that "the removal of internal stresses in the Earth is accompanied not only by normal seismic vulnerability of sectors of the Earth's crust but also by the release of gases, as well as by complex electromagnetic, acoustical and gravitational processes which occupy even the ionosphere. And all these processes emerge as precursors of earthquakes and volcanic eruptions. Such phenomena are also accompanied by ball lightning, strong thunderstorms and snowstorms" [24].

Hence if ball lightning is acknowledged as fragments of large-scale self-luminous formations within the epicenters of earthquakes, tornadoes, etc., one step remains to reach an understanding of the serious role of vacuum domains in these phenomena. Ball lightning, self-luminous formations and vacuum domains actually possess the same physical properties.

Since vacuum domains have high mobility both in the atmosphere and in the rock of the Earth, one can understand the effect of excitation of all the space above the surface of the Earth up to the ionosphere during the effects of earthquakes and volcanic eruptions.

Table 1 presents two more physical properties which are not included in the list of properties indicated above: namely, "shape: ball, ellipsoid, etc.," and "connection with active Sun."

The property "shape: ball, ellipsoid, etc." reflects the fact that a vacuum domain, according to observers, can occupy local, confined regions in space.

The property "connection with active Sun" reflects the increase in the probability of frequency of vacuum domains on Earth during years of peaks in the 11-year solar activity cycles. This latter property follows from the fundamental physical concepts which form the basis for the vacuum domain model.

One can see from the comparison performed on the characteristics in question for the anomalous phenomena and vacuum domains that all the phenomena emerge as a result of the same phenomenon – physical processes in vacuum domains in various material environments and under field conditions.

It is not difficult to see that both physical and mathematical models of vacuum domains must possess extensive capabilities for explaining the processes that occur in them simultaneously: penetration of matter, levitation, electromagnetic and mechanical effects, luminescence, etc. One must keep in mind in this connection that in the current sense, the physical model is not a physical theory based on a single idea – even a very strong, clear idea – but rather a synthetic, theoretical construct based, in this case, on many of the theories created over a period of more than 100 years by many scientists of genius – Maxwell [46], Heaviside [47], Poincaré [48], Minkowski [49], Lorentz [50], Dirac [51], Terletskiy [52], etc. – consistent with modern theories of polarization media, such as the one developed by Polivanov [31] *et al.*, and the physical vacuum, such as the one created by Shipov [53] *et al*.

The point, however, is not the high intellectual level at which the model has been developed but whether a theoretical basis has been prepared for describing the anomalous phenomena listed above and many such phenomena. Study of the model indicates [3, 4, 6] that such a basis has been prepared.

It follows from the properties of penetration of the vacuum domain into matter that the model must be based on physical concepts of the physical vacuum. Moreover, the mathematical model that uses such concepts must have a mathematical description, we dare say at once, of this medium.

1.3. Physical vacuum – not a void

The idea that the physical vacuum is a void arises as early as Democritus. Here is what Einstein and Infeld wrote about it [54]: "Throughout the history of science, from Greek philosophy to modern physics, there have been constant attempts to reduce the outward complexity of natural phenomena to some simple physical ideas and relationships. This is a basic principle of all natural philosophy. It was expressed as early as the work of the atomists. Twenty-three centuries ago, Democritus wrote, ' . . . only atoms and empty space are real.'"

Shipov [55] expresses the current physical ideas about the nature of the physical vacuum: "At the beginning of the twentieth century, with the development of Maxwell-Dirac quantum electrodynamics, on the one hand, and Einstein's theory of gravitation, on the other, a new level of reality – the physical vacuum – had already appeared in theoretical physics as an object for research; in the process, theories differing in nature were producing different ideas about it. While the vacuum is considered as empty four-dimensional space-time produced by Riemann's geometry in Einstein's theory, the vacuum (globally neutral) in Maxwell-Dirac electrodynamics is a kind of "boiling soup" made up of virtual electron particles and positron antiparticles. Further development of quantum field theory demonstrated that the ground state of all quantum fields – the physical vacuum – is formed not only by virtual electrons and positrons but also by all the other known particles and antiparticles in a virtual state. In order to unify these two different ideas about the vacuum, Einstein put forward a program that came to be called the Unified Field Theory Program." Later Shipov writes about the well-known difficulties in carrying out this program. He ends his examination of the physical vacuum problem in this way: "It is becoming clear now that the unified field theory program has grown and overflowed into physical vacuum theory, which is called upon to explain not only the phenomena of objective physics but also psychophysical phenomena."

In connection with our research on the physical vacuum it is necessary to touch on the extremely complex and tangled history of the ether. We shall note first of all that the concept of

the ether was developed in a time when mechanistic ideas were prevalent in physics. The concept of fields was established, and the first steps were made in developing the foundations of the theory of space and time, i.e., the special theory of relativity. It was attempted at that time, of course, to represent the ether as a mechanical medium. In this cluster of physics problems based on Maxwell equations, and especially in connection with Maxwell's bias current, there emerged another idea about the ether as a medium possessing dielectric and magnetic properties at the same time.

The mechanical theories of the ether were rejected. Einstein and Infeld [54] wrote this about the subject: "Discussion of all the various attempts to describe the mechanical nature of the ether as a medium for the transmission of light would be a long story . . . . To construct the ether as a jelly-like substance, physicists have to make several extremely unnatural assumptions. We shall not cite them here: they belong to an almost forgotten past. The result, however, was significant and important. The artificial nature of all these assumptions and the need to introduce such a multitude of them, all quite independent of each other – all this was enough to break down confidence in the mechanical point of view."

However, the idea of the either as a simultaneously dielectric and magnetic medium was also rejected at the same time. Zeldovich and Khlopov [56] wrote this about it in their book: "Students of the works of Maxwell observe that the bias current hypothesis appears in Maxwell's works as if it were self-evident, without any special reservations or hesitation. It may be that the point here is that in the physical picture considered by Maxwell, the bias current corresponded to the real movement of charges in a particular medium – the ether. The existence of the ether was rejected at the end of the nineteenth century."

It is difficult to understand now why the unsound mechanistic models of the ether and the quite acceptable model of the ether as a kind of electromagnetic medium were indissolubly linked. However, in reading the book by Einstein and Infeld cited above, one can only guess about what they were thinking when the writing the book and even somewhat later: if there is a medium, then it is necessarily mechanical. And such a universal, pervasive medium, of course, must present resistance to the movement of the planets in the Solar System. But no such resistance was detected. The ether medium, therefore, does not exist. And if no such medium exists, there are also no material carriers of electrical and magnetic properties in space.

Such surprising properties of matter as superconductivity (H. Kamerling-Onnes, 1911) and superfludity (P. L. Kapitsa, 1938), by the way, were discovered much later, when the ether had already been abandoned. Now, on the other hand, with these properties of matter quite familiar, the movement of the planets without resistance in some ubiquitous medium no longer seems impossible.

The most up-to-date ideas about the physical nature of the physical vacuum, according to which the vacuum is not a void, i.e., the physical vacuum is a medium, have been presented in an article by Simonov and Shevchenko [57] published in the journal *Nauka v Rossii* in 1998. It is appropriate to quote the annotation to the article: "In October 1974, international teams of scientists in the United States and Switzerland discovered a new particle – J/Ψ. It proved very heavy (about three nucleon masses) and long-lived, which suggested the thought of whether it might be made of 'bricks,' which were previously suggested. As early as the mid-sixties, the American theoretical physicist M. Gellmann expressed the idea of the existence of such things. They were called quarks. A characteristic feature of these particles is the fact that no one ever saw them in 'pure form' – only in combination with other particles. Then scientists created a new science, quantum chromodynamics (QCD), analogous to the familiar electrodynamics (QED), in which quarks correspond to electrons, and gluons (particles with zero mass and a spin of 1, which

effect the interaction between quarks) correspond to photons. The quarks, however, carried a new 'charge' called color and had three varieties, while the gluons were of eight sorts, which complicated QCD as compared to electrodynamics, which had been studied in detail. It was thought at that time that there were only three types (aromas) of quarks – light *u*, *d* and *s*; and this picture was not taken seriously. However, the open particle *J*/Ψ was made up of a quark and an antiquark of a new type called a charm, or *c*-quark. It was at the moment of discovery of this fact that the quark nature of the particles in question became a genuine physical reality. Then it turned out, after numerous observations and calculations, that neither quarks nor gluons (i.e., the entire color world inside us and in the surrounding matter) ever escape into outside space: they are locked inside hadron particles. This phenomenon was called confinement (capture). In other words, in putting quarks and gluons together as color particles, we are talking about confinement – capture – of color."

1.4. Physical vacuum – polarization medium

In quantum chromodynamics, the physical vacuum is considered as a lattice, at the nodes of which are located pairs made up of a *c*-quark and a *c*-antiquark connected by a "string"; i.e., these quarks at spaced some distance apart and are dipoles. Such a structure means that the physical vacuum is formed from dipoles and in macroscopic terms is a polarization medium.

Despite the categorical exclusion of the ether in science, among the specialists who work with material polarization media, dielectrics and, in particular, ferrielectrics and magnetics, ferromagnetics and ferrites, the idea, which is natural for them, that Maxwell equations provide a mathematical description for the physical vacuum as a ubiquitous polarization medium possessing electrical and magnetic permittivity equal to one is widespread. With such an approach, electrical and magnetic inductions are the sums of electrical polarizations of the material dielectric medium and the physical vacuum, and magnetic polarizations of the material magnetic medium and the physical vacuum, respectively.

Hence we have another conception, at least at the level of "scientific folklore," of the physical nature of the physical vacuum as an electrical and a magnetic medium at the same time.

The concept of Maxwell equations as equations which also describe the properties of the physical vacuum – polarization medium – is in full agreement with the current understanding of the physical vacuum in the developing theory of quantum chromodynamics.

At the same time, there is no doubt that the Maxwell equations, even if they provide a mathematical model for the properties of the physical vacuum as a polarization electrical and magnetic medium, are not complete. It is necessary also to give a mathematical description for the gravitational properties of the physical vacuum, but now as a gravitational polarization medium and not as empty four-dimensional space-time as provided for by Riemann geometry in Einstein's general theory of relativity.

It is not difficult to assign the physical vacuum pro forma properties as a gravitational polarization medium or even to give a mathematical description for the gravity part of the physical vacuum. Heaviside [47] presented equations of gravidynamics similar to the Maxwell equations as early as 100 years ago (1893). The Heaviside equations can easily be reduced to the current form of Maxwell equations, and gravity polarizations of the physical vacuum can then be introduced by analogy, which is what the author of this book actually did in 1995 [3]. In the study in question, the polarization resembling electrical polarization was called gravitational polarization

of the physical vacuum, while the polarization resembling magnetic polarization was called the spin polarization of the physical vacuum.

Hence the physical analysis of Heaviside equations at the present level results in the physical substantiation of the model of the gravitational part of the physical vacuum as a polarization medium.

Heaviside's dynamic theory of attraction, or gravidynamics, is in full agreement with Minkowski's special theory of relativity. In Heaviside gravidynamics, a relativistic integral law for the conservation of mass is defined, similar to the way in which the relativistic integral of electrical charge conservation is fulfilled in Maxwell electrodynamics. In Minkowski mechanics, the mass defined as the rest mass emerges as a relativistic invariant [58]. In Heaviside gravidynamics, mass plays the same role as the electrical charge in Maxwell electrodynamics. Hence the Heaviside equations are covariant relative to Lorentz transformations, like Maxwell equations.

Relativistic equations of Poincaré [48] and Minkowski [49] gravidynamics follow from Heaviside equations [47] represented, as we know, in their Lorentz-covariant sense in fields. Conversely, Heaviside field equations follow from Poincaré and Minkowski equations (relativistic Poisson equations and D'Alambert wave equations "in potentials") in the same representation.

Thus Heaviside's theory emerges as a strictly relativistic theory of gravitation. Einstein's general theory of relativity (GTR), on the contrary, as Streltsov demonstrated [59], is not a relativistic theory of gravidynamics.

Streltsov devoted attention to the fact that the GTR is constructed based on Einstein's idea that "all energy E possesses a mass proportionate to it (E/c^2)." This condition has been given the name of the law of inertia of energy (LIE).

The LIE is not a covariant law. According to the Minkowski theory, the nonrelativistic relationship $E = mc^2$ must be replaced with Lorentz covariant relationships [58]: $\mathbf{P} = E\mathbf{v}/c^2$, $m^2c^2 = (E/c)^2 - \mathbf{P}^2$, where m is the rest mass, and $\mathbf{P}$ is the particle impulse; i.e., $E = mc^2\gamma$, where $\gamma = (1-\mathbf{v}^2/c^2)^{-1/2}$. The relativistic relationship between mass and energy makes it possible, as Streltsov writes [59], to assert that "if there is an energy that corresponds to any mass, then the mass does not correspond to any energy." In particular, in Heaviside Lorentz-covariant gravitation theory, there are no serious physical grounds for attaching the physical sense of mass densities to the energy densities of fields.

Thus the physical vacuum can be represented as a polarization medium using Maxwell and Heaviside vacuum equations for this purpose, with inductions seen as polarizations of the physical vacuum. The kinematic properties of the physical vacuum in this case will be characterized by Lorentz transformation equations of fields and polarizations (inductions), while the dynamic properties will be characterized by the Maxwell tensor of stresses. Obviously with such an approach, the electromagnetic and gravispin parts of the physical vacuum prove not to be related at all. Following Shipov [53], we shall call this physical vacuum the absolute physical vacuum (APV).

It is not difficult to observe that the physical vacuum cited above – the APV – has been familiar to physicists for more than 100 years (Maxwell in the 1860s [46] and Heaviside [47] in 1893). The APV appears as the result of a new view of theories and definitions which have been known for a long time – vacuum inductions are given the physical sense of polarizations of the physical vacuum. Such a conception of the physical vacuum does not produce any unknown physical phenomena, nor does it affect any field in modern physics. Following Terletskiy and Rybakov [58], one can refer to such the APV as "useless."

1.5. Non-homogeneous physical vacuum and vacuum domains

At the same time, the polarization model of the APV is quite an extensive mathematical construct described by four vector fields, electrical, magnetic, gravitational and spin, and four vector polarizations – inductions of the same descriptions.

The four polarizations of the physical vacuum as a polarization medium make it possible to turn our attention to certain physical phenomena defined by the relationships of magnetic and spin polarizations, and electrical and gravitational polarizations. The basic idea of the possibility of the existence of these relationships in the physical vacuum is simple: the majority of elementary particles simultaneously possess electrical charges and masses, and magnetic moments and spins, and the physical vacuum can be represented as a medium populated by such elementary particles, even if they are quarks, but in the form of dipoles.

It is permissible to suggest that many of the physical polarization phenomena in matter and in the physical vacuum must have the same nature. Gyromagnetic phenomena can be classified as such phenomena in matter; the study of these phenomena started with the experiments of Barnett in 1909 (the appearance of magnetization in a rotating model of ferromagnetic material) and the Einstein-de Haase experiments (rotation of a model of ferromagnetic material in its remagnetization) in 1915 [60, 61]. Phenomena of paramagnetic and nuclear resonances [62] have a gyromagnetic nature, as do processes of pulsed remagnetization of ferromagnetics and ferrites [32, 34].

Gyromagnetic phenomena in a ferromagnetic material are explained based on the hypothesis of the existence of the spin-related (and related, in part, to orbital moments) density of the moment of the quantity of motion – spin polarization defined as a vector collinear with the magnetization vector – the magnetic polarization [61].

One can suggest by analogy in the physical vacuum model that there is a relationship of magnetic and spin polarizations in the vacuum. Such a suggestion was made for the first time by Akimov in his descriptive model of polarization states of the physical vacuum and torsion fields [2].

It was necessary in the construction of this mathematical model of the physical vacuum [3, 4, 6] to use the hypothesis of a linear relationship of electrical and gravitational polarizations as well as magnetic and spin polarizations of the physical vacuum.

One could say, of course, that the relationship of electrical and gravitational polarizations in the physical vacuum should exist on the strength of the symmetry of electrical and gravitational processes and magnetic and spin processes. However, it is possible to go deeper in examining this issue. In that case, we must deal with the problem of negative mass.

We shall not, to begin with, that the physical vacuum as an electrical, magnetic, gravitational and spin polarization medium, is, on the whole, a globally neutral medium. It can consist only of elementary dipoles (electrical and gravitational) and moments (magnetic and spin). With this sense of the physical vacuum, gravitational dipoles must be represented as linked pairs of elementary positive and negative masses. The requirement of negative mass appears in the polarization model of the physical vacuum.

Negative mass is necessary in the Heaviside theory and, consequently, in the model in question for another reason as well. The Heaviside equations describe gravity in an infinite Universe. In this case, however, with the existence of positive mass only, an old problem, already familiar in Newton's theory of gravity emerges: the problem of the gravity paradox – the infinite

potential energy of any gravitational object. The gravity paradox does not arise when the total of positive and negative mass in the Universe is equal to zero, as the electrical paradox does not arise in electrical field theory with the use of the concept of the equality of positive and negative charges in the Universe.

Opinions in modern physics about the existence of negative mass have ranged from total rejection (Zeldovich *et al.* [56, 63]) to acknowledgement and necessity (Terletskiy [52], Shipov [53], Shulgin [64]). There is also the need to introduce negative mass in the polarization model of the physical vacuum, as we saw above. Therefore, the examination of arguments against negative mass, and, consequently, negative energy, takes on great importance.

We find the following wording in the book by Zeldovich and Khlopov [56]: "In Dirac's theory, the existence of the magnetic moment of an electron was obtained directly as a consequence of the fact that the electron has an electrical charge and spin. However, the number of states did not double in this case but quadrupled! In addition to the two states with "up" and "down" spin direction, another two precisely similar states, "spin up" and "spin down," but with negative energy, were predicted for the electron. The problem of states with negative energy emerged. And oh, the properties of these states must be strange! In only this: the total energy in these states is negative, including rest energy ($E_0 = mc^2$; i.e., $E < -mc^2$). In order to increase the speed of such an electron, energy must be taken away from it. And conversely: energy must be transmitted to it in order to stop it. It was obvious that there is no such thing in nature."

However, the actual acknowledgement of particles with negative energies and masses follows from Dirac's theory, if it is assumed that their movement is related not to "heating up" but to "cooling down" of the surrounding particles. It is necessary in this case to proceed to breaking down the law of the increase in entropy. In this case, a problem with a second origin of thermodynamics arises, although everything remains in order with the first origin of thermodynamics (the law of the preservation of energy).

Along with this, one can start breaking down the second origin of thermodynamics by introducing negative mass, but with one necessary condition: with this assumption, the theory itself must explain why the second origin of thermodynamics remains in force within limited volumes in the Universe.

In accepting negative mass, one must thereby accept the quadrigue (group of four) of particles of Terletskiy [52], which is accepted both by Shipov [53] and, in essence, by Shulgin [64]. The "quadrupling of states" in Dirac's quantum theory provides a definite substantiation for this quadrigue of particles.

Terletskiy's quadrigue of particles [52, 53] is a remarkable discovery in the model of the physical vacuum as a polarization medium. The basic property of the four particles of the Terletskiy quadrigue actually is that the sums of the four electrical charges, masses, magnetic moments and spin moments (spins) are equal to zero. From the Terletskiy quadrigue, one can distinguish two dyads of particles in which the sums of their two electrical charges, masses and magnetic and spin moments are also equal to zero. Thus Terletskiy's quadrigue of particles itself and the two component dyads of particles from the quadrigue are appropriate for constructing a model of the elementary cells of the physical vacuum as a globally neutral polarization medium. Hence three physical vacuums emerge in model construction: the absolute physical vacuum (APV), consisting of Terletskiy quadrigues; the physical vacuum of matter (PVM), which contains particles of a dyad, one of which is an ordinary particle; and the physical vacuum of antimatter (PVA), consisting of particles of a dyad, one of which is an antiparticle.

In the APV, all the polarization-inductions – electrical, magnetic, gravitational and spin – are totally unrelated to each other. They depend only on the respective fields (electrical, magnetic, gravitational and spin) and are described by Maxwell and Heaviside vacuum equations.

In the PVM and PVA, the electrical and gravitational polarization-inductions and the magnetic and spin polarization-inductions are interrelated. All these polarizations, in turn, are related by Maxwell and Heaviside vacuum equations.

Hence in the absolute physical vacuum, the polarization model breaks down into two independent models: the Maxwell theory of electromagnetism, and the Heaviside theory of gravispinorics. No law of physics is affected in this regard.

On the contrary, the relationships of electrical and gravitational polarizations and of magnetic and spin polarizations in the PVM and PVA result in a unified system of equations which form the basis for a combined electrogravidynamics model. This system of equations also makes it possible to connect two larger theories: the electronic theory of matter, by way of electrical charges and magnetic polarizations of the Maxwell equations, and continuum mechanics, by way of masses and moments of the quantity of movement of the Heaviside equations.

In the physical vacuums of matter and antimatter, we can see a modified physical vacuum, which makes up the bodies of vacuum domains – the translucent, self-luminous bodies which are the cause of anomalous phenomena. We shall repeat that the bodies of the vacuum domains are immersed in the absolute physical vacuum medium. Each of the vacuums, APV, PVM and PVA, has its own mathematical representation in the form of systems of differential equations in partial derivatives. Hence the description of the physical properties of vacuum domains can be obtained as a result of the solution of boundary value problems of mathematical physics with boundary conditions on the surfaces of the vacuum domains and at infinity.

Thus in the model presented, the physical vacuum is seen as a heterogeneous medium. One part of such a vacuum consists of a homogeneous, isotropic polarization medium, infinite in space, in the form of the APV. This vacuum is found in all material formations (matter is that which possesses positive mass and is located in the same space as the APV). At the same time, there is also another part of the heterogeneous medium present in the same space: distributed negative mass (Shipov [53]), as well as the vacuum domains of physical vacuums of matter and antimatter, which are polarization media. These two latter physical vacuums interact with the APV, which weakens the electrical and gravitational relationships within the vacuum domains.

Hence the non-homogeneous physical vacuum in this book means a physical vacuum of multiple types. We shall mention in this connection that a homogeneous (single type) non-homogeneous physical vacuum is also known in physics. The inhomogeneity of this vacuum is characterized by variation in its density and pressure in space. The idea of the non-homogeneous homogeneous physical vacuum was expressed by Atsyukovskiy [65, 66]. The same idea is considered by Khoteyev [67], who developed the concept of the ether sphere of the Earth. The conception of non-homogeneous ether in these publications is put forward to explain experimentally observed physical phenomena which contradict the established ideas of modern physics. Such hydrodynamic models of the ether, however, fail to make possible a deep and convincing explanation for the effects in question. A considerably more substantial model of the physical vacuum, possibly based on the idea of the existence of diffuse vacuum domains, is necessary for this purpose.

The main objects for study in the polarization model presented for a non-homogeneous physical vacuum are vacuum domains, which are independent objects of the Universe. Consequently, such a model can with equal validity be called both a physical and a mathematical

model of vacuum domains. The concept of the vacuum domain which is introduced – the basic object of the non-homogeneous physical vacuum – makes it possible to define in explicit and concrete form one of the fundamental and extremely timely problems of physics now and in the future: the perception of the physical vacuum as a polarization medium possessing a very rich spectrum of states and manifestations of those states.

2. Polarization model of the non-homogenous physical vacuum

2.1. Models of the physical vacuum

2.1.1. The Need for a non-homogeneous physical vacuum model

The anomalous phenomena (AP) considered in Chapter 1 are surprising phenomena. The AP reflect clear manifestations of known physical processes in a totally unusual combination, and features of processes which are very difficult to explain based on current physical knowledge.

In the AP one can see clear traces of electromagnetic processes: strong electromagnetic radiation in a range of wavelengths at least from fractions of a micron (light radiation) up to meters (effects on television and radio); changes in electrical and magnetic fields (clear signs of electrical breakdown and magnetization in rock at point of contact of self-luminous formations of the AP with the surface of the Earth, and a change in magnetic field in the appearance of AP); electrical discharges (electrical injuries to people and animals by ball lighting).

Attentive study of the information about the behavior of self-luminous formations of AP forces one to hypothesize that the gravitational field changes around them. Signs of levitation associated with AP have been described in the articles indicated above, especially the articles pertaining to the Sasovo explosions.

The AP clearly carry great energy. The presence in them of energy associated with electrical and magnetic fields is obvious. However, one can judge according to the release of heat and the strength of the explosions that the energy of the AP is much greater than the energy associated with electrical and magnetic fields [10, 12]. For this reason alone, one must reject the electromagnetic models of ball lightning (BL) and other AP.

Modern physical theories cannot explain the entry of self-luminous formations of AP into solids and water or the passage of the self-luminous formation of AP through these media. In this regard, electrochemical (fractal) and plasma [10] models of ball lightning and other AP in general become unsound, especially since the formations in question are also observed in space.

One can see from the variety of physical properties of AP indicated above that the mathematical description of these phenomena cannot be based only on a single known fundamental theory. It is necessary to connect a number of such theories, primarily the theories of electromagnetic and gravitational fields.

It should be mentioned that these two theories integrate the fact that " . . . in contract to short-lived nuclear and weak forces, electromagnetic and gravitational forces are long-lived; i.e., they decrease most slowly with distance between particles. It is just this factor that makes it possible to consider electromagnetic and gravity fields as macroscopic and to limit ourselves to a classical description of them" [58].

The theories of electromagnetic and gravity fields are also inadequate to describe AP. Local variation in the gravitational field in the space near an AP cannot be described by current theories of gravity, and the passage of AP through solids and water cannot be explained reasonably, even with the application of both these theories at once. Consequently, a new conception is needed which combines the theories of electromagnetic and gravitational fields and includes new qualities. The third theory, like the first two, must be macroscopic.

The theories of electromagnetic and gravitational fields cover the same physical vacuum. In classical Maxwell electrodynamics and Einstein's theory of gravity (GTR), no properties which would render the equations of the theories in question dependent in the mathematical sense are

attached to this vacuum. However, in the long time which has passed since the development of the great theories of Maxwell and Einstein, the theory of the physical vacuum (PV) was developed, traveling the road from the rejected theories of the ether to virtual particles and antiparticles of quantum field theory [68], and most recently the PV has come to be seen as a quark polarization medium [57].

The population of the PV with virtual particles-antiparticles contains an important start in the understanding that electromagnetic and gravity phenomena can be related in relation to the PV, since the virtual particles-antiparticles are characterized by electrical charges and masses, as well as interrelated magnetic moments and moments of the amount of movement – spins. This relationship is used in a specific way by Akimov [2] in a heuristic model of the polarization states of the PV. The development of the concepts of particles-antiparticles with negative masses in the works of Terletskiy [52] and Shipov [53] eliminates the greatest difficulty in Akimov's ideas of polarizations of the PV involved with the filling of the PV with particles-antiparticles with positive masses. Connecting the ideas of Terletskiy and Shipov with Akimov's results makes it possible to represent the PV as a medium with interrelated polarizations: electrical and gravitational, and magnetic and spin [3, 4, 6].

Meanwhile, if it is assumed that electromagnetic and gravitational polarizations are related in all homogeneous and isotropic space, the relationship must be recognized as weak [3]. Otherwise the model would yield physical phenomena which are not observed in large spaces of the Universe. However, another hypothesis has appeared under the impression of unusual physical properties of the AP – the hypothesis of the non-homogeneous PV [6], according to which the AP formations are local clusters of modified PV in the APV with properties differing from the properties of the main PV. It is suggested the electromagnetic and gravitational polarizations are weakly related in the APV and strongly related in the modified PV. These clusters of the modified PV are called vacuum domains. The spin polarizations could also be called torsion polarizations, since they correspond to Akimov's torsion polarizations [2].

There is a place for the polarizations only in macroscopic physical models of neutral media, which is undoubtedly what the PV medium is. Therefore, the conception of the non-homogeneous PV, as a polarization model, is macroscopic. Therein lies the fundamental different between the model considered below and many of the known PV models of a macroscopic nature. It is important to note in this connection that the polarization model in question is associated with strong physical effects only with a non-homogeneous PV. In this case, spasmodic non-homogeneity of the polarizations in space and, consequently, concentrated bound charged and strong fields develop.

The macroscopic model of the non-homogeneous PV considered below is constructed based on the groundbreaking works of physicists published in the last 150 years and represents a synthesis of the results extracted from these works. All the physical phenomena predicted by this model are of a macroscopic nature. It will become clear from further consideration that it is extremely difficult to recreate the AP in laboratories. In this connection, the non-homogeneous PV model can be tested only in full-scale experiments and measurements.

The macroscopic non-homogeneous PV model makes it possible to simplify the terminology of the AP studied. Instead of the phrase "self-luminous formations of AP," one can simply say "vacuum domains" (VD).

2.1.2. Classical models of the ether

At the turn of the century, the models of the PV were still associated with the concept of the ether – a weightless medium which penetrates, in the words of Lorentz [50], even through atoms and electrons. Terletskiy [58] writes: "Maxwell was an advocate of the mechanical point of view and represented the electromagnetic field in terms of stresses and strains of a special all-penetrating medium – the ether . . . ; Lorentz, the creator of the electronic theory, was also an ether advocate. While believing that an electromagnetic field is a special state of the ether, he nevertheless failed to assign the latter any mechanical properties." Lorentz tried to substantiate the ether hypothesis based on experiments: "Lorentz's hypothesis of the ether at rest with capacities for contractions by bodies explained the aberration, the Fizo entrainment factor, the Michaelson-Morley experiments, experiments with moving light sources and mirrors, the Michaelson-Morley experiments with sunlight, the emission of mobile charges, the Trowton-Noble experiments . . . , but proved unable to explain simply unipolar induction with a permanent magnet." However, Lorentz " . . . finally came . . . to the conclusion that the presence of the ether cannot be observed in any electrodynamic experiment. Lorentz's ether remained an unidentified "thing in itself." While recognizing its uselessness, Lorentz nevertheless was unable to take the final decisive step – to reject the ether. This was done by Einstein, the creator of the theory of relativity. Later the idea of the electromagnetic field as an independent material substance which is the carrier of electromagnetic interactions and is distributed in space gradually took shape" [58].

In a study in 1910 [65], Einstein actually states that "it is impossible to create a satisfactory theory without rejecting the existence of some medium that fills all space." However, in his work in 1920 [65] he is already writing: " . . . extremely close examination indicates that the special theory of relativity does not require the unconditional rejection of the ether. One can accept the existence of the ether, but one shouldn't worry about attributing to it a specific state of movement; in other words, in the abstract, one needs to take away from it the last mechanical feature Lorentz left to it." "To sum up, we can say: by expanding the concept of the physical object, one can imagine objects to which it is impossible to apply the concept of motion. These objects cannot be thought of as consisting of particles, the behavior of each of which is subject to investigation in time." "The special theory of relativity prohibits considering the ether as made up of particles whose behavior in time can be observed, but the hypothesis of the existence of the ether does not contradict the special theory of relativity. One simply should not attribute a state of motion to the ether." "To reject the ether in the final analysis means to accept that empty space has no physical properties. The basic facts of mechanics are not in agreement with such a view." In a work in 1924 [65], Einstein writes: " . . . in theoretical physics, we cannot get along without the ether, i.e., a continuum assigned physical properties, because the general theory of relativity . . . excludes direct long-range action; and each theory of short-range action assumes the presence of continuous fields and, consequently, the existence of the 'ether.'"

One can see from the passages quoted above that the leading figures in physics at the beginning of the century were faced with not one but two ethers: Lorentz's well-known nonrelativistic ether at rest [50], and Einstein's little-known relativistic ether. In the kinematic sense, these two ethers are fundamentally different. The former is associated with an absolute (preferable) reference system, while the latter is compatible with the relativity principle, which assumes the equal status of all inertial reference systems.

While Lorentz, on the basis of analysis of experimental data, attributed physical properties to his ether which rendered it "unobservable" and "a thing in itself," one can say the same thing about Einstein's ether with even greater grounds. In addition, both these ethers make it possible to consider the physical vacuum as a polarization medium. In such an approach, Einstein's

relativistic ether takes on certain electromagnetic properties characterized by Maxwell vacuum equations, as well as dynamic properties characterized by the Maxwell tensor of stresses. Lorentz transformations of coordinates, fields and vacuum polarizations proportionate to the fields obviously characterize the kinematic properties of Einstein's ether. This step in itself, of course, does not alter the conditions of the mathematical theory o electrodynamics. It makes it possible, however, to obtain new ideas for the development of the physical vacuum theory.

The development of Einstein's ideas about the relativistic ether without a "state of motion" by Korukhov and Sharypov [69-71] are of great interest in terms of methodology. According to Korukhov [69], for example: "The speed of light can have the same value for any inertial observer, if the light propagates in a medium that possesses the kinematic property of invariance of rest. . . . A medium with such a condition for motion shows up in examination only in a state of rest. The postulate of invariance of the speed of light can be replaced with an equivalent postulate of invariance of rest of the medium relative to inertial observers." These ideas of the so-called Planckian ether make possible a uniform approach to both polarizations of matter and polarizations of the ether in any inertial reference system.

The non-homogeneous PV model in question is based on Einstein's ether, which has the primary purpose of obtaining mathematical relationships which rest on known results of the use of the special theory of relativity in electrodynamics. The problem of ether wind, however, if one has in mind anisotropic phonon (relic) radiation, does not cease to be urgent [65]. Therefore, further development of the theory of relativity is needed.

Primary attention in this discussion is devoted not to this problem but to the problem of polarizations of the PV, where we can limit ourselves to the application of the special theory of relativity as a good approximation.

2.1.3. Field conception of the physical vacuum

Thus the field conception of the PV, according to which space is filled only with fields, and there is no medium at all present in it, has been affirmed in science since the beginning of the twentieth century. In addition, the following fundamental conditions have come to be indisputable [58]:

1. homogeneity of space and time;
2. isotropicity of space;
3. the principle of relativity;
4. the postulate of constancy of the speed of light in a vacuum.

From these conditions flow Lorentz transformations, as well as the covariance of Maxwell equations in mobile reference systems [58, 72, 73].

The field conception of the PV produced a curious situation. While the Maxwell vacuum equations in the presence of the ether were equations of an ether-medium model, in the case of space lacking a medium, the Maxwell vacuum equations described only the propagation of electromagnetic waves in a vacuum space. Hence some equations in partial derivatives emerged in physics which do not reflect the properties of any physical medium. In this connection, abstract conceptions of inductions and bias current in a vacuum emerged in the Maxwell equations and are causing substantial complications in the understanding of the physical basis of electrodynamics.

2.1.4. Akimov model of polarization states of the physical vacuum

Definite shifts in the direction of the repeated return to the PV as a medium are a result of equations of quantum mechanics and Dirac's electron-positron vacuum [51]. After the experimental discovery of the production of electron-positron pairs, as well as other particle-antiparticle pairs, in a vacuum, a large number of microscopic models of the PV were developed, associated with the theory of virtual (possible) fields and particles; such models are presented in [2], for example. Microscopic models of the PV received a completed form in representations of the quantum field from which both known fields and particles of matter are produced [68]. These theories, however, did not make it possible to create a macroscopic model of the PV for the description of collective physical effects within it.

Akimov's schematic conception of the polarization states of the PV [2] is of great importance on the path to the development of macroscopic models of the PV. In this model, the PV is represented as a structured medium, the elementary cell of which – the fiton – contains a particle-antiparticle pair. The fact that particles-antiparticles simultaneously possess electrical charges and masses, and magnetic moments and moments of the quantity of motion – spins – also draws attention. As a result, the PV appears simultaneously as electrical, magnetic, gravitational and spin polarization media. Electrical and gravitational polarizations and magnetic and spin polarizations turn out to be related theoretically. Akimov's model in fully explicit form returns to the theory of the PV as ether-medium. This ether does not resemble Lorentz's ether or Einstein's ether. Akimov's ether is polarization ether, but with interrelated polarizations. It has a relationship to both electrodynamics and gravidynamics. The polarizations are measurable variables, which can occur only in a macroscopic model of the PV.

2.1.5. Terletskiy particle-antiparticle quadrigues

At the same time, the Akimov model cannot be considered complete, since both the particles and the antiparticles possess positive rest masses. Consequently, the PV in this model must have positive mass. It is obvious that with positive mass of the PV, insurmountable difficulties arise with Newton's law of gravity, and the gravity polarization cannot be strictly determined. The ideas contained in the works of Terletskiy and Shipov provide a way out of this difficult position.

Based on the laws of symmetry, Terletskiy [52] put forward the hypothesis that a particle-antiparticle pair with positive masses and a particle-antiparticle pair with negative masses should appear in the vacuum; i.e., they should be produced as quadrigues.

Shipov [53] created a fundamental theory of the PV by developing the Clifford-Einstein program in regard to the geometrization of physics equations, based on both progressive and rotational relativity (general relativity). Shipov's theory uses the geometry of absolute parallelism and not the Riemann geometry on which Einstein's general theory of relativity is based. The geometry of absolute parallelism is based on the concepts not only of curving but of twisting space-time. There are two twists: right and left. Therefor two physical worlds emerge, with right and left twisting, respectively. According to Shipov's theory, the particles-antiparticles with positive masses belong to the right world. These are the well-known particles and antiparticles. The little-

known particles-antiparticles with negative masses belong to the left world. It is thought at present that they are dispersed in space. The equality to zero of the total electrical charge and the total mass in the Universe and the absolute neutrality of the PV (at every point in space) in regard to both electrical charges and masses follow strictly from Shipov's theory. Matter contains only the positive masses of the right world. The negative mass of the left world is scattered between the matter. The positive and negative electrical charges are balanced in both the right and left worlds. Shipov does not use any new or unknown characteristics of particles and antiparticles. Therefore one must assume that the particles-antiparticles of both right and left worlds simultaneously possess both masses and electrical charges, and magnetic moments and spins.

The Terletskiy microscopic model of particle-antiparticle quadrigues is affirmed in Shipov's theory at the quantum mechanics level.

2.1.6. Akimov's fiton and Terletskiy's particle-antiparticle quadrigue

At the same time, the theory that we were discussing in the previous section is very far from such classical macroscopic concepts as polarization defined as the sum (vector sum, for example) of elementary dipoles or moments in a unit of volume. Therefore, the need arises to make the transition from the microscopic representations of Terletskiy-Shipov to the phenomenological representations of Akimov. This transition inevitably leads to the assertion that Akimov's fiton must contain not a particle-antiparticle pair but a Terletskiy particle-antiparticle quadrigue. In this case, the shortcomings of Akimov's model associated with the positive mass and indeterminate gravitational polarization of the PV are eliminated. The PV becomes fully neutral, and its gravitational polarization is defined precisely, like the electrical polarization of the PV [6].

In populating the Akimov fiton with Terletskiy quadrigues of particles-antiparticles of right and left worlds, we obtain a unified symmetrical system of electrical, gravitational, magnetic and spin polarizations of the PV. On the strength of the fact that the particles-antiparticles of the two worlds simultaneously possess positive and negative charges and masses, as well as magnetic moments and spins, one must expect connections of the electrical and gravitational polarization and the magnetic and spin polarizations.

2.1.7. Polarization-field conception of the physical vacuum

In the theories of dielectrics and magnetics, i.e., in the theories of material polarization media, polarizations characterize the state of matter itself, while the fields are factors of the change in these states. The polarization values in dielectrics and magnetics are actually related to the configurations of the electrical dipoles and magnetic moments, while the fields are related to the forces that cause variations in these configurations. Hence the fields prove to be the cause, while the polarization is the effect of this cause. One can say in this connection that the polarization-field conception has been confirmed in the polarization matter theories in question as a combination of representations of the interactions of various fields with dielectrics and magnetics.

The PV polarizations considered above do not differ fundamentally from the polarizations of matter. Therefore, all the approaches to them remain the same as the approaches to material

polarizations. Consequently, it is also possible to use the conception above, which will be referred to hereinafter as the polarization-field conception of the PV, in the non-homogeneous PV model.

One can note the total similarity of the polarization-field conception in electrodynamics, and, consequently, in electrogravidynamics as well, and the conception of generalized coordinates and generalized forces in mechanics. Obviously the generalized coordinates correspond to polarizations, while the generalized forces correspond to fields. However, this similarity does not in any way mean a return to mechanistic representations in electrodynamics. In this analogy, one must see an identical, objectively existing cause-and-effect relationship between the fundamental concepts of two different theories.

2.2. Model of non-homogeneous physical vacuum from Terletskiy quadrigues and dyads

2.2.1. Basic properties of the physical vacuum of Terletskiy quadrigues

Since various particle-antiparticle pairs are produced in the vacuum, the Akimov fiton can also be made up of various pairs and can have a complex internal structure. These pairs must be based primarily on quarks, electron, proton and neutron. It must be the same in the replacement of particle-antiparticle pairs in the fiton with Terletskiy quadrigues of particle-antiparticle of the right world and particle-antiparticle of the left world. The quadrigue must also be based on quarks, electron, proton, neutron, etc. In addition, the features of the PV considered above are defined not by the complex structure of the fiton but by the properties of another Terletskiy fiton. Therefore, only one Terletskiy quadrigue will be represented in the fiton below, with the basic particle (right world) parameters m – mass; q – electrical charge; s – spin; μ – magnetic moment. Such a fiton is shown in Fig. 1.

1 $\quad$ +m, +q, +s, +μ	2 $\quad$ +m, -q, +s, -μ
3 $\quad$ -m, +q, -s, +μ	4 $\quad$ -m, -q, -s, -μ

Fig. 1.

As one can see from the figure, the fiton contains particle 1 of the right world with the parameters +m, +q, +s, +μ, antiparticle 2 of the right world with the parameters +m, -q, +s, -μ, and two particles-antiparticles 3 and 4 of the left world with the parameters -m, +q, -s, +μ, and -m, -q, -s, -μ, respectively. Based on the idea put forward by Akimov of the unobservability of the PV in an unexcited state, one must assume that particles-antiparticles 1-4 in the absence of fields are

enclosed one in another [2]. In this case, the PV will be absolutely neutral in the sense that its mass, electrical charge, moment of the quantity of motion and magnetic moment are equal to zero, in the microscopic as well as the macroscopic sense.

One can see from an examination of Fig. 1 that even on the basis of classical physical ideas, the fiton in a gravitational field becomes a gravitational dipole, and, consequently, the PV takes on gravitational polarization. In an electrical field, in a similar manner, the PV takes on electrical polarization. In examining the effect of a magnetic field, it is necessary to use fundamental concepts of quantum mechanics [68], according to which the magnetic moment can be directed either according to the orientation of this field or opposite to it. In the case of the effect of a spin field, the same thing pertains to the spins. Based on these ideas, one can see that the PV takes on magnetic polarization in a magnetic field and spin polarization in a spin field.

The most important result of the consideration of the PV consisting of Terletskiy quadrigues is the absence of any connection among the four polarizations. Actually, according to Fig. 1, gravitational polarization develops under the effect of a gravitational field, but electrical polarization does not. The displacement of positive masses (1; 2) and negative masses (3; 4) by a gravitational field results in the displacement of electrical charges, but these charges remain balanced in both positive and negative masses. Quite a similar situation develops under the effect of an electrical field. In this case, the positive and negative mass remain balanced. In the consideration of the effect of magnetic and spin fields, one must keep in mind that the direction of the spin s is rigidly related to the orientation of the magnetic moment μ. And the spin and magnetic polarizations are specifically statistical concepts with a physical sense only in the consideration of a large number of fitons. In addition, in these cases as well, the situation remains quite similar under the effect of gravitational and electrical fields. A change in magnetic polarization is not related in any way to a change in spin polarization, and vice versa.

2.2.2 Three physical vacuums. Non-homogeneous physical vacuum of Terletskiy quadrigues and dyads

If one starts from Akimov's idea of the PV as an unobservable medium in an unexcited state, or, more precisely, as a neutral medium, where the mass and electrical charge of all four polarizations are equal to zero in the microscopic sense, one must acknowledge that, generally speaking, there must three PV. These three PVs are shown in Fig. 2.

| PVM		APV			PVA
+m, +q, +s, +µ	$\Longleftarrow$	+m, +q, +s, +µ	+m, -q, +s, -µ	$\Longrightarrow$	+m, -q, +s, -µ
-m, -q, -s, -µ		-m, +q, -s, +µ	-m, -q, -s, -µ		-m, +q, -s, +µ

Fig. 2.

The PV of Terletskiy quadrigues can be called, following Shipov's practice [53], the absolute physical vacuum (APV). The basic physical properties of this vacuum have been examined above. The PVM, i.e., the physical vacuum of matter, and the PVA, i.e., the physical

vacuum of antimatter, are formed as a result of the division of fitons of the APV into two halves, or two Terletskiy dyads.

One must hypothesize that in some way unknown to us, the particles of half-fitons of the PVM and the half-fitons of the PVA are grouped into some media – "vacuum crystals" – which occupy individual local regions of space in the unbounded space of the Universe, which is filled with the APV medium. It is in just this sense that the non-homogeneity of the physical vacuum is understood in this model.

On the strength of the properties considered above for the particles – antiparticles of the right and left worlds, the half-fitons of the PVA and the PVM in the absence of fields are also neutral in both macroscopic and microscopic senses, like the APV. It is easy to observe that a half-fiton of the PVM includes a particle of the right world, i.e., a real particle, while a half-fiton of the PVA includes an antiparticle of the right worlds, i.e., a real antiparticle. For just this reason, we call the PVM the physical vacuum of matter (but not Matter) and the PVA the physical vacuum of antimatter (but not Antimatter, since Matter is a unity).

2.2.3. Basic properties of physical vacuums of matter and antimatter

The polarizations of the PVM and the PVA, in contrast to the APV, prove to be strongly related in pairs: electrical and gravitational, and magnetic and spin. Under the action of an electrical field on the PVM and the PVA, a gravitational as well as an electrical polarization develops, while under the effect of a gravitational field, these two polarizations also emerge. Under the effect of a magnetic field, a spin as well as a magnetic polarization develops, while under the effect of a spin field, these two polarizations also develop. The indicated features of the PVM and PVA become obvious when one considers the half-fiton of the PVM (Fig. 2 – left) and the half-fiton of the PVA (Fig. 2 – right), if one starts from the particle – antiparticle properties discussed above.

At the same time, one can also see the fundamental difference between the PVM and the PVA. Under the effect of a certain field, the accompanying polarization has the same orientation as the polarization of the type like the field in the case of the PVM. In the case of the PVA, the accompanying polarization has an orientation opposite to that of the polarization of the type like field.

2.2.4. Circulation of matter in the Universe

Based on the model of the PV as consisting of particles-antiparticles of right and left worlds, one can obtain a schematic model of the Universe in which matter develops from the PV and disappears in it. The starting point of such a model is a refined definition of matter: matter is that which has positive mass; i.e., it includes normal (observable) particles and antiparticles with positive masses. As already stated above (Fig. 2), the PVM consists of these particles, while the PVA consists of antiparticles, provided, of course, the APV is set aside. Consequently, matter in the sense specified above can appear as a result of the decomposition of both the PVM and the PVA. In the former case, particles with positive masses should appear, while in the latter, antiparticles, also with positive masses, should appear. However, since antimatter is an exception

in the observable Universe, the idea arises that the reactions associated with the PVM and the PVA occur in different ways.

The PVM decays with a specific relaxation time into the particles +*m*, +*q*, +*s*, +*μ* and -*m*, -*q*, -*s*, -*μ*. If nuclear reactions in which antiparticles are generated are excluded from consideration, one must reject the hypothesis of the decomposition of the PVA. The PVA, on the contrary, in some way unknown to us, collects from the APV the stray particles +*m*, +*q*, +*s*, +*μ* and -*m*, -*q*, -*s*, -*μ* which appear as a result of the decomposition of the PVM and restores the quadrigues of the APV. The circulation of matter occurs in this way.

Figure 3 shows a Terletskiy particle-antiparticle quadrigue (at the top), a dyad of particles of the PVM (left), a dyad of particles of the PVA (right) and individual particles of matter of the right world – ordinary particles – and particles of the left world (with negative mass). The arrows indicate the following transformations: 1 – the separation of PVM particles from the Terletskiy quadrigue; 2 – the separation of PVA particles from the Terletskiy quadrigue; 3 – the separation of particles of matter from the PVM dyads; 4 – the separation of particles of the left world from the PVM dyads; 5 and 6 – the combination of particles of matter and particles of the left world with PVA particles into a Terletskiy quadrigue; 7 – the end of the cycle of the transformation of matter.

Based on the diagram of Figure 3, one can present the following picture of the circulation of matter in the Universe. Particles (dyads) of the PVM and particles (dyads) of the PVA are generated from the APV as a result of the strong energy effect in the stars. They are collected separately into local formations, which are identified in this study with natural self-luminous formations. Hence two types of self-luminous formations must exist; these may provisionally be called PVM and PVA formations.
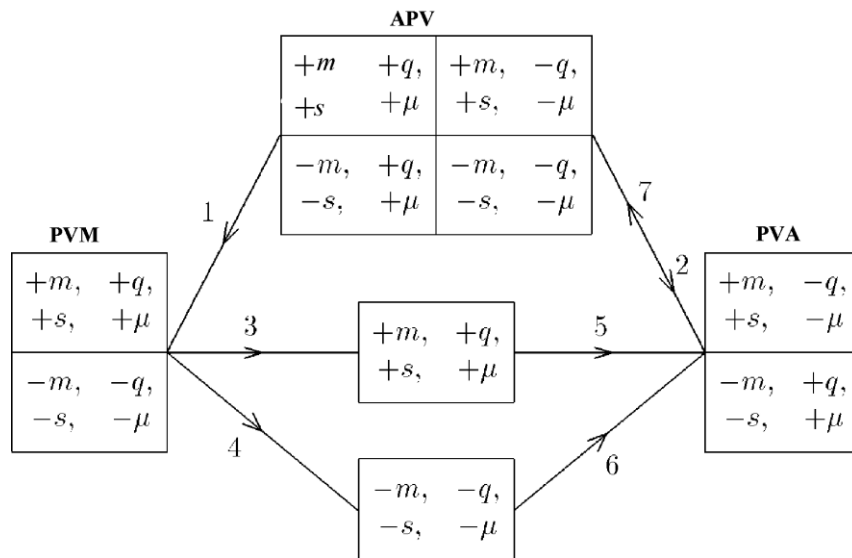
Fig. 3.

Both these types of formations should disappear outside the places where they are generated. Substance, mainly in the form of hydrogen, should be formed around the PVM formations at the expense of the dyads. The PVA formations, on the other hand, should lose their dyads as a result of their connection with particles of substance and particles *-m*, *-q*, *-s*, -µ of the left world. In this case, Terletskiy quadrigues, i.e., the APV, should develop.

2.3. Equations of a macroscopic model of combined electrogravidynamics

2.3.1. Equations of Maxwell and Heaviside in the polarization-field conception of the physical vacuum

The ideas of electrical, magnetic, gravitational and spin polarizations and fields of the PV considered above give rise to a combined model of electrogravidynamics. It is natural that the electromagnetic part of this model should be based on Maxwell electrodynamics. As we know [58], this theory was developed based on the analysis of extensive experimental data. The area of its applicability ends at dimensions less than 10^{-13} cm, i.e., at the distances of the effect of nuclear forces [53].

Three conditions are of fundamental importance in electrodynamics:
1. Linearity of the basic equations of Maxwell;
2. Equilibrium, on the whole, of positive and negative electrical charges;
3. Covariance of the equations of Maxwell relative to the group of Lorentz transformations.

The linearity of the basic equations of Maxwell makes it possible to use the principle of superposition of potentials and fields. The superposition principle, in turn, forms the basis for theories of electrical and magnetic polarizations.

If the electrical charges in space were not, on the whole, in balance, Maxwell's theory would lose its physical content in connection with the divergence of the sums and integrals for the potentials. In this case, it would be impossible to determine the electrical and magnetic forces.

Einstein's special theory of relativity (STR) developed in connection with problems of electrodynamics and, after receiving experimental substantiation, took on independent importance. In particular, the group of Lorentz transformations used in electrodynamics received physical substantiation: transformations of coordinates, fields, polarizations and currents-charges [58].

In the polarization-field conception of the PV, electrical and magnetic polarizations of the PV can be incorporated in equations of Maxwell only in the way in which like polarizations of substance are incorporated.

In the gravitational part of the non-homogeneous PV model, the gravitational and spin polarizations come to the forefront. Therefore, the first fundamental condition of electrodynamics must be extended to the theory of gravitation selected as a component of the model in question; i.e., it must be linear.

In connection with the questions being examined, it is impossible to move past the recognized theory of gravitation – Einstein's general theory of relativity. This theory is nonlinear. However, the theory of regular stars with a mass not exceeding 100 times the mass of the Sun does not require the theory of relativity [63]. In other words, linearized equations of Einstein's GTR, which is what the D'Alambert wave equations in potentials are [73], can be used to describe the gravitational processes in the vicinity of the Sun. Newton's law of gravity follows from one such equation. D'Alambert's equations are unsuitable for incorporating the polarizations of the PV. Therefore, it is necessary to take another step – to switch to equations of gravitation similar to the equations of Maxwell, i.e., to relationships expressed through fields. This transition is familiar as the Maxwellization of the equations of the GTR [74]. Theoretically one can incorporate gravitational and spin polarizations of the PV in such equations. As early as 23 years before Einstein's GTR, however, Heaviside proposed equations of gravitation similar to the equations of Maxwell [47]. These equations conform well to a number of laws and principles of physics. Therefore, one can go directly to the equations of Heaviside, thus bypassing the GTR.

However, there is a great difference between the GTR and Heaviside's theory, in that the former relates to a limited Universe, while the latter relates to an unlimited Universe. Therefore, in Heaviside's theory, as in Newton's theory, there arises the problem of the gravitational potential discrepancy, i.e., the problem of the gravity paradox in a limitless Universe filled with matter [63]. However, this difficulty occurs only in a case where the existence of matter with, and only with, positive mass is assumed.

If we start from Shipov's ideas [53], which state the equality of positive and negative masses in the Universe, the objections related to the gravity paradox are removed at once in Heaviside's (and Newton's) theory of gravity. The fundamental condition of the equality of positive and negative masses appears in Heaviside gravidynamics and is equivalent to the fundamental condition of the equality of positive and negative electrical charges in electrodynamics.

Based on the recognition of the STR as a theory for general application, it is necessary to extend the group of Lorentz transformations to the Heaviside equations as well. In particular, it is necessary to accept the speed gravity waves as equal to the speed of light, assuming mass to be a relativistic invariant.

One can demonstrate that the connection of the Heaviside theory and the STR (in the form of the Minkowski theory) results in the modern Lorentz-covariant theory of attraction (LCTA), for which Streltsov provided substantiation [59]. The only difference is in the fact that the equations of the LCTA are represented by potentials in the form of linear wave equations of D'Alambert. (relativistic equations of Poisson), while the Heaviside equations are represented by fields. It is just this difference, however, which is of fundamental importance in the case of the polarization-field conception of the PV. One can incorporate the polarizations of the PV in the linear field equations of Heaviside as simply as in the linear field equations of Maxwell.

Hence all three fundamental conditions of electrodynamics also become valid in the Heaviside theory, if relativistically invariant masses are substituted for relativistically invariant charges in this case.

A large number of parameters characterizing the state of the PV, greatly exceeding the number of parameters in electrodynamics, emerge in this macroscopic model of the non-homogeneous PV. In this connection, the need arising for introducing a certain uniformity in the designations of related physical variables and for establishing a correspondence of names to

alphabetical designations. In equations of Maxwell, it is advisable to reject even the customary induction and polarization designations which have become international.

The following designations are employed hereinafter for the case of isotropic PV and substance: For fields: **E** – electrical; **M'** – magnetic; **G** – gravitational; **S** – spin. For polarizations of the PV: $\mathbf{P}_{EFV}$ – electrical; $\mathbf{P}_{MFV}$ – magnetic; $\mathbf{P}_{GFV}$ – gravitational; $\mathbf{P}_{SFV}$ – spin. For polarizations of substance: $\mathbf{P}_{EK}$ – electrical; $\mathbf{P}_{MK}$ – magnetic; $\mathbf{P}_{GK}$ – gravitational; $\mathbf{P}_{SK}$ – spin. In addition, the following designations are introduced: ρ_E – the density of electrical charges of the substance; ρ_G – the density of gravitational masses of matter; $\mathbf{J}_E = \rho_E \cdot \mathbf{v}$ – the density of electrical current of the substance; $\mathbf{J}_G = \rho_G \cdot \mathbf{v}$ – the density of gravitational current of the substance; **v** – the velocity of electrical or gravitational current carriers. In a case of movement of an electrical point charge q: $\mathbf{J}_E = \mathbf{v}q\delta(\mathbf{r} - \mathbf{r}_q)$; in the case of movement of point gravitational mass m: $\mathbf{J}_G = \mathbf{v}m\delta(\mathbf{r} - \mathbf{r}_m)$; $\delta(\mathbf{r} - \mathbf{r}_m)$ is the δ-function; $\mathbf{r}_q$ and $\mathbf{r}_m$ are vector-radii of the trajectory of movement of the electrical charge and the gravitational mass, respectively; **r** is the current vector-radius; $\mathbf{v} = d\mathbf{r}_q/dt = d\mathbf{r}_m/dt$.

The equations of Maxwell in the model in question (in the polarization-field conception of the PV) have the following from [58]:

$$\operatorname{div} \mathbf{P}_E = \rho_E; \tag{1}$$

$$\operatorname{div} \mathbf{P}_M = 0; \tag{2}$$

$$\mu^{-1}{}_0 \operatorname{rot} M' = \mathbf{J}_E + \frac{\partial \mathbf{P}_E}{\partial t}; \tag{3}$$

$$\mu^{-1}{}_0 \operatorname{rot} \mathbf{E} = -\frac{\partial \mathbf{P}_M}{\partial t}; \tag{4}$$

$$\mathbf{P}_E = \mathbf{P}_{EFV} + \mathbf{P}_{EK}; \tag{5}$$

$$\mathbf{P}_M = \mathbf{P}_{MFV} + \mathbf{P}_{MK}, \tag{6}$$

where the designations indicated above have been used; μ_0 is the magnetic constant or magnetic permeability of the vacuum.

In the case of the absolute PV: $\mathbf{P}_E = \mathbf{D}$; $\mathbf{P}_{EK} = \mathbf{P}$; $\mathbf{P}_{EFV} = \varepsilon_0\mathbf{E}$, where **D** is electrical induction; **P** is electrical polarization of substance; ε_0 is the electrical constant or electrical permitivity of the vacuum; $\mathbf{M'} = \mu_0\mathbf{H}$ (**M'** – magnetic field); $\mathbf{P}_M = \mathbf{B}/\mu_0$; $\mathbf{P}_{MK} = \mathbf{M}$ (**M** – magnetization); $\mathbf{P}_{MFV} = \mathbf{H}$, where **B** is magnetic induction; **H** is the magnetic field in the APV. In this case, the equations of Maxwell take on the customary form (in the system of MKSA and SI units) [30]:

$$\operatorname{div} \mathbf{D} = \rho_E;$$

$$\operatorname{div} \mathbf{B} = 0;$$

$$\operatorname{rot} \mathbf{H} = \mathbf{J}_E + \frac{\partial \mathbf{D}}{\partial t};$$

$$\operatorname{rot} \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t};$$

$$\mathbf{D} = \varepsilon_0 \mathbf{E} + \mathbf{P};$$

$$\mathbf{B} = \mu_0 \mathbf{H} + \mu_0 \mathbf{M},$$

where $c = (\varepsilon_0\mu_0)^{-1/2}$ is the speed of light in a vacuum.

The equations of Heaviside in the model in question have the following form [3, 74, 75]:

$$\text{div } \mathbf{P}_G = -\rho_G; \tag{7}$$

$$\text{div } \mathbf{P}_S = 0; \tag{8}$$

$$\frac{1}{s_0}\text{rot } \mathbf{S} = -\mathbf{J}_G + \frac{\partial \mathbf{P}_G}{\partial t}; \tag{9}$$

$$\frac{1}{s_0}\text{rot } \mathbf{G} = -\frac{\partial \mathbf{P}_S}{\partial t}; \tag{10}$$

$$\mathbf{P}_G = \mathbf{P}_{GVF} + \mathbf{P}_{GK}; \tag{11}$$

$$\mathbf{P}_S = \mathbf{P}_{SFV} + \mathbf{P}_{SK}, \tag{12}$$

where designations indicated above have been used; s_0 is the spin constant or spin permeability of the vacuum.

In the case of the APV: $\mathbf{P}_{GFV} = g_0\mathbf{G}$; $\mathbf{P}_{SFV} = s_0^{-1}\mathbf{S}$, where $g_0 = (4\pi G)^{-1}$; $G = 6.672 \cdot 10^{-11}$ m³ · kg⁻¹ · c^{-2} – is the gravitational constant, and $c_G = (g_0 s_0)^{-1/2} = c$ is the speed of gravity waves in a vacuum, which is equal to the speed of light in a vacuum. The values of the constants and the dimensions of the variables in the equations of Maxwell and Heaviside are presented in Table 2.

Table 2

Maxwell's equations		Heaviside's equations	
ε_0	$8.855 \cdot 10^{-12}$ m⁻³·kg⁻¹ ·s⁴ ·A²	g_0	$1.193 \cdot 10^9$ m⁻³· kg· s²
μ_0	$1.257 \cdot 10^{-6}$ m· kg· s⁻² ·A⁻²	s_0	$0.9329 \cdot 10^{-26}$ m· kg⁻¹
ρ_E	$\text{m}^{-3} \cdot \text{s} \cdot \text{A} = \text{Kl}/\text{m}^3$	ρ_G	$\text{m}^{-3} \cdot \text{kg} = \text{kg}/\text{m}^3$
$\mathbf{J}_E$	$\text{m}^{-2}\cdot\text{A} = \text{A}/\text{m}^2$	$\mathbf{J}_G$	$\text{m}^{-2} \cdot \text{kg} \cdot \text{s}^{-1} = \dfrac{\text{kg} \cdot \text{m} \cdot \text{s}^{-1}}{\text{m}^3}$
$\mathbf{P}_E$	$\text{m}^{-2}\cdot \text{s}\cdot \text{A} = \dfrac{\text{Kl}\cdot\text{m}}{\text{m}^3}$	$\mathbf{P}_G$	$\text{m}^{-2} \cdot \text{kg} = \dfrac{\text{kg}\cdot\text{m}}{\text{m}^3}$
$\mathbf{P}_M$	$\text{m}^{-1}\cdot\text{A} = \dfrac{\text{A}\cdot\text{m}^2}{\text{m}^3}$	$\mathbf{P}_S$	$\text{m}^{-1}\cdot\text{kg}\cdot\text{s}^{-1} = \dfrac{\text{kg}\cdot\text{m}^2\cdot\text{s}^{-1}}{\text{m}^3}$
$\mathbf{E}$	$\text{m}\cdot\text{kg}\cdot\text{s}^{-3}\cdot\text{A}^{-1} = \dfrac{\text{kg}}{\text{Kl}}(\text{m}\cdot\text{s}^{-2})$	$\mathbf{G}$	m·s^{-2}

M′	$\text{Kg} \cdot \text{s}^{-2} \cdot \text{A}^{-1} = \dfrac{\text{kg}}{\text{Kl}}(\text{s}^{-1})$	S	s^{-1}

One can see from Table 2 and from the equations of Maxwell and Heaviside that $\mathbf{J}_G$ is the density of the quantity of motion or the density of impulses, i.e., the vector sum of the quantity of motion in a unit of volume; $\mathbf{P}_E$ is the sum of densities of electrical dipoles of the PV and substance; $\mathbf{P}_G$ is the sum of densities of gravitational dipoles of the PV and substance; $\mathbf{P}_M$ is the sum of densities of magnetic moments of the PV and substance; $\mathbf{P}_S$ is the sum of densities of moments of quantities of motion (spins) of the PV and substance; $\mathbf{E}$ is the acceleration multiplied by the factor 1 kg/Kl; $\mathbf{G}$ is the acceleration; $\mathbf{M}'$ is the angular frequency multiplied by the factor 1 kg/Kl; $\mathbf{S}$ is the angular frequency. Hence a correspondence is established between the names and the physical natures of the polarization dimensions. The fields $\mathbf{E}$, $\mathbf{G}$, $\mathbf{M}'$ and $\mathbf{S}$ have mechanical dimensions, which reveals their direct relationships to forces and mechanical moments.

2.3.2. Equations of Maxwell and Heaviside as a combination of laws of matter and the physical vacuum

The equations of Maxwell were created based on experimentally established laws of electromagnetism. Both laws related to the PV (almost all such laws: Faraday, Ampere, Coulomb, radiation, etc.) and laws not related to it (the law of the preservation of electrical charges) follow naturally from them. The situation is more complicated with respect to equations of Heaviside. They include only two experimentally established physical laws: Newton's law of gravity and the law of the preservation of gravitational mass. The latter, however, requires special consideration, especially in connection with the relativistic problems of gravitational, inert and rest masses. All other laws which follow from the equations of Heaviside still require their own experimental confirmation. The polarization-field conception of the PV introduces its own extremely important refinements to the laws of the equations of Maxwell and Heaviside. The physical effects on which the equations of Maxwell and Heaviside are based are considered systematically below.

Coulomb's Law in nonrelativistic approximation

When a point electrical charge $\rho_E = q_1\, \delta\,(\mathbf{r} - \mathbf{r}_q)$ is located in the APV, according to (1), there emerges an electrical field

$$\mathbf{E} = \frac{\mathbf{P}_{EFV}}{\varepsilon_0} = \frac{q_1}{4\pi\varepsilon_0 \mathrm{r}_q^{\,3}} \cdot \mathbf{r}_q,$$

where $\mathbf{r}_q$ is a vector, the origin of which is located at the point of the location of the electrical charge q_1, while the end is at the point of observation of the field; r_q is the absolute length of the vector $\mathbf{r}_q$.

The force acting on a point electrical charge q_2 located at the field observation point is expressed as follows:

$$\mathbf{F}_{12} = q_2\,\mathbf{E} = \frac{q_1 q_2}{4\pi\varepsilon_0 \mathrm{r}_q^3}\cdot\mathbf{r}_q\,. \tag{13}$$

The relationship (13) obviously expressed Coulomb's Law. If the electrical charges q_1 and q_2 are positive, they repel each other.

Newton's Law of Gravity in nonrelativistic approximation

When a point gravitational mass $\rho_G = m_1\,\delta(\mathbf{r} - \mathbf{r}_m)$ is located in the APV, according to (7), there emerges a gravitational field

$$\mathbf{G} = \frac{\mathbf{P}_{GFV}}{g_0} = -\frac{m_1}{4\pi g_0 \mathrm{r}_m^3}\cdot\mathbf{r}_m,$$

where $\mathbf{r}_m$ is a vector, the origin of which is located at the point of the location of the gravitational mass m_1, while the end is at the point of observation of the field; r_m is the absolute length of the vector $\mathbf{r}_m$.

The force acting on a point gravitational mass m_2 located at the field observation point is expressed as follows:

$$\mathbf{F}_{12} = m_2\,\mathbf{G} = -\frac{m_1 m_2}{4\pi g_0 \mathrm{r}_m^3}\cdot\mathbf{r}_m \tag{14}$$

The relationship (14) obviously expressed Newton's Law of Gravity. If the gravitational masses q_1 and q_2 are positive, they attract each other.

It is easy to see that the replacement of the plus sign in equation (1) of Maxwell with the minus sign in equation (7) of Heaviside is of fundamental importance.

Law of preservation of electrical charge

The law of preservation of electrical charge follows from Maxwell equations (1) and (3) and has the following form:

$$\mathrm{div}\,\mathbf{J}_E = -\frac{\partial \rho_E}{\partial \mathrm{t}}\,. \tag{15}$$

This equation should be considered based on the condition of covariance of equations of Maxwell relative to Lorentz transformations.

Equation (15) is Lorentz-covariant; i.e., it remains unchanged in both a stationary system and any mobile reference system in the performance of Lorentz transformations for the density of the current $\mathbf{J}_E$ and the density of the electrical charge ρ_E of the form: $\rho_E = \gamma(\rho'_E + J'^1_E \upsilon/c^2)$, $J_E^1 = \gamma(J'^1_E + \rho'_E\upsilon)$, $J_E^2 = J'^2_E$, $J_E^3 = J'^3_E$, where $\gamma = (1 - \upsilon^2/c^2)^{-1/2}$. The primes in these equations relate to a stationary reference system (the mobile reference system moves at a rate υ along axis 1).

In addition, the integral law of the preservation of electrical charge, according to which the total electrical charge Q in some limited region of space remains unchanged (is invariant) in any inertial reference system [58], is also fulfilled.

Law of conservation of gravitational mass

A relationship of the following form follows from Heaviside equations (7) and (9):

$$\text{div } \mathbf{J}_G = -\frac{\partial \rho_G}{\partial t}. \tag{16}$$

This relationship can at once be called the law of the preservation of gravitational mass in connection with the fact that the masses included in the Heaviside equation have a direct relationship to Newton's Law of Gravity. In considering this question, as in the case of equations of Maxwell, one must start with the condition of covariance of the equations of Heaviside relative to Lorentz transformations and the integral law of the preservation of gravitational mass.

Equations (16), like (15), is Lorentz-covariant. Hence the Lorentz transformation for it has precisely the same form as for equation (15); it is only necessary to change the E subscripts to G subscripts. The integral law of the preservation of gravitational mass leads to an unambiguous conclusion: the mass associated with the density ρ_G must be the intrinsic mass; i.e., the rest mass. This mass specifically is a relativistic invariant in Minkowski's theory [58].

Laws of neutrality of matter and the physical vacuum

In the Maxwell theory, the divergences of the electrical and magnetic polarizations of matter are the densities of the bond (polarization) electrical and magnetic charges of matter [31, 32]. Similar definitions can extend to both the electrical and magnetic polarizations and to gravitational and spin polarizations of the PV. With such an approach, equations (1), (2), (5) and (6) of Maxwell and (7), (8), (11) and (12) of Heaviside take on the physical sense of the equality of the sums of free and bound electrical, magnetic and spin charges and gravitational masses of the PV and matter to zero at each point in space.

In particular, it follows from Maxwell equations (1) and (5) that

$$\rho_{EFV} + \rho_{EK} + \rho_E = 0, \tag{17}$$

where $\rho_{EK} = -\text{div } \mathbf{P}_{EK}$ is the density of bound charges of the electrical dipoles of matter [30]; $\rho_{EFV} = -\text{div } \mathbf{P}_{EFV}$, by analogy, is the density of bound charges of the electrical dipoles of the PV.

It follows from Heaviside equations (7) and (11) that

$$\rho_{GFV} + \rho_{GK} + \rho_G = 0, \tag{18}$$

where ρ_{GFV} = div $\mathbf{P}_{GFV}$ is the density of bound masses of the gravitational dipoles of the PV; ρ_{GK} = div $\mathbf{P}_{GK}$ is the density of bound masses of the gravity dipoles of matter [3, 75]. It is taken into account in the definitions of ρ_{GFV} and ρ_{GK} that there is a minus sign at the masses in the equations of Heaviside where there is a plus sign at the electrical charges in the equations of Maxwell.

It follows from Maxwell equations (2) and (6) that

$$\rho_{MFV} + \rho_{MK} = 0, \tag{19}$$

where ρ_{MFV} = -div $\mathbf{P}_{MFV}$ is the density of bound magnetic charges of the PV; ρ_{MK} = -div $\mathbf{P}_{MK}$ is the density of bound magnetic charges of matter.

It follows from Heaviside equations (8) and (12) that

$$\rho_{SVFV} + \rho_{SK} = 0, \tag{20}$$

where ρ_{SFV} = +div $\mathbf{P}_{SFV}$ is the density of bound spin charges of the PV; ρ_{SK} = +div $\mathbf{P}_{SK}$ is the density of bound spin charges of matter.

The fact that the free and bound charges and gravitational masses of the PV and matter in the polarization-field conception of the PV of (17)-(20) are equal to zero can be called the laws of total neutrality of matter and the PV. One must remember that these laws have physical sense for macro-objects.

Laws of continuity of total electrical, magnetic, gravitational and spin currents

The Maxwell equations (3) and (4) can now be represented as follows:

$$\mathbf{J}_{MA} = \mathbf{J}_E + \mathbf{J}_{ED}; \tag{21}$$

$$\mathbf{J}_{EA} = -\mathbf{J}_{MD}, \tag{22}$$

where $\mathbf{J}_{MA} = \mu_0^{-1}$ rot $\mathbf{M}'$; $\mathbf{J}_{EA} = \mu_0^{-1}$ rot $\mathbf{E}$; $\mathbf{J}_{ED} = \partial\mathbf{P}_E/\partial t$ is the sum of the bias electrical current densities of matter and the PV; $\mathbf{J}_{ED} = \partial\mathbf{P}_E/\partial t$ is the sum of the bias magnetic current densities of matter and the PV.

Heaviside equations (9) and (10) can also be represented in the following form:

$$\mathbf{J}_{SA} = -\mathbf{J}_G + \mathbf{J}_{GD}; \tag{23}$$

$$\mathbf{J}_{GA} = -\mathbf{J}_{SD}, \tag{24}$$

where $\mathbf{J}_{SA} = s_0^{-1}$ rot $\mathbf{S}$; $\mathbf{J}_{GA} = s_0^{-1}$ rot $\mathbf{G}$; $\mathbf{J}_{GD} = \partial\mathbf{P}_G/\partial t$ is the sum of the bias gravitational current densities of matter and the PV; $\mathbf{J}_{SD} = \partial\mathbf{P}_S/\partial t$ is the sum of the bias spin current densities of matter and the PV.

In the polarization-field conception of the PV, the bias currents, electrical, magnetic, gravitational and spin, of matter and the PV are polarization currents, and, in this sense, they do not differ from the electrical polarization bias current in matter. Hence all eight bias currents take on a specific physical sense, while in the field conception of the PV, even the bias electrical current in a vacuum is an abstract concept.

The relationships for current densities (21)-(24) include four variables – $\mathbf{J}_{EA}$, $\mathbf{J}_{MA}$, $\mathbf{J}_{GA}$, $\mathbf{J}_{SA}$ – which are associated with the properties of the PV. These variables have a relationship only to the manifestations of material but not matter – to four fields, in this case: $\mathbf{E}$, $\mathbf{M'}$, $\mathbf{G}$, $\mathbf{S}$. The basic property of these currents is reflected in obvious relationships: div $\mathbf{J}_{EA} \equiv 0$; div $\mathbf{J}_{GA} \equiv 0$; div $\mathbf{J}_{MA} \equiv 0$; div $\mathbf{J}_{SA} \equiv 0$. Consequently, according to the Ostrogrdskiy-Gauss theorem:

$$\oint_S \mathbf{J}_{EA} \, d\mathbf{S} = -\oint_S \mathbf{J}_{MD} \, d\mathbf{S} = 0; \tag{25}$$

$$\oint_S \mathbf{J}_{GA} \, d\mathbf{S} = -\oint_S \mathbf{J}_{SD} \, d\mathbf{S} = 0; \tag{26}$$

$$\oint_S \mathbf{J}_{MA} \, d\mathbf{S} = -\oint_S (\mathbf{J}_E + \mathbf{J}_{ED}) \, d\mathbf{S} = 0; \tag{27}$$

$$\oint_S \mathbf{J}_{SA} \, d\mathbf{S} = -\oint_S (-\mathbf{J}_G + \mathbf{J}_{GD}) \, d\mathbf{S} = 0, \tag{28}$$

where S is a closed surface; $d\mathbf{S}$ is the vector-differential of this surface.

The relationship (27) expressed the law of the continuity of total current in the theory of electromagnetism [30]. The relationships (25), (26) and (28), by analogy, can also be called laws of the continuity of total gravitational, magnetic and spin currents, respectively, and the currents $\mathbf{J}_{EA}$, $\mathbf{J}_{MA}$, $\mathbf{J}_{GA}$, $\mathbf{J}_{SA}$ can be called the total currents of the respective descriptions.

Hence in this model of the PV, the equations of Maxwell and Heaviside appear as a combination of relationships expressing the physical, macroscopic laws of matter and the PV. In the case of the absence of matter in the space in question ($\rho_E = 0$; $\rho_G = 0$; $\rho_{EK} = 0$; $\rho_{GK} = 0$; $\rho_{MK} = 0$; $\rho_{SK} = 0$; $\mathbf{J}_E = 0$; $\mathbf{J}_G = 0$), the relationships (17)-(20), (21)-(24) and (25)-(28) do not lose their physical content and represent macroscopic laws of the PV as a material medium. In this case, the laws

$$\rho_{EFV} = 0; \tag{29}$$

$$\rho_{GFV} = 0; \tag{30}$$

$$\rho_{MFV} = 0; \tag{31}$$

$$\rho_{SFV} = 0 \tag{32}$$

express the absolute neutrality of the PV in the absence of matter. The PV remains in the neutral state under the effects of all fields: in the propagation of electromagnetic and gravitational waves, in particular.

In this case, the laws

$$\mathbf{J}_{MA} = \mathbf{J}_{EFV};\tag{33}$$

$$\mathbf{J}_{EA} = -\mathbf{J}_{MFV};\tag{34}$$

$$\mathbf{J}_{SA} = \mathbf{J}_{GFV};\tag{35}$$

$$\mathbf{J}_{GA} = -\mathbf{J}_{SFV}\tag{36}$$

express excitation of the PV by fields in the absence of matter.

Hence in this conception of the PV, all the equations of Maxwell and Heaviside appear as a set of the physical laws considered above reflecting the electromagnetic and gravitational properties of two media at the macro-level: the PV and matter. One must also keep in mind the laws of the superposition of like fields, which are a consequence of the linearity of the equations of Maxwell and Heaviside, in a number of laws of electromagnetism and gravispinorics.

2.3.3. Polarizations of the physical vacuum as a function of fields

The dependencies of the polarizations of the absolute PV, the PVM and the PVA on fields differ, as one can see from the previous examination.

In particular, the polarizations for the APV depend only on their own fields and have the following form (Fig. 1):

$$\mathbf{P}_E = \mathbf{P}_{EFV} = \varepsilon_0\,\mathbf{E};\tag{37}$$

$$\mathbf{P}_M = \mathbf{P}_{MFV} = \omega_0\,\mathbf{M}';\tag{38}$$

$$\mathbf{P}_G = \mathbf{P}_{GFV} = v_0\,\mathbf{G};\tag{39}$$

$$\mathbf{P}_S = \mathbf{P}_{SFV} = \tau_0\,\mathbf{S},\tag{40}$$

where $\omega_0 = \mu_0^{-1}$; $v_0 = g_0$; $\tau_0 = s_0^{-1}$.

For the PVM and PVA, the electrical and gravitational polarizations and the magnetic and spin polarizations are related (Fig. 2). These connections can be expressed in the form of the following two equations:

$$\mathbf{P}_{EFV} = \pm\frac{q}{m}\mathbf{P}_{GFV};\tag{41}$$

$$\mathbf{P}_{MFV} = \pm\frac{\mu}{s}\mathbf{P}_{SFV}.\tag{42}$$

In (41) and (41), the plus sign pertains to the case of the PVM, while the minus sign pertains to the PVA.

Since the electrical and gravitational polarizations of the PV are proportionate to he force $m\mathbf{G}+q\mathbf{E}$, in light of (41), one can obtain two expressions for these polarizations:

$$\mathbf{P}_{EFV} = \varepsilon_0\,\mathbf{E} + \gamma_0\,\mathbf{G}; \tag{43}$$

$$\mathbf{P}_{GFV} = \nu_0\,\mathbf{G} + \gamma_0\,\mathbf{E}, \tag{44}$$

where a plus sign must be attributed to the coefficient γ_0 in the case of the PVM, with a minus sign for the PVA.

Assuming that the magnetic and spin polarizations of the PV are proportionate to the force vector $\mu\mathbf{M'}+s\mathbf{S}$, in light of (42), one can obtain two more similar expressions for the magnetic and spin polarizations:

$$\mathbf{P}_{MFV} = \omega_0\,\mathbf{M'} + \lambda_0\,\mathbf{S}; \tag{45}$$
$$\mathbf{P}_{SFV} = \tau_0\,\mathbf{S} + \lambda_0\,\mathbf{M'}, \tag{46}$$

where the coefficient λ_0 has a plus sign in the case of the PVM and a minus sign in the case of the PVA.

2.3.4. Problems of combined electrogravidynamics

Hence in the case of the filling of space by the APV, the equations of Maxwell and Heaviside, according to (37)-(40), prove unrelated. In this case, the polarization-field and field conceptions of the PV produce indistinguishable results, and the equations of Maxwell (1)-(6) and Heaviside (7)-(12) can easily be converted to a form familiar in the literature.

As already stated above, it is suggested that the PVM and the PVA occupy local regions of space, while the space outside these regions is filled by the APV. One can also assume that mixtures of PVM or PVA with the APV are present in local regions of space. These regions of space are called VD [6]. In the regions of space occupied by the VD, the equations of Maxwell and Heaviside (1)-(12) prove to be related according to (43)-(46). Hence joint problems of electrodynamics and gravidynamics emerge. In these problems, the coefficients γ_0 and λ_0 must be represented by finite functions of the three-dimensional coordinates x, y and z and the time t (for describing the movement and deformations of the local regions in space). In a region of space outside the VD, it should be assumed that $\gamma_0 = 0$ and $\lambda_0 = 0$.

As one can see from the preceding analysis, the coefficients ε_0, ν_0, ω_0, τ_0 have strictly defined numerical values in the APV. However, in regions of space filled with VD, these coefficients can be functions of the coordinates and time.

A full statement of the problems of the electrogravidynamics of the PV also assumes the specification of the fields external to the VD, one of four or their combinations, as both constant and variable, in the form of incident waves (electromagnetic or gravispin), for example. The target functions are the polarizations and fields induced. The induced polarizations make it possible to determine the forces acting on the VD.

The VD penetrate into matter (air of the atmosphere, water, solids). However, while the APV does not interact directly with matter, the PVM and PVA in the form of VD do interact directly with it. This interaction of the VD and matter is of the same kind of major scientific interest as the interaction of the VD with fields. A detailed mathematical description of the members of equations of electrodynamics (1)-(12) reflecting the properties of the matter is necessary for describing the interaction in question.

We shall mention here that the form of the equations of combined electrogravidynamics (1)-(12) and (43)-(46) presented above is close to the physical essence of the equations of Maxwell and Heaviside. However, it is unusual and can cause difficulties in the performance of practical calculations of the physical processes in the VD and associated with the VD. Therefore, the traditional form of the equations in question which was adopted for the field conception of the PV is used below.

2.4. Equations of a macroscopic model of combined electrogravidynamics for practical calculations

2.4.1. General equations of combined electrogravidynamics

In a general case, when the APV or PVM-PVA and matter are considered, the vacuum-matter equations of combined electrogravidynamics with a non-homogeneous PV have the following form [3, 4, 6]:

$$\operatorname{div} \mathbf{D} = \rho; \tag{47$_1$}$$

$$\operatorname{rot} \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}; \tag{47$_2$}$$

$$\operatorname{div} \mathbf{B} = 0; \tag{47$_3$}$$

$$\operatorname{rot} \mathbf{H} = \mathbf{J} + \frac{\partial \mathbf{D}}{\partial t}, \tag{47$_4$}$$

$$\mathbf{D} = \mathscr{E}_0 \mathbf{E} + \varepsilon_1 \mathbf{E}_G; \tag{48$_1$}$$

$$\mathbf{B} = \mu\mu_0 \mathbf{H} + \mu_1 \mathbf{H}_G; \tag{48$_2$}$$

$$\mathbf{J} = \sigma \mathbf{E} + \sigma_1 \mathbf{E}_G + \rho_0 v_0, \tag{48$_3$}$$

$$\operatorname{div} \mathbf{D}_G = -\rho_G; \tag{49$_1$}$$

$$\operatorname{rot} \mathbf{E}_G = -\frac{\partial \mathbf{B}_G}{\partial t}; \tag{49$_2$}$$

$$\operatorname{div} \mathbf{B}_G = 0; \tag{49$_3$}$$

$$\operatorname{rot} \mathbf{H}_G = -\mathbf{J} + \frac{\partial \mathbf{D}_G}{\partial t}, \tag{49$_4$}$$

$$\mathbf{D}_G = \varepsilon_G \varepsilon_{0G}\, \mathbf{E}_G + \varepsilon_1\, \mathbf{E}; \qquad\qquad (50_1)$$

$$\mathbf{B}_G = \mu_G \mu_{0G}\, \mathbf{H}_G + \mu_1\, \mathbf{H}\; ; \qquad\qquad (50_2)$$

$$\mathbf{J}_G = \rho_G v_G = \sigma_G\, \mathbf{E}_G + \sigma_1\, \mathbf{E}\; + \rho_{G0} v_{G0}, \qquad\qquad (50_3)$$

In the system of equations (47)-(50): ρ, ρ_G are the densities of electrical charges and rest masses, respectively; $\mathbf{J}$, $\mathbf{J}_G$ are the densities of electrical and gravitational currents, respectively; $\mathbf{E}$, $\mathbf{E}_G$, $\mathbf{D}$, $\mathbf{D}_G$ are the electrical and gravitational fields and inductions, respectively; $\mathbf{H}$, $\mathbf{H}_G$, $\mathbf{B}$, $\mathbf{B}_G$ are the magnetic and spin fields and inductions, respectively; ε, ε_G are the electrical and gravitational relative permeability (constants) of matter, respectively; μ, μ_G are the magnetic and spin relative permeability (constants), respectively; σ, σ_G are the electrical and gravitational conductivity of matter, respectively; σ_l is the electrogravitational conductivity of matter; $\mathbf{v}$, $\mathbf{v}_G$ are the velocities of electrical and gravitational current carriers, respectively; ρ, ρ_G, $\mathbf{v}_0$, $\mathbf{v}_{G0}$ are the densities of electrical charges and masses and the velocities of macroscopic particles and bodies, respectively;

$$\varepsilon_1 = \varepsilon_{01} + \varepsilon_{11};$$

$$\mu_1 = \mu_{01} + \mu_{11},$$

where ε_{01}, μ_{01} are the electrogravitational and magnetospin permeability of the PV, respectively; ε_{11}, μ_{11} are the electrogravitational and magnetospin permeability of matter, respectively.

The dimensions for the variables and the values of the constants in equations (47)-(50) are shown in Table 3.

The known dimensions for the variables and values of the constants in the equations of Maxwell are given on the left in this table, while the dimensions and values for the equations of Heaviside are given on the right.

Table 3

Maxwell's equations		Heaviside's equations	
ε_0	$8.855 \cdot 10^{-12}\ \mathrm{m^{-3} \cdot kg^{-1} \cdot s^4 \cdot A^2}$	ε_{0G}	$1.193 \cdot 10^9\ \mathrm{m^{-3} \cdot kg \cdot s^{-2}}$
μ_0	$1.257 \cdot 10^{-6}\ \mathrm{m \cdot kg \cdot s^{-2} \cdot A^{-2}}$	μ_{0G}	$0.9329 \cdot 10^{-26}\ \mathrm{m \cdot kg^{-1}}$
ρ	$\mathrm{m^{-3} \cdot s \cdot A}$	ρ_G	$\mathrm{m^{-3} \cdot kg}$
$\mathbf{J}$	$\mathrm{m^{-2} \cdot A}$	$\mathbf{J}_G$	$\mathrm{m^{-2} \cdot kg \cdot s^{-1}}$
$\mathbf{D}$	$\mathrm{m^{-2} \cdot s \cdot A}$	$\mathbf{D}_G$	$\mathrm{m^{-2} \cdot kg}$
$\mathbf{H}$	$\mathrm{m^{-1} \cdot A}$	$\mathbf{H}_G$	$\mathrm{m^{-1} \cdot kg \cdot s^{-1}}$
$\mathbf{E}$	$\mathrm{m \cdot kg \cdot s^{-3} \cdot A^{-1}}$	$\mathbf{E}_G$	$\mathrm{m \cdot s^{-2}}$
$\mathbf{B}$	$\mathrm{kg \cdot s^{-2} \cdot A^{-1}}$	$\mathbf{B}_G$	$\mathrm{s^{-1}}$

The standard system of designations adopted for equations of Maxwell [76] which is in use at present has been taken as the basis in equations (47)-(50). This system has great practical advantages over the system of designations in equations (1)-(12) and (43)-(46), which makes it possible to use a large number of results of solution of problems of electrodynamics without substantial changes in designations, especially due to the similarity of the equations of electrodynamics and gravidynamics. At the same time, the names and dimensions of magnetic and spin fields do not correspond to each other in the system of equations (47)-(50). As one can

see from Table 3, the fields **H** and **H**$_G$ have polarization dimensions. In this connection, a prolonged discussed has developed among the advocates of the field conception of the PV and has been reflected in many electrodynamics courses [30, 58, 72], the subject of which was the explanation of the issue of which vector is the "true" field, **H** or **B**? As one can see from the previous paragraph, this question is clearly resolved within the framework of the polarization-field conception of the PV: the vector **H** is a field, but its dimensionality must be changed; i.e., the vector **M'** $= \mu_0$**H** must be considered a field.. On the other hand, it is obvious that in the mathematical model adopted, the solution of the problem has no determining value.

The form of the equations of electrogravidynamics represented in equations (1)-(12) and (43)-(46) can be used in theoretical studies. In the transition from the form of equations of electrogravidynamics described by the relationships (47)-(50) to (1)-(12) and (43)-(46), one must keep in mind that $\nu_0 = g_0 = \varepsilon_{0G}$; $\tau_0 = s_0^{-1} = \mu_0^{-1}$; $\gamma_0 = \varepsilon_1$; $\lambda_0 = \mu_1 /(\mu_0 \mu_{0G})$.

2.4.2. Estimates of the values of matter permeability and conductivity factors

The permeability factors ε and μ and the conductivity factors σ in the equations of Maxwell for different substances are well known. In this examination, we shall estimate the values of the gravitational permeability factors ε_G, μ_G and conductivity factors σ_G, σ_1 and the electrogravitational permeability factors ε_{11}, μ_{11} of different substances.

The gravitational factors in question are defined most simply in the case of mobile particles of matter which simultaneously possess electrical charges and masses, and magnetic moments and spins (as well as orbital moments of the quantity of motion). In this case, one can use fragments of the electronic theory of matter [60, 77-79].

The force acting on a mobile particles of a substance (at a particle velocity $\upsilon \ll c$) can be represented as

$$\mathbf{F} = q\mathbf{E}' + m\mathbf{E}'_G - m^* \frac{\partial \mathbf{v}}{\partial t}, \tag{51}$$

where **E'** $=$ **E**$_L$ $+$ [**vB**$_L$]; **E'**$_G$ $=$ **E**$_{GL}$ $+$ [**vB**$_{GL}$]; **E**$_L$, **E**$_{GL}$, **B**$_L$, **B**$_{GL}$ are local fields in a stationary reference system, such as a system related to the crystal lattice of a substance; m^* is the effective mass of the particle.

The mechanical moment **T** acting on the elementary moments of a particle – magnetic $\boldsymbol{\mu}$ and spin $\boldsymbol{\mu}_G$ – is expressed as follows [31]:

$$\mathbf{T} = [\boldsymbol{\mu}\mathbf{B}_L] + [\boldsymbol{\mu}_G \mathbf{B}_{GL}]. \tag{52}$$

Equations (51) and (52) differ from similar relationships in the electronic theory of matter in the additional members on the right with the "G" subscripts.

We shall assume now that the local fields are the sums of internal fields acting from adjacent particles of the substance and external fields present in the vacuum region (the APV, of course, in this treatment) in which the particle in question is located. Many models for the determination of the coefficients ε of dielectrics and μ of magnetics start from the calculation of internal local electrical and magnetic fields [60]. In the case considered here, however, where we have in mind substances with the coefficients ε and μ already determined, the calculations of the

internal local gravitational and spin fields do not become superfluous, since a different approach can be used. The effective external electrical field, which takes into account the effect of the gravitational field as well, and the external magnetic field, which takes into account the effect of the spin field as well, can be determined from the expressions for force and moment (51) and (52). The effective gravitational and spin fields can be incorporated in a similar way. The determination of the effective fields leads to the discovery of the dependencies of ε_G, μ_G, σ_G, ε_{11}, μ_{11} and σ_1 on ε, μ and σ. The method for obtaining these dependencies is demonstrated below.

In the case in question, where mobile particles of a substances simultaneously possess masses and electrical charges, and spins and magnetic moments, the following relationships are valid:

$$\mathbf{P} = \frac{q}{m}\mathbf{P}_G; \qquad \mathbf{M} = 2\gamma\,\mathbf{M}_G; \qquad \mathbf{J}_i = \frac{q}{m}\mathbf{J}_{Gi}, \qquad (53)$$

where $\mathbf{P}$ and $\mathbf{M}$ are the electrical polarization and magnetization (magnetic polarization) of the substance, which are the sums of the electrical dipoles $\mathbf{P} = q\mathbf{x}$ and magnetic moments $\boldsymbol{\mu}$ in a unit of volume of the substance; $\mathbf{P}_G$ and $\mathbf{M}_G$ are the gravitational and spin polarizations of the substances, which are the sums of gravitational $\mathbf{P}_G = \mathbf{m}\mathbf{x}$ and spin moments $\boldsymbol{\mu}_G$ in a unit of volume of the substance; γ is the gyromagnetic ratio; $\mathbf{J}_i$ and $\mathbf{J}_{Gi}$ are the electrical and gravitational current densities for the i current carrier in the substance (current carriers include the following: electrons, vacancies and ions); $\mathbf{x}$ is the displacement vector of a mobile particle of the substance in relation to its equilibrium position.

Keeping in mind the equality of inert and gravitational masses in a nonrelativistic approximation, one must emphasize in particular that the relationships (53) are valid only in a case where the length of a gravispin wave, and, consequently, an electromagnetic wave as well, is substantially less than the dimensions of the body of the substance, or in a case where the body is stationary in relation to the surface of the Earth, and the length of a gravispin wave is substantially less than the diameter of the Earth. Otherwise, one can immediately assume $\varepsilon_G = 1$, $\mu_G = 1$, $\varepsilon_{11} = 0$, $\mu_{11} = 0$, $\sigma_G = 0$, $\sigma_1 = 0$. The case of rotating bodies, which is also of interest, is not considered.

In the electrogravidynamics model in question, the classical definitions of electrical and magnetic inductions remain in effect, and the gravitational and spin inductions can be defined by analogy with them:

$$\mathbf{D} = \varepsilon_0\,\mathbf{E} + \mathbf{P}; \qquad (54_1)$$

$$\mathbf{B} = \mu_0\,\mathbf{H} + \mu_0\,\mathbf{M}; \qquad (54_2)$$

$$\mathbf{D}_G = \varepsilon_{0G}\,\mathbf{E}_G + \mathbf{P}_G; \qquad (54_3)$$

$$\mathbf{B}_G = \mu_{0G}\,\mathbf{H}_G + \mu_{0G}\,\mathbf{M}_G. \qquad (54_4)$$

The components of the current densities in the substance in question are expressed as follows according to the definitions presented above:

$$\mathbf{J}_i = \rho_i\,\mathbf{v}_i; \qquad \mathbf{J}_{Gi} = \rho_{Gi}\,\mathbf{v}_i, \qquad (55)$$

where $\mathbf{v}_i$ is the average or drift velocity of the i charge carriers.

The effective fields can be incorporated based on the relationships for forces (51) and moments of forces (52) in light of the relationships of (53):

$$\mathbf{E}^* = \mathbf{E} + \frac{q}{m}\mathbf{E}_G; \tag{56_1}$$

$$\mathbf{E}_G^* = \mathbf{E}_G + \frac{q}{m}\mathbf{E}; \tag{56_2}$$

$$\mathbf{H}^* = \mathbf{H} + \frac{\mu_{0G}}{2\gamma\mu_0}\mathbf{H}_G; \tag{56_3}$$

$$\mathbf{H}_G^* = \mathbf{H}_G + \frac{2\gamma\mu_0}{\mu_{0G}}\mathbf{H}. \tag{56_4}$$

In electrogravidynamics, the polarizations must be determined in proportion to the effective fields.

$$\mathbf{P} = \varepsilon_0(\varepsilon - 1)\mathbf{E}^*; \tag{57_1}$$
$$\mathbf{P}_G = \varepsilon_{0G}(\varepsilon_G - 1)\mathbf{E}_G^*; \tag{57_2}$$
$$\mathbf{M} = (\mu - 1)\mathbf{H}^*; \tag{57_3}$$
$$\mathbf{M}_G = (\mu_G - 1)\mathbf{H}_G^*, \tag{57_4}$$

where ε - 1, ε_G - 1, μ - 1, μ_G - 1 are the electrical, gravitational, magnetic and spin sensitivity of the substance, respectively.

It follows from (53)-(57) that

$$\varepsilon_0 - 1 = \frac{\varepsilon_0 m^2}{\varepsilon_{0G}q^2}(\varepsilon - 1); \tag{58_1}$$

$$\varepsilon_{11} = \varepsilon_0(\varepsilon - 1)\frac{m}{q}; \tag{58_2}$$

$$\mu_G - 1 = \frac{\mu_{0G}}{4\mu_0\gamma^2}(\mu - 1); \tag{58_3}$$

$$\mu_{11} = \frac{\mu_{0G}}{2\gamma}(\mu - 1). \tag{58_4}$$

For conductors of electrical current, we can limit ourselves to a case in which the force acting on a mobile particle is proportionate to the velocity υ_l:

$$\mathbf{F}_i = \beta_i\,\mathbf{v}_i, \tag{59}$$

where $\beta_i = m_i^*/\tau_i$; m_i^* is the effective mass of the i charge carrier, and τ_i is the relaxation time of the i charge carrier [60].

It follows from the third equation of (53) and equations (55) and (59) that

$$\mathbf{J}_i = \sigma_i\mathbf{E} + \sigma_{1i}\mathbf{E}_G; \tag{60_1}$$

$$\mathbf{J}_{Gi} = \sigma_{Gi}\,\mathbf{E}_G + \sigma_{1i}\,\mathbf{E}\ ;\tag{60_2}$$

where $\sigma_i = \rho_i q_i/\beta_i$; $\sigma_{Gi} = \rho_i m_i/\beta_i$; $\sigma_{1i} = \rho_{Gi} g_i/\beta_i$.

In summation of the i current densities in light of the fact that $\rho_i = q_i n_i$, $\rho_{Gi} = m_i n_i$, where n_i is the number of mobile particles in a unit of volume of the substance with the electrical charge q_i and the rest mass m_i, one can obtain the following expressions for conductivity:

$$\sigma = \sum_i n_i q_i^2 / \beta_i;\tag{61_1}$$

$$\sigma_G = \sum_i n_i m_i^2 / \beta_i;\tag{61_2}$$

$$\sigma_1 = \sum_i n_i m_i q_i / \beta_i;\tag{61_3}$$

The electromagnetic and gravispin processes in a substance are characterized by dimensionless relationship factors:

$$\frac{\varepsilon_{11}}{\sqrt{\varepsilon_0 \varepsilon_{0G}}} \cong \pm \frac{m}{q}\sqrt{\frac{\varepsilon_0}{\varepsilon_{0G}}} \cdot \frac{\varepsilon - 1}{\sqrt{\varepsilon}} = \pm\,\eta_\varepsilon\,\frac{\varepsilon - 1}{\sqrt{\varepsilon}};$$

$$\frac{\mu_{11}}{\sqrt{\mu_0 \mu_{0G}}} \cong \pm \frac{m}{q}\sqrt{\frac{\mu_{0G}}{\mu_0}} \cdot \frac{\mu - 1}{\sqrt{\mu}} = \pm\,\eta_\mu\,\frac{\mu - 1}{\sqrt{\mu}};$$

$$\frac{\sigma_1}{\sqrt{\sigma\sigma_G}} = \pm 1 \qquad (i = 1).$$

where

$$\eta_\varepsilon = \frac{m}{q}\sqrt{\frac{\varepsilon_0}{\varepsilon_{0G}}}; \qquad \eta_\mu = \frac{m}{q}\sqrt{\frac{\mu_{0G}}{\mu_0}}.$$

It is obvious that if these coefficients are equal to zero, there is no connection between the electromagnetic and gravispin processes. The greater the value of these coefficients, the stronger the connection will be.

If it is assumed that $m = m_e$, $q = -e$, where m_e and $-e$ are the rest mass and electrical charge of an electron, respectively, the parameters η_e and η_μ come to be equal:

$$\eta_\varepsilon = \eta_\mu = -4.9 \cdot 10^{-21}.$$

Hence the electrogravitational connection in a substance is weak in regard to inductions, even in ferromagnetics and ferrielectrics. The electrogravitational connection in a substance in regard to conductivity currents, however, is strong, which necessitates devoting special attention to it. It is possible that the part of the noise $1/f$ in electronic instruments which fails to find physical explanation, i.e., flicker noise [80], is a consequence of this strong relationship.

In a substance there are not only mobile particles, which possess electrical charges and masses simultaneously, but also electrically neutral mobile particles, such as interstitial atoms in crystal lattices (hydrogen, helium, etc.), which interact weakly with the atoms or molecules of the lattice. In this case, the expression for the gravitational conductivity changes in such a way that

$$\sigma_G = \sum_i n_i m_i^2 / \beta_i + \sum_i n_k m_k^2 / \beta_k.$$ (62)

where $k > i$ are the numbers of mobile particles with the rest mass m_k and the electrical charges $q_k = 0$.

In the latter case, the coefficient characterizing the relationship of conductivities decreases in absolute value:

$$\left| \frac{\sigma_1}{\sqrt{\sigma \sigma_G}} \right| < 1.$$

The form of the equations of combined electrogravidynamics is the same for the description of processes in a substance when it is immersed in the APV as for the PVM and PVA. At the same time, one can assume that the coefficients of the PVM and the PVA $\varepsilon_{01}(\varepsilon_0 \varepsilon_G)^{-1/2}$, $\mu_{01}(\mu_0 \mu_{0G})^{-1/2}$ have many greater values that the coefficients of matter $\varepsilon_{11}(\varepsilon_0 \varepsilon_G)^{-1/2}$, $\mu_{11}(\mu_0 \mu_{0G})^{-1/2}$. This assumption is the basic hypothesis in the model under consideration.

2.5 Equations of mechanics in macroscopic model of non-homogeneous physical vacuum

2.5.1. Equations of the motion of a body in the absolute physical vacuum

In a relativistic model of a non-homogeneous physical vacuum, the motion of a point substantial body in the APV is described by an equation of mechanics of Minkowski [58]:

$$\frac{d\mathbf{P}}{dt} = \mathbf{F},$$ (63)

where $\mathbf{P} = M_1\mathbf{v}$ is a relativistic impulse; $\mathbf{v}$ is the velocity of the movement of the point body; $M_1 = \gamma M$; $\gamma = (1 - v^2/c^2)^{-1/2}$; M is the rest mass of the body; $\mathbf{F}$ is the force acting on the body.

For the sake of generality of the examination, it should be assumed that the body possesses not only a rest mass M but some electrical charge Q. In such an examination, the resultant force acting on this body is as follows:

$$\mathbf{F} = \mathbf{F}_Q + \mathbf{F}_M + \mathbf{F}_{RQ} + \mathbf{F}_{RM},$$ (64)

where

$\mathbf{F}_Q$ is the electrical force acting on a body with the charge Q;
$\mathbf{F}_M$ is the gravitational force acting on a body with the mass M;

$\mathbf{F}_{RQ}$ is the electromagnetic radiation force or the radiation reaction force [58, 79] acting on a body with the charge Q;

$\mathbf{F}_{RM}$ is the gravispin radiation force acting on a body with the mass M.

The expressions for the forces $\mathbf{F}_Q$, $\mathbf{F}_M$, $\mathbf{F}_{RQ}$ and $\mathbf{F}_{RM}$ follow from the field equations of electrogravidynamics.

As already demonstrated above, for the case of the APV, the coefficients of the equations of electrogravidynamics (48) and (50), $\varepsilon_{01} = 0$, $\mu_1 = 0$. It is obvious that in the case in question, also $\varepsilon_{11} = 0$, $\mu_{11} = 0$ and $\sigma_1 = 0$. But then we have: $\varepsilon_1 = \varepsilon_{01} + \varepsilon_{11} = 0$ and $\mu_1 = \mu_{01} + \mu_{11} = 0$. Hence in the case of the movement of a point body in the APV, the expressions for the forces indicated above can be obtained from equations of Maxwell and Heaviside which have absolutely no connection to each other.

The equations of Maxwell in this case have the regular form:

$$\operatorname{div} \mathbf{D} = Q\delta\left(\mathbf{r} - \mathbf{r}_Q\right); \tag{65$_1$}$$

$$\operatorname{rot} \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}; \tag{65$_2$}$$

$$\operatorname{div} \mathbf{B} = 0; \tag{65$_3$}$$

$$\operatorname{rot} \mathbf{H} = Q\,\mathbf{v}\,\delta\left(\mathbf{r} - \mathbf{r}_Q\right) + \frac{\partial \mathbf{D}}{\partial t}; \tag{65$_4$}$$

$$\mathbf{D} = \varepsilon_0\,\mathbf{E}; \tag{65$_5$}$$

$$\mathbf{B} = \mu_0\,\mathbf{H}; \tag{65$_6$}$$

$$\mathbf{v} = \frac{d\mathbf{r}_Q}{dt}. \tag{65$_7$}$$

The equations of Heaviside in this case can be represented in the following form:

$$\operatorname{div} \mathbf{D}_G = -M\delta\left(\mathbf{r} - \mathbf{r}_M\right); \tag{66$_1$}$$

$$\operatorname{rot} \mathbf{E}_G = -\frac{\partial \mathbf{B}_G}{\partial t}; \tag{66$_2$}$$

$$\operatorname{div} \mathbf{B}_G = 0; \tag{66$_3$}$$

$$\operatorname{rot} \mathbf{H}_G = -M\,\mathbf{v}\,\delta\left(\mathbf{r} - \mathbf{r}_M\right) + \frac{\partial \mathbf{D}_G}{\partial t}; \tag{66$_4$}$$

$$\mathbf{D}_G = \varepsilon_{0G}\,\mathbf{E}_G; \tag{66$_5$}$$

$$\mathbf{B}_G = \mu_{0G}\,\mathbf{H}_G; \tag{66$_6$}$$

$$\mathbf{v} = \frac{d\mathbf{r}_M}{dt} = \frac{d\mathbf{r}_Q}{dt}. \tag{66$_7$}$$

On the strength of the independence of the equations of Maxwell and Heaviside in the APV, the task of determining the forces acting on a point body breaks down into two parts: the problem of electrodynamics for determining the forces $\mathbf{F}_Q$, $\mathbf{F}_{RQ}$, and the problem of gravidynamics for determining the forces $\mathbf{F}_M$ and $\mathbf{F}_{RM}$. In electrodynamics, the former problem has been solved in [58, 79]; therefore, the end results can be used.

The expression for the electrical force follows from the determination of the electrical field and the principle of covariance of the equations of Maxwell relative to the group of Lorentz transformations [58].

In particular, it follows from determination of the electrical field that

$$\mathbf{F}_Q = Q\,\mathbf{E}', \tag{67}$$

where $\mathbf{E}'$ is the electrical field in a mobile reference system.

From the Lorentz transformations for the fields, we obtain [58]:

$$\mathbf{E}' = \frac{(1-\gamma)\mathbf{v}(\mathbf{v}\mathbf{E})}{\upsilon^2} + \gamma\left(\mathbf{E} + [\mathbf{v}\mathbf{B}]\right), \tag{68}$$

where $\mathbf{E}$ and $\mathbf{B}$ are the electrical field and magnetic induction, respectively, in a conditional stationary reference system.

The determination of the gravitational field is similar to the determination of the electrical field. One can see from comparison of the mathematical forms of the equations of Heaviside and Maxwell that the principle of covariance relative to the group of Lorentz transformations is fulfilled for them. Therefore,

$$\mathbf{F}_M = M\,\mathbf{E}'_G; \tag{69}$$

$$\mathbf{E}'_G = \frac{(1-\gamma)\mathbf{v}(\mathbf{v}\mathbf{E}_G)}{\upsilon^2} + \gamma\left(\mathbf{E}_G + [\mathbf{v}\mathbf{B}_G]\right), \tag{70}$$

where $\mathbf{E}'_G$ is the gravitational field in the mobile reference system; $\mathbf{E}_G$ and $\mathbf{B}_G$ are the gravitational field and the spin induction, respectively, in the stationary reference system.

The following expressions for the forces $\mathbf{F}_Q$ and $\mathbf{F}_M$ follow from (67)-(70) in a nonrelativistic approximation ($v \ll c$, $\gamma \cong 1$)

$$\mathbf{F}_Q = Q\left(\mathbf{E} + [\mathbf{v}\mathbf{B}]\right); \tag{71}$$

$$\mathbf{F}_M = M\left(\mathbf{E}_G + [\mathbf{v}\mathbf{B}_G]\right). \tag{72}$$

In electrodynamics, the second member in (71) on the right is called the Lorentz force [58]. Therefore, in simultaneous consideration of problems of electrodynamics and gravidynamics, one can more specifically call this member the Lorentz electrical force and the second member on the right in (72) the Lorentz gravitational force. The formula (72) is presented in Yefimenko's book [75].

The specific expressions for the forces $\mathbf{F}_{RQ}$ and $\mathbf{F}_{RM}$ represent a separate problem. It should be noted in this connection that if the force $\mathbf{F}_Q$ is proportionate to Q, and the force $\mathbf{F}_M$ is

proportionate to M, the force $\mathbf{F}_{RQ}$ is proportionate to Q^2 [3, 58], while the force $\mathbf{F}_{RM}$ is proportionate to M^2. Consequently, in the case of the effect of forces $\mathbf{F}_Q$ and $\mathbf{F}_M$, the principle of superposition can be used, while in the case of the effect of forces $\mathbf{F}_{RQ}$ and $\mathbf{F}_{RM}$, it cannot. Therefore, in the former case one can move from the equations of mechanics of the motion of a point body to equations of general mechanics of arbitrary motion (including rotation) of bodies with finite dimensions.

As already demonstrated above, with finite dimensions of substantial bodies, the problem of the relationship of electromagnetic and gravispin processes arises, not only in cases where the lengths of the electromagnetic and gravispin is less than the characteristic dimensions of the bodies. However, in most problems of mechanics, the lengths of the indicated waves is much greater than the dimensions of the bodies in question; i.e., the coefficients in the equations of combined electrogravidynamics (48) and (50) $\varepsilon_1 = 0$, $\mu_1 = 0$ and $\sigma_1 = 0$. Consequently, equations of Maxwell (65) and equations of Heaviside (66) which are not related to each other are valid. Therefore, the problems in question break down into two problems in the mechanics of motion of bodies with finite dimensions (in the APV) as well: problems of pure electrodynamics and problems of pure gravidynamics.

2.5.2. Equations of motion of vacuum domains in the absolute physical vacuum

The hypothesis of the existence of closed regions of space in the space of the APV filled with PVM or PVA has been stated above. In particular, the form of these regions can be spherical, which simplifies calculations. It is also obvious that the space is filled with substance which is non-homogeneous in composition. Spherical formations of PVM or PVA can be found and can move in both rarefied (vacuum, air) and dense (water, solids) substance. These formations are identified with the self-luminous formations (bodies) of anomalous phenomena or VD.

In connection with the problem of VD, two types of problems of mechanics arise:

1. movement of the VD simultaneously in the APV and substance;

2. movement of substance (macroscopic and elementary particles) inside the VD, i.e., in the media of the PVM or PVA.

The solution of problems of the first type can make it possible to determine the conditions for capture and confinement of VD with modern equipment for organizing their systematic radiation under steady-state conditions.

In a hypothetical case of the total absence of substance and fields in space, the VD are devoid of rest mass of the formation. For describing the motion of such formations, it is necessary to incorporate ideas of relativistic quantum field theory [68].

It will be demonstrated below that the VD in fields become dipoles. In electrical or gravitational fields, the VD become both electrical and gravitational dipoles, while in magnetic or spin fields, the VD become both magnetic and spin dipoles (moments). In a substance possessing mass and an electrical charge, the VD become monopoles, electrical and gravitational.

In the presence of fields and substance (in the form of individual atoms, molecules, ions and electrons, as well as dust), the dipoles of the VD capture the substance. Under these conditions, the VD obtain an attached rest mass M as well as an attached electrical charge Q. In

such a general case, which is the closest to actual cosmic conditions, the VD become macroscopic objects of classical relativistic mechanics and, simultaneously, of electrodynamics and gravidynamics. In mechanics, the VD can be considered approximately as a point object situated in a relativistic medium – the APV.

One can see from what has been said that the motion of the VD as a relativistic object of mechanics is described be equation (63). In this equation, in the case in question, the total force can be represented in the following form:

$$\mathbf{F} = \mathbf{F}_Q + \mathbf{F}_M + \mathbf{F}_{DE} + \mathbf{F}_{DG} + \mathbf{F}_{DM} + \mathbf{F}_{DS} + \mathbf{F}_{RQ} + \mathbf{F}_{RM} \, , \tag{73}$$

where

$\mathbf{F}_{DE}$ is the force acting on the VD as an electrical dipole;
$\mathbf{F}_{DG}$ is the force acting on the VD as a gravitational dipole;
$\mathbf{F}_{DM}$ is the force acting on the VD as a magnetic dipole (magnetic moment);
$\mathbf{F}_{DS}$ is the force acting on the VD as a spin dipole (spin moment);

All four of these dipole forces will be established below on the basis of solution of the field problems of combined electrogravidynamics. For description of the motion of VD, the expressions for $\mathbf{F}_Q$, $\mathbf{F}_M$, $\mathbf{F}_{RQ}$ and $\mathbf{F}_{RM}$ are determined in the same way as in the case of a substantial body.

2.5.3. Equations of hydromechanics in the model of a non-homogeneous physical vacuum

Certain types of vortex movement of liquid and gas which are electrically neutral can be related to the effects of spin induction $\mathbf{B}_G$. This induction is included as follows in the basic equation of hydrodynamics of a viscous fluid [81, 82]:

$$\frac{\partial \mathbf{v}}{\partial t} + [\mathbf{\Omega}\, \mathbf{v}] + \frac{1}{\rho} \operatorname{grad} p + \operatorname{grad} \frac{\upsilon^2}{2} + \nu \operatorname{rot} \mathbf{\Omega} = \mathbf{f}; \tag{74}$$
$$\mathbf{f} = \mathbf{E}_G + [\mathbf{v}\mathbf{B}_G],$$

where $\mathbf{v}$ is the velocity of the fluid; $\mathbf{\Omega} = \operatorname{rot} \mathbf{v}$; $\mathbf{f}$ is the mass force; ρ and p are the density and pressure, respectively, of the fluid; ν is the kinematic viscosity factor.

Since the gravitational field is potential,

$$\mathbf{E}_G = -\operatorname{grad} \varphi_G, \tag{75}$$

where φ_G is the gravitational scalar potential.

Therefore, the equation (74) in the case of an incompressible liquid (div $\mathbf{v} = 0$) can be represented as follows:

$$\frac{\partial \mathbf{v}}{\partial t} + [\mathbf{\Omega}\, \mathbf{v}] + \operatorname{grad} H + \nu \operatorname{rot} \mathbf{\Omega} = [\mathbf{v}\mathbf{B}_G]; \tag{76}$$

$$H = \frac{p}{\rho} + \frac{\upsilon^2}{2} + \varphi_{G.}$$

One can go from equation (76) to an equation of Helmholtz of the following form:

$$\frac{\partial \mathbf{\Omega}}{\partial t} + \text{rot}\left[(\mathbf{\Omega} + \mathbf{B}_G)\mathbf{v}\right] + \nu\,\text{rot rot}\,\mathbf{\Omega} = 0. \tag{77}$$

It follows from (77) that a liquid flow is formed in the case $|\mathbf{v}| > 0$, while an inducing force proportionate to $[\mathbf{B}_G\mathbf{v}]$, which causes induced vortex motion in the fluid volume, appears under the effect of a spin field.

According to the equations of Heaviside, any motion of substance inside the fluid volume in question is associated with the appearance of spin induction. This induction, however, is slight, since it is proportionate to the coefficient : μ_{0G}, which has an extremely small value. In connection with this, the corresponding Lorentz gravitational forces are also slight. And the external spin fields from the rotating Earth, Sun, etc., are also slight. Therefore, the Lorentz gravitational force cannot explain the intense rotational movement of substance inside a VD.

2.5.4. Concerning equations of mechanics for a region of space inside a vacuum domain

The question of equations of mechanics in a region of space inside a VD filled with mixtures of PVM or PVA with the APV arises. At the present time, one can make only a more or less substantiated assumption about the possibility of using regular equations of nonrelativistic mechanics inside a VD.

The equations of mechanics of Minkowski and the equations of Maxwell and Heaviside are connected by a single parameter of fundamental importance – the speed of light c. At the same time, all these equations are indissolubly linked to the APV. Consequently, one can say that the speed of light is general among the fundamental parameters of the APV. At a velocity of the movement of some substantial body $v \ll c$, the equations of Minkowski pass into regular equations of nonrelativistic mechanics.

Two parameters with a velocity dimension emerge in combined electrogravidynamics [3]:

$$\upsilon_+ = \frac{c}{\sqrt{(1+a_\varepsilon)(1+a_\mu)}}; \qquad\qquad \upsilon_- = \frac{c}{\sqrt{(1-a_\varepsilon)(1-a_\mu)}},$$

where

$$a_\varepsilon = \frac{\varepsilon_1}{\sqrt{\varepsilon_0\varepsilon_{0G}}}; \qquad\qquad a_\mu = \frac{\mu_1}{\sqrt{\mu_0\mu_{0G}}}.$$

Consequently, one can assume in a case of mixtures of PVM or PVA with APV that the equations of mechanics will be regular equations of nonrelativistic mechanics with $v \ll v_+$, if $a_\varepsilon > 0$ and $a_\mu > 0$, and $v \ll v_-$, if $a_\varepsilon > 0$ and $a_\mu > 0$.

It will be demonstrated below that a VD in magnetic and spin fields takes on spin polarization, which is the density of the moment of the quantity of motion of the PV in the volume of the VD. Following Sedov [83], one can understand this polarization as the intrinsic density of the moment of the quantity of motion of the VD. A VD with captured substance is a uniform mechanical system. Consequently, the VD exchanges the moment of the quantity of motion with the captured substance according to the law of mechanics concerning the preservation of the total moment of the quantity of motion of VD with captured substance.

The mechanical concepts examined are quite sufficient for composing equations of classical mechanics within the limits of the region of space of the VD. However, it is appropriate to present these equations and an analysis of them at the same time as the study of issues of the interaction of VD with substance.

It should be emphasized in particular that while the mechanical interaction of VD with substance by way of Lorentz gravitational force is extremely weak, this same interaction by way of spin polarization proves quite extremely strong. It is the latter mechanical interaction in particular which explains the intense rotating movement of substance inside a VD.

3. Investigation of the physical properties of vacuum domains based on the non-homogeneous physical vacuum model

3.1. Basic trends in research on physical properties of vacuum domains

3.1.1. Comparison of physical properties of vacuum domains and self-luminous formations (bodies)

The foundation for research on the physical properties of VD based on a non-homogeneous PV model was laid in the studies [3, 4, 6]. These studies demonstrated that the energy of gravispin waves reaching the VD from the APV is transformed inside the VD into energy of electromagnetic waves. The energy of electromagnetic waves reaching the VD from the APV, on the other hand, is transformed inside the VD into energy of gravispin waves. These studies also demonstrated than in a gravitational field, a VD becomes both an electrical and a gravitational dipole; i.e., the VD in this case creates both electrical and gravitational fields inside and outside itself. In a magnetic field, the VD becomes both a magnetic and a spin dipole; i.e., it creates both magnetic and spin fields inside and outside itself. In an electrical field, the VD becomes both an electrical and a gravitational dipole; i.e., it creates both electrical and gravitational fields in addition to the Earth's field. And in a spin field, the VD becomes both a magnetic and a spin dipole; i.e., it creates both magnetic and spin fields in addition to the Earth's field. Hence the VD functions simultaneously as a converter of energy and a transformer of two types of waves and four fields.

The physical properties already considered for VD as models of the anomalous phenomena presented in Chapter 1 make it possible to find approaches to the explanation of a number of characteristic properties of these phenomena. For example, the physical properties of natural self-luminous formations (NSLF), which were described in detail in Dmitriyev's monograph [5], can be explained as follows:

1. Radiation of the NSLF in a broad spectrum of electromagnetic waves. This phenomenon occurs as a result of the transformation of gravispin waves into electromagnetic waves within the VD.
2. The development of electrical discharges inside the NSLF. This phenomenon is associated with the electrical dipole that appears in the VD as a result of the effect of the electrical and gravitational fields of the Earth on it.
3. A change in the geomagnetic field near the NSLF. This phenomenon is the result of the development of a magnetic dipole within the VD as a result of the effect of the magnetic and spin fields of the Earth on the VD.
4. A change in the gravitational field of the Earth near the NSLF (weighting and levitation). Such a phenomenon is associated with the appearance of a gravitational dipole within the VD as a result of the effect of electrical and gravitational fields on the VD.
5. Rotation of air inside the NSLF. This phenomenon is the result of a change in the spin polarization of the VD which develops as a result of the effect of the magnetic and spin fields of the Earth on the VD.
6. Capture of dust by the NSLF. This is the result of the effect of gravitational, electrical, magnetic and spin fields of the VD as a quad-dipole.
7. Passage of the NSLF through gases, liquids and solids. This phenomenon is possible due to the fact that the PVM or PVA in the VD is a variety of the PV which interacts with substance only by way of macroscopic fields.

Since the VD in four fields becomes a quad-dipole, four forces of a dipole nature act on it in these same fields: electrical, magnetic, gravitational and spin forces.

Since the VD captures substance, two additional forces act on it in the atmosphere of the Earth: the regular gravitational force proportionate to the mass of the captured substance, and the aerodynamic force resulting from the geometric shape of the VD, as well as the speed of the air flow in the VD location in question.

One additional well-known property of NSLF is associated with the simultaneous effects of the six forces indicated on the VD in the Earth's atmosphere:

8. Unpredictable movement of the NSLF, including movement against the wind.

The VD has no rest mass. The acceleration of the movement of the VD is determined by captured mass. In connection with the fact that part of the dipole forces act directly on the VD, while part of the forces, gravitational and aerodynamic forces, in particular, act on the VD through the captured mass, the release of part of the captured mass of the VD is possible. Another well-known property of NSLF is a result of the release of this mass of the VD:

9. Inexplicably large changes in the acceleration of movement of the NSLF.

The physical conditions of the passage of VD through liquids and solids do not differ fundamentally from the same conditions of the passage of VD through gases. And four dipole forces act on the VD in both liquid and solid. In dense media, however, the processes of depolarization of two dipoles are significantly more pronounced: electrical and magnetic dipoles. The depolarization of the electrical dipole of a VD is the result of conductivity currents in an electrically conductive substance. The depolarization of the magnetic dipole of the VD is the result

of a change in magnetization in a magnetic substance. Therefore, partial depolarization of electrical and magnetic dipoles in dense media results in a decrease in the dipole forces acting on the VD.

The VD introduces four polarizations and, consequently, four additional fields into a solid. Four tensors of striction stress are associated with the fields [58, 61]. The tensors of striction stress related to the gravitational and spin fields can be incorporated by analogy with the tensors related to the electrical and magnetic fields. In addition, another tensor is related directly to the spin polarization: a nonsymmetrical tensor of tangential spin mechanical stresses. All these stresses alter the initial stressed state of the solid, which is characterized by the tensor of initial mechanical stress [61]. The striction, spin and original mechanical stresses, normal and tangential, are summed up algebraically. The development of these stresses can lead to many inexplicable, anomalous phenomena, such as poltergeists.

It is necessary first of all to note the possibility of the capture of VD in individual places in the non-homogeneous, heavily stressed regions in the rocks of the Earth, as well as various structures created by man: buildings, bridges, ships, aircraft, etc. Since a VD is a unique antenna for electromagnetic fields, all the features that characterize the poltergeist phenomenon must be related to captured VD. Unexpected destruction and fires can also be related to such VD.

The passage of VD through stressed sections of the Earth's crust which are non-homogeneous in composition can result in the release of great mechanical stresses, i.e., earthquakes, especially in tectonically stressed areas. Moreover, this relationship is clear. At points of the frequent passage of VD through the rock of seismically loaded sectors, there are no strong earthquakes, since the VD do not all great mechanical stresses to build up. It is possible that this factor explains the lack of seismic activity of the Terekhtin-Katuno dynamo pair in Altai [5]. At points of the rare appearance of VD, on the other hand, great internal mechanical stresses can build up inside the rock. The appearance of VD at these locations, therefore, can be a significant factor in triggering catastrophic earthquakes. Dmitriyev was the first to devote attention to this relationship between VD and earthquakes [5].

The start of the earthquake process obviously can be related to known causes described in the theory of earthquakes [84, 85] rather than to VD. Even in that case, however, VD captured beforehand can rise above the surface of the Earth and cause local earthquakes.

Hence one can point out another property of NSLF conditioned by the striction stress in the rock of the Earth, inside and outside VD:

10. A relationship between the frequency of the appearance of NSLF and earthquakes.

One can see from the examination of the possibilities of a physical model of VD that it makes it possible to explain the most important properties of NSLF.

3.1.2. Circulation of energy and development of gravispin waves in the Universe

It was stated above that for explaining electromagnetic radiation, especially the self-luminescence of NSLF, it is necessary to assume that space is filled with gravispin waves with a high power flow density in any preselected direction; for example, according to Smirnov [10], typical ball lightning with a diameter of about 0.2 m will shine like an electric light bulb with a power of more than 100 W. In this connection, the question arises: what and where are the sources of gravispin waves?

In the study [6], this question is considered in part by the use of closed chains of transformations of energy, which are included naturally in models of combined electrogravidynamics the non-homogeneous PV, specifically the mutually reversible transformations: electromagnetic energy to thermal (EM ⇔ T); electromagnetic energy to mechanical (EM ⇔ M); electromagnetic energy to gravispin (EM ⇔ GS); thermal energy to gravispin (T ⇔ GS); gravispin energy to mechanical (GS ⇔ M); mechanical energy to thermal (M ⇔ T). All six of these transformations of energy are shown in the diagram in Fig. 4.
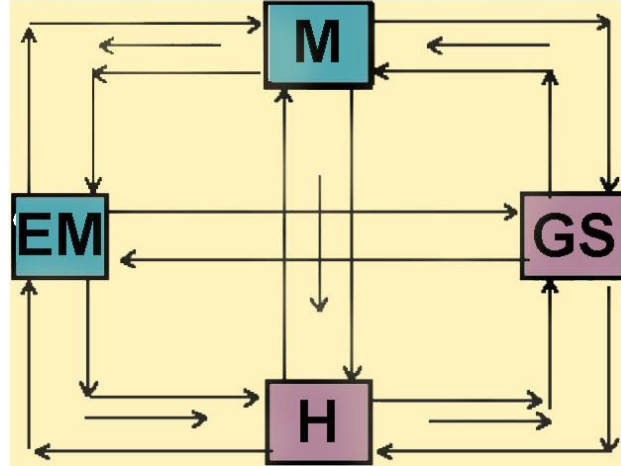
Fig. 4.

Three of the transformations of energy shown in Fig. 4 have been studied thoroughly: EM ⇔ M; EM ⇔ T; M ⇔ T. The transformation of gravitational energy to kinetic energy of the motion of bodies and the reverse has also been studied well. However, GS energy must be understood as three types of energy: gravitational field, spin field and the energy of gravispin waves. The EM energy also must be understood as three types of energy: electrical field, magnetic field and electromagnetic waves.

Hence the model of a non-homogeneous PV brings up problems of the study of little-known transformations of energy: EM ⇔ GS; GS ⇔ T; and two particular transformations: GS ⇔ M, of spin energy to mechanical and the reverse, as well as of gravispin wave energy to mechanical and the reverse.

The study [3] examines some of the little-known transformations of energy indicated above:

- the transformation of the energy of gravispin waves to mechanical energy;
- the transformation of heat to the energy of gravispin waves;
- the reversible transformation of the energy of electromagnetic waves to the energy of gravispin waves.

The paradoxical nature of the three latter transformations of energy is related to the reversed signs in front of the "sources" ρ_G, $\mathbf{J}_G$ in the equations of Heaviside as compared to the signs before the symbols ρ and $\mathbf{J}$ in the equations of Maxwell and with the coefficients ε_1 and μ_1 in the model of combined electrogravidynamics.

It must be stated first of all that the transformations of energy in question violate the postulate of the growth of entropy, i.e., the second origin of thermodynamics. At the same time, these transformations do not affect the first origin of thermodynamics or the principle of causation, in which the cause precedes the effect.

Analysis of the first of the little-known transformations of energy indicated [3] that a gravity antenna in the form of a point body in accelerated movement is not an emitter (radiator) but an absorber (absorbent) of the energy of gravispin waves. Consequently, the mass in accelerating motion is not the cause of the development of the energy of gravispin waves. On the contrary, the energy of outside gravispin waves goes to increase the kinetic energy of the body in accelerated motion.

An absorber of gravispin waves can be described mathematically by means of so-called leading rather than lagging solutions of wave equations of Heaviside [3]. It is known from electrodynamics [58] that the leading solutions will not contradict the principle of causation only in one case, in which sources of outside waves are in the vicinity of the absorber.

Hence a paradoxical situation is associated with the transformation of the energy of gravispin waves into mechanical energy. Instead of the expected source of gravispin waves, we obtained an absorber of the waves. Outside sources of gravispin waves are required again for describing an absorber of energy on the condition that the principle of causation not be contradicted.

The analysis performed on the second transformation of energy – the transformation of heat to the energy of gravispin waves – indicated [3] that on the condition $\sigma_G \sigma - \sigma_1^2 > 0$, the gravispin waves passing through a substance are strengthened due to the heat in the substance. It is obvious that in the passage of gravispin waves through a substance, its temperature should decrease. However, outside sources of gravispin waves are required in this case also for explaining the process of the transformation of energy.

Only in the third transformation – the transformation of the energy of electromagnetic waves into the energy of gravispin waves and the reverse – do sources of gravispin waves appear. The sources and, at the same time, the transformers of these energies are VD. The analysis of the third transformation of energy indicated [3] that in VD located outside substance, periodic 100% transformation of the energy of electromagnetic waves into the energy of gravispin waves and the reverse occurs. This transformation occurs separately at each wave frequency. Therefore, the frequency spectrum of gravispin waves should be similar to the frequency spectrum of the electromagnetic waves in the place where the transformation of energy by VD takes place.

Hence according to this model of the non-homogeneous PV, the sources of gravispin waves in the Universe are the VD – the NSLF – themselves. It turns out that gravispin waves are necessary to explain the self-luminescence of the NSLF. In addition, it happens that these waves again appear due to the VD – the NSLF. The existence of a large number of VD scattered in the space of the Universe and coming into contact with the electromagnetic radiation of the stars is a necessary condition for such a process.

The role and importance of the GS energy can be cleared up from an examination of the transformations of energy shown in the diagram of Fig. 4. If GS energy and all three additional transformations related to GS energy are excluded from consideration in this diagram, a diagram of energy flows which is well known from classical thermodynamics [86, 87] will be obtained. Despite the partial reversibility of the transformations $M \Leftrightarrow EM$, $EM \Leftrightarrow T$ and $M \Leftrightarrow T$, the prevalent total energy flows are in the direction of thermal energy (shown in Fig. 4. by separate arrows); i.e., $M \rightarrow EM \rightarrow T$, $M \rightarrow T$. A continuous increase in thermal energy occurs at the expense

of mechanical and electromagnetic energy. This system includes the transformations of chemical and nuclear energy. Part of these types of energy is transformed immediately into heat, while the mechanical and electromagnetic energy which emerge due to the transformation of chemical and nuclear energy in the final analysis are also transformed into heat.

In the full diagram of Fig. 4, the prevalent energy flows form four energy cycles: T→GS→M→EM→T and T→GS→M→T, in which the VD-NSLF do not participate directly, and T→GS→EM→T and M→EM→GS→M, in which the VD-NSLF do participate directly.

According to the estimates of [3], the energy transformations T→GS and GS→M are weak. This means that at the places in the Universe where intense energy processes take place with a significant growth in entropy, the reverse transformations associated with a decrease in entropy can remain unnoticed. The reverse energy transformations T→GS→M, however, are widespread in the Universe, due, in particular, to the exceptionally high penetrability of GS waves into matter. Therefore, these transformations can play a decisive role in the absence of signs of thermal death of the Universe.

The studies [3, 4 and 6] do not consider two transformations related to GS energy: transformation of the energy of GS waves into mechanical energy of the rotation of the planets and stars around their axes, and the reversible transformation of spin field energy into mechanical energy of the rotation of these same objects. Meanwhile, the two energy transformations in question can be considered thoroughly based on the model of combined electrogravidynamics. Hence the no less interesting problem of the transformation of energy in the rotation of cosmic objects remained less than fully examined.

Thus the seemingly special phenomenon of self-luminescence of the NSLF in the non-homogeneous PV model proved to be related to a large range of fundamental issues of the circulation of energy in the Universe.

3.1.3. Problem of weak explosions of vacuum domains

In considering the problem of weak explosions of VD, one is limited at first to the data of observations pertaining to ball lightning (BL), as the objects from the NSLF family which have been studied the most. One must direct attention to the energy levels of bursts of BL with a diameter of about 0.2 m: the average value is 10^4 J; the maximum values are 10^7-10^8 J [10]. We suggest that weak bursts of BL, at the size indicated above, are characterized by an energy of the order of 10^4 J, i.e., with an energy density of the burst of the order of 10^6 J/m^3.

It is specifically the small average energy level of a burst of BL which is taken as the basis for the well-known theories of BL: the Smirnov plasma-fractal theory [10] and the Tsitovich theory of plasma-dust crystals, droplets and clouds [88]. In Smirnov's theory, the energy of BL develops as a result of the restructuring of parts of the BL frame from fractal threads (carbonized particles of ordinary dust) in denser packing and in essence is the energy of molecular cohesion. In Tsitovich's theory of BL, "the only source of energy . . . is the mechanical energy of sonic vibrations, which is either captured from the beginning in the volume or is captured steadily in the volume of the ball" [88].

The Smirnov and Tsitovich theories are good at explaining the properties of luminous spherical formations resembling BL produced experimentally in various electrical discharges in the presence of combustible gases and particles of dispersible electrodes [10, 11]. However, they fail to provide an explanation for any of the properties of NSLF-BL considered above. In

particular, they explain the luminescence of the formations but cannot explain the electromagnetic radiation, in the decimeter range, for example; they produce energy of the order of 10^4 J which can be accumulated, but they cannot explain explosions with significantly greater energy.

The theories of BL based on regular physical concepts cannot explain the qualitative features of bursts of BL which are well known from the observation data: in many cases, after a burst of BL in open space, it does not disappear and continues its movement [16-20]; in the disappearance of BL after the burst, the blast wave interacts mechanically only with metal objects but passes freely through insulators [17]; some bursts of BL are associated with damage to large segments of electrical and telephone systems [10].

To explain the mechanism of bursts of BL based on the non-homogeneous PV model, in light of the observation data and characteristic energy values of the bursts presented above, the physical model of VD should be refined. It is necessary, first of all, to devote additional attention to the mechanical properties of the PVM or PVA within the volume of the VD. In the fields of the Earth, a VD becomes a quad-dipole. Mechanical stresses inside the VD are the result of the fields of these dipoles.

The only possibility for explaining the observed instances of prolonged existence of an unchanged form of BL under the effect of internal stresses lies in the fact that the PVM or PVA inside the VD-BL possesses the properties of a solid or, in other words, a vacuum crystal. In addition, the properties of rapid changing of the internal structure and the possibility of rapid dispersion of matter at certain maximum stresses inside the VD should be attributed to the PVM or PVA inside the VD, since instances of a change in the form of BL up to division and full disappearance of the BL in the unique blast wave behavior indicated above must be taken into account.

It is easy to see to explain the bursts of BL with the use of the non-homogeneous PV model, problems of three types should be formulated: bursts with preservation of the form of the VD; bursts with a change in the form of the VD; bursts with dispersion of the VD.

The study [6] considers bursts of BL with rapid changing of the form of the VD. It is demonstrated that the values observed for the energy of BL bursts of the order of 10^4 J can be related to the rapid change in the electrical energy of VD. Meanwhile, the simultaneous rapid change in gravitational energy of the VD proved not to be investigated in the study. Consequently, in the problem in question, the energy level of the bursts of BL was understated. It becomes understandable in this connection that the values observed for the energy of bursts of BL of the order of 10^4 J can be described without the assumption of a change in the form of VD. In this case, one can find a more natural mechanism for the detonation of explosions not related to a change in the form of the VD but to an electrical discharge inside the VD.

Hence one can relate another known property of NSLF-BL to a rapid change in dipole electrical and gravitational fields of VD:

11. Weak bursts of BL with an energy of the order of 10^4 J released.

Strong bursts of BL with an energy of the order of 10^8 J released exceed the Trotyl equivalent in terms of the BL volume [17]. And explosions of large NSLF, such as the Tunguska "meteorite," have the features of explosions of hydrogen bombs [35]. In this connection, one can state with great conviction that strong explosions of NSLF cannot be described by equations of the macroscopic non-homogeneous PV model.

To discover the physical nature of strong explosions of NSLF, it is necessary to study the internal microscopic physical properties of PVM and PVA. This task is far beyond the scope of the model in question here. We shall limit ourselves in this study to the most general hypotheses concerning the physical properties of the PVM and PVA, based on the attempt to obtain logically consistent representations of the movement of matter and energy in the Universe.

3.1.4. Vacuum domains in the fields of the Earth

The frequency of the appearance of VD-NSLF at the surface of the Earth increases sharply in years with an active Sun. One can conclude in this connection that the Sun and the other stars are one of the main sources of VD in space. It is inside the stars in particular that one can find the high energy density which is hypothetically sufficient for the decomposition of the APV into PVM and PVA.

The local PVM and PVA structures which are formed move in inner space together with the particles fluxes of solar wind. Objects which are quite different for meteorites and bolides and which can be identified with NSLF-VD are observed there constantly [89-91]. In this connection, problems of the capture of VD by the Earth's fields and by the other planets of the Solar System arise.

In the mechanisms of the capture of VDM and VDA (VD of matter and VD of antimatter), as will be demonstrated below, one can see certain differences; however, the capture of both VDM and VDA by the Earth nevertheless is possible. Therefore, one can start with the hypothesis of the separate filling of the internal volume of the Earth by both VDM and VDA. Hence a kind of integrated vacuum domain is formed inside the Earth. When the quantity of PVM prevails over PVA, it is characterized by the equations of combined electrogravidynamics with averaged parameters $\varepsilon_1 > 0$ and $\mu_1 > 0$. When the quantity of PVA prevails over PVM, it is characterized by the parameters $\varepsilon_1 < 0$ and $\mu_1 < 0$.

The integrated VD in the internal gravitational field of the Earth forms distributed electrical charges of one sign inside itself at $\varepsilon_1 > 0$ and of the opposite sign at $\varepsilon_1 < 0$. In the spin field inside the Earth, which is related to the rotation of the Earth's mass, the integrated VD forms polarization magnetic moments with one orientation along the axis of rotation of the Earth at $\mu_1 > 0$ and with the opposite orientation at $\mu_1 < 0$. The specific electromechanical and chemical processes in the interior of the Earth are the result of distributed electrical space inside the Earth. The Earth's electrical field may be related to these charges. The dipole magnetic field of the Earth may be related to the polarization magnetic moments inside the Earth.

One should assume in connection with the frequent inversion of the geomagnetic field (22 in the last 5 million years [24, 85]) that the quantity of PVM exceeds the quantity of PVA at one polarity of the geomagnetic field, while the quantity of PVA exceeds the quantity of PVM at the opposite polarity.

It is well known [24, 85] that the problem of the Earth's magnetic field is one of the most complex problems of modern geophysics. The hypothesis proposed within the scope of this model does not pretend to solve this problem. At the same time, such a conception of the geomagnetic field follows naturally from the non-homogeneous PV model and can be considered along with other hypotheses. The spin field of the Earth, which is also related to the parameters ε_1 and μ_1 in the non-homogeneous PV model, can be taken into consideration at the same time.

The waves of mechanical oscillations inside the Earth at $\varepsilon_1 \neq 0$ and $\mu_1 \neq 0$ should be accompanied by electromagnetic waves. The mechanical oscillations actually are oscillations of masses; i.e., they are the result of variation in the gravitational and spin fields. And these fields, in a medium with $\varepsilon_1 \neq 0$ and $\mu_1 \neq 0$, should be partially transformed into electrical and magnetic fields.

3.1.5 The relationship of vacuum domains to certain disasters

Strong physical phenomena – disasters, in the everyday sense – such as tornadoes, disruptions in the normal operation of high-voltage electrical power supply systems, collisions of aircraft and ships with NSLF, etc., are associated with NSLF-VD at the surface of the Earth.

Certain features of the tornado phenomenon at first glance are at odds with the thoroughly familiar laws of hydromechanics [9, 21]. The idea of the connection of the tornado with the phenomenon of NSLF-VD emerged from observations of the vortex movement of gas and dust inside and near NSLF-VD (BL, in particular). In a case of the observation of NSLF-VD, the witnesses normally see primarily the NSLF itself, i.e., its shape and self-luminescence, and only then the vortex movement of air and dust inside the NSLF. In the case of observation of tornadoes, on the other hand, it is the tornado itself that is seen first, i.e., its shape, the vortex movement of the air, its monstrous mechanical effects on buildings, etc., and only afterwards do the witnesses see the lightning and self-luminescence inside the tornado column. At the same time, the latter properties mentioned for tornadoes are signs of NSLF-VD. If one is to go further, one must also consider the magnetic and spin polarizations of the NSLF-VD. It is specifically with the spin polarization of VD that one can connect certain properties of tornadoes which are hard to explain: intense rotation of the air, even in a case where there is no tornado column at the surface of the Earth; stability of the shape of the tornado column, etc.

Modern power systems include many electrical transmission lines and have sophisticated protection systems. Therefore, the failure of power systems in geomagnetic storms, such as when the Hydro-Quebec power system in northern Canada went off line for 9 hours during the magnetic storm of March 13-14, 1989, is perceived as a random coincidence (there was a second peak in solar activity in 1991) [24]. Actually, the small change in the magnetic field of the Earth and, we even assume, the strong electromagnetic radiation manifested as radio interference which accompany magnetic storms cannot be the cause of the failure of power systems for whole megalopolises.

However, one can approach the question of the impact of solar activity on power systems from a different direction. Analysis of equations of the non-homogeneous PV indicates that in the penetration of NSLF-VD into power systems, the distributed interphase reactive and active resistances of the electrical transmission lines should change. With rapid movement of the NSLF-VD and, accordingly, a rapid change in these parameters along the lines, running voltage and current waves inevitably develop. Overvoltages, a corona discharge, additional power losses and, in the final analysis, the disconnection of such lines from the generators, up to the point of complete failure of the entire power system, are the result of these waves.

One can also consider the consequences of the convergence and collision of aircraft, ships, etc., with NSLF-VD on the basis of the non-homogeneous physical vacuum model. It is clear from the examination of the properties of VD that these consequences must be catastrophic. In reality, NSLF-VD can penetrate the bodies of the objects in question, as well as the housings or screens

of electronic devices. Even if the NSLF-VD are electrically depolarized in the process, radio, x-ray and gamma radiation will remain and will cause the failure of microcircuits. And these effects are sufficient to cause contingencies/emergencies aboard modern transportation vehicles.

3.1.6 The role of vacuum domains in the change in the dimensions and mass of the Earth

The circulation of matter in the Universe was considered above. Based upon theoretical considerations, a conclusion was that substances appear as a result of decomposition of the PVM, while the APV is formed as a result of absorption of the substance of the right world and the left world in the PVA. One can continue these constructions with the assumption that substance is packed in the form of atoms in quadrigues of the APV; i.e., atoms of Mendeleyev's periodic system appear as a result of decomposition of the PVM. And hydrogen and helium are present at the foundation of the chemical composition given off from the PVM. This hypothesis follows from the ideas of Carry [92, 93] about the increasing mass of the Earth and the planets of the Solar System, especially Jupiter. According to Carry, the increase in the masses of the planets is accompanied by a change in their elementary composition in the direction of the light elements.

Ideas about an increase in the mass of the Earth due to the transformation of the ether into substance have been discussed in the literature of geophysics for more than 100 years [92]. Quite clear signs of an increase in the average radius of the Earth and the other planets of the Solar System are the basis for such ideas. For example, the radius of the Earth 100 million years ago was only 60% of the current radius [92].

At the same time, other concepts, according to which the mass of the Earth remains practically constant, and the increase in the dimensions of the Earth occurs due to a decrease in the density of the substance in its interior [85], are also discussed in the literature in question.

In connection with the problem of mountain formation on the Earth, one comes to understand [84, 85] that the increase in the Earth's dimensions occurs in an irregular manner. The overall pattern of increase is interrupted by temporary suspension of growth and even by a decrease in the dimensions of the Earth. At the present time, incidentally, judging from the process of mountain formation, the dimensions of the Earth are not increasing [84]. The irregular growth in the Earth's dimensions creates difficulties both for advocates of the concepts of growing mass and for the advocates of ideas of the constancy of the Earth's mass in the presence of increasing dimensions. It is difficult to point out the causes of the intermittent nature of the growth in the Earth's dimensions in either model.

For the advocates of the conception of constancy of the Earth's mass, there are powerful arguments for their hypothesis. Kuznetsov [94, 95] states these arguments as follows: "A great many astronomical observations have been conducted in the last 20-30 years . . . : laser probing of the Moon and satellites; precise determination of the period of movement of the Moon; determination of the distances between the deep space communication station and the descending Viking and Mariner-9 craft; radar measurements of distances to the surfaces of Venus and Mercury; optical measurements of the positions of the Sun and the planets, etc. As a result of solution of a combined problem for the Solar System, a number of parameters have been defined and refined, such as elements of orbits, masses of asteroids and, in the final analysis $\Delta G/G$ and $\Delta(GM)/(GM)$ (G is the gravity constant; M is the mass of the Sun and the other observable objects of the Solar System). It was established that $\Delta G/G = (0.2 \pm 0.4) \cdot 10^{-11}$ for a year, while $\Delta(GM)/(GM) = (0.1 \pm 0.8) \cdot 10^{-11}$ for a year. Hence the complex of astronomical observations of

the Solar System which have been achieved provides restraints on the variations in the values of *G* and *GM* which are substantially more rigid (a thousand times more) than those which follow from . . . (author's note: the studies [96, 97], which affirm ideas of an increase in the mass of cosmic objects due to the transformation of the ether into substance, are referenced). One must assume that the experimental results cited fully and completely reject . . . the new models of the Earth in which its mass is constantly increasing".

According to the non-homogeneous PV model, the dimensions and mass of the Earth must increase when the quantity of PVM prevails over PVA inside the Earth and must decrease in the opposite case; they need not necessarily decrease with the same intensity as they increase. It should be assumed that the quantity of PVA inside the Earth at the present time is greater than the quantity of PVM, since the Earth's mass, as indicated above, is not increasing at present. The observed polarity of the geomagnetic field corresponds to this condition of the Earth.

Hence an increase in the Earth's mass is possible when the quantities of PVM which get inside are greater than the quantities of PVA. This case is a result of a change in the polarities of the magnetic and electrical fields of the Earth.

3.1.7 Strong explosions of vacuum domains

Analysis of observations and phenomenological research on NSLF based on the macroscopic non-homogeneous PV model indicates that some explosions of NSLF cannot be explained by rapid processes of change in electrical and gravitational fields. Moreover, the hypothesis that the cause of strong explosions of NSLF might be related to processes of internal restructuring of the PV (i.e., to processes of a microscopic nature) emerges. Hence issues in the study of VD which are of great practicality go beyond the scope of the macroscopic which is being developed.

However, certain ideas about the mechanisms of strong explosions of VD nevertheless can already be obtained on the basis of the schematic model of the circulation of matter in the Universe considered above.

The first mechanism of strong explosions of VD most probably is related only to VD from the PVM. As already stated above, as a result of decomposition of the PVM, hydrogen must appear and, in mixing with the oxygen of the Earth's atmosphere, forms detonating gas. The explosions of this gas may be classified as one of the types of strong explosions of NSLF. The signs of the release of gases from BL are well known. They have been presented in [5]. Descriptions of how BL digs holes in soft ground especially catch one's eye. In this case, the soil is literally blown out of the hole.

The second mechanism of strong explosions of NSLF-VD can be related to the connection of two vacuum domains consisting of PVM and PVA. It is appropriate in this regard to consider the explosion in the Tunguska phenomenon of 1908.

The results of analysis of the evidence and effects of the explosion of the Tunguska "meteorite" in 1908 [35] have puzzled many specialists in the fields of science related to the phenomenon in question. A large number of explosions similar to the explosion of the Tunguska "meteorite" have been described in the last 150 years [13]. It follows from these descriptions that the explosions in question have nothing to do with the falling of meteorites. In the case of the Tunguska phenomenon, systematic research was performed on the genetic effects on vegetation, the isotope composition, thermoluminescence and magnetization of rock in the area of the explosion. This research demonstrated that there had been an extremely powerful burst of

γ-radiation. The force of this explosion, which can be called a photon explosion, has been estimated at a Trotyl equivalent of several tens of megatons [35].

According to the evidence of eyewitnesses, the explosion of the Tunguska "meteorite" was preceded by prolonged (hours) and intricate movement of several self-luminous bodies [35]. It should be mentioned in this connection that the group movement of NSLF is a normal phenomenon [13, 35].

Tornadoes often move in groups, and there is rotation in opposite directions in adjacent tornado columns [9]. The direction of rotation of gas and dust in an NSLF-VD, by the way, is a convincing sign that it consists of PVM or PVA. Consequently, NSLF from different PV can be present in adjacent tornado columns: PVM in one of them, and PVA in the other.

One can assume in this connection that the second mechanism of strong explosions of NSLF-VD is the result of direct contact of two VD – one of PVM and the other of PVA – and the subsequent annihilation of vacuum particles of PVM and PVA with the formation of quadrigues of the APV.

In the case of strong explosions of NSLF-VD which is under examination, the full cycle of transformations of vacuum particles shown in Fig. 5. is realized, bypassing the formation of substance.
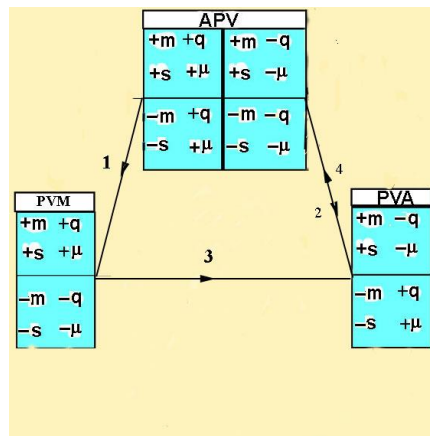
Fig. 5.

The arrows in Fig. 5. indicate the following transformations: 1 and 2 – the release of PVM and PVA particles from a Terletskiy quadrigue; 3 – the combination of PVA and PVM particles into a Terletskiy quadrigue (APV); 4 – the completion of the cycle of transformations of vacuum particles.

The full cycle of transformations of vacuum particles can occur due to the different physical conditions of division of the APV into PVM and PVA in the stars and at the point transformation of the PVM and PVA into APV on the Earth and other planets. The energy released in the annihilation of PVM and PVA is the energy obtained previously by the particles of the PVM and PVA in the splitting up of the APV. Hence another channel for the transfer of energy from the stars into the space surrounding them is established and exists alongside direct electromagnetic radiation and the escape of particles of substance.

In connection with the hypothesis of strong explosions of NSLF-VD as a result of the annihilation of PVM and PVA which is being considered, one must make a few important comments.

The reaction of splitting of the APV into PVM and PVA in the stars must play the role of autoregulator of the processes of nuclear reactions in plasma. This reaction results in an outflow of energy, particles or photons from the reaction zone in plasma, which limits the possibility of the growth of processes of nuclear reactions into the explosion of a star.

Inside the Earth, the PVM and PVA occupy separate regions of its inner space; i.e., they do not mix. It is possible that the great deep magnetic anomalies of the Earth are related not to large local masses of ferromagnetic material but to internal regions of the Earth filled with PVM (the Brazilian magnetic anomaly) and PVA (the Canadian, Siberian and Antarctic magnetic anomalies) [85]. One can also assume that some large earthquakes develop as a result of underground explosions resulting from the reaction of annihilation of limited amounts of PVM and PVA. It is possible that the riddle of the explosion of the planet Phaeton and the formation of the asteroid belt in the Solar System are related to such a reaction, but with the interaction of large amounts of PVM and PVA.

Further development of the theory of elementary particles is required to substantiate the reactions of splitting of the APV into PVM and PVA and annihilation of PVM and PVA, as well as the reaction of separation the PVM with the release of substance. Shulgin's model of elementary particles is an example of such development [64].

The current model of elementary particles considers only two components of matter – matter and antimatter. Shulgin constructs his model of elementary particles based on four components of matter:

"the *first* component is ordinary matter and ordinary particles, such as the electron e^-;

the *second* component is antimatter and antiparticles, such as the positron e^+;

the *third* component is antimatter with negative energy and negative mass, such as the so-called transmirror positron e_t^+;

the *fourth* component is transmirror matter and particles with negative energy and negative mass, such as the transmirror electron e_t^-.

Shulgin's transmirror particles are the very particles with negative masses $-m$, $-s$, $+q$, $+\mu$ and $-m$, $-s$, $-q$, $-\mu$ of the Terletskiy quadrigue. Therefore, Shulgin's model is in agreement with the macroscopic polarization-field model of non-homogeneous physical vacuum which is being considered and in which the concept of the Terletskiy quadrigue is used. At the same time, his model does not contradict the microscopic quark model of elementary particles which is generally accepted at present. Shulgin's model has expanded the possibilities of the standard model and made it possible to explain gravitational interaction in the galaxies on the example of isotope anomalies of meteorites and lunar soil and to avoid the well-known infinite Universe paradoxes. It has also made it possible to determine the probability of interaction of normal and transmirror matter.

According to Shulgin, the basic vacuum particle consists of protoquarks of all four components. Shulgin writes: "We vacuum particle which consists of protoquarks of all four

components of matter the *gluon*. Yes, it is the same gluon which, in undergoing polarization in a field of strong interaction, forms gluon condensate and provides a bond between quarks. It significantly weaker electrical, magnetic and gravitational fields, vacuum gluons are polarized in proportion to the intensity of the fields, which ensures local constancy of dielectric, magnetic and gravitational permeability and a quadratic dependence of the force on the distance between point charges."

Hence, according to Shulgin, the PV is a homogeneous quark medium. The current theory of elementary particles still lacks the finished physical concepts necessary for describing the microscopic phenomena associated with NSLF, much less the macroscopic phenomena. Therefore, at present we can described only macroscopic physical phenomena and processes of NSLF-VD based on the non-homogeneous PV model presented above.

3.2 Statics. Vacuum domain in external slowly changing electrical, gravitational, magnetic and spin fields

3.2.1 Equations of electrogravistatics and magnetospin statics

One can introduce electrogravistatics and magnetospin statics by analogy with electrostatics and magnetostatics. In this process, the corresponding system of equations follows from the equations of the macroscopic model of combined electrogravidynamics; it is necessary only to assume that all four fields change slowly, and that an approximation of equality of their time derivatives, as well as electrical current densities $\mathbf{J}$ and $\mathbf{J}_G$, to zero, i.e., $\mathbf{J} = 0$ and $\mathbf{J}_G = 0$, is permissible.

Then, according to (47)-(50), the equations of electrogravistatics will take on the following form:

$$\operatorname{div}\mathbf{D} = \rho; \qquad\qquad (78_1)$$

$$\operatorname{rot}\mathbf{E} = 0, \qquad\qquad (78_2)$$

$$\operatorname{div}\mathbf{D}_G = -\rho_G; \qquad\qquad (79_1)$$

$$\operatorname{rot}\mathbf{E}_G = 0, \qquad\qquad (79_2)$$

$$\mathbf{D} = \text{\ae}_0\,\mathbf{E} + \varepsilon_1\,\mathbf{E}_G; \qquad\qquad (80_1)$$

$$\mathbf{D}_G = \varepsilon_G\varepsilon_{0G}\,\mathbf{E}_G + \varepsilon_1\,\mathbf{E}. \qquad\qquad (80_2)$$

The corresponding equations of magnetospin statics will have the following form:

$$\operatorname{div}\mathbf{B} = 0; \qquad\qquad (81_1)$$

$$\operatorname{rot}\mathbf{H} = 0, \qquad\qquad (81_2)$$

$$\operatorname{div}\mathbf{B}_G = 0; \qquad\qquad (82_1)$$

$$\operatorname{rot}\mathbf{H}_G = 0, \qquad\qquad (82_2)$$

$$\mathbf{B} = \mu\mu_0\,\mathbf{H} + \mu_1\,\mathbf{H}_G; \qquad\qquad (83_1)$$

$$\mathbf{B}_G = \mu_G\mu_{0G}\,\mathbf{H}_G + \mu_1\,\mathbf{H}. \qquad\qquad (83_2)$$

It is easy to see that the equations of electrogravistatics and magnetospin statics are independent.

3.2.2 A spherical vacuum domain in external homogeneous electrical and gravitational fields

In classical problems of electrostatics and magnetostatics in regard to ellipsoids of dielectrics and magnetics in external homogeneous fields, it has been demonstrated that homogeneous fields and polarizations are established inside the ellipsoids. In cases of homogeneously polarized ellipsoids, their internal fields prove homogeneous. In the special case of an ellipsoid-sphere, the solutions take a compact, easily visible form and are expressed in elementary functions [31]. Just such simplifications should be expected in considering problems of a VD in homogeneous fields, when it has the form of a sphere. Obtaining sufficiently simple field solutions for VD is extremely important in connection with the subsequent complex analysis of the energetic and kinematic properties of the VD. Moreover, NSLF-VD often have the form of a sphere.

We shall make one more simplification related to strengthening of the conditions $\mathbf{J} = 0$, $\mathbf{J}_G = 0$. We shall assume that $\rho = 0$ and $\rho_G = 0$. It is obvious in this case that that $\varepsilon = 1$ and $\varepsilon_G = 1$. Hence VD in the form of a sphere is represented in some initial state preceding immersion in substance.

It is possible that even in space, a VD absorbs the substance captured by fields. However, it is nevertheless extremely interesting theoretically to obtain a representation of the properties of VD in the indicated initial state.

In the case in question, the equations (78) and (79) take on the following form: div $\mathbf{D} = 0$; rot $\mathbf{E} = 0$; div $\mathbf{D}_G = 0$; rot $\mathbf{E}_G = 0$. Consequently, one can introduce two scalar potentials: electrical, according to the relationship $\mathbf{E} = $ -grad φ, and gravitational, according to the relationship $\mathbf{E} = $ -grad φ_G. From these relationships, one can obtain two Laplace equations $\Delta\varphi = 0$ and $\Delta\varphi_G = 0$. And these homogeneous equations make it possible to formulate the boundary conditions at the surface of the sphere-VD: equality of the field components tangent to the surface of the sphere, i.e., $[\mathbf{E}_e\mathbf{n}]_{r=R} = [\mathbf{E}_i\mathbf{n}]_{r=R}$, $[\mathbf{E}_{Ge}\mathbf{n}]_{r=R} = [\mathbf{E}_{Gi}\mathbf{n}]_{r=R}$, and equality of the induction components normal to the surface of the sphere, i.e., $[\mathbf{D}_e\mathbf{n}]_{r=R} = [\mathbf{D}_i\mathbf{n}]_{r=R}$, $[\mathbf{D}_{Ge}\mathbf{n}]_{r=R} = [\mathbf{D}_{Gi}\mathbf{n}]_{r=R}$, where $\mathbf{n}$ is a unit vector of a normal to the surface of the sphere; r is a coordinate in a spherical coordinate system (r, θ, α); R is the radius of the sphere; $\mathbf{E}_e$, $\mathbf{E}_{Ge}$, $\mathbf{D}_e$, $\mathbf{D}_{Ge}$ are the fields and inductions outside the sphere $(r \geq R)$; $\mathbf{E}_i$, $\mathbf{E}_{Gi}$, $\mathbf{D}_i$, $\mathbf{D}_{Gi}$ are the fields and inductions inside the sphere $(r \leq R)$.

In the case in question, with $r \leq R$, the equations (80) can be represented as follows:

$$\mathbf{D}_i = \varepsilon_0 \mathbf{E}_i + \mathbf{P}_{EG}; \tag{84_1}$$

$$\mathbf{D}_{Gi} = \varepsilon_{0G} \mathbf{E}_{Gi} + \mathbf{P}_{GE}, \tag{84_2}$$

where $\mathbf{P}_{EG} = \varepsilon_1\mathbf{E}_{Gi}$ is the electrical polarization which develops inside the sphere as a result of the effect of the field $\mathbf{E}_{Gi}$ inside the sphere; $\mathbf{P}_{GE} = \varepsilon_1\mathbf{E}_i$ is the gravitational polarization which develops inside the sphere as a result of the effect of the field $\mathbf{E}_i$ inside the sphere.

With $r > R$, the equations (80) have the following form:

$$\mathbf{D}_e = \varepsilon_0 \mathbf{E}_e; \qquad\qquad \mathbf{D}_{Ge} = \varepsilon_{0G} \mathbf{E}_{Ge}; \qquad\qquad (85)$$

Finally, it is necessary to represent the conditions at infinity, i.e., as $r \to \infty$.

These conditions in the case in question of the immersion of a VD in a homogeneous electrical field $\mathbf{E}_0$ and a homogeneous gravitational field $\mathbf{E}_{0G}$ have the following form:

$$\mathbf{E}_e \to \mathbf{E}_0; \qquad \mathbf{E}_{Ge} \to \mathbf{E}_{0G}; \quad r \to \infty. \qquad\qquad (86)$$

In light of the conditions of (86), the solution of the problem in question should be sought in the following form:

$$\mathbf{E} = \mathbf{E}_0 + \mathbf{E}(\mathbf{P}_{EG}); \qquad\qquad (87_1)$$

$$\mathbf{E}_G = \mathbf{E}_{0G} + \mathbf{E}_G(\mathbf{P}_{GE}), \qquad\qquad (87_2)$$

where $\mathbf{E}(\mathbf{P}_{EG})$ is the electrical field of the VD which develops as a result of the effect of the polarization $\mathbf{P}_{EG}$; $\mathbf{E}_G(\mathbf{P}_{GE})$ is the gravitational field of the VD which develops as a result of the effect of the polarization $\mathbf{P}_{GE}$.

According to (86) and (87),

$$\mathbf{E}(\mathbf{P}_{EG}) \to \infty; \qquad \mathbf{E}_G(\mathbf{P}_{GE}) \to \infty; \qquad r \to \infty. \qquad\qquad (88)$$

Assume that the polarizations $\mathbf{P}_{EG}$ and $\mathbf{P}_{GE}$ are homogeneous. With such an assumption, two problems emerge: the problem of a homogeneously electrically polarized field, and the totally analogous problem of a homogeneously gravitationally polarized field. The solution of the former problem is well known. Consequently, one can formulate the solution to the latter problem as well. For fields from the polarizations $\mathbf{P}_{EG}$ and $\mathbf{P}_{GE}$ inside the sphere, these solutions have the following form:

$$\mathbf{E}_i(\mathbf{P}_{EG}) = -\frac{1}{3}\frac{\mathbf{P}_{EG}}{\varepsilon_0}; \qquad\qquad (89_1)$$

$$\mathbf{E}_{Gi}(\mathbf{P}_{GE}) = -\frac{1}{3}\frac{\mathbf{P}_{GE}}{\varepsilon_{0G}}; \quad r \le R. \qquad\qquad (89_2)$$

According to (87), the total fields inside the sphere can be represented in the following form:

$$\mathbf{E}_i = -\frac{1}{3}\frac{\mathbf{P}_{EG}}{\varepsilon_0} + \mathbf{E}_0; \qquad\qquad (90_1)$$

$$\mathbf{E}_{Gi} = -\frac{1}{3}\frac{\mathbf{P}_{GE}}{\varepsilon_{0G}} + \mathbf{E}_{0G}; \quad r \le R. \qquad\qquad (90_2)$$

It follows from (84) that

$$\mathbf{P}_{EG} = \varepsilon_1 \mathbf{E}_{Gi}; \qquad\qquad \mathbf{P}_{GE} = \varepsilon_1 \mathbf{E}_i; \qquad\qquad (91)$$

The relationships for fields inside the sphere-VD follow from the vector equations (90) and (91), and we present them in the following form:

$$\mathbf{E}_i = \frac{1}{1 - a_\varepsilon^2/9} \mathbf{E}_0 - \frac{a_\varepsilon \eta_0}{3\left(1 - a_\varepsilon^2/9\right)} \mathbf{E}_{0G};\qquad(92_1)$$

$$\mathbf{E}_{Gi} = \frac{1}{1 - a_\varepsilon^2/9} \mathbf{E}_{0G} - \frac{a_\varepsilon}{3\eta_0\left(1 - a_\varepsilon^2/9\right)} \mathbf{E}_0 ;\qquad(92_2)$$

where

$$a_\varepsilon = \frac{\varepsilon_1}{\sqrt{\varepsilon_0 \varepsilon_{0G}}} ;\qquad \eta_0 = \frac{\sqrt{\varepsilon_{0G}}}{\varepsilon_0} = 1.161 \cdot 10^{\,10} \text{ kg/Kl}$$

And now we shall present expressions for the polarizations inside the sphere-VD:

$$\mathbf{P}_{EG} = \frac{a_\varepsilon}{\eta_0\left(1 - a_\varepsilon^2/9\right)} \varepsilon_{0G} \mathbf{E}_{0G} - \frac{a_\varepsilon^2}{3\left(1 - a_\varepsilon^2/9\right)} \varepsilon_0 \mathbf{E}_0;\qquad(93_1)$$

$$\mathbf{P}_{GE} = \frac{a_\varepsilon \eta_0}{\left(1 - a_\varepsilon^2/9\right)} \varepsilon_0 \mathbf{E}_0 - \frac{a_\varepsilon^2}{3\left(1 - a_\varepsilon^2/9\right)} \varepsilon_{0G} \mathbf{E}_{0G} .\qquad(93_2)$$

The relationships of (93) define the polarizations $\mathbf{P}_{EG}$ and $\mathbf{P}_{GE}$ by way of given fields $\mathbf{E}_0$ and $\mathbf{E}_{0G}$ and parameters. These polarizations, in turn, make it possible to determine the fields outside the sphere-VD [31]. They can be represented conveniently in the form of components in spherical coordinate systems (r, θ', α') with a polar axis z' oriented in the direction of the polarization $\mathbf{P}_{EG}$ (electrical field), and (r, θ'', α'') with a polar axis z'' oriented in the direction of the polarization $\mathbf{P}_{GE}$ (gravitational field).

In the former case, the components of the electrical field from the polarization $\mathbf{P}_{EG}$ are expressed as follows:

$$E_{er}\left(\mathbf{P}_{EG}\right) = 2\frac{d \cdot \cos\Theta'}{4\pi\ r^3};\qquad(94_1)$$

$$E_{e\Theta'}\left(\mathbf{P}_{EG}\right) = \frac{d \cdot \sin\Theta'}{4\pi\ r^3},\qquad(94_2)$$

where $d = P_{EG} \cdot V$ is the electrical dipole of the VD; $V = (4\pi/3)R^3$ is the volume of the sphere-VD; P_{EG} is the vector module of $\mathbf{P}_{EG}$.

In the latter case, the components of the gravitational field from the polarization $\mathbf{P}_{GE}$ have the following form:

$$E_{Ger}\left(\mathbf{P}_{GE}\right) = 2\frac{d_G \cdot \cos\Theta''}{4\pi\ r^3};\qquad(95_1)$$

$$E_{Ge\Theta'}\left(\mathbf{P}_{GE}\right) = \frac{d_G \cdot \sin\Theta''}{4\pi \ r^3}, \tag{95$_2$}$$

where $d_G = P_{GE} \cdot V$ is the gravitational dipole of the VD; P_{GE} is the vector module of $\mathbf{P}_{GE}$.

The fields $\mathbf{E}_e$ and $\mathbf{E}_{Ge}$ outside the sphere-VD can be obtained from (87) by summation of the field components presented above (94) and (95) in the appropriate coordinate system with vector-constant components of $\mathbf{E}_0$ and $\mathbf{E}_{0G}$.

All the solutions presented above for the fields of the sphere-VD (89), (90) and (92), (94) satisfy the conditions at the surface of the sphere-VD and at infinity. The uniqueness of these solutions has been proven [30]. Hence the expressions for the polarizations inside the sphere-VD are the necessary and sufficient condition for obtaining solutions for the problem in question. Since the given fields $\mathbf{E}_0$ and $\mathbf{E}_{0G}$ are homogeneous, the polarizations $\mathbf{P}_{EG}$ and $\mathbf{P}_{GE}$ are also homogeneous according to (93).

3.2.3. A spherical vacuum domain in external magnetic and spin fields

The problem of a VD in the form of a sphere in homogeneous magnetic and spin fields in a case of the absence of substance, when one must assume in equations (83) $\mu = 1$ and $\mu_G = 1$, is similar to the problem of a VD in the form of a sphere in homogeneous electrical and gravitational fields, also in the absence of substance. Therefore, the outward form of the initial equations, boundary conditions and conditions at infinity will be identical in the two problems with the exception of the designations. It is necessary only to attend to the differences between the definitions of magnetic and spin inductions and the definitions of electrical and gravitational inductions. If $\mathbf{D} = \varepsilon_0\mathbf{E} + \mathbf{P}$ and $\mathbf{D}_G = \varepsilon_{0G}\mathbf{E}_G + \mathbf{P}_G$, then $\mathbf{B} = \mu_0\mathbf{H} + \mu_0\mathbf{M}$ and $\mathbf{B}_G = \mu_{0G}\mathbf{H}_G + \mu_{0G}\mathbf{M}_G$. Hence the analog of $\mathbf{P}$ is $\mu_0\mathbf{M}$, and the analog of $\mathbf{P}_G$, obviously, is $\mu_{0G}\mathbf{M}_G$.

It must also be taken into consideration that since $c = (\varepsilon_0\mu_0)^{-1/2} = (\varepsilon_{0G}\mu_{0G})^{-1/2}$, then

$$\eta_0 = \frac{\sqrt{\varepsilon_{0G}}}{\sqrt{\varepsilon_0}} = \frac{\sqrt{\mu_0}}{\sqrt{\eta_{0G}}} = 1.161 \cdot 10^{10} \text{kg/Kl}.$$

We shall note that the coefficient η_0 is included in many of the formulae of electrogravidynamics [3, 4, 6].

Thus, in light of the indicated differences between the problems of a sphere-VD in homogeneous electrogravitational and magnetospin fields in the absence of substance, the analog of (92) will be the following relationships:

$$\mathbf{H}_i = \frac{1}{1 - a_\mu^2/9}\mathbf{H}_0 - \frac{a_\mu}{3\eta_0\left(1 - a_\mu^2/9\right)}\mathbf{H}_{0s}; \tag{96$_1$}$$

$$\mathbf{H}_{si} = \frac{1}{1 - a_\mu^2/9}\mathbf{H}_{0s} - \frac{a_\mu\eta_0}{3\left(1 - a_\mu^2/9\right)}\mathbf{H}_0 ; \tag{96$_2$}$$

where $\mathbf{H}_0$ and $\mathbf{H}_{0S}$ are homogeneous magnetic and spin fields, respectively, outside the sphere-VD; $\mathbf{H}_i$ and $\mathbf{H}_{Si}$ are magnetic and spin fields, respectively, inside the sphere; $a_\mu = \mu_1(\mu_0\mu_{0G})^{-1/2}$.

Using this analogy, one must define the magnetic $\mathbf{M}_M$ and spin $\mathbf{M}_S$ polarizations in the case in question as follows:

$$\mu\mathbf{M}_M = \mu_1\mathbf{H}_{Si}; \qquad \mu_{0G}\mathbf{M}_S = \mu_1\mathbf{H}_i; \qquad (97)$$

It follows from (97) and (96) that

$$\mathbf{M}_M = \frac{a_\mu}{\eta_0\left(1 - a_\mu^2/9\right)}\mathbf{H}_{0S} - \frac{a_\mu^2}{3\left(1 - a_\mu^2/9\right)_0}\mathbf{H}_0; \qquad (98_1)$$

$$\mathbf{M}_S = \frac{a_\mu\eta_0}{\left(1 - a_\mu^2/9\right)}\mathbf{H}_0 - \frac{a_\mu^2}{3\left(1 - a_\mu^2/9\right)_0}\mathbf{H}_{0S}. \qquad (98_2)$$

The components of the magnetic field outside the sphere-VD which develops after the appearance of the polarization $\mathbf{M}_M$ in a spherical coordinate system (r, θ', α') with a polar axis z' oriented in the direction of the polarization $\mathbf{M}_M$ have the following form:

$$H_{er}\left(\mathbf{M}_M\right) = 2\frac{l_M\cos\Theta'}{4\pi\ r^3}; \qquad (99_1)$$

$$H_{e\Theta'}\left(\mathbf{M}_M\right) = \frac{l_M\sin\Theta'}{4\pi\ r^3}, \qquad (99_2)$$

where $l_M = M_M V$ is the magnetic moment of the VD; V is the volume of the sphere-VD; M_M is the vector modulus of $\mathbf{M}_M$.

We shall represent the components of the spin field outside the sphere-VD from the polarization $\mathbf{M}_S$ in a spherical coordinate system (r, θ'', α'') with a polar axis z'' oriented in the direction of the polarization $\mathbf{M}_S$ in a manner analogous to the previous relationships:

$$H_{Ser}\left(\mathbf{M}_S\right) = 2\frac{l_S\cos\Theta''}{4\pi\ r^3}; \qquad (100_1)$$

$$H_{Se\Theta''}\left(\mathbf{M}_S\right) = \frac{l_S\sin\Theta''}{4\pi\ r^3}, \qquad (100_2)$$

where $l_S = M_S V$ is the spin moment of the VD; M_S is the vector modulus of $\mathbf{M}_S$.

While the expressions for the fields $\mathbf{H}_i$ and $\mathbf{H}_{Si}$ are complete according to (96), the components of the fields $\mathbf{H}_e(\mathbf{M}_M)$ and $\mathbf{H}_{Se}(\mathbf{M}_S)$ must be summed with the components of the homogeneous fields $\mathbf{H}_0$ and $\mathbf{H}_{0S}$.

3.2.4. The energy of a vacuum domain in electrical, gravitational, magnetic and spin fields

The most important result of the solution of the problems of a VD in the form of a sphere in electrical, gravitational and magnetospin homogeneous fields is the determination of two dipoles of the VD – electrical $\mathbf{d}$ and gravitational $\mathbf{d}_G$, and two moments of the VD – magnetic $\mathbf{l}_M$ and spin $\mathbf{l}_S$. According to (91), the vector $\mathbf{d}$ is directed according to the orientation of the polarization $\mathbf{P}_{GE}$, while the vector $\mathbf{d}_G$ is directed according to the orientation of the polarization $\mathbf{P}_{EG}$; and, according to (97), $\mathbf{l}_M$ is directed according to the orientation of the polarization $\mathbf{M}_S$, while the vector $\mathbf{l}_S$ is directed according to the orientation of the polarization $\mathbf{M}_M$.

Determining the dipoles and moments of the VD (the moments of the VD can also be referred to as magnetic and spin dipoles) makes it possible to determine the energy of the VD associated with the four fields: $\mathbf{E}_0$, $\mathbf{E}_{0G}$, $\mathbf{H}_0$ and $\mathbf{H}_{0S}$.

The classical calculation of the energy of an isolated dipole in an electrical field has been performed in the theory of electricity by Tamm [61]. On the basis of this calculation, the energy of the VD as a four-dipole in four fields should be represented in the following form:

$$W = W_E + W_G + W_M + W_S \tag{101}$$

where

$$W_E = -\mathbf{d}\mathbf{E}_0; \qquad\qquad W_G = -\mathbf{d}_G\mathbf{E}_{0G};$$
$$W_M = -\mu_0 \mathbf{l}_M\mathbf{H}_0; \qquad\qquad W_S = -\mu_{0G}\mathbf{l}_S\mathbf{H}_{0S}.$$

According to (93), we shall express the energies W_E and W_G as follows:

$$W_E = \left[\frac{2a_\varepsilon^2}{3\left(1 - a_\varepsilon^2/9\right)}W_{0E} - \frac{2a_\varepsilon}{1 - a_\varepsilon^2/9}W_{0EG}\right]\cdot V, \tag{102}$$

where,

$$W_{0E} = \frac{\varepsilon_0\mathbf{E}_0^2}{2} = \frac{\varepsilon_0 E_0^2}{2}; \qquad W_{0EG} = \sqrt{\varepsilon_{0G}\varepsilon_0}\,\frac{\mathbf{E}_0\mathbf{E}_{0G}}{2},$$

$$W_G = \left[\frac{2a_\varepsilon^2}{3\left(1 - a_\varepsilon^2/9\right)}W_{0G} - \frac{2a_\varepsilon}{1 - a_\varepsilon^2/9}W_{0GE}\right]\cdot V, \tag{103}$$

where,

$$W_{0G} = \frac{\varepsilon_{0G}E_{0G}^2}{2}; \qquad W_{0GE} = W_{0EG.}$$

According to (98), the energies W_M and W_S can be represented as follows:

$$W_M = \left[\frac{2a_\mu^2}{3\left(1 - a_\mu^2/9\right)} W_{0M} - \frac{2a_\mu}{1 - a_\mu^2/9} W_{0MS} \right] \cdot V, \qquad (104)$$

where, $W_{0M} = \dfrac{\mu_0 H_0^2}{2};$ $\qquad W_{0MS} = \sqrt{\mu_0 \mu_{0G}} \, \dfrac{\mathbf{H}_0 \mathbf{H}_{0S}}{2},$

$$W_S = \left[\frac{2a_\mu^2}{3\left(1 - a_\mu^2/9\right)} W_{0S} - \frac{2a_\mu}{1 - a_\mu^2/9} W_{0SM} \right] \cdot V, \qquad (105)$$

where, $W_{0S} = \dfrac{\mu_{0G} H_{0S}^2}{2};$ $\qquad W_{0SM} = W_{0MS}.$

General speaking, the fields $\mathbf{E}_0$, $\mathbf{E}_{0G}$, $\mathbf{H}_0$ and $\mathbf{H}_{0S}$ depend on three-dimensional coordinates, but they can be considered approximately as constants within the VD. Therefore, the dipole forces acting on the VD can be defined as follows [61]:

$$\mathbf{F}_{DE} = -\nabla W_E; \qquad (106_1)$$
$$\mathbf{F}_{DG} = -\nabla W_G; \qquad (106_2)$$
$$\mathbf{F}_{DM} = -\nabla W_M; \qquad (106_3)$$
$$\mathbf{F}_{DS} = -\nabla W_S; \qquad (106_4)$$

where ∇ is the gradient operator.

These dipole forces have already been considered but were not defined in the previous chapter in the study of the equation of motion of the VD.

3.2.5. The energy densities of fields on the Earth

According to the expressions (102)-(105), the four energies of the VD of a four-dipole depend on two coefficients, a_ε and a_μ, and four vector fields, $\mathbf{E}_0$, $\mathbf{E}_{0G}$, $\mathbf{H}_0$ and $\mathbf{H}_{0S}$.

One must assume that the coefficients a_ε and a_μ can have values of the order of $1/N$, where N is the form factor of the VD. For example, we know from electrostatics and magnetostatics [30, 31] that $N = 1/3$ for a sphere. Only with such an assumption can one explain the explicit features of levitation and rotation of gas inside BL and NSLF. Three field vectors have been measured on the surface of the Earth: $\mathbf{E}_0$, $\mathbf{E}_{0G}$ and $\mathbf{H}_0$ [78]. Based on the equation of Heaviside $\operatorname{rot} \mathbf{H}_G \cong -\mathbf{J}_G$, one can estimate the value and direction of the vector of the spin field $\mathbf{H}_{0S}$, keeping in mind that it is related to the rotation of the Earth around its axis. One can assume that the vectors of $\mathbf{E}_0$ and

$\mathbf{E}_{0G}$ are collinear. The vectors of $\mathbf{H}_0$ and $\mathbf{H}_{0S}$ clearly are not collinear, but they may be considered collinear in a rough approximation.

Table 4 presents the values of fields E_0, E_{0G}, H_0 and H_{0S} and the energy densities W_{0E}, W_{0G}, W_{0M} and W_{0S}, and

$$W_{0EG} = \sqrt{W_{0E}W_{0G}}; \qquad\qquad W_{0MS} = \sqrt{W_{0M}W_{0S}};$$

at the surface of the Earth, on the assumption of collinearity of the vectors of $\mathbf{E}_0$, $\mathbf{E}_{0G}$, $\mathbf{H}_0$ and $\mathbf{H}_{0S}$.
Table 4

Fields at the surface of the Earth	Energy densities, J/m³	
Electrical (average) $E_0 = 130$ V/m	$W_{0E} = 7.5 \cdot 10^{-8}$	$W_{0EG} = 66$
Gravitational (pole) $E_{0G} = 9.83$ m/s²	$W_{0G} = 5.8 \cdot 10^{10}$	
Magnetic (pole) $H_0 = 19.5$ A/m	$W_{0M} = 2.4 \cdot 10^{-4}$	$W_{0MS} = 10^{-2}$
Spin (pole) $H_{0S} = 10^{13}$ kg/(m · s)	$W_{0S} = 0.5$	

One can see from the data of this table that the gravitational field energy density exceeds the energy densities of electrical, magnetic and spin fields, as well as the energy densities W_{0EG} and W_{0MS}, by several orders.

One must recall that the VD is being considered in its initial state characterized by the conditions $\rho = 0$ and $\rho_G = 0$, i.e., in a state of the total absence of electrical and gravitational interaction with substance.

One can say based on the data of Table 4 that the movement of VD in the fields of Earth is defined in the first approximation by forces related to the density of gravitational energy W_{0G}, but only up to the moment in time when the condition of the absence of substance is no longer in effect.

However, one can perform a preliminary, particularly theoretical investigation of the immersion of a VD in the fields of the Earth without considering the electrical interaction of the VD with substance.

According to (101) and (102), with $W_{0G} \gg W_{0E}$, W_{0M}, W_{0S}, W_{0GE} and W_{0SM}, the full dipole energy of the VD can be represented as follows:

$$W \cong W_G \cong \frac{2a_\varepsilon^2 \cdot V}{3(1 - a_\varepsilon^2/9)} W_{0G}. \tag{107}$$

Since $W_{0G} = \varepsilon_{EG}E^2_{EG}/2$, this energy density can be calculated according to the magnitude of free fall acceleration, designated as E_G.

Table 5 presents the values of E_{0G} and W_{0G} for an internal region of the Earth depending on the radius r [78].

Table 5

R, km	E_{0G}, m/s^2	W_{0G}, 10^9 J/m^3
0	0	0
1217.1	4.36	11.35
3485.7	10.69	68.20
5701.0	10.01	59.79
5951.0	9.976	59.36
6352.0	9.837	57.72
6371.0	9.819	57.51

Outside the Earth, where $r > R_E$, where $R_E = 6371$ km is the radius of the Earth, the density of gravitational energy can be calculated based on Newton's Law, neglecting the mass of the atmosphere. The expression is as follows:

$$W_{0G} = 57.51 \cdot \frac{(6371.0)^4}{r^4} \cdot 10^9 = 0.947 \cdot 10^{26} r^{-4} \text{ J/m}^3.$$

One can compute the derivative

$$-\frac{dW_{0G}}{dr}\bigg|_{r=R_3} = 3.61 \cdot 10^4 \text{ N/m}^3.$$

Figure 6 shows diagrams of the change in the dipole energy W_G of the VD depending on the radius r at $|a_\varepsilon| < 3$ and $|a_\varepsilon| > 3$.

One can see from the figure that at $|a_\varepsilon| < 3$, the energy W_G has a peak at approximately $r = 3485.7$ km. This is the Wichert-Gutenberg boundary that separates the mantle and core of the Earth [78]. Since the energy W_G is potential for the forces acting on the VD, one can say that at $|a_\varepsilon| < 3$, a potential barrier occurs and prohibits the penetration of the VD into the Earth. Under this condition, the VD is repelled from the Earth. But if the VD manages to overcome this barrier in some way, it gets into a potential depression, the minimum of which coincides with the center of the Earth.

On the other hand, with $|a_\varepsilon| > 3$, a potential depression occurs on the Earth with an energy minimum in the area of the boundary between the mantle and the core. However, the region of the Earth's core itself is enclosed by a potential barrier, and under the condition indicated above of $|a_\varepsilon| > 3$, the VD does not penetrate this region.

In the case $|a_\varepsilon| < 3$, a repelling force as follows acts on every m^3 of volume of the VD at the surface of the Earth, according to (106):

$$+2.4 \cdot 10^4 \cdot \frac{a_\varepsilon^2}{1 - a_\varepsilon^2/9}, \frac{\text{H}}{\text{m}^3}.$$

In the case $|a_\varepsilon| > 3$, an attracting force as follows acts on every m^3 of volume of the VD at the surface of the Earth:

$$-2.4 \cdot 10^{4} \cdot \frac{a_{\varepsilon}^{2}}{1 - a_{\varepsilon}^{2}/9}, \quad \frac{H}{m^{3}}.$$
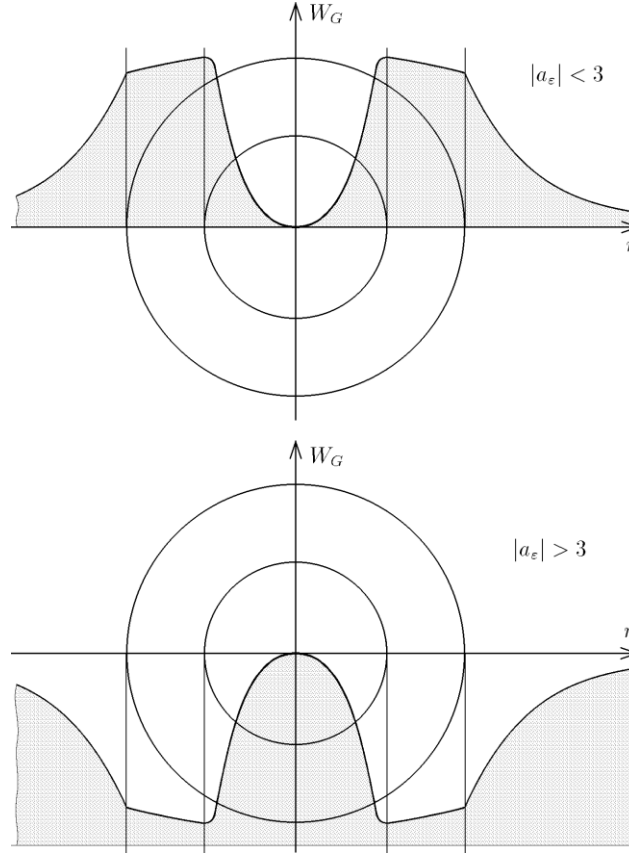
Fig. 6.

In the approximation in question, there is no apparent difference in the interaction of the VD with the Earth at either $a_{\varepsilon} > 0$ or $a_{\varepsilon} < 0$; i.e., one can draw the false conclusion that VD consisting of PVM or PVA can get to the same place from this approximation. In the present approximation, the second members of the expressions (102)-(105) proportionate to a_{ε} and a_{μ}, which change the sign of these expressions with reversal of the sign of the respective coefficients, are eliminated. It is just these second members which define the separation of vacuum domains consisting of PVM or PVA in space.

Based on the dependence of the energy W_G on the radius r represented in Fig. 6, one can conclude that at $\left| a_{\varepsilon} \right| < 3$, the VD do not penetrate, while at $\left| a_{\varepsilon} \right| > 3$ the VD do penetrate deep into the Earth. However, one must take into consideration the electrogravitational depolarization of the VD on the Earth, i.e., the decrease in electrical and gravitational polarizations of the VD as a result of attraction of negative electrical charges to the positive pole of the electrical dipole of the VD and of positive electrical charges of substance to the negative pole of the electrical dipole.

Hence the electrogravitational depolarization of the VD changes the nature of the interaction of the VD with the fields of the Earth in a fundamental way.

3.2.6. The electrogravitational depolarization of a vacuum domain

The nature of the electrogravitational interaction of VD with substance is determined by the initial values of electrical and gravitational polarizations of the VD on the Earth. These polarization values can be determined based on the relationships of (93), for a case in which a VD is located at the surface of the Earth, for example.

Four components of electrical and gravitational polarizations of VD attributed to dimensionless coefficients $k_{1\varepsilon} = a_\varepsilon/(1 - a_\varepsilon^2/9)$ (first member) and $k_{2\varepsilon} = a_\varepsilon^2/(3(1 - a_\varepsilon^2/9))$ (second member) are presented in Table 6, according to (93).

Table 6

Electrical polarization	
$\left\| \dfrac{\varepsilon_{0G} E_{0G}}{\eta_0} \right\| \cong 1 \dfrac{\text{Kl}}{\text{m}^2}$	$\left\| -\varepsilon_0 E_0 \right\| \cong 10^{-9} \dfrac{\text{Kl}}{\text{m}^2}$

Gravitational polarization	
$\left\| \eta_0 \varepsilon_0 E_0 \right\| \cong 10 \dfrac{\text{kg}}{\text{m}^2}$	$\left\| -\varepsilon_{0G} E_{0G} \right\| \cong 10^{10} \dfrac{\text{kg}}{\text{m}^2}$

The coefficients $k_{1\varepsilon}$ and $k_{2\varepsilon}$ can have values of the order of one or more. In this case, the theory in question makes it possible to explain the strong physical effects on the Earth – levitation, in particular – which are associated with NSLF. At the indicated values of the coefficients $k_{1\varepsilon}$ and $k_{2\varepsilon}$ presented in Table 6, dimensional variables can be considered characteristic of the components of electrical and gravitational polarizations.

One can see from the data of Table 6 that in calculating the polarizations, the components of electrical and gravitational polarizations related to the gravitational field of the Earth have an exceptionally large value. The components of polarizations related to the electrical field of the Earth, on the other hand, are negligible.

The value of the electrical polarization of a VD 1 Kl/m^2 is comparable to the record values of polarizations of ferrielectrics. The value of the gravitational polarization 10^{10} kg/m^2 means that the gravitational dipole of a VD with a volume of 1 m^3 has a dipole moment $d_G \cong 10^{10}$ kg · m. The positive and negative masses of the dipole of a VD in the form of a sphere have values of the order of $\pm 10^{10}$ kg (plus or minus 10 million tons).

At the same time, even with the value of the electrical polarization in the Earth's atmosphere indicated above, an electrical discharge between poles of the electrical dipole of the VD and, as a result, the electrical depolarization of the VD are inevitable. Inside the Earth, where the conductivity of the rock is high, almost complete electrical depolarization of the VD should occur. A slight mass in the form of cations and anions of the order of 10^{-8}–10^{-7} kg in the presence of electrical charges of the dipole of the VD of the order of ± 1 Kl is sufficient for full electrical depolarization of the VD in the atmosphere. On the other hand, direct gravitational depolarization

of the VD is impossible. A VD at the surface of the Earth and inside it is actually surrounded by positive mass only. The gravitational dipole under such conditions cannot be destroyed. The only possibility is that captured positive gravitational mass can be attached to the dipole. The captured mass obviously can be attached only to the positive pole of the gravitational dipole. In the Earth's atmosphere, gas will be compressed at the positive pole and rarefied at the negative pole of the dipole.

In electrical depolarization of VD, the bound surface electrical charges of the VD are surrounded by free electrical charges of substance of the opposite sign. One can construct a model of electrogravitational depolarization of VD on the assumption that the depolarizing free electrical charges are proportionate to the bound electrical charges at the surface of the sphere-VD. Then the equations (90) and (91), neglecting the value of the electrical field of the Earth ($E_0 = 0$), will have the following form:

$$E_i = -\frac{1}{3}\frac{P_{EG}}{\varepsilon_0} + E_{Di};$$ (108₁)

$$E_{Gi} = -\frac{1}{3}\frac{P_{GE}}{\varepsilon_{0G}} + E_{0G};$$ (108₂)

$$P_{EG} = \varepsilon_1 E_{Gi};$$ (108₃)

$$P_{GE} = \varepsilon_1 E_i,$$ (108₄)

where E_{Di} is the homogeneous depolarizing intensity of the electrical field inside the sphere-VD associated with the free electrical charges.

The assumption made above that the free and bound electrical charges are proportionate makes it possible to consider the field E_{Di} homogeneous inside the sphere-VD. For determining the electrical field outside the sphere-VD, of course, neglecting the field of the Earth E_0, we shall introduce the pseudopolarization $P_D = 3\varepsilon_0 E_{Di}$ associated with the free electrical charges. Then one can introduce the equivalent polarization of the sphere-VD $P_{EG} - P_D$ and determine the equivalent electrical dipole moment of the VD $d_D = (P_{EG} - P_D)V$. With such an approach, the electrical field outside the sphere must be determined according to the formulae (94), with substitution of d_D for d.

The energy of the VD as a gravitational dipole in a gravitational field, according to (101), is expressed as follows:

$$W_G = -\varepsilon_1 E_i E_{0G} V.$$ (109)

According to (108) and (109), this energy in the case in question with the capture of free electrical charges of substance can be represented as follows:

$$W_G = \frac{2}{3} \cdot \frac{a_\varepsilon^2 V}{1 - a_\varepsilon^2/9} \cdot W_{0G}\left(1 - \frac{3}{a_\varepsilon}\frac{\sqrt{W_D}}{\sqrt{W_{0G}}}\right),$$ (110)

where $W_D = \varepsilon_0 E^2_{Di}/2$ is a parameter with an energy density dimension characterizing the effect of the electrical field on the gravitational energy inside the VD.

In the Earth's atmosphere, the field E_{Di} of the domain changes in jumps with each successive electrical breakdown inside the VD. The breakdown sets in at $E_i \geq E_{br}$, where E_{br} is the maximum of the electrical field intensity before breakdown of the gas of the Earth's atmosphere. The value of E_{br} obviously depends heavily on the pressure, i.e., the elevation above sea level, the humidity, the dust content and the degree of ionization of the gas of the atmosphere. To determine E_{br}, one can use reference and published data cited in [98].

The dependence of the energy $W_G(r)$ for a case of movement of a VD in the atmosphere of the Earth produces the relationship (110) with $W_D = const$ and the condition $E_i < E_{br}$. With $E_i = E_{br}$, an electrical discharge, i.e., a breakdown, is initiated in the VD. One can assume that this process continues to the point of full compensation for the bound vacuum electrical charges of the VD by the free electrical charges of substance, i.e., to a state of the VD characterized by the condition $E_i = 0$. According to (109), a change in the energy W_G from the value $W_G = \pm\varepsilon_1 E_{br} E_{0G} V$ to the value $W_G = 0$ occurs in this way.

The rock inside the Earth possesses relatively high electrical conductivity. Therefore, in a first approximation for this case, one can assume the electrical field $E_i = 0$ and, consequently, $W_G = 0$.
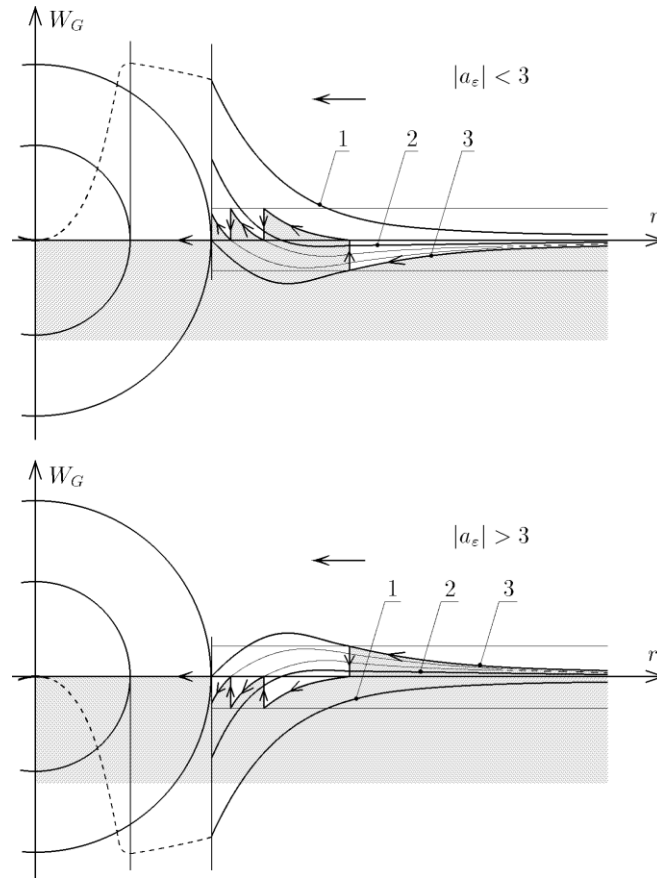
Fig. 7.

Figure 7 shows the dependence of the energy W_G outside the Earth on the radius r at $|a_\varepsilon| < 3$ and $|a_\varepsilon| > 3$ for cases of the movement of a VD toward the Earth, due to sufficiently great kinematic energy of the VD, for example. The fine horizontal lines indicate the values of W_G corresponding to electrical breakdown inside the VD at $W_G = \pm\varepsilon_1 E_{br}E_{0G}V$. The solid curves indicate families of $W_G(r)$ according to (110) with: *1) $W_D = 0$; 2) $W_D = 0.5 \cdot (a_\varepsilon^2/9)W'_{0G}$; 3) $W_D = (a_\varepsilon^2/9)W'_{0G}$,* where $W'_{0G} = 5.8 \cdot 10^{10}$ J/m^3 is the density of the energy of the gravitational field at the Earth's surface.

One can see from Fig. 7 that in the case of a weak effect of all forces except the gravitational force on the VD, at $|a_\varepsilon| < 3$, the VD hovers above the Earth at different altitudes depending upon the magnitude of the free electrical charges captured in space ($W_D \neq 0$). Under the same conditions with $|a_\varepsilon| > 3$, the VD has a potential barrier which prevents its penetration to the Earth. If the VD should overcome this barrier, due to its own kinetic energy associated with capture mass, for example, it then inevitably goes deep into the Earth.

As one can see from Fig. 7, jumps in the energy W_G of two types occur: increases and decreases. The energy jumps upward correspond to the transition of a certain portion of the energy of the gravitational field into energy of the VD. This portion is greater than the energy $W_G = \varepsilon_1 E_{br}E_{0G}V$, since part of it is spent on the release of heat. Energy jumps downward correspond to the transition of a portion of the energy $W_G = \varepsilon_1 E_{br}E_{0G}V$ into heat; i.e., previously stored gravitational energy of the VD is transformed into heat.

Part of the gravitational energy passes into heat during the time of an electrical discharge in the VD. According to the laws of an electrical discharge, the time is extremely short. Therefore, the passage of energy in question is accompanied by an explosion effect.

One can compute the energy of the explosion of the VD (the VD is preserved after the explosion) in the atmosphere at the Earth's surface at a diameter of the VD of 0.23 m, i.e., the characteristic diameter of BL. According to (109),

$$W_G = |\varepsilon_1| E_{br} E_{0G} V = 2 |a_\varepsilon| \sqrt{W_{0G} W_{br}} \cdot V,$$

where $W_{br} = \varepsilon_0 E^2_{br}/2$.

With a VD diameter of 0.23 m, $E_{br} = 3 \cdot 10^6$ V/m, $V = 4\pi R^3/3 = 0.00637$ m^3, where R is radius of the VD; $W_{0G} = 5.8 \cdot 10^{10}$ J/m^3; $W_{br} \cong 40$ J/m^3. Consequently,

$$W_d \cong 2 |a_\varepsilon| \cdot 10^4 \, \text{J}.$$

At $|a_\varepsilon| \sim 1$, the energy of the explosion of a VD is precisely equal to the energy of explosion of average BL [10]. One can comment that in such an explosion, the total electrical energy $3W_{br} \cdot V \cong 0.76$ J is release; i.e., it passes into heat. Hence almost all the energy of explosion of a VD is the result of a rapid change in the gravitational field of the VD.

It is appropriate to emphasize that not only almost complete electrical depolarization but also almost complete gravitational depolarization of the VD occurs as a result of the electrical discharge inside it.

3.2.7. The relationship of spin polarization to the tensor of spin mechanical stresses

According to (98), the magnetic and spin polarizations of a spherical VD can be represented as follows:

$$\mathbf{M}_M = k_{1\mu} \frac{1}{\eta_0} \mathbf{H}_{0S} - k_{2\mu} \mathbf{H}_0; \tag{111$_1$}$$

$$\mathbf{M}_S = k_{1\mu} \eta_0 \mathbf{H}_0 - k_{2\mu} \mathbf{H}_{0S}, \tag{111$_2$}$$

where $k_{1\mu} = a_\mu/(1 - a_\mu^2/9)$ and $k_{2\mu} = a_\mu^2/(3(1 - a_\mu^2/9))$.

The numerical values of the components of these polarizations attributed to the coefficients $k_{1\mu}$ (first member) and $k_{2\mu}$ (second member) at the surface of the Earth are presented in Table 7.

Table 7

Magnetic polarization	
$\left| H_{0S} / \eta_0 \right| \cong 10^3 \, \text{A/m}$	$\left| -H_0 \right| \cong 20 \, \text{A/m}$

Spin polarization	
$\left|\eta_0 H_o\right| \cong 10^{11}\,\mathrm{kg}/(\mathrm{m}\cdot\mathrm{s})$	$\left|-H_{0S}\right| \cong 10^{13}\,\mathrm{kg}/(\mathrm{m}\cdot\mathrm{s})$

One can see from the data of the table that with $k_{1\mu} \sim 1$ and $k_{2\mu} \sim 1$ ($a_\mu \sim 1$) in the magnetic and spin fields of the Earth, the magnetic polarization of a VD has a model value, since the polarization-permeability of ferromagnetics $\sim 10^6$ A/m and for ferrite $\sim 10^5$ A/m. The value of the spin polarization under the conditions in question, on the other hand, is extremely great. Moreover, both of the components of the spin polarization associated with both the magnetic and spin fields of the Earth are also great. One recalls that the spin polarization has the physical sense of the density of the moment of the quantity of motion.

Since the axes of rotation of spin and magnetic poles of the Earth do not coincide (they diverge by approximately $11°$ [84]), the vectors of magnetic $\mathbf{H}_0$ and spin $\mathbf{H}_{0S}$ fields do not coincide in direction (are not collinear) at any point on the surface of the Earth.

Consequently, the vectors of $\mathbf{M}_M$ and $\mathbf{H}_0$ and of $\mathbf{M}_S$ and $\mathbf{H}_{0S}$ are not collinear either. Therefore, two moments of forces not equal to zero act on the VD: $\mathbf{T}_M = [\mathbf{l}_M \mathbf{B}_0]$, where $\mathbf{l}_M = \mathbf{M}_M V$ and $\mathbf{B}_0 = \mu_0 \mathbf{H}_0$, and $\mathbf{T}_S = [\mathbf{l}_S \mathbf{B}_{0S}]$, where $\mathbf{l}_S = \mathbf{M}_S V$ and $\mathbf{B}_{0S} = \mu_{0G} \mathbf{H}_{0S}$.

According to (111),

$$\mathbf{T}_M + \mathbf{T}_S = \frac{k_{1\mu} \mu_0 V}{\eta_0}\left[\mathbf{H}_0 \mathbf{H}_{0S}\right] + k_{1\mu} \mu_{0G} \eta_0 V\left[\mathbf{H}_{0S} \mathbf{H}_0\right] =$$

$$k_{1\mu} \sqrt{\mu_0 \mu_{0G}} \cdot V\left(\left[\mathbf{H}_0 \mathbf{H}_{0S}\right]\right) + \left[\mathbf{H}_{0S} \mathbf{H}_0\right] \equiv 0. \tag{112}$$

The expressions of (111) characterize strictly defined quantitative relationships for the values and orientations of magnetic and spin polarizations of VD in space, depending upon the values and orientations of the magnetic field $\mathbf{H}_0$ and the spin field $\mathbf{H}_{0S}$ of the Earth. The condition (112) obviously is a necessary condition for the fulfillment of the relationships of (111).

For obtaining representations of the magnetospin interaction of VD with the substance of the Earth (i.e., air and water vapor of the atmosphere, and water and solid rock), it is necessary to pause to consider the physical basis of one of the great experiments in the history of physics – the Einstein-de Haase experiment [60, 61]. The essence of this experiment was the rotation of a rod of ferromagnetic material suspended on a fine, flexible thread as a function of a change in the orientation of a remagnetized magnetic field. In addition to confirmation of well-known microscopic ideas which form the basis for the theory of the remagnetization of magnetic materials, ferromagnetic and nuclear resonance described by the equations of Landau-Lifshits, Hilbert, and Bloch, [32, 34, 62], the Einstein-de Haase experiment demonstrated the physical reality of the macroscopic moment on the quantity of motion of substances associated with microscopic spins and orbital magnetic moments. The density of this moment of the quantity of motion was called the spin polarization. In the Heaviside theory, this variable also has field content similar to that of the magnetic polarization (magnetization).

Hence the Einstein-de Haase experiment made it possible to discover the specific type of mechanical interaction of a magnetic field and substance: gyromagnetic effects characterizing the relationship of the magnetic field and the rotating movement of magnetics. The same experiment on the basis of the Heaviside theory, makes it possible to predict another type of interaction of field and substance: gyrospin effects – the relationship of a spin field with the rotating movement of spinorics – of materials possessing a large spin polarization.

In the Einstein-de Haase experiment, the rotation of the model actually occurs as a result of the change in the spin polarization, i.e., the density of the moment of the quantity of motion due to the effect of the magnetic field on the magnetic polarization, which has a rigid connection to the spin polarization. However, while only a change in the spin polarization of the specimen will occur as a result of the effect of spin field, the effect will be the same – rotation of the specimen will occur in connection with the change in the moment of the quantity of motion.

Of the various substances, the strongest spinorics are, at the same time, the strongest magnetics; i.e., the strong spinorics are ferromagnetics. The spin polarization of ferromagnetics, according to (53), $M_S = M_M/2\gamma$, where $\gamma \cong e/m_e$ is the gyromagnetic ratio in a case where spins prevail over orbital moments, where e and m_e are the electrical charge and mass of an electron, respectively. With $M_M \cong 10^6$ A/m, $M_S \cong 3 \cdot 10^{-6}$ kg/(m · s).

It is known that ferromagnetics undergo magnetic reversal when the magnetic field exceeds the level of the coercive force H_c. According to (56), one should expect that ferromagnetics, as spinorics, change the spin polarization at a spin field value greater than the value $H_c = 2\gamma\mu_0 H_c/\mu_{0G}$. If $H_c = 1$ A/m is taken as an example, then $H_{cS} \cong 5 \cdot 10^{31}$ kg/(m · s). Hence, for the remagnetization of a ferrospinoric, a spin field level much greater than the spin field of the Earth – 10^{13} kg/(m · s) – is necessary.

A VD qualitatively is simultaneously a magnetic and a spinoric analog. The only difference between the VD and ordinary magnetics-spinorics, which are normally solids, is that it is penetrable for substance.

It is just this property of a VD which makes it possible to interact with substance not only by way of magnetic and spin fields, i.e., due to the Lorentz electrical and gravitational force, but also by means of gyromagnetic and gyrospin effects.

A VD, as a magnetic, differs quantitatively from normal magnetics not only strongly but, as a spinoric, fundamentally. One can see from the data of Table 6 that the spin polarization value of a VD can reach 10^{13} kg/(m · s), while this polarization value for ferromagnetics, as one can see from the evaluation presented above, is only $3 \cdot 10^{-6}$ kg/(m · s). In addition, a VD has no field thresholds in the form of coercive forces at which polarization changes are initiated. In the VD model under consideration, according to (111), the polarizations are linear functions of fields.

Thus consideration of the physical nature of the Einstein-de Haase experiment forces one to direct attention to the spin polarization of the VD as a factor of strong mechanical, especially rotating interaction of the VD with substance.

The spin moment M_S emerges in the continuum mechanics constructed by Sedov [83] as the internal moment of the quantity of motion. Sedov devoted attention to the fact that even in the APV, in magnetic fields, such as the magnetic field of the Earth, spin polarization develops in practically all media: diamagnetics, paramagnetics and ferromagnetics. This mechanical factor is not taken into account at all in the classical continuum theories: hydromechanics, elasticity theory, etc. One state *a priori* that the spin polarization of media in the APV is slight. However, it is of interest nevertheless to verify whether the gyromagnetic effect is slight in each specific case.

The dipole nature of the non-homogeneous physical vacuum results in its weak force interaction with fields and substance. On the other hand, the model predicts strong interaction due to the moments of these forces. However, the authors of the modern conceptions normally do not make reference to moment equations, either in continuum mechanics or in elasticity theory or in hydromechanics. In those rare cases in which the moment equations nevertheless are considered, this is done only to demonstrate their identity with impulse equations. This result is a direct consequence of the *a priori* assumption that there are no internal moments in the medium, and, as

a result, the tensor of stresses is symmetrical. Sedov constructs continuum mechanics in a more general statement [83]. As an example of a medium with internal moments, he examines a ferromagnetic in a magnetic field and cites the Einstein-de Haase experiment referred to above, which illustrates the manifestation of internal moments. The equation of moments for such a medium does not degenerate into an identity but, in the case of VD, gives rise to the relationship

$$\frac{d\mathbf{M}_S}{dt} = \mathbf{i}\left(\tau_{jk} - \tau_{ik}\right) + \left(\tau_{ij} - \tau_{ji}\right), \tag{113}$$

where τ_{ij} are components of an asymmetrical stress tensor; M_S represents the density of the moment of the quantity of motion; $\mathbf{i}$, $\mathbf{j}$ and $\mathbf{k}$ are unit vectors on the axes x, y and z axes, respectively.

Hence the assumption that the internal moments are equal to zero and, as a result, that the stress tensor is symmetrical limits the range of problems which can be solved correctly to the condition of a constant polarization vector.

One can see from equation (113) that the time derivative from the spin polarization M_S is a factor of the rotating movement of substance inside a VD. At $dM_S/dt \neq 0$, in particular, the tensor of mechanical stresses becomes asymmetrical; i.e., mechanical torque develops inside the VD as a result of unbalanced tangential mechanical stresses. Actually, in the case of an unchanged direction of the vector of M_S along the z-axis, according to (113), we have the following:

$$\frac{dM_{Sx}}{dt} = 0; \qquad \frac{dM_{Sy}}{dt} = 0; \qquad \frac{dM_{Sz}}{dt} = \tau_{yx} - \tau_{xy}, \tag{114}$$

Consequently, $\tau_{xy} \neq \tau_{yx}$, where τ_{xy} and τ_{yx} are mechanical tangential stresses in the plane xy inside the formation.

Hence, according to (114), the intensity of the rotating movement inside the VD depends on the time derivative of the spin polarization and, according to (111), also depends on the time derivatives of the magnetic and spin fields of the Earth. Variations in the geomagnetic field in time are cited in the geophysics literature [85]. In particular, the field changes during magnetic storms. Little is known as yet about the spin field of the Earth; it is still not being measured. There is no doubt, however, that it changes with changes in the angular frequency of rotation of the Earth around its axis. In one year, the ratio $\Delta\omega/\omega$ has an order of 10^{-8}, where ω is the angular rotation frequency of the Earth, and $\Delta\omega$ is the change in it. However, the simplest cause of a change in the value of M_S in time inside a VD, according to (111), is related to changes in $\mathbf{H}_0$ and $\mathbf{H}_{0S}$ as a result of movement of the VD in the magnetic and spin fields of the Earth.

In a case of the movement of a VD along the surface of the Earth, according to (111),

$$\frac{d\mathbf{M}_S}{dt} = \left(k_{1\mu}\eta_0 \frac{d\mathbf{H}_0}{ds} - k_{2\mu}\frac{d\mathbf{H}_{0S}}{ds}\right)\cdot \upsilon, \tag{115}$$

where $\upsilon = ds/dt$ is speed of the VD; s is the length of path of the VD along the Earth.

One can perform numerical estimates of the values of the first and second members on the right in expression (115) assuming that the vertical components of magnetic and spin fields in the region of the Earth's equator are equal, respectively, $H_{0z} = H_0 \cos \theta$; $H_{0Sz} = H_{0S} \cos \theta$, where θ is an angle measured from the axis of rotation of the Earth, $H_0 \cong 20$ A/m is the magnetic field and

$H_{0S} \cong 10^{13}$ kg/(m · s) is the spin field at the Earth's pole. Assume that the speed of movement of the VD is directed perpendicular to the equator and is equal to 30 m/s. Then, at $ds = R_E d\theta$, where R_E is the radius of the Earth, one can obtain the following evaluations:

$$\eta_0 \left| \frac{dH_0}{ds} \right| \cdot \upsilon \cong 10^6 \, \frac{\text{H}}{\text{m}^2} = 10 \, \frac{\text{kg}}{\text{cm}^2}; \tag{116$_1$}$$

$$\left| \frac{dH_{0S}}{ds} \right| \cdot \upsilon \cong 5 \cdot 10^7 \, \frac{\text{H}}{\text{m}^2} = 500 \, \frac{\text{kg}}{\text{cm}^2}. \tag{116$_2$}$$

Hence, according to (114), tangential mechanical stresses $\tau = \tau_1 + \tau_2$ directed in circles around the axis of rotation with centers on the axis of rotation develop inside the mobile VD in planes perpendicular to the axis of rotation. The two components of these stresses, without consideration of the sign, are expressed as follows:

$$|\tau_1| \cong 10 \, k_{1\mu}, \text{ kg/cm}^2; \qquad |\tau_2| \cong 500 \, k_{2\mu}, \text{ kg/cm}^2,$$

Where

$$k_{1\mu} = \frac{a_\mu}{1 - a_\mu^2/9}; \qquad k_{2\mu} = \frac{a_\mu^2}{3\left(1 - a_\mu^2/9\right)}.$$

In interpretation of the evaluations obtained for the tangential stresses inside the VD, one must take into account the assumption made above, according to which the VD can be filled not only with PVM or PVA but also with mixtures of these media with the APV. In the former case, the values of the coefficients a_ε and a_μ have their own limit values, which we assume to be equal to one. In the latter case, these coefficients are small, i.e., $a_\varepsilon \ll 1$ and $a_\mu \ll 1$. The assumption was made based on the fact of the great variety of the intensity of luminescence of NSLF and their other properties.

With $a_\mu \sim 1$, the coefficients $k_{1\mu} \sim 1$ and $k_{2\mu} \sim 1$. The values of the tangential stresses inside the VD in this case will have extremely large values in rapid movement of the VD in non-homogeneous magnetic and spin fields. If a VD with such tangential stresses, such as $\tau \sim 500$ kg/cm^2, is located in the Earth's atmosphere, the rotation of air inside the VD will be associated with great centrifugal forces which displace gas toward the circumference of the VD. It is obvious that in this case, there will be severe rarefaction of the gas inside the VD. In cases of a change in the magnetic and spin fields inside the Earth, a VD will cause a strong mechanical effect there.

According to the estimates performed for tangential stresses, even at $a_\mu \ll 1$ and $a_\varepsilon \ll 1$, a VD can cause rotating movement of air with a slight change in magnetic and spin fields. It is possible, therefore, that the rotation of air, dust, etc., is no less a characteristic sign of the presence of a VD than its luminosity.

In regard to energy, a VD with magnetic and spin polarizations functions as a converter of the type of energy that effects its movement into heat. In particular, if the VD is in motion as a result of the effect of forces of an atmospheric pressure differential, in a tornado, for example, it is

the energy of the mobile air masses that is converted first into mechanical vortex movement of the gas and then into heat. In this case, the VD obviously has an inhibiting effect on the movement of mobile air masses. Hence forces of a dissipative nature appear in the equation of the mechanical movement of a VD in a number of potential forces.

The rotation of a gas inside and around the VD causes practically no spin depolarization of the VD. This assertion can easily be verified by performing estimate calculations. For example, the rate of movement of water is 1 m/s at the surface of a river 1000 m wide and 10 m deep; the local spin field is $5 \cdot 10^3$ kg/(m · s), which is much less than the Earth's spin field of 10^{13} kg/(m · s).

The magnetic depolarization of the VD and, consequently, the related spin depolarization are possible only in magnetic media in the Earth rock and seawater with good electrical conductivity.

Hence in most cases, one need not take into account the magnetospin depolarization of the VD. It is sufficient just to determine the forces acting on the VD from the magnetic and spin fields of the Earth using the formulae (104)-(106). This effect obviously will be substantial only in a case of strong electrogravitational depolarization of the VD, where the forces related to the gravitational field energy density will be slight.

We shall note that the physical Einstein - de Haase effect in the VD should be classified as one of the types of strong interaction of substance and field, magnetic and spin at once.

3.3.   Quasistatics. Field interaction of vacuum domains with substance

3.3.1. Problems of quasistatics in the model of the non-homogeneous physical vacuum

In considering physical processes of the immersion of VD in substance, we shall understand substance to mean not only the air in the Earth's atmosphere but also dense substances in the form of the rock and water of the Earth, as well as objects of large-scale artificial structures created by human hands. Questions concerning the penetration of VD into a denser substance, movement inside it and the effect of the VD on the dense substance can be studied by solution of a number of specific problems of the model of combined electrogravidynamics with a separate VD. In this case, we cannot limit ourselves any longer to the static approximation of the equations of the model. Many physical parameters of dense substance, after all, differ fundamentally from the physical parameters of gas of the Earth's atmosphere. In dense substance, one can see all the physical phenomena described by the model. Therefore, in the case in question, it is necessary to consider all the equations (47)-(50) of the non-homogeneous PV model, and it is no longer possible in these equations, of course, to neglect all partial time derivatives at once.

Moreover, in many problems of the immersion of VD in dense substance, the quasistatic approximation [58], which is well known in the classical theory of electromagnetism, can be used. This approximation assumes that the time delay involved in the propagation of electromagnetic waves in the region in question is equal to zero. And such an approximation can be used only in cases where the dimensions of the region of space in question are much less than the length of an electromagnetic wave characteristic of the basic parameters of the medium and the characteristic frequencies of change of the external electromagnetic effect. Such a region of space is normally distinguished quite naturally in the form of some inhomogeneity of substance, i.e., in the form of the body in question.

In combined electrogravidynamics, the conditions of a quasisteady state have the same form as in electrodynamics. Only one must keep in mind the length of a gravispin wave in addition to the length of an electromagnetic wave. When the length of the gravispin wave is taken into account, the region of space in question is also distinguished quite naturally. It is the region occupied by the VD with its closest surroundings.

The characteristic feature of quasistatic approximations in electrodynamics is the separation of electrical field and electric current problems, which are solved in the theory of electric current in electrolytes, capacitive structures, semiconductor systems, etc., and magnetic field and electric current problems, which are investigated in magnetic field theory.

In the model of combined electrogravidynamics, it is also advisable to separate problems of electrogravitation and problems of gravispinorics in both static and quasistatic approximations.

3.3.2. A vacuum domain in an electrically conductive medium. Contact explosions of large vacuum domains

The process of immersion of a VD, in the form of sphere, for example ($\varepsilon_1 = $ const, $0 < r \leq R$; $\varepsilon_1 = 0$, $r > R$), in an electrically conductive medium, characterized by the parameters ε, σ ($\varepsilon_G = 1$), is described by the electrogravitation group of equations (47)-(50):

$$\operatorname{div} \mathbf{D} = \rho; \qquad \operatorname{div} \mathbf{D}_G = \rho;$$

$$\mathbf{D} = \varepsilon_0 \mathbf{E} + \varepsilon_1 \mathbf{E}_G; \qquad \mathbf{D}_G = \varepsilon_{0G} \mathbf{E}_G + \varepsilon_1 \mathbf{E} ;$$

$$\mathbf{J} = \sigma \mathbf{E} + \sigma_1 \mathbf{E}_G; \qquad \operatorname{div} \mathbf{J} = -\frac{\partial \rho}{\partial t}.$$

The following relationships follow from these equations with the use of the approximation $\mathbf{J} = \sigma \mathbf{E}$:

$$\rho + T \frac{\partial \rho}{\partial t} = -\frac{\varepsilon_1}{\varepsilon_{0G}} \rho_G = -a_\varepsilon \eta_0^{-1} \rho_G \qquad \text{at } 0 < r \leq R \qquad (117)$$

$$\rho + \tau_M \frac{\partial \rho}{\partial t} = 0 \qquad \text{at } r < R \qquad (118)$$

where $T = \tau_M(1 - a_\varepsilon^2/\varepsilon)$; $\tau_M = \varepsilon\varepsilon_0/\sigma$ – is the Maxwell type of relaxation of the electrically conductive medium.

We shall assume that the VD penetrates rapidly into the electrically conductive medium due to the effect of magnetic and spin forces for the time $\Delta t << T$.

We shall count the time from the moment of the end of the time interval Δt. As we shall see from further consideration, it is quite natural to set $\rho = 0$ at $t = 0$ both inside ($0 < r \leq R$) and outside ($r > R$) of the VD. Then, according to (117), the time dependence of the electrical charge density inside the VD has the following form:

$$\rho = -a_\varepsilon \eta_0^{-1} \rho_G \left(1 - \mathrm{e}^{-t/T}\right), \qquad (119)$$

Outside the VD, $\rho = 0$.

Since, according to the law of the preservation of electrical charge, div $\mathbf{J} = -\partial\rho/\partial t$, using (119) and (118), one can obtain the following equations for the current density in an electrically conductive medium:

$$\mathrm{div}\,\mathbf{J} = -\frac{a_\varepsilon \rho_G}{T\eta_0}e^{-t/T}, \quad 0 < r \le R; \qquad (120)$$

$$\mathrm{div}\,\mathbf{J} = 0, \qquad r < R. \qquad (121)$$

It is appropriate to pause at the physical content of the equations (117)-(120). It was demonstrated above that a VD in the air of the Earth's atmosphere in fields $\mathbf{E_0}$ and $\mathbf{E_{0G}}$ simultaneously becomes an electrical and a gravitational diopole. The density of the air ρ_G, incidentally, is not equal to zero. Therefore, according to (117), the VD in air takes on a bound electrical monocharge

$$q = \rho' \cdot V, \qquad (122)$$

where V is the volume of the VD; $\rho' = -a_\varepsilon\, \eta_0^{-1}\rho_G$ is the density of the bond polarization electrical charge of the VD; ρ_G is the density of the air.

In air at the surface of the Earth ($\rho_G = 1.293$ kg/m^3), the VD bound electrical charge density, according to (122), has the following numerical value:

$$\rho' = -1.11 \cdot 10^{-10} a_\varepsilon.$$

The electrical field at the surface of the VD under the conditions indicated above is:

$$E = \rho' \cdot \frac{R}{3\varepsilon_0}, \qquad (123)$$

where R is the radius of the sphere-VD.

If we take $R = 1 \div 1000$ m, according to (123), $E = -4.18 \div -4.18 \cdot 10^3$ V/m at $a_\varepsilon = 1$. Hence the VD in air has an extremely small bound electrical charge, with which an extremely weak electrical field is associated, according to (123). Such a field cannot cause electrical breakdown of the air. Comparatively slow depolarization of the electrical bound monocharge of the VD, of course, should also occur in the air, according to (117). But on the strength of the low value of this monocharge, the depolarizing electrical charge consisting of free current carriers is also small.

In examining the depolarization of VD in the rocks and water of the Earth, one must devote attention to the sharp increase in the density of the substance ($\rho_G = 10^3 - 10^4$ kg/m^3). According to (122), the electrical monocharge in the Earth increase by three-four orders of magnitude as compared to its value in air.

Depolarization of the bound electrical charge of the VD inside the Earth occurs due to conductivity electric currents. According to (120), the density of this electric current inside the VD is as follows:

$$J = J_r = \frac{\rho'}{3T}e^{-t/T} \cdot r, \quad 0 < r \le R. \qquad (124)$$

According to (120) and (121), the density of this current outside the VD is as follows:

$$J = J_r = \frac{\rho'}{3T} e^{-t/T} \cdot \frac{R^3}{r}, \quad r > R \tag{125}$$

The release of heat is related to the conductivity current densities inside and outside the VD. The thermal power density can be defined as follows: $p_T = \mathbf{J} \cdot \mathbf{E} = J_r^2/\sigma$.
Thermal power is released inside the VD:

$$P_{Ti} = \int_0^R p_T \cdot 4\pi \, r^2 dr = \frac{4\pi(\rho')^2}{9 \cdot 5 \cdot \sigma \, T^2} e^{-2t/T} \cdot R^5.$$

Thermal power is released outside the VD in direct proximity to its outer surface:

$$P_{Te} = \int_0^R p_T \cdot 4\pi \, r^2 dr = \frac{4\pi(\rho')^2}{9 \cdot \sigma \, T^2} e^{-t/T} \cdot R^5.$$

Hence in immersion of the VD inside the Earth, the following total thermal power is released:

$$P_T = P_{Ti} + P_{Te} = \frac{2 \cdot 4\pi(\rho')^2}{3 \cdot 5 \cdot \sigma \, T^2} e^{-2t/T} \cdot R^5. \tag{126}$$

Based on expression (126) for thermal power, one can obtain a relationship for the energy released in contact of the VD with the dense, electrically conductive substance of the Earth:

$$W_T = \int_0^\infty P_T dt = \frac{(\rho')^2 R^2}{5\varepsilon_0 (1 - a_\varepsilon^2/\varepsilon)} \cdot V, \tag{127}$$

where $V = 4\pi R^3/3$ is the volume of the sphere-VD.
In a case of dense substance, according to (122), we have the following value of the VD bound polarization electrical charge density:

$$\rho' = -a_\varepsilon \eta_0^{-1} \rho_G = -\left(10^{-7} \div 10^{-6}\right) a_\varepsilon, \, \text{Kl/m}^3.$$

The limited values of energies W_T obviously can be obtained only at positive values of the time constant $T = \tau_M (1 - a_\varepsilon^2/\varepsilon)$, i.e., at $a_\varepsilon < \sqrt{\varepsilon}$ ($\varepsilon > 1$). It has long been known [3] that great difficulties arise in many problems of combined electrogravidynamics and the non-homogeneous PV at $a_\varepsilon > 1$ and $a_\mu > 1$. On the other hand, starting from the bases of the polarization theory of the vacuum equations of Maxwell and Heaviside presented above, one can see that the coefficients ε_1 and μ_1 and, consequently, a_ε and a_μ, should be limited in regard to modulus.

If such a limitation is expressed by the inequalities $|a_\varepsilon| \leq 1$ and $|a_\mu| \leq 1$, one can avoid the difficulties indicated above: in particular, the difficulties associated with the energy W_T.

The time constant T at $|a_\varepsilon| \leq 1$ is an extremely small value. It follows that the energy W_T is released in an extremely short time; i.e., a contact explosion should occur in contact of a VD with the substance of the Earth.

According to (127), the energy density of the contact explosion is as follows:

$$W_{0T} = \frac{W_T}{V} = \frac{(\rho')^2 R^2}{5\ae_0 \left(1 - a_\varepsilon^2 / \varepsilon\right)}, \tag{128}$$

i.e., this energy is proportionate to the square of the radius of the sphere-VD. It is not difficult to ascertain that the contact explosion energy density will approach a characteristic value of the order of 10^6 J/m³ at a radius R equal to several kilometers. On the other hand, at the radii typical of BL, the contact explosion energy is low. Hence contact explosions with quite significant effects should be expected in the contact of large NSLF-VD with the Earth [42].

Moreover, large NSLF-VD are attracted to the Earth more strongly than small ones. The electrostatic force associated with the mirror image of the electrical monocharge of a VD in the Earth is defined as follows:

$$F = \frac{q^2}{4\pi\varepsilon_0 (2H)^2}, \tag{129}$$

where q is the electrical monocharge of the VD, determined according to (122); H is the elevation of the position of the VD above the surface of the Earth.

The force F presses the VD toward the surface of the Earth. One can see from (129) and (122) that the specific force

$$\frac{F}{V} = \frac{a_\varepsilon^2 \rho_G^2 R^3}{3\varepsilon_{0G} (2H)^2}, \tag{130}$$

i.e., the force per unit of volume of pressing of the VD to the Earth is proportionate to the cube of the radius of the sphere-VD. Consequently, the larger the VD, the more strongly it is pressed to the Earth and, accordingly, the faster it goes into the interior of the Earth.

3.3.3. The Earth's electrical field

It was established above that a VD introduces an electrical monocharge, positive or negative, depending on the sign of the coefficient ε_1 of the equations of the model, deep into the dense substance of the Earth.

We assume that a large number of VD move from space to the Earth. They either are deflected away from the Earth or penetrate deep into its dense substance, thus introducing both positive and negative electrical charges there. These charges do not necessarily add up to zero. It is possible that in individual geological periods, either the positive or the negative electrical charge carried into the Earth may be prevalent. We also suggest that some of the VD with positive and negative electrical charges are annihilated inside the Earth with the release of photons. However,

VD with the same electrical charges are not annihilated. Hence in individual geological periods, either negative or positive electrical charges accumulate in the Earth.

As one can see from the solution of the problem of depolarization of the VD, the bound electrical charge of a VD in the electrically conductive medium of the Earth is quickly neutralized; i.e., the bound electrical monocharge of the VD and the depolarizing electrical charge come to be equal in sum to zero. The depolarizing electrical charge, however, is taken from the electrically neutral substance of the Earth. Therefore, an electrical charge which is opposite in sign to the depolarizing electrical charge develops at the VD inside the Earth. This latter electrical charge, which consists of free electric current carriers, emerges at the Earth's surface.

In other words, an electrical charge equal to the excess charge of vacuum domains located in the Earth emerges at the surface of the Earth. If this electrical charge of the VD of the same sign inside the Earth increases, electric current flows toward the surface of the Earth from inside it. We shall designate the density of this current J_i.

It is well known [24, 85], on the other hand, that electric current also runs from the Earth's surface into the atmosphere. We shall designate the density of this current J_e.

On the strength of the law of conservation of electrical charge,

$$\int_{-\infty}^{t} J_i \, dt - \int_{-\infty}^{t} J_e \, dt = q_0, \tag{131}$$

where q_0 is the electrical charge density at the surface of the Earth, which at present is $-1.15 \cdot 10^{-9}$ Kl/m^2.

The electrical current density in the Earth's atmosphere can be represented as follows, according to one of the equations of the model (48):

$$J_e = \sigma_e E_\varepsilon - \sigma_1 g, \tag{132}$$

where E_e is the intensity of the Earth's electrical field; σ_e is the electrical conductivity of the air of the Earth's atmosphere; g is the acceleration of gravity.

The first member on the right in (132) represents the conductivity current, while the second member on the right is the gravitational electric current associated with large particles – electric current carriers – such as raindrops or snowflakes.

It follows from (131) that

$$\frac{dq_0}{dt} = J_i - J_e. \tag{133}$$

Assuming that the electrical field inside the Earth is equal to zero, we obtain:

$$\varepsilon_0 E_e = q_0. \tag{134}$$

It follows from (132) and (133) that

$$\frac{dq_0}{dt} + \frac{q_0}{T_e} = J_e + \sigma_1 g, \tag{135}$$

where $T_e = \varepsilon_0/\sigma_e$ is the Maxwell relaxation time in the Earth's atmosphere.

According to Skanavi [77], the electrical conductivity of the air under normal conditions $\sigma_e = 8 \cdot 10^{-14} \ \Omega^{-1} \cdot m^{-1}$.

Consequently, $T_e = 8.85 \cdot 10^{-12}/(8 \cdot 10^{-14}) \cong 110$ s.

If the electrical charge of the Earth remains constant for a time period of the order of T_e, one can assume $dq_0/dt = 0$ in (135) and, consequently,

$$q_0 \cong T_e \left(J_i + \sigma_1 g \right), \tag{136}$$

and also, according to (133),

$$J_i = J_e. \tag{137}$$

The current J_i associated with the VD in the Earth in the model under consideration for the Earth's electrical field is a current source. Based on equations (132)-(137), with $q_0 = -1.15 \cdot 10^{-9}$ Kl/m^2, and $\sigma_e = 8 \cdot 10^{-14} \ \Omega^{-1} \cdot m^{-1}$ ($E_e \cong 130$ V), one can obtain the following numerical result: $J_i + \sigma_1 g = q_0/T_0 = \sigma_e E_e = = 1.04 \cdot 10^{-11}$ A/m^2. Hence to determine the current density J_i, it is necessary to determine the average current density $\sigma_1 g$ associated with precipitation on Earth; however, the incomplete data presented in [24, 85], for example are still insufficient for solving this problem.

The model in question for the Earth's electrical field is constructed from the bottom up, i.e., from the interior of the Earth to the lower layers of the atmosphere. There are other familiar models of the Earth's electrical field which are constructed from the top down, such as the model of a continuously operating ionosphere MHD generator [99]. It is obvious that neither approach is complete at this point. It is suggested, therefore, that attention be devoted to the nontraditional approach presented above for the problem of the Earth's electrical field, which involves the vacuum domain phenomenon.

3.4. Waves. Transformations of the energy of gravispin waves into other types of energy

3.4.1. Problems of the electrogravimechanical transformation of energy

The similarity of electrodynamics and gravidynamics is sufficient to perform an energy analysis of the equations of Heaviside based on the Umov-Pointing theorem [30] in exactly the same way as it is performed in regard to equations of Maxwell. This analysis indicates that gravitational currents do not form emitters but absorbers of the energy of gravitational waves. Yefimenko [75] was the first to note this feature of the equations of Heaviside.

It was demonstrated above that vacuum-substance equations of Heaviside can be written on the basis of the vacuum equations of Heaviside and simple physical representations of polarizations and gravitational currents inside substance, similar to what was done on the basis of vacuum equations of Maxwell and the electronic theory of substance in the derivation of the vacuum-substance equations of Maxwell [58]. In other words, parameters ε_G, μ_G and σ_G are incorporated in the equations of Heaviside which are completely analogous to the parameters ε, μ and σ in the vacuum-substance equations of Maxwell. In this connection, it is necessary to make

only on important comment in regard to the principle of equality of inert and gravitational mass [58]. The movement of mobile masses inside the framework of substance (the crystal or quasicrystalline lattice) begins only when the wavelength of gravitational waves is less than the characteristic dimension of the body in question. It is necessary to assume, therefore, that the gravitational wave length is much greater than the dimensions of the body in question, $\varepsilon_G = 1$, $\mu_G = 1$ and $\sigma_G = 0$. The energy analysis of vacuum-substance equations of Heaviside not only confirms that the gravitational currents form absorbers but also demonstrates that a gravitational wave passing through the body takes out of it energy that is characterized by a specific power (per unit of volume) $\sigma_G j_G^2$.

One can see from the examination performed that in terms of energy, the vacuum-substance equations of Heaviside are strictly opposite to the analogous equations of Maxwell. Hence in gravidynamics, the fundamental conditions of physics are affected: the first and second origin of thermodynamics, i.e., the law of the growth of entropy, and the principle of causality.

Further examination of the equations of Heaviside demands an investigation of the physical model represented by these equations. In this connection, one can say at once that the case of the absence of outside waves in space, which, as a rule, is considered in electrodynamics, leads in this case to the violation of all the fundamental positions of physics listed above. In gravidynamics one can agree to violations of the law for the increase in entropy while going forward persistently in the search for negoentropy [100]. It is impossible, however, to agree to the violation of the first origin of thermodynamics (the law of the conservation of energy) or the principle of causality. In a case where space is not filled preliminarily with gravitational waves, the absorbers of energy of the gravitational waves in the equations of Heaviside prove unfounded. In this case, it is impossible to answer the question of where the energy is taken from in the mechanical systems represented in the equations of Heaviside by gravitational currents. For mathematical description of the absorbers, it is necessary to use so-called advanced solutions of wave equations. It is known from electrodynamics [58] that the advanced solutions will not violate the principle of causality in only one case, where outside wave sources are located in the vicinity of the absorber. The very idea of the filling of space with gravitational waves would be senseless without the assumption of the existence of sources of outside gravitational waves in space.

Hypotheses for filling space with a gas consisting of gravitons are well known, from Stanyukovich's book [101] is an example. However, at least two difficult questions arise in connection with these hypotheses. First, the sources of radiation of gravitational waves of any power level starting from low frequencies are unknown. Second, if such a thing exists in nature, it would seem that such powerful gravitational radiation should certainly be observed experimentally [102].

It should be emphasized in connection with the first question that according to the model of Heaviside considered above, there are no radiation sources in the form of gravitational waves of currents. It is also true, however, that the absorbers of gravitational waves are extremely weak. For example, an accelerated electron emits $4.2 \cdot 10^{40}$ times more electromagnetic power than it absorbs gravitational power. One can observe in connection with the second question that electrical and gravitational forces acting on an electron will be equal, if the energy of the gravitational field is the same $4.2 \cdot 10^{40}$ times greater than the energy of the electrical field. Hence the presence of gravitational waves in the Universe, even with an extremely high energy density, can remain unnoticed. It is appropriate to state also that space is filled with immeasurably greater energy of a constant gravitational field than with energy of a constant electrical field. At the

surface of the Earth, for example, the gravitational field energy density is $5.8 \cdot 10^{10}$ J/m^3, while the electrical field density is only $4 \cdot 10^{-7}$ J/m^3.

A powerful source of gravitational waves was discovered in this study with the reversible 100% transformation of electromagnetic energy into gravitational energy within the body of a vacuum domain.

From the examination performed, one can see the following. First, the energy of gravitational waves, in absorption on moving bodies and particles (the movement of which is reflected by gravitational currents in the equations of Heaviside), increases the kinetic energy of this ordered movement. Second, the gravitational waves, in passing through substance, carry away part of the heat; i.e., it is as though they eliminate part of the unordered movement. Third, the gravitational wave energy itself develops in vacuum domains from electromagnetic energy that is scattered (mainly by the stars).

3.4.2. The transformation of the energy of gravispin waves into mechanical energy in the absolute physical vacuum

In the model of electrogravimechanics, any mechanical system is a receiving gravispin antenna that absorbs the power of outside gravispin waves. This power increases the kinetic energy of movement in mechanical systems, but only very slightly. In normal mechanical systems, the loss of power related to friction covers the inflow of the power in question practically completely. On a cosmic scale, the transformation of gravispin energy into mechanical energy can play a significant role.

Problems of the transformation of gravispin energy into mechanical energy are similar to the problems of the radiation of electromagnetic waves in connection with the fact that the vacuum equations Maxwell and Heaviside are similar. Therefore, the formulae for the absorption of the energy of gravispin waves can be obtained from formulae of the emission of the energy of electromagnetic waves by substituting masses with a minus sign for electrical charges with a plus sign, the coefficient ε_0 for ε_{0G} (μ_0 for μ_{0G}), and $-c$ for the speed of light c. As an example, one can obtain the formula for the transformation of gravispin energy into kinetic energy (power), such as for the planets of the Solar System. In this case, one must use the Umov-Pointing theorem, integrating the Umov-Pointing vector with respect to the surface of a sphere of radius $R \rightarrow 0$ which encloses the planet (seeing it as a point with a given mass). One can use the expressions for electrical and magnetic fields of a point electron in accelerating movement [79], in which it is necessary to perform the substitutions indicated above. With such an approach, the gravitational field of a planet in a nonrelativistic approximation is expressed by the following relationship (with $r \leq R \rightarrow 0$):

$$\mathbf{E}_G = -\frac{m\mathbf{r}}{4\pi\varepsilon_{0G}r^3} - \frac{m[\mathbf{r}[\mathbf{r}\dot{\mathbf{v}}]]}{4\pi\varepsilon_{0G}c^2 r^3} \tag{138}$$

The spin field is expressed as follows:

$$\mathbf{H}_G = -\frac{m[\mathbf{v}\mathbf{r}]}{4\pi r^3} + \frac{m[\mathbf{r}[\mathbf{r}[\mathbf{r}\dot{\mathbf{v}}]]]}{4\pi\ c r^4} \tag{139}$$

where **r** is a vector-radius, the origin of which is located at a point of the planet; m is the mass of the planet; **v** and $\dot{\mathbf{v}}$ are vectors of the velocity and acceleration of the planet in its movement in orbit around the Sun.

In an approximation of circular orbits, where the acceleration is perpendicular to the velocity, the following expression for the power follows from (138) and (139):

$$-\int_S \mathbf{\Pi}_G \, d\mathbf{S} = \frac{m^2 (\dot{\mathbf{v}})^2}{6\pi\varepsilon_{0G} \, c^3} = W, \tag{140}$$

where $d\mathbf{S}$ is an oriented element of the surface of a sphere of radius $R \to 0$, and $\mathbf{\Pi}_G = [\mathbf{E}_G \mathbf{H}_G]$ is an Umov-Pointing vector.

It is interesting to note that even under the conditions $R \to 0$, $\mathbf{v} \perp \dot{\mathbf{v}}$ in (140) remain only the second members of the expressions for the fields (138) and (139), i.e., the "radiation" members. The power flows associated with other vector products either are equal to zero or satisfy the condition of equality of the flow entering the sphere to the flow leaving the sphere (quite a laborious proof is omitted here). As one can see from (140), the power flow here is in the opposite direction as compared to the power flow in the case of a point electron; i.e., power is used by the planet and goes to increase the kinetic energy of its movement.

The following formula for the gravispin power $(\dot{\upsilon} = \upsilon^2 / R_C)$ used by the plant follows from (140):

$$W = \frac{m^2 \upsilon^4}{6\pi\varepsilon_{0G} R_C^2}, \tag{141}$$

where R_C is the average distance of the planet from the Sun. The numerical values of the power W are presented in Table 8 for all the planets of the Solar System and for the Moon (in its revolution around the Earth) [78].

Table 8
Powers of movement of the planets of the Solar System and the Moon

	m, 10^{24} kg	υ, 10^3 m/s	R_C, 10^{10} m	W, W
Mercury	0.33	48.8	5.8	$3.03 \cdot 10^8$
Venus	4.9	35.0	10.8	$5.08 \cdot 10^9$
Earth	5.98	29.8	15.0	$2.08 \cdot 10^9$
Mars	0.65	24.2	22.8	$4.57 \cdot 10^6$
Jupiter	1899	13.1	77.8	$2.90 \cdot 10^{11}$
Saturn	568	9.65	142.7	$2.32 \cdot 10^9$
Uranus	86.8	6.78	287	$3.22 \cdot 10^6$
Neptune	103	5.42	450	$7.52 \cdot 10^5$
Pluto	1.1	4.75	595	28.7
Moon	0.0735	1.02	0.0384	$6.54 \cdot 10^4$

The additional kinetic energy of the movement of objects of the Universe obviously goes at least partially to overcome friction in the environment and tidal movement. This effect is

equivalent to the appearance of some negative macroscopic gravitational pressure. The necessity of such a pressure for the stability of the galaxies, for example, has been demonstrated in Shulgin's work [64].

3.4.3. The transformation of heat into energy of gravispin waves in the absolute physical vacuum

The removal of heat from a substance by gravispin waves, in the case of the APV, can be considered at $\varepsilon_1 = 0$ and $\mu_1 = 0$, since $\varepsilon_0\varepsilon_{0G} >> \varepsilon_{11}^2 = \varepsilon_1^2; \mu_0\mu_{0G} >> \mu_{11}^2 = \mu_1^2$, but with $\sigma\sigma_G \cong \sigma_1^2$. In the case of monochromatic plane linearly polarized waves, electromagnetic and gravispin fields can be represented by the following relationships:

$$E_z = \text{Im}\,\dot{E}_z \exp\,i\omega(t + sx);$$
$$E_{Gz} = \text{Im}\,\dot{E}_{Gz} \exp\,i\omega(t + sx);$$
$$H_y = \text{Im}\,\dot{H}_y \exp\,i\omega(t + sx);$$
$$H_{Gy} = \text{Im}\,\dot{H}_{Gy} \exp\,i\omega(t + sx),$$

where ω is the angular frequency; s is a parameter with an inverse velocity dimension; $i\omega s = \gamma$ is the wave propagation constant; i is the imaginary unit; $\dot{E}_z, \dot{E}_{Gz}, \dot{H}_y, \dot{H}_{Gy}$ are complex amplitudes of fields on the axes of y and z coordinates; x is the coordinate along which the waves propagate.

As in electrodynamics [58], it is necessary in electrogravidynamics to keep in mind waves with an elliptical polarization. For describing these waves, one must incorporate in the consideration the amplitude $\dot{E}_z, \dot{E}_{Gz}, \dot{H}_y, \dot{H}_{Gy}$ in addition to the amplitudes $\dot{E}_y, \dot{E}_{Gy}, \dot{H}_z, \dot{H}_{Gz}$. Since the principle of superposition remains in effect, however, it is sufficient for analysis of the roots of s to consider only one linearly polarized wave.

The following expressions follow from equations (47)-(50) in the approximation indicated above:

$$\left(\mu\mu_0 \mathcal{E}_0 + \frac{\mu\mu_0\sigma}{i\omega} - s^2\right)\dot{E}_z + \frac{\mu\mu_0\sigma_1}{i\omega}\dot{E}_{Gz} = 0; \tag{142$_1$}$$

$$\left(\mu_G\mu_{0G}\varepsilon_G\varepsilon_{0G} - \frac{\mu_G\mu_{0G}\sigma_G}{i\omega} - s^2\right)\dot{E}_{Gz} - \frac{\mu_G\mu_{G0}\sigma_1}{i\omega}\dot{E}_z = 0; \tag{142$_2$}$$

$$\left(\mu\mu_0 \mathcal{E}_0 + \frac{\mu\mu_0\sigma}{i\omega} - s^2\right)\dot{H}_y + \frac{\mu_G\mu_{0G}\sigma_1}{i\omega}\dot{H}_{Gy} = 0; \tag{142$_3$}$$

$$\left(\mu_G\mu_{0G}\varepsilon_G\varepsilon_{0G} - \frac{\mu_G\mu_{0G}\sigma_G}{i\omega} - s^2\right)\dot{H}_{Gy} - \frac{\mu\,\mu_0\sigma_1}{i\omega}\dot{H}_y = 0; \tag{142$_4$}$$

The equality to zero of the determinants of each of two homogeneous systems of equations (142) produces the same biquadratic equation, the roots of which are:

$$s_{1,2,3,4} = \pm\sqrt{s^2}, \qquad (143)$$

where

$$s^2 = \frac{A+B}{2} \pm \sqrt{\frac{(A-B)^2}{4} - \frac{\mu\,\mu_0\mu_G\mu_{0G}\sigma_1^2}{(i\omega)^2}};$$

$$A = \varepsilon_0\mu\mu_0 + \frac{\mu\mu_0\sigma}{i\alpha\omega}; \qquad B = \varepsilon_G\varepsilon_{0G}\mu_G\mu_{0G} - \frac{\mu_G\mu_{0G}\sigma_G}{i\omega}.$$

The $\pm$ signs in (143) define the direction of propagation of waves along the x-axis. The $\pm$ signs in the expression for s^2 distinguish the roots of electromagnetic and gravispin waves, respectively.

In a case of relatively large values of electrical conductivity, i.e., for metals, semiconductors and plasma, the expression for s^2 can be represented as follows for an electromagnetic wave:

$$s^2 \cong \varepsilon_0\mu\mu_0 + \frac{\mu\mu_0\sigma - \mu_G\mu_{0G}\sigma_1^2/\sigma}{i\omega}, \qquad (144)$$

and in the following form for a gravispin wave:

$$s^2 \cong \varepsilon_G\varepsilon_{0G}\mu_G\mu_{0G} - \frac{\mu_G\mu_{0G}(\sigma_G - \sigma_1^2/\sigma)}{i\omega}, \qquad (145)$$

If electrical and gravitational current carriers which simultaneously possess electrical charges and masses (electrons, vacancies, ions) are prevalent in the substance, the determinant $\sigma_G\sigma - \sigma_1^2 \cong 0$ (see above). In this case, according to (145), for a gravispin wave,

$$s^2 = \varepsilon_G\varepsilon_{0G}\mu_G\mu_{0G}, \qquad (146)$$

i.e., it propagates in the substance without an exchange of energy. However, if electrically neutral mobile particles (hydrogen, helium) are prevalent in the substance, the determinant $\sigma_G\sigma - \sigma_1^2 \gg 0$, and for a gravispin wave,

$$s^2 = \varepsilon_G\varepsilon_{0G}\mu_G\mu_{0G} - \frac{\mu_G\mu_{0G}\sigma_G}{i\omega}, \qquad (147)$$

while for an electromagnetic wave,

$$s^2 = \varepsilon_0\mu\mu_0 + \frac{\mu\mu_0\sigma}{i\omega}, \qquad (148)$$

One can see from equations (147) and (148) that if the propagation constant for an electromagnetic wave $\gamma = i\omega s$ has a positive real part, i.e., Re $\gamma > 0$, then for the gravispin wave Re $\gamma < 0$. This means that when the fields of a direct electromagnetic wave increase exponentially,

the fields of a gravispin wave increase exponentially. This is to say that in the case in question, the gravispin wave takes heat out of the substance, thereby increasing its own energy.

3.4.4. The reversible transformation of the energy of electromagnetic waves into energy of gravispin waves inside the body of a vacuum domain

In the case of physical vacuums of matter or antimatter, one must assume the following: $\varepsilon = \mu = \varepsilon_G = \mu_G = 1$; $\sigma = 0$; $\sigma_G = 0$; $\sigma_1 = 0$; $\varepsilon_1 \neq 0$; $\mu_1 \neq 0$. Below significant simplifications of the calculations will be linked to the equation

$$\varepsilon_0 \mu_0 = \varepsilon_{0G} \mu_{0G} = \frac{1}{c^2}$$

and the following coefficient will be of great importance:

$$\eta_0 = \sqrt{\frac{\varepsilon_{0G}}{\varepsilon_0}} = \sqrt{\frac{\mu_0}{\mu_{0G}}} = 1.16 \cdot 10^{10} \ \frac{\text{kg}}{\text{Kl}}.$$

As under the previous item, the fields can be represented as complex relationships. By substituting these expressions for the fields into (47)-(50) under the conditions indicated above, one can obtain the following equations:

$$\left(\varepsilon_0 \mu_0 + \varepsilon_1 \mu_1 - s^2 \right) \dot{E}_z = -\left(\varepsilon_{0G} \mu_1 + \varepsilon_1 \mu_0 \right) \dot{E}_{Gz}; \tag{149$_1$}$$

$$\left(\varepsilon_{0G} \mu_{0G} + \varepsilon_1 \mu_1 - s^2 \right) \dot{E}_{Gz} = -\left(\varepsilon_0 \mu_1 + \varepsilon_1 \mu_{0G} \right) \dot{E}_z; \tag{149$_2$}$$

$$\left(\varepsilon_0 \mu_0 + \varepsilon_1 \mu_1 - s^2 \right) \dot{H}_y = -\left(\varepsilon_0 \mu_1 + \varepsilon_1 \mu_{0G} \right) \dot{H}_{Gy}; \tag{149$_3$}$$

$$\left(\varepsilon_{0G} \mu_{0G} + \varepsilon_1 \mu_1 - s^2 \right) \dot{H}_{Gy} = -\left(\varepsilon_{0G} \mu_1 + \varepsilon_1 \mu_0 \right) \dot{H}_y. \tag{149$_4$}$$

Two systems of homogeneous equations are presented in (149). The equality of their determinants to zero produces the same biquadratic equation in relation to the roots:

$$s_{1,2,3,4} = \pm \sqrt{s^2}, \tag{150}$$

where

$$s^2 = \frac{1}{c^2} + \varepsilon_1 \mu_1 \pm \sqrt{\left(\frac{1}{c^2} + \varepsilon_1 \mu_1 \right)^2 - \Delta_\varepsilon \Delta_\mu};$$

$$\Delta_\varepsilon = \varepsilon_0 \varepsilon_{0G} - \varepsilon_1^2; \qquad \qquad \Delta_\mu = \mu_0 \mu_{0G} - \mu_1^2.$$

We shall reduce (150) to a more convenient form by means of dimensionless variables

$$a_\varepsilon = \frac{\varepsilon_1}{\sqrt{\varepsilon_0 \varepsilon_{0G}}}; \qquad a_\mu = \frac{\mu_1}{\sqrt{\mu_0 \mu_{0G}}}.$$

With the redesignations indicated, one can represent the squares of the respective roots in (150) as follows:

$$s_+^2 = \frac{1}{c^2}\left(1 + a_\varepsilon a_\mu + a_\varepsilon + a_\mu\right) = \frac{1}{c^2}\left(1 + a_\varepsilon\right)\left(1 + a_\mu\right), \qquad (151_1)$$

$$s_-^2 = \frac{1}{c^2}\left(1 + a_\varepsilon a_\mu - a_\varepsilon - a_\mu\right) = \frac{1}{c^2}\left(1 - a_\varepsilon\right)\left(1 - a_\mu\right), \qquad (151_2)$$

where the first expression corresponds to a plus sign, while the second corresponds to a minus sign from the root in determining s^2.

It is not difficult to see that the expressions

$$v_+^2 = \frac{1}{s_+^2} = \frac{c^2}{1 + a_\varepsilon a_\mu + a_\varepsilon + a_\mu}; \qquad (152_1)$$

$$v_-^2 = \frac{1}{s_-^2} = \frac{c^2}{1 + a_\varepsilon a_\mu - a_\varepsilon - a_\mu}. \qquad (152_2)$$

are the squares of two field wave phase velocities. with $a_\varepsilon > 0$ and $a_\mu > 0$, obviously $v_+^2 < v_-^2$.

By substituting the expressions for s^2 according to (151) into (149), we obtain the following relationships for the field amplitudes:

$$\dot{E}_{z+} = \eta_0 \dot{E}_{Gz}; \qquad \dot{H}_{y+} = \eta_0^{-1} \dot{H}_{Gy+}; \qquad (153_1)$$

$$\dot{E}_{z-} = -\eta_0 \dot{E}_{Gz}; \qquad \dot{H}_{y-} = -\eta_0^{-1} \dot{H}_{Gy-}; \qquad (153_2)$$

It follows from (153) that the relationships between complex field amplitudes with plus and minus signs does not depend on the cross parameters ε_1 and μ_1.

We shall note that the products of the field amplitudes are equal; i.e.,

$$\dot{\Pi}_+ = \frac{1}{2}\dot{E}_{z+}\overset{*}{\dot{H}}_{y+} = \dot{\Pi}_{G+} = \frac{1}{2}\dot{E}_{Gz+}\overset{*}{\dot{H}}_{Gy+}; \qquad (154_1)$$

$$\dot{\Pi}_- = \frac{1}{2}\dot{E}_{z-}\overset{*}{\dot{H}}_{y-} = \dot{\Pi}_{G-} = \frac{1}{2}\dot{E}_{Gz-}\overset{*}{\dot{H}}_{Gy-}, \qquad (154_2)$$

where $\dot{\Pi}_+, \dot{\Pi}_{G+}, \dot{\Pi}_-, \dot{\Pi}_{G-}$ are values characterizing the power fluxes (the star indicates a complex conjugate variable).

We suggest that the existence of waves propagating at different phase velocities υ_+ and υ_- is devoid of physical sense. It would be necessary in this case to assume four types of electromagnetic and, at the same time, gravispin waves.

To exclude such a situation, we shall move from individual special solutions to combinations of these solutions of the system of vacuum equations (47)-(50) for plane waves. This makes it possible to obtain the following combinations of solutions (since η_0 is a real number, it is advisable to go functions of a real variable):

$$E_z = \frac{1}{2} E_0 \left[\sin\left(\omega t \pm \omega \upsilon_+^{-1} x\right) + \sin\left(\omega t \pm \omega \upsilon_-^{-1} x\right) \right]; \tag{155_1}$$

$$E_{Gz} = \frac{1}{2} E_{0G} \left[\sin\left(\omega t \pm \omega \upsilon_+^{-1} x\right) - \sin\left(\omega t \pm \omega \upsilon_-^{-1} x\right) \right]; \tag{155_2}$$

$$H_y = \frac{1}{2} H_0 \left[\sin\left(\omega t \pm \omega \upsilon_+^{-1} x\right) + \sin\left(\omega t \pm \omega \upsilon_-^{-1} x\right) \right]; \tag{155_3}$$

$$H_{Gy} = \frac{1}{2} H_{0G} \left[\sin\left(\omega t \pm \omega \upsilon_+^{-1} x\right) - \sin\left(\omega t \pm \omega \upsilon_-^{-1} x\right) \right]; \tag{155_4}$$

where

$$\frac{1}{2} E_0 = E_{z+} = E_{z-}; \qquad\qquad \frac{1}{2} E_{0G} = E_{Gz+} = -E_{Gz-};$$

$$\frac{1}{2} H_0 = H_{y+} = H_{y-}; \qquad\qquad \frac{1}{2} H_{0G} = H_{Gy+} = -H_{Gy-};$$

$$E_0 = \eta_0 E_{0G}; \qquad\qquad H_{0G} = \eta_0 H_0.$$

It follows obviously from (155) that

$$E_z = E_0 \sin\left(\omega t \pm \omega \upsilon^{-1} x\right) \cos\omega \frac{\upsilon_+^{-1} - \upsilon_-^{-1}}{2} x; \tag{156_1}$$

$$H_y = H_0 \sin\left(\omega t \pm \omega \upsilon^{-1} x\right) \cos\omega \frac{\upsilon_+^{-1} - \upsilon_-^{-1}}{2} x; \tag{156_2}$$

$$E_{Gz} = \pm E_{0G} \cos\left(\omega t \pm \omega \upsilon^{-1} x\right) \sin\omega \frac{\upsilon_+^{-1} - \upsilon_-^{-1}}{2} x; \tag{156_3}$$

$$H_{Gy} = \pm H_{0G} \cos\left(\omega t \pm \omega \upsilon^{-1} x\right) \sin\omega \frac{\upsilon_+^{-1} - \upsilon_-^{-1}}{2} x, \tag{156_4}$$

where

$$\upsilon^{-1} = \frac{\upsilon_+^{-1} + \upsilon_-^{-1}}{2}.$$

According to (156), the total power flow of electromagnetic and gravispin waves averaged over time has the same value in any section perpendicular to the x axis (in the plane yz), i.e.,

$$\Pi + \Pi_G = \overline{E_z H_y} + \overline{E_{Gz} H_{Gy}} = \frac{E_0 H_0}{2}. \qquad (157)$$

The expressions for fields (156) represent a uniform solution for both electromagnetic and gravispin waves. This solution demonstrates that the energy of an electromagnetic wave passes into the energy of a gravispin wave, and vice versa. The period for full transformation of the energy of an electromagnetic wave into the energy of a gravispin wave and back is expressed by the relationship

$$\Delta x = \frac{2\pi}{\left(\upsilon_+^{-1} - \upsilon_-^{-1}\right)\omega} = \frac{\lambda}{c\left(\upsilon_+^{-1} - \upsilon_-^{-1}\right)}, \qquad (158)$$

where λ is the electromagnetic wave length.

An important theoretical result of the analysis of the model in question is the fact that a powerful source of gravispin waves in the space of the Universe is identified within the model in the form of vacuum domains.

Conclusion

The model of the non-homogeneous physical vacuum is based upon a new worldview (a system of conceptions of nature and society) according to which the "vacuum is not void." This worldview, which is being developed by modern theoretical physics, is going to replace the worldview formulated as early as Democritus, according to whom, "Only vacuum and the void are real." This new worldview produces a physics of substance and the physical vacuum. The worldview of Democritus produced only the physics of substance.

With Democritus's worldview, mankind is approaching the year 2000 with disquieting results, especially in the fields of power generation and the environment. The relatively easily accessible deposits of oil, gas, coal and uranium are rapidly being exhausted. More and more energy is required to exploit the less accessible deposits of non-renewable energy sources. The efficiency of the production of useful energy is falling, and the environmental load born by nature is increasing. Obtaining energy from nuclear fusion not only involves well-known difficulties, both scientific, technical and economic, but also has uncertain prospects in regard to energy efficiency and the environmental consequences.

It is as if Democritus's worldview puts beams in the eyes of even the greatest physicists and does not allow them to see directly and understand the physical phenomena that does not fall within the framework of this worldview. The old story connected with the assimilation of the ideas of quantum mechanics is also being repeated.

It is well known that the Club of Rome decided that the stable development of human civilization is possible with a population of 10^9 people on the Earth. The number of people on Earth at the present time greatly exceeds this number. In this connection, the destruction of human civilization will begin within the next few centuries. This apocalyptic prediction, however, fortunately is based on the worldview of Democritus.

One can see from the polarization model of the non-homogeneous physical vacuum even if on a hypothetical level, that the new worldview "vacuum is not a void" produces a forecast for future human civilization entirely different from that of the Club of Rome. It follows from the model that electrical and magnetic traps for capturing the vacuum domains can be created, and that they can be transported in these traps. The joining of vacuum domains of two different types, according to the model, must result in obtaining energy previously captured by the vacuum domains as a result of thermonuclear reactions in the Sun and the stars. This energy is renewable and concentrated, in contrast to many of the types of energy on which the attention of mankind at present is focused. Due to the use of the energy of vacuum domains, man will be able to conquer the large regions of outer space.

The model of the non-homogeneous physical vacuum makes it possible to predict a set of scenarios for physical processes, which would be completely impossible within the framework of contemporary physics. All these "impossible" scenarios can become possible due to the high capacity for penetration of vacuum domains into substance. For example, explosions of "safe" fuel tanks of aircraft and rockets, "unexpected" explosions of combustible gases in mines, "inexplicable" explosions of stores of explosives, the failure of electronic circuits in "reliable" screens protecting them against radiation and electromagnetic emissions, etc., can be explained.

The model makes it possible to find approaches to the explanation of the harmful impact of the environment on human health in areas of the pathogenic zones of the Earth. These zones are located at the points of fractures of the Earth's crust, where the basic quadrupole vacuum can contain a significant dipole vacuum admixture.

The model confirms the results of phenomenological studies of A. N. Dmitriyev on the great role of vacuum domains in geological and geophysical processes in general and earthquake and volcanic eruption processes in particular. On the basis of the model, V. I. Merkulov has demonstrated the determining role of vacuum domains in processes of the development of tornadoes and tropical hurricanes.

Hence the model of the non-homogeneous physical vacuum can be of great practical importance. The urgent task of experimental study of vacuum domains arises in this connection. For this purpose, it is necessary to establish laboratory conditions for the research by confining vacuum domains in electrical and magnetic traps.

References

1. Florenskiy, P. A. *The Virtual in Geometry. Expanding the Range of Two-Dimensional Images in Geometry*. Moscow: Pomorye, 1922. Moscow: Lazur, 1991. 96 pp.

2. Akimov, A. Ye., and V. Ya. Tarasenko. "Models of polarization states of the physical vacuum and torsion fields." *Izd. vuzov. Fizika*, 1992, Now. 3, pp. 13-23.

3. Dyatlov, V. L. "Linear equations of macroscopic electrogravidynamics." Moscow: 1995 (Preprint / MITPF AYeN; No. 11). 24 pp.

4. Dyatlov, V. L. "Electrogravimechancal transformation of energy." Moscow: 1995 (Preprint / MITPF AYeN; No. 12). 9 pp.

5. Dmitriyev, A. N. *Natural Self-Luminous Formations*. Novosibirsk: Izd. In-ta matematiki, 1998. 191 pp.

6. Dmitriyev, A. N., and V. L. Dyatlov. "A model of the non-homogeneous physical vacuum and natural self-luminous formations." Novosibirsk: 1995 (Preprint / IM SO RAN, No. 16). 34 pp.

   _____ *Vestnik MIKA*, 1996, issue 3, pp. 65-76.

7. Merkulov, V. I. *Electrogravidynamic Model of the UFO, Tornado and Tropical Hurricane.* Novosibirsk: Izd. In-ta matematiki, 1998. 71 pp.

8. Kvasov, N. T. *Ball Lightning. Hypotheses and Facts. The Abnormal in the Normal.* Minsk: Universitetskoye, 1989. 87 pp.

9. Nalivkin, D. V. *Hurricanes, Storms and Cyclones.* Leningrad: Nauka, 1969. 488 pp.

10. Smirnov, B. M. "Physics of ball lighting." *UFN*, 1990, Vol. 160, issue 4, pp. 1-46.

11. Korum, K. L., and J. F. Corum. "Experiments on the creation of ball lightning by means of a high-frequency discharge and eletrochemical fractal clusters." *UFN*, 1990, Vol. 160, issue 4, pp. 47-58.

12. Smirnov, B. M. "Radiation processes with the participation of fractal structures." *UFN*, 1993, Vol. 163, No. 7, pp. 51-64.

13. Kolchin, G. K. *The UFO Phenomenon. The View from Russia*. St. Petersburg: Stalker, 1994. 383 pp.

14. Valle, G. *Parallel World. (Great Mysteries of the Earth)*. Moscow: Progress, Pangeya, 1995. 272 pp.

15. Zigel, F. Yu. *The UFO Phenomenon. Observations and Studies*. Moscow: Inventsiya, 1993. 200 pp.

16. Singer, S. *The Nature of Ball Lightning*. Moscow: Mir, 1973. 238 pp.

17. Barry, D. *Ball Lightning and Beaded Lightning*. Moscow: Mir, 1983. 264 pp.

18. Smirnov, B. M. *The Problem of Ball Lightning*. Moscow: Nauka, 1988. 124 pp.

19. Stakhanov, I. P. *On the Physical Nature of Ball Lightning*. Moscow: Atomizdat, 1979. 163 pp.

20. Stakhanov, I. P. *On the Physical Nature of Ball Lightning*. Moscow: Energoatomizdat, 1985. 150 pp.

21. Merkulov, V. I. *Hydrodynamics Familiar and Unfamiliar*. Moscow: Nauka, 1989. 135 pp.

22. *Aperiodic, Rapidly Progressing Phenomena in the Environment. Proceedings of the Second Interdisciplinary Scientific and Technical Seminar*. Tomsk: Izd. TPI, 1990. 352 pp.

23. Yaklichkin, Yu. I. *The Askinskiy Poltergeist*. Moscow: Profizdat, 1997. 185 pp.

24. Dmitriyev, A. N. *Natural Electromagnetic Processes on the Earth*. Gorno-Altaysk: RIO "Univer-Print" GAGU, 1995. 80 pp.

25. Dmitriyev, A. N. "New problems in the study of unusual environmental phenomena." In collection of articles: *Traces of Space Effects on Earth*. Novosibirsk: Nauka, 1990, pp. 3-22.

26. Lunev, V. I. "Luminous spheres in Siberia and the Far East: phenomenology, experiments, hypotheses." *Izv. vuzov. Fizika*, 1992, No. 3, pp. 65-86.

27. Dmitriyev, A. N. "Geophysical aspects of anomalous phenomena and global ecology." *Izv. vuzov. Fizika*, 1992, No. 3, pp. 30-38.

28. Kuzovkin, A. S. "The UFO phenomenon and ball lightning." *Investigation of UFOs in the USSR. Collection 1*. Moscow: 1982. PP. 59-64. (On manuscript rights.)

29. Dmitriyev, A. N., Yu. P. Pokholkov, Ye. T. Protasevich and V. P. Skavinskiy. *Plasma Formation in Energy Active Zones*. Novosibirsk: Izd. OIGGiM SO RAN, 1992. 212 pp.

30. Netushil, A. V., and K. M. Polivanov. *Electromagnetic Field Theory*. Moscow: GEI, 1956. 190 pp.

31. Polivanov, K. M. *Ferromagnetics*. Moscow-Leningrad: GEI, 1957. 256 pp.

32. Pirogov, A. I., and Yu. M. Shamayev. *Magnetic Cores for Automation and Computer Devices.* 3rd Edition. Moscow: Energiya, 1973. 264 pp.

33. Polivanov, K. M., V. L. Dyatlov and M. G. Vitkov. "Calculation of remagnetization in light of the surface effect and dynamic properties of the substance." *Izv. Vuzov. Radiotekhnika*, 1961, No. 6.

34. Dyatlov, V. L. "Accounting for eddy currents and viscosity in the remagnetization of strip cores in large fields." *ND Vsh. Elektromekhanika i avtomatika*, 1959, No. 2, pp. 3-13.

35. Dmitriyev, A. N., and V. K. Zhuravlev. *The Tunguska Phenomenon of 1908 - A Form of Sun-Earth Correlations.* Novosibirsk: Izd. IGG SO AN SSSR, 1984. 143 pp.

36. Pudovkin, A. K. "Ball lightning in the Novosibirsk Academic Village. *UFN*, 1996, Vol. 166, No. 11, pp. 1253-1254.

37. Olkhovatov, A. Yu. "The Sasovo Explosions of 1991 and 1992. *Fizika Zemli*, 1995, No. 5, pp. 88-94.

38. Vonnegut, B. "Electrical theory of tornadoes." *J. of Geophysical Res.* 1960, Vol. 65, No. 1, pp. 203-212.

39. Biryukov, A. S., S. R. Grigoryan, V. I. Garkusha, *et al.* "Sources of low-frequency radiation. Effect on the Earth's radiation belts." Moscow: VINITI, No. 5204-V88.

40. "Ice from Space." *Nauka I zhizn*, 1997, No. 9, pp. 74-75.

41. Frank, L. A., and Huyghe, P. *The Big Splash.* Birch Lane Press, 1990.

42. Dmitriyev, A. N., V. L. Dyatlov and K. D. Litasov. "Physical model of kimberlite pipes formation: new constraints from theory of non-homogeneous physical vacuum" *Extended Abstracts of the 7th International Kimberlite Conference.* Capetown, South Africa, 1998. Pp. 196-198.

43. Sentman, D. D., E. M. Wescoff, D. L. Oslorn, D. L. Hampton and M. J. Heavner. "Preliminary results from the SPRITES 94 Aircraft campaign" *Geophys. Res. Letters*, 1997, Vol. 22, No. 10, pp. 1205-1212.

44. Feynman, R., R. Leyton and M. Sands. *Feynman Lectures on Physics. Electricity and Magnetism.* Vol. 5. Moscow: Mir, 1966. 296 pp.

45. Sidorin, A. Ya. *Precursors of Earthquakes.* Moscow: Nauka, 1992. 192 pp.

46. Maxwell, J. K. *Selected Works on Electromagnetic Field Theory.* Moscow: GITTL, 1954. 687 pp.

47. Heaviside, O. A. "Gravitational and Electromagnetic Analogy." *The Electrician*, 1983, pp. 282-282, 359.

48. Poincaré, H. *Rend. Circ. Mat. Palermo*, 1906, Vol 21. 129 pp.

49. Minkowski, H. *Phys. Z.*, 1909, Vol. 10. 104 pp.

50. Lorentz, G. A. *Old and New Problems of Physics*. Moscow: Nauka, 1970. 370 pp.

51. Dirac, P. A. M. *Memoirs of an Unusual Time*. Collection of articles, Y. A. Smorodinskiy, ed. Moscow: Nauka, 1990. 208 pp.

52. Terletskiy, Y. P. *Paradoxes of the Theory of Relativity*. Moscow: Nauka, 1966. 120 pp.

53. Shipov, G. I. *Theory of Physical Vacuum*. Moscow: NT-Tsentr, 1993. 353 pp.

54. Einstein, A., and L. Infeld. *The Evolution of Physics. The Development of Ideas from the First Concepts to Relativity and Quantum Theory*. Moscow-Leningrad: GITTL, 1948. 267 pp.

55. Shipov, G. I. "Psychophysical phenomena and the theory of the physical vacuum." *Collected Materials of the Scientific and Practical Conference "Consciousness and the Physical World."* Moscow, November 1996. Moscow: 1996. Pp. 69-75.

56. Zeldovich, Ya. B., and M. Yu. Khlopov. *The Drama of Ideas in the Perception of Nature. Particles, Fields, Charges.* Moscow: Nauka, 1988. 239 pp.

57. Simonov, Yu. A., and V. I. Shevchenko. "The capture and release of quarks." *Nauka v Rossii*, 1998, No. 2, pp. 4-8.

58. Terletskiy, Ya. P., and Yu. P. Rybakov. *Electrodynamics*. Moscow: Vyssh. shk., 1990. 352 pp.

59. Streltsov, V. N. "Gravitational field potentials of a moving body as a consequence of the Lorentz transformation of Newton's potential." Dubna: 1994 (OIYaI, rep. D2-94-326). 3 pp.

"Newton's relativistic force of gravity." Dubna: 1995 (OIYaI, rep. D2-95-216). 4 pp.

"The general theory of relativity as a consequence of the law of the inertia of energy. The Lorentz-covariant theory of gravity." Dubna: 1995 (OIYaI, rep. D2-95-331). 8 pp.

"On the formula $E = m\gamma c^2$." Dubna: 1995 (OIYaI, rep. D2-95-473). 4 pp.

"The problem of the shift in the perihelion of Mercury." Dubna: 1996 (OIYaI, rep. D2-96-5). 2 pp.

"Gravitational potential cannot be a tensor." Dubna: 1996 (OIYaI, rep. D2-96-66). 3 pp.

"The general theory of relativity (critical notes)." Dubna: 1996 (OIYaI, rep. D2-96-284). 6 pp.

60. Kittel, C. *Introduction to Solid-State Physics*. 2nd Edition. Moscow: GIFML, 1962. 696 pp.

61. Tamm, I. Ye. *Principles of the Theory of Electricity*. Moscow: GITTL, 1954. 620 pp.

62. Altshuler, S. A., and B. M. Kozyrev. *Electronic Paramagnetic Resonance*. Moscow: GIFML, 1961. 367 pp.

63. Zeldovich, Ya. B., and I. D. Novikov. *Relativistic Astrophysics*. Moscow: Nauka, 1967. 654 pp.

64. Shulgin, V. G. *The Second, Almost Invisible Universe. Part 3. Galaxies and the Infinite Universe*. St. Petersburg: 1994 (Manuscript). 72 pp.

65. *Ether Wind. Collected Articles*. V. A. Atsyukovskiy, ed. Moscow: Energoatomizdat, 1993. 288 pp.

66. Atsyukovskiy, V. A. *General Ether Dynamics*. Moscow: Energoatomizdat, 1990. 280 pp.

67. Khoteyev, V. Kh. *Constructing Space*. St. Petersburg: Progress-Pogoda, 1998. 121 pp.

68. Berestetskiy, V. B., Ye. M. Lifshits and L. P. Pitayevskiy. *Quantum Electrodynamics*. 3rd Edition. Moscow: Nauka, 1989. 728 pp.

69. Korukhov, V. V. "Fundamental constants and the structure of the Universe." *Physics at the End of the Century: Theory and Methodology*. Novosibirsk: Izd. IF i Pr. SO RAN, 1994. 52 pp.

70. Korukhov, V. V., and O. V. Sharypov. "The possibility combining the properties of invariant rest and relative motion based on a new model of space with minimum length." *Filosofiya nauki*, 1995, No. 1, pp. 38-49.

71. Sharypov, O. V. "The development of a new physical picture of the world based on the Planckeon hypothesis." *Filosofiya nauki*, 1995, No. 1, pp. 50-57.

72. Sommerfeld, A. *Electrodynamics*. Moscow: Izd. inostr. lit., 1958. 501 pp.

73. Landau, L. D., and Ye. M. Lifshits. *Field Theory*. Moscow: GIFML, 1962. 423 pp.

74. Brillouin, L. *New View of the Theory of Relativity*. Moscow: Mir, 1972. 142 pp.

75. Jefimenko, O. D. *Causality, Electromagnetic Induction and Gravitation*. Star City: Electret Scientific Co., 1991. 180 pp.

76. Chertov, A. G. *International System of Measurement Units*. Moscow: Rosvuzizdat, 1963. 166 pp.

77. Skanavi, G. I. *Physics of Dielectrics. Region of Weak Fields*. Moscow-Leningrad: GITTL, 1949. 408 pp.

78. *Physical Variables. A Handbook*. I. S. Grigoryev and Ye. Z. Meylikhov, eds. Moscow: Energoatomizdat, 1991. 1232 pp.

79. Novaku, V. *Introduction to Electrodynamics*. Moscow: Izd. inostr. lit., 1963. 303 pp.

80. Buckingham, M. *Noise in Electrical Instruments and Systems*. Moscow: Mir, 1986. 399 pp.

81. Kochin, N. Ye., I. A. Kibel and N. V. Roze. *Theoretical Hydromechanics. Part I.* 6th Edition. Moscow: GIFML, 1963. 583 pp.

82. Kochin, N. Ye., I. A. Kibel and N. V. Roze. *Theoretical Hydromechanics. Part II.* 4th Edition. Moscow: GIFML, 1963. 727 pp.

83. Sedov, L. I. *Continuum Mechanics*. Volume 1. Moscow: Nauka, 1970. 490 pp.

84. Kuznetsov, V. V. *Physics of terrestrial catastrophic phenomena*. Novosibirsk: Nauka, 1992. 95 pp.

85. Kuznetsov, V. V. *Physics of the Earth and the Solar System (Models of Formation and Evolution)*. 2nd Edition. Novosibirsk: Izd. IGG SO AN SSSR, 1990. 216 pp.

86. Radchenko, I. V. *Molecular Physics*. Moscow: Nauka, GIFML, 1965. 479 pp.

87. Landau, L. D., and Ye. M. Lifshits. *Continuum Mechanics*. Moscow: GITTL, 1954. 795 pp.

88. Tsitovich, V. N. "Plasma-dust crystals, droplets and clouds." *UFN*, 1997, Vol. 167, No. 1, pp. 57-99.

89. Grebennikov, V. S. "Electrophonic bolides of Siberia, the Urals and the Far East." *Meteorite Research in Siberia*. Novosibirsk: Nauka, 1984. Pp. 191-203.

90. Romich, M., and D. Lamar. "Anomalous sounds and electromagnetic phenomena related to the flight of bolides." *Meteorite Matter in the Earth's Atmosphere*. Moscow: Nauka, 1966. Pp. 38-68.

91. Dmitriyev, A. N., and G. M. Ivanova. "Helioperiodicity of detonating bolides." *Abstracts of Papers of the International Scientific and Technical Seminar "Aperiodic, Rapidly Progressing Phenomena in the Environment."* Tomsk, April 18-24, 1988. Tomsk: 1988. Pp. 106-108.

92. Carry, W. *In Search of the Patterns of Development of the Earth and the Universe*. Moscow: Mir, 1991. 447 pp.

93. Carry, S. W. *The Expanding Earth*. Amsterdam-Oxford-New York: Elsevir Sci. Publ. Co., 1976. 488 pp.

94. Kuznetsov, V. V. "Are the approaches to the physics of the Earth correct?" *Geologiya i geofizika*, 1996, Vol. 37, No. 6, pp. 117-122.

95. Kuznetsov, V. V. "The gravitational field of the Earth in the geological past." *Geologiya i geofizika*, 1996, Vol. 37, No. 10, pp. 98-107.

96. Veselov, K. Ye., G. V. Krug, K. A. Slavinskiy and T. V. Dolitskaya. *Physical and Geological Principles of the Concentration of Global Reef Formation*. Moscow: Izd. MGU 1993. 127 pp.

97. Dmitriyevskiy, A. N., I. A. Voloshin and G. I. Shipov. *The Earth's Energy Structure and Geodynamics*. Moscow: Nauka, 1993. 154 pp.

98. Meek, L., and L. Craigs. *Electrical Breakdown in Gases*. Moscow: Izd. inostr. lit., 1960. 603 pp.

99. Poletavkin, P. G. *Space Energetics*. Moscow: Nauka, 1981. 152 pp.

100. Dmitriiyev, A. N. "Participation of irreversible processes in the origin and development of life." *Principles of Development and Historicism in Biology and Paleobiology*. Novosibirsk: Nauka, 1990. Pp. 226-235.

101. Stanyukovich, K. P. *Gravitational Field and Elementary Particles*. Moscow: Nauka, 1965. 311 pp.

102. Nesterikhin, Yu. Ye., S. G. Rautian and G. I. Smirnov. "Laser gravity wave detector." *ZhETF*, 1978, Vol. 75, issue 1 (7), pp. 3-7.