Unification of electromagnetism and gravitation. Antigravitation

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This article was published like chapter 3 in the Leonov's book: Quantum Energetics. Volume 1. Theory of Superunification. Cambridge International Science Publishing, 2010, pp. 167-261. The problem of unification of electromagnetism and gravitation was formulated by Einstein. But only I solved this problem in the theory of Superunification. For this, I had to find a common particle which is the carrier of electromagnetism and gravity at the same time. This particle is a quanton - a quantum of four-dimensional space-time. Gravity appears inside the quantised space-time as a result of its deformation (Einstein's curvature) under the influence of the gravitational mass of the body (particle). And vice versa, the mass of a body (particle) is born as a result of spherical deformation of quantised space-time. Mass is a cluster (bunch) of electromagnetic energy of deformed quantised space-time. The electromagnetic energy of deformation of this cluster is equivalent to mass according to Einstein's formula mC^2. The movement of mass is the wave transfer of the spherical deformation of quantised space-time in accordance with the principle of wave-particle duality.

The beginning of the 20th century was marked by the development of the theory of relativity. In the framework of the general theory of relativity (GTR), Einstein laid the foundations of gravitation as the properties of distortion of the space-time, assuming that there is a unified field which is the carrier of electromagnetism and gravitation. In 1996, the space-time quantum (quanton) and the superstrong electromagnetic interaction (SEI) was discovered as the united field which is the carrier of electromagnetic and gravitation interactions. The concentration of the quantons (quantum density of the medium) is the main parameter of the quantised space-time. In electromagnetic interactions the concentration of the quantons does not change and only the orientation and deformation polarisation of the quantons change. Gravitation is manifested in the case of the gradient redistribution of the quantum density of the medium, changing the quanton concentration. Electromagnetism and gravitation have been unified within the framework of the quantum theory of gravitation based on the quantum as the unified carrier of electromagnetism and gravitation.

3.1. Introduction

This chapter is concerned with the quantum theory of gravitation (QTG) and is an independent section of the theory of the elastic quantised medium (EQM) and the theory of the unified electromagnetic field (TUEM), continuing analysis of the processes in the quantised space-time [1]. In the

EQM theory and TUEM, the new quantum theory of gravitation (QTG) is based on complete denial of the nature of gravitation through the processes of energy exchange by the particles-gravitons (like photons) – hypothetical carriers of gravitational interactions, which have not been detected in experiments [2]. As shown by analysis of gravitation in the TUEM which integrates the fundamental interactions, including electromagnetism and gravitation, gravity cannot be explained by assuming that photons fly between the solids and transfer gravitation. If this was the case, the gravitons would have been already detected. The old exchange quantum theory of gravitation is a dead theory which cannot even be resuscitated as it has been possible in, for example, modernisation of the quantum chromodynamics (QCD) in TUEM. In this case, the initial matter is represented by only four whole monopole charges (two electrical and two magnetic) [1], representing new quarks, and the structure is determined not only of hadrons but also of all elementary particles with their fields, including gravitational fields.

Instead of the hypothetical graviton particles, the new quantum theory of gravitation considers the real carriers of the gravitational field - quantons. These are space-time quantons which are also carriers of gravitation, integrating gravitation and electromagnetism through the superstrong electromagnetic interaction (SEI). The quantons do not fly between the solids and are static particles belonging to the stationary and absolutely quantised space-time in the local domain through which energy exchange processes take place in all electromagnetic and gravitational interactions, with the general equation of these interactions being very simple (2.1, 2.38) [1]:

$$\Delta x = \pm \Delta y \qquad (3.1)$$

where Δx and Δy are the displacements of the electrical e and magnetic g elementary charges of the monopole type (with no mass) from the zero state inside the quanton in the quantised space-time, respectively, m.

As shown in [1], the (–) sign in (3.1) indicates the electromagnetic interactions determined by the electromagnetic polarisation of the quantised space-time. Equation (3.1) can be transformed quite easily into the main equations of the electromagnetic field in vacuum together with their solutions [1]. The (+) sign in (3.1) corresponds to the gravitational interactions, determined by spherical deformation and according to Einstein by the 'distortion' of the quantised space-time. In this work, we do not study the processes of gravitational interaction in the region of the ultra-microworld 10^{-25} m, studying the displacement (3.1) of the charges in the quantons, as in [1]. This is a separate subject in which real superstrings, as quantum objects of electromagnetism and gravitation, are found.

In this work, we continue the development of the Einstein concepts for the gravitational distortion of space-time in which the given concept in the conditions of the quantised medium is regarded as its real deformation. This has become possible because of new fundamental discoveries in which the primary matter is represented by the quantised space-time, as a real medium with the field (weightless) form of matter with no analogues with the known matter (ponderable) media. For this purpose it is necessary to return to the two global Einstein's ideas: 1) the concept of the unified field, integrating electromagnetism and gravitation, 2) the search for the deterministic fundamentals of quantum theory in the path of unification with the theory of relativity which Einstein attempted to realise in the framework of the general theory of relativity. These two Einstein's concepts are realised in the quantum theory of gravitation.

At present, theoretical physics is in an obvious crisis in which the classical knowledge does not make it possible to explain the experimental facts in the domain of the microworld of elementary particles. Regardless of the considerable expenditure on the construction of more and more powerful accelerator (supercolliders) and their scientific servicing, the discovery of new elementary particles have not helped physicists in understanding their structure and nature. It is necessary to scaledown the work on powerful and expensive particle accelerators because of the obvious hopelessness of the investigations, with the well-known English theoretical physicist, Noble prize laureate S. Weinberg noting: *'basically, the physics enters some era in which the experiments are no longer of shedding light on fundamental problems. The situation is very alarming. I hope that the sharp minds of experimentators will find a way out of the situation'* [3].

The current state of physical sciences has been accurately described by academician Novikov in a discussion at the Presidium of the Russian Academy of sciences (RAS) (shortened version): *'I think that we can now claim that there is a crisis in theoretical physics throughout the world. The point is that many extremely talented people, educated and well-prepared for solving the problems of physics of elementary particles and the quantum theory of the field have in fact become pure mathematicians. The process of mathematisation of theoretical physics will not lead to anything good for science'* [4]. I would like to add myself that the theory of Superunification of interactions, as a purely mathematical theory, has reached a deadlock. The attempts to justify the existing situation by a Standard model, because the branch of standardisation does not relate to physics which should develop dynamically and should not be restricted by a standard. If we are discussing models, only physical models can be used in physics and knowledge of these models justifies the application of even most complicated mathematical apparatus. However, if a physical model is accurately constructed then, although this is paradoxic, it can be described by a very simple mathematical apparatus.

I believe that the crisis of theoretical physics is caused by the fact that it is not possible to integrate not only fundamental interactions but also the concepts of absolute and relative. If mathematics is not capable of constructing a Superunification model, it is necessary to avoid using mathematical models and start a search for a physical model which would enable the Superunification of interactions.

Such a physical model was found in 1996: the space-time quantum (quanton) and superstrong electromagnetic interaction were discovered. New fundamental discoveries were used as a basis for proposing the theory of the elastic quantised medium (EQM) and the theory of Superunification [1, 5-17]. There is no need to look for a unified mathematical formula for unification but it is necessary to find a unified particle integrating various categories: space and time into a unified substance – quantised space-time; electricity and magnetism into electromagnetism; electromagnetism and gravitation; electromagnetism, gravitation and strong and electroweak interactions. A general equation (3.1) has been derived which describes the state of electromagnetism and gravitation in the quantised space-time as a unified field.

Naturally, the development of the quantum theory of gravitation effects various global problems of physics, such as the existence of absolute space and the action of the relativity principle which have been regarded erroneously as incompatible categories, assuming that the principle of relativity is characteristic only of empty space. This was a serious mistake which inhibited the development of the theory of gravitation. It is therefore necessary to explain briefly the existing contradictions.

Einstein himself characterises the state of space-time as a unified field: *'we can how the transition to the general theory of relativity changes the concept of space... Empty space, i.e. space without a field, does not exist. The space-time does not exist on its own nuy only as a structural property of the field. Thus, Descartes was not very far from the truth when he assumed that the existence of empty space should not be considered. The concept of a field as a real object in combination with the general principle of relativity was required to show the true principle of the Descartes idea: there is no space 'free from the field'* [18].

The discovery of the space-time quantum (quanton) as the carrier of the unified field excludes the existence of empty space-time, integrating the absolute space-time and the relativity principle. To prove that the relativity principle is a fundamental property of the absolute quantised space-time, it was essential to avoid using false assumptions which were made in theoretical physics at the beginning of the 20s when justifying the fundamental nature of the relativity principle.

I should mention that Newton introduced absolute space and absolute time into physics which exclude the concept of relativity as a fundamental category independent of absolute space and time (shortened version): ‘ *???, always remains the same and is stationary. The relative (space) is its measure or some restricted moving parts, in relation to some solace. The absolute time passes uniformly. The relative time is the measure of duration in the ordinary life’* [19]. According to Newton, there is the stationary absolute space and absolute time, and the measurement of motion and time in everyday life is the process of relative measurements in absolute space and time.

Newton’s formulation of absolute space and time dominated in science of over a period of two centuries without any contradictions but at the beginning of the 20th century, doubts were cast by scientists because in the experiments carried out by Michaelson and Morley they did not detect the absolute space which Lorenz linked with the stationary gas-like aether. The strongest criticism was published by French mathematician and physicist A. Poincaré who attempted to substantiate the fundamentality of the relativity principle: *‘absolute space does not exist, we know only relative motions. There is no absolute time. The acceleration of a solid should not depend on its absolute speed. Accelerations depend only on the difference of the speeds and the difference in the coordinates of the solids and not on the absolute values of speed in the coordinates’* [20].

In a general case, the main assumptions of the relativity principle, formulated by Poincaré, may be reduced to the following:

1. We cannot detect the absolute speed in relation to the stationary space-time using devices placed in a closed room, i.e., without observing the sky with stars.

2. In all inertial counting systems, i.e., in the systems moving by inertia uniformly and in a straight line, all the physical laws are invariant, i.e., they do not depend on the speed of motion in empty space, excluding the structure of space as such.

Nowadays, Poincaré formulations are regarded as erroneous. New fundamental discoveries have made it possible to develop the concept of the measurement of absolute speed in quantised space-time and the results can be used for the development of appropriate devices. In the region of relativistic speeds, the invariance of the laws, in particular, gravitation, is disrupted because of its non-linear amplification. It would simple crush us.

As already mentioned, in many cases, the development of concepts in science is based on rejection of other concepts: Poincaré categorically rejected Newton's absolute space. Poincaré, as a theoretical physicist, and an excellent analyst, had at that moment at his disposal only scarce experimental information on some properties of the electron and negative results of Michaelson (and subsequently, Morley) interference experiments which did not record aether wind. Naturally, Poincaré as a physicist linked his analysis with the negative results of Michaelson experiments, which determine the logics of his considerations. There is nothing unnatural in this, because science develops by the method of testing errors. Initially, the great Newton formulated the existence of absolute space and time and also regarded relativity as the properties of absolute space. Subsequently, after almost 200 years Poincaré started to reject Newton and since his logic consideration at the time were relatively convincing and apparently confirmed by experiments, the Poincaré reasoning influenced the development of physics in the 20th century. Of course, Newton could not longer oppose Poincaré. Taking into account the fact that subsequently after 50 years Einstein carried out his investigations within the framework of the theory of activity, the main assumptions of the principal relativity, formulated by Poincaré, became classic (although erroneous).

Consequently, Newton's absolute space and time were completely dislodged from physics. The 20th century is the dominant century of relativity without absolute spaxe which had existed for 200 years previously. At the beginning of the 20th century, the principal relativity moved physics from the critical state but now at the beginning of the 21st century theoretical physics is again in deep crisis. There are strong suggestions of scientists in many countries of the world on the insolvency of Einstein's theory of relativity and on the return to Newton's absolute space. Criticism is made not only of Einstein, as the author of the theory of relativity, but also of Poincaré and Lorenz who laid the foundations of the theory of relativity. It is now necessary to protect Einstein, Lorenz and Poincaré because they substantiated the fundamentality of the principle of relativity, although they erroneously rejected Newton (with the exception of Lorenz). However, the principle of relativity can no longer be excluded from physics and it is also not necessary to verify it additionally. The principle of relativity exists in the absolute manner in all physical processes and phenomena, as the fundamental property of the quantised space-time.

Analysing sharp movements of scientific world view from one extreme to another, it is surprising that nobody has attempted to examine the problem of compatibility of Newton's absolute space and time and the principle of relativity, introducing appropriate corrections. The scientific battle of giants of physics, even after their death, does not lead to any fruitful results and generates a next crisis. At the beginning of the 20th century when the fundamentals of the theory of relativity were developed, the unique properties of the quantised space-time as the absolute space-time in the form of a specific quantum medium or, more accurately, the quantised medium, were not known. Since the properties of quantised space-time where not known, it was not possible to develop an instrumental base which would make it possible to investigate absolute space-time. However, even at that time, nobody proved that Newton's absolute space is 'irrelative' and invariable.

If we accept the opposite view that the absolute space-time is a changing category characterised by internal relativity, all the Poincaré considerations collapse as a house of cards. This is a typical case of global errors in considerations when a specific thesis is regarded as true and the opposite interpretation is not even investigated. All the possible variants are investigated in science, rejecting unfounded one. Another variant is added, according to which the absolute space-time is capable of changes, and Poincaré's variant becomes insolvent. The absolute space-time can be dislodged from physics also taking into account the fact that it is not a simple medium but it is the quantised medium. Physics has already encountered the unique properties of superfluidity of liquid helium as a quantum fluid. However, the properties of liquid helium did not have any stroing effect on the development of quantum theory, like the discovery of the elastic quantised medium (EQM) whose unique properties form the basis of quantised space-time.

In this book, we do not examine the transformation of coordinates in various reference systems because this problem has been extensively studies and is in fact investigated in the theory of relative measurements. For physics, the confirmation of the fundamentality of the principle of relativity, as the unique properties of absolute space-time, is linked with the principle of spherical invariance which results from the quantum theory of gravitation [11].

The quantum theory of gravitation can be developed because of the return of the concept of Einstein's unified field and the concept of the deterministic nature of quantum theory which Einstein defended throughout his life. Now we can talk about the development of the quantum theory of relativity which is based on Einstein's fundamental ideas.

3.2. Nature of the electromagnetic wave. The luminiferous medium

3.2.1. Return to the luminiferous medium

In order to remove obstacles in the path of quantum theory of gravitation, it is necessary to return to the luminiferous medium to physics, as a real manifestation of the superstrong electromagnetic interaction. Rejection of absolute space resulted in the unjustified rejection of the concept of the luminiferous medium, with the electromagnetic wave given the properties of an independent field which does not require a carrier. The return to the unified Einstein field which is a simultaneous carrier of electromagnetism and gravitation requires confirmation that the electromagnetic wave cannot form without quantised space-time as a unified field. If somebody starts to write a book of scientific errors, the best example of such an error is the rejection of the luminiferous medium and assumption that the electromagnetic wave has the properties of the independent electromagnetic field which does not require a carrier. Can we imagine sea waves without water? Similarly, we cannot imagine electromagnetic waves without a luminiferous medium.

Regardless of the fact that in [1] special attention was given to the principles of electromagnetic interactions as the property of quantised space-time, it is necessary to mention, at least briefly, that the quantised space-time, as a luminiferous medium, is reality. As a theoretician and also experimentator, I am surprised by the naivity of theoreticians who have no methodology for experimental studies. In the 20th century, the theoreticians rejected the luminiferous medium which had existed in physics for more than 200 years previously, because of the giants of physical thinking, such as Descartes, Huygens, Faraday, Maxwell, Hertz, and many others. This rejection was made on the basis of the experiments carried out by Michaelson and Morley who, as shown by analysis, proved the fundamentality of the principle of spherical invariance in the conditions of quantised space-time but did exclude a specific luminiferous medium. To reject the luminiferous medium as such, it is necessary to formulate methodically precise experiments. For this purpose, it is necessary to use a pipe and remove physical vacuum from it, i.e., a luminiferous quantised medium, and investigate whether light passes through this tube or not. If the light does not pass through the tube, its propagation is caused by the luminiferous quantised medium which has been removed from the tube. However, no such direct experiment has been carried out. Experiments carried out by Michaelson and Morley to detect aether wind, as an unproven property of the luminiferous medium, cannot be regarded as accurate in relation to the luminiferous medium.

From the procedural viewpoint, the situation is in the absurd state because in the conditions on the Earth the luminiferous quantised medium cannot be removed from the tube. However, since no such experiment has been carried out, nobody has had the right to exclude the luminiferous medium from physics. In particular, the exclusion of the luminiferous medium resulted in an absurd situation in physics in which the logics of physical experiment in the theory was replaced by abstract mathematical models based on the incorrectly formulated experiments from the procedural viewpoint. It is difficult to imagine how one can manipulate the most complicated equations, trying to find a solution of the problem, without knowing its physical model. The model of the quantised luminiferous medium, represented by the quantised space-time, has proved to be so successful that it has made it possible to explain not only the structure of all main elementary particles, including photons (light carriers), but also deal with the entire range of the problems of electromagnetic waves in Maxwell equations. I should mention that Maxwell derived his outstanding equations without analytical considerations, using the concept of the luminiferous medium and assuming that no wave can propagate without a medium [21].

Paradoxically, it is the rotor models of the electromagnetic waves in the Maxwell equations which were used to exclude the luminiferous medium without any justification, taking into account the negative results of Michaelson and Morley experiment in the attempts to detect aether wind which has no relation with the luminiferous medium. It was assumed that the electromagnetic wave is a unique vortex state of the electromagnetic field in which the vortex of the magnetic field generates the vortex of an electrical field and, vice versa, forming the electromagnetic wave, as an independent field. This is a purely metaphysical approach with no material substantiation. How can a vortex be generated in absolute emptiness? To move forward, it is necessary to discard various vortex concepts in electromagnetism resembling aether wind. In the quantised space-time there are the electromagnetic rotors and circular fields, but no vortices. This is an experimentally confirmed fact.

Investigating the rotor state of the quantised space-time in the electromagnetic wave, I have not detected any vortices in them. The vortex is rotation of the medium around some centre. The quantised space-time is a superhard and superelastic medium which simply cannot be twisted into a vortex, as in the case of a gaseous aether. The properties of space-time do not permit this. We can change the topology of the quantised space-time in accordance with (3.1) where electromagnetism or gravitation become evident in space-time. In order to generate an electrical or magnetic rotor, the topology of the quantised space-time must be changed in such a manner as to close around the circumference of the electrical or magnetic axes of the quantons as a result of orientational polarisation [1]. However, the orientational polarisation of quantons in the form of a circle does not resemble a vortex because the quantons are not twisted into a vortex flow like the particles of water or gas.

However, the problem of rotors and circular fields in electromagnetism is not of principal importance because special attention must be given to the nature of magnetism and electricity and the mechanism of transformation of electricity into magnetism and vice versa. At present, physics links the nature of magnetism with dynamic electricity. This is a metaphysical approach because magnetism is manifested as magic and nobody knows why. However, magnetism is a real material medium which requires its carrier in the form of magnetic charges (Dirac monopoles). Modern physics regards magnetic monopoles as hypothetical particles which have not as yet been detected in experiments. New discoveries show that the magnetic monopoles are linked inside the quantum into magnetic dipoles and they do not exist in the free condition. We cannot observe directly the free magnetic charges and they are seen indirectly in experiments in all electromagnetic processes in which magnetism forms from electricity, and vice versa.

If we analyse the generally accepted studies of the theory of electromagnetism, we detect in most cases the same repetition of the formal approach to the Maxwell equations in vacuum when explaining the vortex nature of the electromagnetic wave [22–28]: *at present, it is preferred to regard the formation of vortices of a magnetic field during changes of the electrical field exactly as the formation of vortices of the electrical field with the variation of the magnetic field, as the main property of the electromagnetic field'* [28]. Figure 1a shows an erroneous vortex mechanism of the propagation of the electromagnetic wave in which the vortex of the magnetic field generates the vortex of the electromagnetic field and, vice versa, in the direction of propagation of the electromagnetic wave. The vortices are expressed through the rotors **E** and **H**, situated in the orthogonal planes. To ensure that rotor **H** can generate the rotor **E**, they should be shifted in phase with time by quarter of a cycle to ¼T. Classic electrodynamics does not offer any other explanation. However, this is an antiscientific assumption on the mechanism of propagation of the electromagnetic wave. This is confirmed by the graphical representation of the electromagnetic wave in experiments.

Figure 3.1b shows the experimental distribution of the vectors of the strength of the electrical **E** and magnetic **H** fields in the electromagnetic wave in the quantised space-time. In experiments, no vortices were detected

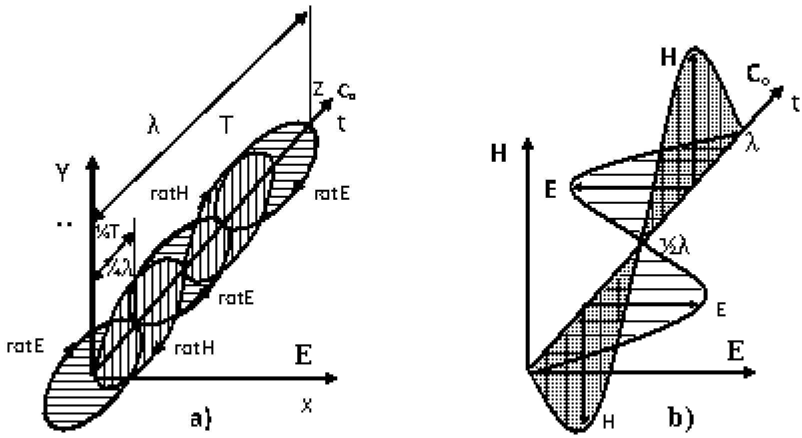

Fig. 3.1. Erroneous representation of the vortex mechanism of propagation of the electromagnetic wave (a) and actual distribution of the vectors of the strength of electrical **E** and magnetic **H** fields in the electromagnetic wave in quantised space-time (b).

in the electromagnetic wave. In addition, the vector of the strength of the electrical field **E** and the vector of the strength of the magnetic field **H** change simultaneously with time *t*, without any phase shift by quarter of a cycle ¼ *T* (or wavelength ¼λ), as shown in Fig. 3.1a. The simultaneous formation of the vectors **E** and **H** in the electromagnetic wave ensures that no preference is given to electrical or magnetic fields. This means that the electrical field cannot generate a magnetic field in the electromagnetic wave, and vice versa, showing that the vortex concept is incorrect. The electrical and magnetic fields exist simultaneously in the electromagnetic wave.

For a vortex to form in the direction of propagation of the electromagnetic wave, the vectors **E** and **H** should have the longitudinal component as shown in Fig. 3.1a. However, the longitudinal component is not present in the experiments and the electromagnetic wave contains only the transverse vectors **E** and **H**. This proves once again that the generally accepted vortex concept of the propagation of the electromagnetic wave, shown in Fig. 3.2a, does not have any scientific substantiation.

It would appear that the laws of electromagnetic induction, discovered by Faraday, are umbeatable: a magnetic field generates a circular electrical field, and vice versa. If we consider a vibrational circuit consisting of an inductance and a capacitance, the energy of the electrical field in the circuit transforms to the energy of the magnetic field, and vice versa, determining the phase shift of ¼*T*. Why is it that the laws of electromagnetic induction do not hold in the electromagnetic wave and the energies of electrical and magnetic fields do not change into each other but change simultaneously?. It has been found that the volume density of energy W_v in the electromagnetic wave is determined by two components E and H (2.170) [1]:

$$W_v = \frac{EH}{C_0} \tag{3.2}$$

Equation (3.2) can be easily transformed to the intensity of the flux **S** of electromagnetic radiation (Pointing vector) (2.171) in the vector form, when the components **E** and **H** exist simultaneously

$$\mathbf{S} = W_v \mathrm{C}_0 = |\mathbf{EH}| \tag{3.3}$$

The question of simultaneous existence of the vectors **E** and **H** in the electromagnetic wave was formulated for the first time in the EQM theory when the discovery of the space-time quantum (quanton) enabled the quanton to be regarded as a carrier of superstrong electromagnetic interaction and the disruption of the zero state (3.1) of this interaction determines the conditions of formation of the electromagnetic wave in vacuum [5–15]. This problem has been examined in detail in a general study [1].

It is surprising that throughout the entire 20th century, theoretical physicists, knowing the fact that the concept of vortex propagation of the electromagnetic wave in vacuum does not correspond to the experimental results, assumed that everything is okay here and complicated the mathematical apparatus of the electromagnetic wave without knowing the reasons for the problem. Even the introduction of the four-dimensional vector potential of the electromagnetic field did not make it possible to solve this problem not only with respect to the classic electromagnetic wave but also with respect to the photon, as a specific quantum state of electromagnetic wave, regarding the photon as a wave-corpuscule. All these problems were solved in the EQM theory, but the investigation of these problems is outside the framework of this book whose main subject is determined by the fundamental nature of the principle of relative–absolute dualism, linked with the realias of the luminiferous medium. It is therefore important to mention the main assumptions of the EQM theory with respect to the luminiferous medium.

The realias of the luminiferous medium are linked with the unification of electricity and magnetism in electromagnetism, as an independent substance of the quantised space-time, unifying simultaneously space and time. Figure 3.2a shows schematically and conditionally the space-time quantum (quanton) in projection in the equilibrium (zero) state. Complete information

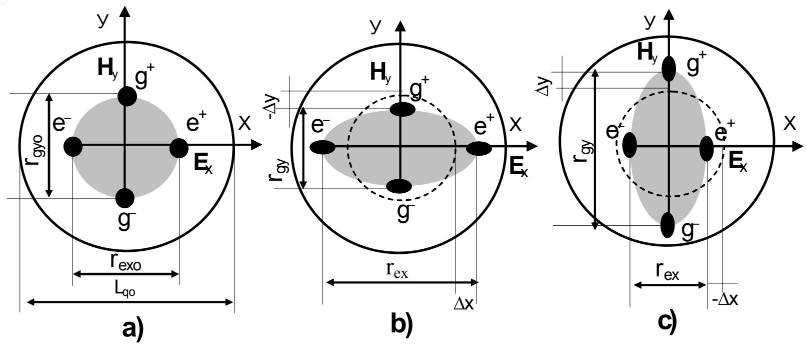

Fig. 3.2. Electromagnetic polarisation of a quanton in passage of an electromagnetic wave. The equilibrium (zero) state of the quanton (a); excited polarised state of the quanton (b) and (c).

on the volume tetrahedral structure and properties of the quanton can be found in [1, 12–15]. In this case, it is important to understand that the quanton unifies electricity and magnetism and includes four monopole (with no mass) elementary charges: two electrical charges (e^+ and e^-) and two magnetic charges (g^+ and g^-) linked by the relationship (2.6) [1, 12–15]:

$$g = C_0 e = 4.8 \cdot 10^{-11}\,\mathrm{Dc} \tag{3.4}$$

where $e = 1.6 \cdot 10^{-19}$ C is the elementary electrical charge; C_0 is the speed of light in the quantised space-time unperturbed by gravitation (in the region of the weak gravitational field of the Earth $C_0 \sim 3 \cdot 10^8$ m/s).

The magnetic charge g is measured in diracs [Dc] = [Am^2], i.e., in honour of Paul Dirac who introduced the magnetic charge (Dirac's monopole) into physics [29–31]. The unification of electricity and magnetism inside a quanton ensures the superstrong electromagnetic interaction which is a unique 'adhesive' (glue) bonding two different substances into one. Experimentally, this is confirmed by all electromagnetic processes. Attention should be given to the fact that the electrical and magnetic axes of the quanton (Fig. 3.2), linking the appropriate electrical and magnetic dipoles, always remain orthogonal in relation to each other, determining the orthogonality of the vectors **E** and **H** in the electromagnetic wave which forms as a result of the disruption of electromagnetic equilibrium (zero state) of the quantised space-time.

The process of space quantisation includes filling the volume of space with quantons. Taking into account the tetrahedral arrangement of the charges inside the quanton, the orientation of the quantons in the volume is determined by their random coupling, excluding some priority direction of the electrical and magnetic axes of the quanton in space and, at the same time, determining the isotropic properties of space as a homogeneous medium, electrically and magnetically neutral but having electrical and magnetic properties which are considered together by electrical ε_0 and magnetic μ_0 constants. On the other hand, the quantum is a volume electromagnetic elastic resonator, a unique 'electronic clock ", defining the course of time in space, unifying space and time into a single substance, i.e., quantised space-time. Consequently, a unique clock works at every point of the quantised space, determining the rate of the electromagnetic processes.

The non-excited state of the quanton (Fig. 3.2a) determines its zero equilibrium state when the distances r_{exo} and r_{gyo} between the centres of the monopole charges inside the quanton are constant values, and, as shown by the calculations, are linked with the diameter L_{q0} of the quanton by the relationship (2.7) [1]:

$$L_{q0} = 2r_{exo} = 2r_{gy0} = 0.74 \cdot 10^{-25} \text{ m} \tag{3.5}$$

The dimensions of the quanton (3.5) enable us to write one of the main parameters of the quantised space-time, establishing the concentration of the quantons in the unit volume of the non-perturbed vacuum as the quantum density of the medium ρ_0 (where $k_f = 1.44$ is the coefficient of filling of vacuum with spherical quantons):

$$\rho_0 = \frac{k_3}{L_{q0}^3} = 3.55 \cdot 10^{75} \frac{\text{quantons}}{\text{m}^3} \tag{3.6}$$

Attention should be given to the total symmetry of electricity and magnetism inside the quanton which is expressed in the fact that in the equilibrium state the energy W_e of the electrical field of interaction of the electrical charges (e^+ and e^-) is equivalent to the energy W_g of the magnetic field of interaction of the magnetic charges (g^+ and g^-), i.e., $W_e = W_g$, with (3.5) taken into account:

$$W_e = W_g = \frac{1}{4\pi\varepsilon_0} \frac{e^2}{r_{ex0}} = \frac{\mu_0}{4\pi} \frac{g^2}{r_{gy0}} = 0.62 \cdot 10^{-2} \text{ J} \tag{3.7}$$

The internal accumulated energy of the quanton is determined by the sum of the electrical and magnetic energies (2.7) and equals $1.2 \cdot 10^{-2}$ J or 10^{16} eV. Taking into account the high concentration of the quantons (3.6), the energy capacity of one cubic meter of vacuum is of the order of 10^{73} J. This is a colossal concentration of energy and activation of this energy would result in the birth of another universe as a result of a big bang when the matter part of the universe started to form from a similar state comparable with the cubic meter which on the scale of the universe may be regarded as a point. However, the absence in nature of free magnetic charges and the presence of a surplus of electrical charges indicates that the singular state was of the purely electrical nature in the absence of the magnetic component. The state proved to be unstable, capable of activation. In the presence of the magnetic component it is not possible to split the quanton into magnetic and electrical charges because of its very high energy capacity representing the quantised space-time as the most stable substance in nature.

Equation (3.4) gives the relationship of the electrical and magnetic parameters of the quantum, determines their symmetry and establishes the exact relationship (3.4) between the magnetic and electrical elementary charges. The ratio of the charges obtained previously by Dirac is not correct because it results in the disruption of symmetry between electricity and magnetism of vacuum [28–30]. It is interesting to note that the electrical ε_0 and magnetic μ_0 constants of the quantised space-time are fundamental constants whose effect is evident at distances considerably smaller than the quanton diameter of $\sim 10^{-25}$ m, like the effect of the Coulomb fundamental law for electrical and magnetic charges [1].

The equations (3.4) and (2.7) have the form of Maxwell equations for vacuum which link electricity and magnetism in the electromagnetic excitation of both an individual quantum and of a large group of quantons in the quantised space-time when in the conditions of passage of the electromagnetic wave through the luminiferous medium there is both the deformation and orientation polarisation of the quanton.

Figure 3.2b shows the process of deformation polarisation of the quantum as a result of its electromagnetic excitation when using the half cycle of the wave, the electrical monopole charges e inside the quantons are stretched along the electrical axis X, determining their displacement Δx from the zero state. In this case, the magnetic charges g are also displaced to the centre of the quanton by the value $-\Delta y$, in accordance with (3.1), ensuring that the energy of the quantum does not change. During the second half cycle of passage of the wave (Fig. 3.2c) the process of polarisation of the quantum changes to an opposite process. The electrical charges are displaced to the centre of the quantum and the magnetic charges from the centre, simultaneously, also ensuring that the quanton energy is maintained. The validity of the laws of conservation of energy in the electromagnetic wave is confirmed experimentally on the basis of the absence of excess energy in the wave. The wave transfers only the energy of electromagnetic excitation [1, 12–15].

Attention should be given to the fact that the displacement of the magnetic charges to the centre of the quanton (Fig. 3.2b) increases the energy of the magnetic field inside the photon. The electrical charges are also displaced from the centre of the photon reducing the energy of the electrical field inside the quanton, equal to the increase of the energy of the magnetic field and ensuring at the same time the constancy of the quanton energy in the electromagnetic wave. The quanton is characterised by the simultaneous transition of electrical energy to magnetic energy and vice versa. The variation of energy inside the quanton (a group of quantons) as a result of disruption of electromagnetic equilibrium is manifested externally as simultaneous induction of the vectors **E** and **H** in the quantised medium and the appearance of the Pointing vector (3.3) which determines the transfer of electromagnetic energy (3.2) by the electromagnetic wave [1]. The duration of the transitional energy processes inside the quanton is determined by the time T_{q0} (2.50) of passage of the electromagnetic wave through the quantum, determining the period of resonance oscillations of the quantum

$$T_{q0} = \frac{L_{q0}}{C_0} \approx 2.5 \cdot 10^{-34}\,\text{s} \tag{3.8}$$

Equation (3.8) shows clearly that the discrete space characterised by the fundamental length L_{q0} also specifies the course of time T_{q0}. Equation (3.8) unifies space and time as a luminiferous medium. Time T_{q0} (3.8) is the duration of the fastest process in nature, regardless of the fact that it is tens of orders of magnitude longer than the Planck time. On the other hand, the minimum time T_{q0} enables us to discuss the quantised nature of time which is proportional to $n_t T_{q0}$, where coefficient n_t is an integer from 1 to ∞. If we select the most stable reference time, the quantum is the best solution as a reference in nature. However, even this is not an ideal reference time because it depends on the perturbing gravitation potential, and in strong gravitational fields such a clock slows down and on the surface of a black hole it will stop working.

Returning to the analysis of the passage of the electromagnetic wave in the quantised space-time, it should be mentioned that it has been possible to find for the first time physical models which actually prove the existence of the currents of electrical and magnetic displacement in vacuum. This was also pointed out by Heaviside. Physical models which were used as a basis for analytical derivation of the Maxwell equations [1, 12–15] were developed. We can demonstrate the derivation of the Maxwell equations, differentiating (2.7), but it is more convenient to represent the density of the currents of electrical $\mathbf{j}_c$ and magnetic $\mathbf{j}_g$ displacements in the vector form through identical speeds **v** of displacement of the charges inside the quanton and the quantum density of the medium ρ_0 (3.6), taking into account the orthogonality of the vectors $\mathbf{j}_e$ and $\mathbf{j}_g$ (2.4):

$$\begin{cases} \mathbf{j}_e = 2e\rho_0\mathbf{v} \\ \mathbf{j}_g = 2g\rho_0\mathbf{v} \end{cases} \qquad (3.9)$$

Substituting (3.9) into (3.4), we obtain a relationship between the densities of the currents of electrical and magnetic displacement in the electromagnetic wave in vacuum in the form of a vector product in which the speed of light C_0 is a vector orthogonal to the vectors $\mathbf{j}_e$ and $\mathbf{j}_g$ (2.60):

$$\left[\mathbf{C}_0\mathbf{j}_e\right] = -\mathbf{j}_g \qquad (3.10)$$

Figure 3.3 shows the graph of the electromagnetic wave in the quantised space-time in the coordinates of the displacement currents $\mathbf{j}_g$ and $\mathbf{j}_e$ (3.10). This graph does not differ from the graphs in Fig. 3.1b in which the parameters of the wave are represented by the vectors of the strength of the electrical **E** and magnetic **H** fields, linked directly with the densities of the displacement currents [1, 12–15]:

$$\begin{cases} \mathbf{j}_e = \varepsilon_0 \dfrac{\partial\, \mathbf{E}}{\partial\, t} \\ \mathbf{j}_g = -\dfrac{\partial\, \mathbf{H}}{\partial\, t} \end{cases} \qquad (3.11)$$

The presence of the displacement currents $\mathbf{j}_g$ and $\mathbf{j}_e$ in the electromagnetic wave results in a disruption of the electromagnetic equilibrium of the quantised space-time and in a simultaneous appearance of the electrical and magnetic fields are represented by the changes in time *t* of the vectors **E** and **H** in (3.01), when the simultaneous parameters **E** and **H** in the electromagnetic wave are not linked with the vortex nature of the electromagnetic wave. Substituting (3.11) into (3.10) we determine a distinctive relationship between the parameters **E** and **H** (2.55) (with a

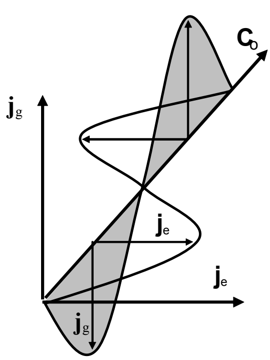

Fig. 3.3. Graphs of the electromagnetic wave in the quantised space-time in the coordinates of the displacement currents $\mathbf{j}_g$ and $\mathbf{j}_e$.

dot) in the vector form for the harmonic electromagnetic wave [1, 12–15]:

$$\varepsilon_0\left[\mathbf{C}_0\dot{\mathbf{E}}\right] = -\dot{\mathbf{H}} \tag{3.12}$$

Figure 3.1b already shows the graph satisfying equation (3.12). Knowing parameter **E** in the electromagnetic wave, we can always calculate parameter **H** and vice versa, using equation (3.12). Consequently, the Maxwell equations for vacuum can be reduced to a single rotor-free equation which can be presented in different forms. However, this does not mean that the rotor-free equations (3.10), (3.11) and (3.4) of the electromagnetic field in vacuum cast doubts on the Maxwell rotor equations. The discovery of the quantum enabled detection of the rotors of the electromagnetic spherical wave but not in areas where they could not be found, but on the sphere itself around the radiation source at a distance from an antenna, bypassing the near-range region.

Figure 3.4 shows the simultaneous circulation vectors **E** and **H** on the sphere of the electromagnetic wave in the orthogonal sections in relation to the radiation centre 0. The circulation is described by the classic Maxwell rotor equations for vacuum

$$\begin{cases} \mathbf{j}_e = \text{rot } \mathbf{H} = \varepsilon_0 \dfrac{\partial \mathbf{E}}{\partial t} \\ \mathbf{j}_g = \dfrac{1}{\mu_0} \text{rot } \mathbf{E} = -\dfrac{\partial \mathbf{H}}{\partial t} \end{cases} \tag{3.13}$$

Classic scientists must be understood more comprehensively tham the extent to which they understood the process themselves. In the Maxwell equations for the electromagnetic wave in the vacuum rot **H** and rot **E** are present simultaneously and cannot generate each other. This may be expressed taking into account (3.10)

$$\varepsilon_0\left[\mathbf{C}_0 \text{ rot } \mathbf{H}\right] = -\text{rot}\,\mathbf{E} \tag{3.14}$$

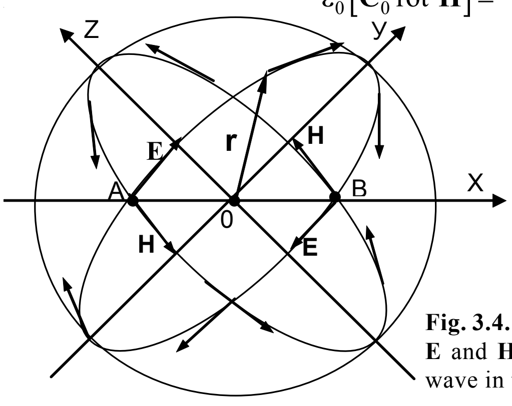

Fig. 3.4. Simultaneous circulation of the vectors **E** and **H** on the sphere of the electromagnetic wave in the orthogonal sections in relation to 0.

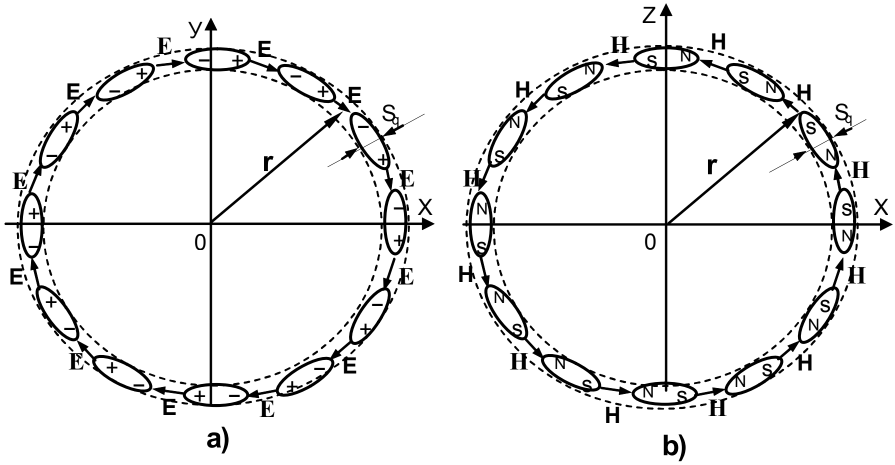

Fig. 3.5. Nature of circulation of the strength of the electrical **E** (a) and magnetic **H** (b) fields in the electromagnetic wave in relation to 0.

Equation (3.14) takes into account the orthogonality of the vectors **H**, **E** and $\mathbf{C}_0$ which is shown at any point on the sphere of the wave (Fig. 3.4). The nature of manifestation of the rotors **E** and **H** on the sphere of the electromagnetic wave is shown clearly in Fig. 3.5 where the electrical (a) and magnetic (b) dipoles inside the quanton try to close on the sphere as a result of orientation polarisation, establishing the circulation of the strength of the electrical **E** (a) and magnetic (b) fields in the electromagnetic wave in relation to the radiation centre 0. Taking into account the fact that the vectors **E** and **H** inside the quanton are orthogonal in relation to each other, this orthogonality is fulfilled at any point on the sphere of the wave so that a very large number of rotors can be found.

As shown by calculations, in a real electromagnetic wave the displacement of the charges and the angle of rotation of the quantons as a result of deformation and orientation polarisation are extremely small and this indicates the superelastic properties of the quantised space-time. It should be mentioned that the electromagnetic processes in vacuum are of the statistical nature because of the high concentration of the quantons (b) and the tetrahedral arrangement of the charges inside the quanton. Therefore, the Maxwell equations for the electromagnetic wave in vacuum at any point of (3.9)...(3.13) reflects the mean statistical parameters **E** and **H** as a result of disruption of electromagnetic equilibrium of the quantised space-time. The displacement of the charges Δx and Δy (3.1) inside the quantum links in a simple manner the Maxwell equations and the wave equations of the electromagnetic field [1].

Thus, a brief introduction into the electromagnetic structure of the quantised space-time shows convincingly that electromagnetism is the inherent property of the space-time which is used not only as the carrier of the electromagnetic wave but also as a luminiferous medium. The quantum representations of the nature of the electromagnetic wave can also be applied to the structure of the photon as a unique quantum form of the electromagnetic wave containing the rotors of the electrical and magnetic fields (3.14). However, the theory of photon radiation and the structure of the photon are relatively complicated materials and this is outside the subject range discussed here and, therefore, I should only discuss briefly the fundamental assumptions of photon radiation, omitting mathematical proofs.

In the nucleation of a photon, for example as a result of emission of an orbital electron, the formation of the photon starts with the same scenario of the spherical electromagnetic wave (Fig. 3.4). However, since the rate of these processes is very high and they transfer to the range of relativistic speeds, the photon manages to form two rotors: electrical and magnetic, situated in the orthogonal polarisation planes. Taking into account the fact that the rotors of the photon are not capable 'inflating' at the speed of light, like the rotors of the spherical wave, the structure of the photon is stabilised and represents a two-rotor particle-wave in the quantised space-time. The theory of relativity claims unambiguously that the two-rotor photon cannot inflate (swell) like the classic spherical wave. However, the photon as a quantum bunch of the electromagnetic energy of the wave type differs from the spherical wave by the fact that the energy of the photon $\hbar\nu$ is proportional to the frequency ν of its electromagnetic field ($\hbar$ is the Planck constant). This is strictly proven in the EQM theory and the Superunification theory but is not investigated in the present book.

Figure 3.6 shows the simplified scheme of the two-rotor low-energy photon. Circulation of the vectors of the strength of the electrical **E** and magnetic **H** fields takes place in the orthogonal polarisation planes in

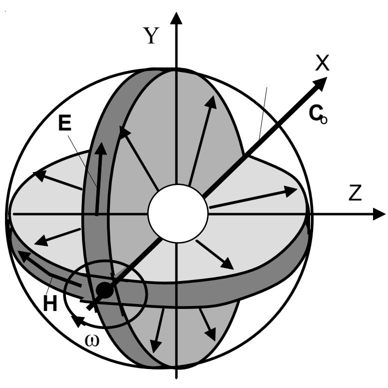

Fig. 3.6. Two-rotors structure of the low-energy photon emitted by the orbital electron.

accordance with Maxwell equations. The photon has the main axis and moves in the direction of this axis in the space with the speed of light C_0, and the polarisation planes in the optical media can rotate around this axis as a result of the interaction of the rotor fields with the lattice of the optical media. In contrast to the spherical electromagnetic wave or the flat wave which has only the transverse vectors **E** and **H**, the rotor fields of the photon have longitudinal components **E** and **H**, and the vectors **E** and **H** remain transverse in relation to the direction of the vector of the speed of the photon only on the main axis. At present, the theory of EQM and Superunification has at its disposal the complete mathematical apparatus for the investigation of the structure and unique properties of the photon as a particle-wave.

3.2.2. Optical media. Fizeau experiment

Analysis of the interaction of the rotor fields of the photon with the lattice of the optical media whose pitch is considerably smaller than the wavelength of the electromagnetic field of the photon shows that this interaction is statistical and the photon is capable of trapping by its field periodically some atomic nuclei of the lattice, ensuring the rotation of deformation planes and wave trajectory of movement of the photon in the optical medium. In a general case, the photon shows the wave properties twice in movement in the optical medium:

1. The circulation of the vectors of the strength of the electrical **E** and magnetic **H** fields in the rotors of the photon ensures wave transfer of electromagnetic energy of the photon with the speed of light $\mathbf{C}_0$ as a result of the effect of the luminiferous medium, i.e. quantised space-time. In vacuum, the photon trajectory is a straight line.
2. In optical media, the periodic interaction of the rotor fields of the photon with the fields of the lattice of the optical medium periodically deflects the photon trajectory from the straight line in the luminiferous medium, determining its wave trajectory. The movement along the wave trajectory with the speed of light $\mathbf{C}_0$ indicates that the speed of light slows down in optical media because the duration of movement along the wave trajectory is longer than the duration of movement along the straight line.

The problem of reduction of the speed of light in the optical medium is not explained by the dielectric properties of the medium which are not in agreement with the refractive index of the medium. This was a serious problem of modern physics. If an optical medium is regarded as a luminiferous medium, the reduction of the speed of light in the optical medium in comparison with vacuum is not governed by logical thinking because vacuum is not regarded as a luminiferous medium. All is well if we return the properties of the luminiferous medium to vacuum which ensures the wave transfer of the photon with the speed of light C_0. In the optical medium which contains the luminiferous medium, the speed of the photon is also determined by the wave speed of light C_0 in the luminiferous medium. Only the trajectory is distorted, transforming from a straight line to a wave trajectory.

Figure 3.7 shows the approximation of the wave trajectory of movement of the photon in the optical medium by the periodic broken line. We can always select a broken line whose length is equivalent to the length of the wave trajectory of the photon by determining the same duration of passage of the photon in the optical medium. Analysis of the movement of the photon along the periodic broken trajectory greatly simplifies the calculations. It may be seen that the vector of the speed of light $\mathbf{C}_0$ in movement of the photon in the optical medium along the wave line periodically changes its direction in relation to the straight line (axis *Z*), remaining a constant value as regards the modulus, i.e. C_0 = const. The constancy of the modulus of the speed of light in the optical medium is linked with the luminiferous medium, i.e., with the quantised space-time, and is governed by the conditions of the special theory of relativity developed by Einstein.

In Fig. 3.8 the speed of light in the optical medium is represented in the phase (complex) plane as the complex speed of light ϑ_{c0} at point 1 which are determined by its modulus C_0 and the angle (argument) β_0, where i is the imaginary unity, $e = 2.71...$

$$\vartheta_{c0} = C_{p0} + iC_{y0} = C_0 e^{i\beta_0} \tag{3.15}$$

$$C_0 = \text{const} \tag{3.16}$$

The modulus of complex speed C_0 (3.16) is linked by the Pythagoras theorem with the actual phase speed C_{po} of the photon along the axis Z and the imaginary speed C_{y0} on the axis *Y* in (3.15), with C_0 represented by two

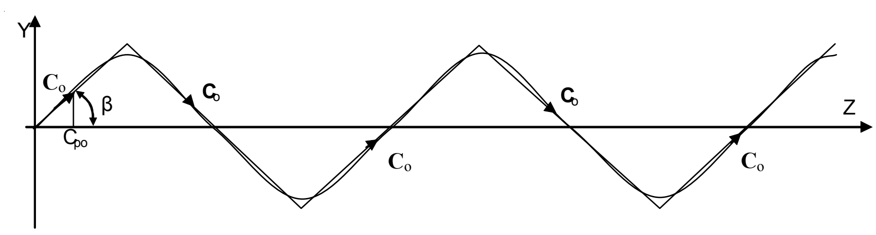

Fig. 3.7. Approximation of the wave trajectory of the movement of the photon in the optical medium by the broken line.

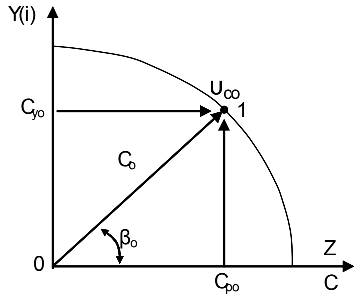

Fig. 3.8. Representation of the speed of light υ_{co} in the optical medium on the phase plane.

components: mutual C_{po} and transverse C_y, where the indexes ($_0$) denote that the parameters of the speeds to the optical medium that is stationary in relation to the observer:

$$C_0^2 = C_{p0}^2 + C_{y0}^2 = \text{const} \tag{3.17}$$

Comparing angles β_0 in Fig. 3.8 and 3.7 shows clearly that it is the same angle which determines the refractive index n_0 of the optical medium:

$$n_0 = \frac{C_0}{C_{p0}} = \frac{1}{\cos\beta_0} \tag{3.18}$$

In the moving optical media with the relative speed v_z in the direction of the Z axis, the light is not carried away by the optical medium, not even partially, because the speed of light is linked with the luminiferous medium and remains a constant value (3.16). In the excellent experiments carried out by Fizeau, partial trapping of the light is an apparent effect because in fact the refractive index n_0 (3.18) and the angle β_0 (3.50) of the optical medium change to new parameters; n_v and β_v, which determine the new phase speed C_{pv} of light in the moving medium (index ($_v$) denotes the parameters in the moving medium):

$$n_v = \frac{C_0}{C_{pv}} = \frac{1}{\cos\beta_v} \tag{3.19}$$

The complex speed of light υ_{cv} in a moving medium with speed v_z differs from the complex speed υ_{co} (3.15) in the stationary medium with the constant modulus C_0 (3.16)

$$\vartheta_{cv} = C_{pv} + iC_{yv} = C_0 e^{i\beta} \tag{3.20}$$

The increase of the phase speed of light C_{pv} in the moving medium at constant C_0 can take place only as a result of a decrease of the apparent component C_{yv} of the complex speed ϑ_{cv} (3.20). Since the modulus of speed C_0 is determined from the sum of the squares of the speeds (3.17), the simple

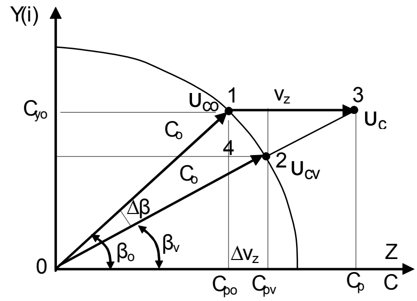

Fig. 3.9. Summation of the speeds in the moving optical medium on the phase plane.

arithmetic summation of the speeds C_{po} and v_z in determination of the phase speed C_{pv} is not correct and leads to serious errors. The summation of the speeds is determined from the sum of the squares of longitudinal C_{pv} and transverse C_{yv} components.

Figure 3.9 shows a graphic summation of the speeds C_{po} and v_z on the complex plane in the condition in which the modulus of the speed of light C_0 remains constant in the luminiferous medium. In the stationary optical medium, the complex speed of light ϑ_{co} (3.15) at point 1 is determined by argument β_0 under the condition (3.16). In the moving optical medium, the complex speed of light ϑ_{cv} (3.20) at point 2 is determined by argument β_v under the condition (2.16). If the speed of light C_0 were not linked with the luminiferous medium and would be be linked with the optical medium as C_{po}, then in complete trapping of the light by the moving optical medium, the total speed C_p would be determined by the arithmetic sum:

$$C_p = C_{p0} \pm v_z \tag{3.21}$$

However, equation (3.21) does not correspond to the results of experimental measurements. In the Fizeau experiments, the phase speed of light C_{pv} in the moving medium is determined by the equation which includes the increment of the speed $\Delta v_z < v_z$

$$C_{pv} = C_{p0} \pm \Delta v_z < C_p \tag{3.22}$$

Equation (3.22) is usually erroneously linked with the fact that the light is partially trapped in the moving medium. If we carry out the vector summation of the speed of light C_0 and the speed v_z of movement of the optical medium, the vector of the total speed υ_c at point 3 is higher than the speed of light C_0 which in principle is not possible because the speed of light C_0 is connected with the luminiferous medium.

In order to determine accurately the phase speed of light C_{pv} in the moving medium, the speed be regarded as a projection on the *Z* axis, on the basis of the complex speed ϑ_{cv} (3.20) at the point 2 (Fig. 3.9). For this purpose, into equation (22) it is necessary to add the true increase of the phase speed Δv_z as a vector quantity determined from the triangles 1-10-3 and 1-2-4 on the basis of their similarities with the angle β_0 with (3.18) taken into account

$$\Delta v_z = v_z \sin^2 \beta_0 = v_z (1 - \cos^2 \beta_0) = v_z \left(1 - \frac{1}{n_0^2}\right) \tag{3.23}$$

Equation (3.23) is an approximate equation because the arc of the circle 1-2 in the triangle 1-2-3 distorts its corners. Therefore, expressing Δv_z through the angle β_v, we obtain the second approximate equation:

$$\Delta v_z = v_z \sin^2 \beta_v = v_z (1 - \cos^2 \beta_v) = v_z \left(1 - \frac{1}{n_v^2}\right) \tag{3.24}$$

A more accurate expression for Δv_z is determined as the intermediate value between (3.23) and (3.24)

$$\Delta v_z = v_z \left(1 - \frac{1}{n_0 n_v}\right) \tag{3.25}$$

Substituting (3.23) into (3.22), we determine the phase speed of light C_{pv} in the moving optical medium to the first approximation; the equation for this is well known in physics [24]

$$C_{pv} = C_{p0} + \Delta v_z = C_{p0} \pm v_z \left(1 - \frac{1}{n_0^2}\right) \tag{3.26}$$

Substituting (3.25) into (3.22) we determine a more accurate equation for the phase speed of light C_{pv} in the moving optical medium taking into account the fact that in reality the angle $\Delta\beta$ (Fig. 3.9) is extremely small, because the difference β_0 and β_v, which determines the condition $nv \sim n_0$, is:

$$C_{pv} = C_{p0} \pm \Delta v_z = C_{p0} \pm v_z \left(1 - \frac{1}{n_0 n_v}\right) \tag{3.27}$$

Taking into account (3.18) and (3.19), expression (3.27) is easily converted to the well-known expression for the summation of the speeds of the special theory of relativity proposed by Einstein on the condition of constant speed of light C_0 [32]

$$C_{pv} = \frac{C_{p0} \pm v_z}{1 + \frac{C_{p0} v_z}{C_0^2}} \tag{3.28}$$

All the previously derived equations (3.26), (3.27) and (3.28) hold for the phase speed of light in the moving optical medium on the condition of the presence of the luminiferous medium in which the speed of light C_0 is constant. The constancy of the speed of light (3.16) is the basis of the special theory of relativity. In the moving optical medium, the speed of light C_0 can be constant only in the presence of the luminiferous medium. Therefore, the equation for summing up the speeds (3.26) in the special theory of relativity is fully suitable for the determination of the phase speed of light C_{pv} in the moving optical media because it is determined on the basis of the sum of the squares of the longitudinal and transverse components of the speeds in movement of the photon along the wave trajectory in the optical medium, including in its relative motion, and is not determined by the arithmetic sum. This is given by the conditions of constancy of speed of light in the luminiferous medium (3.16).

The results showing that the phase speed of light is lower than the arithmetic sum of the speeds was detected for the first time in the Fizeau experiments but the accurate explanation of this effect was provided only by the EQM theory in which the photon moves along the wave trajectory in the optical medium and its refractive index changes in the relative movement of the optical medium. When developing the theory of photon radiation and of the photon itself which is not so simple (and this is not the subject of this book) it is important to mention the fact that, regardless of the statistical nature of behaviour of the photon in the optical medium, its parameters are fully predictable, because the reasons for these phenomena become apparent. As claimed by Einstein, the quantum theory became deterministic with the discovery of the quantum of space-time (quanton) and superstrong electromagnetic interaction.

A brief analysis of the quantised space-time enables the concept of the luminiferous medium to be returned to physics. This removes obstacles in the path to the quantum theory of gravitation which has been developed completely on the realias of the elastic quantised medium capable of compression and stretching. The electromagnetic interactions are characterised by the displacement of the charges inside the quanton (1) in which the convergence of the electrical charges is associated with the simultaneous removal of the magnetic charges thus saving the quanton energy. The concentration of the quantons in the unit volume remains unchanged. Gravitational interactions are also characterised by the simultaneous displacement (1) of the charges in the quantum, only to one side, for approach or movement away from each other, uniformly compressing or stretching the quanton and changing its energy. As mentioned, in this book we do not examine the processes of displacement of the charges inside the quanton as a result of gravitational interactions. It is important to note that gravitation is characterised by compression or stretching of the quantons resulting in changes of the concentration of the quantons in the unit volume leading to the gradient redistribution of the quantum density of the medium in the quantised space-time. The unification of electromagnetism and gravitation takes place through the quantum, and in some cases electromagnetic interactions are evident whereas in others it is gravitational excitations as the properties of the unified field – the carrier of superstrong electromagnetic interactions (SEI).

3.3. Fundamentals of gravitation theory Open quantum mechanics system

3.3.1 Two-component solution of Poisson equation

The quantum theory of gravitation (QTG) is based on the concept of distortion of space-time proposed by Einstein which in the realias of the quantised medium transfers to deformation of the medium. In this case, it should be mentioned that gravitation starts with the elementary particles, more accurately, with the formation of mass at the elementary particles. Any elementary particle, including particles with mass, – the source of the gravitational field – is an open quantum mechanics system being an integral part of the quantised space-time.

There are no closed quantum mechanics systems in nature. They were invented by people because of the restricted, at that time, knowledge of the nature of things. This is the only method of understanding the phenomena in nature when investigating the observed objects and items. It appears that a flying stone is an object separated by its natural dimensions in itself, and is not linked with, for example, the Earth. However, the stone will fall on the Earth, like Newton's apple. It appears that the thrown stone is in fact not isolated from the Earth and is within the region of the Earth gravitational field from which it is very difficult to escape. However, we cannot see the gravitational field, and the falling stone appears to us as an independent closed system, a thing in itself.

If we could see the gravitational field, we would see an astonishing image. The gravitational field would be in the form of an aura surrounding the flying stone. This aura is determined by the formation of the quantised space-time around the stone. The Earth is surrounded by the same gravitation aura. We would see how the Earth aura absorbs the stone, whilst on the Earth surface the auras do not manage, ensuring the constant effect of gravity. However, this is only the external side. As mentioned, gravitation starts at the elementary particles including the composition of all solids, and the total gravitational field of the solid forms because of the effect of the principle of superposition of the fields. All the elementary particles and, correspondingly, all the solids, are open quantum mechanics systems.

The transition to the open quantum mechanics systems in the physics of elementary particles and the atomic nucleus enables us to investigate the problems of quantum mechanics already from the viewpoint of the unification of electromagnetism and gravitation. We can understand the structure of elementary particles which in fact are not so elementary and their composition includes a huge number of quantons, determining their quantised state, because of which the energy and mass of the particle may increase with the increase of the speed of the particle. The transition to the open quantum mechanics systems has become possible only on returning to the scientific concept of the absolutely quantised space-time. Consequently, it has been possible to determine the structure of the main elementary particles, electron, positron, proton, neutron, neutrino, photon, and also find the reasons for the formation of mass at the elementary particles [5–17].

In order to link the structure of the elementary particles and their mass with the deformation properties of the quantised space-time, we examine the process of formation of mass in the nucleons. For this purpose, it would be necessary to determine the shell structure of the nucleon, with the shell being capable of compressing the quantised space-time, forming the nucleon mass. This is possible if the nucleon shell is a spherical network, with the nodes of the network carrying the monopole electrical charges with alternating polarity, forming an alternating shell. In this case, regardless of the presence of the non-compensated charge in the proton shell, nucleons can be pulled together by alternating charges of the shells. These attraction forces are of the purely electrical nature, acting over a short period of time, but their parameters completely correspond to nuclear forces. The electrical nature of the nuclear forces fully fits the concept of the unified field on the path to Superunification of interactions [14].

Attempts to solve the problems of this type were made a long time ago within the framework of the so-called quantum chromodynamics (QCD) based initially on three quarks, and now the number of parameters in the QCD has exceeded 100, increasing the number of problems which must be solved [33]. In addition to describing the action of nuclear forces and substantiating the charge of the adrons, and they include nucleons, it is important to solve the problem of formation of the nucleon mass which cannot be solved by the QCD. This is a dead theory which has been partially resuscitated in the EQM theory and Superunification theory, if quarks are treated as whole electrical and magnetic charges (Fig. 2) and the interaction of whole quarks is transferred to quantons and the shell of the nucleons as an independent 'seed' charge of the electron (positron) [14]. In this case, we can describe the structure and state of any elementary particle, not only of the quantons, but also of leptons which include the electron and the photon. It appears that four monopoles (two electrical and two magnetic charges) are sufficient for describing not only elementary particles, both open and still unopen, but also all fundamental interactions.

The attempts to explain the presence of mass at elementary particles and introduction into the quantum theory of exchange particles, the so-called Higgs particles, which provide mass for other particles [34, 35], have proved to be unfounded, regardless of the application of the most advanced mathematical apparatus. According to theoretical prediction, the Higgs particles should be detected in experiments in the giant accelerator (supercolliders) at CERN in Geneva. However, these particles were not detected an dthe very expensiver supercollider had to be closed down because it proved to be useless. The theory of EQM and TUEMF (theory of the united electromagnetic field) have already saved billions of dollars to the world scientific community, describing the structure of elementary particles and the nature of the gravitational field and mass [12, 14].

Also, quarks have not been detected in experiments, not even indirectly in the form of quark-gluon plasma which should be detected when the proton reaches very high energies of the order of 200 GeV/nucleon [33]. QCD predicted that in this case the proton should 'melt', generating quark-gluon plasma. Recently, it has been reported that some plasma had been produced at high speeds and energies and it is linked with the quark-gluon plasma. However, I really doubt the very concept of the quark-gluon plasma which can be represented by the electron-positron plasma in breakdown of the alternating shell of the nucleon, if this can take place [13]. On the other hand, analysis of the Usherenko effect [13] with superdeep penetration of particles of the micron size into steel targets with the generation of colossal energy 10^2–10^4 times greater than the kinetic energy of the particles indicates that the electron-positron plasma in the gas is detected in experiments, and the results may form the basis of ball lightning [6].

We now transfer to the subject of this section, i.e., the physics of open quantum mechanics systems. Here it is necessary to understand how elementary particles form in the quantised space-time. The two-rotor structure of the photon was already shown in Fig. 3.6 as a specific particle-wave in the luminiferous medium, as some quantum bunch of the energy of electromagnetic polarisation of the quantised space-time. The suggestion that the photon can exist only at the speed of light confirms its exclusively wave nature in the luminiferous medium. The photon is an open system which is a part of the luminiferous medium without which the photon cannot form and be transferred. The open quantum mechanics systems include all known elementary particles which differ from the photon by the fact that the photon is the only particle which does not include electrical charges of the monopole type separated from the quantum and only represents the wave excited state of the quantons through which they are transferred as a single wave (soliton).

All the remaining elementary particles include electrical charges of the monopole type in their composition. Naturally, it is not possible to describe the entire spectrum of the elementary particles. Therefore, in this book analysis is restricted to investigations of the formation of mass at the nucleons (protons and neutrons) which represent a suitable example of an open quantum mechanics system. The presence of an alternating shell in the nucleon enables us to define a distinctive gravitational boundary capable of spherical compression and stretching, forming the gravitational field of the nucleon. Consequently, the theory of gravitation and nucleons can be applied to all spherical solids, including cosmological objects, for which the surface has the form of a conventional gravitational boundary in the medium characterised by the mean statistical parameters of the medium. For non-spherical solids, only the near field is distorted, and the far field transfers to a spherical one, governed by the principle of superposition of the fields, in which the sum of spherical gravitational fields of all elementary particles, including the composition of the solid, determines its gravitational field. In the electron and the positron there is no distinctive gravitational boundary and they are placed in a separate class of the particles with a central seed charge which forms a more complicated gravitational field [10–17].

Figure 3.10 shows in the section the region of quantised space-time with a spherical alternating shell of the nucleon (the dotted sphere) formed inside the region. The shell is initially compressed to a sphere with radius R_S. As already mentioned, the non-perturbed quantised space-time is characterised by the quantum density of the medium ρ_0 (6). Evidently, in compression of the shell of the nucleon together with the medium, the quantum density ρ_2 in the middle of the shell increases above ρ_0 as a result of stretching of the external region whose quantum density ρ_1 decreases. This is the process of spherical deformation of the quantised space-time as a result of which the mass and gravitational field appear at the nucleon.

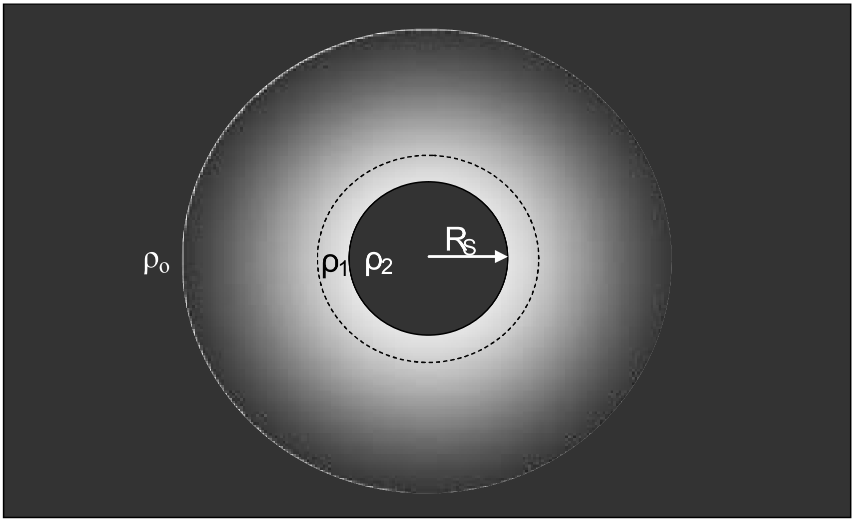

Fig. 3.10. Formation of the gravitation field and the nucleon mass as a result of spherical deformation of the quantised space-time by the shell of the nucleon with radius R_S.

The shell of the nucleon has the function of a gravitational boundary, separating the medium with different quantum densities ρ_1 and ρ_2 inside the nucleon and outside its shell.

The alternating shell of the nucleon has noteworthy properties. It can pass through the stationary quantised space-time like a fishing net immersed in water. In movement, the alternating shell of the nucleon retains the spherical deformation of the quantised space-time ensuring the wave transfer of the mass of the nucleon and the corpuscular transfer of the alternating shell. In experiments, this is confirmed by the results which show that the nucleons are governed by the principle of the corpuscular-wave dualism and represent a particle-wave as an open quantum mechanics system.

In the model shown in Fig. 3.10, the space topologically changes when this topology differs from the topology of the non-deformed space. The geometry of such space-time can be represented by a population of Lobachevski spheres with different curvature, threaded onto each another, forming the topology of the Lobachevski spherical space. Taking into account that the dimensions of the quanton are of the order of 10^{-25} m, and the radius R_S on the nucleon is approximately 10^{-15} m, then in relation to the fundamental length of 10^{-25} m of the given space, the radius of the Lobachevski spheres is a very high value. This corresponds to the postulates of the Lobachevski theory and for mathematicians the given region of investigations is a gold vein because it has specific practical applications.

The model, shown in Fig. 3.10, can be calculated quite easily mathematically because it is determined by the properties of a homogeneous quantised medium whose plastic state is described by the Poisson equation [10–17]. It should be mentioned that there is still no Poisson gravitation equation. In the general theory of relativity, the classic Poisson equation is replaced by the more complicated Einstein tensor equation whose solution has not helped physicists to understand the reasons for gravitation [36].

Any 'distortion' of the quantised space-time is linked with two types of deformation: compression and extension, accompanying each other in elastic media. Compression deformation is balanced by tension deformation. In the absence of the second component which resists deformation in the elastic quantised medium, the space should be unstable and any gravitation should result in the collapse of the mass of matter into a black hole or microhole. However, the instability of quantised space-time has not been observed in experiments. Quantised space-time shows the properties of a highly stable and durable medium indicating the presence in space of the elastic properties capable of resisting any deformation.

In particular, the model of spherical deformation of the quantised space-time shown in Fig. 3.2 demonstrates clearly that compression deformation of the nucleon shell to radius R_S inside the shell is balanced by the tensile deformation of the quantised space-time on its external side. This model makes it possible to obtain for the first time the correct equations of state of the nucleon as a result of the spherical deformation of quantised space-time.

The solution of the problem is reduced to the determination of the distribution function of the quantum density of the medium in space: ρ_1 – on the external side of the gravitational boundary with radius R_S and ρ_2 – inside the nucleon boundary. Inside the region R_S this problem is solved by an elementary procedure. The number of quantons N_{q0} inside the region R_0 with volume V_0 prior to compression and after compression N_{q2} in R_S remain constant and is determined by quantum density ρ_0:

$$N_{q0} = N_{q2} = \rho_0 V_0 = \frac{4}{3}\pi R_0^3 \rho_0 \tag{3.29}$$

In compression, the internal volume V_0 decreases to V_S and the quantum density ρ_2 correspondingly increases:

$$\rho_2 = \frac{N_{q0}}{V_S} = \rho_0 \frac{V_0}{V_S} = \rho_0 \left(\frac{R_0}{R_S}\right)^3 \tag{3.30}$$

Equation (3.30) determines quantum density ρ_2 inside region R_S as a value which does not depend on the distance r inside the compressed region.

A difficult mathematical problem is the determination of the distribution function of quantum density ρ_1 in the external region from the interface R_S in relation to the distance r. The attempts for direct derivation of the differential equation on the basis of the redistribution of quantum density and its unification do not give positive results. The resultant equations were diverging and solutions infinite. This can be explained from the physical viewpoint. In compression of the internal region R_S the released volume is filled from the external side with quantons which are pulled to the interface from the external field from the surrounding quantised space-time. Since the spatial field is continuous, the movement of the quantons at the interface from the external field spreads to infinity, leading to diverging equations. When these problems are encountered in theoretical physics, it is necessary to find other approaches to solving them because the currently available mathematical apparatus is not suitable for solving the infinity problem.

In this case, the formulated task is solved by purely algebraic methods because the given scalar field is characterised by the absolute parameters (ρ_0, ρ_1, ρ_2) and it is not necessary to work with the increments of these parameters. To solve the given task, it is necessary to analyse another state of the given field when the continuous compression of the region R_S reaches the finite limit, with restriction by radius R_g, and further compression of the field is not possible. This state may determine the state of the black microhole, characterising the nucleon by gravitational radius R_g which is a purely calculation parameter, representing the hypothetical interface at which the quantum density of the medium ρ_1 on the external side decreases to ρ_0, i.e. $\rho_1 \to 0$ at $R_S \to R_g$. As a result, the functional dependence $\rho_1(r)$ with the increase of the distance from the nucleon by the distance r has the form of a single curve for the specific radius R_g, ensuring the balance of the quantum density of the medium

$$\rho_0 = \rho_1 + \rho_1' \tag{3.31}$$

Equation (3.31) includes ρ_1' as an apparent quantity, characterising the deficit of quantum density ρ_1 in relation to the non-deformed space-time with quantum density ρ_c

$$\rho_1' = \rho_0 - \rho_1 \tag{3.32}$$

The functional dependence ρ_1' determines the curvature of the distorted space-time and has the form of a typical inverse dependence which should be determined by finding the degree n of the curvature of the field $1/r^n$. Whilst the exponent n is unknown, is this an integer 1, 2, etc, or a fraction? From the mathematical viewpoint it is incorrect. From the viewpoint of physics this approach is justified because we define the curvature of the scalar field and verify whether the given temperature corresponds to or differs from the experimental data. It is more rational to replace curvature $1/r^n$ by its equivalent R_g/r^n connected with R_g. The dependence ρ_1' is a function of distance r for R_g/r_n

$$\rho_1' = \rho_0 \frac{R_g}{r^n} \tag{3.33}$$

From the balance (3.31) taking (3.33) into account, we obtain

$$\rho_1 = \rho_0 - \rho_1' = \rho_0 - \rho_0 \frac{R_g}{r^n} = \rho_0 \left(1 - \frac{R_g}{r^n}\right) \tag{3.34}$$

In the limiting case at $r = R_g$, the function (3.34) is equal to 0

$$\rho_1 = \rho_0 \left(1 - \frac{R_g}{R_g^n}\right) = 0 \tag{3.35}$$

The condition (3.34) is fulfilled unambiguously at the equality

$$\frac{R_g}{R_g^n} = 1 \tag{3.36}$$

Equality (2.36) holds at $n = 1$, which requires confirmation. This is possible only if the shell of the nucleon inside the quantised space-time remains spherical in any situation, determining the principle of spherical invariance [11].

Thus, the required distribution of the quantum density ρ_1 (r) at any distance r is determined by the exponent of the first-degree $n = 1$ from distance r

$$\rho_1 = \rho_0 \left(1 - \frac{R_g}{r}\right) \text{ at } r \le R_S \tag{3.37}$$

Equation (2.37) includes the relative dimensional curvature k_R of space-time which is highly suitable in analysis of its deformation

$$k_R = \frac{R_g}{r} \le 1 \tag{3.38}$$

In the limiting case at $r = R_g$, the relative curvature of the field has the maximum value equal to 1. In all other cases, the curvature of the field increases with the increase of the distance from the region R_g and is always smaller than unity.

If we compare the equations (3.37) and (3.30) of the distribution of quantum density ρ_1 and ρ_2, it is necessary to reduce the parameters of the field in (3.30) to the same form (2.37), expressing ρ_2 by the relative curvature of the field k_R (3.38). For this purpose, we determine the 'jumps' $\Delta\rho_1$ and $\Delta\rho_2$ of quantum density of the medium at the interface R_S in relation to ρ_0 on the external $\Delta\rho_1$ and internal $\Delta\rho_2$ sides, respectively. Evidently, because of the symmetry of the field at the interface, the increase of the quantum density $\Delta\rho_2$ inside, possibly by means of the same decrease of the quantum density $\Delta\rho_1$ on the external side, we can ensure the balance of the quantum density at the interface

$$\Delta\rho_1 = \Delta\rho_2 \tag{3.39}$$

The jump of the quantum density of the medium $\Delta\rho_1$ on the external side is determined from equation (3.37) on the condition that $r = R_S$

$$\Delta\rho_1 = \rho_0 - \rho_1 = \rho_0 \frac{R_g}{R_S} \tag{3.40}$$

Taking equations (3.40) and (3.39) into account, we determine the value of the quantum density of the medium ρ_2 inside the nucleon

$$\rho_2 = \rho_0 + \Delta\rho_1 = \rho_0\left(1 + \frac{R_g}{R_S}\right) \tag{3.41}$$

As a result of transformations, quantum densities ρ_1 (3.37) and ρ_2 (3.41) of the spherically deformed quantised space-time have been reduced to the same form and have the form of the system

$$\begin{cases} \rho_1 = \rho_0\left(1 - \dfrac{R_g}{r}\right) & \text{at } r \geq R_S \\ \rho_2 = \rho_0\left(1 + \dfrac{R_g}{R_S}\right) \end{cases} \tag{3.42}$$

The distribution of the quantum density of the medium (3.42) was determined for the two components ρ_1 and ρ_2 which balance each other, forming a stable system. The system (3.42) is the correct solution of the Poisson gravitational equation for the spherically deformed space-time on the basis of the efficiently selected physical model of the nucleon for the elastic quantised medium (EQM). It should be mentioned that the solution of the tasks described previously cannot be carried out by purely mathematical methods without knowing the physical model of gravitation which is based on the straight mathematical conditions defined by nature.

3.3.2. Deformation vector D

We use the divergence operation of the gradient of quantum density of the medium for solving (3.42). For this purpose, we introduce the deformation parameter **D** of the quantised space-time. Deformation **D** is a vector indicating the direction of the fastest variation of the quantum density of the medium for the deformed space-time. In this case, the deformation rector **D** is determined by the gradient of quantum density with respect to the direction. For the spherically deformed space-time, the deformation vector **D** is determined by the gradient of the quantum density of the medium with respect to radius **r** [10–17]:

$$\mathrm{D} = \mathrm{grad}\ \rho_1 = \frac{\partial \rho_1}{\partial \mathbf{r}} = \rho_0 \frac{\partial}{\partial \mathbf{r}}\left(1 - \frac{R_g}{r}\right) = \rho_0 \frac{R_g}{r^2}\mathbf{1}_\mathbf{r} \tag{3.43}$$

where $\mathbf{1}_r$ is the unit vector in the direction of radius r.

As indicated by (2.43), the initial field of distribution of the quantum density in the operation of the gradient changes to the vector of the field of a family of the vectors **D** directed from the deformation centre.

Further, we determine the flow $\Phi_\mathbf{D}$ of the deformation vector **D** penetrating any closed spherical surface S around the interface R_S (deformation centre) of the deformed quantised space-time

$$\Phi_\mathrm{D} = \oint_S \mathbf{D} dS = \frac{\rho_0 R_g}{r^2} 4\pi r^2 = 4\pi\rho_0 R_g \tag{3.44}$$

Divergence is determined by the limit of the flow of the field originating from some volume to the value of this volume when it tends to 0. However, in this case, the volume of the spherically deformed space-time does not tend to 0 and it tends to the limiting volume V_S, determined by radius R_S. This is the volume of the elementary particle, which is very small, in comparison with the dimensions in the macroworld. Accepting that V_S is the volume close to zero volume, we write the Poisson gravitation equation for the quantum density of the medium

$$\mathrm{div}\ \mathbf{D} = \frac{\lim}{V \to V_S} \frac{1}{V} \oint_S \mathbf{D} dS = 4\pi\rho_0 \frac{R_g}{V_S} \tag{3.45}$$

Or

$$\mathrm{div}\ \mathbf{D} = div(\mathrm{grad}\ \rho_1) = 4\pi\rho_0 \frac{R_g}{V_S} \tag{3.46}$$

The Poisson vector equation (3.46) in the rectangular coordinate system appears in the partial derivatives of the second order with respect to the directions (x, y, z) for the quantum density of the medium ρ (in a general case)

$$\frac{\partial^2 \rho}{\partial x^2} + \frac{\partial^2 \rho}{\partial y^2} + \frac{\partial^2 \rho}{\partial z^2} = 4\pi\rho_0 \frac{R_g}{V_S} \tag{3.47}$$

If we integrate the equations (3.46) and (3.47), we obtain (3.42) for the external and internal regions in relation to the gravitational interface. This method initially enabled us to find a solution of the equation (3.42) and then transfer from the solution to deriving the Poisson equation.

It is also necessary to pay attention to the fact that the Poisson equation for the quantum density of the medium is equivalent, as regards the format, to the Poisson equation for the gravitational potentials. The theory of gravity, as a partial case of the general theory of gravitation, uses only one gravitational potential, the so-called Newton potential φ_n for the elementary particle with the mass m

$$\varphi_n = -\frac{Gm}{r} \tag{3.48}$$

Here $G = 6.67 \cdot 10^{-11}$ Nm²/kg² is the gravitational constant.

In the presence of a perturbing mass M with the potential φ_n, the test mass m is subjected to the effect of the Newton attraction force $\mathbf{F}_n$

$$\mathbf{F}_n = m \cdot \text{grad}\,(-\varphi_n) = G\frac{mM}{r^2}\mathbf{1}_r \tag{3.49}$$

In a general case, the field of the gravitation potential φ is described by the Poisson potential:

$$\frac{\partial^2 \varphi}{\partial x^2} + \frac{\partial^2 \varphi}{\partial y^2} + \frac{\partial^2 \varphi}{\partial z^2} = 4\pi G\rho_m \tag{3.50}$$

where ρ_m is the density of matter of mass m, kg/m³.

3.3.3. Equivalence of energy and mass

Comparing (3.50) and (2.47) it may be seen that the field of the gravitation potential and the field of quantum density of the medium are equivalent fields but they are represented by different parameters.

However, the field of the quantum density of the medium uses four parameters distributed in space: ρ_0, ρ_1, ρ_1', ρ_2. Three parameters are reflected directly in the solution (3.42) of the Poisson equation (3.47). The fourth parameter ρ_1' (3.32) determines the balance of the quantum density of the medium in the external region of the space.

For the spherically symmetric field of the gravitational charge (mass), the solution of the Poisson equation (3.50) is determined only by a single parameter distributed in space – Newton potential φ_n (3.48). Comparative analysis of the parameters of the field of quantum density of the medium and of the field of the gravitation potential shows that to describe efficiently the deformed quantised space-time using gravitational potential the entire set of the gravitational potential is not sufficient. Undoubtedly, the question of the gravitational potentials generated difficulties in the classic theory of gravitation and the well-known solution (3.48) holds only for describing the unstable space, because there is no second compensating component, as in the solution of (3.42).

To ensure the fulfilment of the conditions of stability and stability of the quantised space-time, it is necessary to find the equivalent parameters of the gravitation potentials for the four parameters of the quantum density of the medium ρ_0, ρ_1, ρ_1', ρ_2. On the whole, the quantised space-time, unperturbed by gravitation, is described by the quantum density of the medium ρ_0 (3.6). It is necessary to find the equilibrium gravitational potential φ_0 which would characterise, just like ρ_0, the quantised space-time, unperturbed by gravitation. For this purpose, we use the principle of the equivalent rest mass m_0 and its energy W_0

$$W_0 = m_0 C_0^2 \tag{3.51}$$

The rest mass m_0 and its energy W_0 are associated with the gravitational potential φ_0. To expres this association, it is necessary to expand the features of the gravitational potential φ_0 which links not only the gravitating masses (3.49) but also links the separate mass of the variation of the energy W of spherical deformation in the formation of the mass of the elementary particle which is described by the differential equation

$$m = \frac{dW}{d\varphi} \tag{3.52}$$

Previously, physics regarded the mass as a measure of inertness, without knoving the reasons for this measure. The differential equation (3 .52) shows that the mass is characterised by the variation of energy W of quantised space-time as a result of spherical deformation, regarding the mass as an open quantum mechanics system. This is possible only in the conditions of the energy-consuming quantised space-time with the colossal concentration of energy (3.7) in the unit volume. In this case, the gravitational potential links the energy and mass through the corresponding changes of the energy and potential:

$$\frac{\Delta W}{\Delta \varphi} = \frac{W_0}{\varphi_0} = m_0 \tag{3.53}$$

From (3.53) and (3.51) we obtain

$$W_0 = m_0 \varphi_0 = m_0 C_0^2 \tag{3.54}$$

From equation (3.54) we determine the gravitation potential φ_0 of the quantised space-time

$$\varphi_0 = C_0^2 \tag{3.55}$$

In the classic theory of gravity, potential φ_0 is regarded as the Newton potential (3.48) at infinity. Naturally, in this interpretation, potential φ_0 is regarded as zero. With reference to the energy consuming quantised space-time, potential $\varphi_0 = C_0^2$ characterises the vacuum unperturbed by gravitation. This is a fundamental correction to the gravitation theory.

Equation (3.55) shows that gravitation potential C_0^2 corresponds to the quantum density ρ_0 (3.6) of the vacuum unperturbed by gravitation. This addition to the theory of gravitation shows that the investigated field of the quantised space-time is gravitational in its nature and even in the absence of the perturbing mass it has the gravitation potential C_0^2. Gravitation potential C_0^2 is a real potential existing in nature. Its existence is confirmed by the equivalence of rest mass m_0 and energy W_0. Actually, integrating (3.52) we determine the work associated with the transfer of mass m_0 as a gravitational charge in the region of the field with the gravitational potential C_0^2 in formation, in the quantised space-time, of a particle with the mass m_0, the nucleon in this case

$$W_0 = \int_0^{C_o^2} m_0 d\varphi = m_0 C_0^2 \tag{3.56}$$

Equation (3.56) is the simplest and easiest to understand derivation of the equivalence of mass and energy. By reversing the procedure, from (3.56) we obtain a conclusion that the cosmic vacuum has potential C_0^2. This should not be doubted because the equivalence between the mass and energy is an experimental fact verified many times. In the EQM theory, the expression C_0^2 is not a square of the speed of light, it is the gravitational potential of the unperturbed physical vacuum with the dimension [J/kg = m²/s²].

3.3.4. Gravitation diagram

Why is it that physics could not detect previously the presence of the gravitational potential C_0^2 in vacuum taking into account its very large size? The point is potential C_0^2 is distributed over the entire space and we can take only relative measurements associated with the change of the gravitational potential. Direct analogy with the electrical potential, applied to a very large metallic sheet with a person placed on the surface of the sheet with a voltmeter is not capable of measuring the electrical potential of the sheet because the voltmeter measures only the potential difference.

Nobody has been able to obtain the correct solution of the Poisson equation (3.50) by direct unification for a two component system by analogy with the solution of (3.42). Therefore, the equivalence between the quantum density of the medium ρ_0 and gravitation potential C_0^2 is used. After replacing ρ_0 by C_0^2 in (3.42) we obtain the correct solution of the Poisson equation (3.50) for the gravitation potentials in the form of a system of two components

$$\begin{cases} \varphi_1 = C^2 = C_0^2\left(1-\dfrac{R_g}{r}\right) \text{ at } r \geq R_S \\ \varphi_2 = C_0^2\left(1+\dfrac{R_g}{R_S}\right) \end{cases} \tag{3.57}$$

where φ_1 and φ_2 are the distribution functions of the gravitation potential for the spherically deformed space-time, J/kg.

Potential φ_1 is determined for the external region outside the interface of the medium R_S. Potential φ_2 is determined for the region inside the spherical interface R_S. In further calculations, potential φ_1 is be written as C^2. This is highly suitable because the quadratic root of φ_1 determines the speed of light in the quantised space-time perturbed by gravitation.

Figure 3.11 shows the gravitational diagram of the distribution of the quantum density of the medium (3.42) and gravitation potentials (3.57) as the two-dimensional representation of the spherically deformed Lobachevski space (Fig. 3.10). A special feature of the gravitational diagram of the nucleon is the presence of a gravitation well in the external region of the quantised medium outside the interface with radius R_S, and the interface is characterised by a jump of the quantum density of the medium and the gravitation potential. On the gravitational diagram we can clearly see the 'curvature' of the quantised space-time which cannot be seen on the spheres of the Lobachevski space (Fig. 3.10) in the three-dimensional representation. For spherical deformation, the curvature (3.38) of space is inversely proportional to distance r to the centre of the nucleon and depends only size of the perturbing mass m, i.e., depends on the extent of deformation (3.43) of the quantised space-time.

The gravitational diagram in Fig. 3.11 shows clearly the area of the Newton potential φ_n (3 .48) as the apparent potential (which does not exist in reality), included in the balance of the gravitational potentials

$$C^2 = C_0^2 - \varphi_n \qquad (3.58)$$

In reality, there is only the gravitational potential C_0^2, referred to as the action potential. From solution of (3.57) we can write the function of distribution of the effect potential C^2 in the external region from the interface R_S

$$C^2 = C_0^2 - C_0^2 \frac{R_g}{r} \qquad (3.59)$$

It may be seen that the equations (3.58) and (3.59) are completely identical, and by combined solution of these integrals we determine the value of Newton potential φ_n through potential C_0^2

$$\varphi_n = C_0^2 \frac{R_g}{r} \qquad (3.60)$$

The Newton potential φ_n from (3.48) is substituted into (3 .60):

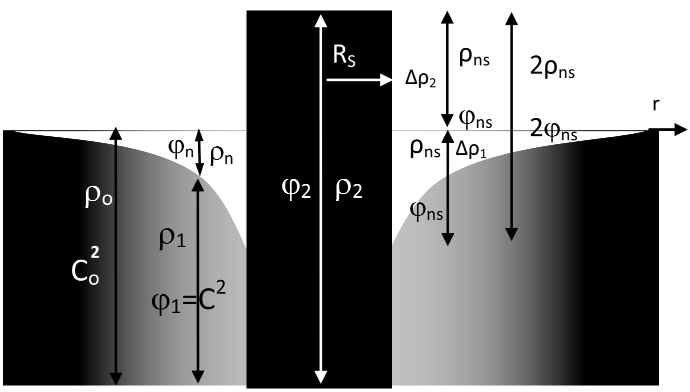

Fig. 3.11. Two-dimensional representation of the Lobachevski space in the form of the gravitational diagram of the distribution of the quantum density of the medium (ρ_1, ρ_2) and gravitational potentials (φ_1, φ_2) of the nucleon; ρ_2 is the region of compression of the medium, ρ_1 is the region of stretching of the medium.

$$\frac{Gm}{r} = C_0^2 \frac{R_g}{r} \tag{3.61}$$

From (3.61) we determine the value parameter R_g

$$R_g = \frac{Gm}{C_0^2} \tag{3.62}$$

Equation (3.62) determines the value of the gravitational radius R_g in the EQM theory which differs from the Schwarzschild radiu by the absence of the multiplier 2 [37]. Immediately, attention should be given to the fact that the gravitational radius R_g (3 .62) is not suitable for elementary particles because the elementary particle is not capable of gravitational collapse. The gravitational radius R_g (3.62) in the theory of gravitation of elementary particles is a purely calculation hypothetical parameter. In the general theory of gravitation, the gravitational radius is a completely realistic parameter, characterising the limiting gravitational compression (collapse) of the matter of the object into a black hole.

Substituting the value of the gravitation radius R_g (3.62) into (3.46) and (3.47), we transform the Poisson equation to the classic form (3.50)

$$\frac{C_0^2}{\rho_0} \operatorname{div} \operatorname{grad}(\rho_1) = 4\pi G \rho_m \tag{3.63}$$

Taking into account the fundamental nature of the principle of superposition of the fields, the equations derived previously for the gravitational field of the nucleon are valid for describing the gravitational fields of any spherical solids, including cosmological objects. In this case, every elementary particles, included in the composition of the solid, concentrates inside itself a compression region by means of extension of the external region. Consequently, the surface of the solid may be regarded as the gravitational interface with the radius R_S within which the mean value of the quantum density and potential are determined by the parameters ρ_2 (3.42) and φ_2 (3.47). On the external side in relation to the gravitational interface, the gravitational field of the solid is described by the quantum density of the medium ρ_1 (3.42) and the gravitational action potential C_2 (3.47). If the solid is compressed into a black hole (microhole), radius R_S decreases to the gravitational radius R_g (3 .62)

3.3.4. Black hole

Figure 3.12 shows the gravitational diagram of a black hole (microhole) as a result of compression of the matter of a solid with a radius R_S (Fig. 3.11)

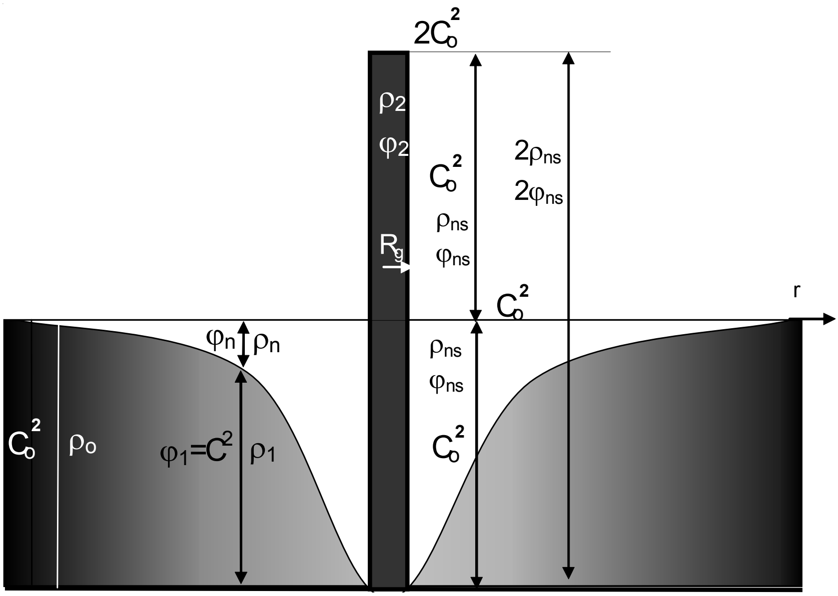

Fig. 3.12. Gravitational diagram of the black hole (microhole) in compression of the gravitational radius R_S (Fig. 3.11) to the gravitational radius R_g.

to gravitational radius R_g (3.62). The distinguishing feature of the black hole is the presence of discontinuities of the quantised space-time as a luminiferous medium on its surface with radius R_g. Substituting $r = R_g$ (3.62) into (3.42) and (3.57), we obtain that the quantum density on the surface of the black hole on the external side is $\rho_1 = 0$ and the gravitational effect potential $C^2 = 0$. The presence of discontinuities of the luminiferous medium on the surface of the black hole determines the conditions in which the light cannot penetrate into the inside of the black hole and leave the hole, making the hole invisible. This is confirmed by the results of calculations, assuming that the effect potential C^2 (3.57) determines the speed of light in the quantised medium from the balance of the gravitational potentials:

$$C^2 = C_0^2 - \varphi_n \tag{3.64}$$

$$C = \sqrt{C^2} = C_0\sqrt{1 - \frac{\varphi_n}{C_0^2}} \tag{3.65}$$

Substituting the value of the Newton potential (2.60) $\varphi_n = C_0^2$ on the surface of the black hole into (3.65) we determine that the light on the surface of the black hole is arrested, $C = 0$. Recording of the objects of the type of black hole shows experimentally that its invisibility is determined by the discontinuities of the luminiferous medium. On the other hand, equation (3.65) can be used to determine the speed of light in the gravitation-perturbed quantised space-time.

3.3.6. Additional gravitational potentials

To describe the regions of spherically deformed space-time, the theory of Superunification uses four gravitational potentials: C_0^2, C^2, φ_n, φ_2 (3.57) in contrast to classic gravitation in which only one Newton gravitational potential φ_n is known. The fact that the three additional gravitational potentials C_0^2, C^2 and φ_2 are unknown makes all the attempts of theoretical physics ineffective in development of the theory of gravitation. Taking into account that every value of the gravitational potential has its own quantum density of the medium (3.42), we can write the relationships between them through coefficient k_φ, denoting ρ_1' (2.32) as ρ_n, i.e., $\rho_1' = \rho_n$, corresponding to the Newton potential φ_n (3.60)

$$k_\varphi = \frac{\rho_0}{C_0^2} = \frac{\rho_1}{C^2} = \frac{\rho_n}{\varphi_n} = \frac{\rho_2}{\varphi_2} = 4 \cdot 10^{58} \frac{\text{quantons}}{\text{J}} \frac{\text{kg}}{\text{m}^3} = \text{const} \tag{3.66}$$

3.3.7. Newton gravitational law

The replacement of the Newton potential φ_n (3.60) by the effect potential C^2 (3.64) in Newton's law of universal gravity also does not change the attraction force $\mathbf{F}_n$ (3.49)

$$\mathbf{F}_n = m \cdot \operatorname{grad} C^2 = m \cdot \operatorname{grad}(C_0^2 - \varphi_n) = G\frac{mM}{r^2}\mathbf{1}_r \tag{3.67}$$

Thus, substitution of the Newton potential φ_n by the effect potential C^2, including in the Poisson equation in the Superunification theory, does not change the well-known assumptions of the theory of gravity and greatly expands the possibilities of this theory. Most importantly, it provides a physical understanding of the processes taking place in vacuum during its gravitational perturbation and determines the fundamentals of the quantum theory of gravitation (QTG) as a result of spherical deformation of the quantised space-time when the quanton is the carrier of the gravitational field.

3.4. Reasons for relativism Principle of spherical invariance

3.4.1. Relativistic factor

Scientific theories can be divided into two groups: phenomenological and deterministic. Phenomenological theories are the theories of the descriptive plan when the fact that the reason for the phenomenon is not known is compensated by the approximation of the experimental dependence by a mathematical equation. This is a relatively ‘painful’ direction of investigations because the search for the mathematical formula is often extremely time consuming and requires the development of a relatively complicated mathematical apparatus. The ideal theory is the deterministic theory in which the reasons for the phenomenon and the physical model of the process are known, and we can derive analytically the mathematical equation for describing the phenomenon. However, this is an even more difficult task because we must find an accurate physical model. Figures 3.10, 3.11 and 3.12 show the models of the gravitational field as a result of spherical deformation of quantised space-time. The mathematical description of these models no longer causes any difficulties. However, the models described previously are static and do not take into account the speed of movement of the particles (solid) in the quantised space-time.

The experiments show that the mass of the particle m increases with increasing speed of the particle, and this increase is especially large in the region of relativistic speed, close to the speed of light C

$$m = \gamma m_0 = \frac{m_0}{\sqrt{1-\frac{v^2}{C_0^2}}} \tag{3.68}$$

where γ is the relativistic factor.

3.4.2. The normalised relativistic factor

Equation (3.68) differs from the widely known equation by the fact that the mass m_0 is linked with the stationary absolute quantised space-time with gravitational potential C_0^2, determining the rest energy (3.56) of the particle. However, a shortcoming of (3.68) is that the mass of the particle increases to infinity with the increase of the speed of the particle v to the speed of light C_0. This can be regarded as true if the quantised space-time itself were not characterised by the limiting parameters, including the finite value of the speed of light C_0 which is not limitless. This means that the relativistic particles, even when they reach the speed of light, should have limiting finite but not infinite parameters. To solve the given problem, we replace the relativistic factor γ in (3.68) by introducing the normalised relativistic factor γ_n into the balance (3.64), with the factor restricting the limiting parameters of the relativistic particle by normalisation coefficient letter to k_n, equating the balance (3.64) to 0 at $v = C_0$

$$C^2 = C_0^2 - \frac{\varphi_n}{\sqrt{1 - k_n \frac{v^2}{C_0^2}}} = 0 \tag{3.69}$$

Substituting into (3.69) φ_n from (3.60) at $r = R_S$ and $v = C_0$, we determine the value of the normalisation coefficient k_n and the value of the normalised relativistic factor γ_n [12-17]:

$$\gamma_n = \frac{1}{\sqrt{1 - \left(1 - \frac{R_g^2}{R_S^2}\right)\frac{v^2}{C_0^2}}} \tag{3.70}$$

3.4.3. Dynamic balance of gravitational potentials

Now we can write the dynamic balance of the gravitational potentials of the particle in the external region of the quantised space-time, characterising the state in the entire range of speeds, including the speed of light C_0, and determining the limiting parameters of the mass $m_{\max}$ and energy $W_{\max}$ on reaching the speed of light $v = C_0$ [12–17]:

$$C^2 = C_0^2 - \gamma_n \varphi_n \tag{3.71}$$

3.4.4. Limiting parameters of relativistic particles

$$m_{\max} = \frac{C_0^2}{G} R_S \tag{3.72}$$

$$W_{\max} = \frac{C_0^4}{G} R_S \tag{3.73}$$

Equations (3.69)–(3.73) were derived under the condition that in the limiting case when reaching the speed of light, the relativistic particle changes to a dynamic black microhole with radius R_S. On reaching the speed of light in accordance with (3.72) and $R_S = 0.8 \cdot 10^{-15}$ m, the proton acquires the limiting mass of the order of 10^{12} kg, corresponding to the mass of an iron asteroid with a diameter of 1 km.

3.4.5. Hidden mass. Mass balance

Multiplying (3.71) by R_S/G at $r = R_S$, we obtain the balance of the dynamic mass *m* of the particle in the entire range of speeds in the absolute quantised space-time

$$m = \gamma_n m_0 = m_{\max} - m_s \tag{3.74}$$

Equation (3.74) includes the hidden mass m_s of the particle, as the imaginary component of the quantised space-time. Consequently, the dynamic mass *m* (3.74) of the particle is determined by the difference between its limiting $m_{\max}$ and hidden m_s masses. When the speed of the particle is increased, the increase of the dynamic mass of the particle takes place as a result of the decrease of its imaginary component, ensuring the balance of (3.74). Physically, this takes place as a result of the fact that the alternating shell of the nucleon as a field grid traps inside larger and larger quantities of the quantons, increasing the quantum density of the medium inside the quanton as a result of reducing it on the external side, as shown in the gravitational diagrams in Fig. 3.11 and 3.12. This increases the spherical deformation of the medium and, correspondingly, increases the mass of the particle.

3.4.6. Hidden energy. Energy balance

Multiplying the mass balance (3.74) by C_0^2, we obtain the dynamic balance of the energy of the particle in the entire range of speeds, including the speed of light

$$W = \gamma_n W_0 = W_{\max} - W_s \tag{3.75}$$

Equation (3.75) includes the hidden energy W_s of the particle as the imaginary component of quantised space-time. Consequently, the dynamic mass *W* of the particle (3.74) is determined by the difference between the limiting $W_{\max}$ and hidden W_s energies of this mass. With the increase of the speed of the particle, the increase of the dynamic energy of the particle takes place as a result of the decrease of the apparent component of the particle, ensuring the balance (3.75).

In the range of low speeds $v \ll C_0$, the normalised relativistic factor γ_n (3.70) changes to factor γ (3.68) which can be expanded into a series and, rejecting the terms of higher orders, the balance (3.74) can be reduced to the well-known form

$$W = W_{\max} - W_s = m_0 C_0^2 + \frac{m_0 v^2}{2} \tag{3.76}$$

As indicated by (3.76), the increase of the kinetic energy of the particle with the increase of the speed of the particle is equivalent to the increase of the dynamic mass of the particle, $m = W / C_0^2$.

3.4.7. Dynamic Poisson equations

In a general case, the state of the dynamic particle in the quantised space-time is described by the distribution of the quantum density of the medium (3.42) and gravitational potentials (3.57) by introducing the normalised relativistic factor γ_n (3.72), taking into account the absolute speed of the particle v:

$$\begin{cases} \rho_1 = \rho_0 \left(1 - \frac{\gamma_n R_g}{r}\right) & \text{for } r \geq R_S \\ \rho_2 = \rho_0 \left(1 + \frac{\gamma_n R_g}{R_S}\right) \end{cases} \tag{3.77}$$

$$\begin{cases} \varphi_1 = C^2 = C_0^2 \left(1 - \frac{\gamma_n R_g}{r}\right) & \text{at } r \geq R_S \\ \varphi_2 = C_0^2 \left(1 + \frac{\gamma_n R_g}{R_S}\right) \end{cases} \tag{3.78}$$

The dynamic systems (3.77) and (3.78) are the solution of the dynamic Poisson equation for the distribution of the quantum density of the medium ρ and gravitational potentials φ which can be written in a more suitable vector form:

$$\frac{C_0^2}{\rho_0} \operatorname{div} \operatorname{grad}(\rho_0 \pm \gamma_n \rho_n) = 4\pi G \rho_m \tag{3.79}$$

$$\operatorname{div} \operatorname{grad}(C_0^2 \pm \gamma_n \varphi_n) = 4\pi G \rho_m \tag{3.80}$$

where ρ_n is the quantum density of the medium determined by the Newton potential φ_n (3.66), quantum/m^3.

In the Poisson equation (3.79) and (3.80) and the div grad population includes the unification constants ρ_0 and C_0^2, which can be removed from the differentiation operation in both (3.50) and (3.63), because the derivative of the constant is equal to 0. However, in this case, the two-component equations (3.79) and (3.80) lose their physical meaning because their solutions are determined by the systems (3.77) and (3.78) for the external and internal regions of the spherically deformed space-time. The sign (–) in (3.79) and (3.80) corresponds to the external region and the sign (+) to the internal region. The parameter ρ_m in (3.79) and (3.80) is regarded as the density of matter in [kg/m^3], generated as a result of the spherical deformation of the quantised space-time which increases with the increase of the speed of the particle. The equations (3.79) and (3.80) are equivalent but expressed by different parameters (3.66) of the quantised medium.

As already mentioned, nobody has as yet been able to find exact solution nor derive the accurate gravitational Poisson equation, describing the state of the particle in the quantised space-time in the entire speed range, including relativistic speeds. This has now been possible as a result of quantum considerations of the nature of gravitation in which the quantum of the space-time (quanton), as an universal unifying particle, is a carrier of gravitation interactions. The discovery of the quanton has been used as a basis for the quantum theory of gravitation (QTG).

3.4.8. Dynamic curvature of space-time

Undoubtedly, the classic Poisson equation (3.50) ceased to satisfy the gravitational theory a long time ago, and attempts to find a suitable substitute were made by Einstein in the general theory of relativity representing the equation in the tensor form [38]:

$$R_{ik} - \frac{1}{2} g_{ik} R = -\chi T_{ik} \tag{3.81}$$

Comparing equation (3.81) with the new Poisson equations (3.79) and (3.80) it becomes clear that the new equations are far simpler and have unambiguous solutions (3.77) and (3.78). At the time when Einstein worked on the theory of gravitation within the framework of the general theory of relativity, the parameters of the quantised space-time such as the quantum density of the medium ρ_0, ρ_1, ρ_n, ρ_2 (3.66) were not known, and only the Newton potential φ_n was available of the four gravitational potentials C_0^2, C^2, φ_n, φ_2, corresponding to (3.56). Naturally, not knowing the true parameters of the quantised space-time, it was not possible to describe the gravitational state of the particle (solid) or of several particles (many-body problem).

Since the equations (3.79) and (3.80) become non-linear with the introduction of the normalised relativistic factor γ_n their exact solution can not be obtained by purely mathematical methods for the space with an arbitrary curvature. However, this solution can be found much easier by taking into account the physical model of spherical deformation of the quantised space-time when the dynamic curvature k_{RV} of the space-time is given by the simple parameters in (3.77)... (3.80)

$$k_{RV} = \frac{\gamma_n R_g}{r} \leq 1 \tag{3.82}$$

The solutions of (3.77) and (3.78) describe the state of a single particle in the quantised space-time in the absence of external gravitational perturbation. In the presence of several sources of gravitation, it is necessary to compile systems of equations (3.77) and (3.78) for the external region and establishing gradually the hierarchy of the effect from a stronger to a weaker source. This is determined by the fact that the weak source of gravitation is situated inside the gravitational well of a stronger source, and not vice versa. Only this procedure can be used to formulate the many-body problem in which the gravitational field in the dynamics is a complicated non-linear function with a non-linear curvature. However, taking into account the principle of spherical invariance, the solution of this complex problem may be reduced to the superposition of fields as spherical fields of the point sources with the radius R_g which greatly simplifies the solution. For example, the location of an orbital electron in a gravitation well of a proton nucleus along a greatly stretched orbit does not enable the electron to emit because on approach of the electron to the nucleus the increase of the electrical energy is compensated by the equivalent decrease of the gravitational energy of the system which was previously never taken into account in the calculations [11]. The quantum problems of radiation of the orbital electron are solved by the quantum theory of gravitation.

Understanding the non-linear nature gravitation, Einstein was forced to find equations which, in his opinion, would be more suitable for describing gravitation, including in the region of relativistic speeds. For this purpose, it was necessary to modernise the classic Poisson equation in (3.81) by replacing div grad (φ) by R_{ik}. In the right-hand part, $4\pi G\rho m$ was substituted by tensor χT_{ik}. The term $\frac{1}{2}g_{ik}R$ was added from formal considerations [38]. The curvature of space in (3.81) is characterised by the Ricci tensor R_{ki} taken from the apparatus of Riemann (non-Euclidean) geometry, adding to (3.81) the tensor T_{ik} of the energy of matter momentum. Undoubtedly, the solutions of the tensor equation (3.81) are not as simple as the systems in (3.77) and (3.78). The Poisson equations (3.79) and (3.80) can also be modernised and reduced to a single equation, expressing the gravitational interaction by the dimensionless dynamic curvature k_{RV} of space-time (3.82)

$$\text{div grad}(1 \pm k_{RV}) = \frac{4\pi G}{C_0^2}\rho_m \tag{3.83}$$

An interesting feature of the Poisson equation (3.83) it is that it resembles the Einstein equation (3.81) by the fact that it does not operate with a classic parameters of the gravitational field and considers only the curvature of the field as a relative dimensionless parameter.

All the equations (3.69)–(3.84) were derived under the condition of spherical deformation of quantised space-time, determining the principle of spherical invariance in the entire speed range, including relativistic speeds. This means that the gravitational field of the elementary particle remains spherical with the increase of the speed of the particle to the speed of light when the particle transfers into a dynamic relativistic black microhole, retaining its spherical shape. As mentioned previously, the effect of the principle of superposition of the fields enables the principle of spherical invariance to be also applied to cosmological objects, including planets. If the gravitational field of the Earth would be compressed in the direction of motion, this would have been detected in the experiments carried out by Michaelson and Morley [20]. However, this was not detected. In fact, the Morley and Michaelson experiments provide an experimental confirmation of the principle of spherical invariance.

3.3.9. The speed of light

Previously, the equation (3.65) was derived for the speed of light in the static gravitational field. Now, operating with the dynamic balance (3.71) of the gravitational potentials in the external region of the quantised space-time, we determine the speed of light C in any region perturbed by gravitation with the dynamic potential $\gamma_n\varphi_n$ in the entire speed range, including relativistic speeds

$$C = C_0\sqrt{1 - \frac{\gamma_n\varphi_n}{C_0^2}} \tag{3.84}$$

Equation (3.84) shows that the speed of light on the Earth surface in the horizontal plane remains a constant quantity for the given speed because of the spherical symmetry of the Earth gravitational field. This means that the arms of the Michaelson interferometer should record the same speed of light in the direction of movement of the Earth and across this direction, confirming the principle of spherical invariance. The Earth behaves as an independent centre in the quantised space-time, retaining its spherical gravitational field in the local region of space.

3.5. Nature of gravity and inertia Simple quantum mechanical effects

3.5.1. Formation of mass

To understand the nature of gravitation and gravity it is necessary to understand the nature of the mass of the particle (solid). In the classic theory of gravitation, the mass of the particle (solid) is used as a measure of gravity and inertia. Einstein added that the mass is the measure of curvature of space-time. Now, the theory of Superunification shows that the spherical deformation of quantised space-time is the measure of mass. Thus, this shows that the mass is a non-independent secondary formation in the quantised space-time, does not represent an isolated system (thing-in-itself) and is an open quantum mechanics systems, linked permanently with the quantised medium as its bunch of the energy of spherical deformation of the medium. In fact, the classic mass typical of physics dissolved in the quantised space-time as the measure of matter which in the region of the microworld of the elementary particles simply does not actually exist. In reality, there is only the spherically deformed local region of the quantised space-time whose deformation energy (3.56) determines the particle mass. Therefore, the movement of the particle with the mass in the superelastic quantised medium is the wave transfer of the energy of spherical deformation of the medium governed by the effect of the principle of corpuscular-wave dualism.

The Superunification theory makes it possible to derive equations describing the mass m by the vector of spherical deformation $\mathbf{D}$ (3.43) of the quantised space-time. The Gauss theory determines unambiguously the mass by the flow of deformation vector $\Phi_{\mathbf{D}}$ (3.43) penetrating through the closed surface S around the particle [12]:

$$m = k_0 \oint_S \mathbf{D}\, dS \tag{3.85}$$

$$k_0 = \frac{C_0^2}{4\pi G \rho_0} = 3 \cdot 10^{-50} \frac{\text{kgm}^2}{\text{quanton}} \tag{3.86}$$

Equation (3.85) treats the mass of the particle (solid) as the parameter of spherical deformation of quantised space-time. Remove the spherical deformation from the quantised medium and the mass disappears. This is observed in annihilation of the positron and the electron when the energy W of spherical deformation of the particles is released and transfers to the electromagnetic energy of radiation of gamma quanta [13]:

$$W = mC_0^2 = k_0 C_0^2 \oint_S \mathbf{D} dS \qquad (3.87)$$

Equation (3.87) determines the equivalence of the mass and energy of deformation of the quantised space-time. The spherical deformation of the quantised medium is not linked with the disruption of its electromagnetic equilibrium [1] because the quanton is compressed uniformly from all sides, establishing the same displacement of the charges with the sign (+) inside the quanton (1). The spherical deformation of the medium can be regarded as the longitudinal displacement of the quantons along the radius in the direction to the gravitational boundary of the particle (solid). The release of the energy (3.87) of spherical deformation into photon electromagnetic radiation is also associated with the fact that the carrier of gravitation is a quantum which is also the carrier of electromagnetism and the carrier of the electromagnetic wave. All these problems are described convincingly by the theory of Superunification, but they are outside the framework of this chapter.

3.5.2. Reasons for gravity and inertia

Naturally, the reasons for gravitation are also associated with the deformation of the quantised space-time, like the reasons for inertia, determining the equivalence between gravity and inertia. The reasons for gravity can be investigated starting with the analysis of the region of the ultra-microworld of quantons when displacement radiation (3.1) of the charges inside the quantum is possible, as implemented in the analysis of the electromagnetic interactions in the quantised medium [1]. However, the reasons for gravity can also be investigated by analysing the state of the quantised medium as some scalar continuous field when the variation of the topology of quantised space-time as a result of its spherical deformation results in the gradient redistribution of the quantum density of the medium and the formation of gravitational forces or inertia forces.

Figure 3.13 shows that in the gravity field of the Earth 1, generated by the mass M, the test solid 2 with mass m is attracted in accordance with the Newton's law of universal gravitation with the force $\mathbf{F}_n$ (3.49), directed to the centre of the Earth along the radius $\mathbf{r}$. The gravitation-perturbed Earth field is represented by the equipotentials 3 of the quantum density of the

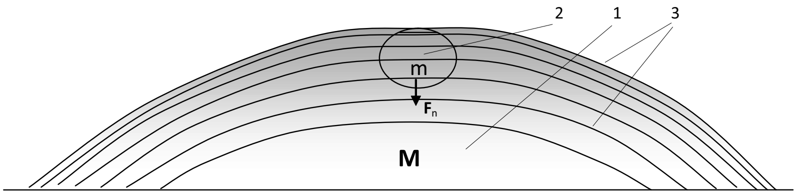

Fig. 3.13. Manifestation of the gravitational force F_m acting on the mass 2 (m) in the gradient vacuum field 3, perturbed by the mass 1 (M).

medium (or by the equipotentials of the gravitational action potential). This perturbing field is a gradient field, reducing the quantum density of the medium at the surface of the Earth represented by a 'more stretched' distribution of the equipotentials 3. The Newton law of universal gravitation (3.49) is based on the solution (3.78) of the Poisson equation (3.80) for the gravitational action potential of action C^2 whose presence in space is determined by the perturbing mass of the Earth M. Therefore, for further analysis we shall use equation (3.67)

$$\mathbf{F}_n = m \cdot \mathrm{grad}\, C^2 = m \cdot \mathrm{grad}(C_0^2 - \varphi_n) = G\frac{mM}{r^2}\mathbf{1}_r \tag{3.88}$$

We can analyse the gradient distribution of the gravitational potentials in (3.88) which also leads to the formation of the force $\mathbf{F}_n$ (3.88). However, the gravitational potentials are the calculated mathematical parameters of the gravitational field and together with the quantum density of the medium they are the purely physical parameters of the scalar field which can be represented ideally analysing already the physical model of gravity. Consequently, we can formulate ideal experiments investigating hypothetically the behaviour of the quantum density of the medium in the gravitational interactions, avoiding errors in analysis. The analysis of gravitational potential does not offer this possibility. Taking into account the equivalence of (3.66) to the quantum density of the medium and gravitation potentials, we can write the law (3.88) replacing the gravitational action potential C^2 by the quantum density of the medium ρ_1 (3.42) which characterises the perturbing gravitational field with the mass M in which the perturbing mass m is situated (Fig. 3.30)

$$\mathbf{F}_n = m\frac{C_0^2}{\rho_0}\mathrm{grad}(\rho_1) = G\frac{mM}{r^2}\mathbf{1}_r \tag{3.89}$$

Equation (3.89) shows that the nature of gravity is determined by the gradient of the quantum density of the medium of the perturbing mass *M*. Figure 3.13 shows clearly how the perturbing gradient field with mass *M* penetrates through the test mass *m* causing in this mass the redistribution of the quantum density of the medium and, at the same time, generating the gravitational force $\mathbf{F}_n$ (3.89). As indicated by (3.89), the transition to the quantum density of the medium does not change the nature of the law of universal gravity but gives it a physical meaning because equation (3.89) includes the deformation vector **D** (3.43) of quantised space-time, determined by the perturbing mass *M*:

$$\mathbf{F}_n = \frac{C_0^2}{\rho_0} m \cdot \mathrm{grad}\,(\rho_1) = \frac{C_0^2}{\rho_0} m\mathbf{D} \tag{3.90}$$

Equation (3.90) shows that the reason for gravity is determined by the additional deformation **D** inside the test mass *m*, determined by the gradient field of the perturbing mass *M*. Evidently, Einstein tried to find an equation similar to (3.90), developing the theory of gravitation in the general theory of relativity (GTR) and using the distortion of the space-time as a basis for gravitation, utilising Riemann geometry (3.81).

On the other hand, the deformation vector **D** in (3.90) is an analogue of acceleration vector **a** establishing the equivalence of gravity and inertia. If the test solid with the mass *m* is subjected to the effect of accelerating force equivalent to force $\mathbf{F}_n$ (3.19), this leads to the gradient redistribution of the quantum density of the medium inside the solid and the formation of the deformation vector, determined by inertia. This deformation vector can be conveniently denoted by the indexes $\mathbf{D}_2^i$, indicating the inertia properties of deformation (index *i*) and the fact that this deformation takes place inside the solid (index $_2$)

$$\mathbf{F}_n = m\mathbf{a} = m\frac{C_0^2}{\rho_0}\mathbf{D}_2^i \tag{3.91}$$

From equation (3.91) we obtain the value of the deformation vector $\mathbf{D}_2^i$ inside the solid, determined by its acceleration **a**

$$\mathbf{D}_2^i = \frac{\rho_0}{C_0^2}\mathbf{a} \tag{3.92}$$

We separate the test solid 2 with the mass *m* from the gravitational field of the perturbing mass *M* (Fig. 3.13) and leave along the effect of the force $\mathbf{F}_n$ which however in this case is the accelerating force. As indicated by the calculations carried out previously, because of the equivalence between gravity and inertia the deformation vector $\mathbf{D}_2^i$ (3.92) inside the test solid,

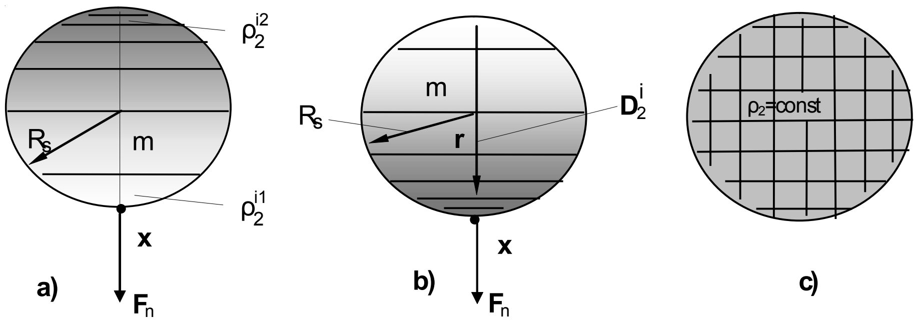

Fig. 3.14. Redistribution of the quantum density of the medium inside the solid as a result of the effect of accelerating force $\mathbf{F}_n$ (a), the formation of the quantised medium in acceleration of the solid (b), and the uniform grid of the quantum density of the medium in the absence of acceleration and gravity (c).

determined by acceleration of the solid, should be equivalent to the gradient of the quantum density of the medium (3.19) generating gravity.

Figure 3.14a shows that the effect of the perturbing force $\mathbf{F}_n$ in the direction **x** on the test mass *m* results in the acceleration **a** of the solid (3.92) leading to the redistribution of the quantum density of the medium inside the gravitational interface R_s of the test solid. In principle, phase transitions of the quantised space-time are detected inside the particle (solid) in acceleration. It may be seen that inside the solid in the direction **r**, the quantum density of the medium increases from ρ_2^{i1} to ρ_2^{i2}, forming the gradient of the quantum density of the medium inside the solid which determines the direction and magnitude of the deformation vector D_2^i of the vacuum field inside the gravitational boundary (Fig. 3.14b):

$$\mathbf{D}_2^i = \text{grad}\,(\rho_2^i) \tag{3.93}$$

Figure 3.14c shows that the absence inside the test mass of the gradient of the quantum density of the medium which is represented by the uniform grid indicates that the solid does not experience acceleration or gravity from the side of the perturbing mass. In this case, the test solid is in the absolue rest condition or uniform and straight movement with respect to inertia in the quantised space-time.

Thus, the new fundamental discoveries of the quantum of space-time (quanton) and superstrong electromagnetic interaction (SEI) have made it possible for the first time to examine the reasons for gravity and inertia in the quantum theory of gravitation. The quanton, as the carrier of gravitational interactions, returns the classic nature to the quantum theory of gravitation, the deterministic understanding of the nature of gravitation and quantum theory which Einstein defended in his dispute with Bohr.

Returning to the nature of gravity, it is necessary to pay special attention to the presence of a gravitational well around the gravitating mass, as shown in the gravitational diagram (Fig. 3.11). Figure 3.15 shows that the test mass 2, situated inside the gravitational potential well, tries to 'fall' on the bottom of the gravitation well under the effect of gravitational forces. Only on the bottom of the gravitational well does the system reach the stable state associated with the effect of gravitation as attraction forces. Naturally, gravitational well does not exist in the case of spherical deformation of quantised space-time (Fig. 3.10 and 3.13). The gravitational well appears as a result of the transformation of the three-dimensional Lobachevski space into the two-dimensional distribution of the quantum density of the medium and gravitational potentials of the gravitational diagram. However, the gravitational well model itself is suitable as an example of the effect of gravity and has never been investigated in this role in the theory of gravity.

In a general case, examining the gravity in the absolute space-time, it is necessary to consider the absolute speed v required for increasing the rest mass of both perturbing M_0 and test mass m_0. This is achieved by introducing the normalised relativistic factor γ_n (3.70) into the gravity equation (3.88)

$$\mathbf{F}_n = \gamma_n m_0 \cdot \mathrm{grad}(C_0^2 - \gamma_n \varphi_n) = \gamma_n^2 G \frac{m_0 M_0}{r^2} \mathbf{1}_r \qquad (3.94)$$

From the procedural viewpoint, the problem of measuring the absolute speed in the quantised space-time has been solved because it determines the quantum density of the medium inside the particle (solid) which is a function of absolute speed (3.77). The availability of this procedure in future will make it possible to construct devices measuring the absolute speed in relation to the quantised medium.

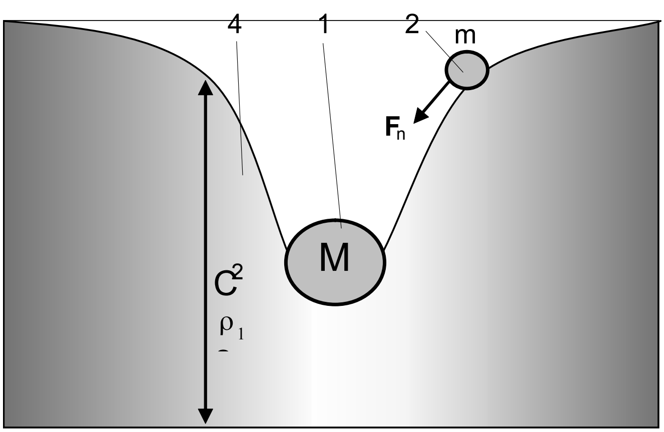

Fig. 3.15. Presence of a gravitational well in the vacuum field around the perturbing mass 1 (M) explains the effect of gravitational force $\mathbf{F}_m$ on the test mass 2 (m).

3.5.3. Simple quantum mechanics effects

The equivalence of gravity and inertia, as the properties of the quantised space-time, enables us to examine simple quantum mechanics effects which are well-known in physics as the direct confirmation of the presence of the elastic quantised medium with which we must interact constantly in everyday life:

Example 1. Inertia.

Equation (3.91) shows convincingly that the quantised space-time reacts only to the acceleration determined by the internal deformation of the accelerated solid. Any attempt from outside to accelerate or slow down encounter resistance from the side of the elastic quantised medium. Previously, physics regarded the acceleration under the effect of external forces as the properties of the solid not linked with the elastic quantised medium. However, this contradicts the third Newton law in which any effect meets a response interaction. In the present case, the effect of the external accelerating force is counteracted by the internal force which determines the redistribution of the quantum density of the medium inside the accelerated solid (3.90), (3.93) (Fig. 3.14). This effect is felt by 'pushers' of the nucleus sensing the pressure of the force from the side of the nucleus. Any acceleration or deceleration of a machine is felt by everybody on the basis of the rearrangement of the quantum density inside the solid accompanied by force jolts. We ourselves are a part of the elastically quantised medium which penetrates us, determining the forces of gravity and inertia as the radius of the quantum density of the medium inside the solid.

Example 2. Reduction or increase of the weight of a gyromotor

Figure 3.16a shows a stand with the gyromotor 1, positioned on a beam balance. The gyromotor 1 contains the external rotor 2 in the form of a ring, the stator 3 and the hermetically sealed casing 4 from which air has been removed. The gyromotor its placed on the lever 5 with the axis 6 and the counterweight 7 representing the balanced beam balance. When the gyromotor it started up, the weight of the gyromotor on the beam balance decreases or increases. The change of the weight of the gyromotor increases with the increase of the power of the gyromotor, i.e., it depends on the speed of rotation and the moment of inertia of the rotor 2. For powerful gyromotors, the disbalance of the forces makes exceed the weight of the gyromotor.

It would appear that the gyromotor is a closed system and the moment of the forces, acting on the rotor, should be completely balanced by the moment of forces acting on the stator. There should be no external

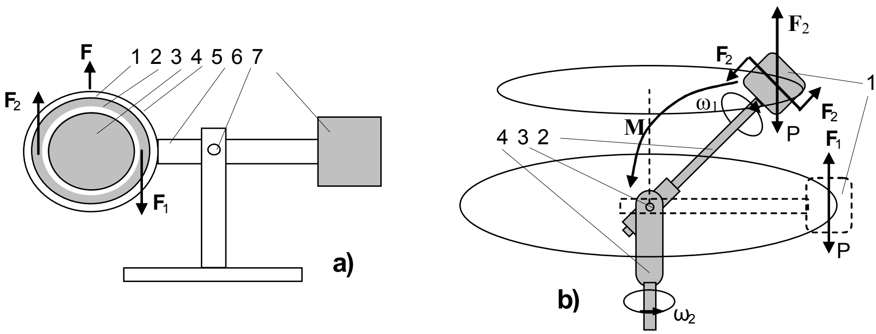

Fig. 3.16. Simple quantum mechanics defects. Reduction or increase of the weight of the flywheel (a); reversed gyroscopic effect (b).

modification of these completely balanced force moments. However, this is the case if the gyromotor has the form of a closed conservative system and the effect of the internal forces and moments in this system would not carry any work in lifting the gyromotor in the field of Earth gravity on the beam balance.

However, the gyromotor is an open quantum mechanics systems, linking the interaction of the rotor of the gyromotor with the elastic quantised medium. If the rotor of the gyromotor is wedged, there will be no external effects, regardless of the fact that the rotor and stator are subjected to the effect of electromagnetic forces and moments. However, in detorsion the rotor accelerates and this results in the redistribution of the quantum density of the medium inside the rotor and in the formation of unbalanced forces of interaction with the quantised medium. If the rotor is rotated in the anticlockwise direction, the forces of resistance from the side of the elastic quantised medium will be directed in the direction opposite to the direction of rotation of the rotor. In Fig. 3.16a this is represented by forces $\mathbf{F}_1$ and $\mathbf{F}_2$ which act on the rotor in the local zones of the plane of the lever 5. However, regardless of the equality of the forces $\mathbf{F}_1 = \mathbf{F}_2$, the moments generated by these forces are determined by the radii r_1 and r_2 from the point of application of the forces to the axis 6 of rotation of the beam balance. Consequently, we can compile the balance of the moments and can calculate the unbalanced local force $\mathbf{F}$:

$$F_2 r_2 - F_1 r_1 = \frac{1}{2}(r_1 + r_2)F \tag{3.95}$$

$$F = 2F_1 \frac{(r_2 - r_1)}{(r_1 + r_2)} \tag{3.96}$$

Integrating over the entire volume of the rotor in projection on the horizontal plane, we can determine the sum of all local forces **F**, acting on the rotor of the gyromotor in the direction against the gravitational force on the condition of rotation of the rotor when its acceleration becomes apparent. In statics, in rotation of a rotor with a constant speed these effects are not detected because the elastic quantised medium interacts with the matter of the rotor by a non-equilibrium force only during its acceleration (3.92). Similarly, this effect is not detected in an electronic balance, because it is determined by the effect of moments (95).

Example 3. Reversed gyroscopic effect

The direct gyroscopic effect determines the capacity of a flywheel to maintain the direction of the axis of rotation in space. The gyroscopic effect has not as yet been convincingly explained, with the exception of commenting on the inertia properties of the rotating flywheel, without understanding the reasons for inertia. If the quantum theory of the bodies of revolution is treated as the theory of open quantum mechanics systems, we go outside the framework of the given subject. Therefore, we investigate only the reversed gyroscopic effect when the force precession of the rotor of the gyromotor results in the formation of a pair of Coriolis forces capable of generating a momentum lifting the gyromotor in the direction against gravitational forces. This is a suitable example of the open quantum mechanics systems in which the work of lifting the gyromotor in the direction against gravitational forces as a result of non-conservative forces demonstrates convincingly the elasticity of the quantised space-time. Everybody who repeats this experiment with his/her own hands feels that the space-time is an elastic medium, although the device itself which shows the reversed gyroscopic effect does not contain any springs.

Figure 3.16b shows the diagram of a stand which includes the gyromotor 1, secured to the lever 2. The lever itself is placed on the horizontal axis 3 which is connected with the vertical shaft 4. The rotor of the gyromotor 1 rotates with high speed ω_1. The vertical shaft rotates with low speed ω_2. At a specific ratio of the frequencies of rotation when frequency ω_2 corresponds to the precession frequency, the gyromotor hangs from the lever 2 in the horizontal position (dotted lines), counteracting the gravitational force **P** by the force $\mathbf{F}_1$. The increase of frequency ω_2 increases force $\mathbf{F}_2$ which overcomes force **P** and stops the gyromotor 1 on the lever 2 from lifting and carrying out work. Moment **M**, acting on the lever 2 with the gyromotor 1, is caused by Coriolis forces **F** and determined by the length of the lever *r* and by the inertia moment *J* of the gyromotor rotor [39]

$$\mathbf{M} = \mathbf{F}_2 r = J|\omega_1 \cdot \omega_2| \tag{3.97}$$

The observed effect of carrying out work in lifting the gyromotor in the direction against the gravitational forces is a suitable example of the open quantum mechanics system. The gyromotor is not a closed system of conservative forces which are not capable of carrying out external work. If it is assumed that moment **M** is determined by the effect of the conservative forces, there will be no lifting of the gyromotor, even if the moment **M** were capable of moving the lever 2. Only the work of external non-conservative Coriolis forces, determined by interaction with the elastic quantised medium, is capable of carrying out work in lifting the gyromotor.

The direct and reversed gyroscopic effects are used in different applications in technology and also in cases in which the complete compensation of the gyroscopic moment is required [39–41].

One could mention many examples of simple quantum mechanics systems based on gyroscopic effects. However, all these examples have one shortcoming, i.e., the Coriolis forces, acting on the flywheel during its movement along the radius, compensate each other generating a momentum capable of forming an unbalanced force only in the local region, acting only on the rotor and not on the system as a whole. The classic Coriolis forces can be used to generate the lifting force of a craft.

In cases in which it is possible to change actively the direction and magnitude of Coriolis forces, we obtain an unbalanced force of the system as a whole, capable of lifting aircraft. Similar effects were detected in experiments several decades ago by English inventor John Searle [42] and have been confirmed by experiments in Russia [43]. However, only in the theory of Superunification based on the electromagnetic nature of gravity and inertia has it been possible for the first time to explain theoretically the new experimental facts and indicate methods of formation of the unbalanced force and its application in aircraft [17].

It should be mentioned that the Superunification theory is the physics of open quantum mechanics systems, which start with elementary particles and extends to all objects in our universe.

3.6. The principle of relative-absolute dualism. Bifurcation points

3.6.1. Energy balance

Modern physics does not operate with absolute speeds in absolute space-time and all the measurements are only relative. For this reason, there are no reports in scientific literature on the investigation of the movement of a particle (solid) in the absolute space taking the absolute speed into account, although these investigations are interesting because they provide unique results. Taking into account the reality of the absolute quantised space-time as a specific elastic quantised medium, the investigations of the absolute movement make it possible to write the energy balance (3.75) of the particle (solid) in the entire speed range v from 0 to C_0:

$$W = W_{\max} - W_s = \gamma_n m_0 C_0^2 \tag{3.98}$$

In the range of non-relativistic speeds $v \ll C_0$, equation (3.98) changes to (3.76):

$$W = W_{\max} - W_s = m_0 C_0^2 + \frac{m_0 v^2}{2} \tag{3.99}$$

Equation (3.99) includes the rest energy W_0 (3.56) and kinetic energy W_k of the particle (solid) in the range of non-relativistic speeds

$$W_k = \frac{1}{2} m_0 v^2 \tag{3.100}$$

3.6.2. Absolute speed

In principle, as already shown, the energy of the particle (solid) in a general case is unique and is determined by the energy (3.98) and spherical deformation of quantised space-time which in turn is linked with the speed of movement v through the normalised relativistic factor γ_n (3.70). The particle (solid) itself is not capable of changing its energy or speed but is capable of changing concentration ρ_2 and ρ_1 (3.77) of the quantons inside the gravitational interface and on the outside, ensuring a jump $\Delta\rho_1$ and $\Delta\rho_2$ of the quantum density of the medium (Fig. 3.11). Any of the parameters of the medium: ρ_1, ρ_2, $\Delta\rho_1$, $\Delta\rho_2$, determines the speed v of the particle (solid). To simplify calculations, we investigate the variation of the quantum density of the medium ρ_2 (3.77) inside the particle (solid) in relation to speed v:

$$\rho_2 = \rho_0 \left(1 + \frac{\gamma_n R_g}{R_S} \right) \tag{3.101}$$

Equation (3.101), like (3.77) and (3.78), is interesting because of the fact that it determines accurately the internal state of the particle (solid) in the absolute space-time in the entire speed range from 0 to C_0. Consequently, we can obtain solutions in absolute quantities. From (3.101) we determine γ_n and subsequently solve the task with respect to speed v from γ_n (3.70)

$$\gamma_n = \left(\frac{\rho_2}{\rho_0} - 1\right)\frac{R_S}{R_g} = \frac{\Delta\rho_2}{\rho_0}\frac{R_S}{R_g} \tag{3.102}$$

$$v = C_0 \sqrt{\frac{\left(\frac{\Delta\rho_2}{\rho_0}\right)^2 - \left(\frac{R_g}{R_S}\right)^2}{\left(\frac{\Delta\rho_2}{\rho_0}\right)^2\left(1 - \frac{R_g^2}{R_S^2}\right)}} \tag{3.103}$$

Function (3.103) is implicit with respect to the variation of quantum density $\Delta\rho_2$ but it can be used for the accurate determination of the absolute speed v from the increment $\Delta\rho_2$ in relation to ρ_0. This means that the absolute speed can be controlled by devices if we control the variation of the quantum density of the medium. The Poincaré postulate according to which this cannot be carried out using devices was made for the level of knowledge at the beginning of the 20th century when the quantum theory of gravitation was not known.

Analysis of the equation (3.103) for the value of absolute speed $v = 0$ and $v = C_0$ gives accurate relationships for the parameters of the particle (solid):

1. at $v \geq 0$, $\Delta\rho_2 \geq \rho_0 \frac{R_g}{R_S}$ (3.104)

2. at $v \leq C_0$, $\Delta\rho_2 \leq \rho_0$ (3.105)

The variation of the quantum density of the medium in the entire speed range from 0 to C_0 increases from (3.104) to (3.105), increasing the energy of spherical deformation of the quantised space-time in accordance with (3.98). However, analysis of the kinetic energy (3.100) of the particle (solid) already results in an energy paradox whose nature is associated with the specific features of movement in the quantised medium.

3.6.3. Energy paradox of motion dynamics

To determine the reasons for the energy paradox, we investigate the following problem of motion. A cannon ball with the mass m was ejected from the barrel of a cannon and impacted on a thick wall with relative speed v, and was embedded in the wall and partially fractured it. It is necessary to determine the absolute kinetic energy of the cannon ball at the moment of impact on the wall, assuming that the absolute speed of the cannon is v_0 and is considerably lower than the speed of light C_0 and the rest mass of the cannon ball m_0. In the first approximation, in solving the problem in the range of non-relativistic speeds we can ignore the increase of the mass of the ball in relation to speed, assuming that $m = m_0$, and compensate the increase of the mass by the equivalent increase of kinetic energy.

In the first case, we calculate the absolute kinetic energy W_k (3.100) of the cannon ball substituting the absolute speed $v = v_0 + \Delta v$ into equation (3.100)

$$W_{k1} = \frac{1}{2}mv^2 = \frac{1}{2}m(v_0 + \Delta v)^2 = \frac{1}{2}m(v_0^2 + \Delta v^2 + 2v_0 \Delta v) \tag{3.106}$$

In the second case, it is assumed that to the absolute kinetic energy W_{k0} of the ball prior to ejection from the cannon it is necessary to add the kinetic energy of the cannon ball ΔW_k, obtained as a result of firing. Consequently, the absolute kinetic energy W_{k2} of the cannon ball is determined by the sum of two energies:

$$W_{k2} = W_{k0} + \Delta W_k = \frac{1}{2}mv_0^2 + \frac{1}{2}m\Delta v^2 = \frac{1}{2}m(v_0^2 + \Delta v^2) \tag{3.107}$$

We determine the difference ΔW of the energies W_{k1} (3.106) and W_{k2} (3.107) from the equation

$$\Delta W = W_a - W_{ka} = mv_0 \Delta v \tag{3.108}$$

The absolute kinetic energy W_{k2} (3.107) of the cannon ball in the second case corresponds to the experiments. However, the absolute kinetic energy W_{k1} (3.106) can also correspond to the experimental data. We obtain a paradoxic situation in which on reaching the same absolute speed v in the quantised space-time the kinetic energy of the particle may have two different values. Energy W_{k1} (3.106) is higher by $mv_0\Delta v$ (3.108) in comparison with W_{k2} (3.107). This situation is known in physics but it could be explained only on the basis of the Superunification theory.

The reason for the energy paradox is the occurrence of phase transitions at the moment of acceleration (deceleration) of the particle (solid), associated with the redistribution of the quantum density of the medium inside the shell of the elementary particles, included in the composition of the matter of the cannon ball (including atomic nuclei). This is an internal special feature of movement with acceleration, and if this movement with acceleration is interrupted we obtain the previously mentioned energy paradox. The phase transitions inside the shell of elementary particles can be studied as a result of advances in the quantum mechanics of open quantum mechanics systems.

To explain the reason for the energy paradox, we return to analysis of the spherical model of the nucleon in Fig. 3.11 which includes the internal and external regions separated by the gravitational interface with radius R_S whose role is played by the alternating shell of the nucleon. The external region of the spherically deformed quantised space-time determines the gravitational field of the nucleon which remains spherically invariant with the increase of the absolute speed of the particle, up to the speed of light. In this case, we are interested in the internal region of the particle. It has already been mentioned that an increase of speed v increases the quantum density of the medium ρ_2 (3.101) inside the shell of the nucleon as a result of a decrease of the quantum density of the medium on the external side. It is now necessary to study the phase transitions of the quantum density inside the shell of the particle (solid) in acceleration (3.92).

Classic physics regards the acceleration as an inertial property of the isolated particle (solid) in a closed quantum mechanics system. The measure of inertness is the mass. At that time, no mention could be made of any internal connection of the particle (solid) with the quantised space-time as the open quantum mechanics system. This concept restricted the field of activity of the investigator and did not permit penetration into the gist of the problem. The reasons for inertia are associated with the phase transitions of the quantum density of the medium (3.93) inside the gravitational interface of the particle when the gradient redistribution is observed in the direction of the effect of the accelerating force only at the moment of acceleration determined by the transition process of the change of the speed of motion (Fig. 3.14).

It should be mentioned that the process of movement of the solid is determined by the entire set of motion of the elementary particles in the composition of the solid. This process is electromagnetic, taking into account the electromagnetic nature of the quantised space-time [1]. The shell of the nucleons also consists of electrical charges [14]. The electron contains a central electrical charge [10–17]. The quantised space-time is filled with quantons which include two electrical and two magnetic monopole charges [1]. The spherical deformation of the quantised space-time, being the process of compression and stretching of the quantons, is associated with the displacement of the electrical and magnetic charges inside the quantons (3.1) from equilibrium. Therefore, the movement of the particle (solid) is a complicated dynamic electromagnetic process. As any electromagnetic process, this process consists of two components: active and reactive. The active component determines the observed active losses or energy release. The reactive component ensures the resonance exchange of electromagnetic energy between the particle and the quantised space-time.

It would appear that motion by inertia is not linked with the energy exchange because we cannot detect the external effect of forces on the solid (particle) moving by inertia. However, this is only the external side of the problem. As already mentioned, the movement by inertia is a wave transfer of spherical deformation of the quantised space-time seen externally as the mass transfer of the solid (particle). Therefore, movement by inertia is associated with the exchange energy processes between the moving solid (particle) and the quantised medium where the leading front of the solid (particle) deforms the medium, and the rear front of the solid (particle) releases deformation of the medium, returning the energy used for the formation back to the medium thus ensuring the law of conservation of energy. This is a resonance electromagnetic process of energy exchange during movement leading to the internal balance of reactive energy seen externally as the free motion of the solid (particle) by inertia.

3.6.4. Resistance to movement in vacuum

The attempts to determine the resistance to movement of the solid in vacuum were made by other investigators, including I. Yarkovskii, who assumed that the resistance of vacuum to movement is proportional to the cube of speed [44]. We investigate specific forces of the resistance to the movement of a non-relativistic particle in the quantised medium, restricting our considerations to the wave transfer of only the rest mass m_0. During movement, the particle describes a cylindrical tube in space whose deformation energy determines the energy used for motion. Calculations can be carried out more efficiently for a continuous solid tube within the framework of the gravitational interface R_S. Taking into account that the energy of deformation of the medium on the external side, balanced by the energy on the internal side of the gravitational interface, is distributed equally, we determine the reduced mass m_v of the cylindrical tube with the density of matter ρ_m in the doubled volume $V = \pi \cdot R_S^2 \cdot x$, taking into account the correction for ⅔ in transition to a spherical particle with radius R_S from a cylinder with the same radius and length $2R_S$ (x is the length of the tube in the direction of movement along the X axis):

$$m_v = 2V \cdot \rho_m = \frac{4}{3}\pi \cdot R_S^2 \cdot x \cdot \rho_m \qquad (3.109)$$

(3.109) is multiplied and divided by R_S. Taking into account that $m_0 = 4/3R_S^3 \cdot \rho_m$, we determine the energy W_1 of deformation of the medium which the leading front of the electron carries out during its movement taking into account the normalised relativistic factor γ_n (3.70)

$$W_1 = \gamma_n m_v C_0^2 = \gamma_n m_0 C_0^2 \frac{x}{R_S} \tag{3.110}$$

Resistance force $\mathbf{F}_{1C}$, exerted by the quantised medium on the leading front in movement of the electron, is determined as a derivative of energy W_1 (3.110) in direction x:

$$\mathbf{F}_{1C} = \frac{dW_1}{dx} = \frac{\gamma_n m_0 C_0^2 dx}{R_S dx} = \frac{\gamma_n m_0 C_0^2}{R_s} \mathbf{1}_x \tag{3.111}$$

On the other hand, the rear front of the particle in the wave motion in the quantised space-time releases spherical deformation of the medium, releasing reactive energy W_2, whose value is equal to the energy W_1 (3.110). This results in the formation of pushing force $\mathbf{F}_{2T}$ equal to the resistance force $\mathbf{F}_{1C}$ (3.111) but acting in the opposite direction, ensuring the energy balance and compensation of the forces

$$W_1 - W_2 = 0, \quad \mathrm{F}_{1C} - \mathrm{F}_{2T} = 0 \tag{3.112}$$

The energy balance and compensation of forces (3.112) result in motion by inertia. Externally, this is seen as a process which does not require energy or force. However, the movement by inertia is a highly energy consuming (3.100) and force (3.111) electromagnetic process leading to the exchange of reactive energy between the moving particle (solid) in the quantised medium and sustaining the wave transfer of mass. This is the answer to the question: ‘why does the particle (solid) move by inertia?’.

3.6.5. Dynamics equations

In acceleration of the particle (solid), the balance of energy and forces (3.112) is disrupted as a result of the effect of external force **F** which carries out work W (3.75) less the rest energy W_0 in acceleration of the particle (solid) changing its speed

$$\mathbf{F} = \mathbf{F}_{1C} - \mathbf{F}_{2T} = \frac{d(W - W_0)}{dx} = \frac{d(\gamma_n C_0^2 m_0)}{dx} = C_0^2 \frac{dm}{dx} \tag{3.113}$$

The dynamics equation (3.113) reflects most objectively the physical nature of the acceleration of the particle (solid) under the effect of force **F** on the path x as the variation of mass dm in acceleration along the path x in the entire range of absolute speeds from 0 to C_0, where $m = \gamma_n m_0$

$$\mathbf{F} = C_0^2 \frac{dm}{dx} \tag{3.114}$$

Equation (3.114) was not used previously in dynamics because acceleration was not linked with the increase of mass and deceleration with the decrease of mass. The mass in (3.114) is a variable quantity along the acceleration path x. If rest mass m_0 in (3.114) is taken away from below the differential as a constant in the absolute space-time, then taking into account $m = \gamma_n m_0$, we obtain the dynamics equation in which only γ_n is a variable parameter

$$\mathbf{F} = m_0 C_0^2 \frac{d\gamma_n}{dx} \tag{3.115}$$

In the speed range $v \ll C_0$ γ_n (3.70) is expanded into a series, rejecting terms of higher orders

$$\gamma_n = 1 + \frac{1}{2}\frac{v^2}{C_0^2} \tag{3.116}$$

Substituting (3.116) into (3.115), transforming constants and multiplying the left and right parts by dt (t is time), we obtain

$$\mathbf{F}dt = \frac{1}{2} m_0 \frac{d(v^2)}{dx/dt} = \frac{1}{2} m_0 \frac{d(v^2)}{dv} = m_0 v \tag{3.117}$$

Equation (3.117) is connected with the absolute space-time when the speed v is counted from 0 for the mass m_0. Integrating (3.117) with respect to time in the range from 0 to t, we obtain the well-known relationship between the momentum and the amount of motion in the non-relativistic speed range

$$\mathbf{F}t = m_0 v \tag{3.118}$$

Equation (3.118) is linear and, consequently, the variation of t and v is also linear

$$\mathbf{F}dt = m_0 dv \tag{3.119}$$

Equation (3.119) is the Newton dynamics equation

$$\mathbf{F} = m_0 \frac{dv}{dt} = m_0 \mathbf{a} \tag{3.120}$$

The classic dynamics equation (3.120) is not accurate from the physical viewpoint because the mass is not a constant and is a variable quantity including in the range of the non-relativistic speeds. However, I have shown in considerable detail that the equations (3.119) and (3.120) are derived from the dynamics equation (3.114) and (3.115) in the normalisation of the mass from a variable quantity to a constant. However, this is a purely mathematical measure based on the variable value of the mass. Naturally, in the case in which the mass is regarded as a constant, the compensation of mass with the increase of the mass with speed can be carried out by kinetic energy (3.106) and (3.107).

Now, when we have been able to explain briefly the internal processes of dynamics of the particle (solid) of motion in the quantised medium, including by inertia, we return to the analysis of the energy paradox determined by the fact that the kinetic energy can be determined by both equation (3.106) and (3.107). As already mentioned, motion with acceleration is linked with the effect of the external force on the particle (body) which is balanced by the internal force of the phase transition of the quantum density of the medium inside the shell of the elementary particle leading to the redistribution of the concentration of the quantons in the direction of movement.

Figure 3.14c shows the uniform distribution of the quantum density of the medium ρ_2 = const inside the gravitational interface of the particle (solid). This corresponds to the state of uniform and straight movement of the particle (solid) by inertia or its rest (absolute or relative).

Figures 3.14a and 3.14b shows the phase transitions of the quantum density of the medium in the direction of increasing its concentration in the region of the leading front of the particle (solid) in the direction of movement and in the direction of the vectors of speed **v**, acceleration **a** and force $\mathbf{F}_m$. This leads to the appearance of the additional deformation vector $\mathbf{D}_2^i$ (3.92)–(3.93) of the quantised medium determined by acceleration. It is now important to understand that the acceleration of the particle (solid), in addition to the change of the spherical deformation of the quantised space-time are associated with the increase of speed, to the phase transition of the quantum density of the medium inside the shell of the particle. This is an energy process and is associated with additional work in accelerating the particle.

3.6.6. Bifurcation points

We now return to the concept of the inertial and non-inertial systems of motion. The inertial system of a particle (solid) moving by inertia is characterised by the uniform distribution of the quantum density inside the shell (Fig. 3.14c). The solid consists of a population of particles and has a gravitational interface in the quantised medium, passing on the surface of the solid. A distinctive feature is that the quantum density of the medium inside the gravitational interface of the solid is determined by the averaged-out quantum density of the medium. However, as soon as the particle (solid) starts to accelerate, phase transitions of the quantum density of the medium start to appear in the direction of acceleration (Fig. 3.14a). The system, moving with acceleration, is non-inertial. Thus, if the particle (solid) moves with acceleration and the accelerating forces are subsequently removed and the solid moves by inertia and then again with acceleration, the system will be transferred from non-inertial to inertial and then back to non-inertial. This forms the nature of motion and determines the energy losses of active and reactive energies which are connected with the previously mentioned transitions from the non-inertial to inertial system and vice versa. Therefore, every time when phase transitions of the quantum density of the medium take place, the exchange energy process, determined by the reactive component, change and the total energy of the system also changes and this leads to the formation of the previously mentioned energy paradox.

The reasons for the energy paradox can be easily explained using Fig. 3.17 which shows the quadratic dependences (3.106) and (3.107) of the kinetic energy of the cannon ball on the speed of movement v. If the cannon ball were accelerated in the absolute space-time from zero (0) to absolute speed v, the absolute kinetic energy of the cannon ball W_{k1} would be determined by equation (3.106) and this will be in complete agreement with the experimental observations. However, we have not detected the acceleration of the cannon ball to speed v_0 in the section (0–a) of curve 1. This means that the cannon ball, which accelerated at some time together with the cannon and the Earth to speed v_0, underwent a transition from the non-inertial to inertial system. The cannon ball underwent phase transition of the quantum density of the medium at the moment of acceleration and deceleration. Subsequently, the cannon ball, moving by inertia with absolute speed v_0 in quantised space-time, is not subjected to phase transitions. At the point (a) the shot was made which again accelerated the cannon ball by Δv to speed v. The cannon ball again underwent phase transitions of the quantum density of the medium, changing the nature of motion at the point (a) which travelled along the curve 2 to the point (c) with the absolute kinetic energy W_{ka} which corresponds to the experiments.

In principle, point (a) is a bifurcation point bifurcating the nature of movement of the cannon ball at the moment of phase transition of the quantum density of the medium determined by acceleration at the moment of ejection from the cannon. The bifurcation point (a) characterises the discontinuous nature of acceleration and transition to movement by inertia. If, I repeat, there were no phase transitions of the quantum density of the medium at the bifurcation point (a), and the cannon ball continued moving with acceleration from point (0) to point (b), the absolute kinetic energy W_{k1} at the moment when the ball reaches the absolute speed v at the point (b) would correspond to the equation (3.106). It can be seen that the energy required by the ball to reach the absolute speed v differs in relation to the nature of movement and the phase transitions of the quantum density of the medium. This is a surprising conclusion which results from the principle of relative–absolute dualism, in which the nature of movement along the curve 2 in in section (a-c) changed at the point (a) from the absolute to relative category.

The decrease of the kinetic energy required for the acceleration of the body of the particle along the curve (0-a-c) to speed *v* (Fig. 3.17) can be efficiently explained by physical considerations. The point is that at the bifurcation point (a) the phase transition of the quantum density of the medium disappears because of the completion of the effect of acceleration on the solid (particle). The phase transition energy, determined by the deformation $\mathbf{D}_2^i$ of the quantised medium is released into the quantised medium as a result of reactive exchange of energy without photon radiation. However, the increased energy of the spherical deformation of the medium on the external side is retained in this case. The body (particle) changes to the state shown in Fig. 3.14c without the internal stress of the phase transition. The subsequent acceleration of the solid (particle) without the internal stress of the phase transition is easier than in the presence of the phase transition. Therefore, the energy required for the acceleration of the solid (particle) to absolute speed *v* in the presence of the bifurcation point (a) requires a small amount of energy for the value $mv_0\Delta v$ (3.108) in comparison with constant and continuous acceleration without point (a). The pulsed acceleration of the elementary particle is more economical than

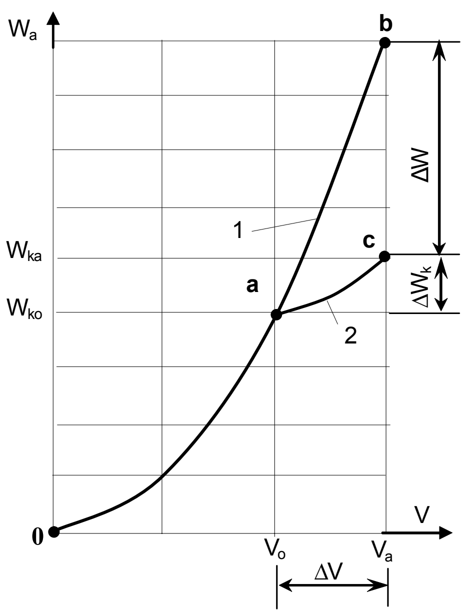

Fig. 3.17. Quadratic dependences of absolute 1 and relative 2 energies of the solid (particle) in relation to speed *v* of motion in the absolute space-time. The bifurcation point - (a).

continuous acceleration.

3.6.7. Complex speed

It should be mentioned that in this case the effect of the principle of relative–absolute dualism is determined by the quadratic dependences of the kinetic energy on the speed of movement. In fact, the momentum of the amount of motion *mv* is proportional to the first degree of speed. This simplifies its used in calculations in comparison with kinetic energy. It may be proven mathematically that any dynamics of motion is of the electromagnetic nature in the conditions of the relative–absolute dualism, including those in the presence of the bifurcation point (a) on the acceleration curve. For this purpose, equation (3.107) is transformed by separating from it the sum of the squares of the speeds:

$$\frac{2W_{k2}}{m} = \Delta v^2 + v_0^2 \qquad (3.121)$$

Evidently, $2W_{k2}/m$ in (3.121) is nothing else but the square of the absolute modulus of complex speed v^2 of the particle (solid). The modulus of complex speed v differs from speed v because it is not the sum of speeds and is linked through the sum of the squares of speeds

$$v^2 = \Delta v^2 + v_0^2 \qquad (3.122)$$

From (3.122) we determine the modulus of complex speed v

$$v = \sqrt{\Delta v^2 + v_0^2} \qquad (3.123)$$

In the complex form, absolute speed v is described by the generally accepted equations (where $i = \sqrt{1}$ is the apparent unity, the number $e = 2.71...$)

$$\upsilon = \Delta v + iv_0 = v \cdot e^{-i\varphi_v} \qquad (3.124)$$

The equation (3.124) includes the angle of the phase of the phase transition of the quantum density of the medium in acceleration of the solid (particle) by speed Δv. The phase angle φ_v is determined from the Euler equation:

$$\varphi_v = \arccos\frac{\Delta v}{v_a} = \arccos\frac{\Delta v}{\sqrt{v_0^2 + \Delta v^2}} = \arccos\frac{\Delta v / v_0}{\sqrt{1 + \frac{\Delta v^2}{v_0^2}}} \qquad (3.125)$$

Equation (3.125) can be derived through the sinus of the angle φ_v. This is not of principal importance. The important fact is that the speeds v_0 and Δv, included in (3.124) are principally different speeds with different physical meaning. The speed v_0 is the reactive speed of motion by inertia without acceleration and does not require any energy. Speed Δv is the speed which continuously increases in acceleration of the solid (particle) and requires energy. As mentioned previously, the process of motion in the quantised space-time is an electromagnetic dynamic process with the reactive (apparent) component v_0 and the active (real) accelerating component by the value Δv. In the present case, when the cannon ball after ejection accelerated by Δv in relation to the absolute speed v_0, the kinetic energy W_{k1} of the ball should be calculated from the modulus of complex speed v (2.123)

$$W_{ka} = \frac{1}{2} m v_a^2 = \frac{1}{2} m \left(\sqrt{v_0^2 + \Delta v^2}\right)^2 = \frac{1}{2} m (v_0^2 + \Delta v^2) \tag{3.126}$$

It may be seen that in the presence of phase transitions of the quantum density of the medium in acceleration of the solid (particle) and also in the presence of the bifurcation point (a) on the curves 1 and 2 in Fig. 3.17, the absolute kinetic energy should be calculated on the basis of the square root of the sum of the squares of the speeds, and not on the basis of the sum of speeds. This means that the modulus of complex speed is considered in the calculations. This corresponds to the experimental data and equation (3.107).

It is again necessary to mention that the equation of complex speed (3.124) holds only in the range of non-relativistic speeds, far away from the speed of light. It can be transferred with rough approximations, accepting that the limiting value of the modulus of absolute complex speed v is equal to the maximum speed of light C_0 in (3.122)

$$C_0^2 = \Delta v^2 + v_0^2 \tag{3.127}$$

Consequently, the probable increase of real speed Δv is determined from (3.127), on the condition that the imaginary part v_0 is also situated in the range of relativistic speeds

$$\Delta v = \sqrt{C_0^2 - v_0^2} = C_0 \sqrt{1 - \frac{v_0^2}{C_0^2}} \tag{3.128}$$

Equation (3.128) includes the relativistic vector γ used by Einstein in the special theory of relativity. However, in this case, it is derived from the principle of relative–absolute dualism

$$\gamma = \frac{1}{\sqrt{1 - \frac{v_0^2}{C_0^2}}} = \frac{C_0}{\Delta v} \tag{3.129}$$

We transform (3.129) by multiplying by rest mass m_0

$$m_0\gamma = m_0 \frac{C_0}{\Delta v} \tag{3.130}$$

Equation (3.130) includes the Einstein relativistic mass $m = m_0\gamma$ which can increase to infinity with the increase of speed v_0 to the speed of light C_0. This is explained by a rough approximation and by the fact that initial equation (3.129) does not hold in the range of relativistic speeds. As already mentioned, by introducing the normalised relativistic factor γ_n (3.70) in the theory of Superunification it was possible to get rid of the infinite value of the relativistic mass. It should be mentioned that (3.127) can be easily transforms into a four-dimensional interval, being a rough approximation in description of the properties of space-time.

In the range of relativistic speeds for straight motion with acceleration in the dynamics equation (3.120) m_0 is replaced by the relativistic mass $m = m_0\gamma_n$ which already takes into account the normalised relativistic vector γ_n (3.70)

$$\mathbf{F} = m_0\gamma_n \frac{d\mathbf{v}}{dt} \tag{3.131}$$

3.6.8. Relativistic momentum

In (3.131), the force vector **F** coincides with the speed vector **v**. In this case, from (3.131) we obtain the relativistic momentum **p** for straight acceleration

$$\mathbf{p} = m_0\mathbf{v}\gamma_n \tag{3.132}$$

Equation (3.132) makes it possible to determine the limiting values of the momentum $p_{\max}$ of the particle which the latter receives when the speed v is increased from 0 to C_0 with (3.72) and (3.6) for m_0 taken into account

$$\mathbf{p} = m_0\mathbf{C}_0 \frac{R_S}{R_g} = m_{\max}\mathbf{C}_0 \tag{3.133}$$

In a general case of non-straight movement, when the force vector **F** does not coincide with the speed vector **v**, the relativistic dynamics equation (3.115) can be transformed by multiplying the left and right parts by dt as in (3.117)

$$\mathbf{F}t = m_0C_0^2 \frac{d\gamma_n}{dv} = m_0C_0^2 \frac{d}{dv}\left[1-\left(1-\frac{R_g^2}{R_S^2}\right)\frac{v^2}{C_0^2}\right]^{-\frac{1}{2}} \tag{3.134}$$

We determine a derivative of the complex function (3.131) and the value of the relativistic momentum in the entire range of speeds from 0 to C_0

$$\mathbf{p} = m_0 v \left[1 - \left(1 - \frac{R_g^2}{R_S^2} \right) \frac{v^2}{C_0^2} \right]^{-\frac{3}{2}} \left(1 - \frac{R_g^2}{R_S^2} \right) \approx m_0 v \cdot \gamma_n^3 \qquad (3.135)$$

The investigation show that the momentum (3.134) is transverse to the speed vector in contrast to the longitudinal momentum (3.132). In movement of the particle, for example, along a sinusoidal trajectory, the general momentum is determined by the vector sum of the transverse and longitudinal momenta. The momentum (3.135) corresponds to the dynamics equation with γ_n^3.

Thus, the transition to the absolute quantised space-time enables us to solve quite easily complex problems associated with the determination of the limiting parameters of the relativistic particles. Knowing the acceleration of a particle in a force field, these equations can be used to calculate the acceleration time. Taking into account that the speed of the solar system together with the Earth is considerably lower than the speed of light, the Earth can be regarded as a stationary object in relation to which we take relativistic measurements of the parameters of the particles in the conditions on the Earth. It is pleasing to see that the resultant dynamics equations for the absolute space-time, many of which are well-known, can be transferred to the range of relative measurements. Naturally, being restricted by the space available in this section, it should be mentioned that this subject can be discussed for ever.

However, most importantly, the analysis of the dynamics of the particle (solid) shows that the continuous absolute and intermittent relative movements differ in the bifurcation points (a) on the acceleration curve in Fig. 3.17, determined by the phase transitions of the quantum density of the medium in transition of the particle (solid) to the regime from the inertial to non-inertial system, and vice versa. Relativity is the fundamental property of the quantised space-time, determining the principle of relative–absolute dualism. This is confirmed by the analysis of the large number of experimental data. The principle of relativity does not require any additional verification. It is necessary to develop further the quantum theory of relativity as the theory of relative measurements in the absolute quantised space-time in the conditions of distortion of the space by gravitation.

3.7. Wave mass transfer. Gravitational waves

As already mentioned, the movement of the particle (solid) in the superhard and superelastic quantised space-time is possible only if there is wave mass transfer which is experimentally confirmed by the principle of corpuscular wave dualism in which the particle shows simultaneously the wave and corpuscular properties. The particle having the wave properties forms the basis of quantum (wave) mechanics. However, the calculation apparatus of quantum mechanics, because of the absence of any data on the quantised structure of space-time and its elementary quantum (quanton), is restricted to the wave function which is of the statistical type. The presence of the quantised structure of space-time enables us to derive analytically the wave equation of the elementary particle which determines the wave mass transfer.

We examine the movement of mass as the movement of the gravitational diagram (Fig. 3.11) when the spherical symmetric distribution of the quantum density of the medium which determines the mass of the elementary particle is transferred in the quantised medium with speed v. We write the distribution function of the quantum density of the medium ρ_1 (3.77)

$$\rho_1 = \rho_0 \left(1 - \frac{\gamma_n R_g}{r} \right) \tag{3.136}$$

We examined the simplest case in which the particle moves in the quantised medium by inertia, and the variation of the quantum density of the medium is investigated in movement of the sphere with radius r:

$$r = \sqrt{x^2 + y^2 + z^2} \tag{3.137}$$

The transfer of the gravitational diagram along the X axis by the distance ∂x results in a change of the quantum density of the medium by the value $\partial \rho$ of the speed of movement of the electron $\mathbf{v}$ on the axis X

$$v = \frac{\partial x}{\partial t} \tag{3.138}$$

From equation (3.136) we determine the partial derivatives on the axis X at $y = 0$, $z = 0$ and $r = x$

$$\frac{\partial \rho}{\partial x} = \rho_0 \frac{R_S}{x^2} \gamma_n \tag{3.139}$$

In (3.139) we replace the increment ∂x by the equivalent increment $v \partial t = x$ from (3.138) and determine the partial derivative of (3.136) with respect to time t

$$\frac{\partial \rho}{\partial t} = v \cdot \rho_0 \frac{R_S}{x^2} \gamma_n \tag{3.140}$$

Substituting into (3.140) the value of the partial derivative on the X axis from (3.139), we obtain the wave equation of the electron during its movement in the quantised medium on the X axis

$$\frac{\partial \rho}{\partial t} = v \frac{\partial \rho}{\partial x} \tag{3.141}$$

The movement of the electron on the X axis is one-dimensional. However, the movement of the electron involves some volume of the space, with wave processes taking place also on the axes Y and Z. Taking into account the spherical symmetry of the electron, the speed of propagation of the wave transfer of the quantised medium along the axes X and Z, responsible for the formation of a gravitational well of the electron, is also equal to the speed of movement of the electron v. Consequently, we can write the three-dimensional wave equation of the electron in the partial derivatives with respect to the unit vectors **i**, **j**, **k**

$$\frac{\partial \rho}{\partial t} = \mathbf{v} \left(\frac{\partial \rho}{\partial x} \mathbf{i} + \frac{\partial \rho}{\partial y} \mathbf{j} + \frac{\partial \rho}{\partial z} \mathbf{k} \right) \tag{3.142}$$

Equation (3.142) includes the speed v of the particle in any arbitrary direction, ensuring the spherical symmetry of the gravitational field of the moving particle which theoretically spreads to infinity. The transfer of the gravitational field of the particle is the wave transfer of mass by a single wave of the soliton type in the form of a small ball, consisting of a large number of spheres inserted onto each other. The leading front of the gravitational field of the particles approchaes the elastic quantised medium and causes wave perturbation in the medium, and the trailing edge appears be travelling down from the medium, restoring its initial parameters of the non-perturbed field. This is a resonance exchange process which provides for the energy balance (3.112) in uniform movement.

Increasing the order of the derivatives in (3.141), we obtain the wave equation of the second of the particle in partial derivatives

$$\frac{\partial^2 \rho}{\partial t^2} = v^2 \left(\frac{\partial^2 \rho}{\partial x^2} + \frac{\partial^2 \rho}{\partial y^2} + \frac{\partial^2 \rho}{\partial z^2} \right) \tag{3.143}$$

Since the quantum density of the medium is an analogue of its gravitational potential of action C^2, the wave equations (3.142) and (3.143) can be expressed by means of the gravitational potential

$$\frac{\partial C^2}{\partial t} = v\left(\frac{\partial C^2}{\partial x}\mathbf{i} + \frac{\partial C^2}{\partial y}\mathbf{j} + \frac{\partial C^2}{\partial z}\mathbf{k}\right) \quad (3.144)$$

$$\frac{\partial^2 C^2}{\partial t^2} = v^2\left(\frac{\partial^2 C^2}{\partial x^2} + \frac{\partial^2 C^2}{\partial y^2} + \frac{\partial^2 C^2}{\partial z^2}\right) \quad (3.145)$$

For a single wave moving uniformly and in a straight line in relation to the particle without radiation, the solution of the equations (3.142)...(3.145) determines the spherically symmetric distribution of the quantum density of the medium (ρ_1 and ρ_2) (3.77) and gravitational potentials (φ_1 and φ_2) (3.78).

The movement of the particle, described by the wave equations, shows that complicated wave processes take place inside the quantised medium. These processes are associated with the redistribution of the quantum density of the medium in space. The wave equations can be transformed into the motion equations (3.138).

It should be mentioned that in contrast to the wave equations of the electromagnetic field [1], the wave equations of the particle (solid) are characterised by the longitudinal deformation of the quantised medium, and not by the transverse displacement of the charges in the quantons and in the electromagnetic wave. The wave mass transfer, as a typical example of the gravitational wave with the longitudinal deformation of the quantised medium, is encountered in everyday life. For this reason, the many attempts to detect gravitational waves with transverse oscillations have not yet been and obviously will not be successful [47].

Free gravitational waves, not associated with the movement of the quantised medium of the particles, should be described by the previously mentioned longitudinal wave equations (3.142)...(3.145). A distinguishing feature of the free electromagnetic wave is that its speed of propagation is equal to the speed of light C_0 instead of v, for example

$$\frac{\partial^2 \rho}{\partial t^2} = C_0^2\left(\frac{\partial^2 \rho}{\partial x^2} + \frac{\partial^2 \rho}{\partial y^2} + \frac{\partial^2 \rho}{\partial z^2}\right) \quad (3.146)$$

The wave equation (3.146) of the free gravitational wave in the elastic quantised medium is similar to the equation of the ultrasound wave which is also the longitudinal equation. The wave propagates in the form of the zones of longitudinal compression and rarefraction of the quantised medium. Evidently, Prof. A. Veinik was one of the first investigators who discovered similar waves [12]. It is possible that Veinik's discovery intersects with Kozyrev waves [46]. It is shown in the theory of Superunification that the topologies of the electromagnetic and gravitational waves are completely different. The topology of the cosmic quantised space-time is associated with its distortion. Consequently, it may be assumed that in the distorted space-time, the light beam and the beam of the gravitational wave travel along different curved trajectories, generating the Kozyrev effect in splitting of a single radiation star source [46].

Figure 3.18 shows the possible distortion of light beams and of the gravitational wave which enable the observer 3 to observe the same star 1 in different coordinates (1 and 2) of the stellar sky. Investigation of the theory of longitudinal gravitational waves in the elastic quantised medium resulted in new methods of investigation and reception [15] which may be used in various areas: from communication technologies to medicine. Taking into account the possible colossal penetration capacity of the gravitational waves, it is hoped that it would be possible to construct completely new diagnostic systems which should be far safer than x-ray radiation. However, this requires extensive and detailed investigations.

3.8. Time problems. Chronal waves

The theory of quantum gravitation (TQG) cannot be examined separately from time whose carrier is the quanton, defining the course of time with a period of $2.5{\cdot}10^{-34}$ s (3.8) in the quantised space-time. In this respect, the quanton is a unique and universal particle combining electromagnetism and gravitation, space and time. The TQG and Superunification theory describes for the first time the material time carrier, the actual 'electronic clock', defining the course of time at every point of the quantised space-time. The

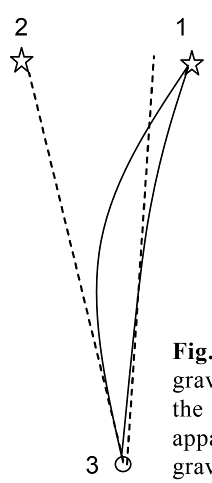

Fig. 3.18. Kozyrev effect of splitting the stellar light source and the gravitational wave as a result of different distortion of the light beam in the beam of the gravitational wave. 1) actual position of the stars; 2) apparent position of the star as a result of distortion of the beam of the gravitational wave; 3) observer.

concentration of the time carriers in the volume of the space is determined by the quantum density of the medium ρ_0 (3.6) for the quantised space-time non-perturbed by gravitation:

$$\rho_0 = \frac{k_3}{L_{q0}^3} = 3.55 \cdot 10^{75} \frac{\text{quantons}}{\text{m}^3} \tag{3.147}$$

The period T_{q0} (2.8) of the electromagnetic oscillation of the quinton is determined by speed C_0 of the electromagnetic wave [1]:

$$T_{q0} = \frac{L_{q0}}{C_0} = \frac{1}{C_0}\left(\frac{k_3}{\rho_0}\right)^{\frac{1}{3}} \approx 2.5 \cdot 10^{-34}\,\text{s} \tag{3.148}$$

In the case of the gravitational perturbation of the quantised space-time, the course of time T_{q1} and T_{q2} is determined by the changed quantum density of the medium ρ_1 and ρ_2 (3.77):

$$T_{q1} = \frac{1}{C}\left(\frac{k_3}{\rho_1}\right)^{\frac{1}{3}} \tag{3.149}$$

$$T_{q2} = \frac{1}{C_2}\left(\frac{k_3}{\rho_2}\right)^{\frac{1}{3}} \tag{3.150}$$

The equations (3.149) and (3.150) determine the course of time in the external region (3.149) in relation to the gravitational boundary and inside the region (3.150) in the presence of a perturbing gravitational mass (Fig. 3.11). Substituting into (3.149) the speed of light C (3.84) and the quantum density of the medium ρ_1, we obtain the course of time in the external region in relation to the gravitational boundary in the entire range of speeds from 0 to C_0 of the perturbing mass. Similarly, we transform (3.150) [11]:

$$T_{q1} = T_{q0}\left(1 - \frac{\gamma_n R_g}{r}\right)^{-\frac{5}{6}} \tag{3.151}$$

$$T_{q1} = T_{q0}\left(1 + \frac{\gamma_n R_g}{r}\right)^{-\frac{5}{6}} \tag{3.152}$$

Analysis of (3.151) shows that with the increase of gravity and the speed of movement of the perturbing mass, period T_{q1} (3.151) in the vicinity of the mass increases. This is equivalent to slowing down the course of time.

Within the same gravitational boundary, the passage of time (3.152) is accelerating. Naturally, the passage of time in space is given by the elastic properties of the space-time quantum (quanton) as a volume resonator having the role of a specific 'electronic clock'. With the increase of the speed of the solid and the decrease of the quantum density of the medium on its surface the elastic properties of the medium decrease and, correspondingly, the passage of time in the vicinity of the solid slows down.

Finally, it is interesting to examine the movement of the biological clock of a cosmonaut travelling in a spaceship at the speed close to the speed of light. Einstein treated this problem as a Gemini paradox where the slowing down of time at high speeds causes that one of the gemini, who returned from a space flight, finds his brother to be an old man whereas he has remained young. In fact, this problem is not so simple, and the Gemini paradox is only an original Einstein concept in order to attract the attention of society to the theory of relativity in popularisation of this theory.

Taking into account the behaviour of matter in the quantised medium at high speeds close to the speed of light, it may be predicted that the cosmonaut inside a spaceship will be simply squashed by the force of gravity of his own body and even his matter may transform to the state of a dynamic black microhole. However, even at lower speeds, the passage of time inside the shell of elementary particles forming the body of the cosmonaut increases because the quantum density of the medium increases. The speed of time decreases in the external region outside the shell (gravitation boundary) of the particles inside the body of the astronaut. If it is assumed that the cosmonaut is not squashed by the force of gravity, then it is difficult to forecast at the moment how his space travel will be reflected in ageing of the organism. However, even if one travels at a speed equal to half the speed of light, and this is a very high speed of the order of 150 000 km/s, the increase of the force of gravity and the change of the passage of time will be small and the cosmonaut will not notice them. For the cosmonaut, it is more difficult to withstand overloading and weightless state. However, in movement with constant acceleration equal to the freefall acceleration on the Earth's surface, it is possible to solve the problem of weightlessness [17].

The equation (3.151) shows that the passage of time in the quantised medium perturbed by gravitation is distributed nonuniformly and has the form of a scalar field which may be referred to as a chronal field. In fact, the chronal field is described by the Poisson equation for the passage of time with the solutions of the equation represented by the equations (3.151) and (3.152).

If we are discussing the quanton as the carrier of the chronal field, the quanton only defines the speed of time but does not act as an integrator like a clock. The quanton only defines the rate of electromagnetic processes to which all the known physical processes are reduced. When discussing the clock, we are discussing the summation of time periods. Being part of the quantised space-time, we move in it constantly as a result of the wave transfer of mass and take part in the colossal number of energy exchange processes with a great number of quantons. Therefore, all the physical processes may be regarded as irreversible. It is not possible to enter the same river twice. The arrow of time is directed only to the future.

The biological ageing of the organism with time is also associated with irreversible processes, regardless of the fact that up to now the genes of the old age and death have not been found and, evidently, will never be found, because death is caused by the external disruption of the genetic apparatus, responsible for the reproduction of cells during splitting. The telomerise ageing mechanism, discovered by Russian scientists Olovnikov has only confirmed this. Somebody invisible breaks the ends of the chromosomes, responsible for splitting of the cells. The cells stop splitting and die. For this reason, during the lifetime, the cell splits on average 50-100 times and the person then dies. It may be claimed with confidence that the failure of the genetic apparatus is caused by cosmic radiation, including neutrino, whose speed, concentration and direction distribution we do not know.

If we do not solve the problem of the effective protection of the genetic apparatus, as an open quantum mechanical system, against the entire range of cosmic radiation, all the people will be doomed to die. We constantly live in the region of cosmic radiation, a unique slow 'Chernobyl' which gradually disrupts our organism. The exponential dependence of failure of the organism confirms this concept. It is necessary to develop the maximum effort here and utilise the achievements of physics in biophysics to ensure that the mankind is grateful to scientists. This will be the penance for the development of atomic and thermonuclear weapons.

3.9. Antigravitation. Accelerated recession of galaxies

Antigravitation is the opposite of gravitation. If the gravitational effect leads to the mutual attraction of the solids which rolled into a gravitational well (Fig. 3.15), the effect of antigravitation is directed to mutual repulsion of solids and particles. The effect of gravitation is linked with the plus mass (or plus density of matter) which is included in the solutions (3.77) and (3.78) of the Poisson equation (3.79) and (3.80). Antigravitation is associated with the formation of the minus mass ($-m$) in the elastic quantised medium.

The effect of this mass changes the sign in the solutions (3.77) and (3.78) of the opposite sign:

$$\begin{cases} \rho_1 = \rho_0 \left(1 + \dfrac{\gamma_n R_g}{r}\right) \text{ at } r \geq R_S \\ \rho_2 = \rho_0 \left(1 - \dfrac{\gamma_n R_g}{R_S}\right) \end{cases} \quad (3.153)$$

$$\begin{cases} \varphi_1 = C^2 = C_0^2 \left(1 + \dfrac{\gamma_n R_g}{r}\right) \text{ at } r \geq R_S \\ \varphi_2 = C_0^2 \left(1 - \dfrac{\gamma_n R_g}{R_S}\right) \end{cases} \quad (3.154)$$

Figure 3.19 shows the gravitational diagram of the minus mass of the distribution of the quantum density of the medium (3.153) and gravitational potentials (3.154) [12, 15, 16]. The gravitational diagram of the minus mass differs greatly from the gravitational diagram of the plus mass (Fig. 2.11) by the fact that the quantum density of the medium inside the gravitational boundary R_S in the case of the plus mass increases as a result of its spherical compression and in the case of the minus mass the quantum density inside the gravitational boundary decreases because of its stretching. This is possible if the external tensioning of the quantised medium is greater than the tensioning of the gravitational boundary. Evidently, the state of the particles (solids) is highly unstable. This is confirmed by the actual absence of a large number of particles with the minus mass.

The presence of the minus mass does not yet mean explicitly that the particle belongs to antimatter. For example, the electron and the positron have the plus mass, although the positron is an antiparticle in relation to the electron. However, this is a very large problem, which is outside the framework of this chapter.

The presence of the minus mass is used as an indication of antigravitational interactions in which the particles (solids) have the property of antigravitational repulsion, in contrast to gravitational attraction. However, it should be mentioned immediately that the direction of the force is not determined by the presence of the mass or minus mass but by the direction of the deformation vector **D** (3.90) of the quantised medium which is always directed in the region its extension:

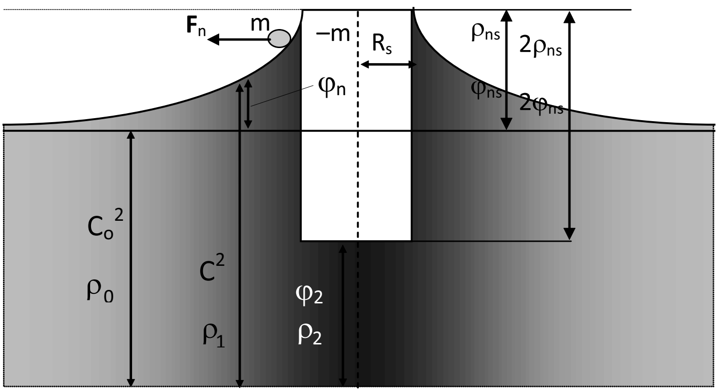

Fig. 3.19. Gravitational diagram of the minus mass and the effect of antigravitation repulsion (rolling from a hillock).

$$\mathbf{F}_n = \frac{C_0^2}{\rho_0} \mathrm{m}\cdot\mathrm{grad}(\rho_1) = \frac{C_0^2}{\rho_0} m\mathbf{D} \tag{3.155}$$

For the plus mass (Fig. 3.15), force $\mathbf{F}_n$, like the vector **D** acting on the test mass *m* are directed to the bottom of the gravitational hole in the region of reduction of the quantum density of the medium.

The minus mass forms a gravitational hillock (Fig. 3.19). Vector **D** and also force $\mathbf{F}_n$ are directed to the region of reduction of the quantum density of the medium, i.e., in the direction opposite of the perturbing minus mass. It appears that the test mass *m* tends to roll down from the gravitational hillock, showing the properties of antigravitational repulsion.

It should be mentioned that the minus mass cannot always show the antigravitational properties. If the perturbing mass *M* forms a gravitational well, and the minus mass $[-m] \ll M$, the gravitational well is capable of pulling in the minus mass.

We encounter the phenomenon of gravitational repulsion in everydays life. For example, orbital electrons do not fall on the atom nucleus because of the presence on the surface of nucleons of the gravitational interface which has the form of a steep gravitational hillock (Fig. 3.11). The electron finds it very difficult to overcome the hillock. In fact, the interface with radius R_S is a potential gravitational barrier which can be overcome only in the presence of a tunnelling effect which is characteristic of the alternating shell of the nucleon. Electron capture is possible only in this case [14]. In other cases, the effect of antigravitational repulsion does not allow the electron to fall on the atomic nucleus. In this case, the antigravitation phenomenon is not linked with the minus mass and is determined only by the direction of the deformation vector **D** which is always directed into the region of reduction of the quantum density of the medium.

This example shows convincingly that antigravitation is also widely encountered in nature, like gravitation. This knowledge results in new fundamental discoveries. We can mention examples of the presence of an electron of the zones of antigravitational repulsion which have a significant effect in the interaction of the electron with other particles at shorter distances. The same zones are found, as already mentioned, in the alternating shells of the nucleons, generating repulsive forces at short distances, which balance the nuclear forces, not allowing the nucleons to merge into a single atomic nucleus and disappear in it [14]. At shorter distances, the effect of antigravitation is comparable with the effect of electrical forces because it is determined by the deformation vector **D** on a very steep gravitational hillock (Fig. 3.11) and not by interacting masses.

To complete this section, it is necessary to mention an example of global antigravitation repulsion on the scale of the universe which is experimentally detected as the effect of accelerated recessions of the galaxies [47]. It has been suggested in astrophysics that this effect can be explained only by the effect of antigravitation, but it is erroneously assumed that the centre of the universe contains a large quantity of hidden minus mass. As already mentioned, the effect of antigravitation should not be linked unavoidably with the presence of the minus mass, and it is sufficient to form the direction of the deformation vector **D** as a result of the redistribution of the quantum density of the medium.

This model of the universe with the cyclic redistribution of the quantum density of the medium whose gradient determines the direction of the deformation vector and forces in the region with a lower quantum density of the medium, was proposed as early as in 1996 [5, 6]. Figure 3.20a shows the model of a closed universe in the form of a spherical shell of a specific thickness filled with an elastic quantised medium. Inside and outside there is emptiness (or something we know nothing about). This shell has the form of a volume resonator with the oscillations of the quantum density of the medium which is cyclically distributed from the internal interface to the periphery, and vice versa. The distribution of the quantum density of the medium inside the shell in the region A at some specific moment of the oscillation period is shown in Fig. 3.20b. It may be seen that the gradient of the quantum density of the medium which determines the direction of the effect of the vector **D** and forces **F** is directed to the periphery and prevents accelerated recession of the galaxies.

In all likelihood, the period of natural oscillations of the universe, linked

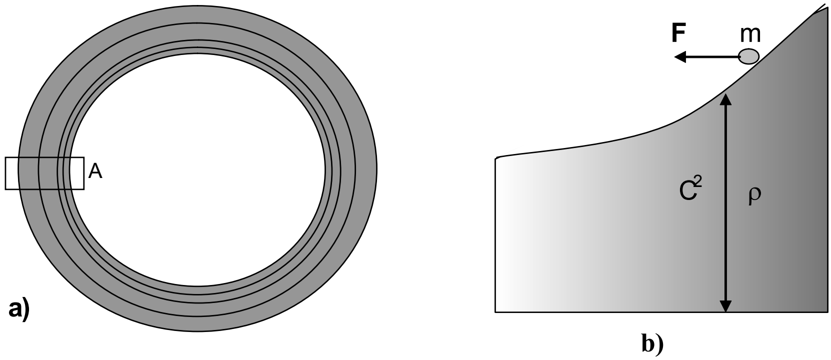

Fig. 3.20. The shell model of the closed universe (a) with the gradient of the quantum density of the medium and antigravitational repulsion of galactics (b).

with the cyclic redistribution of quantum density of the medium in the thickness of the shell, can be expressed in tens of billions of years. It may be predicted that after one billion years, the redistribution of the quantum density of the medium in the shell of the universe changes to the opposite. In this case, the galaxies start to move in accelerated fashion to the internal interface of the universe. I do not present here the results of calculations of the cyclic oscillations of the quantum density of the medium in the shell model of the universe because this is the area of work of professional astrophysicists, like the investigations of black holes (Fig. 3.12).

3.10. Dimensions of the space-time quantum (quanton)

Up to now, in studying the properties of the vacuum field, the dimensions of the space quantum (quanton) were assumed to be of the order of 10^{-25} m, which is ten orders of magnitude smaller than the classic radius of the electron. Naturally, experimental measurements of the dimensions of such a small magnitude are not yet possible because of the fact that no methods and devices are available. It is at present difficult to predict the construction of supersensitive measuring equipment in the range of measurement of the linear dimensions in the microworld on the level of the dimensions of 10^{-25} m. If this becomes possible, it will be based on the new principles, resulting from the Superunification theory.

Evidently, a promising direction in the area of investigation of the small dimensions of the order of 10^{-25} m is the application of torsional fields in the quantised space-time. If it is possible to produce oscillations of this type in vacuum, then in focusing of radiation it may be possible to reach the level of interaction of the dimensions of the quanton. The possibilities of electron microscopy are limited by the size of the electron. New methods of quantum microscopy will be limited by the dimension of the quanton but, in any case, the resulting power of quantum microscopy with respect to linear dimensions will be tens of orders of magnitude greater than the power of electron microscopy.

At the moment, we determine the dimensions of the quanton by analytical calculations in the Superunification theory. For this purpose, it is necessary to perturb the quantised space-time and analyse the response reaction to the external perturbation. In particular, the capacity of the quantised space-time for spherical deformation enables us to derive equations linking together the parameters of deformation of the quantised space-time and the energy of the elementary particle. On the other hand, deformation of the quantised space-time is determined by the energy of a great number of quantons in its deformed local region. Linking the parameters of the perturbing particle with the parameters of the quanton in the deformed region of space, we can determine the calculation dimensions of the quantons.

Therefore, the particle perturbing the vacuum field is represented by the electrically neutral neutron with a shell structure with a distinctive gravitational interface (chapter 5). The gravitational diagram of the neutron is shown in Fig. 3.11. The diagram makes it possible to analyse the processes of spherical deformation of the quantised space-time on the plane, determining the distribution of the quantum density of the medium (or gravitational potentials) on the basis of the solution of the Poisson equation for the gravitational field of the particle.

The method of calculating the dimensions of the quanton is based on the distinctive relationship of the diameter L_{q0} of the quantum with the quantum density of the medium ρ_0 of the non-perturbed quantised space-time:

$$\rho_0 = \frac{k_3}{L_{q0}^3} = \frac{1.44}{L_{q0}^3}\frac{\text{quantons}}{\text{m}^3} \tag{3.156}$$

The filling coefficient $k_f = 1.44$ takes into account the increase of the density of filling of the volume with the spherical particles represented by the shape of the quanton. The value of the filling coefficient is determined by analytical calculations.

From equation (3.156) we determine the quanton diameter

$$L_{q0} = \sqrt[3]{\frac{k_3}{\rho_0}} \tag{3.157}$$

Thus, in order to determine the dimension of the quanton (3.157), it is necessary to know the quantum density ρ_0 of the medium of the non-perturbed vacuum field. It is not possible to measure directly or determine the quantum density of the non-perturbed quantised space-time. Therefore, the quantised space-time must be perturbed by the neutron whose gravitational diagram correspond to Fig. 3.11 and we must use the previously derived the equation for the quantum density ρ_2 of the medium inside the particle defined by the gravitational spherical interface with radius R_S (3.42)

$$\rho_2 = \rho_0 \left(1 + \frac{R_g}{R_s} \right) \tag{3.158}$$

Physical processes preceding the formation of the gravitational diagram (Fig. 3.11) can be regarded as two separate cases equivalent to each other. The first case characterises the compression of the quantised space-time by the gravitational interface to the state determined by equation (3.158). In the second case, the increase of the quantum density of the medium (3.158) inside the gravitational interface can be regarded as the transfer of the quantons from the external region of space to the internal region. A gravitational well forms on the external side, and the quantum density of the medium inside the particle increases by the value $\Delta\rho_2$ in comparison with the non-perturbed quantised space-time:

$$\Delta\rho_2 = \rho_2 - \rho_0 = \rho_0 \frac{R_g}{R_s} \tag{3.159}$$

In Fig. 3.11, the increase of quantum density $\Delta\rho_2$ of the medium is indicated by the darkened area. The energy of spherical deformation W_0 of the quantised space-time in the formation of the neutron mass is determined on the basis of the equivalence of mass and energy (3.56)

$$W_0 = \int_0^{C_0^2} m_0 d\varphi = m_0 C_0^2 \tag{3.160}$$

On the other hand, the energy of spherical deformation W_0 (3.56) can be be determined by the work for transferring the quantons from the external region through the gravitational interface into the internal region of the particle. This is determined by the energy conservation law. Further, it is necessary to determine the number of quantons Δn_2 transferred into the internal region of the particle. This can be determined quite easily knowing the volume of the neutron V_n in the present case, and the change of the quantum density of the medium in the internal region of the particle $\Delta\rho_2$ (3.39), (3.40):

$$\Delta n_2 = V_n \Delta\rho_2 = V_n \rho_0 \frac{R_g}{R_s} \tag{3.161}$$

The volume of the particle V_n is determined by the volume of its internal region, restricted by the radius R_S

$$V_n = \frac{4}{3}\pi R_s^3 \tag{3.162}$$

Taking into account (3.162), from (3.161) we determine the excess Δn_2 of quantons in the internal region of the particle:

$$\Delta n_2 = \frac{4}{3}\pi R_s^3 \Delta\rho_2 = \frac{4}{3}\pi R_s^2 R_g \rho_0 \tag{3.163}$$

The total number of the quantons n_2, situated in the internal region of the particle, is determined by the quantum density of the medium ρ_2 (3.158)

$$n_2 = \frac{4}{3}\pi R_s^3 \rho_2 = \frac{4}{3}\pi R_s^3 \rho_0 \left(1 + \frac{R_g}{R_s}\right) \tag{3.164}$$

Knowing the number of excess quantons Δn_2 (3.163), transferred into the internal region of the particle, and the deformation energy $W_0 = m_0 C_0^2$ (3.160) of the quantised space-time, we determine the work W_q of the transfer of a single quanton from the external region of the quantised space-time to the internal region of the particle:

$$W_q = \frac{W_0}{\Delta n_2} = \frac{3 m_0 C_0^2}{4\pi R_s^2 R_g \rho_0} \tag{3.165}$$

Equation (3.165) can be simplified by expressing the gravitational radius R_g by its value (3.62)

$$W_q = \frac{W_0}{\Delta n_2} = \frac{3 C_0^4}{4\pi R_s^2 G \rho_0} \tag{3.166}$$

From equation (3.166) we remove the rest mass of the particle, although its limiting energy W_{max} does not appear there (3.73)

$$W_{max} = \frac{C_0^4}{G} R_S \tag{3.167}$$

$$W_q = \frac{W_0}{\Delta n_2} = \frac{3}{4\pi R_s^3 \rho_0} \frac{C_0^4}{G} R_s \tag{3.168}$$

Thus, the work W_g for the transfer of a single quanton from the external region of the quantised space-time to the internal region of the particle is determined by the equations (3.165), (3.166), (3.160) and, on the other hand, it characterises the work of exit of the quanton from the non-perturbed quantised space-time.

Undoubtedly, the determination of the work of exit of the quantum is a relatively complicated mathematical task, and the conditions of the task include the interaction of the monopoles inside the quanton with the entire set of the electrical and magnetic charges of other quantons in the local region of the deformed space. Therefore, it is proposed to use a simpler method which takes into account electromagnetic symmetry of the non-perturbed quantised space-time. For this purpose, we use the equation (3.168) according to which the work of exit of the quanton can be determined on the basis of the limiting energy of the particle $W_{\max}$ (3.167) and the number of quantons n_0 in the non-deformed region of space in the volume of the gravitational interface R_S is

$$W_q = \frac{W_{\max}}{n_0} = \frac{3}{4\pi R_s^3 \rho_0} \frac{C_0^4}{G} R_s \qquad (3.169)$$

where

$$n_0 = \frac{4}{3}\pi R_s^3 \rho_0 \qquad (3.170)$$

In particular, the electromagnetic symmetry of the quantised space-time determines the equivalence of the energy of exit of the quanton with its internal electromagnetic energy (2.12), (2.70) on the condition $L_{q0} = 2_{e0} = 2r_{g0}$

$$W_q = \frac{1}{2\pi\varepsilon_0} \frac{e^2}{L_{q0}} + \frac{\mu_0}{2\pi} \frac{g^2}{L_{q0}} = \frac{1}{\pi\varepsilon_0} \frac{e^2}{L_{q0}} \qquad (3.171)$$

Finally, equation (3.171) contains only the electrical parameters of the quanton which simplifies further calculations. The equivalence of the energy of exit of the quanton (3.166) to its internal electromagnetic energy (4.171) determines the continuity of the quantised space-time at the continuity of the quanton itself so that we can modify the equations (3.166) and (4.171)

$$W_q = \frac{3C_0^4}{4\pi R_s^2 G \rho_0} = \frac{1}{\pi\varepsilon_0} \frac{e^2}{L_{q0}} \qquad (3.172)$$

From equality (3.172) we determine the required quantum density ρ_0 of the non-perturbed quantised space-time

$$\rho_0 = \frac{3\varepsilon_0 C_0^4 L_{q0}}{4e^2 R_s^2 G} \qquad (3.173)$$

Substituting (3.173) into (3 .157) for the determination of the dimensions of the space quantum, we determine the required equality

$$L_{q0} = \sqrt[3]{\frac{k_3}{\rho_0}} = \sqrt[3]{\frac{4k_3 e^2 R_s^2 G}{3C_0^4 \varepsilon_0 L_q}} \qquad (3.174)$$

Further, raising the left and right parts of the equations (3.174) to the cube and solving the equation with respect to the dimension of the quanton L_{q0}

$$L_{q0}^4 = \frac{4}{3} k_3 \frac{1}{C_0^4} e^2 R_s^2 \frac{G}{\varepsilon_0} \qquad (3.175)$$

From (3.175) we finally determine the diameter of the quanton L_{q0}

$$L_{q0} = \frac{1}{C_0}\left(\frac{4}{3}k_3\right)^{\frac{1}{4}}\left(\frac{G}{\varepsilon_0}\right)^{\frac{1}{4}}(eR_s)^{\frac{1}{2}} \qquad (3.176)$$

Equation (3.176) determines the diameter of the quanton for the non-perturbed quantised space-time which is a constant. It may be seen that all the parameters included in (3.176) are constants, with the exception of the radius of the gravitational interface R_S of the neutron. This means that the radius of the gravitational interface of the neutron is also a constant. The existing experimental procedures enable us to determine the root mean square radii of the proton and the neutron on the level of 0.81 F = $0.81 \cdot 10^{-15}$ m

$$R_s = (0.814 \pm 0.015)F \approx 0.81 \cdot 10^{-15}\,\text{m} \qquad (3.177)$$

Substituting (3.177) into (3.176) we obtain the numerical value of the diameter of the quanton (the space-time quantum)

$$L_{q0} = \frac{1}{C_0}\left(\frac{4}{3}k_3\right)^{\frac{1}{4}}\left(\frac{G}{\varepsilon_0}\right)^{\frac{1}{4}}(eR_s)^{\frac{1}{2}} =$$
$$= \frac{1}{3\cdot 10^8}\left(\frac{4}{3}1.44\right)^{\frac{1}{4}}\left(\frac{6.67\cdot 10^{-11}}{8.85\cdot 10^{-12}}\right)^{\frac{1}{4}} \times \qquad (3.178)$$
$$\times\left(1.6\cdot 10^{-19}\cdot 0.81\cdot 10^{-15}\right)^{\frac{1}{2}} = 0.74\cdot 10^{-25}\,\text{m}$$

Regardless of the fact that the method of calculating the quanton diameter is based on the perturbation of the quantised space-time by the neutron, the resultant equation (3.170) holds for the quanton situated in the non-perturbed vacuum. This assumption is correct because the actual deformation of the quanton by the neutron is negligible in comparison with the quanton dimensions. This may be confirmed by substituting the neutron parameters into (3.18). In (2.7) and in further sections, the final equation for the quanton diameter in the state unperturbed by gravitation is written in the following form

$$L_{q0} = \left(\frac{4}{3}k_3\frac{G}{\varepsilon_0}\right)^{\frac{1}{4}}\frac{\sqrt{eR_s}}{C_0} = 0.74\cdot 10^{-25}\,\text{m} \qquad (3.179)$$

Thus, the dimensions of the quanton are determined by the linear length of the order of 10^{-25} m. It may be accepted that the length of 10^{-25} m is the fundamental length for our universe, determining the discreteness of the quantised space-time. This does not mean that in nature there are no dimensions smaller than the fundamental length. In comparison with the fundamental length of 10^{-25} m which determines the quanton dimensions, electrical and magnetic charges, including the structure of the monopoles, can be regarded as point formations with the size of the order of Planck length of 10^{-35} m. The actual displacements of the charges inside the quanton, as shown in chapter 2, are considerably smaller than the Planck length.

From (3.179) we determine the quantum density of the non-deformed quantised space-time

$$\rho_0 = \frac{k_3}{L_q^3} = \frac{1.44}{L_q^3} = 3.55\cdot 10^{75}\,\frac{\text{quantons}}{\text{m}^3} \qquad (3.180)$$

Equation (3.180) shows that the quantum, together with the four electrical and magnetic quarks, is the most widely encountered particle in the universe and determines the structure of weightless quantised space-time, a medium with the unique properties.

10. Conclusions for chapter 3

The unification of electromagnetism and gravitation was regarded as a fact. It has been established that gravitation is of the electromagnetic nature whose carrier is the superstrong electromagnetic interaction (SEI).

Gravitation appears in the quantised space-time as a result of its spherical deformation in the formation of the mass of elementary particles.

Correct two-component solutions of the Poisson gravitational equation in the form of a system have been determined for the first time. The functions of distribution of the quantum density of the medium and gravitational potentials inside the particle (solid) in the external region of the spherically deformed quantised space-time have been determined.

It is shown that these spherical functions remain invariant in the entire range of speeds, including the speed of light, and formulate principle of spherical invariance and relative-absolute dualism.

The principal relativity is the fundamental property of the quantised space-time.

Gravity is caused by the gradient of the quantum density of the medium and by its deformation vector with the gravity and inertia acting in the direction of this vector.

The force of inertia is also caused by the gradient of the quantum density of the medium and works in the direction of the deformation vector.

The gravitational field is quantised in its principle. The space-time quantum (quanton), as a carrier of the gravitational field, is used as a basis for developing the quantum theory of gravitation.

The discovery of the quanton has returned the deterministic base to the quantum theory which was supported by Einstein. The classic wave equation of the elementary particle determining the wave transfer of mass in the superhard and the superelastic quantised medium was analytically derived for the first time.

The wave transfer of mass determines the effect of the principle of corpuscular-wave dualism in which the particle shows both the properties of the wave and the corpuscule.

It has been established that the free gravitational wave with the speed of light and longitudinal oscillations of the quantised medium, generating the longitudinal the zones of compression and tension in the quantised medium, can exist in the quantised space-time.

The nature of gravitation, which explains the accelerated recession of the galaxies of our universe, has been determined.

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